VALUE-ADDED PRODUCTS FROM BEEKEEPING

Table of Contents

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Contents

FOREWORD

Contents - Previous - Next

Many of the beekeeping activities in developing countries in the past have been oriented towards honey production. Wax usually was a by-product and other possible products have rarely found consideration. Such neglect of other products has a variety of reasons among which an easily accessible market or the lack of knowledge about production and further use are of major importance. While production methods of other primary products can be adapted from common beekeeping texts, the further elaboration and use of the same products can rarely be found. If so, descriptions range from highly specific scientific results to self-proclaimed experts fraudulently exploiting consumer ignorance. In order to present a comprehensive and practical review this bulletin tries to synthesize available information from scientific literature and practical, technical literature including the few in-depth reviews available on some of the primary bee products such as honey, Wax and propolis.

Worldwide the usage of such primary products as propolis, royal jelly and bee venom have increased mostly due to inclusion in cosmetic preparations. Medicinal use will increase once better and more detailed studies are completed, which however may not yet be in the very near future. The use of honey and other products has also increased in many countries because of the increasing health awareness and the high esteem of bee products in various processed and unprocessed forms.

In past publications the Agricultural Services Bulletins on beekeeping have sought to increase technical knowledge of beekeeping itself. During the last decades, the level of beekeeping and production knowledge in many developing countries has increased considerably. It was therefore considered necessary to provide further information for the expansion of beekeeping activities in order to increase income generation and stability as well as access to healthier products. Thus, this volume is intended to provide information on the utilization of all primary beekeeping products and in this way improve the possibilities for diversification in beekeeping activities. The new perspective for additional income generating activities for beekeepers and non-beekeepers alike may, under the right circumstances, also increase beekeeping viability in an otherwise often marginal business environment.

Most of the described products can also be produced by non-beekeepers, thus indirectly benefitting beekeeping by increasing the market for primary beekeeping products and opening opportunities for small, often home-based business activities.

Many of the described products can be produced with traditional skills on a very small, home-based production level but also on a medium to large industrial scale and are adapt for a variety of cultural and economic environments. This is very important since primary beekeeping products and their value added, processed products will increasingly have to find local markets, since international prices are too often below local production costs and require quality standards not easily reached by a young, developing industry. Diversification with value-added products therefore offers an opportunity to strengthen local markets which then permit a more solid beekeeping production to expand from a broad base into exportation. In this sense it is hoped that the provided information not only increases

the viability and production of beekeeping and with it local living standards, but that it also can contribute to healthier products, import substitution and eventually increased incentives for regional and global trade.

Contents - **Previous** - **Next**

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Dedication:

This book is dedicated to those ever laborious, wonderfiil little companions, the honeybees, that their labour will be appreciated with love by all those producing, using and consuming their unique products.

CHAPTER 1
INTRODUCTION

Contents - Previous - Next

1.1 What are "value added" products from beekeeping?

The best known primary products of beekeeping are honey and wax, but pollen, propolis, royal jelly, venom, queens, bees and their larvae are also marketable primary bee products. While most of these products can be consumed or used in the state in which they were produced by the bees, there are many additional uses where these products form only a part of all the ingredients of another product. Because of the quality and sometimes almost mystical reputation and characteristics of most primary bee products, their addition to other products usually enhances the value or quality of these secondary products. For this reason, the secondary products, which partially, or wholly, can be made up of primary bee products, are referred to here as "value added" products from beekeeping.

Many of the primary beekeeping products do not have a market until they are added to more commonly used, value added products. Even the value of the primary products may increase if good use is made of them in other products, thereby increasing the profitability of many beekeeping operations.

In some cases the traditional and early technological uses of primary bee products have been replaced by other (often synthetic products) because of better availability, lower cost and/or easier processing. But in regard to food or health products, there are no synthetic substances which can substitute for the wide variety of characteristics of primary bee products. Only when it comes to highly specialized applications and conditions, will synthetics sometimes outperform these unique and versatile products. In that sense, all products containing one or several of the primary bee products are value added products. Furthermore, the combination of several bee products synergistically increases their beneficial significance beyond their individual biological values.

Since monetary resources are limited in many societies the additional value cannot always be obtained in the form of higher prices, but may show itself in the form of preferred purchases. For the same reasons though, some products may not be able to compete against cheaper synthetic products. In such cases, the added value and cost may make a product unsuitable, unless other markets can be found.

1.2 The purpose of this bulletin

The purpose of this bulletin is to distribute and make available information on the manufacturing, processing and marketing of value added bee products. It is directed at beekeepers as well as non-beekeepers, small entrepreneurs, extension officers and those involved in small business development. Therefore, it tries to provide enough information to understand the primary products and their present and potential use. It should also enable the reader to properly buy, store, process, package and market the primary products, as well as the value added products derived from them.

Traditionally, honey is considered the major beekeeping product. Wax has played a considerable role in only a few parts of the world and propolis is even less known. However, with increasing knowledge about beekeeping and an awareness of the beneficial aspects of many bee products, the use and demand for other products is increasing. The inclusion of "natural" bee products in cosmetics, medicines and foods has improved consumer appeal. While such appeal is not always based on scientific evidence, more and more studies confirm at least some of the traditionally claimed benefits of primary bee products.

This bulletin cannot be a scientific review of the rapidly increasing volume of research available, but it attempts to give a brief yet comprehensive overview of the current state of knowledge. Thus the reader should be able to make conclusions about the myriad of sometimes miraculous effects and cures claimed for bee products. References to more detailed articles, reviews and speciality journals are made to guide those whose interests go further.

It is also impossible in the context of this bulletin to give more than a summarized description of all the primary bee products. However, an attempt has been made to give enough information for the reader, including non-beekeepers, to understand the products and to be able to draw conclusions on their proper use.

Some of the value added products mentioned in this bulletin require advanced manufacturing technology. Many, if not most can be made on a small-scale but, like cosmetics, would benefit from better processing technology and specialized training for the manufacturers. The general philosophy behind this bulletin, however, is to stimulate creative experimentation with new and old products suitable for local markets and customer needs.

In addition to presenting the multitude of possible uses for bee products, it is hoped that the information provided can lead to more diversified and increased income for beekeepers. It should help to create small business opportunities for non-beekeepers and improve the health, nutrition and economic situation of beekeepers and those who are willing to choose alternatives to today's abundance of over-processed and/or synthetic drugs, cosmetics and foods.

Finally, the bulletin should stimulate beekeeping as a hobby and so may be a valuable source of recreation and relaxation.

1.3 How to use the bulletin

In the same way that two cooks, using the same recipe to produce different tasting dinners, the recipes and guidelines in this bulletin will produce different results in different places. Availability and quality of ingredients will vary from country to country, as will working conditions, customer preferences and marketing possibilities for the products. Therefore, the given recipes and recommendations have to be tried under local conditions. Recipes, ingredients, flavours, colours, consistencies, packaging and quality have to be adjusted to local markets. Where possible, alternatives and variations have been suggested.

The reader who is considering making beeswax candles or cosmetics should find enough information to decide whether he or she can physically, technically and economically afford to start the particular kind of production. Furthermore, he or she should be able to produce a variety of simple, good quality products with the information provided.

For most product categories there are more detailed and specialized publications available, which should be used to expand or improve a chosen activity. Since many of these books are expensive and in some countries difficult to obtain, as complete a picture as possible is presented in this bulletin. In addition, addresses of sources for books, laboratory tests, information and marketing assistance are given.

The goals of this bulletin therefore are to serve as a resource guide, a source of ideas and as a practical "cookbook" on products made with primary bee products.

Contents - **Previous** - **Next**

CHAPTER 2
HONEY 1

2.1 Introduction

Honey is the most important primary product of beekeeping both from a quantitative and an economic point of view. It was also the first bee product used by humankind in ancient times. The history of the use of honey is parallel to the history of man and in virtually every culture evidence can be found of its use as a food source and as a symbol employed in religious, magic and therapeutic ceremonies (Cartland, 1970; Crane, 1980; Zwaeneprel, 1984) an appreciation and reverence it owes among other reasons to its unique position until very recently, as the only concentrated form of sugar available to man in most parts of the world. The same cultural richness has produced an equally colourful variety of uses of honey in other products (see Figure 2.1).

"Honey is the natural sweet substance produced by honeybees from the nectar of blossoms or from the secretion of living parts of plants or excretions of plant sucking insects on the living parts of plants, which honeybees collect, transform and combine with specific substances of their own, store and leave in the honey comb to ripen and mature. This is the general definition of honey in the Codex Alimentarius (1989) in which all commercially required characteristics of the product are described. The interested reader is also referred to other texts such as "Honey, a comprehensive survey" (Crane, 1975).

Honey in this bulletin, will refer to the honey produced by Apis mellifera unless otherwise specified. There are other honeybee species which make honey, and other bees and even wasps which store different kinds of honeys as their food reserves. More details on honey from other bees are given in section 2.11.

2.2 Physical characteristics of honey

Viscosity

Freshly extracted honey is a viscous liquid. Its viscosity depends on a large variety of substances and therefore varies with its composition and particularly with its water content (Table 2.1 and 2.2). Viscosity is an important technical parameter during honey processing, because it reduces honey flow during extraction, pumping, settling, filtration, mixing and bottling. Raising the temperature of honey lowers its viscosity (Table 2.3) a phenomenon widely exploited during industrial honey processing. Some honeys, however, show different characteristics in regard to viscosity: Heather (Calluna vulgaris) Manuka (Leptospermum scoparium) and Carvia callosa are described as thixotrophic which means they are gel-like (extremely viscous) when standing still and turn liquid when agitated or stirred. By contrast a number of Eucalyptus honeys show the opposite characteristics. Their viscosity increases with agitation.

Figure 2.1: A display of various products in which honey is an ingredient.

Table 2.1:
Variation of the viscosity of honey at 25^{0}C, containing 16.5% water, according to the botanical origin and therefore the composition of the honey (Munro, 1943).

Type	Viscosity (poise)
Sage	115
White clover	94
Sweet clover	87

Table 2.2:
Variation of the viscosity of white clover honey at 250 C according to its water content (Munro, 1943).

Water content (%)	Viscosity (poise)
13.7	420
15.5	138
18.2	48
20.2	20

Table 2.3:
Viscosity of sweet clover honey containing 16.1% water according to temperature (Munro, 1943).

Temperature (°C)	Viscosity (poise)
13.7	600.0
20.6	189.6
29.0	68.4
39.4	21.4
48.1	10.7
71.1	2.6

Density

Another physical characteristic of practical importance is density. Honey density, expressed as specific gravity in Table 2.4, is greater than water density, but it also depends on the water content of the honey (Table 2.4). Because of the variation in density it is sometimes possible to observe distinct stratification of honey in large storage tanks. The high water content (less dense) honey settles above the denser, drier honey. Such inconvenient separation can be avoided by more thorough mixing.

Table 2.4:
True specific gravity of honeys with different water content (White, 1975a).

Water content (%)	Specific gravity at 20°C	Water content (%)	Specific gravity at 20°C	Water content (%)	Specific gravity at 20°C
13.0	1.4457	16.0	1.4295	19.0	1.4101
14.0	1.4404	17.0	1.4237	20.0	1.4027
15.0	1.4350	18.0	1.4171	21.0	1.3950

Hygroscopicity

The strongly hygroscopic character of honey is important both in processing and for final use. In end products containing honey this tendency to absorb and hold moisture is often a desired effect such as, for example, in pastry and bread. During processing or storage however, the same hygroscopicity can become problematic, causing difficulties in preservation and storage due to excessive water content. From Table *2.5* it can be readily seen that normal honey with a water content of 18.3 % or less will absorb moisture from the air at a relative humidity of above 60%.

Table 2.5
Approximate equilibrium between relative humidity (RH) of ambient air and water content of a clover honey (White, 1975a).

Air (%RH)	Honey (% water content)
50	15.9
55	16.8
60	18.3

65	20.9
70	24.2
75	28.3
80	33.1

Surface tension

It is the low surface tension of honey that makes it an excellent humectant in cosmetic products The surface tension varies with the origin of the honey and is probably due to colloidal substances. Together with high viscosity, it is responsible for the foaming characteristics of honey.

Thermal properties

For the design of honey processing plants its thermal properties have to be taken into account. The heat absorbing capacity, i.e. specific heat, varies from *0.56* to 0.73 cal/g/^{0}C according to its composition and state of crystallization. The thermal conductivity varies from 118 to 143 x 10-~ cal/cm^2/sec/^{0}C (White, 1975a). One can therefore calculate the amount of heat, cooling and mixing necessary to treat a certain amount of honey, i.e. before and after filtration or pasteurization. The relatively low heat conductivity, combined with high viscosity leads to rapid overheating from point-heat sources and thus the need for careful stirring and for heating only in water baths.

Colour

Colour in liquid honey varies from clear and colourless (like water) to dark amber or black (see Figure 2.2). The various honey colours are basically all nuances of yellow amber, like different dilutions or concentrations of caramelized sugar, which has been used traditionally as a colour standard. More modern methods for measuring honey colour are described below. Colour varies with botanical origin, age and storage conditions, but transparency or clarity depends on the amount of suspended particles such as pollen. Less common honey colours are bright yellow (sunflower) reddish undertones (chestnut) greyish (eucalyptus) and greenish (honeydew). Once crystallized, honey turns lighter in colour because the glucose crystals are white. Some of the honeys reportedly "as white as milk" in some parts of East Africa are finely crystallized honeys which are almost water white, i.e. colourless, in their liquid state.

The most important aspect of honey colour lies in its value for marketing and determination of its end use. Darker honeys are more often for industrial use, while lighter honeys are marketed for direct consumption. In many countries with a large honey market, consumer preferences are determined by the colour of honey (as an indication of a preferred flavour) and thus, next to general quality determinations, colour is the single most important factor determining import and wholesale prices.

Honey colour is frequently given in millimetres on a Pfund scale (an optical density reading generally used in international honey trade) or according to the U.S. Department of Agriculture classifications (White, 1975c and Crane, 1980):

USDA colour standards	**Pfund scale (mm)**
- water white	0 to 8
- extra white	> 8 to 17
- white	> 17 to 34
- extra light amber	> 34 to 50
- light amber	> 50 to 85
- amber	> 85 to 114
-darkamber	> 114

Figure 2.2: Different coloured honeys of unifloral and multifloral origin. (courtesy of F. Intoppa)

More recent but not widely practised methods of colour description use spectral colour absorption of honey (Aubert and Gonnet, 1983; Rodriguez L6pez, 1985).

Crystallization

Crystallization is another important characteristic for honey marketing, though not for price determination. In temperate climates most honeys crystallize at normal storage temperatures. This is due to the fact that honey is an oversaturated sugar solution, i.e. it contains more sugar than can remain in solution. Many consumers still think that if honey has crystallized it has gone bad or has been adulterated with sugar.

The crystallization results from the formation of monohydrate glucose crystals, which vary in number, shape, dimension and quality with the honey composition and storage conditions. The lower the water and the higher the glucose content of honey, the faster the crystallization. Temperature is important, since above 25 ˚ and below 5 ˚C virtually no crystallization occurs. Around 14°C is the optimum temperature for fast crystallization, but also the presence of solid particles (e.g. pollen grains) and slow stirring result in quicker crystallization (see 2.12.2). Usually, slow crystallization produces bigger and more irregular crystals.

During crystallization water is freed. Consequently, the water content of the liquid phase increases and with it the risk of fermentation. Thus, partially crystallized honey may present preservation problems, which is why controlled and complete crystallization is often induced deliberately. In addition, partially crystallized or reliquified honey is not an attractive presentation for retail shelves (see Figure 2.3).

a)

b)

Figure 2.3: Honeys in different stages of crystallization, (a) fermentation in partially crystallized honey and (b) different stages of reliquification after previous crystallization due to storage over very long periods of time or at relatively high

temperatures. These unattractive changes can be avoided by controlled crystallization, proper storage and possibly pasteurization. (courtesy of F. Intoppa)

2.3 The composition of honey

The average composition of American honeys, more or less representative of all honeys, is shown in Table 2.6. Table 2.7 lists the various components identified in honeys from all around the world.

Sugars account for 95 to 99% of honey dry matter. The majority of these are the simple sugars fructose and glucose which represent *85-95%* of total sugars. Generally, fructose is more abundant than glucose (see Table 2.6). This predominance of simple sugars and particularly the high percentage of fructose are responsible for most of the physical and nutritional characteristics of honey. Small quantities of other sugars are also present, such as disaccharides (sucrose, maltose and isomaltose) and a few trisaccharides and oligosaccharides. Though quantitatively of minor importance, their presence can provide information about adulteration and the botanical origin of the honey.

Water is quantitatively the second most important component of honey. Its content is critical, since it affects the storage of honey. Only honeys with less than 18% water can be stored with little to no risk of fermentation. The final water content depends on a number of environmental factors during production such as weather and humidity inside the hive, but also on nectar conditions and treatment of honey during extraction and storage. It can be reduced before or after extraction by special techniques (see 2.6.9).

Among the minor constituents **organic acids** are the most important and of these gluconic acid, which is a by-product of enzymatic digestion of glucose, predominates. The organic acids are responsible for the acidity of honey and contribute largely to its characteristic taste.

Minerals are present in very small quantities, potassium being the most abundant. Dark honeys, particularly honeydew honeys are the richest in minerals.

Other trace elements include **nitrogenous compounds** among which the enzymes originate from salivary secretions of the worker honeybees. They have an important role in the formation of the honey. Their commercial importance is not related to human nutrition, but to their fragility and uniqueness. Thus their reduction or absence in adulterated, overheated or excessively stored honeys serves as an indicator of freshness. The main enzymes in honey are invertase (saccharase) diastase (amylase) and glucose oxidase.

Traces of other proteins, enzymes or amino acids as well as water soluble vitamins are thought to result from pollen contamination in honey.

Virtually absent in newly produced honey, hydroxvmethylfurfural (HMF) is a byproduct of fructose decay, formed during storage or during heating. Thus, its presence is considered the main indicator of honey deterioration.

Even though some of the substances responsible for honey colour and flavour have been identified (see Table 2.7) the majority are still unknown. It is more than likely that honeys from different botanical origins contain different aromatic and other substances which contribute to the specific colours and flavours and thus allow to distinguish one honey from another. Similarly, it is very likely that, depending on their botanical origin, honeys contain traces of pharmacologically active substances. Some of them have been identified, such as those responsible for the toxicity of certain honeys (see also section 2.9), but for the majority of possible substances, scientific verification requires further studies.

Table 2.6
Average composition of U.S honeys and ranges of values (White, et al., 1962)

Component (% except pH and diastase valute)	Average	Standard deviation	Range

Water	<>17.2	1.5	13.4 - 22.9
Fructose	38.2	2.1	27.2 - 44.3
Glucose	31.3	3.0	22.0 - 40.7
Sucrose	1.3	0.9	0.2 - 7.6
Maltose (reducing disaccharides calculated as maltose)	7.3	2.1	2.7 - 16.0
Higher sugars	1.5	1.0	0.1 - 8.5
Free acids (as gluconic acid)	0.43	0.16	0.13 - 092
Lactone (as glucolactone)	0.14	0.07	0.0 - 0.37
Total acid (as gluconic acid)	0.57	0.20	0.17 - 1.17
Ash	0.169	0.15	0.020 - 1.028
Nitrogen	0.041	0.026	0.000 - 0.133
pH	3.91	-	3.42 - 6.10
Diastase value	20.8	9.8	2.1 - 61.2

2.4 The physiological effects of honey

2.4.1 Unconfirmed circumstantial evidence

For thousands of years honey was the only source of concentrated sugar. uniqueness, scarcity and desirability connected it to divinity very early in human history thus ascribing to it symbolic, magic and therapeutic significance. Much of the myth many of the traditional medicinal uses have continued until today.

Few of these medicinal benefits have seen scientific confirmation and they are not always exclusive to honey. The majority are due to the high sugar content and therefore can also be found in other sweet substances with high sugar contents. It was not by accident that sugar, when first introduced to Europe, was considered a medicine for many diseases and was used with caution.

The major properties and effects commonly attributed to honey (Donadieu, 1983) are briefly described below, but there are hundreds of different local uses in various countries, according to the specific cultures and traditions, and it is impossible to mention all of them. The Koran also mentions several uses for honey and other bee products (El Banby, 1987).

Nutritional benefits

Honey is said to facilitate better physical performance and resistance to fatigue, particularly for repeated effort; it also promotes higher mental efficiency. It is therefore used by both the healthy and the sick for any kind of weakness, particularly in the case of digestive or assimilative problems. Improved growth of non-breast fed newborn infants, improved calcium fixation in bones and curing anaemia and anorexia may all be attributed to some nutritional benefit or stimulation from eating honey.

Benefits to the digestive apparatus

Honey is said to improve food assimilation and to be useful for chronic and infective intestinal problems such as constipation,

duodenal ulcers and liver disturbances. Salem (1981) and Haffejee and Moosa (1985) have reported successful treatment of various gastrointestinal disorders.

Benefits to the respiratory system

In temperate climates and places with considerable temperature fluctuations, honey is a well known remedy for colds and mouth, throat or bronchial irritations and infections. The benefits, apart from antibacterial effects, are assumed to relate to the soothing and relaxing effect of fructose.

Benefits to skin and wound healing

Honey is used in moisturizing and nourishing cosmetic creams, but also in pharmaceutical preparations applied directly on open wounds, sores, bed sores, ulcers, varicose ulcers and burns. It helps against infections, promotes tissue regeneration, and reduces scarring also in its pure, unprocessed form (Hutton, 1966; Manjo, 1975; Armon, 1980 and Dumronglert, 1983). If applied immediately, honey reduces blistering of burns and speeds regeneration of new tissue. Many case histories are reported in the literature for human as well as veterinary medicine (sores, open wounds and teat lesions in cows). A cream, applied three times per day and prepared from equal parts of honey, rye flour and olive oil, has been successfully used on many sores and open wounds -even gangrenous wounds in horses (Lu~hrs, *1935)*. Lu cke (1935) successfully tested a honey and cod liver oil mixture suspended in a simple non-reactive cream base on open wounds in humans, but he gave no details on proportions.

Table 2.7:
List of coupoponds found in honey, but not necessarily present in all honeys (from Gonnet and Vache, 1985 modified with data from Withe, 1975b Bogdanov and Crane, 1990)

Carbohydrates (75-80 %)	Acids (0.1-0.5 %)	Proteins and amino acids (0.2-2 %)	Minerals (0.1-1.5 %)	Vitamins	Aroma constituents		Others
Monosaccharides (70-75%):	Gluconic acid (70-80 % of total acids)	Different types of proteins of bee and plant origin	Potassium	Ascorbic acid	Esters:	Ketones and aldehydes:	Lipids:
Fructose	Acetic acid		Sodium	Riboflavin	Methyl formate	Furmaldehyde	Glycerides
Glucose	Butyric acid	Free amino acids:	Calcium	Pantothenic acid	Ethyl formate	Acetaldehyde	Sterols
	Citric acid	Proline	Magnesium	Niacin	Methyl acetate	Propionaldehyde	Phospholipids
Disaccharides:	Formic acid	Lysine	Iron	Thiamine	Ethyl acetate	Butyraldehyde	Palmitic acids
Maltose	Lactic acid	Histidine	Copper	Pyridoxine	Propyl acetate	Isobutyraldehyde	Oleic acid
Isomaltose	Maleic acid	Arginine	Manganese	Biotin	Isopropyl acetate	Valeraldehyde	Lauric acid
Saccharose	Malic acid	Aspartic acid	Chlorine	Folic acid	Ethyl propionate	Isovaleraldehyde	Myristoleic acid
Nigerose	Oxalic acid	Threonine	Phosphorous			Caproaldehyde	Stearic acid
Turanose	Pyroglutamic acid	Serine	Sulphur		Methyl butyrate	Benzaldehyde	Linoleic acid
Maltulose	Succinic acid	Glutamic acid	Aluminum		Ethyl butyrate	Methacrolein	
Kojibiose	Fumaric acid	Glycine	Iodine		Isoamyl butyrate	Acetone (dimethyl ketone)	Polyphenols
Neocerulose	Tartaric acid	Alanine	Boron			Acetoin	
Gentiobiose	α-Ketoglutaric acid	Cystine	Titanium		Methyl valerate	Methylethyl ketone	Toxic substances (occasionally)
Laminaribiose		Valine	Molybdenum		Ethyl valerate	Diacetyl	
2 Ketoses, unidentified	probably present:	Methionine	Cobalt		Methyl isovalerate	Furfural	Choline
		Isoleucine	Zinc	Enzymes	Methyl pyruvate	5-hydroxymethyl furfural (HMF)	Acetyl choline
Higher saccharides:	α- or β-glycerophosphate	Leucine	Lead				Pinocembrin
Melezitose	glycolic acid	Tyrosine	Tin	Diastase (α- and β-amylase)	Methyl benzoate	Alcohols:	
Erlose	glucose-6-phosphate	Phenylalanine	Antimony		Ethyl benzoate	Methanol	Traces of beeswax
1-kestose	2- or 3-phosphoglyceric acid	Tryptophan	Chromium	Invertase (glucoinvertase, but also very small amounts of fructoinvertase)	Methyl phenylacetate	Ethanol	
Raffinose	pyruvic acid		Nickel		Ethyl phenylacetate	Propan-1-ol	Microscopic particles:
Panose				Glucose oxidase		Propan-2-ol	Pollen
Isopanose				Catalase	Methyl anthranilate	Butan-1-ol	Fungal spores
Maltotriose				Acid phosphatase	Diethyl ether	Butan-2-ol	Bacterial spores
Isomaltotriose						Isobutanol	Algal cells
Isomaltotetraose				shown to be absent:		2-methyl-1-butanol	Yeasts
Isomaltopentaose				Lactase		3-methyl-butan-1-ol	
Centose				Protease		3-methyl-butan-2-ol	
				Lipase		Pentan-1-ol	
						Pentan-2-ol	
						6-methallyl alcohol	
						2-phenylethanol	
						Benzyl alcohol	
						3-phenylpropan-1-ol	
						4-phenylbutan-1-ol	
						Furfuryl alcohol	

Benefit to eye disorders

Clinical cases or traditional claims that honey reduces and cures eye cataracts, cures conjunctivitis and various afflictions of the cornea if applied directly into the eye, are known from Europe (Mikhailov, *1950),* Asia, and Central America. This is said to be more true for Meliponid and Trigonid honeys from South and Central America and India. There are also case histories of ceratitis rosacea and corneal ulcers, healed with pure honey or a 3 % sulphidine ointment in which Vaseline was replaced by honey.

Medicine-like benefit

Frequently, specific benefits of unifloral honeys are reported, based on the traditional assumption that honey made from the nectar of a medicinal plant has the same or similar beneficial activity as the one recognized for the whole plant or some parts of it. Even if no transfer of active ingredients is involved, mechanisms similar to homeopathic potentiation are possible. Empirically effective therapies such as Bach flower therapy and aroma-therapy suggest that there can be much more to the medicinal value of honey than chemical analysis and quantification reveals. These claims are not supported by orthodox scientific evidence.

Diabetes

Frequently, claims are voiced that honey is good for diabetics. This is unlikely to find confirmation because of its high sugar content. However, it is better than products made with cane sugar, as a study by Katsilambros et al., (1988) has shown. It revealed that insulin levels were lower when compared to the uptake of equal caloric values of other foods, but blood sugar level was equal or higher than in the other compared products shortly after eating. In healthy individuals, the consumption of honey produced lower blood sugar readings than the consumption of the same quantity of sucrose (Shambaugh et al., 1990).

Ayurvedic medicine

Traditional, but well-studied medicinal systems as the ayurvedic medicine of India, use honey predominantly as a vehicle for faster absorption of various drugs such as herbal extracts. Secondarily, it is also thought to support the treatment of several more specific ailments, particularly those related to respiratory irritations and infections, mouth sores and eye cataracts. It also serves as a general tonic for newborn infants (see also section 2.9), the young and the elderly, the convalescent and hard working farmers (Nananiaya, 1992, personal communication). In general, no distinction is being made between honey from Apis mellifera A. cerana or A. dorsata.

Other benefits

Honey is said to normalize kidney function, reduce fevers and help insomnia. It is also supposed to help recovery from alcohol intoxication and protect the liver; effects also ascribed to fructose syrups. Heart, circulation and liver ailments and convalescent patients in general improved after injection with solutions of 20 and 40% honey in water (Kaul, 1967).

2.4.2 Scientific evidence

According to scientific evidence it would be better to consider honey as a food, rather than a medicine. Most of the benefits described above, at least for internal use, can most likely be ascribed to nutritional effects of some kind. On the other hand, our scientific understanding of cause and effect, typically only confirmed if a single compound measurably affects a well defined symptom, is far too limited to explain possibly more complex and subtle, particularly synergistic interactions.

Energy source

As food, honey is mainly composed of the simple sugars fructose and glucose, which form the basis of almost all indications on how, when and why to use it. The main consideration is the fact that honey provides immediately available calories, from which it derives its energy value for healthy and sick people: quick access to energy without requiring lengthy or complicated digestive action. The same direct absorption also carries a risk of pathological sugar metabolism, such as diabetes and obesity.

Non-energetic nutrients

Often honey is recommended because of its content of other nutrients like vitamins and minerals, but their quantity is so low

that it is unrealistic to think they can provide any significant supplement in a deficient diet (Table 2.8). Similar arguments are made for the nutritional and health benefits from most other bee products, particularly pollen and royal jelly. Although their beneficial characteristics have been shown in numerous cases, they cannot be based on simple numeric values, i.e. X amount of substance Y. Yet, it is well known that the quality and availability of a nutrient is important for its usefulness to the body. Micronutrients in unprocessed honey can be assumed to be of the highest quality possible. Thus from a nutritional point of view, a synergistic balancing effect or one that unlocks the availability of other nutrients already present, is one of the more plausible yet untested hypotheses.

Topical applications

Topical applications under controlled conditions have shown accelerated wound healing in animals (Bergman et al., 1983, El Banby et al. 1989) and of experimental burn wounds in rats (Burlando, 1978) but also of various types of wounds, including post-operative ones in humans (Cavanagh et al., 1970; Kandil et al., 1987a, b and 1989; Effem, 1988 and Green, 1988). Similar, yet not equal, effects are obtained with the application of purified sucrose and special polysaccharide powders (Chirife et al., 1982). External as well as internal wounds from operations become bacteriologically sterile within a few days and dry out. The simultaneous stimulation of tissue regeneration by honey reduces scarring and healing times. In addition, dressings applied with honey do not stick to the wounds or delicate new skins. In many tropical field hospitals, where antibiotics and other medicines are scarce, honey has been employed successfully for a long time.

Table 2.8:
Nutrients in honey in relation to human requirements (Crane, 1980)

Nutrient	Unit	Average amount in 100 g honey	Recommended daily intake
Energy equivalent	kcal	304	2800
Vitamins			
A	I.U.	-	5000
B1 (Thiamin)	mg.	0.004 - 0.006	1.5
B2 (Riboflavin)	mg.	0.002- 0.06	1.7
Nicotinic acid (niacin)	mg.	0.11.- 0.36	20
B6 (Pyridoxine)	mg.	0.008 - 0.32	2.0
Pantothenic acid	mg.	0.02 - 0.11	10
Bc (Folic acid)	mg.	-	0.4
B12 (Cyanocobaltamine)	mg.	-	6
C (Ascorbic acid)	µ g	2.2 - 2.4	60
D	mg.	-	400
E (Tocopherol)	I.U.	-	30
H (Biotin)	I.U.	-	0.3
Minerals	mg.		

Calcium	mg.	4 - 30	1000
Chlorine	mg.	2 - 20	
Copper	mg.	0.01 - 0.1	2.0
Iodine	mg.	-	0.15
Iron	mg.	1. - 3.4	18
Magnesium	mg.	0.7 - 13	400
Phosphorous	mg.	2 - 60	1000
Potassium	mg.	10 - 470	-
Sodium	mg.	0.6 - 40	-
Zinc	mg.	0.2 0.5	15

Antibacterial activity

Antibacterial activity is the easiest to test and is probably the most studied biological activity of honey. In normal honey it is attributed to high sugar concentration and acidity (pH range 3.5 to 5.0). Yet, since also diluted honey has shown antibacterial activity, the active ingredient was attributed to an elusive substance generically termed "inhibin". Much of this activity was later attributed to hydrogen peroxide (H_20_2) an enzymatic by-product during the formation of gluconic acid from glucose. The responsible enzyme, glucose oxidase is basically inactive in concentrated normal honey. Thus, in honey solutions (diluted honey) with the right pH, antibacterial activity is largely due to the presence of hydrogen peroxide. The biological significance of such a mechanism arises from the requirement to protect immature honey (with high moisture content) inside the colony until higher sugar concentrations are achieved.

Both mechanisms can partially explain the sterilizing effect of honey on wounds and some of its efficacy against cold infections, but it does not explain its beneficial effect on burn wounds (Heggers, et al., 1987) and faster wound healing with less scarred tissue. Subralimanyam (1993) has experienced 100% acceptance of skin grafts after storage in honey for up to 12 weeks. Antibacterial activity varies greatly between different types of honey (Dustmann, 1979; Revathy and Banerji, 1980; Jeddar et al., 1985 and Molan et al., 1988). In addition to glucose oxidase, honey seems to contain other mostly unknown substances with antibacterial effects, among which are polyphenols. These other factors have been identified in a few cases (Toth et al., 1987; Bogdanov, 1989 and Molan et al., 1989) but as a whole there are few scientific studies on the various claims of the beneficial effects of honey. However, it has been well demonstrated that most of the antibacterial activities of honey are lost after heating or prolonged exposure to sunlight (Dustmann, 1979).

Information sources on honey therapy

Mladenov (1972) published a book (in Rumanian) on honey therapy in Rumania and there are several articles on honey therapy in Apimondia (1976) as well as in Crane (1975 and 1990). The American Apitherapy Society collects case histories and scientific information on all therapeutical uses of bee products.

2.5 The use of honey today

2.5.1 As a food

Honey is most commonly consumed in its unprocessed state, i.e. liquid, crystallized or in the comb. In these forms it is taken as

medicine, eaten as food or incorporated as an ingredient in various food recipes.

However, honey is considered a food only in a few societies such as those of the industrialized countries in Europe and North America, Latin America, North Africa, the Near East and increasingly in Japan. In most parts of Africa it is used for brewing honey beer and to a much lesser degree, as medicine. In most of Asia it is generally regarded as a medicine or at most an occasional sweet. High per capita consumption in industrialized nations (see 2.10) does not reflect the consumption of unprocessed honey per person but includes a very large quantity of honey used in industrial food production, i.e. as a food ingredient.

In order to increase consumption and to make the various honeys more attractive, a large variety of packaging and semi-processed and pure honey products are marketed. Though they are strictly still "only" honey, their form of presentation can add a certain value to the primary product and is therefore briefly discussed here. One of the more appreciated forms, price wise at least, of selling natural honey seems to be honey in its natural comb. Including pieces of comb honey in jars with liquid honey (chunk honey) is very attractive to many consumers and appears to disperse suspicions of adulteration. Creamed honey (soft, finely crystallized honey) is a very pleasant product which is convenient in use because it does not drip. Honey is sometimes "enhanced" by adding pollen, propolis and/or royal jelly without changing the state of the honey itself. These products are described in the pollen, propolis and royal jelly chapters. For other "improvements" in the form and size of packaging see section 2.6.11.

In some countries the appearance of the marketed honey is not very important, i.e. it may be liquid, crystallized or semi-crystallized and with or without wax particles etc. Therefore it can be bottled as it is. In other countries, consumers want not only clean honey but also prefer liquid honey. Consumer education may change this attitude, particularly where it is based on the widespread but false belief that honey crystallizes because it is adulterated with sugar. To remain liquid however, many honeys require special processing (see 2.12.1).

Slow crystallizing honeys can be sold without further processing or may be used, if lightly coloured, to pour around bottled chunks of comb honey or fruits and nuts. Light coloured honeys are particularly suitable for sale as comb honey in special clear packages (see Figure 2.16 a). But any kind of honey can be sold as comb honey as long as the combs are evenly sealed and relatively new, i.e. with white or light yellow wax. In blending different honeys, attention has to be paid to the final ratio of glucose to fructose and the possible need for additional heat treatments Fast and slow crystallizing honeys low in moisture content can be processed to prolong their liquid state (see section 2.12.1) or can be forced to crystallize under controlled conditions to achieve a soft and uniform consistency (see section 2.12.2).

Uniformly crystallized honey is attractive both visually and for its convenience of use. It is also less likely to ferment than badly crystallized or semi-crystallized honeys (see Figure 2.3). Different storage temperatures in different climates, among other factors influence the crystallization and speed of re-liquefaction of honeys. Stored above 25°C, most honeys remain liquid or reliquify slowly, but lose much of their aroma in just a few months

2.5.2 As a food ingredient

The traditional use of honey in food preparations has been substituted in most cases by sugar and more recently by various sugar syrups derived from starches. These exhibit similar composition and characteristics, but at a much reduced cost. At the same time, as part of the increasing appreciation of more natural products in many countries, honey has been "rediscovered" as a valuable food and therefore confers, also as an ingredient, an enhanced market value to the end product. Many honey containing industrial products which were developed in the last decades, but which did not have the expected success, are currently being remarketed more successfully.

Outside of the thousands of "home-made" recipes in each cultural tradition, honey is largely used on a small scale as well as at an industrial level in baked products, confectionary, candy, marmalades, jams, spreads, breakfast cereals, beverages, milk products and many preserved products. In particular, the relatively new industry of "natural", health and biological products uses honey abundantly as the sweetener of first choice, together with non-refined sugars in substitution of refined sucrose (cane and beet sugar). In fact, honey can substitute all or part of the normal sugar in most products (see 2.12.11). Limitations are presented on one side by costs and handling characteristics and on the other by the natural variations in honey characteristics which change the end product, make it more variable and require more frequent adjustments in the industrial formulations (recipes).

Recipe books for home use of honey have been published in many languages. Many of these recipes can also be adapted for

artisanal and small scale production. Aside from the occasional information in special trade books or journals, information or recipes about large-scale uses of honey are difficult to find. One French text on industrial food production with honey is a good source (Paillon, 1960). Otherwise the National Honey Board of the USA (see Annex 2) is able to provide information and technical assistance including tips on promotion and marketing, to small and large industrial users of honey.

To **baked** products**,** aside from the already mentioned consumer appeal, honey confers several other advantages such as a particular soft, spongy (springy) consistency which persists longer. Products that contain honey also dry out more slowly and have a lesser tendency to crack. These properties are due to the hygroscopicity of honey, a trait honey has in common with other sweeteners high in fructose, like acid-hydrolysed corn syrup or other syrups made from starches and fruit juices. Another advantage consists of more uniform baking with a more evenly browned crust at lower temperatures. These characteristics too, are mostly due to the fructose content. Yet another advantage is an improved aroma, conferred by relatively small percentages of honey (up to 6% by weight of the flour) in sweet cakes, biscuits, breads and similar products (see Figure 2.4). Since most beneficial effects can be obtained with relatively small quantities, the baking industry prefers strong flavoured honeys thus maximizing flavour for the lowest possible cost. On the other hand not more than one third of the sugar in a baking recipe should normally be replaced by honey.

In **confectionerv** production, honey is still included in many traditional products which are consumed locally in considerable quantities but are also exported, such as torrone from Italy, tur6n from Spain, nougat from France and halvah from Turkey and Greece. For the production of caramels (bonbons) honey is used only in very small quantities, since its hygroscopicity presents a major disadvantage: it reduces the preservation time and softens the caramels at the surface causing them to stick together. Some caramels, made with special machinery have a liquid honey core. In gelatinous or gum products, honey can be used in the same way as other flavouring agents (aromas or fruit pulp). The chocolate industry uses honey in only a few products. One Swiss chocolate in particular, in which honey is included in the form of broken nougat, can be found worldwide.

In the **breakfast cereal** industry, honey is used either in its liquid or in its dried and pulverized form, both for better flavour and increased consumer appeal. It can be mixed with cereal flakes and dried fruits or applied as a component of the sweetening and flavouring film which covers the flakes. The dryness or hardness of the cereal can be adjusted with the honey content and the degree of drying. Some cereal recipes are given in Chapter 3.

Numerous **snack bars (candy bars)** are marketed in which honey constitutes the binding and sweetening agent. Other ingredients of the mixtures can be dried fruits (like raisins, figs, apples, apricots, prunes, dates, pineapple, papaya, etc.), nuts and seeds (like hazelnuts, walnuts, almonds, brazil nuts, pistachios, ground nuts, cashew nuts, sesame seeds, sunflower seeds, linseeds or coconut flakes), cereals of all kinds (rolled, as flakes or in puffed form) and possibly other ingredients such as milk powder, pollen, cacao, carob and aromas. The ingredients are chopped to various sizes and mixed with the hot honey and sugar. Depending on the composition and the degree of heating of the sugars (including honey) a more or less solid product is obtained after cooling. Some can be cooled in moulds, some be cut after cooling and others, which remain soft, have to be layered between wafers or biscuits and coated with chocolate. In any case, all such products are fairly hygroscopic and need to be packed with material impermeable to moisture. A few recipes can be found in Chapter 3 and section 2.12.6.

In the wide variety of **spreads** for bread, there are products in which honey is either the major ingredient, such as "flavoured" honeys, or in which it only substitutes for sugar as in cream spreads and fruit preserves. Flavoured honeys are usually marketed in crystallized form as the addition of the other ingredients speeds up the crystallization anyhow. It is better to control the crystallization and mixing rather than leaving it to chance and having the other ingredients separate from the liquid honey after a short time. The ingredients are either mixed with the honey at the same time as the seed crystals or they are mixed after crystallization has been completed, to obtain a harder or softer end product respectively. For further details see recipes of creamed honey in section 2.12.2. Sun-dried or freeze-dried fruits like raisins, apricots or strawberries may be chopped and nuts and seeds may be pureed and included in the honey, as may be cacao, cream or milk powders and even butter. In some cases the product has to be stored in a refrigerator.

Separate attention needs to be devoted **to honeys with added aromas or essences, be** it fruit or other aromatic essences. Such practices are, or at least have been, more common in Eastern Europe where sometimes the aromas, food colouring or even medicinal drugs were fed to the bees in sugar syrup and the "honey" extracted from these colonies sold as "strawberry honey" or "mint honey", etc. However, they are not truly honey (see definition in section 2.1). To the consumer they present something very similar to natural honeys, at least in appearance. Therefore, European Union (EU) legislation does not allow commercialization of these products under the name of honey. Adding aromas to liquid or creamed honey produced from natural sources is yet a different approach compatible with European legislation, if labelled accordingly, but of questionable consumer appeal. This honey must be labelled so it can be distinguished from unifloral honeys.

Figure 2.4: Some honey-based bakery products also showing granola (mijesli) bars.

In the preparation of **marmalades** and **jams,** honey can replace all or part of the sugars used. The fruit and honey mixture is concentrated by boiling or under vacuum (reduced pressure) until a sugar concentration of at least 63 % is reached, which is sufficient for preservation. The boiling time can be reduced by using partially sun-dried fruits. Any reduction of boiling time or temperature will improve flavour and reduce caramelization. The last two methods, boiling under reduced pressure and using sun-dried fruits, preserve the original flavours better. The use of sun-dried fruit also requires less fuel and 1e~~ expensive equipment (see section 2.12.12). For these types of preserves a refractometer is helpful to determine the final sugar concentration. Another alternative is the preparation of "semi-preserves", i.e. those which use less sugar (honey) and boiling (30 minutes), store well in their unopened (sterilized) original containers, but once opened have to be refrigerated or consumed within a few days. The same procedures as under section 8.10.7 can be followed.

The quantity and ratio of honey and fruits varies with the fruit and the choice of preserves. Fresh fruits contain between 3 and 20% of sugar and honey contains approximately 80% thus the approximate requirements can be calculated. To obtain a suitable consistency in those preserves with a relatively low sugar content, pectin is added at a rate of 0.1 to 0.2%. Lemon juice or citric and tartaric acid may have to be added to make the mixture sufficiently acidic for the pectin to gel. For home and artisanal use of honey in marmalades, jellies and fruit syrups, there is a multitude of family recipes, but industrial use of honey in preserves remains very limited, probably because of economic considerations. A simple honey jelly made from a mixture of honey, pectin and water is presented in section 2.12.13.

In Italy, a product type with **whole dried fruits or nuts** in honey, or honey with dried fruits and nuts, is quite popular (see Figure *2.5)*. Clear jars, preferably glass, are partially filled with low moisture, slow crystallizing, light coloured honey and then filled with dried fruits or nuts. If dried fruits with a relatively high water content like pineapple, chestnut, apricots and figs are added, fermentation may occur and the final moisture content of such honeys has to be closely observed or the honey be replaced (see section 2.12.8).

Figure 2.5 : Hazel nuts packed in liquid honey.

The use of **honey** mixed with **milk or milk products** is a very common home remedy against colds and infections of the throat. In the industrial sector some non-medicinal honey-milk products exist, such as pasteurized and homogenized milk sweetened with honey for long-term storage. One particular honey-milk is prepared with dried milk powder plus 25 % honey and 10% glucose (Spo~ttel, *1950)*. Another product is yoghurt with honey (Spanish Dairy Corp., *1975)*. In South America dulce de leche (sweet milk) is almost as essential to the Argentinean diet as meat, and is an extremely popular spread. Though mostly prepared with other sugars, honey makes for a much richer flavour (see section 2.12.7). In yoghurt, honey is used as a sweetener or like other flavourings and is mixed at the rate of 10 to 15 % either before or after fermentation. Alternatively, it may be left separately at the bottom of the container. The mixing causes a slight loss of viscosity of the yoghurt, which can be corrected by adding skimmed milk solids (Brown and Kosikowski, 1970). One of the Italian industry leaders in this sector produces a yoghurt with orange blossom honey, the aroma of which blends very well with the yoghurt. In special combination packages a fruit granola mix is packed above a honey-sweetened yoghurt (Colangelo, 1980).

Adding honey to **ice creams** has been suggested several times, but at least in Italy, ice creams sweetened with honey have never had much commercial success, probably due to the fact that these ice creams melt more easily and at lower temperatures than those made with sugar. This causes problems in distribution and open sales presentations together with other sugar-based ice creams. In other countries, but particularly when ice cream is sold in pre-packaged individual portions or larger 0.5 to 2 litre containers, honey-based ice creams are marketed successfully. The addition of more than 7.5 % honey softens the ice cream significantly, due to its lower freezing point.

In the industrial **non-alcoholic beverage** industry, the use of honey is relatively recent and is expanding. The reasons can be found in a wider distribution of "functional" drinks such as health orientated, strengthening or replenishing isotonic drinks. Honey drinks are most frequently mixed with lemon juice for a pleasant sweet and sour taste, but other fruit flavourings such as apple juice are often added. In 1990, over 40 new honey drinks were introduced in Japan, of which one (on a honey and lemon

juice base) was introduced by the Coca-Cola Bottling Co. of Tokyo **(PRC,** 1990). In many fruit juices too, honey is added as a flavouring and sweetener. In apple juice it is also used to clarify the fresh juice (Lee and Kime, 1984) by adding 4% of a solution containing equal proportions of honey and water (Wakayama and Lee, 1987). Ice tea can be flavoured and clarified with the addition of honey and lemon juice.

These new beverages take advantage of a special ultrafiltration process. This filtration through special membranes eliminates any impurities, microscopic granules (pollen) microorganisms and even macromolecules such as proteins, which might otherwise produce turbidity or flocculation in clear beverages. Such ultrafiltered honey loses some of its flavour and colour but gains in consistency, which is highly appreciated by food processors for its lower production cost. This ultrafiltration may soon find wider application not only in the beverage industry, but also in the dairy, cosmetic and pharmaceutical industries (Lagrange, **1991).**

For inclusion in some recipes, honey is also **dried or dehydrated** by various industrial techniques (Olstrom, 1983), usually some type of vacuum or spray drying. However, dried honey is even more hygroscopic and needs to be stabilized by mixing with other powders such as starches, flours or other non-hygroscopic sugars, which are compatible with the final recipe. The percentage of stabilizers is in general around 55 % but may vary from 20 to 70% in case of, for example, porous maltitol powder (Ebisu et al., 1988). The powdered honey is used in dry mixes for cakes, breads and drinks or energy health powders and avoids the need to handle any liquid or sticky honey. Other applications are in cosmetics and alcoholic beverages, where additional water content is not desired or where handling of liquids increases production cost. Lupke (1980) discusses the use of dried honey in baked goods in Germany. Yener et al. (1987) describes different production techniques used in Turkey for the stabilized dry honey powder. Crane (1990) reports granular dried honey as reducing shrinkage of meat products by 19% and production of an additive-free dried honey powder has been mentioned in the Speedy Bee (1988).

Honey is also used in the manufacturing of sauces, the preparation of canned meat and honey cured (cooked) hams. Distilled alcoholic beverages incorporate honey as a flavouring agent after distillation, as for example Benedictine in France, Drambuie in Scotland, Irish Mist in Ireland, Grappa al Miele in Italy, Krupnik in Poland, Barenfang in Germany and many others.

For all the mentioned preparations, most of all for those with a high honey content, the quality and flavour of that honey are important. Any recipe will have to be adapted to the type of honey available and most of all to its water content, which determines the cooking or baking times in pastries and preserves, and the appearance, consistency and stability of other products.

2.5.3 As an ingredient in medicine-like products

The medicinal use of honey is probably its most widely known use, but such uses do not require special preparations. If not used straight, it is mixed at home with other liquids such as hot milk, teas or other infusions, wine and other alcoholic beverages. The pharmacopoeias of many countries describe a honey-based preparation which can be prepared by pharmacists (honey rose water) which is used for topical application in infected throats and various ulcers of the mouth (see 2.12.15).

More common is the use of honey in herbal and other traditional extracts. If the extract is presented in the form of a syrup, the preparations need to be sterilized with heat before or after the addition of the active ingredients, or a preservative like potassium sorbate or alcohol needs to be added. Sometimes fermented honey syrups are used as a base. These fermented syrups are made by adding yeasts to a mix that contains a much higher ratio of sugar to water (1:1) than is used for honey wines, mead or beer (see next section). Plant extracts are added after fermentation and clarification.

The addition of honey to herbal extracts and also prior to fermentation (as described above) is commonly practised in ayurvedic medicine as mentioned in 2.4.1. Traditional African medicinal extracts are also mixed with honey and probably not only because they are easier to take that way. In Europe, many traditional formulations are also known and some were even recommended by Hippocrates (Adams, 1939).

Honey is also a fundamental ingredient in some medicinal wines and vinegars. In one case herbs are crushed and immersed for 10 to 30 days in the wine, to which some alcohol may be added in order to improve the extraction and preservation. The liquid obtained needs to be filtered and pasteurized; honey is then added.

Contents - **Previous** - **Next**

2.5.4 Products of honey fermentation

Contents - Previous - Next

In many regions honey is or was the only, or the most accessible source of fermentable sugars. In some parts of non-islamic Africa, the traditional manufacture and consumption of honey beer is still very common. The base is crudely pressed or drained honey, often with added brood or pollen. An additional nutrient base is generally provided for the yeasts, which may add characteristic flavours as well (see 2.12.5). Occasionally, other available sugars or sugar sources are added, but always the beverage is consumed before fermentation is finished. Preparation by a skilled brewer (in East Africa most commonly women) can be as fast as 5 to 6 hours. Consumption (most commonly by men) is usually still faster.

In Europe, traditional fermented honey products, some similar to African honey beers, others more refined for longer storage, have largely been abandoned and replaced with grape wines and grain beers. The fundamental problem with mead, the honey wine drinkable only after some months or years of maturation, is that without precise control of the yeasts and other microorganisms growing in the must, final flavours can often be very disappointing. The must of honey water by itself does not contain sufficient yeasts, nor the right kind of yeasts or nutrients to allow rapid fermentation. The yeasts most commonly found in honey (Zygosaccharomyces) grow only in concentrated solutions with more than *50%* sugar. Unlike honey beer production, even if sufficient yeast is added at the onset to produce rapid fermentation, the whole process lasts much longer, during which strong flavours derived from other microorganisms can develop. Probably also in order to cover unpleasant flavours, old mead recipes often prescribed the addition of fruits or aromatic herbs. The beverage is then referred to as metheglin.

New microbiological understanding of fermentation processes lead to better controlled working conditions and more reliable production. The result is better control of final flavours. As a consequence, production of meads is becoming more popular again (see 2.12.4). There have been many books and articles published describing various processes and recipes. Among them in French by Guyot (1952), in Spanish: Persano (1987) and in English: Adam (1953), Morse (1964 and 1980), Morse and Steinkraus in Crane (1975), a recently reprinted edition of Gayre (1948) as Gayre and Papazian (1986), Berthold (1988a) and Kime et al., (1991). For those with access to international computer networks, a discussion group of mead producers has been established. Further information can be accessed through any of these many recipes and instructions will certainly help, but only personal experience and lots of patience may produce a tasty mead.

Through refermentation by careful addition of honey or incomplete primary fermentation prior to bottling, a sparkling mead can be produced. Refermentation with selected yeasts can also produce a sherry mead. In Poland, meads with extremely high sugar contents are traditionally produced from musts using equal volumes of honey and water. This "Dwojniak" has to mature for very long periods (5 to 7 years) but the primary fermentation is similar to the one mentioned earlier for medicinal syrups from plant extracts and can be conducted with the honey's own osmophilic yeasts. A must with a honey to water ratio of 1:2 requires only 3 years of aging and is prepared with a special strain of wine yeast (Malaga type). This "Trojniak" is still fairly sweet and is preferably made from cornflower (Centaurea) honey (Morse and Steinkraus, 1975).

Honey vinegar can be produced from mead in the same way as wine vinegar. Unless there is some very special appreciation of this unique flavour, the production however, is hardly feasible economically. Mead can also be used as a base from which distilled alcoholic beverages can be produced. Such production is usually for home consumption only.

Most countries permit the production of alcoholic beverages for personal consumption, but require special licenses for commercial production and sale. Equally,

there may be restrictions on the use of certain additives and of course, there are countries in which alcohol production, sale and consumption are not allowed at all. Therefore it is necessary to first inform oneself about the local regulations and proceed from there. A few detailed recipes can be found in the recipe section (2.12.4).

2.5.5 Others

The tobacco industry is estimated to use more than 2000 tons of honey annually to improve and preserve tobacco's aroma and humidity (Nahmias, 1981). Since tobaccos, at least in part, are valued according to the rate at which they dry, the importance of honey for the more valuable tobaccos can easily be understood.

Wax moth larval diets sometimes contain honey to improve survival rates (Eischen and Dietz, 1990). These larvae are raised for scientific experiments and fish bait and could be used as human food as well. Diet descriptions and raising instructions are given in section 8.10.11.

Honey is also mixed in solutions with other substances to attract insects for pollination of some agricultural crops. There is however, no scientific study which shows that such treatment increases pollination significantly.

Nahmias (1981) mentions the use of honey for treating meat packing paper in the USA and coating coffee beans prior to roasting in order to increase the aroma of each product.

The cosmetic industry uses honey as a skin moisturizer, softener and restorer of the skin's own moisturising factors in creams, soaps, shampoos and lipsticks. Because of its stickiness it can however only be employed in small quantities. Further details can be found in Chapter 9.

2.6 Honey harvesting and processing

High colony yields are only possible with well populated colonies in areas with abundant nectariferous flora. The honey needs to be harvested before the bees can consume it for further colony development, but sufficient quantities have to be left to provide for the basic needs of the colony. The different management techniques to provide the above conditions depend on the local conditions and cannot be the subject of this chapter, but are found in regular beekeeping textbooks. However, the different management and harvesting techniques can influence the final quality of the honey (Krell et al., 1988).

The following discussion on honey harvesting and processing is intended for both the honey buyer as well as the producer in order to clarify the necessary precautions to be taken to assure a high quality primary product. Only if the raw material is of good quality can the end product be of good quality.

2.6.1 Colonv management

The exploitation of honeybees by man is basically aimed at the harvest of honey. The most rudimentary and ancient method, still employed in some parts of the world, consists of collecting honey from wild swarms. Usually, no attention is paid to the survival of the robbed colony. Combs with honey, but also with brood and pollen are either consumed directly, without any transformation, or used in the production of fermented drinks. Honey from this kind of harvesting is most

frequently mixed with pollen and brood juice and all other parts of the hive. While nutritious, it is not a product that can be included in processing of value added products, other than the production of locally appreciated fermented drinks.

The next step in the technological evolution of beekeeping is the keeping of bees in "traditional" hives, made of any kind of suitable, locally available material: tree trunks, rock caves, bark, straw or other plant materials, mud, dung, clay, cut timber or even special cavities provided in stone or mud walls. Harvest time is when the colony has stored the maximum amount of honey. Different degrees of care as to the survival of the colony, are used during harvest, depending on the type and abundance of the bees and the knowledge of the beekeeper. Sometimes, more refined techniques are employed, such as dividing colonies or moving hives according to nectar flows. Thus production becomes more reliable, still involves little expense, but nevertheless remains relatively low in volume. Honey produced from this type of beekeeping can be of good quality depending on the knowledge and care taken by the beekeeper. Product quality ranges from that of the most negligent honey robber to that of a quality conscious, topbar hive producer.

A further evolutionary step is represented by the use of hives with moveable combs, but without frames or foundation sheets. Examples are the topbar hives of Africa now used worldwide and the antique "anastomo cofini" topbar reversed skep hives of Greece. This type of beekeeping unites low cost materials and traditional practices with some of the advantages of frame hive beekeeping, i.e. the possibility to inspect and manipulate the hive and therefore to progress to a more intensive hive management. Honey is extracted mostly by pressing, sometimes by dripping, but also by melting combs in order to separate wax from honey. This last method is not recommended because the overheating and mixture with old combs spoils the quality of the honey. Pressing (see Figure 2.6 and 2.9) and dripping can produce good quality honeys, but even with good comb selection they still contain large amounts of pollen. This by itself is no problem - on the contrary it is more nutritious - but many markets prefer a clear, non-opaque honey.

The more intensive beekeeping practices of the last century were based on the moveable frame hives and virtually all the honey on the international market still comes from this type of beekeeping. All common management practices are aimed at increasing honey yield, either directly through colony migration, adding honey supers and harvesting, or indirectly, by stimulating early colony growth, swarm control, feeding during off-season and pest and disease control. Higher productivity, when compared to well managed topbar hives however, only results from the reusability of the combs and the possibility of migratory beekeeping due to better comb stability. Centrifugal extraction allows quick processing of large quantities and produces honey with the least amount of contamination by other hive materials. The handling of large quantities allows other processing technologies which foster the production of a uniform product with high control of quality standards.

2.6.2 Unifloral honeys

Unifloral honeys represent a sizeable and well-paid portion of the European honey market. Their production depends on management through site selection and selective harvesting. Increasing consumer knowledge and appreciation of honey is developing a particular market niche for honey identifiable by a characteristic colour and flavour, and originating from one or few sources of flowers (see Figure 2.2).

Figure 2.6 : Honey presses in the foreground and water jacketed settling tanks in the background at the honey processing centre of Northwestern Bee Products, Kabompo, Zambia, which buys, processes and exports honey and wax from mostly traditional barkhive beekeeping.

Differential pricing sometimes makes the production from rarer floral sources very attractive. Even in some developing countries, honeys from certain areas are preferred, though not always directly for reasons of floral origin, but sometimes for quality, liquidity, colour or simply because it looks and tastes the way the most commonly available honey tastes.

The techniques to produce unifloral honeys are based on the possibility of separating honey of one floral period from earlier and later nectar flows on an economically interesting scale. The most commonly used technique is based on migratory beekeeping. Timing the relocation of apiaries, as well as the placing and removing of supers, is of greatest importance. Care also needs to be taken that honey already present in the colony cannot contaminate the colour or flavour of the unifloral harvest. Even if the production of unifloral honeys is not possible or economically feasible, the organoleptic characteristics of the honey (appearance, colour, flavour and taste) are still the elements that more than anything else contribute to its consumer appeal. It is therefore always a good practice whenever possible to avoid harvests that are not much appreciated, i.e. move bees to other areas or leave bitter or otherwise unfavourable honeys to the bees and harvest only at other times of the year.

2.6.3 Contamination during production

The location of colonies in industrial zones or other areas with considerable air pollution such as cities, can lead to considerable contamination of the various hive products with noxious or toxic chemicals. In Canada, USA, UK and Italy, honeybees were used to monitor environmental pollution, since accumulations of certain metals and other substances could be measured in hive products, mostly in pollen but also in honey (Meyer, 1977; Tong et al., 1979; Bromenshenk et al., 1985 and Accorti, 1992). Agricultural use of toxic chemicals is another common and very likely source of contamination. Crane (1990) gives a list of pesticides found in contaminated honey and the quantities in which they are commonly found. Their overall presence is low in regard to permissable limits in fruits for example, but nevertheless, they are present.

Radioactive contamination throughout Europe after the Chernobyl nuclear reactor incident showed in nectars and honeys for a considerable time (Kaatz, 1986 and Dustmann and von der Ohe, 1988). Since most of the contamination was due to plant uptake of radioactive elements replacing normally occurring minerals, the overall content remained relatively low. Although closer to the accident scene and immediately after the incident, safety limits were exceeded. This was mostly due to short lived iodine isotopes, as for example in Austria (Österreichischer Imkerbund, 1986).

Further contamination may result from dirty water sources and non-floral sugar sources. One very productive location, giving several abundant harvests all year round, was, for example, very close to the centre of Georgetown, Guyana. However, it was also very close to the local soft drink factory which continuously spilled considerable amounts of sugar. Such honey was not truly honey and had a very characteristic taste.

The worldwide exchange and shipping of honeybee colonies and queens has led to the introduction of new honeybee diseases in many parts of the world. Unadapted bees cannot resist the new infections and help from the beekeeper is required. Such help usually involves chemical treatments. If unsafe chemicals are used or even if relatively safe chemicals are applied in exaggerated quantities or at inappropriate times, honey is contaminated. Problems with such contaminations have increased in recent years. Buyers are increasingly alert and test regularly for residues. Another source of contamination is the treatment of combs against wax moth during storage. All available chemical treatments leave residues in the wax and only abundant aeration (ventilation) for at least a couple of weeks can reduce the hazard. Well ventilated storage without chemicals is preferred.

2.6.4 Contamination during harvesting

Many harvesting methods are available to separate bees from their honey. Combs can be taken out one at a time and bees may be removed by shaking and brushing. Whole supers can be cleared of bees with a strong air blower. An inner cover or special board with a one-way bee escape can be placed below the honey super. Up to one deep, or two shallow supers, can thus be cleared in 24 hours, if enough space is available below. This method cannot be recommended if colonies are sitting unprotected in the sun, which might melt the combs in the now unventilated supers. None of these three methods will contaminate the harvested honey.

The use of unpleasant smelling chemicals to drive bees away is a technique preferred by many beekeepers because it is quick and easy. Some of the chemicals are illegal for use in many countries, leave unpleasant flavours and odours, are toxic and are absorbed by wax and honey, e.g. carboxylic acid, benzaldehyde, nitrobenzene and others (Daharu and Sporns, 1984). Careful use of butyric acid, marketed as "Bee-go" in the USA has so far not been proven to produce any contamination, but in general, the use of chemicals during harvesting cannot be recommended.

Excessive use of smoke during harvesting will flavour the honey quickly, no matter which smoker fuel has been selected (see Figure 2.7). Microscopic contamination with soot can also be detected. No chemicals should be included in the smoke. Though unavoidable with some bees, heavy use of smoke can be reduced by selecting more favourable (but perhaps more inconvenient) harvesting times (weather, time of day) and shorter and more frequent harvests. A summary of various production features influencing honey quality is presented in Table 2.9.

Figure 2.7 : Heavy smoking during harvesting will flavour the honey.

2.6.5 Cleanliness

Honey in combs, be it in supers of frame hive beekeeping or in the broken combs from topbar or traditional fixed comb beekeeping, already needs to be regarded as a food product. From a microbiological point of view, mature honey is a very stable product, which is neither altered by, nor, does it permit the multiplication of bacterial or fungal organisms. It can nevertheless be contaminated by either non-biological substances or by potential human pathogens. Every caution and care in hygiene should therefore be taken to prevent any form of contamination.

This general requirement must be taken into account during all processing phases. Already in the comb, contrary to many beekeepers' beliefs, honey is exposed to the danger of contamination, since the surface area of contact with the environment is very large. Contact with humid air (during days between harvesting and extraction), with the soil (supers set on the ground, truck bed, honey house floor or combs and frames dropped on the ground), unprotected transportation on dirt roads or in dirty buckets without a lid during comb harvesting and exposure to insects and other animals, can adversely affect honey quality (see Figure 2.8).

Table 2.9:
Beekeeping methods which may have negative effects on the quality of the honey

Beekeeping method	Possible damage to honey
Location of hives in densely urbanized or industrialized zones or areas otherwise subjected to strong environmental pollution, including agricultural pesticide use	Contamination of honey with noxious or toxic residues, possibly damaging to human health, or with sugars not of nectar or honey dew origin
Inappropriate use of antibiotics and other drugs or chemicals to treat or prevent honeybee diseases or control pests	Contamination of honey with the same substances
Use of organic chemicals like naphthalene, ethylene dibromide or paradichlorobenzol for comb protection during storage and treatment against wax moths	Contamination of honey with the same substances
Use of chemical repellents during honey harvesting	Contamination of honey with the same substances
Inadequate use of smoke by quantity or type of combustion matieral	Smoky odour and other flavours of honey and contamination with microscopic soot
Use of old and dark combs and/or brood combs	Honey of darker colour, comb odour, higher acidity and faster aging

Use of combs with residual honey from a previous year	Honey high in yeasts and possibly faster fermentation; premature crystallization of susceptible liquid honeys; contamination of unifloral honeys
Harvesting of incompletely sealed combs, particularly during the nectar flow	Excessive moisture content in honey

The extraction room or space needs to be exceedingly clean as well as the space where the honey supers or combs are stored prior to processing. If processed outside, processing should not be done during a windy or rainy day. All surfaces, hands and containers coming into contact with the honey need to be particularly clean. The need for clean water may influence the site of processing centres or the feasibility of beekeeping in certain areas. In many countries there are explicit rules to which any honey producer has to adhere, as far as minimum facilities and cleanliness in the extracting room are concerned.

Figure 2.8 : Honey comb cropping in traditional or topbar hive beekeeping should only be done in buckets with well sealing lids. The same type of buckets are necessary for storage of extracted honey.

Among developing countries, Trinidad and Tobago is an excellent example for such rules and the compliance of beekeepers to these standards (see Annex 2 for contact address).

Containers and processing equipment need to be made of material compatible with this very acidic food. No copper, iron, steel or zinc should be used as they dissolve into the honey and may affect colour and flavour, and might reach toxic levels. If further processed into other products, chemical reactions of the contaminants with other ingredients might cause strange discolorations and off-flavours. Instead, stainless steel, glass and food grade plastic can be recommended. Galvanized steel (zinc) may be used for surfaces which come into contact with honey only for short periods, such as in extractors. Used containers need to be free of any odours since honey will absorb these very quickly. Storage containers made of improper material can be coated completely with beeswax or food grade plastic liners to avoid any direct contact. There is, however, no adequate protection if the containers have been used previously for toxic chemicals.

2.6.6 Processing

Uncapping is the first real step of honey processing. It consists of the removal of the thin wax layer that seals the honey cells. The wax caps can be sliced off with a sharp, thin, long knife or special knives heated by steam or electricity. Large numbers of frames are more rapidly processed with partially or completely automated uncapping machines which cut or chop the wax caps with blades, chains or wires.

In comb harvesting the equivalent step is the comb selection (eliminating pieces of comb with pollen or even brood - something that should already have been done during harvesting) the removal of bees etc. and the subsequent thorough mashing of combs. Processing proceeds further by either letting this wax and honey mixture separate by dripping through a screen (strainer) or by pressing it in special honey presses (see Figure 2.9). Modified centrifugal extractors (see Figure 2.10) can also be used (Krell, 1991).

Honey frame processing proceeds, after uncapping, to centrifugal extraction. Extractors range in size from a manual 2-frame model to motorized units extracting more than 12 deep supers at a time. More commonly, 24 to 72-frame radial extractors are used for commercial enterprises. The smaller units for part-time beekeepers can be made out of recycled materials (see Figure 2.10). Though honey can be extracted faster and more completely at higher temperatures, the combs will become softer and might break. Therefore, extraction temperatures should not exceed 30^0C.

2.6.7 Purification

The next step is the removal of any impurities such as wax particles, other debris and air bubbles incorporated during extraction. There are two practical techniques: settling and straining. The first simply consists of leaving the honey in a suitably large container, so that impurities can separate according to their specific weight, i.e. air bubbles, wax particles, insect pieces and other organic debris float to the surface while mineral and metallic particles drop to the bottom. The surface scum can be removed carefully, or honey can be drawn off near the bottom for bottling without disturbing either surface scum or bottom sediment. Settling velocity varies with particle size (the smallest settle the slowest), container size and honey viscosity, i.e. moisture content and temperature.

At temperatures of 25-30^0C settling is generally rather quick and can be completed in a few days. Tanks have to be well covered to avoid excessive contact with air. The process can be accelerated by letting honey flow through special buffer tanks prior to filling into the settling tanks. In these buffer tanks the honey is heated through a water jacket, similar to a water bath and then forced to flow up and down through several compartments in the process of which impurities

remain at the surface Such a device works well with medium quantities and once heated like this, the honey can also be filtered more easily.

a) **b)**

Figure 2.9: a) Small, common honey press in Zambia;
b) Larger honey press used to squeeze honey from cappings in Italy.

Subsequent settling frees honey of air and foam and, if containers are big enough, allows some mixing of extractions from various colonies, i.e. blending to achieve a certain degree of uniformity of the end-product. The disadvantage is the cost of the containers for the extra storage lasting several days, which in large operations requires several very large tanks and large amounts of extra space.

Straining can be used instead of, or in addition to, settling. It is more frequently used in larger processing plants, where many tonnes of honey are processed every day and where it is therefore inconvenient and uneconomic to immobilize honey for as long as is required for settling.

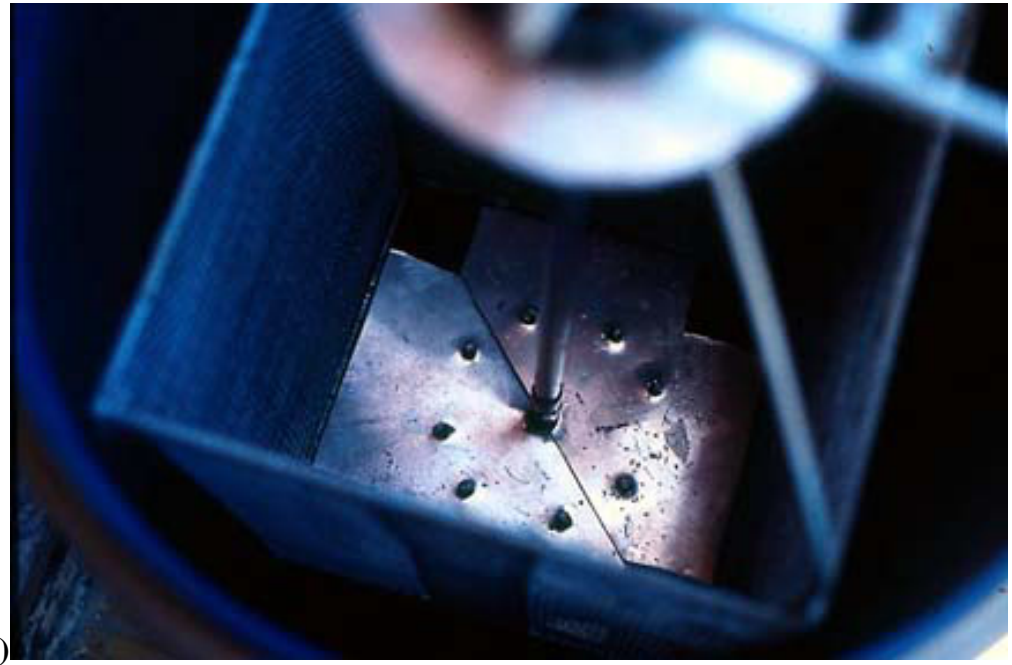
Strainers can be simple metallic screens, preferably covered with a fine nylon mesh (fine nylon stockings are the best) or a nylon sack filter submerged in a tall, narrow tank. The sack-like filter can also be made of several layers of increasingly finer metal screens (perforated metal sheets). These filters have the advantage of a large filter surface which can be submerged to avoid any further inclusion of air. The finest mesh size used commonly has holes of 0.1 - 0.2 mm diameter. The temperature, for this kind of straining, must be near 30°C.

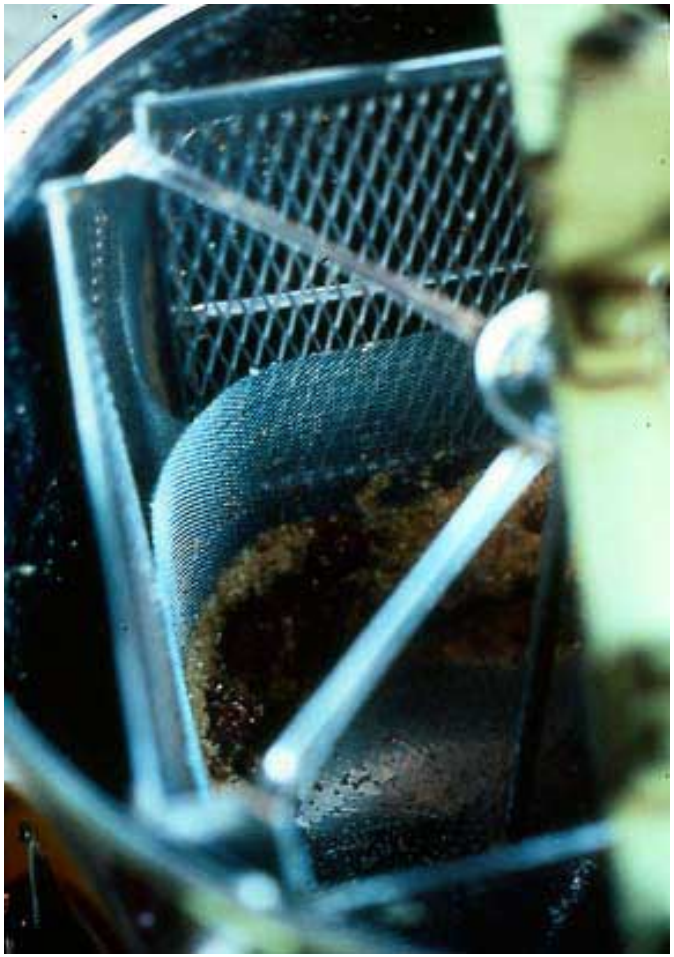
Finer filtering is usually only done in association with pasteurization and heating of honey to 77 -78°C (see 2.12.1). It serves the purpose of removing all fine materials, including pollen, in order to delay crystallization for as long as possible. Such filtration requires high pressure filters with diatomaceous earth. Since it requires heating, and particularly because it removes some natural ingredients such as pollen, this honey cannot be sold as table grade honey in EEC countries. Consumers in some countries regard it as inferior in quality, while it is the preferred quality for supermarkets and other large marketing chains which want a product with a long shelf-life in a homogeneous liquid state.

a)

d)

b)





c) 

e) 

Figure 2.10: Manual 4 frame radial (medium size super frames), 4 frame tangential (2 deep and 2 medium size super frames) and comb honey extractor all in one made from construction steel, bicycle parts, 110 litre plastic drum and 5-mesh galvanized screen. This is a beekeeper's design (Mr Beizel, Formosa, Argentina) adopted and modified during an FAO sponsored beekeeping project *TCP/ARG/0051*.
a) View of top of extractor with basket modified for six shallow super frames or 2 deep super frames. Ideally, the gear and chain assemblage should have a plate below it to protect the honey from oil or other debris. The whole assembly can be easily removed for cleaning or use of the drum for storage.
b) Bottom of wire basket with support for radial extraction, covered with aluminum (or wood) plate for broken comb extraction.
c) A 4-frame (8-shallow) tangential extractor modified for radial 4-frame and broken comb extraction.
d) A normal tangiential extractor similar to
e) modified for broken comb extraction with solid bottom plate and a finer mesh screen (5-mesh) at the bottom 15-20 cm. e) A large honey press/extractor for separating honey from comb uncappings used in Italy.

All the above purification methods can only be applied to liquid honeys. It is therefore preferable to use them immediately after extraction, when honey is still naturally liquid and at the right temperature. In processing plants of large buyers, it is however often necessary to purify honeys that have already crystallized. In this case, the honey has to be melted first without destroying any of its characteristics (see 2.12.1).

Even the small buyer sometimes has to clean purchased honey, since most beekeepers do not process their honey to sufficient standards for inclusion in other

products and often not even well enough for bottling for direct retail sale. Here too, it is important to proceed as soon as possible after purchase, before crystallization commences. On a small to medium scale, settling is usually the least expensive and least labour-intensive method, particularly if the honey barrels can be stored for a few days in a warm (30 – 35°C) room. As with larger buyers, additional straining assures that the raw product offers at least a minimum standard of hygiene requirements.

Extracted, cleaned or purified honey is ready to be consumed directly or to be included into other products. But processing technology does not end here Other techniques are employed to prepare a product of uniform, constant and agreeable appearance, or to prevent the only possible storage problem: fermentation.

2.6.8 Moisture content

Moisture content of honey is practically the most important quality parameter, since it affects storage life and processing characteristics Even though moisture can be removed after extraction, only completely ripe honey should be harvested, i.e. combs with more than 75 % of the honey cells sealed. To achieve such results prior to the very end of the nectar flow, the colony has to have sufficient super space for storing incoming and ripening honey. When the average atmospheric humidity is not much above 60%, a moisture content below 18% may be expected in the honey (see Figure 2.5). In more humid climates even sealed cells can contain honey with more than 24% even 28% moisture content (Krell, unpublished, and Crane, 1990, respectively). Combs containing fresh nectar should never be harvested, because it can dilute and spoil the whole harvest - unless of course the purpose of harvesting the honey is making beer.

Post-harvest reduction of moisture content can be achieved by leaving honey supers in warm rooms at 30 to 35 ^{0}C and circulating warm air through them. At this time, the surface area of the comb relative to the honey mass is still fairly large and does not require any extra equipment for efficient evaporation. In relatively cool climates the circulation of air heated to 35 ^{0}C can reduce moisture content in open honey cells by 1 to 3 %. This is the easiest and cheapest of all post-harvest moisture controls. The relative humidity of the air at 35 C has to be controlled, however. If it is more than 60%, aerial moisture will have to be removed by a dehumidifier. In tropical climates, the air temperature will have to be considerably higher (damaging to honey) or prior dehumidification of the air will be necessary. This requires a small, specially sealed room and a dehumidifier.

Post-extraction moisture removal is slightly more involved (Alfa-Laval, 1988), but small scale methods are available (Maxwell, 1987 and Platt and Ellis, 1985). Krell (1992) described a cheap small scale honey drier, adaptable also for solar heating, in which hot air is conducted over a thin film of honey running on an inclined surface. Large scale solar or semi-solar models have been tried successfully (Paysen, 1987). In industrial plants, vacuum driers are used at less than 45 ^{0}C, similar to those for dehydrating fruit juices and other foods, but smaller vacuum driers especially made for honey drying are available for less than US$10,000 (see Figure 2.11). Many other systems have been designed over the years, but honey should require such treatment only under exceptional conditions.

2.6.9 Prevention of fermentation

Fermentation is the only microbiological alteration to which honey is susceptible. Only osmophilic yeasts can grow in the high sugar concentrations, but their presence is ubiquitous in honey, nectar, hive interiors, dust and soils. Their rate of multiplication increases proportionally with increasing water content, up to a certain point. Below 18 % moisture content there is little probability of fermentation, but even at concentrations below 17.1 % the risk of fermentation cannot be completely excluded. This aspect of fermentation depends on factors such as the quantity of yeast and other growing factors - honey temperature and the distribution and availability of water following crystallization.

Appropriate and expensive cold storage (see section 2.7) but above all, careful production techniques, can prevent fermentation. If, after all precautions and care, honey cannot be harvested at less than 18% water content, excessive moisture should be removed (see section 2.6.8). Either one of the previously described methods, if carefully used and if honey has not yet fermented, can prevent fermentation without degrading the honey.

Another method is based on pasteurization and the destruction of the yeasts. The osmophilic yeasts found in honey die after only a few minutes of exposure to temperatures between 60 to 65 ^{0}C. If the honey is heated and cooled quickly enough, with special heat exchangers feasible only on an industrial scale, very little damage occurs to the honey. Often these pasteurization treatments have two functions, the prevention of fermentation and the postponement of crystallization (see section 2.12.1).

Relatively small quantities of honeys with high moisture content do not justify complicated and costly pasteurization, or drying. They should be directed towards a market with immediate consumption, for processing into other food items or for fermented drinks (see recipes in section 2.12). Such honey should not be considered for shipping over long distances as containers might explode. Careful heating in a water bath to wax melting temperatures (about 65 ^{0}C) and subsequent cooling in a water bath with running water may prolong storage life. For small quantities, this is an acceptable compromise between spoilage by fermentation and some loss of quality by heating. Under most circumstances, however, water baths are overheated and honeys are not properly stirred and cooled down rapidly enough. Pasteurization on a small scale can therefore only be recommended for emergencies and not as a routine procedure as it is used in many places. The pasteurized honey needs to be bottled hot in a clean environment in order to prevent reinfection with omnipresent yeasts.

Contents - **Previous** - **Next**

2.6.10 Heating

As can be understood from the previous discussions on viscosity, fermentation and moisture control and as will be seen in the following sections, heating of honey makes production easier in many ways. Simultaneously however, any application of heat has a negative effect on honey through the loss of thermolabile, aromatic substances, which is proportional to the temperature and duration of heating (see also section 2.7.). The basic concept therefore is to heat the honey only to the lowest temperature and for the shortest period consistent with the desired technical objective.

Honey owes its distinctive characteristics not to the stable major compounds which can be found in any other sweet product such as sugar, molasses, syrup and marmalade, but to the multitude of minor components originating from the nectar and the bees themselves. Many of these substances which give honey its specific aroma, flavour and some of the biological activities are unstable over time and thermolabile, i.e. they are destroyed by heat. This uniqueness and fragility affords honey its legal protection and consumer preference, at least in most of Europe. All the following precautions in regard to heating, storage and further processing are made in consideration of these fundamental quality characteristics of honey

Figure 2.11 : Small to medium-scale vacuum drier for removing moisture from already extracted honey (courtesy of Dadant and Sons, Inc.).

With respect for the just-mentioned effect on its quality and its peculiar physical characteristics, honey needs to be heated always with particular care. Its low thermal conductivity makes uniform heating throughout a large body of honey very difficult and the use of high temperature heat sources like open flames or a boiling water bath may quickly lead to local overheating. This may cause significant alterations of the honey's characteristics, even caramelization. When heating in industrial plants is required in order to reduce honey viscosity or melt crystals, special large surface heat exchange systems are used with a heat source only a few degrees above the temperature to which the honey is to be heated.

For the melting of crystallized honeys in large containers, thermoregulated rooms or water baths are maintained

at temperatures between 35 and 50° C. Some melting times for different size containers and temperatures are given in Table 2.10, but times also depend on the type of honey. For heating smaller quantities, only indirect heating through the water bath method should be used (see Figure 2.12) and the water should never be more than 5-10° C hotter than the desired temperature of the honey. It should certainly never be boiling. Appropriate cooling has to be provided afterwards, like running water through the water bath.

Figure 2.12 : Small-scale heating of honey in a water bath. The inside pot should not touch the bottom of the larger, water-filled pot. Wood blocks or stones may be used to support it.

In large containers heating can be provided externally or internally with special heating coils through which hot water is circulated. Usually, some kind of mixing device like propellers, blades or recirculating pumps are added in order to facilitate heat exchange. In fact, in large processing plants, smaller containers are preheated in warm rooms kept at 6O~7O0. As soon as the honey softens at ***35*** to 40^0C, it drips out of the inverted containers over grids or inclined surfaces kept at *35 - 45* ^{0}C. Before reaching the high room temperature it is then pumped out of the hot room into large melting vats where the melting of crystals is completed.

For smaller operations thermostatic electric heater bands are wrapped around the honey containers. Alternatively, electrically heated or hot water coils of a size adapted to the container, are set on top of the crystallized honey, slowly sinking under their own weight through the softening honey. Solar heating could be used to preheat or soften the honey to speed up the process. Even the water for the heating coils can be inexpensively heated by solar energy, since only relatively low temperatures are required.

Table 2.10:
Time required on hot rooms for melting a finely crystallized honey (17.5% water content) in a hot room without stirring, according to container size and room temperature (Jeanne, 1985)

Container size	40°C	45°C	50°C
20 kg	24 hrs	18 hrs	16 hrs

50 kg	48 hrs	36 hrs	24 hrs
80 kg	108 hrs	72 hrs	60 hrs
300 kg	-	108 hrs	72 hrs

2.6.11 Packaging

The bottle or package should be leakproof and airtight so as to safely contain the product, but also present the product in an attractive form, enticing the consumer to buy it. The label, container shape and material or other packaging material should be chosen accordingly.

Labels also have to provide all legally required information and preferably a lot number to help the producer track down any problems. For discussion of special labels, packages and label printing, etc., see also section 9.9. All confections, independent of size, have to be labelled correctly, according to local laws. In addition to the legally required information, some information may be provided to the consumer on the various uses of the particular product. Though packaging does not improve the product itself, it may very well add value to the product. One such value added form consists of packaging small portions for hotels and airlines or of special gift packages with honeys of different colours and origin, or of special containers such as clay pottery (see Figure 2.13). Single portions may be packed in plastic straws (see Honeystix in Annex 2), flexible plastic bags, aluminum and plastic envelopes or inside soft plastic in the shape of animals. Multi-dose soft tubes can be sold singly or in small packages as snacks which may be carried safely to work or school, picnics, or while jogging.

a)

b)

Figure 2.13: a) A few small honey packages for tourists or hotels, restaurants and airlines. b) A display of various decorative honey containers and dispensers.

For most retailing of pure honey, the preferred packing material is glass followed by plastic or, for large quantities, metal containers coated with materials appropriate for contact with acidic food. In any case, the containers have to have a secure airtight lid. Screw top lids on glass jars are the most secure. Heat-sealed plastic and aluminum lids on plastic cups are fairly safe as well. Though not as appealing as clear glass jars, transparent or semitransparent plastic containers in stackable cup or jar form are cheaper and easier to ship and store. Screw top lids on plastic jars often leak during transport and result in sticky containers, honey loss and spoilage. A more rigid container and heat-sealed inner lids or plastic films, as used on many medicine bottles could solve this problem. Waxed cartons have been abandoned because they were not safe enough. Half and one-litre flexible polyethylene bags have been used in several countries for many years. These are extremely economic to ship, but require that the consumer has a special outer container suitable for holding the honey or the honey bag.

Recycled glass bottles may be appropriate if they can be cleaned adequately and a cork-type seal can be provided. Bottles which previously contained any oils, household cleaners, gasoline or any other non-food or non-drinkable liquid should never be used. If bottles are cleaned with soap they have to be rinsed many times. If water is limited, the bottles should be washed with sand and clean water without soap. Most screw tops for bottles do not close very well and ants frequently enter such bottles. Leaving wax and other hive debris in the honey to form a plug in the bottle neck appears to protect honey from aerial moisture and in some cases might even retard fermentation. It is however, not a form presentable to most urban consumers. Corks or wooden taps which do not seal hermetically need to be sealed with hot beeswax.

Different honey-containing products require their own specific packaging, most of which is discussed together with the products. Package choice should however also consider recyclability, disposability and environmentally friendly manufacturing of the packing materials. Excessive packaging in many countries is not only wasteful, it also contributes to pollution and waste disposal problems.

The decision about which form of presentation or packaging to choose for marketing should take into consideration the predominant local form of use, the honey characteristics (such as crystallization, fermentation and colour) the volume, the length of time between processing, retailing and consumption, the availability and cost of filling technologies and packaging materials, the potential appeal to the consumers and the environmental compatibility of materials.

2.7 Storage

Storage containers for liquid or crystallized honey should be made either of glass or stainless steel or coated with food approved plastic, paint or beeswax. Nothing should be allowed to impart any odour to the honey. Particularly if used containers are recycled, care must be taken that they are absolutely clean and have not the slightest residual odour. Honey readily absorbs odours of all kinds and these can, for example, be readily absorbed by a beeswax coating and then passed into the honey. Containers previously used for toxic chemicals, oils or petroleum products should never be used for storing any bee products, even after coating with paint, plastic or beeswax.

Openings in wholesale containers have to be big enough to facilitate removal even of crystallized honey. To keep moisture out, lids have to be airtight and all products should be kept away from heat and (preferably) light. Also, most products containing honey should be protected from excessive moisture by special packaging: baked products in moisture proof clear plastic bags, caramels in separate plastic or waxed paper wraps and single portions of liquid or pulverized product in laminated foil envelopes made of aluminum foil covered with plastic or plastic and paper envelopes. Storage rooms should have a temperature near 20^0C and a relative humidity of less than *65 %*. Storage of honey at more than 25 ^{0}C causes increasing quality loss with time, due to progressive chemical and enzymatic changes.

Honey is considered a stable product, in the sense that it is not spoiled by the bacteria and fungi normally responsible for food spoilage. Products containing honey however, are preferred targets for such organisms and therefore demand pasteurization (stabilization with heat) or chemical preservatives (according to product requirements) plus adequate storage and protection from recontamination after production. Proper storage and packaging together with quick marketing and consumption will reduce or eliminate the need for preservatives.

Fermentation remains the major threat to unprocessed honey, whether it is liquid or crystallized. The prevention of fermentation has already been discussed in section 2.6.9. Therefore storage conditions have to prevent fermentation through either low temperature storage or by preventing further absorption of moisture.

Even honeys which are not susceptible to deterioration by yeasts however, can be subject to other progressive alterations due to chemical and enzymatic action. These changes include organoleptic characteristics such as colour, taste and aroma, together with a loss of biologically active substances (inactivation of enzymatic and antimicrobial activity). Substantial changes may also occur in the sugar composition with an increase of disaccharides and other complex sugars and a corresponding decrease in simple sugars. Other transformations of the initial composition include an increase of acidity and HMF content. These changes occur in all honeys, but at different rates according to their initial composition (more moisture and a lower pH result in faster changes) and storage temperatures (higher temperatures also lead to faster change). The same changes take place even faster during (and after) the heat treatments of various processing technologies. Though damaged honey does not become dangerous to human health, it nevertheless loses some of its nutritional and organoleptic values. Therefore in almost all countries, legal limits are set for the degree of "ageing" (or deterioration) of honey for food use (see quality control section 2.8).

Heat and sunlight (mostly the ultra violet (UV) spectrum) can destroy the quality of honey both in brief high exposure or in low level exposure over a long period of time. Some decay is unavoidable, but it should be kept to a minimum. UV radiation destroys glucose oxidase and thus most of the antibacterial activity. Table 2.11 lists the half-life of diastase in honey at different storage temperatures. Since it is difficult to give a precise preservation limit for honey, due to the large variability of different factors, HMF and diastase are used as indicators of damaging treatment received by a honey during either processing or storage. Decreasing half-life, i.e. faster disappearance of diastase, can therefore be equated with increasing damage to honey. However, initial diastase contents vary in different honeys and have to be known for the fresh untreated material. HMF is used more frequently as an indicator since its value is close to zero in very fresh honeys (other than a few tropical honeys) and its level increases with time and exposure to heat.

EC regulations state a minimum of 8 diastase units for honey. Thus a honey initially containing 16 units can no longer be sold as food grade honey if stored for 4 years at 20^0C, 18 months at 25^0C, 7 months at 30^0C, 4 months at 32^0C etc (see Table 2.11). In view of normal production to consumption periods, a storage temperature of 20^0C is considered an economical compromise. In warm climates it is important to protect storage vessels from overheating and possibly cool them by special shading or ventilation. Processing, moving and selling honey have to be as fast as possible. Care also needs to be taken that the honey is not damaged by overheating during trucking (particularly during parking in direct sunlight) or while waiting for reloading in harbours or railroad yards. The same is true for small bottles of honey sold at road sides or in market stands. They should never be left in the sun.

Table 2.11:
Diastase half-lives calculated for different storage temperatures (White et al., 1964).
(The half-life is the time in which the diastase content decreases to half its original value.)

Temperature (°C)	Honey diastase half-life
10	12,600 days (34.5 years)
20	1,480 days (4 years)
25	540 days (18 months)
30	200 days (6.6 months)
32	126 days (4.2 months)
35	78 days (2.6 months)
40	31 days
50	5.38 days
60	1.05 days
63	16.2 hours
70	5.3 hours

71	4.5 hours
80	1.2 hours

Considering the aspects of presentation of the product, maintaining its liquid or crystallized form is important (see also Figure 2.3). Only cold storage below 5^0C is suited to simultaneously prevent crystallization, melting of crystallized honey and fermentation. Such storage is however expensive and rarely used on a large-scale except to briefly preserve special honeys for further elaboration. Storing liquid honeys above 25 ^{0}C to prevent any crystallization can only be recommended if very quick sales are expected. A temperature of 20^0C was mentioned as a compromise for storage of liquid and crystallized honey. Those honey products exhibiting the same physical characteristics as natural honey need to follow the same guidelines as those for the unprocessed product. Other processed products containing honey may have individually different storage temperature requirements.

2.8 Quality control

The quality control of honey has two principle purposes. to verify its genuineness i.e. to reveal possible frauds such as artificial honeys, adulteration etc., and to determine its quality in respect to the needs of the processor and the market. The composition limits of the natural product are defined internationally by the Codex Alimentarius Commission (Codex Alimentarius, 1989 and 1994, see Annex 4) which also mentions the officially approved analytical methods. In many countries more restrictive laws and regulations exist to which one must refer if marketing in these countries is intended. Legal quality standards serve to protect the consumer, be it the processor or the end consumer.

Adulteration

In many countries it is customary to call any sweet syrup "honey". Corn, cane or rice syrup and even molasses can be seen labelled as honey. Thus it may be legal to call things honey which, according to international standards, are not. It is in the interest of the local beekeepers to have laws that define honey more precisely or at least reserve the name bee's honey for a product conforming to international standards.

Most simple adulterations of honey can be detected if certain characteristics exceed the legal quality standards, for example by a high sucrose content (> 8%) if simple cane or beet sugars are added, or high HMF values if acid hydrolysed corn syrup is used. The latter has fructose/glucose ratios similar to honey (HMF >200, White, 1980). If however, the high fructose corn syrup is used, which is produced by enzymatic processes and contains fructose/glucose ratios similar to honey, the detection of ^{13}C isotopes (White and Doner, 1978) or thin-layer chromatography (White, et al., 1979) are required. This high fructose corn syrup is not yet readily available in many developing countries, however. The isotope method can detect adulteration with any kind of cane sugar or corn syrup; even in products allegedly containing honey only as a minor ingredient (Donor et al., 1979).

Simple field methods for detection of adulteration without laboratory equipment are based on taste, viscosity (most adulterated honey is thinner, but so is honey with a high moisture content) or its solubility in cold water (see Figure 2.14). If a droplet of honey poured into cold water stays together without dissolving rapidly, it is most likely pure honey. This can be observed best against the light with a dark background. If the edges of the droplet or the thread starts dissolving during pouring, the honey is likely to have been adulterated or has a very high water content. In any case it should be kept separate from other honey until more precise tests can be carried out.

Production quality

For companies' internal quality control of production and processing different parameters may have to be taken into consideration, which depend on the requirements of the manufacturer. Internal standards serve to allow production control and product standardization, and to adjust production cost to various product requirements and different quality levels. These quality levels may be established internally, may be demanded by the market, or may be required by a company under whose label the product will be marketed. Since honey is included in a wide variety of products, these standards cannot be given here, but must be investigated through local authorities and industry organizations.

The parameters most frequently controlled by enterprises which receive honey for further processing are the condition of containers, cleanliness, the homogeneity of the shipment, organoleptic characteristics (taste and aroma), colour, moisture content, degradation of honey measured by diastase and HMF content, composition of principal sugars and microscopic examination for the determination of botanical and geographical origin. Depending on the needs of the manufacturer, some or all of these characteristics are controlled. Large enterprises have their own laboratories while smaller manufacturers can only perform simple measurements themselves such as colour, taste and moisture determinations and have to rely on outside laboratories for more detailed analysis. Table 2.12 shows an outline of controls adopted by some European honey processors. Other parameters not mentioned in this table, such as the microbiological control of honeys destined for use in dairy products or the identification of residues of noxious contaminants such as pesticides and bee drugs are rarely controlled.

a)

b)

c)

d)

Figure 2.14 : A simple field test for adulteration of honey. a) Pure honey pours and settles without readily dissolving. b) and c) honey mixed homogeneously with equal amounts of a 70% sugar syrup (sucrose) does not pour as straight and creates turbulence and turbidity almost instantly, but particularly after pouring a greater quantity or slightly disturbing the water. The honey syrup settles irregularly at the bottom. d) 70% sugar syrup (sucrose) only; turbidity is even stronger and no distinct settlement at the bottom occurs.

Table 2.12:
Outline of quality control measures taken by a typical European honey processor on honey prior to processing

Parameters	Control method	Limits
Containers	Direct observation	Adequate material and condition

Homogeneity of lot	Direct observation	Apparent homogeneity according to observable characteristics in whole shipment
Impurities	Direct observations of honey surface in container, filtration, or polarized light test	Presence of limited impurities such as bee and wax particles
Organoleptic characteristics	Organoleptic analysis on an average sample	Absence of defects such as strange odours and tastes, fermentation, overheating or otherwise unpleasant characteristics. Correspondence to samples from producers and to foreseen standards for end product classification
Colour	Optical comparison with Pfund meter of according to Lovibond (Gonnet, 1986a)	Correspondence to producer sample and foreseen standards for product type (Accorti et al., 1986)
Moisture content	Refractometer measurements (Codex Alimetarius, 1989)	Less than 18.0% for top grade (less than 21% max. limit)
HMF	Colorimetric method (Codex Alimentarius, 1989)	Less than 10mg/kg for top grade (40mg/kg is maximum limit)
Microscopic characteristics	Quantitative and qualitative pollen analysis (Louveaux et al., 1978)	Correspondence to declared botanical and geographic origin
Others	Official methods	According to legal limits

White et al., (1988) described relatively simple laboratory techniques and set-ups for basic quality testing of honey to determine adulteration and degeneration. Bianchi (1991, in Spanish) in an FAO bulletin describes even simpler methods. The extract of the Codex Alimentarius in Annex 4 describes the official laboratory procedures for honey quality tests.

Any control should always include verification of the proper functioning of the processing techniques and of the finished products, i.e. the consistency of characteristics important for the presentation such as colour, appearance, physical consistency, taste and aroma. Of course, each honey containing product has its own set of production and legal quality standards which need to be observed. A sample of each processing batch should be retained under normal distribution and storage conditions, in order to monitor product shelf-life.

It is advisable that all processed products containing honey for which formulations and processes have been newly adjusted, are run through a small test (pilot production) to verify the acceptability of the product and the preservation characteristics and to reduce cost of unforeseen problems. Also in this case, the preservation of a sample of the product is good practice. Particularly during such trials and test runs, it is important to keep precise notes of all production parameters, even those that seem unimportant. This will be very helpful if some problems have to be corrected. During actual production, lot numbers on labels will be helpful in tracking down

problems even if not required by law.

2.9 Caution

Honeys of some flowering species are reported in the literature as toxic (White, 1975c and Kerkvliet, 1981) because of their content of active ingredients from nectars or honeydews which are noxious or toxic to humans. Although these honeys are not very common, they can be of particular importance in some localities. The plant families and genera from which a few species have been reported to produce toxic honeys include Ericaceae (Rhododendron, Azalea, Arbutus, Andromeda, and Kalmia); Solanaceae (Datura, Hyoscyamus, and Atropa; Compositae (Senecio jacobaea or ragwort); Lagnonaceae (Gelseminum); Ranunculaceae (Aconitum), some species of the genus Euphorbia in South Africa and the honeydew of Coriaria arborea from New Zealand (Crane, 1990). Bitter and off-flavoured honeys are produced from many more species.

The consumption of honey by infants less than one year of age is not recommended by the US Food and Drug Administration (Anonymous, 1981). This recommendation is based on the correlation of some infant deaths with the ingestion of botulism spores (Clostridium botulinum) from honey. The spores were recognized in very few samples of Californian honey for the first time in 1976 (Huhtanen et al., 1981) and more recently also in the UK (Crane, 1979) and Italy (Aureli et al., 1986). Other surveys in Italy (Quagho et al., 1988), France (Cohn et al., 1986) and Norway (Hetland, 1986) have not found any C botulinum spores in any honey samples. Though omnipresent in the environment and in many foods, the spores normally are not capable of developing in the intestines of adults or children. However, since very young infants often have less acidic digestive tracts amd less competition from a bacterial flora as yet little developed, Clostridium spores may develop in their intestines. The toxin produced by the bacteria binds irreversibly to motor nerve endings and can only be overcome by the growth of new nerve endings. Some of the typical symptoms are mild paralysis (failure to thrive), moderate to severe paralysis, which requires hospitalization, and fulminant (sudden and intense) paralysis which can lead to death without warning. Other milder symptoms can be constipation, listlessness, lethargy, diminished appetite or activity and lack of muscle control.

In the USA there have been direct correlations between honey consumption and infant botulism, but it is difficult to say whether the one third of world-wide infant botulism cases, in which infants had prior exposure to honey, were due to ingestion of spores from honey. Spores in honey cannot grow or multiply unless they have a watery, anaerobic (no oxygen) medium with a more or less neutral pH. Therefore even in the newborn infant, special conditions have to come together to allow the spores to germinate and produce their toxin, such as after changes in the intestinal flora due to antibiotics, anomalies of intestinal secretions or others. The risk for a child less than one year old contracting this infection has been estimated by Lawrence (1986) to be about 1 in 12,000. Such a risk is likely to be higher during the first one or two months and lower during the second half of the year.

In India and many other parts of the world honey is given to newborn babies during the first few days of life as a special tonic, particularly if they were born weak or prematurely (Arora and Kual, 1973; Bansal et al., 1973 and Bhandari and Patel, 1973). In countries with better infant nutrition and generally more hygienic conditions, honey may be eliminated from the diet of an unweaned child, since it is not an essential food. Under less favourable nutritional conditions the risk of ingesting C. botulinum spores through eating honey and the resulting possibility of death must be weighted against the benefit of strengthening the young organism against many other more common stresses and diseases.

Normally, C. botulinum causes problems only in badly preserved products (contaminated or insufficiently boiled preserves or conserves, pH near 7, absence of oxygen, and storage at room temperature). Cooking the product at 80^0C for a few minutes will destroy the toxin and bacteria, but spores will survive up to 130^0C. The presence of C. botulinum in honey is not due to any carelessness or mistreatment of the honey, nor can it be

eliminated with normal processing other than ultrafiltration. Conditions in properly stored honey will not allow the bacteria to grow and produce any toxin. Fortunately, it is not a risk for anybody with a healthy intestinal flora or above the age of six months or a year.

Products containing honey and intended for human consumption or cosmetics should be treated as carefully as any food item, and with even greater care as regards storage if they are prepared with no preservatives.

2.10 Market outlook

Data about world-wide honey production are published every year by FAO. In 1991, world production reached almost 1,200,000 tonnes. The increased production in the last 20 years, despite fluctuations in individual regions and countries (both industrialized and non-industrialized) is accredited to an increase in the number of hives and production per colony. The major producers are Russia, China, USA, Mexico, Argentina, Canada, Brazil and Australia. The major exporters are China, Mexico and Argentina, but the highest colony yields are recorded in Australia and Canada which have a favourable environment as well as highly developed colony management. The major consumers and importers are the industrialized countries led by Germany, Japan, USA and UK. The increased consumption over the last few years can be attributed to the general increase in living standards and a higher interest in natural and health products. Western Europe as a whole imported approximately 140,000 tonnes which is about *55 %* of consumption. The average EU per capita consumption of 600 g per year varies widely amongst individual nations, from Greece with 300 g per capita to Germany with 1,800 g per capita.

The international market usually trades honey in 300 kg metal drums and only a very small percentage of the market is traded in retail containers. The latter is mostly between neighbouring countries and within Europe, but also to the Near East and other small markets which do not justify proper bottling facilities for importers. Creamed honey from Canada is an exception with its worldwide distribution, and so is the still very limited exportation of bottled honey from Argentina to Spain.

International prices depend, as with any other commodity, on supply and demand. During the first half of the 1970's prices increased markedly (tripling between 1970 and 1974 with increasing demand) but declined rapidly in the years immediately following. In the last 20 years however, the price has remained basically within the same range of slightly less than US$1/kg for light to extra light amber honey without any defects. Price fluctuations were influenced by market variations in producer as well as consumer nations and of course by currency fluctuations. The quality of the honey in general determines the price class, e.g. table grade (US grade A) or industrial grade (US grade C or D). Such parameters as moisture content, cleanliness, off-flavours and homogeneity are major considerations. Some importers require extra low HMF values for prime grades, but colour though not a quality, determines the final price once the minimum quality requirements within each grade are fulfilled.

In general, light-coloured honeys bring the highest price and dark ones are most frequently used for industrial production. Mild flavoured honeys are preferred, but characteristically flavoured honeys bring top prices in some countries. Large honey packers usually prefer honeys with a low tendency to crystallize. Some unifloral honeys such as Hungarian Black Locust honey bring twice the price of regular, multifloral honey. Small shipments into Switzerland of unifloral honeys such as lavender honey, in most cases already bottled, bring much higher prices. Local prices in most developing countries are higher than the international market prices and prices in neighbouring countries with less honey production or favourable exchange rates may sometimes be quite attractive.

Consumption of honey may increase further, particularly in some Asian and Latin American countries, and there is a large production potential still unexploited, but international prices are below production costs in many

countries. Therefore, rationalization, product specialization and local marketing are extremely important before international markets can be approached.

Almost 20 years ago, industrial consumption of honey was only *5* to 15% of total honey consumption (UNCTADIGATT, 1977). This proportion has increased in the meantime and is expected to continue increasing, considering the advantageous consumer appeal of products with honey as an ingredient. Unfortunately, this section of the honey market still represents the lower priced end of the spectrum, yet will require more product uniformity i.e. processing, in the future.

The retail market for honey products has very different conditions and depends much more on the economic, cultural and social conditions of each community or country. Also, a product refused in one region may still enjoy special appreciation and market value in another. This is also true for unprocessed honeys.

In countries with a well developed honey consumption, product diversity is increasing on the basis of different product qualities and characteristics. In addition to the traditional liquid and crystallized honeys of different colours, diversification based on taste and botanical or geographic origin is slowly increasing. Unifloral honeys are increasingly requested and appreciated, despite their higher prices. Multifloral honeys from certain geographic regions are also increasingly popular and appreciated by local consumers or tourists. Occasionally, some honeys become known outside their local or national markets such as Canadian clover honey in Europe or Zambian forest honey in the UK. If, for industrial use, standardization becomes more important, i.e. the same uniform characteristics in every batch, the blending of different honeys will become unavoidable. For direct marketing and for more sophisticated (appreciative) markets, the selection and distinction of particular products is the more likely and more remunerative way to achieve market expansion.

There are no separate market statistics on products containing honey or on special (unifloral or creamed) honeys. Their markets are very local, except for cosmetics, snack bars and in the future, beverages. Other exceptions may be specialized honeys like unifloral honeys, those from certain forest types or those produced in regions which are guaranteed to be uncontaminated. Occasionally other products may find a market niche among exports, but processed products for sophisticated markets face extremely high quality demands and competition.

Expansion of markets with honey-containing products should be considered on a national level or for across-the-border trade. Consumer education and of course, spending power will probably be the most important factors influencing the possibility of expanding local markets or for increased product diversity. The examples given in this chapter might serve as ideas for possible modification and adaptation to individual circumstances.

2.11 Honey from other bees

In the foregoing pages the honey referred to was always from Apis mellifera, the European, African and Near East honeybee species which has now spread all around the world. This honey is undoubtedly the most widely collected, but regionally there are honeys made by other bee species which are sometimes collected in considerable quantities. The other Asian Apis species make a honey very similar in composition and taste to A. mellifera honey. Honeys from non-stinging social bees (Meliponini) are generally more liquid and vary widely in flavour.

Apis cerana can be raised in hives like some of the tropical A. mellifera species. It was the only manageable species in most of Asia until the introduction of European bees in many parts of Asia. Honey yields from A cerana are very small in tropical regions (3-10 kg per colony) and only slightly larger in more temperate climates (up to 25 kg per colony, with occasional exceptions). Insufficient scientific data are available to define

quality standards as for A. mellifera honey. In an experimental comparison by Vorwohl (1968) ~A. cerana honey was basically distinguished from A. mellifera honey by a lower diastase and higher water content. Amino acid contents were also different and sometimes exceptionally high acidity values were recorded (Persano, personal communication). Honeys from the other two Apis species, A. dorsata and A. florea are only collected from wild colonies and less frequently from A. florea, probably because of its much smaller nest size and yield. Nothing is known about the honeys of the more recently described Asian Apis species A. andreniformis, A. laboriosa and A. koschevnikovi. These species are similar to A. florea, A. dorsata and A. cerana respectively and their honeys, collected in the same way as the ones of their "sister~' species, are therefore likely to be very similar as well.

Social, stingless bees (Meliponini) store honey in special honey pots rather than combs (see Figure 2.15). Their honey is either robbed from wild nests or, with some of the more prolific species, from specially provided nest sites (boxes). The Inca and Maya cultures of South and Central America are said to have had flourishing beekeeping activities with Meliponini species. The honeys, often very different from species to species, have a much higher water content, are more acidic and have a stronger bacteriostatic (inhibitory) effect than A. mellifera honey and contain no diastase (Persano, personal communication; Cortopassi-Laurino and Gelli, 1991). They were locally appreciated for their therapeutic activities, similar to that of honeybee honey. Their topical use in eye cataracts and other corneal afflictions is widely known. Other insects which store sweet reserves and are occasionally robbed by man are some bumble bee (Bombus) and social wasp species (Nectarina and Polybia).

Figure 2.15: The sealed and unsealed honey and pollen pots of a stingless bee nest in South America.

2.12 Recipes

The following honey recipes have been chosen as examples of the many product possibilities in different fields. Almost all can be used as a base for numerous variations suggested by the availability of particular ingredients, by the needs and preferences of the market, together with the distribution, taste, customs, habits, needs and

economic abilities of the final customer. Other suggestions can be found in section 2.5. The suggested recipes and described uses cover several trades and industries. They therefore cannot cover in-depth all aspects, such as general, legal, technical or economical considerations, or the best manufacturing techniques of specific products. In many cases, like industrial bakery or medicinal preparations, the manufacturer has to have specific skills which cannot be transmitted in this publication. Nevertheless, those recipes that are presented should allow good quality production at least on an artisanal and small to medium scale of production. It would be appreciated by the local beekeeping industry if larger food producers could take some of the product ideas and develop their own product formulations using local beekeeping products. For any specific industrial or semi-industrial production problems or formulation possibilities, enquiries can be directed to the National Honey Board of the USA, a non-government organization financed mainly by and for the U.S. honey industry.

For practical purposes, the descriptions of processing and preparing liquid, creamed, section, comb and chunk honey are included in this recipe section. No economical consideration has influenced the choice of recipes, but solely the usefulness of the product type for artisanal, small or medium scale production.

Contents - **Previous** - **Next**

2.12.1 Liquid honey

Some honeys remain in a liquid state naturally, if they have a low glucose content and a glucose to water ratio of less than 1.8 (e.g. honey from black locust, chestnut and tupelo), a high water content or if they are kept constantly at a temperature of more than 25 ^{0}C (or less than *5* ^{0}C). It must be remembered that high water content and temperatures above 25 ^{0}C are not desirable for the quality of honey.

If it is necessary to keep honey liquid for extended periods of time, some special measures have to be taken to ensure such liquidity. The following discussion is intended to give some practical hints for preventing crystallization.

In order to liquify honey which has already crystallized or has started to crystallize, the honey is most commonly heated ~ust prior to sale) to 40 - 50^{0}C until all the crystals are dissolved. The dissolution of the crystals is more commonly referred to as "melting" by beekeepers. It is more practical to melt the honey prior to bottling, but it is quicker after bottling when complete melting of all crystals is easier to control.

The length of time that honey remains liquid after such melting is variable and depends, as with unprocessed honey, on its composition and the storage temperature. Once heated honey recrystallizes, it should not be melted again, since the much larger crystals now require more heat to melt them. The degradation caused by a single treatment like this, including the damage caused by heating honey for 24 hrs at 40^{0}C and the time required to melt it completely, is far less than that produced by prolonged storage at a temperature above 25^{0}C (see Table 2.11).

For industrial processing, relatively complex techniques (not just melting the crystals) are employed to delay re-crystallization. As a first step honeys are selected and mixed in such a way that the final product shows constant colour and flavour characteristics and a relatively low glucose content. For that reason honeys with high glucose content such as rape, sunflower and composite honey are generally excluded.

The following processing method was suggested by Gonnet (1977) for honeys or honey mixtures with a glucose content of less than *35* % and a glucose to water ratio of less than 2 (see Table 2.13 for a summary of the equipment needed). Honey is partially melted in a hot room and transferred to a heated vat where it is mixed until almost all crystals have dissolved. It is then strained to eliminate contamination by foreign debris and pasteurized at 78^{0}C for *5-7* minutes using a fine-leaved heat exchanger.

Table 2.13:
Equipment of a typical processing plant for bottling liquid or crystallized honey (* with pasteurization).

Equipment	Use
Melting room	Controllable temperature at 35-50°C for warming, melting and softening of honey in barrels and jars
Pumps	Moving honey from one tank or machine to another, adapted for liquid and/or crystallized honey

Jacketed tank (#1)	receiving "dirty" honey direct from the melting room to complete melting, settling, mixing and heating
Strainer	Eliminating visible impurities
Heat exchanger (#1)*	Quickly heating honey to 65°C for honey to be recrystallized or to 78°C for liquefaction with pasteurization
Filter*	Removing all or part of the microscopic impurities
Heat exchanger (#2)*	Quickly cooling the honey
Jacketed Tank (#2)	Receiving "clean" honey, cooling it to 30°C and mixing it with seeds for controlled crystallization; mixing honey during crystallization at 20°C, or receiving honey previously cleaned and crystallized directly from the melting room, where it has been softened by heating to not more than 30°C.
Storage tank	Receiving warm liquid honey from the strainer or heat exchanger for bottling
Bottling machine	Bottling various size containers with liquid or crystallized honey

Together with the next step, this heating is the most important, since high temperature, besides destroying yeasts, also melts the micro-crystals responsible for starting (seeding) re-crystallization. In the next step, ultra-fine filtration under pressure, using different micropore filters or diatomaceous earth, removes very fine particles such as pollen, bacteria, etc., which might serve as seeds for restarting crystallization. Subsequently, honey passes through similar heat exchangers which cool it to bottling temperature (57^0C according to the American school (Townsend, 1975) -or 35 ˚C according to the European school (Gonnet, 1977)). It is then bottled, preferably in dry-cleaned containers. An extra step which can further prolong the liquid state is quick cooling of the bottled product and storage for *S* weeks at 0^0C before releasing it onto the market. After this treatment liquid storage is prolonged, but crystallisation can still occur.

This kind of filtration is a normal and accepted practice in the USA, Canada and various Latin American countries and is preferred, because in addition to a longer liquid shelf-life, it gives a clearer and brighter product. As already mentioned, in European countries such complete filtration which eliminates any microscopical particles, is forbidden. It deprives honey of valuable substances such as pollen and makes it impossible to identify its botanical and geographical origin by means of pollen analysis. It also makes impossible the identification of other microscopic elements normally found in honey. Thus honey destined to be marketed in EEC member countries cannot be filtered this way.

2.12.2 Creamed honey

As an alternative to liquid honey, techniques have been developed to guide the natural crystallization of honey towards completely crystallized, stable and homogeneous end products with a pleasant appearance, creamy consistency and good reception by most consumers. The advantage of this method is that it does not require any treatment which would alter by any means the fragile and beneficial characteristics of the honey. In addition, these methods are also well suited for small scale production and become more complicated only with an increase in quantity.

The basic principle consists of accelerating the natural tendency to crystallize by the addition of a small quantity of

already crystallized honey. This method can be used with all honeys which show a tendency to crystallize either rapidly, slowly or incompletely. In the most simple method, liquid honey (naturally liquid or liquified) is mixed with completely crystallized honey, preferably containing very fine crystals, at a ratio of 9 to 1. The mixture should be warmed to only 24 to 28^{0}C in order to allow easier mixing and to ensure that none of the crystals are melting. No air bubbles should be included during this mixing. Prior to bottling, the honey is left to settle for a few hours to allow any air bubbles to escape. After bottling, the containers are kept as close to 14^{0}C as possible. Depending on the moisture content, crystallization is complete in about 10-14 days and a fine crystal honey of more or less solid consistency is obtained.

The major inconvenience of this method is the excessive hardness reached by low moisture honeys due to the formation of transversal crystals, special agglomerations. To avoid such occurrences, potentially unpleasant for the consumer, a method has to be chosen which allows the separation of each individual crystal and which thus gives the honey a creamy consistency. One aesthetic problem with this type of preparation is the formation of whitish blooms on the surface and inside enclosed air bubbles, due to the surface evaporation of water and drying of glucose crystals.

One method of softening this crystallized honey consists of two distinct phases. In the first phase the guided crystallization is conducted as described previously. However, the honey (seeded with fine crystals) is left to crystallize for approximately 10 days in larger containers (25 to 300 kg) at a temperature of 14^{0}C. Instead of bottling, the containers are then placed into a warm room at 28 to 30^{0}C until the honey has become a little softer. During this second phase, with the honey always below its melting point, a homogenizer or mixer is introduced into the softened honey in order to break up the crystals (Gonnet, 1985 and 1986). Once stirred, it can be bottled. Alternatively, even the simple warming in the heating room and subsequent bottling will give satisfactory results, since even this small movement of the softened honey will break up the crystals. The critical point to watch is the temperature during softening and stirring, which should always remain below 28^{0}C. If the crystals start melting the whole process will fail.

In another method, the seeded honey is stirred at a temperature at which the crystals readily grow (near 20^{0}C). The same water-jacketed vats for heating honey can be used cooling with cold water. Agitation accelerates crystal formation considerably and helps formation of smaller crystals. After two to three days, crystallization is complete and honey can be bottled, possibly raising the temperature a few degrees to ease the flow.

The difficulty here is to stir a cold and therefore very viscous mass of honey. This not only requires considerable mechanical force, but also carries a risk of incorporating air and creating a foam. It is therefore necessary to work with sufficiently powerful motors and a slowly rotating propeller (a few rotations per minute) which should remain immersed in the honey. In the largest industrial operations, in addition to the standard mixing devices, a continuous cooling and scraping system is employed for homogenization. For small quantities not exceeding 100 kg at a time, it is possible to do everything manually and stir once or twice a day with a long wooden paddle.

Creamed honeys, produced by one of the last two processes, will always have a creamy consistency more or less fluid, depending on the water content. The main disadvantage of these preparations is their instability at warm temperatures. If stored at temperatures above 20 ^{0}C for many months the crystals tend to precipitate on the bottom of containers leaving a more or less thick, liquid layer at the surface. This separation of liquid and crystalline phases (or partial reliquefaction) is more rapid in honeys with a higher moisture content and at temperatures close to or above 25 °C. In temperate climates with honeys averaging less than 18% moisture and low storage temperatures (favouring crystallization) guided crystallization appears a very advantageous and profitable process, as the profusion of the Dyce process in Canada indicates (Dyce, 1975).

A problem common to all these processes is the choice of seed honey, which has to have very fine crystals itself. Some honeys naturally form very small crystals. However, if no such honey is available, a normal, crystallized honey can be milled by passing it through a meat grinder or grinding it with a pestle and mortar to reduce the size

of the crystals. If creamed honeys can be found (for example in a shop) they can be used as a starter. Small quantities are mixed with liquid honey and left to crystallize for ten days at 14^0C with occasional stirring. This is then used as seed for a larger batch, always mixing seed honey with liquid honey at the ratio of 1:9 i.e. 1 kg of seed honey to 9 kg of liquid honey. This process can be repeated until the final, desired batch size is reached. When bottling, sufficient crystallized honey should be retained to seed the next batch.

For the manipulation of cold and therefore very viscous honey, the mixer, pump and bottling machine have to be very strong. The facilities and structures necessary for cooling during processing and storage are expensive. Smaller scale manual operations do not have these difficulties and can produce an attractive product cheaply and without expensive equipment, if ambient temperatures are not too high. Lastly, if the honey to be processed has a high moisture content and there is a possibility of fermentation, it should be pasteurized at *65* ^{0}C for *5* to 10 minutes before crystallization. In this case, the seed honey has to be free of yeasts.

2.12.3 Comb honey

A particular type of colony management is required for honey destined to be sold in complete comb. Apart from being the most traditional form, it can also be sold to a market which rarely has access to this most basic of all bee products. Its implied guarantee of purity and freshness is appreciated by many consumers. Special production techniques have been developed to produce a clean, fresh-looking piece of section, cut-comb or chunk honey, which is easy to ship, handle and retail. In any case, these products require special care during preparation and do not favour long transportation at warm ambient temperatures, nor long-term storage.

Section comb honey is a small section of completely sealed comb built of virgin (new) beeswax, preferably with light-coloured honey which remains liquid until consumed. Round, square or hexagonal sections with prefabricated wood or plastic frames are given to the colonies with a very thin foundation sheet. The specially prepared colony fills up the sections with comb and honey which is directly packaged in an attractive clear container (plastic wrap, box with clear window etc) to protect the contents from contamination, moisture and breakage. Special frames and packaging material are sold by most beekeeping suppliers, but forms, construction and quality vary from country to country (see Figure 2.16).

Regular beekeeping texts do not always cover section comb honey production, because it requires more intensive management and better planning. A special treatment of the subject is given in a book by Morse (1978) and in the new edition of the Hive and Honeybee (Graham, 1992). Short articles, such as Taber (1991), occur occasionally in the various beekeeping journals.

For special attractions, some beekeepers have produced comb inside narrow mouthed bottles, by providing a guide and enticing bees to build comb and store honey inside the bottles themselves.

Cut comb honey can be produced in regular frames or topbar hives. If foundation sheets are used they should be particularly thin and no wires or other reinforcing materials should be incorporated into the comb. Pieces are carefully cut according to the package shape and size and are left on a wire rack to drain the honey from the cut cells, taking care to keep bees away. Once dry, they can be packaged like section comb honey in clear protective containers. Extra care needs to be taken not to break any sealed cells or smear honey over them because it will look unattractive later on. If left in the sun even momentarily, wax cappings will become transparent and the comb will break easily with the slightest movement. All other conditions, such as light-coloured honey, cold storage and avoiding rough transportation and handling are the same as for section comb honey.

Smaller comb pieces can also be packed inside jars, which may then be filled with liquid honey. Ideally the comb honey and the liquid honey will be of the same light clear colour. Each jar should have only one cleanly cut "chunk" and honey should not crystallize before consumption.

2.12.4 Mead

The quality and taste of mead depends, apart from fermentation control and the quality of the various ingredients, mostly on the characteristics and taste of the selected honey.

The first production phase consists of the preparation of the must. A good quality honey with the desired flavour should be selected and a good water supply obtained. The water can influence the mead' 5 flavour, particularly since public water supplies often have all kinds of minerals, chemicals and other ingredients" in them. Clean and soft rain or well water are best, but should be boiled first. The honey has to be dissolved in the water. larger quantities the honey should be pre-mixed in a small amount of warm water.

The quantities to be used depend on the water content of the honey and the desired sweetness and alcohol content of the mead. In general, one considers 2.3 kg of honey per 100 litres of water for each alcohol grade (% by volume) in the final product. More precisely, one has to add 21 % sugar solids (measuring only the sugar content of the honey without water) to obtain a dry mead with 12% (by volume) alcohol. Increasing the sugar solids to 25 % leads to a final alcohol content of 14-15 %. Further additions of sugar leads to residual sugar in the final product and therefore a sweeter mead.

Pasteurization is generally not necessary prior to fermentation but filtration to remove any solid particles is recommended. One school of mead makers does however recommend sterilizing or pasteurizing the must before adding the selected yeasts. This can be achieved either by heating to 78^0C for 7 minutes or by adding tablets that produce sulphur dioxide, as used in regular wine making. These tablets are also known as bisulphite or "Campden" tablets. The sulphur dioxide gas will escape and will not flavour the mead. These same tablets can be used to disinfect bottles, siphons, corks and funnels.

Minerals and salts are added to the cooled must as yeast nutrients (urea, ammonium phosphate, cream of tartar, tartaric and citric acids). The acids are supposed to improve the taste and prevent growth of undesirable microorganisms. Various nutrient combinations are listed in the detailed recipes below. If 50% of the water is substituted with fruit juice, none of these additives are necessary, since the fruit juice provides both nutrients and the right yeasts. Some countries do not allow the addition of fruit juices to mead.

An adequate quantity (0.5 to 2%) of selected, active, acid resistant champagne yeasts or brewers yeasts, but not bread yeasts, are added. The choice of yeast influences the final flavour, but selection is more important in order to have complete and uninterrupted fermentation. An actively growing yeast solution should be prepared for larger batches (see second recipe below). For small batches, the yeasts can be added directly to the must.

In order to speed up the fermenting process in mead making, Qureshi and Tamhane (1985) immobilized yeast cells in calcium alginate cells. Improvements in taste are said to be obtained by flash heating the must, before adding the yeast, or 30 seconds to 102^0C and instant cooling to 7^0C (Kime et al., 1991).

Fermentation has to take place in the absence of air (oxygen) in appropriate containers, preferably made from ceramics, stainless steel or glass or in wooden barrels. To exclude outside air a special fermentation lock is placed in the opening of the container, so that gas from the fermentation can exit, but outside air cannot enter. This is important, particularly towards the end of fermentation when less gas is produced inside. If too much oxygen enters, the mead will turn into vinegar. The simplest method, but not a completely safe one, is to place a cotton ball in the opening of the container or in a perforation of the stopper. Another improvisation is a plastic hose leading from the same perforated stopper into a glass of water, with the end of the hose always submerged in water. The glass always has to be kept at a lower level than the end of the tube in the stopper as a precaution against sucking the seal water back into the fermentation vessel.

a)

b)

Figure 2.16: a) Section comb honey, stored by bees directly in special round or square clear plastic sections. b) Decorative wooden sections are prepared with a thin foundation sheet and placed in supers in lieu of frames and in the same manner as plastic sections.

During fermentation the must should be maintained at a constant temperature of 20° to 25 ^{0}C (18 ^{0}C according to Morse and Steinkraus, 1975) but not exceeding 28 ^{0}C. The exact temperature is not absolutely critical since fermentation will also take place at other temperatures but at different speeds. The longer the fermentation, the greater the risk of contamination by other bacteria or yeasts will become. At higher temperatures fermentation will be faster, but will produce less alcohol. At lower temperatures fermentation will become progressively slower and

eventually stops.

After 2 to 3 days of fermentation, an oxygenation of the mead by decanting it into another container may be beneficial but not necessarily so. Once fermentation has slowed down however, decanting is beneficial to prevent the mead from becoming bitter from the dead yeast accumulated at the bottom of the container. Otherwise, the must is left undisturbed for approximately one month or until no more gas exits from the fermentation lock. The liquid is then carefully poured or syphoned off with a hose, without disturbing the sediment. This decanting is not enough to clarify a mead made from only honey. For complete clarification, extremely fine filtration or the addition of precipitating agents such as tannins (2.5 g dissolved in alcohol, per 100 litres), bentonite (100 g/l00 1) colloidal protein solutions or egg white beaten very well (the whites from 2 eggs for 100 1) is necessary. After a few days the liquid is syphoned off again or filtered. Alternatively, boiling the must prior to fermentation will precipitate most of the proteins responsible for clouding mead (Berthold, 1988a) but will also eliminate most of the honey aroma.

Finally, the mead has to be aged to develop its flavour. The use of oak barrels is best, but aging in bottles is possible. Different preparations reach maturity at different ages (6 months to 3 years) but at least 18 months should be considered. For commercial operations the addition of a preservative like potassium sorbate (15 - 20 gibO 1) may be used or the mead may be pasteurized immediately prior to bottling.

For the production of vinegar it would be advantageous to start the mead with a must of half the concentration of honey, but the same amount of nutrients. After one month of alcoholic fermentation (in the absence of air) a culture of vinegar bacteria (Acetobacter aceti) are added. Alternatively, a little of ready-made vinegar may be added, but not commercial, pasteurized vinegar. The containers are then left open to the air, but should be covered to prevent dust and other debris from entering. At 20° to 25°C and with sufficient bacteria, the process can be completed in just a few days, but would more likely take 1 to 9 months. After occasional tasting or acid testing to determine the point of maturity, the vinegar can be bottled for sale or personal consumption. A level of *5 %* acid (by volume) is considered mature.

The following is a step by step description of the basic mead making process as adapted from Steinkraus and Morse (1966) for a dry (non-sweet) mead from white clover honey with a final alcohol content of about 12% by volume. This approach is rather "high-tech" and nutrients may be hard to get, but it demonstrates the necessary points of production control. For most productions, the nutrients can be simplified (see following recipes).

1. *Nutrients for one litre of must:*

5.000 g	*Citric acid (or 2.528 g citric acid and 2.468 g of sodium citrate, which require less pH adjustment)*
1.229 g	*Ammonium sulphate*
0.502 g	*Potassium phosphate (K2PO4)*
0.185 g	*Magnesium chloride*
26.42 mg	*Peptone*
52.80 mg	*Sodium hydrogen sulphate*
5.28 mg	*Thiamine (vitamin B_1)*
2.64 mg	*Calcium pantothenate*
1.98 mg	*Meso-inositol*
0.26 mg	*Pyridoxine (vitamin B_6)*

0.013 mg	*Biotin (vitamin H)*

- Honey is diluted to 21 % solids with water. If crystallized, the honey is heated to 60-65 ^{0}C to facilitate dissolution;

- all of the above nutrients are added to the diluted honey;

- the pH is adjusted to 3.7-4.0 with sodium hydroxide or hydrochloric acid;

- when cooled to about 27^{0}C, the 150 litre batch is placed in a 200 litre oak barrel;

- the batch is inoculated with 0.5% by volume of active yeast culture and sealed with a fermentation lock (}or preparation of such a growing yeast culture see the second recipe);

the mead is maintained at 18 ^{0}C during fermentation;

- after 6 months of aging it is decanted and filtered through Celite 503 or similar filter-aid, to remove yeasts;

- total acidity is adjusted to 0.6% with citric or tartaric acid;

- the mead is pasteurized at 63 ^{0}C for 5 minutes and bottled while hot.

Other possible modifications such as decantation, pasteurization, disinfection, nutrient alternatives, filtration, clarification, fermentation temperatures and aging have already been discussed.

2) Gonnet et al., (1988) recommended the preparation of a starter culture of yeast particularly for larger batches. The following proportions are for such a starter batch. The final must therefore consists of: 1) a sugar and water mix, at a ratio according to previously mentioned criteria; 2) nutrients added in the same quantities per litre as given for the starter batch below and 3) the yeast starter batch at 2% by volume of the total must.

Ingredients for the starter batch:

10 l	*Water*
1.5 kg	*Honey*
1.1 kg	*Selected yeasts*
29.5	*Nutrient salt mix*

The honey is dissolved in the water and at 25 ^{0}C the nutrient salts and yeast are added. Mix well and leave for three days at 25 ^{0}C in a container sealed with a fermentation lock. After that, once stirred well, it can be added to the final must at 2% by volume.

Nuteients per litre of must or starter batch:

0.250 g	*Diammonium phosphate*

0.250 g	*Potassium bitartaric (cream of tartar)*
1.875 g	*Trataric acid (or 1.750 g of citric acid)*
0.050 g	*Potassium metaisulphite*
0.250 g	*Yeast extract*

3) Soldati and Piazza (1985, unpublished communication) following nutrients per litre of must (and many other ingredients with no apparent difference due to use of lower describe the use of the variations of these basic or higher concentrations):

2.00 mg	*Ammonium sulphate*	*or*	*750 mg*	*Ammoinum carbonate*
0.75 mg	*Potassium metabisulphite*		*1000 mg*	*Ammonium phosphate*
1.00 mg	*Citric acid*		*500 mg*	*Citric acid*
0.25 mg	*Vitamin complex (unspecidfied)*			

They start with a 1.3 mixture of honey and water and a Baume' (a unit to measure sugar content) reading of 13.5° to 14.5°. *After the initial pasteurization and addition of the nutrients, 10% of the must is used for a starter batch to which the selected yeasts are added. One to two days later when the yeasts are fully active, the starter batch is added to the rest of the must. when the must has reached a Baume' of* 0.1°**,** *for a dry mead (or earlier if so desired), fermentation is interrupted by transferring the liquid (without sediment) into another container in which the (second) fermentation continues for another 15 to 30 days. At this point the mead is clearer and can be filtered and bottled. For storage reasons, the mead should have at least 10% alcohol and not less than 3.5 g/l acidity, measured as tartaric acid.*

Contents - **Previous** - **Next**

2.12.5 Honey beer

Honey beer is easier and faster to make than mead. It cannot be stored for more than a few hours but once it has become flat, it may be revitalized by addition of more honey. Across the African continent, there are many ways of preparing this popular beverage. Without knowledge of microbiology some ingenious ways have been designed to maintain yeast cultures and inoculate subsequent batches with the desired kind of yeast. Uncontrolled as the process might appear to the uninitiated, there are brewers who have excellent control without knowing the biological background of the brewing process. The following are a few recipes from East Africa.

1) A typical commercial honey beer in Kenya is described by Paterson in Crane (1975) as containing a considerable amount of refined cane sugar, jaggery or freshly squeezed cane juice. The higher the honey content though, the better the beer is considered. Paterson mentions a recipe of 27 kg of honey with 108 kg of sugar in

250 litres of water. To a large 200 litre drum or barrel 20 to 30 slices of the muratina or sausage tree, Kigelia aethiopica (Bigniniaceae) are added. Besides supposedly giving strength (higher alcohol content?) and flavour to the beer, the slices probably also serve to inoculate the beer with the right kind of yeast. After fermentation, the beer is crudely filtered and the muratina slices are removed and dried for use in the next batch. Production takes several days to complete.

2) Kihwele ~ersonal communication) from Dar-es-Salaam, Tanzania, uses 5 litres of honey in 18 1 of water to which he adds 6 teaspoons of dry yeast. The fermentation, taking place in a dark, warm place will allow consumption after 5 to 7 days. In a similar recipe, one of the authors (Krell) not wanting to go through the lengthy process of the third recipe, made batches of honey beer with honey to water ratios of approximately 1 .~4 using dry baking yeast and no additional yeast nutrients. The higher the initial amount of yeast, the sooner the fermented product is drinkable (1 to 2 days). Larger amounts of yeast, such as 10 teaspoons of dry yeast per litre, left a strong yeasty flavour in the beer. Even starting smaller amounts of yeast a day ahead and adding them to the final batch never provided a beer that was drinkable in less than 24 hours. However, the same author has seen brewers in Zambia prepare a batch within 6 hours from a yeast starter batch.

Figure 2.17: Honey beer fermentation can be so rapid that the broth appears to be boiling.

3) None of the traditional beer brewers use cultured yeasts, but many know how to prepare special nutrient "cakes", possibly containing some of the right yeasts, or they know how to reinoculate (as described in the first recipe). The following recipe is a traditional method from Zambia and has been documented by Clauss (personal communication). The starter is also used for making maize (corn) beer and is the same one seen by one of the authors in the almost "instant" beer production mentioned under 2). The first and/or second batch are a little slower, since the yeast population still has to build up. Reusing the dried cake, however, or even a left over portion of the beer with a new cake will allow much faster fermentation.

- *Soak some maize until it germinates, then dry it (toast it in a hot pan if desired) and pound it into a relatively fine powder,*
- *Repeat the same process with finger millet (Some brewers do not roast but only sun-dry the germinated seeds, since the toasting may add flavour);*
- *Mix the maize and millet flour and boil slowly in a good quantity of water for a long time until the volume is reduced to a quarter, i.e. from 20 litres to 5 litre, or until a pasty consistency is reached;*
- *Leave it to cool and wait one week,*
- *Add some raw germinated millet flour and lukewarm water and stir everything into a thick paste.*

The paste is now ready to be added to a 1:4 mixture of honey and water. Amounts and ratios vary considerably and depend on each brewer's experience. By using this starter, a batch of beer can be produced in half to one day. Modifications apparently allow some brewers to produce the beer even faster (see Figures 2.17 and 2.18).

Addition of pollen and brood is accidental. While pollen may add nutrients for the yeast, the brood mostly causes acidity and off-flavours in the beer. It should therefore be avoided as much as possible.

2.12.6 Honey liqueurs

The following 4 recipes are taken from a promotional leaflet for various liqueurs which was printed in 1903. The alcoholic portion of the liqueur is not derived from honey fermentation, but through the addition of alcohol in its pure form or as a distilled beverage such as aquavit, schnaps, gin, vodka, cachassa, rum or arrack.

1) Macerate 2 kg of aromatic, juicy, finely chopped fruits in 2 litres of alcohol (70 to 96%). Keep in a well covered container or sealed bottle. After one month filter and press out the fruit through a very fine cloth. To this liquid add 2.25 kg of honey dissolved in 2 litres of boiled water.

2) In another method, practically the same as above, the alcohol is substituted by aquavit (a distilled grain alcohol of 40 to 60% alcohol by volume). After maceration and filtration, 375 g of honey are added directly for every litre of alcohol/juice.

3) Similarly, one might use aromatic herbs, flowers or spices instead of, or in addition to the fruits For example, 50 g of dry orange peel are macerated in one litre of alcohol (70%). After 15 days the mix is filtered and 600 g of honey, dissolved in 600 ml of water, is added.

Figure 2.18: Beer brewer selling her product from traditional gourds.

4) The honey itseij may be the only aromatic substance added to the alcoholic beverage like honey aquavit or honey whisAy. It is added to the distilled beverage either directly or with a little water. The quantities vary with the desired results, but the choice of honey is extremely important to harmonize flavours.

2.12.7 Honey spreads

To avoid separation of honey and pureed fruits or nuts only crystallized honeys should be used. There are basically two techniques. The ingredients are mixed with the liquid honey at the same time as the seed crystals or they are mixed after the crystallization has been completed, to obtain either a hard or soft product, respectively. To mix dried fruits with crystallized and softened honey in small batches, a clean meat grinder may be used.

In the following recipe apricots have been used but other fruits can be selected and fruit proportions be increased until those of fruit spreads and marmalades are reached. When changing the type of honey and fruits, care should be taken that their flavours are compatible.

Ingredients (in parts by weight) after Berthold (1988b)

8.5	*Light coloured honey (liquid or liquified)*
1	*Seed honey (finely crystallized)*
0.5	*Dried apricots (very dry, high quality)*

If the moisture content of the honey is high and fermentation is possible, pasteurize the honey after mixing with the pureed or ground fruit at 65 ^{0}C for 10 minutes. Add the seed honey to a small quantity of liquid honey. when evenly mixed, add to the rest of the liquid honey fruit mix. If a meat grinder is available and fermentation risk is low, the dry fruit and the seed honey plus a small quantity of liquid honey may be passed through it twice. Mix thoroughly with the liquid honey and fill into clean, wide-mouthed jars. Seal and leave to stand at 14 ^{0}C for at least 5 days or until crystallized. Finally, clean the outside of the jars and apply an attractive label.

Honey tahena paste

Ingredients (in parts by weight) modified after El-Shahaly et al., (1978):

63	*Honey (creamed)*
37	*Tahena (sesame seed butter)*

Prepare the sesame seed butter (chop sesame seeds in a blender or grind until fine), emulsijy to prevent oil separation and add the honey. Optional additions are 0.1 part artificial honey flavour, 3 parts sorbitol (to decrease desiccation of the paste) or 2 parts lecithin (to improve texture and spreadability). Creamed honey should be used. Packed in either wide-mouth jars or aluminum tubes, the paste should be refrigerated at 6^{0}C to prevent changes in appearance (oil separation) and organoleptic characteristics which may occur in even relatively short periods of time.

Dulce de Leche

For this very popular Argentinean spread which is normally made with refined sugar, honey is dissolved in a small amount of water. Milk is added, mixed well and boiled careflilly while stirring until the mixture has a creamy, paste-like consistency. Proportions may vary from 1:8 to 1.1 for the honey and milk depending on the desired flavour and consistency. Preparation from dried milk dissolved in very little water is possible and faster, but less heating will result in other flavours.

2.12.8 Honey with fruits and nuts

Fruits in honey

Sun-dried fruits with as low a moisture content as possible should be used, but they should still be

soft. They can be placed directly into the honey, either whole, chopped or pureed. Partially dried fruits or those with a high moisture content even when dried should be covered with honey for a few days in a sealed container. After the honey is poured off the process can be repeated two or three times until the honey is no longer diluted with water quice) from the fruits. Then the fruits can be mixed with the final batch of honey and bottled. This process is necessary since the juice in the fruit will add too much water to the honey. Pasteurization of both fruits and honey will improve hygiene and storability and will reduce the risk of fermentation, but may affect the flavour. The diluted honey which is removed during the process can be used as fruit syrup preferably after being pasteurized.

Nuts in honey

The previous process can be repeated with nuts, but as commercially available nuts are already fairly dry, they do not usually need to be dried any further. Care should be taken that the honey flavours mix well with the chosen nuts. Since a nut and honey mix can also have a considerable aesthetic appeal, light coloured, liquid, slow crystallizing honey should be used. Distinctive glass jars can add flirther consumer appeal (see Figure 2.5).

If bottled by hand, or if the bottling machine allows, honey and nuts can be mixed before bottling. Otherwise the correct amount of honey should be placed into the jar and the nuts added later. The correct ratios need to be adjusted for each nut type. Nuts should be tightly packed so that they cannot float to the top and leave a pure honey stratum at the bottom. Some packers use a special clear plastic insert to keep the nuts from floating to the top.

2.12.9 Honey with pollen and propolis

Ingredients (in parts by weight):

1000	*Honey*
100	*Propolis*
125	*Pollen*
1-3	*Royal jelly (optional)*

Finely grind the dry pollen pellets and the hardened frozen) propolis. Warm 200 parts of honey in a water bath and mix in the pollen and propolis powder. After a few minutes of cooling stir the mixture into the rest of the honey. If refrigerated, the honey will stiffen and have less of a tendency to separate. Royal jelly might be added as well or propolis extract (paste) may be used instead of raw propolis. Propolis and pollen can also be mixed in equal volumes. It would of course be best to include all these ingredients in crystallized (creamed) honey before or after crystallization.

2.12.10 Honey paste for dressing wounds

Pure liquid honey or honey mixed with other beneficial creams or ointments may be used to dress wounds. The following is a very versatile paste useful as a home remedy for many ailments.

Ingredients (in parts by weight) after Uccusic (1982):

10	*Wax*
3	*Propolis extract (10% ethanol extract)*
2	*Honey*

Melt the wax and during cooling mix in the propolis extract and finally the honey. Store in a tight jar in a cool and dark place. This paste can be applied on all kinds of sores and open wounds, can be cliewed for mouth infections like paradontosis or used for skin damaged due to radiation, poisoning or acid burns. For serious infections or wounds, however, a doctor should be consulted.

2.12.11 Sugar substitution

Honey can replace cane sugar in almost any recipe. Since honeys are of different flavours and compositions, however, such replacements may result in changes of flavour, consistency, cooking times and the quantities of other ingredients required. In industrial baked products honey is therefore only used to replace small quantities of sugar. In addition, strong flavoured or dark, cheap honeys are preferred since less honey is required to obtain some honey flavour and consequently, less of the cheaper sugar has to be replaced. When substituting most or all of the sugar with honey, mild-flavoured honeys may be more desirable as they will not overpower other flavours of the product.

Since honey is denser than crystallized, packed sugar and therefore has greater sweetening power per volume than sugar, most cookery books recommend the use of 1 cup of honey for 1 ¼ cups of sugar or that 1 cup of sugar can be replaced by 4/5 of a cup of honey. Recommendations are not uniform, and others recommend replacing 1 cup of sugar with only ½ to *3A* of a cup of honey. When recipes are given in weight, honey can be substituted approximately 1:1 or, considering the moisture content, add up to 20% more honey in weight than sugar. The extra water added in the form of honey needs to be accounted for as well. Thus for every cup of honey added, approximately **1/5** to ¼ of a cup less liquid should be used in the recipe. By weight: for every 1 kg of sugar substituted by 1000-1200 g of honey, 180-200 g (180-200 ml) less water should be used. For most corn syrups, honey can be substituted 1:1 by weight as well as by volume, even though corn syrup often contains more water than honey. For industrial quantities more specific calculations based also on the sugar composition of the specific honey, are necessary.

Too much honey in a recipe may cause too much browning in a baked product. To neutralize the acidity of honey (unless sour cream or sour milk is called for in the recipe) add a pinch of baking soda. If honey is substituted in jams, jellies or candies, slightly higher temperatures must be used in cooking, but conversely, when baking bread, lower temperatures are required. In candies, more persistent beating (mixing) and slightly higher caramelization temperatures are needed. Also careful packaging and storage of the final product may be required to prevent absorption of atmospheric moisture.

When using honey for a recipe that also involves use of oil or fat, measure the oil or fat first in the

measuring container. Removal of honey from the same container will then be easier and more complete.

2.12.12 Fruit marmalade

This marmalade is special in that it uses pre-dried fi~uit pulp, which reduces cooking time and thereby also preserves a much better flavour and uses less energy (fuel wood). It also uses less sugar than other traditional recipes, yet preserves well. Though originally formulated for sugar, a portion of the sugar can be replaced. By replacing only 5 to 10% of the sugar with a mild honey, the flavour can be slightly improved. Using more honey will produce a stronger honey flavour and increases the cost. The original recipe had been formulated by G. Amoriggi (personal communication) for small to medium scale processing using sun-dried pulp. Many more food canning and preservation recipes can be found in Geiskopf (1984).

Ingeredients

10 kg	*Fruit pulp (fresh)*
6 kg	*Sugar (or 5.4 kg sugar and 0.6 kg honey)*
40 tblsp.	*Lemon o lime juice, i.e. 4 tblsp./kg pulp (or 10 teasp. Of citric acid, i.e. 1 teasp./kg pulp)*

The recipe is best with pure mango or a papaya and banana pulp mixed at a ratio of 7.~3. Extract the pulp and mix with haij of the sugar and haij of the lemon juice (no honey yet). Spread in layers of 1 - 1.5 cm on trays of stainless steel, aluminum or aluminum foil, cover the pulp to protect it from insects, mice etc., and place it in a solar drier.

If a refractometer is available, the pulp is left in the drier until it has a minimum sugar content of 43 - 45% total solids. ft is then transferred into a pot where the other haij of the sugar and lemon juice and all the honey are added. The paste is simmered over medium heat until it reaches a sugar concentration 67%. Continuous stirring is necessaiy.

If a refractometer is not available, leave the pulp in the solar drier for approximately 7 hours of continuous sun (e.g. from 9 am to 4 pm) and leave on the stove until it "looks" like marmalade (or until it reaches approximately 105 ^{0}C).

If part of the sugar is replaced by the honey, the honey should not be added to the pulp batch before solar drying, since it will make drying more difficult and prolon ged. Honey may also be added when reducing and heating of the pulp is almost complete. Instead, the honey should be added as late as possible during the finale slow boiling of the paste so as to preserve as much of the beneficial characteristics and flavour of the honey as possible. The moisture content of the honey is not important and the ratios of sugar to honey can be changed as well, but the product will have to be heated slightly longer to reach the same sugar solids percentage.

2.12.13 Honey jelly

This jelly recipe follows the instructions of a pectin manufacturer, Unipectina Spa in Bergamo, Italy.

Ingredients for 1 kg of honey jelly:

220 g	*Water*
3-4 g	*Pectin*
800 g	*Honey*
1.5-2 ml	*Tartaric acid (at a concentration of 50% weight/volume in water)*

The pectin is soaked in the cold water, dispersed by stirring and brought to a boil which is continued until the weight has been reduced to 200 g. Then the honey is added and heated to 60^0C. The heating is stopped, the acid added and the mix poured into moulds or other containers.

If no mechanical mixer is available, the pectin can also be dispersed in a small quantity of honey and the water be added to this paste. To avoid fermentation, the mix may be heated to 77^0C and bottled without any other sterilization or it may be heated to 60-65 ^{0}C and bottled in sterilized jars. The final solids content should be 65-68% at a pH of 3.1-3.3. The honey acts here as a sweetening as well as a flavouring agent. Parts of it can be replaced with fruit juices or purees to provide other flavours.

2.12.14 Syrups

Honey fruit syrup - from a promotional pamphlet of 1910

Obtain or press a good quality, clean and fresh fruit juice. Filter it and add honey at a ratio of 5:3 (honey to juice) by weight Boil to sterilize and bottle. To prepare a drink, it is diluted with water. The fruit juice and honey mix from section 2.12.8. can be heated for pasteurization and bottled hot after any necessary correction of concentration.

Honey-fruit-vinegar syrup - from a promotional pamphlet of 1903

Ingredients (in parts by weight):

1	*Fruits (juicy and cromatic)*
1	*Vinegar*
2	*Honey*

Place fruit (whole or cut, according to type) in the vinegar. Let it soak for 5 days, occasionally stirring and squeezing more juice out of the fruits. Press the liquid through a fine cloth and add the honey. Boil for 5 minutes only and bottle. This syrup is diluted with water (3 tblsp. of syrup per glass) for a refreshing drink.

Syrup base for herbal preparations

Dissolve 2 to 3 parts of honey in 1 part of water and heat to 65 ^{0}C for a few minutes. To this syrup various plant extracts with therapeutic or aromatic effect can be added.

If the plant extracts were made with alcohol the storage life of the syrup is increased. Otherwise some alcohol may be added as a preservative.

2.12.15 Rose honey

1. *Ingredients (in parts by weight) after the Italian Pharmacopoeia from Negri (1979):*

20	Honey
4	Red rose petals (aromatic variety)
5-7	Boiling water

Prepare an inflision (tea) of the mashed rose petals in the boiling water and leave for 24 hours. Filter through a very fine cloth and press out. Mix the rose water with the liquid honey and leave in the cold until it reaches a density of 1.32. This mixture has a limited storage life. As an alternative to the last stage, boil the mix briefly and bottle while hot.

1. *Ingredients (in parts by weight) after the German Pharmacopoeia from Negri (1979):*

1	*Rose petals*
5	*Ethanol (ehtyl alcohol, 65%)*
1	*Glycerol*
9	*honey*

Mash and soak the rose petals in the alcohol for 24 hours. Filter and press the obtained liquid and mix with the other ingredients. Reduce to a final volume of 10 parts by heating in a water bath. As an alternative to the last stage, the mixture can be boiled briefly and bottled hot.

Contents - **Previous** - **Next**

2.12.16 Caramels

General considerations

Caramels and candies offer a large variety of products in terms of flavour, colour, consistency and shape (see Figure 2.19). Candy making is an art of its own. The consistency of the candies depends very much on the temperature reached during heating and a candy thermometer would therefore be very useful. Other tests can be used to estimate the right temperature which is particularly important since adding honey to a recipe requires a higher temperature for caramelization which cannot always be calculated in advance.

With sufficient experience, the colour, boiling behaviour and threading of candy can be used to recognise the critical temperatures. For testing, fresh and cool (preferably chilled) water should be used each time and the pan should be removed from the heat in order to avoid overheating during the test. The following description of the signs for different stages of caramelization and candy processing is adapted from Rombauer and Rombauer Becker (1975).

Figure 2.19: Various caramels, jellies and gums made with honey. One type, on the right, is also flavoured with propolis.

-A thread stage is reached when the candy forms a 5 cm coarse thread when dropped from a spoon. Begins at 110^0C.

-The **soft ball** stage is reached when a small quantity of syrup, dropped into chilled water, forms a ball

which does not disintegrate, but flattens out of its own accord or when gently picked up with the fingers. Begins at 1 12^{0}C.

-The **firm ball** will hold its shape and will not flatten unless pressed with the fingers. Begins at 117^{0}C.

-The **hard ball** is more rigid, but still pliable. Begins at 121^{0}C.

-The **soft crack** stage is reached when a small quantity of the hot syrup, dropped into chilled water, will separate into hard threads which, when removed from the water, will bend. Begins at 132^{0}C.

-The **hard crack** stage is reached when the same threads are hard and brittle. Begins at 149^{0}C.

-Caramelized sugar is obtained at 154° to 170^{0}C when a pure sugar syrup turns golden brown. It will turn black and lose its sweetness at about 177^{0}C.

During heating the temperature rises slowly up to 105 ^{0}C, but will increase much more rapidly thereafter. It should be carefully watched and controlled. Preheat the thermometer in hot water before inserting it into the candy and make sure that it does not touch the bottom of the pan. After the ingredients have been well mixed and the temperature reached 100 ^{0}C, stirring should stop. Do not scrape the edges of the pan once the boiling stage has been reached as the sugar crystals on the edge will cause the candy to granulate rather than stay smooth. When the boiling point has been reached, just cover with a lid and in 2 to 3 minutes the steam will have washed off the sides. Uncover and continue without stirring. If granulation occurs anyway, add a little water and start again.

The pan should not be disturbed during cooling or when removing it from the heat for testing without a thermometer. Use only a very clean spoon for testing. The cooling candy should never be beaten, kneaded or mixed before it has cooled to 45 ^{0}C.

There are two ways of cooling. The pot can be placed immediately into cold water until the pot bottom can be touched without discomfort. The other way, as described in these recipes, is to pour the hot candy onto a cold and buttered marble slab, a heavy buttered platter or a cooled tray. Pour the candy carefully as it may splash and burn somebody. Also, let the candy run from the pan and do not scrape out the stiffer material at the bottom which may have reached a different stage of crystallization and may behave differently if mixed with the rest of the batch. If adapting sugar-only recipes for use with honey, remember also that honey needs higher temperatures to reach the appropriate stage of caramelization and may require more beating (kneading) if the recipe requires it.

Should the candy have cooled too much for further processing, the mass can be carefully tesoftened in a water bath. If the syrup was cooked at too high a temperature and crystallized too hard, the candy can be reheated in a water bath with about 18 to 20% of water added and stirred constantly until it is completely liquefied. It can then be returned to the pan and heated to boiling point, covered to remove crystals from the sides of the pan, uncovered and reheated to the appropriate caramelization point.

Colouring and flavouring should proceed once the candy mass has cooled to a temperature manageable for kneading or stirring (less than 45 ^{0}C). Food aromas can be incorporated at the same time. While still pliable, other ingredients such as candied fruits, nuts, ginger, coconut or jam can be added. These are more likely to be added to candy heated only to the soft ball stage. Once kneaded or mixed in, the candy can be cut into the

desired shapes and coated with confectioners sugar or chocolate.

Coating with chocolate is rather tricky and requires correct environmental conditions as well as special packaging and is not possible without refrigeration in hot climates. The weather during dipping should be cool and dry, or the room should be cooler than 21 ^{0}C with a relative humidity of less than 55% and should be free of draughts. Any type of bar chocolate is very slowly melted in a water bath. The chocolate is stirred until it reaches 54 ^{0}C. If it is not stirred constantly at temperatures above 38 ^{0}C, the cocoa butter will separate out. Remove from the heat but maintain the temperature at about 31 ^{0}C. The candy needs to be maintained at about 21 ^{0}C. Dip candies one at a time and let them drain on a wire rack or screen. If large quantities are prepared, the dipping should be done in a smaller, separate container. The drippings can be remelted again. The extra chocolate on the dipping fork can be used to make small designs on the candy to distinguish different fillings. Refrigerate the product for a few hours before packing.

Honey caramels

Ingredients (in parts by weight) after Paillon (1960):

0.75	*Honey*
6	*Sugar*
0.75	*Glucose*
2	*Warm water*
q.s.	*Vanilla powder, alcohol extract etc.*

Heat the water in a large skillet (frying pan). Ensure that no odd flavours from the skillet can affect the product. Reduce the heat and dissolve the sugar in the hot water, stirring it to avoid caramelization on the bottom. Add the glucose, which is placed to dissolve in the middle of the syrup. The glucose may be replaced by honey and added at a later stage. Let it simmer for a while. Skim off the foam and clean crystals from the edges of the pot by covering it for three minutes. Uncover, stir and heat until the hard ball stage is reached, between 1250 and 128 ^{0}C. Use a thermometer or drop test for control. Add the honey and aromas and continue heating until the soft crack stage is reached at 145 ^{0}C. Pour the hot liquid onto a cold and greased su~ace or tray. Allow to cool sufficiently until a good malleability ~liabihty) is reached, spread it evenly and stamp or press out the desired shapes or forms. Let it cool for a few moments and cover with sugar crystals or powdered sugar prior to packing. These caramels can be flavoured with honey only or with other essences and herbal extracts such as vanilla, eucalyptus, liquorice or mint. The cutting has to be done relatively quickly before the caramel becomes too hard.

Butter honey caramels

Ingredients (in parts by weight) after Paillon (1960):

2.5	*Sugar*
0.8	*Warm water*
4	*Glucose*

1.5	*Honey*
0.625	*Butter*
q.s.	*Salt*

Wet the sugar with the warm water, heat slowly and melt. Continue stirring and add the glucose, melt and heat slowly to 118^{0}C. Add the butter and honey, bring slowly back to 11 7^{0}C or possibly 118^{0}C. Spread quickly on a cold, buttered marble suiface between two metal or wooden bars and cut rapidly with a circular knife (a round, rotating blade). Pack while still warm.

Coconut fudge

Ingredients (in parts by volume) modified after Rombauer and Rombauer Becker (1975):

24	*Sugar*
12	*Honey*
8	*Milk*
1	*Vinegar*
q.s.	*Salt*
20	*Moist, shredded coconut*
3	*Butter*

Stir the first S ingredients together over medium heat until the sugar is dissolved. Stir until boiling then cover for about 3 minutes to remove crystals from the sides of the pan. Uncover, reduce heat and cook slowly to the soft ball stage (115 to 118^{0}C) without stirring. Remove from the heat and stir in the coconut and butter. Pour the hot candy onto a buttered platter or pan until it is cool enough to handle, then shape it into small balls or other preferred shapes. Place them on foil or wire racks to dry. Wrap the pieces individually for packaging. For small trial batches, 1 part could be equivalent to 1 tablespoon and 16 parts equal to 1 cup.

Honey roasted nut bars

The following recipe is very flexible since the proportions of sugar, honey and nuts can be varied in order to produce either a solid caramel bar with a few nuts, or nuts coated with caramelized sugar and honey (see Figure 2.19). Availability of moisture-proof packaging materials and economical (cost) considerations determine whether the honey proportion can be increased.

Ingredients (in parts by weight) modified after Paillon (1960):

		Possible range in %
10	*Sugar*	*10-80*

2.5	*Honey*	*0-75*
1.25	*Almonds or other nut, whole or broken*	*0-80*
2.5	*Water*	*25-35 (on sugar)*
1.25	*White vinegar*	*0-50 (on water)*

Dissolve the sugar in the water and vinegar, place over medium heat and stir continuously. when boiling, add the honey, mix and reheat to a boil; cover for three minutes to remove crystals from the side of the pan, uncover and without stirring bring to a golden brown soft or hard crack stage according to preference. Add the nuts and cook for a few more minutes without raising the temperature. Then pour onto a cold, lightly oiled marble plate or buttered tray. Cut before the candy turns hard and wrap after cooling in moisture sealed packages or place in large glass jars for display. For candy coated nuts, with a higher proportion of nuts to sugar, the nuts should be stirred or shaken in a small amount of hot syrup. They may also be boiled briefly with the syrup. It may be found easier to immerse the nuts in a larger quantity of syrup and drain excess syrup while cooling on a wire rack. The drained candy can be reheated again after adding extra water (see general introduction to this section).

In Greece, the above recipe is popular in proportions of 1 part sugar, 5 parts honey and 5 parts roasted sesame seeds. Greek halvah (see below) is a spicier version and demonstrates another variant of this recipe.

Greek halvah

Ingredients (in parts by weight) after Crane (1975):

5	*Honey*
3	*Olive or sesame oil*
2	*Chopped or ground nuts (alos sesame seeds)*
10	*Sugar*
5	*Flour*
3	*Water*
q.s.	*Ground cloves and ground cinnamon*

Heat the oil until it is very hot. Then gradually pour in the flour, stirring slowly until the flour turns brown (30-45 minutes). Meanwhile make a syrup of the sugar, honey and water, boil it for approximately 30 minutes over low heat until a soft crack stage is reached. Add the spices and nuts and also mix in the browned flour. Stir constantly over low heat until the mass has thickened. Turn off the heat and cover the pan for 5 minutes, then pour onto an oiled baking sheet, marmor or pan. when cool, cut into squares or bars and sprinkle with icing sugar or cinnamon.

2.12.17 Nougat and Torrone

This preparation is very similar to ordinary candy preparations and general processing procedures described

in the previous section.

Ingredients (in parts by weight) after Paillon (1960):

10	*Honey*
14	*Sugar*
3	*Water*
10	*Whole pealed almonds, blanched or toasted*
0.6	*Unsalted, dried or blanched pistachio nuts*
2	*Confectioners sugar (powdered or icing sugar) eggs (whites only, from 4 eggs per kg of honey)*
q.s.	*Vanilla extract*
q.s.	*Wafers*

Figure 2.20: Torrone and various nut, sesame seed and granola bars made with honey.

Mix the sugar, honey and water at room temperature in a large and deep fireproof pan. Leave for about two hours, stirring occasionally until a syrup is formed. Then place on medium heat and bring to a boil while stirring, being careftil to avoid any caramelization at the bottom of the pan. when boiling, cover for 3 minutes until crystals on the sides of the pot have been removed by the steam. Uncover, reduce heat and slowly increase temperature to 120-125 ^{0}C, according to the hardness desired in the final product. Remove from the heat and fold the previously mounted (beaten) egg whites into the hot syrup with either a wooden spatula or a mechanical mixer. Mix for a few minutes and when homogeneous, return the pot to low heat. Reheat to 120 ^{0}C while stirring. Once this candy has almost reached the hard crack stage, remove from the heat and add the warm, toasted almonds followed by the pistachio nuts and vanilla extract. Pour onto cold

marble between two buttered bars of the desired height or into buttered trays dusted with confectioners (4)owdered) sugar. The trays or the marble slab may also be lined with baker's wafer paper, ostia or very thin wafers (all must be edible). Once levelled at the desired thickness (0.5 to 1 cm) the nougat should also be covered by the same wafers. Weigh down the wafers and allow to set in a cool, dry place for 12 hours, then cut or saw into desired shapes and pack.

Recipes for the Italian torrone and Spanish tor6n are very similar. The torrone is characterised by the addition of hazel nuts equivalent to half the quantity of almonds and omitting pistachios. (The overall almond and nut content is increased to 60% of total weight.) Also added are finely grated lemon peel and as an option orange peel (a tblsp. each per kg of torrone) or a tblsp. of citronel (candied citron-rind) instead of the orange peel. For small-scale home recipes caramelize the sugar directly in the pan and the honey in its own water bath. Fold the mounted egg white into the caramelized honey. Then, both hot portions are mixed and brought to the final temperature close to the hard crack stage. Other ingredients have to be mixed in very quickly, if they are not preheated. Cacao paste can be added as well to change colour and flavour, replacing up to 25 or 30% of the nuts. To complement the cacao flavour, the almonds should be replaced with hazelnuts and any citrus or citronel flavours can be omitted.

2.12.18 Honey gums

Ingredients (in parts by weight) after Paillon (1960):

3	*Gum of Senegal, of gum arabica*
2.3	*Water*
2.5	*Sugar*
1	*Honey*
0.6	*Glucose*
q.s.	*Aroma, flavouring essence or colouring*

Dissolve the gum in the water, warming it lightly while stirring with a spatula. Mix the sugar with the honey, add glucose and bring this paste to a boil in a water bath while stirring vigorously. Add the filtered gum solution to the melted sugars. Heat together and verif' the right stage of boiling by dropping a small quantity into some moulds. when the boiling is judged as having reached the right stage, all of the mass is poured at a temperature of 85 - 90^{0}C.

The moulds are prepared in wooden drawers or trays filled with a thick layer of starch. The desired form is created in the starch with stamps of the required shape. The liquid is carefully poured into these cavities with a fine-spouted container. Once cooled, the trays are turned onto a large mesh screen and the extra starch is collected below. The gums can be cleaned with a blow of air (do not blow on them by mouth). Once the excess starch is removed, the gums are humidified with a jet of steam, dusted with or rolled lightly in fine crystal or confectioner's sugar and dried for afew minutes in an oven before being packed.

Colours and aromas can be mixed with the water and added to the gum to create more variety. Flavours can also be mixed towards the end of the boiling phase.

2.12.19 Gingerbread

Under the name of gingerbread a number of different recipes in different countries are used. The typical recipes from which it derived its name were those which included ginger and other spices that complement ginger, such as cinnamon and cloves. A recipe with wheat flour and one without wheat flour are given below. Measurements for small trial batches are given in brackets.

1) Ingredients (in parts by volume) modified after Rombauer and Rombauer Becker (1975):

5	*Butter*	*10*	*Honey*
5	*Sugar*	*10*	*Warm water*
	Eggs (1 per 5 cups, or per 0.5 kg of flour)	*0.3*	*Grated orange rind (optional)*
25	*All-purpose wheat flour*		
0.2	*Baking soda (2 teasp. Per 0.5 kg of flour)*		
0.1	*Baking powder*		
0.2	*Cinnamon and ginger, each*		
0.1	*Salt*		

Preheat oven to 175 ^{0}C. Melt the butter in a heavy pan and allow it to cool. Add the sugar and egg, then mix well. Sift together the dry ingredients: flour, baking soda, baking powder, spices and salt, and mix them well. In yet another pot dissolve the honey in the warm water and add the orange rind if desired. Alternately, add the dry and liquid ingredients to the sweetened butter, mixing well. Bake for one hour in greased trays. The dough should be 1.5-2 cm thick.

2) Ingredients (in parts by volume) for a wheatless gingerbread after Rombauer and Rombauer Becker (1975):

12.5	*Rye or rice flour (e.g. cups)*	*5*	*Butter*
12.5	*Cornstarch*	*10*	*Honey*
0.3	*Baking soda (3 teasp.)*	*5*	*Sugar*
0.2	*Baking powder*	*10*	*Warm water*
0.2	*Cinnamon*		*Well beaten eggs (4 per 0.5 kg of rye or rice flour)*
q.s.	*(or 0.05) ground cloves*		
q.s.	*(or 0.05) ground cloves*		

Preheat oven to 165 ^{0}C. Prepare and mix all ingredients as in the previous recipe. Combine both wet and dry ingredients, beat and knead until thoroughly mixed. Bake in a greased tray for 60 to 70 minutes or until the dough fails to stick to a thin wooden stick inserted in the mix.

3) The following recipe from Paillon (1960) may be modified by including eggs, changing flour types and replacing the ammonium bicarbonate with baking powder or with (1:1) tartaric acid and baking soda. The tartaric acid or baking powder should however not be added until the dough is ready to be baked. Ammonium bicarbonate, if it can be obtained, produces a longer lasting, crisper cookie. It needs to be pounded and dissolved in warm liquid prior to adding to the dough and evaporates relatively quickly if it is not stored in an airtight container. The very high content of raising agent (baking soda and ammonium bicarbonate) can be reduced with only minor changes in the consistency of the dough. A few nuts may be included as well as a good dose of ground cinnamon and cloves. Conversely, the malt extract and glucose are not essential and may be omitted. Glucose can be replaced by honey or sugar. If brown colouring is necessary, caramelized sugar (heated until it is almost black in colour) can be used without greatly affecting the flavour.

Ingredients (in parts by weight):

4.5	*Wheat flour*	*0.5*	*Ground ginger*
0.5	*Rye flour*	*2.0*	*Cubed citron*
5.2	*Honey*	*0.12*	*Sodium bicarbonate*
0.05	*Malt extract*		*(baking soda)*
0.35	*Glucose*	*0.08*	*Ammonium bicarbonate (or baking powder)*

Careftilly bring the honey and glucose mix to a boil in a water bath and add the malt extract. Pour the hot liquid over the flour and spice mix. Knead the compact dough and include the rest of the ingredients except the ammonium bicarbonate. Retain at least two thirds of the ammonium bicarbonate or baking powder, and all of the tartaric acid, if used. Let the dough sit for one week in a wooden drawer in a cool place.

Preheat the oven to 160^{0}C and continue preparations by kneading the dough until it turns white. Add approximately ¼ litre of milk or water while kneading and add the rest of the ammonium bicarbonate, baking powder or tartaric acid. Spread the dough in a greased and floured baking tray and cut into rectangles of 7 cm by 3 or 4 cm. Paint with beaten egg and dissolved confectioners sugar (optional) then bake at 160 to 190^{0}C, according to the thickness of the dough (testing as in the last recipe above). when the trays are removed from the oven, break the gingerbread into the precut portions.

2.12.20 Marzipan

Ingredients (in parts by weight):

10	*Sweet almonds*
1	*Bitter almonds*
7	*Honey*
1.5	*Rose water*

Finely grind the peeled and blanched almonds. Add honey and rose water and then leave for a day. No baking is necessary. The rose water can be replaced with lemon or orange juice. The marzipan can be sold in all kinds of shapes and be covered with cocoa powder or dipped in chocolate. ft can also be coloured and used for decorations. The bitter almonds can be replaced by a few drops of bitter almond extract.

2.12.21 Honey in bakery products

Bread

For replacing sugar in any bread recipes see section 2.12.11. Only one simple bread recipe will be given here, as adapted from Crane (1980).

Ingredients (in parts by weight):

700	*Wheat flour (whole wheat flour can be used)*
450	*Milk*
7	*Honey*
20	*Fresh yeast (or 5 dried yeast)*
5	*Salt*

Mix the yeast and honey, add to the warm milk and leave for 10 minutes. Mix the shortening with the flour and the salt, then add the milk to form a smooth, elastic dough. Knead well and add water if necessary. Leave to rise for 2.5 hours (or until double in size) in a warm place (30^{0}C) and in a deep, greased, pre-warmed (30^{0}C) covered container. Then divide in two, knead lightly, leave to rest 10 minutes, form into loaves in baking tins, cover with a cloth (ensure that the cloth does not touch the dough) and allow it to rise in the same warm place again for an hour or until double in size. Then bake in a preheated oven at 220 ^{0}C for about 40 minutes or until golden brown. Recipes with baking soda instead of yeast are much easier and quicker, since no rising is required, which is a phase very sensitive to disturbances.

Coconut oat cookies

Ingredients (in parts by weight) adapted from Crane (1980):

25	*Margarine*	*20*	*Dried, shredded coconut*
4.5	*Honey*	*35*	*Brown sugar*
30	*Flour*	*0.4*	*Sodium bicarbonate (baking soda)*
25	*Rolled oats*	*3*	*Warm water*

Dissolve the baking soda in water. Thoroughly mix all dry ingredients. Melt the margarine and add the honey. Mix everything together in a bowl. Place small portions (tablespoon size) on a greased baking sheet, allowing space for spreading. Bake for 10-15 minutes at 180^{0}C, or until the desired crunchiness is obtained.

Honey biscuits

Ingredients (in parts by weight):

3.5	*Flour*		*Eggs (6 per kg flour)*
1.2	*Honey*	*0.1*	*Baking powder*
25	*Rolled oats*	*3*	*Warm water*

Warm the butter, mix it with the honey and slowly add the other ingredients. Cool the dough before rolling out small amounts on a floured suiface. Cut out shapes of biscuits and bake in a preheated oven for 15 minutes at 200 ^{0}C.

Honey peanut butter cookies

Ingredients (in parts by volume):

10	*Flour*	*4*	*Honey*
4	*Peanut (groundnut) butter*		*Eggs (8 per kg flour)*
1	*Margarine*	*0.1*	*Baking powder*
2	*Sugar*	*q.s.*	*Vanilla extract*

Prepare peanut butter in a blender or grind finely. Mix the first three ingredients then add the rest one after the other. when smooth, leave for a few hours or refrigerate. Place small amounts (tablespoon size) on a greased baking sheet, allowing sufficient space for spreading and bake in a preheated oven at 165 ^{0}C for 7-10 minutes, depending on the thickness of the cookies, or until they are golden brown.

[1] **This Chapter is a joint effort between Lucia Piana and Rainer Krell with the former having provided the bulk of the information** (in **Italian, translated in part by L. Persano Oddo).**

Contents - **Previous** - **Next**

CHAPTER 3
POLLEN

3.1 Introduction

Innumerable stories and even more rumours exist about the mysterious powers of pollen and its nutritional value. Pollen is frequently called the "only perfectly complete food". High performance athletes are quoted as eating pollen, suggesting their performance is due to this "miracle food", just as the "busy bee" represents a role model for an active and productive member of society. Using suggestive names, labels and descriptions in marketing of various products containing pollen sometimes reach almost fraudulent dimensions, creating false hopes and expectations in people, often connected with high prices of the product. Such practices are untruthful, unethical and should be avoided.

It is however, often difficult for a lay person to verify the numerous claims, particularly those backed up with so-called reports from "doctors". Conversely, it does not always take a "scientific" study to prove that a food (or substance of herbal origin) has a medicinal or otherwise beneficial effect. Many times, modern science is not willing or able to prove beneficial effects according to its own rigid standards, methods and technologies. However, as a whole, caution should be exercised in accepting the many claims made to the credit of pollen and for that matter also for the other products incorporating products from the bee hive.

Pollen grains are small, male reproduction units (gametophytes) formed in the anthers of the higher flowering plants (see Figure 3.1). The pollen is transferred onto the stigma of a flower (a process called pollination) by either wind, water or various animals (mostly insects), among which bees (almost 30,000 different species) are the most important ones.

Each pollen grain carries a variety of nutrients and upon arrival at the stigma it divides into several cells and grows a tube through the often very long stigma of the flower. Growth continues to the embryo sac in the ovarium of the flower, inside which one egg cell will fuse with a sperm cell from the pollen and complete the fertilization. Depending on the requirements for this process and the mode of transport from one flower to the next, i.e. insects, water or wind, each species of plants has evolved a characteristic pollen type. Thus, the pollen grains from most species can be distinguished by their outer form and/or by their chemical composition or content of nutrients. The knowledge of this is used in the identification of paleontological discoveries (paleopalynology) and in the identification of geographic and botanical origin of honeys (melissopalynology).

To determine the value of pollen as a supplementary food or medicine, it is important to know that pollen from each species is different and no one pollen type can contain all the characteristics ascribed to "pollen" in general. Therefore, in this text, pollen will always refer to a mixture of pollen from different species, unless otherwise mentioned. A logical conclusion is that pollen from one country or ecologic habitat is always different from that of another. People who are allergic to pollen will have noticed this during their travels.

Figure 3.1 : Close up of a lily flower. The anthers (large yellow structures) release pollen in such abundance that it falls onto the petals. Note also the pollen grains adhering to the stigma surface. (Photo courtesy of F.Intoppa)

For those who see in nature something more than just the mechanical and chemical interactions of substances and organisms, it might be added that flowers form a very special part of plants. They carry special "energies" which are used in traditional alternative medicinal practices such as therapies with Bach flowers, aroma therapy or the use of numerous herbal teas. Such energies may well be carried by certain chemical substances other than water, but this is not necessarily the case, as for example, homeopathic preparations demonstrate.

Since pollen is a part of these flowers and in addition is or represents the male reproductive portion, it also has very special "energies" or values of its own. In a wider understanding in certain philosophical environments, special plant and pollen surface structures interact with cosmic energies and may acquire some of their characteristics by this means.

Apart from these less orthodox explanations, certain empirical results have in the past been described for the effects of pollen on humans and animals. These will be discussed under medicinal uses. As far as the miracle food aspect of pollen is concerned, the diversity of pollen must be emphasized again and the fact that some pollen types (i.e., pine and eucalyptus) are nutritionally insufficient even for the raising of honeybee larvae. In an excellent review, Schmidt and Buchmann (1992) compared the average protein, fat, mineral and vitamin content of pollen with other basic foods. Pollen was richer in most ingredients when compared on a weight or calorie content basis than such foods as beef, fried chicken, baked beans, whole wheat bread, apple, raw cabbage and tomatoes. While comparable in protein and mineral content with beef and beans, Pollen averages more than ten times the thiamin and riboflavin or several times the niacin content. Pollen is usually consumed in such small quantities that the daily requirements of vitamins, proteins and minerals cannot be taken up through the consumption of pollen alone. However, it can be a substantial source of essential nutrients where dietary uptake is chronically insufficient.

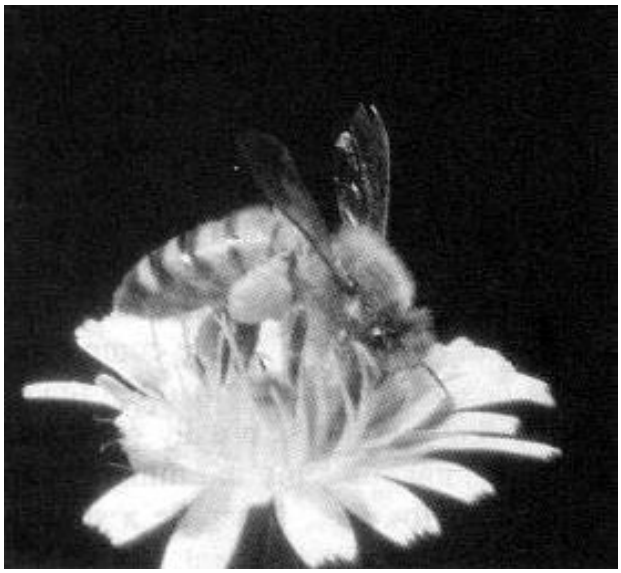
If the nutritional benefit of pollen in small dosages is accepted, as described in many non-scientific publications, it must be understood as a synergistic effect. That is, a wide variety of beneficial substances interact to improve absorbtion or use of the nutrients made available to the body from regular nutrition. Pollen nutrients may also balance some deficiencies from otherwise incomplete or unbalanced supplies, absorption or usage.

The pollen which is collected by beekeepers and used in various food or medicinal preparations is no longer exactly the same as the fine, powdery pollen from flowers. The hundreds or sometimes millions of pollen grains per flower are collected by the honeybees and packed into pollen pellets on their hind legs with the help of special combs and hairs (see Figure 3.2). During a pollen collecting trip, one honeybee can only carry two of these pollen pellets.

The pollen collected by honeybees is usually mixed with nectar or regurgitated honey in order to make it stick together and adhere to their hind legs. The resulting pollen pellets harvested from a bee colony are therefore usually sweet in taste. Certain pollen types however, are very rich in oils and stick together without nectar or honey. A foraging honeybee rarely collects both pollen and nectar from more than one species of flowers during one trip. Thus the resulting pollen pellet on its hind leg contains only one or very few pollen species. Accordingly, the pollen pellet has a typical colour, most frequently yellow, but red, purple, green, orange and a variety of other colours occur (see Figure 3.3).

The partially fermented pollen mixture stored in the honeybee combs, also referred to as "beebread" has a different composition and nutritional value than the field collected pollen pellets and is the food given to honeybee larvae and eaten by young worker bees to produce royal jelly. Saying pollen is the perfect food because it is the only food source for honeybees other than honey, their major carbohydrate source is not only based on a questionable comparison between human needs and bee requirements, but also on plain misinformation.

a) **b)**



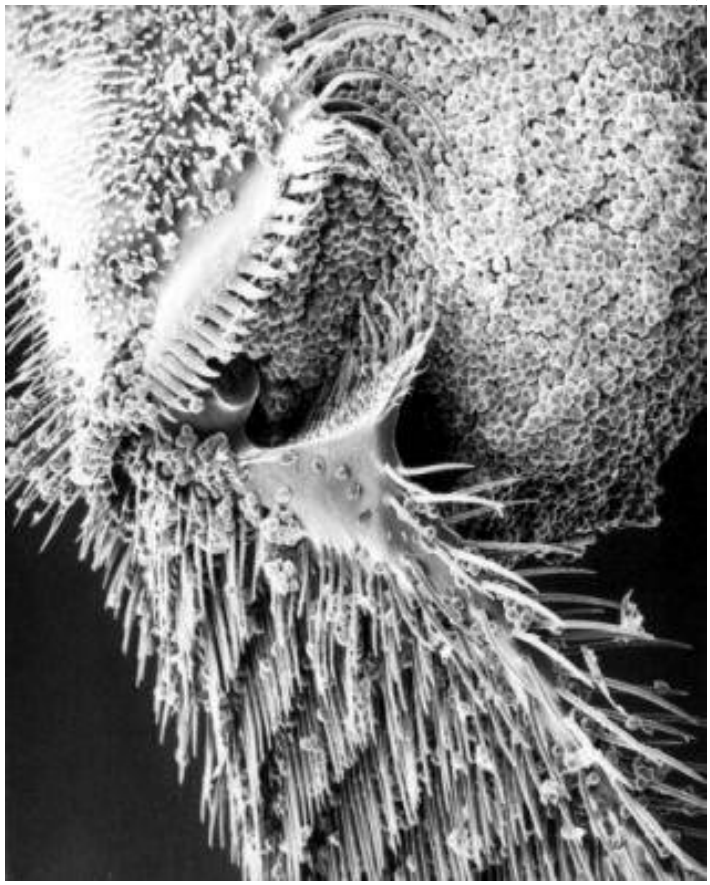


Figure 3.2: a) A honeybee forager collecting pollen from a composite flower. The pollen grains caught in the specially branched hairs of honeybees are brushed off with the legs, moistened with nectar or honey and compacted in the pollen pellets on the outside of the hind legs (photo courtesy of F. Intoppa). b) A scanning electron microscopic enlargement of the hind leg of a honeybee with the pollen pellet on the outside (photo courtesy of R.C. Davis). The bottom section of the leg consists of the pollen brush. The joint between the leg segments serves to compact the pollen and push it to the outside, thus forming the typical pollen pellet.

3.2 Physical characteristics of pollen

Pollen grains range from 6 to 200 µ m in diameter, and all kinds of colours, shapes and surface structures may be observed. These are usually typical enough to allow species or at least genus identification (see Figures 3.3 and 3.4). Most pollen grains have a very hard outer shell (sporoderm) which is very difficult or impossible to digest. It is so durable that it can be found in fossil deposits millions of years old. There are, however, pores which allow germination and also extraction of the interior substances.

3.3 The composition of pollen

Since the composition of pollen changes from species to species, variation in absolute amounts of the different compounds can be very high. Protein contents of above 40% have been reported, but the typical range is 7.5 to 35%: typical sugar content ranges from 15 to 50% and starch content is very high (up to 18%) in some wind-pollinated grasses (Schmidt and Buchmann, 1992). Composition of pollen and bee-collected pollen however, has to be distinguished. Some average values for bee-collected pollen are shown in Table 3.1.

Figure 3.3: Different coloured pollen pellets collected byhoneybees (Photo courtesy of F. Intoppa)

The major components are proteins and amino acid, lipids (fats, oils or their derivatives) and sugars. The minor components are more diverse (Table 3.2). All amino acids essential to humans (phenylalanine, leucine, valine, isoleucine, arginine, histidine, lysine, methionine, threonine and tryptophan) can be found in pollen and most others as well, with proline being the most abundant. Many enzymes (proteins) are also present but some, like glucose oxidase which is very important in honey. have been added by the bees. This enzyme is therefore more abundant in "beebread" than in fresh pollen pellets.

Only 16 of the 31 fatty acids found in pollen had been identified by 1989 (Shawer et al. 1987 and Muniategui et al., 1989). Palmitic acid is the most important one, followed by myristic, linoleic, oleic, linolenic, stearic acids etc. Simal et al., (1988) list 7 sterols, including cholesterol. Mono-, di- and triglycerides are fairly abundant, too.

Most simple sugars in pollen pellets such as fructose, glucose and sucrose come from the nectar or honey of the field forager. The polysaccharides like callose, pectin, cellulose, lignin sporopollenin and others are predominantly pollen

components. After storage in the comb the further addition of sugars and enzymes creates beebread, through lactic acid fermentation.

Table 3.1:
The average composition of dried pollen

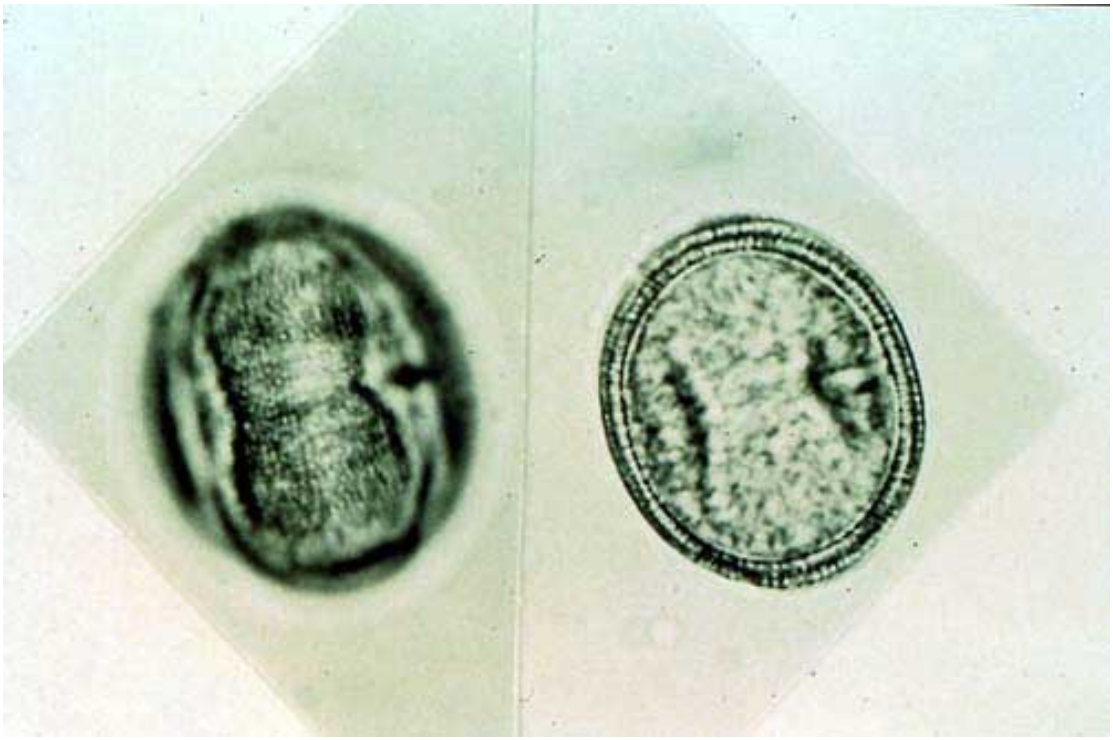
	Bee-collected		Hand-collected
	%[a]	%[b]	%[b]
Water (air-dried-pollen)	7	11	10
Crude protein	20	21	20
Ash	3	3	4
Ether extracts (crude fat)	5	5	5
Carbohydrate			
Reducing sugars	36	26	3
Non-reducing sugars	1	3	8
Starch	-	3	8
Undetermined	28	29	43

[a] *As reported by Tabio et al., 1988*
[b] *As reported by Crane, 1990*

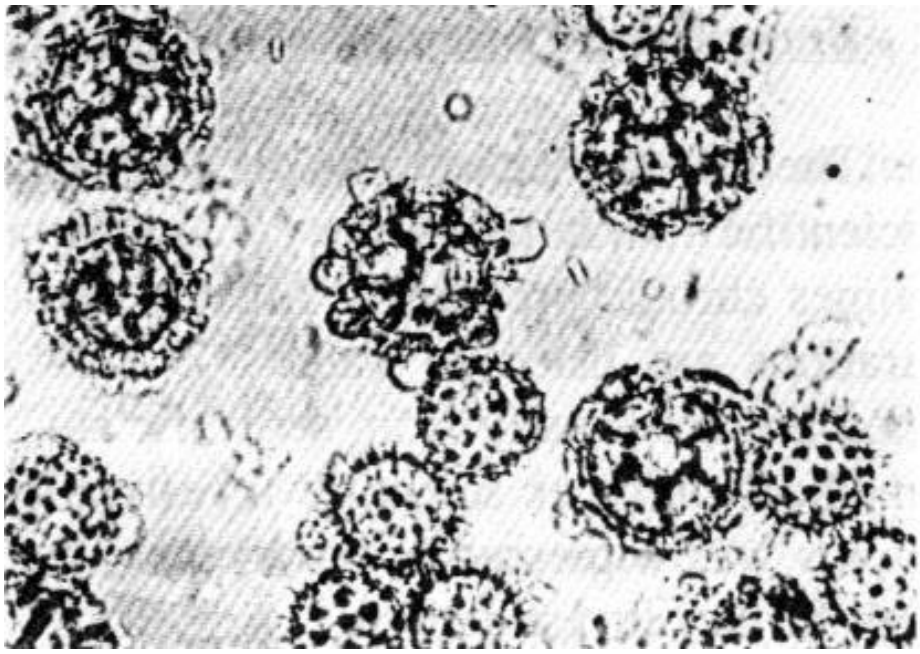
Table 3.2:
Minor components of bee collected pollen (Crane, 1990)

Flavonoids	At least 8 (flavonoid pattern is characteristic for each pollen type)
Carotenoids	At least 11
Vitamins	C, E, B complex (including, niacin, biotin, pantothenic acid, riboflavin (B_2), and pyridoxine (B_6)).
Minerals	Principal minerals: K, Na, Ca, Mg, P, S. Trace elements: A1, B, C1, Cu, I, Fe, Mn, Ni, Si, Ti and Zn
Terpenes	
Free animo acids	All
Nucleic acids and nucleosides	DNA, RNA and others
Enzymes	More than 100
Growth regulators	Auxins, brassins, gibberellines, kinins and growth inhibitors

a) Anarcadium sp. From honey in Guyana

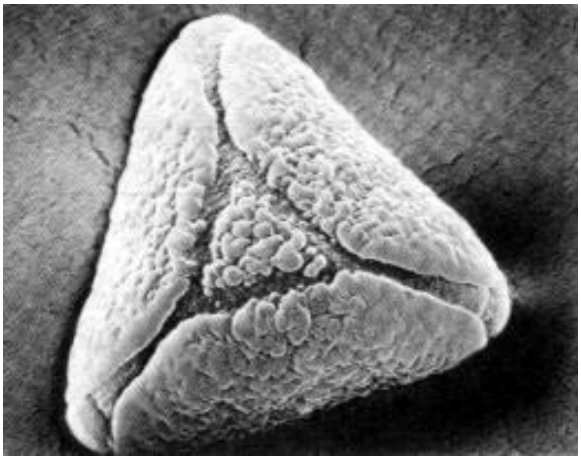


b) Vernonia perotteti gr. (large) and Synedrella gr (small, spiny) from honey in Malawi

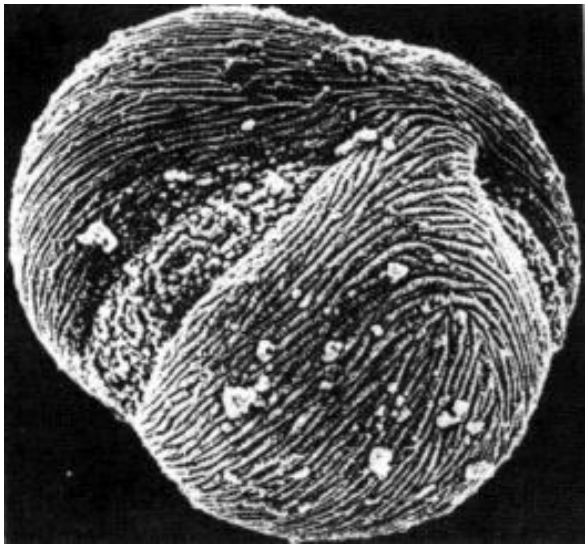


c) Eucalyptus camaldulensis, light microscope

d) Eucalyptus sp., scanning electron microscope (SEM)



e) Acerplantanoides (SEM, approx. 2600x)



f) Centaurea cyanus (freeze sectioned, SEM approx 2400x) showing thick pollen wall)

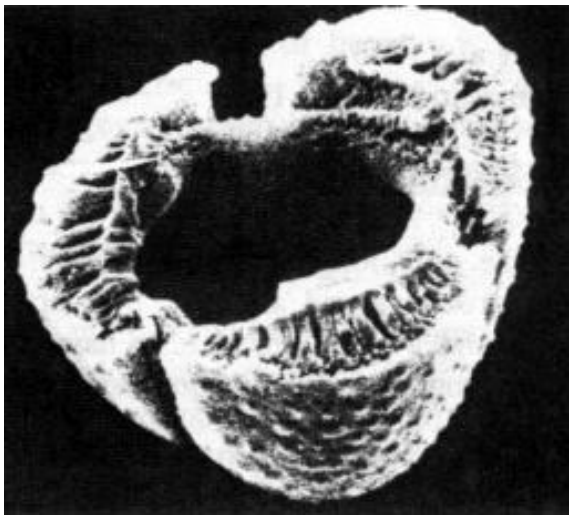


Figure 3.4: Pollen grains of various species. Photos courtesy of (a) L. Persano Oddo; (b and c) G. Ricciardelli d'Albore from Persano Oddo et al., (1988); (d) F. Intoppa; (e and f) S. Nilsson from Nilsson et al., (1977).

3.4 The physiological effects of pollen

3.4.1 Unconfirmed circumstantial evidence

The effects and benefits derived from pollen consumption, according to some of the non-scientific literature on the subject are endless. Many people report improvement of sometimes chronic problems. Most of the major ailments reported to improve with pollen preparations are listed in Table 3.3. However, one should be aware that the benefits reported are not usually from scientific studies but are merely personal experiences without any medical or other scientific investigation of claims. Sometimes the disappearance of symptoms was witnessed by physicians, but the reasons for such cures were not confirmed through further investigations.

Table 3.3:
Non-scientific claims and reports of benefits, cures or improvements derived from the use or consumption of bee-collected pollen.

Improvements	Cures of benefits
Athletic preformance	Cancer in animals
Digestive assimilation	Colds
Rejuvenation	Acne
General vitality	Male sterility[a]
Skin vitality	Anaemia[b]
Appetite[b]	High blood pressure[b]
Haemoglobin content[b]	Nervous and endocrine disorders[b]
Sexual prowess	Ulcers
Performances (of a race horse)	

[a] *Ridi et al., 1960*
[b] *Sharma and Singh, 1980*

3.4.2 Scientific evidence

The only long-term observations on the medicinal effect of pollen are related to prostate problems and allergies. Several decades of observations in Western European countries and a few clinical tests have shown pollen to be effective in treating prostate problems ranging from infections and swelling to cancer (Denis, 1966 and Ask-Upmark, 1967).

Supplementation of animal diets with pollen has shown positive weight gain and other beneficial effects for piglets, calves, broiler chickens and laboratory cultures of insect (see 3.5.2).

Certain bacteriostatic effects have been demonstrated (Chauvin et al, 1952) but this is attributed to the addition of glucose oxidase (the same enzyme responsible for most antibacterial action in honey) by the honeybee when it mixes regurgitated honey or nectar with the pollen (Dustmann and Gunst, 1982). Therefore, this activity varies between pollen pellets and is much higher in beebread. A very slight antibacterial effect can also be detected in pollen collected by hand (Lavie, 1968).

There is some evidence that ingested pollen can protect animals as well as humans against the adverse effects of x-ray radiation treatments (Wang et al., 1984; Hernuss et al., 1975, as cited in Schmidt and Buchmann, 1992).

3.5 The uses of pollen today

3.5.1 As medicine

In order to desensitize allergic patients, pollen is usually collected directly from the plants, to allow proper identification and purity. A pollen extract is then injected subcutaneously. Desensitization through ingestion of pollen is claimed, but has not received any scientific confirmation.

For treatment of various prostate problems, pollen is usually prescribed in its dry pellet form as collected by the bees. Pollen from different countries or regions seems to work equally well. However, pollen has not been officially recognized as a medicinal drug.

Since the consumption of pollen appears to improve the general condition and food conversion rate in animals as well as people, its support in accompanying other cures should be solicited more frequently. There may be other medicinal uses in traditional medicine which, however, have not been published in readily accessible journals.

3.5.2 As food

The major use of pollen today is as a food or, more correctly, as a food supplement (see Figure 3.5). As stated earlier its likely value as a food for humans is frequently overstated and has never been proven in controlled experiments. That it is not a perfect food, as stated on many advertisements, food packages and even in various non-scientific publications should be obvious. Its low content or absence of the fat soluble vitamins should be sufficient scientific evidence. This does not mean that its consumption may not be beneficial, as has been shown scientifically with various animal diets.

Pollen has been added to diets for domestic animals and laboratory insects resulting in improvements of health, growth and food conversion rates (Crane, 1990; Schmidt and Buchmann, 1992). Chickens exhibited improved food conversion efficiency with the addition of only 2.5% pollen to a balanced diet (Costantini & Ricciardelli d'Albore, 1971) as did piglets (Salajan, 1970). Beekeepers too, feed their colonies with pure pollen, pollen supplements or pollen substitutes (see 3.11.6) during periods with limited natural pollen sources. The relatively high cost of pollen suggests the need for a detailed feasibility analysis of pollen as food additive or supplement.

Only a good mixture of different species of pollen can provide the average values mentioned in the tables describing the composition of pollen. The real value of diversity of pollen content, however, lies in the balance of these nutrients and the synergistic effect of the diversity as well as more subtle effects or characteristics related to their origin rather than their quantitative presence. Those very subtle characteristics and sensitive compounds are easily lost with improper storage and processing, something to carefully watch when making or buying quality products containing "bee" pollen.

The stimulative effect of pollen and its possible improvement of food conversion in humans as well as animals, should be of particular interest to those who have an unbalanced or deficient diet. There are no hard scientific data to back up this information, but a detailed study might show tremendous potential benefit to a very large portion of human society. The only serious problem with incorporating pollen in foods like candy bars, sweets, desserts, breakfast cereals, tablets and even honey is the widespread allergic susceptibility of people to pollen from a wide variety of species (see 3.10).

Beebread

Traditional beekeeping cultures with honeybees or stingless bees, usually appreciate the stored pollen, i.e. beebread (see Figure 3.6). Its characteristic sour taste together with brood and honey is a delicacy consumed directly during harvesting. The pollen stored by honeybees undergoes a lactic acid fermentation and is thus preserved. This final storage product is called beebread. As also mentioned in Chapter 8, these beebread combs may be sold directly but a recipe in 3.12.2 describes the preparation of fermented pollen in a similar way. This improves the nutritional value of pollen and avoids the need for freezing.

Natural and homemade beebread will keep for a considerable time and can easily be transported to the market and served - even in small quantities - as an excellent source of otherwise scarcely available nutrients. It can be sold clean and by itself or immersed in honey to make it more attractive in taste. Small pieces of comb can thus be sold or given away as candy.

The nutritional value of beebread is much higher in places where limited food variety or quantity create nutrient imbalances. It is particularly children who might benefit the most from regular pollen supplements in their diets.

3.5.3 In cosmetics

Pollen has only recently been included in some cosmetic preparations with claims of rejuvenating and nourishing effects for the skin. The effectiveness has not been proven, but there is a considerable allergy risk for a large percentage of the population. Therefore this practice is not very advisable since it excludes a large proportion of potential customers and puts others at risk of having or developing very unpleasant allergic reactions.

Including alcoholic or aqueous pollen extracts (see 3.11.1) in cosmetic formulations appears to cause no or only rare allergic reactions. While little is known about the effectiveness of such extracts, they are still the preferred method of preparation for formulations in the cosmetic industry.

Figure 3.6: Beebread, fermented pollen, is stored in open cells (lighter cells). Usually it is found near or on the brood combs, between honey and brood. Harvesting usually destroys the associated brood and comb.

3.5.4 For pollination

Hand and bee-collected pollen have been used for mechanical or hand pollination. The viability of hand-collected pollen can be maintained for a few weeks or months by frozen storage. Bee-collected pollen however, starts losing its viability after a few hours and increasingly with age. It is believed that some of the enzymes added by bees during foraging inhibit the pollen's ability to germinate on the flower stigma (Johansen, 1955, and Lukoschus and Keularts, 1968). Large-scale applications with mechanical dusters or by using dusted honeybees for dispersion were only moderately successful.

3.5.5 For pollution monitoring

Since the 1980's, experiments have shown that pollen collected by honeybees reflects environmental pollution levels when examined for metals, heavy metals and radioactivity, (Free et al., 1983; Crane, 1984 and Bromenshenk et al., 1985). Contaminants can be quantified and sampling may be cheaper than most standard methods currently in use. Attempts have also been made to use pollen-collecting honeybees for the identification of potential mining areas (Lilley, 1983). The same effect of accumulating aerial deposits and selective plant secretions of minerals beneficial when used to monitor pollution control becomes a hazard if pollen from heavily polluted areas is used for human or animal consumption.

3.6 Pollen collection

Extreme care should be taken that pollen is not contaminated by bees collecting from flowers treated with pesticides. During, and for several days or weeks after treatment of fields or forests in an area of several square kilometres (in a circle of at least 3-4 2 km diametre) around the apiary, no pollen should be collected. This is independent of the method of pesticide application. Even systemic pesticides have been shown to concentrate in pollen of, for example coconut (Rai et al., 1977). Since a pollen pellet is collected from many flowers, even small quantities of pesticides per flower can be accumulated rapidly to reach significant concentrations.

Though pollen pellets are collected before they enter the hive, treatment of colonies for bee diseases, can contaminate the pollen pellets. Though, for example, cleaning of debris from the hive and bees regurgitating syrup, nectar or honey during collection of the pellets.

Pollen pellets are removed from the bees before they enter the hive. There are many designs of pollen traps (see Figures 3.7 to 3.8) some easier to clean and harvest, others more efficient or easier to install. The efficiency rarely exceeds 50%, i.e. less than 50% of the returning foragers loose their pollen pellets. Bees are ingenious in finding ways to avoid losing their pellets, like small holes or uneven screens and may even rob pollen from the collecting trays, if access is possible. Under some circumstances, pollen collection methods and regimes may interfere with normal colony growth or honey production. Therefore, standard beekeeping manuals should be consulted for the timing of collections (Dadant, 1992).

Pollen should be collected daily in humid climates but less frequently in drier climates. To avoid deterioration of the pollen and growth of bacteria, moulds and insect larvae, pollen should be dried quickly. Ants can remove considerable amounts from pollen traps. Krell (personal observations) reports that losses can be up to 30% in temperate climates.

Pollen needs to be dried to less than 10% moisture content (preferably 5 % or 8% according to some laws) as soon as possible after harvesting. A simple method uses a regular light bulb (wE and 1 1OV or 20W and 220V) suspended high enough above a pollen carton or tray so that the pollen does not heat to more than 40 or 45 ^{0}C. For solar drying, the pollen itself should be covered to avoid direct sunlight and overheating.

After drying, the pollen needs to be cleaned of all foreign matter. A tubular tumbler made out of a wire mash with a fan can clean considerable quantities of pollen pellets. Simpler winning methods can be used too. Benson (1984, in English) and Marcos (1991, in French) give very good accounts on trapping and subsequent processing of pollen.

Most types of pollen traps are currently only fitted to standard frame hives. are fitted to traditional log, clay or straw hives, small modifications are necessary.

Beebread is usually found on brood combs or combs near the brood nest. Available quantities are normally very small and inadvertently the brood comb and sometimes the whole colony are destroyed during harvest. A team of Russian scientists described a nondestructive means of extracting beebread from combs, harvesting 300-600 kg per year from 1500 colonies (Nakrashevich et al., 1988).

Some races of bees will store large quantities of beebread when colonies have become queenless, or the brood nest and/or plenty super space, are above an empty box with combs. Such manipulations will be more difficult or impossible with most traditional bee hives but modifications may be worthwhile. As mentioned earlier, beebread can also be made at home from bee-collected pollen(see section 3.12.2).

Other social bees usually store their pollen in special containers separate from the brood combs. These "pollen pots" can therefore be harvested without destroying the nest, but caution is necessary not to deplete the food sources completely.

3.7 Pollen buying

Quality control of pollen is difficult and under most circumstances impossible. It is therefore very important that the buyer knows the supplier well and can trust him. A reliable supplier should have all necessary storage and processing facilities and use them. Furthermore the production area, not only the residence or processing centre, should be free of agrochemicals and industrial pollution (and chemical treatments of the colonies). There are less and less of these regions in industrialized countries and a vast array and quantity of agrochemicals are now being used even in developing countries. More remote

zones have problems with proper storage and transport and may require special collection and storage centres.

a) **b)**

Figure 3.7: a) Pollen trap design to fit into a hive entrance between the bottom board and the brood chamber. b) The screen through which the bees have to pass can be made of a thick plastic sheet (at least 3 mm) with holes of 4.7 mm diameter for European honey bees and of 4.2 mm diameter for smaller bees such as from African races. Two wire screens with holes of similar size can also be used, spaced 4 to 7 mm apart.

Sometimes, unethical, deceptive marketing or ignorance prevents consumers or buyers to be informed about the above conditions. Until reliable tests have been developed and legal requirements force more frequent testing only responsible producers can be relied upon.

Buying processed products requires similar caution. The processor has to use gentle processing procedures to maintain those subtle qualities of pollen, which earned it its collected during four days. This type of trap is placed between bottom board and brood reputation. The buyer, whether consumer, retailer or processor has to be very careful and pay considerable attention to all handling and processing from the field collection to the final product. A truthful label could describe all the essential steps taken in order to guarantee the quality of the product. The need for highly ethical behaviour and knowledge at all levels is a requirement to be considered seriously, by anyone starting in this business, be it producer, processor or distributor. Forming a self-controlling organization, which certifies and controls producers and manufacturers may be useful or necessary to minimise fraud or avoid unreliable quality.

Figure 3.8: Pollen tray of a modified OAC trap (Waller, 1980) with two types of pollen chamber permitting better ventilation and pollen removal without disturbance of the colony. Returning foragers are forced to crawl through a double screen of 5-mesh wire (5 wires per inch) with 4-7 mm distance between screens.

3.8 Storage

Pollen, like other protein rich foods, loses its nutritional value rapidly when stored incorrectly. Fresh pollen stored at room temperature loses its quality within a few days. Fresh pollen stored in a freezer loses much of its nutritive value after one year. Longer, improper storage leads to the loss of a few particular amino acids, which cause deficiencies in brood rearing (Dietz, 1975). When dried to less than 10% (preferably 5%) moisture content at less than 45°C and stored out of direct sunlight, pollen can be kept at room temperature for a several months. The same pollen may be refrigerated at 5°C for at least a year or frozen to –15°C for many years without quality loss as tested by feeding to honeybee colonies and recording brood rearing rate (Dietz and Stephenson 1975 and 1980).

Since sunlight, i.e. UV radiation, destroys the nutrient value of pollen, other more subtle characteristics probably suffer worse damage. Storage of dry pollen in dark glass containers, or in dark cool places, is therefore a requirement.

3.9 Quality control

Only a few countries, such as Switzerland and Argentina, have legally recognized pollen as a food additive and established official quality standards and limits. Though sold in many health food stores, pollen is not considered an additive by the US FDA (Food and Drug Administration) and it does not have to comply with special standards. It is, however in the producer's own best interest to maintain the highest standards of cleanliness for his product.

The Argentinean standards require microbiological characteristics of not more than $1SOx1O^0$UFC/g aerobic microbes, $1O^0$UFC/g fungi and no pathologic microorganisms. The moisture content should not exceed 8% (controlled by vacuum drying at 45 mm Hg and 65^0C). Other limits include a pH of 4-6, protein content of 15-28% Kjeldahl (N x 6.25) of dry weight, total hydrocarbons of 45-55 % of dry weight and a maximum ash content of 4% of dry weight (determined at 600 ^{0}C).

Pollen used for cosmetic purposes should have the same, if not a better quality than that destined for consumption as food. The first quality control is assessment of gross contamination with foreign substances, i.e., parts of bee and hive debris. Further controls might include measurement of moisture content and a bacterial count. Determination of various

agrochemicals, including drugs used inside bee colonies are possible and may be required in some circumstances. These analyses require sensitive, expensive chromatographic equipment.

Since air pollutants and agro-chemicals have been shown to accumulate in pollen collected by bees (see 3.5.5) pollen should originate from unpolluted areas with the lowest chance of contamination by agrochemicals, industrial pollutants and drugs applied by beekeepers. Producers from such areas should make particular note of this in their advertising.

Degradation of pollen nutrients by inadequate collection, drying and storage can only be tested by bioassay, i.e. feeding pollen to honeybee colonies and observing the quantity of brood reared, which is a very lengthy and laborious process. Therefore, only reliable primary products who have the required knowledge and facilities should be considered as supplies.

Contents - **Previous** - **Next**

3.10 Caution

Pollen allergies, also called hay fever have been known for a long time but in today's stressful environment it seems that more and more people suffer from allergies. Often it is difficult to identify the exact source. Specific pollen allergies may be avoided by changing one's environment. Desensitization with established Western medical methods (subcutaneous injections of pollen extracts) are slow and generally have only a temporary effect, so they need to be repeated. Traditional and alternative health practitioners have claimed to cure pollen allergies. It is said that the consumption of locally produced honey has a desensitizing effect because all honeys contain small quantities of pollen. However, not all available pollen species are collected by bees and thus may not occur in the particular honey. There is not even anecdotal evidence that honey consumption will remedy pollen allergies, but consuming small quantities of honey regularly has not harmed anyone yet. The consumption of pressed honey which always has a very high pollen content, may at times cause small allergic reactions (personal experience) Feinberg et al., (1940) have shown in numerous comparisons that pollen consumption only marginally improved allergic reactions, so marginally in fact that it cannot be recommended, nor can improvements be distinguished from improvements possibly due to general improvements in health.

The greatest risk of allergic reactions exists with the direct consumption of pollen. This, however, can be avoided by consuming pollen packed in capsules or coated pills which prevent direct contact with any mucous membranes. Once in the digestive tract, the body generally does not show any allergic reaction. Again, careful trials by sensitive individuals are recommended if consumption is assisted upon.

This preempts any foods in which pollen has been incorporated, but allows taking pollen for special health reasons. Barrionuevo (1983) and personal trials by the author, who is strongly allergic to some pollen species, confirmed that by avoiding contact with eyes, nose, mouth, throat and pharynx, no allergic reactions occurred with ingested pollen. Intestinal allergies to pollen are rarer than most food allergies (Schmidt and Buchmann, 1992). Still, careful trials by sensitive individuals are recommended for all products containing pollen.

Since there are so many different substances in the different pollen species to which people react with allergies, only some extractions or a general denaturalization can inactivate most of the allergens for commercial production. This probably ruins some of the beneficial characteristics of the pollen as well. Getting pollen from areas without the allergy-causing species may help individuals who want to consume pollen, but such identification and separation is unlikely to be feasible for commercial production.

A simple muscle resistance test (kinesiology) can show allergic sensitivities before actual contact with the substance occurs.

As a precaution, everybody, even those people who have not known any pollen allergies before, should first try very small quantities of the pollen or the product containing the pollen. Allergic reactions

normally occur within a short period of time, from a few minutes to a few hours.

To avoid any problems with customers and with those who consume foods or use cosmetics and medicine-like products containing pollen, it would be advisable to include a warning on the product label, for example "This product contains pollen which may cause allergic reactions. Try small quantities first".

Pollen should not be collected or purchased from areas with heavy industrial, urban or agricultural pollution (pesticide). The geographical origin of the pollen should be known, and producers as well as buyers and retailers should be using adequate cold storage.

3.11 Market Outlook

Dried pollen prices in the USA range from US$5 to 13 per kg wholesale and US$11 30 per kg retail (American Bee Journal, 1993). Encapsulated pollen or pollen tablets sell vials of 50 to 100 units and retail at prices of up to US$900/kg, at least in Italy and the

The bulk pollen consumer market seems to be growing in industrialized countries, but pollen tablets are still a common feature of health food stores and command an excessively high price. Encapsulation and extraction of pollen lend themselves easily to small scale manufacturing and result in safer consumer products.

Most of the buyers and large scale sellers of pollen are also honey traders. Crane (1990) however reports that a lot of commercial pollen is not bee collected, but machine-collected from certain wind pollinated plants which release very large quantities of dry pollen.

At least in industrialized countries and those with increasing numbers of health conscious consumers, pollen consumption is likely to increase further. It is difficult to see how wholesale prices of bulk pollen could drop much lower. On the other hand, there seems to be a wide market for reasonably priced, encapsulated pollen and tablets.

Promotion of pollen from uncontaminated, unpolluted or even tropical forest areas may find a small consumer base in importing countries.

The high nutritional value of pollen should find special consideration in rural communities. Though not a traditional food, the ease of mixing it with other foods should facilitate acceptance. Rural hospitals could be the first to promote the use of pollen.

Figure 3.9 : Various commercial products containing bee-collected pollen in either a processed or unprocessed (from left to righ): liquid pollen extract, granola bar (musli), different coloured pollen pills and capsules and dried pollen.

3.12 Recipes

Pollen can be added to a variety of foods and snacks. It does not involve any special adaptation of recipes, because the pollen is usually added in small quantities. However, pollen has a distinct flavour of its own and is usually slightly sweet. Thus it will alter delicate flavours and can even be detected in products with stronger flavours such as chocolate bars or granolas. Quantities should therefore be adjusted according to flavour.

Considering the sensitivity of pollen, its inclusion in products requiring processing (particularly heating) may cause a significant loss of beneficial effects. Fermentation into beebread may not only preserve many of the beneficial characteristics, but also add new enzymatic ingredients. Since pollen can easily be included in most recipes, only a few are provided here which might be marketable by small enterprises, including beekeepers. Various processed forms (encapsulated, pills, extracts) are presented (see Figure 3.9) and additional recipes can be found in Chapters 2, 5, 8 and 9.

3.12.1 Pollen extract

To avoid the granular structure of pollen or avoid some of the allergenic effects, pollen extracts can be prepared. The most common solvents for extraction are various types of alcohols. The higher the alcohol concentration, the more complete is the extraction of oils, fats, colours, resins and fat soluble vitamins from pollen. Solvents with lower concentration of alcohol mainly dissolve tannins, acids and carbohydrates. Therefore, with a variation of the alcohol concentration different types of extracts can be prepared. A propylene glycol extract contains most water soluble material, leaving behind the proteins, thus eliminating most if not all allergenic material. Such an extract is well suited for external applications such as in cosmetics. Oil extractions have been reported as inefficient. Treatment with

diethylene glycol monomethyl ether discolours pollen and its extracts (D'Albert, 1956) where coloration may not be desired (cosmetics).

The following extract is prepared with a very high percent alcohol (95 % or more) to get most of the substances out of the pollen. The alcohol has to be food grade (fit for human consumption). Distilled beverages usually contain 40-60% alcohol or less, and so only produce less complete extracts.

A glass bottle or glazed clay pot is filled with 4 parts of 95% alcohol and 1 part of beebread (Dany, 1988). Bee-collected pollen can be used as well, but beebread has different (higher) nutritional values (see 3.12.2). Agitate the mixture at least once a day and leave it for 8 days. More frequent agitation improves extraction. The mixture is filtered through afine cotton cloth and stored in a dark glass bottle. It can be stored for a long time. The filtrate can again be washed in water and this weaker extract may be used immediately.

For further potentiation, 50 g of broken propolis can be added for extraction at the start. For medicinal purposes other herbal extracts can be added as well as mead, royal jelly etc.

A revitalizing concentrate, a teaspoon taken three times a day, is described (in parts by weight). Different proportions and additional ingredients are possible.

4	*Honey*	*4*	*Honey*
1	*Wheat germ (or wheat extract)*	*0.5*	*Pollen (or extract)*
1	*Pollen extract*	*0.5*	*Yeast (or stimulating plant extarct)*
1	*Dry yeast (brewers or bakers yeast)*	*0.05-0.5*	*Royal jelly*
0.1-0.4	*Royal jelly*		

3.12.2 Beebread (after Dany, 1988)

Normally, the term beebread refers to the pollen stored by the bees in their combs. The beebread has already been processed by the bees for storage with the addition of various enzymes and honey, which subsequently ferments. This type of lactic acid fermentation is similar to that in yoghurts (and other fermented milk products) and renders the end product more digestible and enriched with new nutrients. One advantage is almost unlimited storability of beebread in comparison with dried or frozen pollen in which nutritional values are rapidly lost. The natural process carried out by the bees can more or less be repeated artificially with dry or fresh bee-collected pollen. It is important however, to provide the correct conditions during the fermentation process.

The container

Wide-mouthed bottles or jars with airtight lids are absolutely essential. Airtight stainless steel or glazed clay pots can also be used. Containers should always be large enough to leave enough airspace (20 to

25 % of the total volume) above the culture.

The temperature

The temperature for the first two to three days should be between 28 and 32^0C; the bees maintain a temperature of approximately 34°C. After the first two or three days the temperature should be lowered to 20°C.

The high initial temperature is important to stop the growth of undesirable bacteria as quickly as possible. At this ideal temperature all bacteria grow fast so that an excess of gas and acid accumulates. Only lactic acid producing bacteria (lactobacilli) and some yeasts continue to grow. The former soon dominate the whole culture. This final growth of lactobacilli should proceed slowly, hence the reduction in temperature after 2-3 days.

The starter culture

It is best to start the culture with an inoculation of the right bacteria such as Lactobacillus xylosus or lactobacilli contained in whey. Freeze-dried bacteria are best if they can be purchased, but otherwise, the best cultures are those that can be obtained from dairies. Whey itself can be used. If the whey is derived from unprocessed fresh milk it should be boiled before use. A culture can also be started with natural beebread.

Preservation

Fermentation produces a pleasant degree of acidity (ideally pH 3.6-3.8). Some pollen species may promote excessive yeast growth but this does not spoil the beebread. If the flavour is strange or some other mildew-like or unpleasant odours arise from the beebread, discard it and try again. The final product, can be stored for years, once unsealed, it can be dried and thus is storable for many more months.

General conditions

For successful fermentation, exact quantities are less important than the correct conditions:

- the pollen to be fermented needs to be maintained under pressure
- the air space above the food needs to be sufficient (20-25 % of total volume)
- the container needs to be airtight
- the temperature should not drop below 18°C

Ingredients (in parts by weight):

10	*Pollen*
1.5	*Honey*

2.5	*Clean water*
0.02	*Whey or very small quantity of dried lactic acid bacteria*

Clean and slightly dry the fresh pollen. If dried pollen is used, an extra 0.5 parts of water is added and the final mix soaked for a couple of hours before placing it in the fermentation vessels. If the mixture is too dry, a little more honey-water solution can be added.

Heat the water, stir in the honey and boil for at least 5 minutes. Do not allow the mix to boil over. Let the mix cool. When the temperature is approximately 30-32 ^{0}C, stir in the whey or starter culture and add the pollen. Press into the fermentation container.

When preparing large quantities in large containers, the pollen mass should be weighted down with a couple of weights (clean stones) on a very clean board.

Close the container well and place in a warm place (30-32 ^{0}C).

After 2-3 days, remove to a cool area (preferably at 20^{0}C). 8 to 12 days later the fermentation will have passed its peak and the beebread should be ready. The lower the temperature, the slower is the progress of fermentation. Leave the jars sealed for storage.

3.12.3 Honev with pollen

Health food stores and beekeepers sometimes add up to 5 % (by weight) of pollen to honey. Using fresh pollen may lead to fermentation of the honey. Very well dried and finely ground pollen, however is more difficult to mix into the honey. Mix the pollen with a smaller quantity of honey and then add it to the final batch.

No matter how well the powdered pollen pellets are mixed into the honey, the pollen will separate and rise to the top of the honey in a very short time. This does not look very attractive but people will be more inclined to buy the product if the cause is explained properly on the label. This is a more palatable way to eat pollen than eating the dry pellets directly and appears to preserve the delicate characteristics of pollen very well. One way to avoid separation is to mix the pollen with creamed or crystallized honey (see recipes in Chapter 2).

The most likely customers for such products are people who are more knowledgeable and very health conscious. Therefore, other bee products such as royal jelly or propolis can be added to the honey mixture and a still better price may be obtained. How much this improves the health or nutritional value of the honey mix remains unanswered. Since honey improves the uptake of several nutrients, it may benefit the absorption of other substances as well. The resulting product should have a fairly long shelf life, but particularly if royal jelly is added, the product should be refrigerated.

3.12.4 Granola or breakfast cereals

Dry pollen pellets can be sprinkled directly over a prepared breakfast or incorporated in a cereal. Most prepared cereals require baking during processing or heating prior to eating, either would reduce the beneficial characteristics of pollen.

In order to be included in granola, pollen pellets need to be pulverized and then sprinkled over the cooling cereal (granola) while it is still moist and sticky. Inclusion in the granola dough prior to baking is not recommended.

Pulverized pollen pellets may be mixed dry with powdery breakfast cereals or sprayed onto the cereal together with a honey (sugar) syrup possibly including other flavours or fruit juice after roasting or baking of the cereal.

An alternative for baked granolas as well as dry cereals (muesli) would be to include one or more measured portions of dried pollen pellets in a separate bag, ready to be added by the consumer. This avoids problems for some allergic consumers, saves processing and preserves the beneficial characteristics of pollen.

Granola

A basic granola recipe requires:

One or more of the rolled or puffed grains (rye, wheat, barley, buckwheat, oat, rice or some of the local grains still grown in many parts of the world), heated vegetable oil and a variety of seeds, nuts, dried fruits, coconut, wheat germ, etc., shredded or finely chopped and added in proportions determined by the preference of the manufacturer or customer.

Dried milk powder can be added and dried fruits, fruit juice or honey can be used for sweetening. Any pollen or insect larvae should only be added after toasting.

The rolled grains are spread in a baking pan and toasted under fre quent stirring for 10 to 15 minutes in an oven heated to 150^{0}C. Then the rest of the ingredients are added and toasted for another 15 minutes with more stirring. A simpler alternative which however reduces the nutrient value of some of the ingredients involves mixing all the ingredients together and toasting them - also at 150 ^{0}C - for 35 minutes. Once cooled, store tightly covered and preferably refrigerated.

A muesli or dry cereal usually consists only of dried ingredients. No toasting or baking is necessary. The same granola ingredients can be mixed but without the oil. For consumption, the muesli is mixed with cold milk, water or fruit juice. Alternatively, it may be briefly boiled to soften the rolled grains.

Granola bars

To make granola bars, the same granola mixture should be pressed into the preferred shape after the first toasting. The second toasting is then completed at a slightly lower temperature and over a longer period of time. If sufficient honey is used, the hot mixture can be pressed into oiled forms also just before the toasting is finished, when the granola is still moist and sticky.

The sample recipe below is adapted from "The Joy of Cooking" (Rombauer and Rombauer Becker, 1975):

Ingredients (in parts by volume, e.g. cups):

2	*Rolled oats*	*1*	*Dry milk*
2	*Rolled rye or barley*	*2*	*Coarsely chopped almonds*
2	*Wheat or corn flakes (or rolled)*	*2*	*Shredded or flaked coconuts*
1	*Vegetable oil*	*2*	*Hulled sunflower seeds*
1	*Honey*	*1*	*Sesame seeds*
3	*Wheat germ*	*q.s.*	*Pollen, insect larvae or dried fruits*

Preheat the oven to 150 ^{0}C. Scatter the rolled grains on a baking sheet or pan and toast for 15 minutes in the oven, stirring frequently. Slowly heat the oil and honey and add the remaining ingredients. Then combine with the toasted grains and spread thinly in the pan, continuing to toast in the oven and stirring frequently for another 15 minutes or until the ingredients are toasted. While the ingredients are still warm and sticky, sprinkle the pollen pellets, pollen powder, insect larvae or chopped dried fruits onto the granola and form into bars of the desired size.

3.12.5 Candy bars

There are many ways of preparing candy bars with nuts, chocolate, grains, popcorn and puffed rice to which pollen or even larvae can be added For replacing part of the sugars with honey in any recipe see the recipe section in Chapter 2.

The following is a general recipe from the same source as the granola and can be modified substantially for different flavours, textures etc.

Ingredients (in parts by volume):

3	*Honey*
4	*Butter*
0.3	*Water*
4 to 6	*Slivered almonds (or other nuts, larvae or pollen)*
3	*Melted semisweet chocolate*
1	*Finely chopped nuts, larvae, pollen or raisins*

Sliver or break large nuts such as almonds, hazelnuts and brazil nuts but, peanuts, for example, can be

left whole. If a roasted nut flavour is preferred, add the nuts at the beginning to the honey, butter and water mix. If not, spread them on a buttered slab or pan and pour the cooked syrup over them.

Heat the honey, butter and water in a heavy skillet. Cook rapidly and stir constantly for about 10 minutes or until the mixture reaches the hard-crack stage (150^{0}C). Add the nuts and larvae quickly and pour into a buttered pan or slab or pour the syrup over the nuts on a buttered slab. When almost cool, sprinkle with pollen powder (or crushed pollen pellets) and brush with the melted chocolate. Before the chocolate hardens, dust with the finely chopped nuts, larvae or pollen. After cooling, break into pieces and wrap individually.

In order to form even-sized bars or round shapes, pour the syrup into buttered moulds. Before completely cooled, these bars can be dipped in melted chocolate and sprinkled with any of the above materials for decoration. For special care with chocolate coatings, see also recipes in Chapter 2.

Many regions have their own special and preferred sweets and candy bars. Pollen can be incorporated into many of these recipes. Such incorporations should take place towards the end of processing, and the first cooling phase, in order to preserve as much as possible of the subtle characteristics and benefits of the pollen.

Cereal-fruit bar

The following two recipes (adapted from Dany, 1988) preserve all the nutritious values which might otherwise be destroyed through heating in the previous preparations. The baking described in the granola and candy bar recipes is replaced by drying at temperatures of 40 to 45 ^{0}C. This also facilitates processing for those who do not have access to baking stoves.

The oats used here can be replaced by one or a mixture of other grains. They should however be rolled into flakes. The pollen extract (3.12.1) mentioned here, can also be powdered, bee-collected pollen or the fermented manmade beebread mentioned in section 3.12.2.

Basic Ingredients (in parts by volume):

4	*Rolled oats*
1	*Boiled water or fruit juice*
0.2	*Vegetable oil or fat*
0.2	*Dry yeast (brewers yeast, bakers yeast or other)*
0.6-1.2	*Pollen extract*
q.s.	*Salt*

The following ingredients (by piece per 50 g. of oats) can be mixed according to taste and availability:

2	*Figs*	*Or*	*1 tablesp*	*Chopped chocolate*
½	*Banana*		*4*	*Dried apricots*
½	*Apple*		*½*	*Apple*
2 teasp	*Ground almonds*		*1 tablesp*	*Soybeans (toasted or boiled)*
1 tablesp	*Sunflower seeds*		*1*	
1 tablesp	*Raisins*		*1 tablesp*	*Raisins*
5	*Dates*		*1 tablesp*	*Chopped nuts*

A small amount of honey can be added for sweetening.

For a more unusual flavour the following is recommended:

50 g	*Rolled oats*
30 g	*Fresh pureed tomatoes*
1-2 tblsp	*Pollen extract*
½	*A pureed green pepper*
½	*Finely chopped onion*
1	*Clove of garlic*
s.q.	*Small quantities of herbal spices: estragon, thyme, rosemary, marjoram, oregano or chili pepper (according to taste)*

The pollen extract is dissolved in the water or fruit juice and the liquid poured over the rolled grains. Stir and leave for a while to allow absorption of the liquid, then add the other ingredients, mix and knead well and if necessary add a little water.

Spread the dough to dry on an oiled slab, board or sheet, to a thickness of 1 cm or less. Wax paper or a food grade plastic foil may also be used instead of the oiled slab. The thinner the dough is spread, the better the drying. Precut the dough into bars with a knife

Drying:

Slow drying at low temperatures is recommended. In a warm room, in an opened solar drier or in the direct sun, the mixture should be covered with a cloth to exclude flies, bees, dust and other contaminations. In an oven, the temperature should not exceed 50 ^{0}C with a door left partly open.

The fruit and nut mixtures will keep for a couple of weeks but the vegetable mixture should be

consumed as soon as possible. Individual bars can be wrapped in waxed paper or plastic foil approved for food use.

3.12.6 Pollen supplements and substitutes in beekeeping

Haydak (1967) successfully tested a soybean flour, dried brewer's yeast and dry skimmed milk mixture in the proportions of 3:1:1. As a pollen substitute fed to honeybee colonies during a period of shortage, the mixture stimulated early colony development and overcame pesticide damage. One kilogramme of this substitute should be mixed with 2 litres of a concentrated sugar syrup in order to make it attractive to the bees. The sugar syrup is mixed in proportions of 2 parts granulated sugar with 1 part of hot water. A few egg yolks can be added as well and the mixture should be left standing overnight. The final consistency should be such that the paste stays on top of the frames, preferably wrapped in wax paper to prevent it from drying out.

Pollen supplements can be mixed from dried bee-collected pollen and various types of sugar syrup. However, the nutritional value of pollen (as larval food) deteriorates with time and under certain storage conditions as described in section 3.8. A more detailed discussion on this subject can be found in Dietz (1975).

3.12.7 Cosmetics

The claims attributed to the cosmetic effects of pollen have not been proven nor do pollen-based products seem to outperform alternative non-allergenic products. Given the risk to a growing percentage of allergic customers, it is not possible to recommend use of pollen in commercial products. If one wants to include pollen in personal cosmetics, the pollen pellets should be well dried and carefully ground to a very fine powder. They are likely to remain slightly abrasive, but can be ground further. The powder is mixed without heating at 1 % or less into any preferred preparation. Some alcoholic extracts, appear to cause no allergic reactions. Unfortunately, nothing is known about their effectiveness. For recipes see Chapter 9.

3.12.8 Pills and capsules

The best profit margin for selling pollen appears to be in selling it pill form. As mentioned earlier, the value of 1 kg of pollen pills or capsules can reach US$900 as compared to US$1 11-30 for 1 kg of dried pollen in the same stores. This enormous price margin cannot be achieved everywhere, but reflects a consumer attitude that exists in some countries.

In order to process pollen into pills a simple machine is necessary, which even second hand may cost a few thousand dollars. A paste of pollen and honey is prepared for pressing. No additives are necessary but gum arabic or a little pulverized wax can be incorporated. Coating the pills with wax render them non-allergenic, i.e. preventing contact with mucous membranes. If no pill press is available, more gum arabic or other gel and wax mixtures should then be used so that pills can be formed individually (see also 5.16.5).

For small enterprises, a more economical and feasible way of marketing dried pollen pellets for human

consumption is by encapsulation. Gelatine capsules of 0 or 00 size are filled with the dried pollen. If the filling is conducted carefully, little or no pollen should be left on the outside, where it could cause harm. Extra cleaning may be required and a warning about possible allergic reactions should be printed on the label.

There are small, manually operated capsule fillers available for just a few dollars. Medium-size machines, which can fill 500 to 1000 capsules per hour can be made by a precision workshop (see Figure 3.10 and Annex 2). Bigger machines handling up to 10,000 capsules per hour are available for large scale production. Pollen can be encapsulated dry in its original pellet form, as a ground powder, a honey/pollen paste, or in combination with other products particularly honey (for longer preservation) but also with propolis and royal jelly. Capsules should be stored in well sealed glass or plastic bottles. They should preferably be refrigerated and consumed within 180 days. Frozen storage and the use of higher proportions of honey or propolis will significantly prolong the useful storage life.

a)

b)

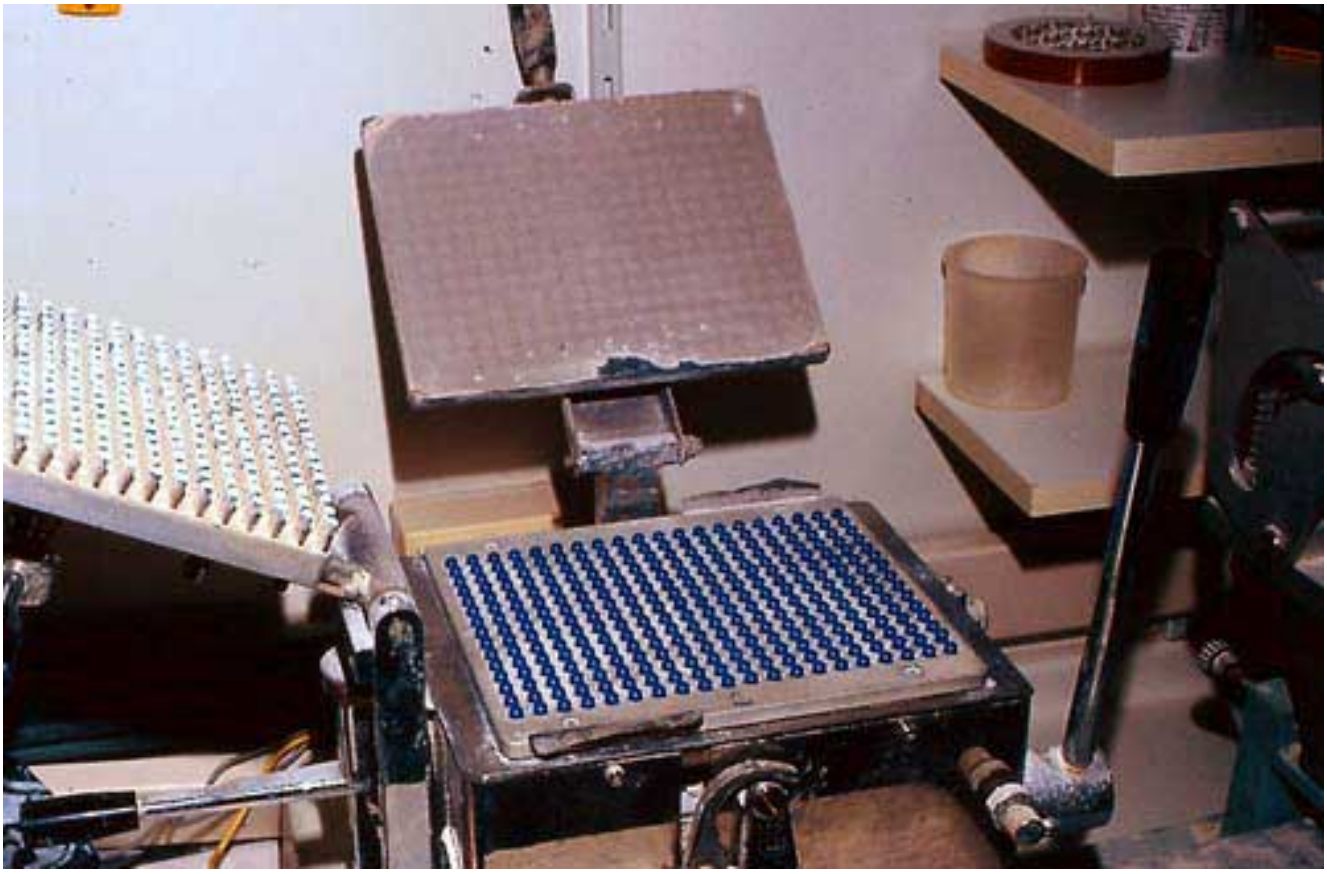


Figure 3.10: Medium-size hand-operated capsule filler. a) One machine separates the capsule halves, sorts and places them into separate trays. b) A second machine allows filling of capsule halves in presorted trays from a) and then closes the capsules. Using both machines, 1500-4 000 capsules can be filled, compacted and closed per hour by one person.

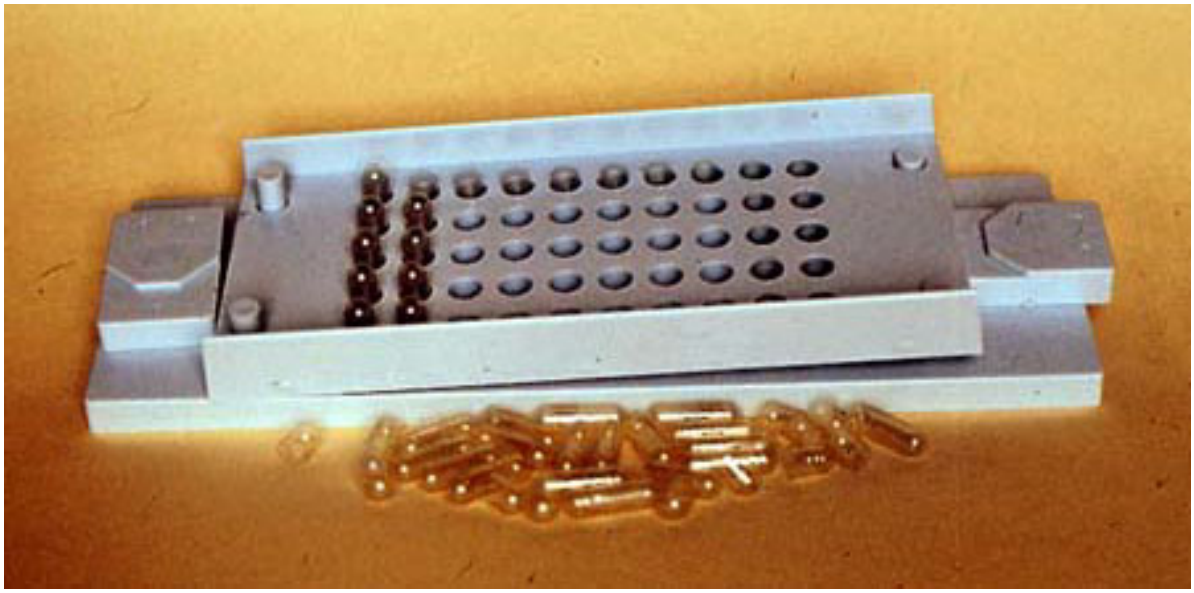


Figure 3.11: A small and cheap device for manually filling small quantities of hard gelatin capsules. With the top piece raised, as on the right, the pollen is brushed into the capsules. Once the top piece is lowered, as on the

left side, the capsules can be closed.

Contents - Previous - Next

CHAPTER 4 WAX

4.1 Introduction

The word wax describes a large variety of substances of plant and animal origin, as well as man-made products which are mostly petroleum derivatives. However, natural waxes are not single substances, but a mixture of various long-chain fatty acids and a variety of other constituents, depending on their origin. Each wax therefore has unique physical and chemical characteristics which are exploited in a multitude of applications. In particular, wax from the honeybee has an extremely wide spectrum of useful applications and occupies a very special position among waxes.

Young bees in the hive, after feeding the young brood with royal jelly, take part in the construction of the hive. Engorged with honey and resting suspended for 24 hours together with many other bees in the same position, 8 wax glands on the underside of the abdomens of the young bees secret small wax platelets. These are scraped off by the bee, chewed and masticated into pliable pieces with the addition of saliva and a variety of enzymes. Once chewed, attached to the comb and re-chewed several times, they finally form part of this architectural masterpiece, a comb of hexagonal cells, a 20 g structure which can support 1000 g of honey. Wax is used to cap the ripened honey and when mixed with some propolis, also protects the brood from infections and desiccation. Together with propolis, wax is also employed for sealing cracks and covering foreign objects in the hive. The wax collected by the beekeeper is that which is used in comb construction. Frame hive beekeeping produces wax almost exclusively from the cap and top part of the honey cells.

For centuries, beeswax was appreciated as the best material for making candles. Before the advent of cheap petroleum-based waxes, tallow (rendered animal fat) was used for cheap candles and for the adulteration of beeswax. Ancient jewellers and artisans knew how to form delicate objects from wax and cast them later in precious metals. Colours of ancient wall paintings and icons contain beeswax which has remained unchanged for more than 2000 years (Birshtein et al., 1976). The wrappings of Egyptian mummies contained beeswax (Benson et al., 1978) and beeswax has long found use in medicinal practices and in creams and lotions. Of all the primary bee products it has been, and remains, the most versatile and most widely used material.

Figure 4.1 : Wax processed from traditional beekeeping at the

honey factory in Kabompo, NW Province, Zambia.

Other waxes derived from plants and animals (data from Brown, 1981 and Tulloch, 1970) include:

Carnauba is obtained from the leaves of Copernicia cerifuga, a palm tree found in Brazil It melts at 83-86°C.

Ouricuri is also obtained from the leaves of a palm tree found in tropical America, but it is of lower quality than Carnauba wax. It melts at 84°C.

Candelilla is obtained from a reed-like plant found in Mexico and California. It melts at 70^{0}C and has a yellowish colour.

Esparto is obtained from esparto grass as a by-product of the artisanal paper industry. It produces a high gloss finish with very little rubbing. It melts at 73^{0}C.

Sugarcane Wax is a by-product of sugar refining. It melts at 78 to 80^{0}C.

Ozokerite is a mineral wax. It is mined.

Ceresin is a mixture of purified ozokerite and paraffin wax.

Ghedda is the general name applied to waxes from the Asian Apis species.

Spermaceti is a very high quality wax obtained from the head of sperm whales. Since there is an international agreement restricting the hunting of these animals, no more spermaceti wax should be used or traded. In most recipes spermaceti can be replaced with beeswax. Synthetic substitutes exist as well.

Shellac with a melting point of 74-78^{0}C, shellac is secreted by the Lac insect (Laccifer lacca, Coccoidea) in Asia, and is used for electrical insulation, seals and certain polishes.

Chinese insect wax is produced by Coccus ceriferus and Brahmaea japomca (Coccoidea). It melts at 82-84^{0}C. Other wax producing Coccoidea are Icerva purchasi and Dactylopius coccus whose waxes melt at 78^{0}C and 99-101 ^{0}C, respectively.

Other wax producing Coccoidea are Icerva purchasi and Dactylopius coccus whose waxes have melting points at 78^{0}C and 99-100^{0}C, respectively.

Many reviews of wax have been published of which some of the more comprehensive are by Bull (1977) Walker (1983a) and Coggshall and Morse (1984), Hepburn (1986) and Crane (1990). An international market review for beeswax was conducted by the International Trade Centre of UNCTADIGATT (ITC, 1978).

Many bee species produce wax but unless otherwise mentioned, only the wax of the honeybee species Apis mellifera will be referred to in this bulletin. Wax from other honeybee species (ghedda wax) is very similar, but has characteristics sufficiently different for it not to be used by the cosmetic industry. Even the wax produced by A. mellifera is not always the same. Thus, the cosmetic industry generally prefers beeswax from Africa.

4.2 Physical characteristics of beeswax

Virgin beeswax, immediately after being secreted, elaborated and formed into comb, is white (see Figure 4.2). It becomes darker with use inside the hive as pollen, silk and larval debris are inadvertently incorporated. Rendered, but untreated beeswax comes in varying shades of yellow. Pure white beeswax on the market has always been bleached.

Figure 4.2 : Newly constructed white comb in a traditional log hive.

The melting point of beeswax is not constant since the composition varies slightly with its origin. Various pharmacopoeias give a range of 61-66^{0}C or more commonly, 62-65 ^{0}C. Its relative density at 15 ^{0}C is 0.958 - 0.970 g/cm^3 and its electrical resistance ranges from 5x10^{12} to 20x10^{12} Ohm m (Crane, 1990). Its thermal conductivity coefficient is *2.5* x d10^{-3} Jcm/s˚Ccm^2. The saponification value of beeswax is 85-100 (Smith, 1951).

Beeswax is an inert material with high plasticity at a relatively low temperature (around 32 ^{0}C). By contrast, at this temperature most plant waxes are much harder and of crystalline structure. Beeswax is also insoluble in water and resistant to many acids, but is soluble in most organic solvents such as ether, benzine, benzol, chloroform, turpentine oil and after warming, in alcohol and fatty oils.

Ghedda waxes from the Asian honeybee species are described as softer and more plastic, but do not have a significantly different melting point (Warth, 1956). The melting point of wax from three Meliponid (stingless bee) species ranged between 64.6 and 66.5 ^{0}C (Smith, 1951 and Phadke et al., 1969). Bumble bee wax has a much lower melting point at 30-40^{0}C and bumble bees therefore mix their wax with pollen in order to improve its structural strength (Alford, 1975). Other insect waxes are normally used for protective body coatings, rather than for structural purposes. They are therefore very different in their composition as well as their physical characteristics and they have much higher melting points.

4.3 The composition of beeswax

Pure beeswax from Apis mellifera consists of at least 284 different compounds. Not all have been completely identified but over 111 are volatile (Tulloch, 1980). At least 48 compounds were found to contribute to the aroma of beeswax (Ferber and Nursten, 1977). Quantitatively, the major compounds are saturated and unsaturated monoesters, diesters, saturated and unsaturated hydrocarbons, free acids and hydroxy polyesters. Table 4.1 lists the proportion of compounds as presented by Tulloch (1980).

There are 21 major compounds, each making up more than 1 % of the pure unfractionated wax. Together they account for *56%* of the wax. The other 44% of diverse minor compounds probably account for beeswax's characteristic plasticity and low melting point (Tulloch, 1980).

Table 4.1:
Composition of beeswax (after Tulloch, 1980). Major compounds are those forming more than 1% of the fraction. The number in brackets indicates the number of compounds making up at least 1 % of the unfractionated, pure wax. The number of minor compounds, those with less than 1% of the fraction, is only an estimate.

Description	% of fraction	Number of components in fractoin	
		Major	Minor
Hydrocarbons	14	10 (5)	66
Monoesters	35	10 (7)	10
Diesters	14	6 (5)	24
Triesters	3	5	20
Hydroxy monoesters	4	6 (1)	20
Hydroxy polyesters	8	5	20
Acid esters	1	7	20
Acid polyesters	2	5	20
Free acids	12	8 (3)	10
Free alcohols	1	5	?
Unidentified	6	7	?
TOTAL	**100**	**74**	**> 210**

The ratio of ester values to acids, a character used by the various pharmacopoeias to describe pure beeswax is changed significantly by prolonged or excessive heating. At 100^0C for 24 hours the ratio of ester to acid is changed beyond the limits set for pure beeswax.Longer heating or higher temperatures lead to greater degradation and loss of hydrocarbons (Tulloch, 1980). These changes also influence the physical characteristics of the wax. Thus, excessive heating during rendering or further processing changes the wax structurally and alters the beneficial characteristics of many of its minor compounds, not only the aromatic and volatile compounds.

Bleaching destroys at least the aromatic compounds of wax. Bleached wax no longer has the pleasant and typical aroma of wax and it can be assumed that it also lacks many of the other minor compounds.

Various plant growth promoting substances, such as myricil alcohol (Weng et al., N-1979), triacontanol (Devakumar et al., 1986), gibberellin GA_3 (Shen and Zhao, 1986) and a rape oil steroid (Jiang, 1986) have been detected in and isolated from beeswax. Kurstjens et al., (1990) describe at least 11 proteins in the freshly secreted wax scales of A. mellifera capensis worker bees and 13 proteins in the wax combs of A. m. scutellata and A. m. capensis.

The composition of wax from Asian honeybee species is much simpler and contains fewer compounds in different proportions (Phadke et al., 1969, 1971; Phadke and Nair, 1970, 1973 and Narayana, 1970). These ghedda waxes therefore cannot be used as substitutes for Apis mellifera wax in certain recipes. Since little is known about which compounds or mixtures cause the beneficial medicinal and dermatological effects of beeswax, no conclusions can be drawn from the composition data alone. Ghedda waxes are used locally in many of the same ways as Apis mellifera wax is used in other parts of the world. Meliponid waxes, which are less like honeybee wax than Ghedda wax, have been used by Amerindians for many of the same purposes, as honeybee waxes (Posey, 1978).

Beeswax is considered safe for human consumption and has been approved as an ingredient in human food in the USA (USA, 1978). It is inert, i.e. it does not interact with the human digestive system at all and passes through the body unaltered. However, substances dissolved or encapsulated in wax are slowly released. This property is exploited in many medicinal preparations (see 4.5.10). At the same time these properties can create a problem when wax is stored near toxic chemicals and pesticides or after treatment with various drugs inside the hive. Any fat soluble toxins can be absorbed and then released much later when the wax is consumed as food, used in cosmetics or given to bees in the form of foundation sheets.

4.4 The physiological effects of wax

Most of the effects of beeswax are described in the section on applications (section 4.5). Because it is inert, beeswax has no direct effect on humans or larger animals. However, its indirect effects can be very strong.

If mixed with medicinal drugs or poisonous baits, wax preserves the active materials longer and releases them slowly. It can be used to create thin non-corrosive, non-allergenic protective films on many surfaces from metals to fruits and human skin. Thus it protects against external damage such as corrosion and abrasion as well as against moisture loss. It is a good electric insulator and, when saponified with borax, allows the mixture of very stable and smooth emulsions for cosmetics. Even in small concentrations it improves other formulations in the same way.

A very small anti-inflammatory and antioxidant activity can be observed in beeswax due possibly to some inclusions of propolis or other minor ingredients.

4.5 The uses of wax today

In the past, beeswax had a wide range of uses. Though in many cases beeswax can be replaced with cheaper, synthetic waxes, its very special characteristics, medicinal benefits, plasticity and aroma ensure its continuing use. Many of these characteristics cannot be achieved with artificial waxes. The trend for more natural products in cosmetics may also increase its use. Presently, there is a scarcity of beeswax in industrialized countries, at least seasonally.

In industrialized countries, most nationally produced wax is used by beekeepers for foundation sheets. Approximately one third of imported wax is used for cosmetics, one third for pharmaceutical preparations one fifth for candles and the rest for other, minor uses (ITC, 1978).

In developing countries with traditional beekeeping methods, wax is often wasted. If it is rendered, most is subsequently exported and only relatively small proportions are used by local manufacturers. This, however, depends very much on the local industry. There are many possibilities for good quality products in local emerging markets and in import substitution. Adj are (1984) listed over 150 uses of beeswax as described also in an old 1954 edition of " The Hive and the Honeybee"

A few examples from the wide range of products in which beeswax can be included, together with a few recipes for small or home-based industrial production are described below. There are many types of synthetic waxes available today, often with superior characteristics for special applications Apart from price and availability however, beeswax has preferred characteristics in a wide range of applications and conditions. There are very few products which consist only of beeswax or in which only beeswax can be used, but the value or characteristics of most other products are enhanced or complemented by its inclusion.

4.5.1 In beekeeping

In countries with frame hive beekeeping, the majority of locally produced beeswax is consumed by beekeepers for the making of wax foundations - the patterned sheets of wax which are given to the bees as a guide for construction of their combs. Bees will not accept foundation made of synthetic waxes such as paraffin wax. Small quantities of paraffin wax mixed with beeswax may be accepted by the bees. Using such mixed foundation sheets, however, is a severe breach of good beekeeping practices, since it will adulterate all wax rendered from such combs. Non-frame beekeepers use melted wax or strips of smooth wax sheets as guides for bees to start their combs on. Each beekeeper can easily make the strips by dipping wet boards into melted wax (see Figure 4. 3a and 4.4 top right). Patterned sheets are usually made by specialized manufacturers, since the pattern imprinting requires special roller presses. Such presses, until recently, were very expensive, ranging from hand operated roller presses at about US$ 800 each to complete manufacturing lines costing many tens of thousands of dollars (see Figure 4.3 and 4.4). However, since at least 1989 inexpensive presses with moulded plastic rollers have been available for a fraction of the price of metal rollers in Brazil (see Cylindros Alveolador in Annex 1 and Figure 4. 3d). These plastic rollers do not last as long as steel rollers, but they are much cheaper to buy.

In order to reduce damage during hive management and honey extraction in centrifugal extractors, foundation sheets are reinforced with wire either by the beekeeper (frame per frame) or by the manufacturer who embeds the wire into the foundation sheet (see Figure 4.4). Sheets come in different sizes to fit the various sizes of frames. Standardized frame hive equipment within one country and preferably also in neighbouring countries will make manufacturing easier and more economical. Sheets should always fit the whole width of the frame, otherwise bees will not attach the comb to the frame. This weakens the comb and thus defies the main purpose of the frame. It also reduces the surface area for brood and honey storage by more than 5 %. In most countries foundation sheets are traded by manufacturers against raw wax with a mark-up for labour and equipment cost. Many manufacturers are also suppliers of beekeeping equipment, but also beekeeping cooperatives or large beekeepers sometimes make foundation sheets.

Fledgling beekeeping operations in countries with no tradition of beekeeping always have problems making their own wax foundation, since not enough beeswax is produced. Materials have to be imported or beekeeping started as a topbar operation. It takes a fairly stable frame hive beekeeping industry, i.e. one that is not growing too fast, to supply all foundation needs to its beekeepers because wax

production from this type of beekeeping is low (1-2% in weight of honey production as compared to 10-15 % in topbar and traditional beekeeping).

Bottom board and side wall scrapings which contain large percentages of propolis can be processed into cheap wood preservatives (see recipes 4.11.10) particularly for hive equipment, or may be used by beekeepers for baiting swarm traps. However, these scrapings should never be mixed with other beeswax, since they destroy its quality for other uses.

a)

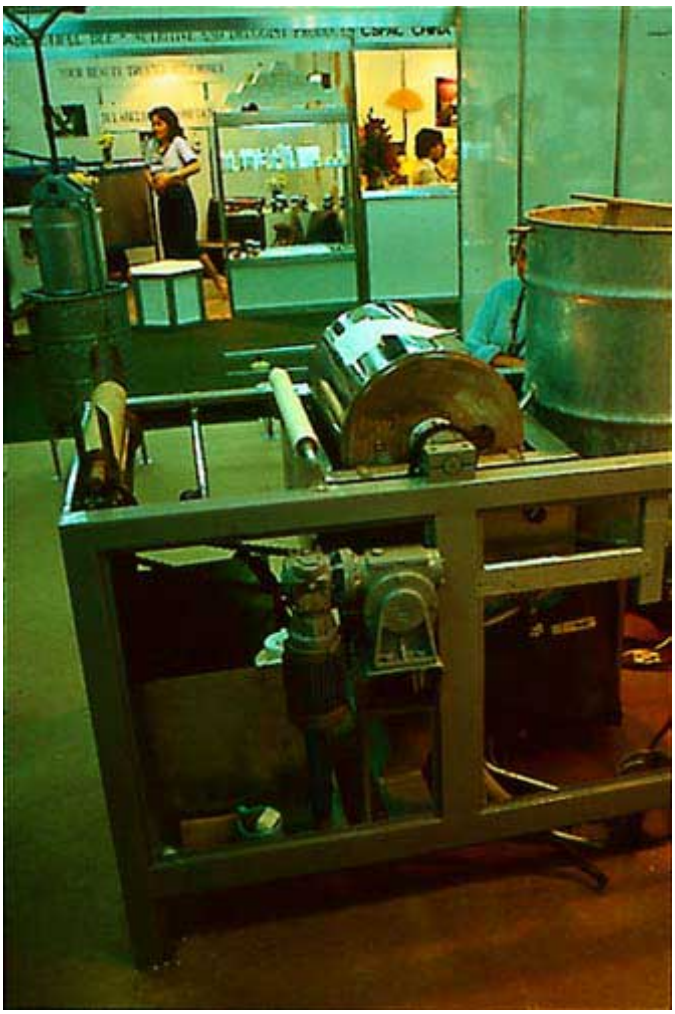
b)

c)

d)

Fig 4.3 a) Melted wax starter strips from unpatterned wax sheets for topbar hives.
b) Simple foundation press for single sheets requires more practice and nore wax per sheet; can also be made from gypsum (plaster) using commercial foundation to prepare the plaster moulds.
c) Motorised foundation rollers with moist.
d) Hand-operated, low cost, plastic foundation rollers

a) **b)**



c) 

Figure 4.4: Top left: Medium size set up for the production of continuous wax sheets with a cooled drum rotating through a liquid wax bath. Top right: Rack and liquid wax bath for the production of multiple wax sheets by hand-dipping moist, wooden boards into the molten wax. Bottom: Wired frame with wired foundation sheet. All Langstroth and Dadant size frames should have at least four horizontal wires. Vertical wires can be embedded into the wax sheet by some manufacturers, but either of the wiring methods is usually sufficient.

4.5.2 For candle making

Beeswax, next to the cheaper tallow, was the major raw material for candles until the development of cheaper petroleum products such as paraffin wax, which was introduced during the last century. Since beeswax has a higher melting point than most paraffin waxes (most of which melt between 480 and 68^{0}C) beeswax candles remain straight at higher ambient temperatures. If wick size is correctly proportioned with respect to the diameter of the candle, they are less likely to drip than candles made from other materials. Waxes with a melting point above 88^{0}C do not perform well during burning. The Roman Catholic church requires that its ceremonial candles are made with at least 51 % pure beeswax. A detailed description of candle making is given in the recipe in section 4.11.2.

4.5.3 For metal castings and modelling

Because of its plasticity, beeswax is easily formed and carved. It maintains its shape well even over very long periods of time as proven by wax sculptures found in ancient Egyptian graves. Its relatively low melting point permits easy and complete removal from casting moulds. The hollow space left in these moulds can then be filled with molten metal. Already in ancient times whether in Asia, the Americas or Europe, craftsmen using this V lost wax method, sculpted small, solid metal figures, jewellery, large hollow sculptures and more recently also bells. Until today, different mixtures of beeswax and other waxes are used to create special forms and surfaces for jewellery and artistic sculptures.

No special preparations are necessary to use beeswax in these applications and in an indirect way, the resulting sculptures or jewellery may be considered a value added product from beekeeping. However far fetched this analogy may be, the lost wax technique is a craft in its own right and requires careful study. It may be undertaken using highly refined plasters like in dentistry, temperature controlled ovens and gas torches, but it is also possible on a very simple level using locally available clays and home-built furnaces. Both are beyond any simple descriptions that can be provided here, but Feinberg (1983) gives details for small-scale manufacturers.

The sculptures of Madam Tussaud's in London are widely known and copied in many countries. In the museum, famous people are copied in wax and dressed as life-sized figures. A mixture of three parts beeswax and one part of a harder wax are used (Sargant, 1971). Modelling in wax, or ceroplasty is a well developed art used also for scientific models in important collections around the world (Olschki, 1977). During the last century, wax flower modelling was apparently popular in Europe. A bibliography on wax modellers, collections and history has been published by Pyke (1973) and a handbook on sculpting with wax and plaster by Miller (1974).

4.5.4 In cosmetics

The unique characteristics of beeswax give a certain solidity to emulsified solutions, facilitate the formation of stable emulsions and increase the water holding capacity of ointments and creams. These and other characteristics, which only beeswax combines in one substance, make beeswax irreplaceable in the cosmetics industry. Though the desired effects can often be achieved with as little as 1 to 3 % beeswax (Coggshall and Morse, 1984) final proportions are also determined by the relatively high cost of beeswax.

Beeswax not only improves the appearance and consistency of creams and lotions but is also a preferred ingredient for lipsticks, because it contributes to sheen, consistency and colour stabilization. Other cosmetic applications are found in cold creams (8-12% beeswax content by weight), deodorants (up to 35 %), depilatories (hair removers, up to 50%), hair creams ***(5-10%),*** hair conditioners (1-3%), mascara (6-12%), rouge (10-15%), eye shadows (6-20%) and others.

Since ancient times, the basic recipe for creams and ointments has consisted of a mixture of beeswax and oil in various proportions according to the desired consistency. Traditionally, vegetable oils were used but they become rancid and limit the period for which such creams can be used. Today, most plant oils have been replaced by mineral oils such as liquid paraffin or preservatives are added. Selective use of vegetable oils from olives, corn, peanuts, jojoba, cacao, palms, coconuts and others still continues, since many of their beneficial effects cannot be provided by synthetic mineral oils.

In order to mix the otherwise incompatible beeswax and oils with water, all of which are essential ingredients of any cream or lotion, an emulsifier has to be added. Borax is the classic emulsifier, available in most pharmacies. Today's "high-chemistry" cosmetics use a large array of other synthetic emulsifiers. The chemical process on which the emulsification is based is the saponification of the acids in beeswax, i.e. the result is technically a soap. The associated cleansing effect is exploited in so-called cleansing creams, which are very much like simple skin creams.

To remove the free acids from beeswax so that it no longer needs an emulsifier and can be easily mixed with pigments and mineral products, a special process was developed and patented (Brand, 1989). The free acids are removed through reaction with glycidol at 80-120^{0}C in the presence of a basic catalyst.

Recipes for cosmetics, including preparations of depilatory waxes, are presented in Chapter 9.

4.5.5 Food processing

Beeswax has been used in a variety of products and processes from packaging to processing and preservation. It has also been used as a separation agent in the confectionary industry (Ribot, 1960) and in cigarette filters (Noznickli and Likwoh, 1967). Many of these applications could be accomplished with other, cheaper waxes. Since most of these processes involve large scale and complicated production procedures, they are not described here -

A common, simple and small scale application for beeswax is the protection of containers against the effects of acids from fruit juices or honey. Steel drums for storage and shipment of honey have to be treated to prevent corrosion and dissolution of iron. The treatment may involve an expensive food grade paint, a plastic liner made from a food grade plastic film or a thin coat of beeswax.

4.5.6 Industrial technologv

A patent by Enger (1976) describes a material for encapsulating electrical and electronic apparatus for use in high moisture or chemically active environinents. One example consisted of at least 50% (ideally 70% by weight) of silicone, mixed with a fluorocarbon (20% tetrafluorethylene and a natural animal or mineral wax (10% beeswax) and, if necessary, an inert filler. After polymerization or fluorethylene vulcanization with a catalyst and/or heat, the inert product becomes impermeable to ions and fluid.

Another patent describes the preparation of a material for embedding or electrically insulating circuits of high and ultra-high frequency. The mixture of 10-30% ceresin wax, 55-65 % beeswax and 15-25 % ethylcellulose has a high melting point, is very hard at high temperatures, very strong when cold and can be remelted (Franklin, 1951).

A patent for an anti-corrosion rust inhibitor describes the incorporation of one or more different waxes, including beeswax. These waxes are mixed with crystalline polyethylene and polystyrene then heated to more than 200^0C. The residue is removed and after adding liquid paraffin, it is boiled until it is homogeneous. The transparent, creamy liquid not only lubricates saws, just as pure beeswax would do, but protects iron, copper, brass, aluminum, chrome and nickel surfaces (limori, 1975). Other effective coatings contain beeswax; one such is composed of 90% mineral jelly and 10% beeswax (Sanyal and Roy, 1967).

In other formulations, beeswax may be used as a binder, particularly if lubricant characteristics are required (Bera et al., 1971) or if mixtures have to be ingested (see 4.5.10). Pure beeswax was once used for lubricating wire rods during high pressure continuous extrusion of wire (Fuchs, 1970). Beeswax has also been used to decrease viscosity and improve slip casting properties when casting glass under pressure (Bezborodov, 1968). For agricultural pest control, beeswax has been an ingredient of slow release pellets of pyrethrum pesticides (Ahmed et al., 1976). Waxing of the threads on pipes was reported to prevent joints from corroding or locking and simultaneously made them waterproof (Brown, 1981).

4.5.7 Textiles

Textiles and papers can be waterproofed with various products containing beeswax and a French patent is referred to in section 4.11.8. Emulsions containing beeswax for leather treatment have been described in many publications and a basic recipe is provided in section 4.11.7.

Batik is a traditional method of colouring cloth, adaptable to both small and large scale production for artistic and commercial applications. It is based on the principle that wax will protect areas which are not supposed to be stained by the dye in which the cloth will be immersed. By multiple applications, very complex, multi-coloured designs can be achieved (see Figure 4.5). This technique was refined in several Asian countries and is now used around the world. Today, because of its high cost, beeswax has been largely replaced by cheaper alternatives. The wax is used in its pure form and needs no processing before application. Various books about batik have been published in different languages and can often be found in local bookstores.

a)

b)

Figure 4.5 : Batiks from Sri Lanka (top) and Barbados (bottom), both Very popular with tourists, form the basis of a small but profitable local industry.

4.5.8 Varnishes and polishes

A patent was recently registered for a varnish made from dammar resin and beeswax to be used for paintings and for art restoration (Krzyzynski, 1988).

Other recipes for varnishes, sometimes also including propolis are given in section 4.11. If propolis is included, the suitability of the locally available material should be tested. Knopf and Ogait (1961) reported that propolis containing a large percentage of balsam (which has non-drying properties) adversely affected the quality of the varnish. Propolis from different places can exhibit considerable variation in balsam content.

Detailed discussions and recipes for preparations with synthetic wax are presented by Jones (1977) who also lists reasons such as the formation of soft, easily marred films and a lack of availability, why natural beeswax is increasingly being replaced by other waxes in polishes.

4.5.9 Printing

In the old art of etching or engraving, beeswax was used as a protective surface coating. Wax was applied to a heated metal plate. The

excess drained off while the remaining wax solidified into a thin film through which the design was drawn. The application of concentrated nitric acid or a mixture (1:8 by volume) of concentrated hydrochloric and nitric acids for a few minutes etched away the exposed metal and left the engraved part ready for negative printing. Today, a liquid asphalt is normally used instead. A US patent (Hughes, 1960) uses beeswax as part of a liquid protective coating for plastic lithography plates and also for automobiles.

Glass can be etched with hydrofluoric acid after protecting those areas with beeswax which are to remain clear.

All of the acids mentioned are highly toxic and corrosive. Special precautions are required to avoid contact with clothing, skin and eyes.

Various inks, pens, markers and even carbon paper often contain small amounts of beeswax (Polishchuk and Denisova, 1970). One patent (Morishita et al., 1978) for typewriter ink includes a recipe of 1 part Japan wax or beeswax, 1 part Hitaide resin 503, S parts fluorescent granules (pigment) and 0.02 part Emulgen PP 150 (an emulsifier).

4.5.10 Medicine

As a coating for drugs or pills, beeswax facilitates ingestion but retards dissolution of the enclosed compounds until they reach the digestive tract. Beeswax can also be prepared as a mixture with the drug and then functions as a time release mechanism, releasing the drug over a longer period of time.

One such suppository base (a substance which allows slow release of another substance) has been developed on the basis of 5% beeswax, 5% palmitic acid and 90% of Nubon, a semi-synthetic hydrogenated vegetable oil (El-Sabbagh et al., 1988). This was used initially with chloramphenicol. In another preparation, beeswax alone served as the carrier for the drug. On an experimental basis nalidixic acid suspended in beeswax remained longer in the blood of tested animals after oral application than when the acid was administered directly (Lee and Lee, 1987). With another drug, the antihistamine chlorpheniramine maleate, various mixtures of glyceryl monostearate, stearic acid, lactose and higher proportions of beeswax had been successfully tested as a base. Many more examples can be found in pharmaceutical and medical literature. Each drug application requires its own specific modifications of the rudimentary base formulation.

Chewing dark comb (but not the old, black brood comb) without honey, brood or bee-bread is known to be effective against colds. A study by Maksimova-Todorova et al., (1985) has shown that even the wax fractions of propolis have antiviral activities. Older combs contain among many other things a good portion of propolis.

Beeswax can be used to fill capsules with equal amounts of drugs or other ingredients of various granule sizes. The granules of drugs are made adhesive by coating them with molten wax (about 90g molten wax for 3kg of granules), fat or glycerol, by spraying with liquid paraffin or by mixing them with powdered wax or fat and heating. After thorough mixing the hard capsules are pressed with their open end into an evenly spread layer of the mixture (Iwamoto et al., 1965). This process can also be adapted to making pills with pollen.

A mixture of equal parts melted beeswax and honey is recommended for treating cracked hooves of animals. It should be applied after the cracks have been thoroughly cleaned.

4.5.11 Others

Other products in which beeswax provides some improvement and in which it is a traditional ingredient, include grafting wax, crayons, floor and furniture polish, general purpose varnish, sealing wax, corrosion prevention, protective car polishes and sewing thread - especially for sail and shoe making.

Again, in many of these products, beeswax can be replaced by cheaper synthetic waxes. The recipes in section 4.11 may be considered as general guidelines for the manufacture of any of the described products, using either beeswax or other available waxes. The special characteristics derived from the use of beeswax may be of importance in some particular conditions and may bring a better price for the product.

The fact that plant growth stimulators have been isolated from beeswax favours it over synthetic substitutes for use as a grafting wax. An Indian study on A. cerana wax suggests that its triacontanol content may be an economical alternative source for this plant growth stimulator (Devakumar et al., 1986).

Many other applications for beeswax, in cosmetics and pharmaceuticals may benefit also from the presence of minor components which have not yet been thoroughly investigated.

4.6 Wax collection and processing

There are several ways of collecting beeswax. Morse (1965) has experimented with the idea of producing beeswax directly from

clustered bees with a caged queen and no foundation. Comb building was prevented by exposing clusters to continuous daylight and wax scales were collected below the cluster. This may be suitable for certain experimental requirements, but is not economically feasible with the current prices of wax.

More commonly in frame hive beekeeping, wax is rendered from the cappings removed during honey extraction. This produces a very high quality, light coloured wax. Light coloured broken combs provide the next quality of wax, whereas old black brood combs yield the smallest proportion and lowest quality of wax. Scrapings from side walls and the bottom board contain very high proportions of propolis and should not be mixed with better quality waxes. They can be used in swarm traps, for hive wood treatments, or in other preservatives for wood (see recipes in section 4.11.10).

In areas with traditional and topbar hive beekeeping, different qualities of wax can be produced by separating new white honey combs from darker ones or from those with portions of brood. Since whole combs are harvested and crushed or pressed, the proportion of wax per kilogramme of honey (10-15%) is much higher than with frame hive beekeeping, where the yield is only 1-2%.

Before processing, all comb or wax pieces should be washed thoroughly to remove honey and other debris. Crane (1990) even suggests soaking combs in water for several hours, or up to two days for older brood combs. The first wash, if done with small amounts of water can be used for beer brewing or if no infectious diseases are present for refeeding to the bees.

Several methods of rendering wax are possible and may be adapted to various circumstances. Wax can be separated in solar wax melters, by boiling in water then filtering, or by using steam or boiling water and special presses. If soft water or rain water is not available for these processes, hard water (high calacium content) may be used, but 0.1 % of vinegar should be added to it (Crane, 1990). The different methods are described in further detail in many beekeeping publications, for both small scale, low investment processing and for larger scale operations (Clauss, 1982; Adjare, 1984 and 1990; Coggshall and Morse, 1984; Hepburn, 1986; Gentry, 1988; Graham, 1992 etc).

Wax should never be heated above 85 ^{0}C. If wax is heated directly (without water) or above 85 ^{0}C discolouration occurs. Therefore wax always needs to be processed in water or in a water bath. Wax should not be processed in unprotected steel, iron or copper containers, since it will discolour from reaction with these metals. Direct exposure of wax to hot steam results in partial saponification.

The residues from wax rendering contain sufficient nutrients to be used as poultry food or be turned into good compost. A Polish study measured a crude protein content of 22.12% When added at 4% to the rations of laying hens instead of green forage meal, the residue maintained all growth and health characteristics and improved egg yolk colour (Faruga et al., 1975). With some precautions, the residue can also be included in diets for rearing wax moth larvae (see 8.10.7).

4.7 Buying

A buyer should make sure wax has been stored for a few weeks after processing in water, since newly cleaned wax may contain up to 20% by weight of water. Much of this water will be lost during the first few weeks of storage. Unpleasant surprises found inside larger blocks of wax may be rocks or other heavy materials.

Beeswax should have its characteristic yellow colour and sweet aroma when bought as rendered beeswax. The grey coloured layer at the bottom of inadequately cleaned wax cakes is mostly debris. It should be scraped off and may be reprocessed to extract more wax.

Wax cleaned in a solar wax extractor can sometimes be less aromatic and will be much whiter, almost the pale white colour of paraffin wax. The aroma of beeswax can be destroyed by overheating and chemical bleaching. Dark coloured beeswax has either been inadequately cleaned or has been processed in unsuitable containers made of iron, copper, brass, nickel, zinc (galvanized steel) or their alloys. The latter discolouration can only be reversed with a special metal binding (chelating) process. White (1966) described using approximately 1.9 g of the sodium salt of ethylene-diamine tetra-acetic acid (EDTA) in a litre of soft (rain) water to process approximately 400 g of wax. The mixture was boiled at 100^{0}C for one hour, stirring continuously in a stainless steel, glass or aluminum container. After cooling, the bottom layer was scraped off while the clean part was remelted in clean water and cooled.

Adulteration with other waxes is difficult to detect without chemical analyses and physical tests, some of which are described in 4.9.

4.8 Storage

Beeswax should only be stored in its rendered, clean form. Before rendering, it will quickly be attacked by wax moths, which are able to destroy large quantities of wax in short periods of time (see Figure 4.6). Clean wax in large blocks is not attacked by wax moths. The honey guide of Africa (Indicator minor) is uniquely adapted to digesting wax with an intestinal flora of Micrococcus cerolyticus and the yeast Candida albicans (Friedman et al., 1957). However, the honey guide rarely consumes or steals large amounts of wax while it may destroy wax foundation sheets.

Storage should be in cool dry places and never in the same room with any kind of pesticide. Wax will slowly crystallize over time and as a consequence become harder, but this process is reversible without any damage, just as with crystallized honey. The white bloom, i.e. dust, that sometimes appears on the outside of a wax cake or candle consists of small wax crystals. When melted or pressed with the rest of the wax it reverts to normal beeswax without any residues or impurities. Wax can be stored for very long periods of time without losing its major characteristics as items from Egyptian graves more than 2000 years old have shown.

Figure 4.6: Wax comb destroyed by wax moths before it was rendered into clean wax.

The storage requirements of products made with beeswax are affected by the added ingredients. Polishes containing only mineral or non-vegetable oils can last for years, but cosmetic emulsions, which are mixtures of water and oil have a very limited shelf-life ranging from a few weeks to a few months (and longer if refrigerated). Unless some alcohols, propolis or other preservatives are added, emulsions are an excellent environment for microorganisms to flourish. Clean ingredients, a clean working environment and proper storage are very important to maintain the quality of products and prolong their storage life.

4.9 Quality control

Beeswax, when sold in solid blocks should always both be clean and have the colour and odour characteristics described in section 4.7. Though adulteration is easy (usually with cheap paraffin waxes), its detection is only possible with chemical tests, but it will very likely be detected by any larger buyer long before it reaches an industrial user. Adulteration renders the whole batch useless for most purposes and constitutes a considerable loss to the buyer. Therefore, such practices usually result in a buyer ceasing to buy from the supplier and possibly from the country from which the wax came.

Quality standards for wax are set in most countries according to their pharmacopoeias. A few industries like the Japanese cosmetic industry but also the American Wax Importers and Refiners Association specify their own limits (see ITC, 1978). In addition, for each industrial product in which beeswax is being used, there are other industry standards to be observed. These have to be obtained from the respective industry representations or trade publications. Such standards may vary considerably from country to country and manufacturer to manufacturer.

To detect adulteration, a number of tests may have to be conducted. The simplest is to determine the melting point, by measuring the temperature at which the first liquid wax appears during very slow heating. It should be between 61 and 66^{0}C or preferably between 62 and 65 ^{0}C. However, values within this range are not a guarantee of purity.

Determining the saponification cloud point is an officially accepted, sensitive method for determining adulteration. The method is limited to detecting quantities greater than 1 % of high melting (80-85 ^{0}C) paraffin waxes, or more than 6% of low melting (50-55 ^{0}C) paraffins. The test measures the amount of hydrocarbons which saponify (turn into soap) in a specific amount of ethanol and give a clear solution. If the solution becomes clear at or below 65 ^{0}C, the wax is probably unadulterated with paraffin. If it is adulterated, the solution will turn clear only at a higher temperature. Some of the details of this test are described by Tulloch (1973) for the American Wax Importers and Refiners Association and in section 4.11.15. The saponification cloud point is not suited to detect adulteration with carnauba wax, but gas liquid chromatography (GLC) can detect the 6% of free C_{32} alcohol (an alcohol molecule with 32 carbon atoms) contained in Carnauba wax. Beeswax only contains very little (Tulloch, 1980).

Tulloch (1980) also suggests that GLC can be used to detect adulteration of beeswax with as little as 1 % of petroleum hydrocarbons from low melting paraffins, but not for detecting low levels of high melting paraffin waxes.

Pharmacopoeia list ester values from 66 to 82 but most beeswaxes range between 72 and 80. Tulloch (1980) suggests values of 70 to 80 are most typical. Acid values range from 16.8 to 24 and ratios between ester and acid values are fairly stable and narrow, mostly between 3 3 and 4.2. The ratios can change after excessive heating and can exceed 4.2 with heating to 100 ^{0}C for only 24 hours, while the ester and acid values might remain within set limits. Ester and acid values in waxes from other Apis species may be significantly different (Ikuta, 1931 and Phadke et al., 1969).

In Africa, adulteration of beeswax with dark and sticky Trigona (Meliponidae) wax has been reported (Smith, 1951). Such wax is of little value in most industrial and beekeeping applications, since the resins are difficult to remove.

For standard testing methods, references can be obtained from Crane (1990), ITC (1978), Apimondia, pharmacopoeias and industry associations.

Contents - **Previous** - **Next**

4.10 Market outlook

The cosmetics and pharmaceutical industries have no complete substitute for beeswax. At least small quantities will always be needed to maintain quality and specific characteristics. Beekeepers using frame hive technology are their own best clients and use most of what they produce. Industrial needs are largely provided by imports from countries with traditional beekeeping techniques. In many other applications, beeswax is replaced with synthetic waxes and compromises in quality are accepted by the manufacturers because of the reduced cost and greater availability of synthetic waxes. Industrial use of beeswax might increase if availability would increase and become more reliable or if prices could drop significantly. The balance between cheap substitutes, the large needs of beekeepers themselves and quality considerations for uses of beeswax has kept prices stable but relatively low for many years, despite scarcity in supplies. Beeswax prices for imports into the USA went above US$4/kg in the early 1980's, but are now fluctuating between US$2.10 and 3.00/kg wholesale for light-coloured wax, occasionally reaching US$6 - 7/kg. Darker wax is 10 - 20% cheaper. Like honey prices, prices for beeswax may vary considerably from place to place.

Markets and prices for products made from beeswax vary widely from country to country. Generally, the best margin between raw material value and end product price may be obtained in cosmetic preparations and jewellery. Most other applications, including pharmaceuticals, except dermatological and traditional medicinal products, are part of a very different industry which requires much larger investments and higher technologies. In these industries beeswax forms only a minuscule part both of the manufacturing process and of the final product.

The refining of beeswax for export is not common at the moment. Most industrial users prefer to buy crudely rendered and filtered wax directly from local sources because their own processing guarantees better quality control. A reliable processor should be able to establish a good enough reputation to also export refined products. Most companies prefer to buy in larger quantities (5-15 tons).

4.11 Recipes

The recipes described below are taken from various sources. They were chosen to highlight principle ingredients and demonstrate basic methods. They are not the only ways of making the product, nor necessarily the best or most economic. Many variations and substitutions are possible. Specific institutions and trade publications may be contacted for more detailed information. This is particularly true for more recent advances, because of the high degree of specialization and enormous volume of new information. Such details go beyond the possibilities of this publication. Instead, it is hoped that a large variety of ideas can be provided to people with special problems which may help them to develop new products adapted to their cultural, economical and technological environment.

Presentation of a recipe does not guarantee that it will fulfil the desired effect, nor that it will be without side-effects. Anybody using the following recipes should be advised that some of the chemicals are toxic, caustic or damaging to the environment, particularly if discarded improperly. Information should be obtained about the legal requirements concerning use of certain ingredients, precautions to be taken, labelling of finished products and permission to use selected ingredients for the manufactured product.

4.11.1 Bleached wax

Bleached beeswax is preferred for many cosmetic preparations and candles because it permits better colour control of the final product. However, it is lacking in most of the aromatic components.

A non-chemical method for bleaching beeswax is the use of sunlight. The wax is flaked, i.e. cut into small pieces, and exposed to the sun on large trays. It should not be allowed to melt and must be protected from contamination with dirt, dust and other debris. Particularly in tropical climates extra ventilation will be required to avoid melting. Wax left in

solar wax extractors will also slowly bleach and slowly turn white.

Berthold (1993) describes a method of bleaching which goes back to the ancient Greeks. The beeswax is flaked and bleached in the sun, then boiled in clean, clear sea water. The scum layer floating on top is skimmed off and the heating repeated. The cooled wax is flaked again and bleached once more in the sun. A final melting in soft fresh water may be necessary to rinse out the salt residues.

Most commercial operations today use chemicals for bleaching wax or special absorbent filters. Among the many possible chemicals are oxalic acid, hydrogen peroxide, orthophosphoric acid, citric acid, sodium dichromat, sodium permanganate, potassium permanganate, ammonium persulfate, benzoyl peroxide and others. After mixing bone charcoal and Fuller's earth or diatomaceous earths into liquid wax and agitating for several hours, impurities are adsorbed and then removed with a filter press.

Berthold (1993) described two practical methods of chemical bleaching. The first one uses oxalic acid, a highly poisonous substance which needs to be handled and stored with care. Glasses and rubber or plastic gloves should always be worn. Water should be kept nearby for washing the skin or face in case of accidents. Spills need to be cleaned up immediately and the acid should be stored in well labelled containers beyond the reach of children. Chemicals should not be spilled or discarded into open water (drainage ditches, creeks, ponds and lakes). If there is no other way of discarding them, chemicals should be poured into a hole in the ground, far away from wells, and then covered with soil. Stainless steel, fire proof glass or enamel containers need to be used for heating the wax. Containers should only be partially filled so that the mixture will not boil over, particularly if processing takes place over an open flame.

The wax has to be heated above its melting point for at least 10 minutes and stirred in water, to which approximately one tablespoon of oxalic acid has been added per 4 litres of water. Four litres of the above acid/water mix can be used to bleach up to 10 kg of wax in one batch, but the exact proportions should be determined for the local wax and water conditions. Slightly higher concentrations of citric acid are required and the heating will have to be extended. Since citric acid, however, is much less toxic and dangerous, it should be preferred over oxalic acid. To control the progress of bleaching, a small quantity of the wax is ladled or spooned into cold water. If not sufficiently bleached, heating should continue and/or a very small quantity of acid be added. If sufficiently bleached, the wax should be cooled, re-melted in a larger quantity of clean water and moulded into blocks for sale.

In the second method of bleaching described by Berthold (1993), small quantities of 30-50% reagent grade hydrogen peroxide (this is very caustic) is added to the melted wax and water mixture. The temperature is maintained at 65-70 ^{0}C and stirring will expedite the bleaching process. Progress can be checked as in the oxalic acid method. If only low concentration hydrogen peroxide is available, larger quantities will have to be used and the stirring and heating will have to be maintained for longer - up to 30 or even 45 minutes (the concentration of hydrogen peroxide cannot be increased by evaporation). Again, the bleached wax should be re-melted once in clean water to remove all reagents. The exact proportions of hydrogen peroxide, water and the quantity of wax processed, need to be determined by experimentation. As with all recipes, a small batch should be tried first, before processing larger quantities.

Oxalic acid is also used for bleaching wood and is often available in wood stores and hardware stores. Other compounds sold for wood bleaching are unsuitable and cannot be used instead. Pharmacies (drug stores) might stock both oxalic acid and hydrogen peroxide, but these are likely to be of very low concentration. Beauty salons may also stock hydrogen peroxide and chemical supply houses should have both chemicals. If beeswax has to be processed at all, solar bleaching is still the least expensive, least dangerous and least toxic procedure.

4.11.2 Candle makin2

The basic elements of a candle are the solid wax as fuel for the flame and a wick, which serves to bring the molten wax to the flame. Oil lamps work on the same principle, but they need a container to hold the liquid fuel.

The best material for the wick is a fibre which burns with very little ash at low temperatures. Pure cotton thread is the

best. Several thin cotton threads should be braided or plaited together until the desired thickness is reached. Twisting of the threads is not recommended, since they might unwind during burning and then create an irregular flame consuming much more fuel. Commercially produced candle wick can often be purchased in speciality shops.

The wick needs to be in the centre of the candle for even burning. The diameter of the wick in proportion to candle diameter is important to maximize the light obtained from the quantity of wax and to prevent wax dripping down the side of the candle. Thicker candles need thicker wicks, but thick candles with a relatively thin wick burn longer and give less light, since the flame is shaded by the remaining edges of the candle. The precise ratio depends on the purpose of the candle and should be determined by experiment.

Beeswax for candles needs to be extremely clean and free of all impurities (propolis or pollen) otherwise the candle will sputter while burning, give irregular light and possibly be splattering hot beeswax. Beeswax purchased from most beekeepers must usually be reprocessed at least once more in clean water.

There are various pigments available from specialty suppliers for colouring wax and some natural dyes will also work. Regular paint pigments are often insoluble in fat or burn incompletely and so should not be used. Normal food colouring does not work very well as it will leave residues, might clog the wick or produce stains. If only applied as a thin outer layer it may be acceptable but special fat soluble pigments give much better results.

Figure 4.7 : A display of homemade candles from West Africa (from left to right): stained candle moulded in PVC pipe, coloured wax with trimmed tip, candle still inside of bamboo mould, 2 candles rolled from wax foundation sheets, decorated candle from plastic cup mould, candle from bamboo mould (bottom).

Candles can be made by various processes (see Figure 4.7). The most suitable techniques for home use or small scale manufacturing involve using candle moulds or wax sheets to roll candles. In all cases, extreme care needs to be taken since beeswax is highly flammable and because of its high heat capacity, can cause severe burns when dropped onto bare skin. Wax for candle making should always be heated in a water bath (see VlProblemsV! below). Stainless steel or glass containers are recommended, but tin cans may be used for small quantities.

Rolled candles

Plain or patterned wax sheets are rolled around a central, wax impregnated wick. The wick has to be soaked in hot wax for a while and cooled in a very straight shape by suspending it with a weight attached at the bottom. The size, height, thickness and length of the wax sheet determines the shape and size of the candle. Frequently, the patterned foundation sheets for beekeeping are used (see Figure 4.7). No special moulds or complicated procedures are involved: it is a very clean and simple process which is easy to carry out.

The sheets are very easy to make. A smooth, wetted, wooden board dipped a few times into molten wax will make two sheets at a time (one on each side of the board). If only small quantities of wax are available, the liquid material can be poured into a flat mould made with a rectangular frame laid on a smooth surface (a wooden board, aluminum sheet or thick glass). The mould or board should be treated with soapy water or diluted honey to prevent the wax sticking to it. It will also be easier to remove the wax if the mould is flexible. A warm mould will facilitate spreading of small quantities of wax to provide a thin sheet. The mould surface can be sculpted to give the candle surface a special decorative effect like, for example, with beekeeping foundation sheets.

Moulded candles

The most common process for making candles uses moulds to give the wax its final shape. All kinds of patterns can be used; moulded candles do not have to be round. They can be square, triangular, oval, egg shaped, conical, all kinds of other geometric shapes or simply an irregular, carved design. In principle, the mould has to withstand the temperature of the molten wax (up to 100^0C), should not expand or shrink too much with changing temperature and should be easy to remove from the hardened candle.

For round stick candles, the choice of a mould depends on the size of the desired candle and the materials available. Pre-manufactured metal moulds are available from some specialized suppliers, but any round tube of the right internal diameter can be used: galvanized steel, aluminum, polyvinyl chloride (PVC), some types of rubber and bamboo. To facilitate removal of the candle, the PVC or bamboo could be carefully slit on one side. Held together with wire or string during the pouring, it can be opened a little to remove the candle. A small seam of wax might be left on the candle, but this can be carefully scraped off.

The longer the mould, the more difficult it will be to remove the candle. For solid, one-piece moulds and candles of 2 to 3 cm in diameter, a length of 12 to 15 cm is most practical. If a freezer or refrigerator is available, the moulds and candles may be cooled for a few hours. Cold wax will shrink away from the mould and can be pushed out easily.

The moulds need to be prepared so that the wax will not stick to their surface. Diluted honey or soap can be used as a coating. Silicones are also suitable but Vaseline (petroleum jelly) is not since it will be melted by the wax and will mix into the outer layer. Any coating that is used will have to be wiped off the finished candle with a damp cloth without wetting the wick.

To secure the wick in the centre of the mould, one end is tied to a small stick using a slip khot. The wick is threaded through the mould without touching the coated walls and the stick is placed into two notches cut in the rim of the mould to hold the wick in the centre of the tube. The loose end of the wick is tied tightly to another stick fitting into the notches on the opposite end of the mould. Ensure that the wick is in the centre of the tube.

One end of the mould is covered with a leaf, foil, clay or stick and placed into sandy ground. The mould should be warmed as much as possible in a stove, near a fire or inside a solar wax melter. Its temperature should be as close to that of the molten wax as possible. A few minutes after all the wax has melted in the water bath, it can be poured slowly into the hot moulds. The hotter the wax, the better is the final result, but it should not be boiling. Wax in the pouring container should not be allowed to cool down too much. Once poured, the mould may be covered so that no dirt enters. Moulds and candles should cool down as slowly as possible, e.g. in a warm room without draughts and direct sunlight.

After about two hours, thin candles (2-3 cm diameter) should have cooled down enough to remove them from the mould. The sticks are removed from both ends, making sure not to pull the wick from the centre of the candle. The mould is opened, refrigerated or the candle pushed out immediately. Any mould coating is carefully wiped off. The wick is cut to a length of 1 cm on the burning end and trimmed and cleaned at the other end. The candle should be stored in a cool, dark place and be wrapped in some clean paper or plastic bag to keep it from getting dusty and dirty. Newspaper should not be used because the print might transfer onto the candle.

Problems

If the mould cools down too fast or was not hot enough during pouring, the centre of the open end of the candle might sink. It may be refilled with liquid wax immediately after the first pouring has started to solidify and showed first symtoms. The same conditions may also lead to cracked candles. If either occurs, preventive measures include pouring the wax even hotter (but still without boiling it), prewarming the moulds bettered pouring the wax during the warmest time of the day (preferably in the sun) and cooling the moulds slowly in a warm, draught-free place.

If the solidified wax contains small droplets of water, the candle will sputter during burning as with the inclusion of dirt. To avoid this problem, freshly cleaned and processed wax may be heaated for a little longer before dipping or pouring the candles. A period of 5 to 10 minutes close to l00°C should be enough and is said to also improve the non-drip quality of the candle.

The larger the operation becomes, the more important proper control of the temperature conditions will become.

Odd shaped candles

Odd shaped candles cannot be pushed out of a mould without opening it. they have to be carved individually, or a mould has to be prepared out of at least which, when tied together, has one open end into which the wax can be poured. Therefore they have to be carved individually, or a mould has to be prepared out of at least two pieces which, when tied together has one open end into which the wax can be poured. A simpler alternative is to produce two half caldles in separate moulds and then "glue" the halves toghether with molten wax. Otherwise, the same methods and cautions apply as for stick candles.

The moulds can be made around a clay, wood or wax model with resins, silicone rubber, clay or metal, using techniques similar to those employed in metal casting and dentistry.

Figure 4.8 : Various shaped candles and packaging. A dipped candle is laying on the bottom.

Dipped candles

Very nicely shaped classic candles can be made by repeatedly dipping a weighted or stiffened wick into a liquid wax bath at *65* ^{0}C. An additional layer of wax is built with each dip. If the temperature of the wax is regulated correctly, this method produces excellent candles, but requires considerable skill and patience. Only very high quality candles and those for special ceremonial purposes are now made this way. Candles have to be immersed fast, left long enough to warm the solid wax and be withdrawn at just the right speed to avoid ripples on the candle and drippings on the bottom. Between dips, candles have to cool for a few minutes. Eason (1991) gives a simple and very clear account on how to dip beeswax candles. Very skilled craftsmen can also pour hot wax over the wick in order to build up thick candles.

Pressed candles

For industrial processes candles can also be pressed, extruded or drawn. To make pressed candles the wax is first powdered by atomizing (by spraying a fine mist) liquid wax during cooling. The powder is then pressed into the desired forms. For extrusion, a hollow tube with a wick in its centre is drawn from a perforated metal sheet and cut into the desired lengths. For drawn candles a continuous wick is intermittently drawn through liquid wax and holes of increasing diameter in metal sheets.

Sculptured candles

In some countries sculptured candles are popular (see Figure 4.8). Thick candles can be sculpted into various artistic shapes, such as animals or ceremonial or religious symbols for birthdays or other special occasions. They can also be decorated with surface materials such as sand and may be painted in different colours. Sculptured casting moulds can be made with silicone rubber so that particular shapes can be produced in larger numbers.

Economics

Although cheap paraffin wax candles are available in most rural areas, the manufacture of beeswax candles can be an additional incentive for beekeepers or for women to get started in beekeeping. In areas with no readily accessible

market for beeswax, it is all too often thrown away after honey processing. Under these circumstances, even cheap candles made by mixing paraffin wax with beeswax are an improvement which can provide an additional source of income or avoid extra expenses on lighting. Once larger quantities of wax are saved by beekeepers or beer makers, other markets can be accessed. Beeswax mixed with even the smallest quantity of paraffin or other synthetic wax should never be given back to bees in the form of foundation sheets or comb starters, because all wax subsequently produced from these colonies will be adulterated.

Further reading

For those interested in more details, the book of Coggshall and Morse (1984) is highly recommended. Other practical details can be found in a variety of publications, mostly bee journals. Some very simple illustrated methods are shown in the Peace Corps beekeeping manual (Gentry et al., 1985; Gentry, 1988) and in an ITDG (1978) publication. The following literature describes particular processes in more detail: the making of reusable and sculptured moulds from silicone rubber (Rigby and Hepburn, 1981), hand dipping of candles (Driesche, 1983), general tricks of the trade (Vinci, 1981; Furness, 1974 and 1986; Coutare and Guzzi, 1989) and supply sources for the UK (Higginbottam, 1974) The basic principles are all the same, but differences usually arise in the material selected for moulds, many of which have been mentioned in these publications.

Figure 4.9 : Special, moulded, carved and painted candles from displays in Germany (Mungersdorff, Koln)

4.11.3 Cosmetics

Only one very basic recipe for making a very simple cream is given here. All other recipes can be found in Chapter 9.

Ingredients (in parts by volume):

1	*Beeswax*	*0.06*	*Borax*
3	*Mineral oil*	*2*	*water*

Heat the wax and mineral oil in a water bath until the wax has melted (70^{0}C). Heat the water to the same temperature and dissolve the borax (approx. ig borax per lOOg of total ingredients). Slowly pour the water phase into the oil phase while stirring vigorously, but not so fast as to incorporate air into the cream. Continue stirring until the mixture has cooled and formed a creamy emulsion. Shortly before it solidifies, aromatic essences can be added. Propolis extract can be incorporated into the liquid phase when the temperature is about 40-50 ^{0}C. If the mixture separates or does not solidijy evenly, reheat it and try again. Patience and experience will lead to success. Store in airtight containers. The cream will keep for many weeks unless short sheij life ingredients such as vegetable oils, tallow or royal jelly have been added.

Most skin creams are used to provide moisture to the skin, keep the skin moist and for replacing some of the oils of the skin. A basic cream therefore contains water, an oil and a wax to make the mixture creamy and allow even distribution of the water. Since water does not mix with oils or wax, an emulsifier (in this case borax) must be added. The emulsifier changes the acids of the wax into soaps which then mix well with water. The proportions of the ingredients can vary but not more than 6.8% borax, on the weight of wax, should be used. Since borax is not very soluble in the mixture and if too much is added, the cream will have a rough texture (Crane, 1990).

Many different vegetable or mineral oils can be used but the disadvantage of vegetable oils is that they become rancid within a few weeks. Such oils are widely available and some of them have additional beneficial characteristics. Whichever oils are used, they should be as clean as possible usually of higher than food grade. The water that is used should be the best available. Rain or fresh spring water is considered best, but filtered well water or clean pipe water

may also be used. Heavily chlorinated pipe water may be harmful and the calcium in hard water reacts unfavourably with beeswax and other cosmetic ingredients. Clean and uncontaminated water is becoming increasingly rare in all parts of the world so special attention should be paid to this important ingredient. Industrial cosmetics are usually made with distilled or de-ionised water.

4.11.4 Grafting wax for horticulture

Mix one part melted beeswax with one part of resin and enough lard or tallow to make the mixture pliable Some finely ground charcoal may be added to protect the wound against sunlight. The mixture may be spread warm or applied in thin strips (Crane, 1990).

Melt equal portions of resin and beeswax in a double boiler or water bath and mix well. After cooling roll the mixture into sticks and store them (individually wrapped) in a cool place. Another recipe recommends a mixture of equal parts resin, beeswax and lard, prepared in the same way.

Since some growth hormones have been discovered in beeswax, the above formulations may actually be better than some commercial preparations.

4.11.5 Polishes and varnishes

Judging by the variation in recipes, it is obvious that there are many ways of preparing a wood finish or polish suitable for particular application. Turpentine is the most commonly available natural solvent for wax, but other oils may be substituted to avoid the rather strong odour of turpentine. Suitable alternatives are orange, lemon or linseed oil, naphtha or other liquid refined petroleum fractions and to a lesser degree, other refined vegetable oils. The wax content can range from 5 to 50% and occasionally even more. The consistency of the paste or oil may change, but can be corrected with appropriate adjustments in the proportions of each ingredient, e.g. less oil or more wax if it is too liquid.

Paste furniture polish:

Ingredients (in parts by volume) taken from several old and new references:

8	*Turpentine*	*1*	*Liquid soap*
1	*Beeswax*	*4*	*Soft water (rain)*
1	*Pine oil*		

Melt the wax in the turpentine using a double boiler or water bath over low heat. Care is required since turpentine is highly flammable. At the same time, mix die soap in the warm water. when both mixes have cooled a little, or are of similar temperature, pour the water phase into the oil phase and mix thoroughly but gently. Once cooled to less than 50 ^{0}C add the pine oil. while it is solidijying, spoon or pour the product into wide-mouthed jars or cans which should be sealed immediately. Label the container appropriately. If the wax hardens too quickly or too soon, it may be re-heated.

Aromatic oils (£or example, a few drops of lemon oil, pine oil or any other oily aromatic extract) can be added in small quantities to any polish. They should be added when the polish is cool but still soft.

2) *Ingredients (in parts by volume):*

Melt and mix equal parts of turpentine, linseed oil and beeswax in a water bath. Stir well and when cool spoon into wide mouthed labelled jars or flat tin cans.

Liquid furniture polish:

1) Ingredients (in parts by volume) from several old and new references:

4	*Turpentine*	*1*	*Liquid soap*
1	*Beeswax*	*2*	*Soft water (rain)*

Mix in the same way as the creamy polish. Store in small labelled screw top bottles.

2*) Ingredients (in parts by volume or weight):*

1	*Beeswax*	*1*	*Linseed oil*

Melt and mix in a water bath and store in labelled screw top bottles. The proportions of beeswax and linseed oil can be varied considerably.

Other oils can be added, and also resins which may help to create a slightly harder su~ace film.

If the beeswax/linseed oil mix is boiled until there is some stringy residue forming at the bottom, the clear liquid above can be poured off and used as a varnish.

3) Ingredients (in parts by weight) adapted from Gentry (1988):

4	*Beeswax*	*2*	*Turpentine*
1	*Orange, lemon, coconut or linseed oil*		

Grate the beeswax into the turpentine. Add one of the oils and mix. The turpentine will dissolve the wax and no heating is necessary. Store in labelled tins or bottles with tight fitting lids.

In order to improve the quality of this and other above polishes, try to get better refined ingredients, particularly turpentine or oils.

Spray polish

All recipes for spray application of beeswax were found to either contain highly toxic chemicals or those which are destructive to the upper atmosphere of the earth and are, therefore not described here.

For optimization of health, environmental hazards and wood preservation, the beeswax/linseed oil polish is best.

Figure 4.10: Furniture polish spray with beeswax and a polish paste based mostly on beeswax.

Floor Polish

1) For wooden floors, mix equal parts of beeswax and turpentine. The polish can be used as soon as the beeswax is dissolved.

2) A cheaper product for wooden floors and cement or tiled floors may be prepared as follows:

Ingredients (in parts by volume):

1	*Beeswax*	*1.5-2*	*Paraffin wax*
4	*White spirit, kerosene or diesel fuel*		

Melt the waxes in a water bath, remove from heat for safety and slowly stir in the spirit or juel. The only disadvantage of this polish is the noxious smell of the fuels after waxing the floor. Many commercial polishes, at least in East Africa, contain these feels as judged by the odour.

3) Ingredients (in parts by weight) adapted from Gentry (1988):

2	*Beeswax*	*1*	*Potash*

3.5	*Soft water (rain)*

Heat 2.5 parts of water and add the wax to it. Mix the potash with the rest of the water and pour it into the mixture of wax and water. Heat until it becomes a milky fluid. A similar product may be made by using soap instead of potash and less water.

Shoe polish, cream type

Ingredients (in parts by weight) adapted from Minrath (1957):

4.3	*Carnauba wax*	*3*	*Soap, flaked*
3	*Paraffin wax*	*50*	*Water*
	or beeswax	*q.s.*	*Water soluble*
8.5	*Turpentine*		

Melt the two waxes in separate containers in a water bath and then slowly add the paraffin wax or beeswax to the carnauba wax. Remove from the heat. when this mixture has cooled down but not yet started to solidift, slowly add the turpentine. Dissolve the soap in the water, heat to boiling, then mix in the pigments and the wax-turpentine solution. Continue stirring until it is cool.

To obtain the right shade of colour, the following equivalents may be added:

Black - Acid Black, Brown - Bismarck Brown G, Red - Crocein Scarlet, Orange-Orange II, and Yellow - Metanil Yellow.

Shoe polish, wax type

Ingredients (in parts by weight) adapted from Minrath (1957):

20	*Paraffin wax or beeswax*	*70*	*Tupentine*
3	*Carnauba wax*	*q.s.*	*Dyes*
4	*Montan wax*		

Melt the first three ingredients, adding each one after the other has melted, then add the colour. when thoroughly mixed, discontinue heating, remove from the heat source (for safety) and slowly add turpentine while stirring.

To produce the desired shade of colour, the following oil soluble dyes or their equivalent may be incorporated:

Black - Nigrosin, Brown - Bismarck Brown, Red - Rhodamin, Orange - Chrysoidin, and Yellow - Auramin.

If one or the other waxes are not available, they can be replaced with beeswax. The consistency of the final polish may change slightly, but this should not alter significantly the performance of the product.

4.11.6 Cravons

For crayons for drawing on glass or plastic, melt together equal parts of beeswax and asphaltum in a water bath. Add

a little lampblack while mixing and allow to cool. Before completely cold, roll pieces into sticks on a smooth su~ace. Other pigments can be added to provide different colours. Wrap in paper.

Another source (Gala Books, 1971) describes using 4 parts of wax, 1 part of tallow and 1 part of lampblack and, for most other colours, a mixture of 2 parts wax, 1 part tallow and 1 part chrome yellow, prussian blue or 4parts zinc white. Ordinary paint pigments may also be used. These mixes are usually pressed into the right shape. They may also be rolled into sticks and wrapped in paper. Tallow is rendered beef fat and it can be obtained from butcher's shops, slaughterhouses etc.

4.11.7 Leather preserves

1) The recipe recommended by Lloyd (1957) is identical to the first recipe of liquid jurniture polish (4.11.5)

2) Another liquid recipe uses equal parts of turpentine and wax, plus a fat soluble dye. The wax component can be varied according to availability or the final consistency required of the polish.

3) *Minrath (1957) suggested 200 g of montan wax, 160 g paraffin wax and 30 g of stearic acid in an equal quantity of turpentine (390g) . Any one or all of the waxes can be replaced by beeswax.*

Melt each wax separately, remove from heat and combine them careflilly, then add molten stearic acid. Once the mixture has cooled but while it is still liquid, add the oil soluble dye. when the mixture begins to solidift, stir in the turpentine.

4) *Ingredients (in parts by weight) adapted from Minrath (1957):*

20	*Paraffin wax or beeswax*	*70*	*Tupentine*
3	*Carnauba wax*	*q.s.*	*Dyes*
4	*Montan wax*		

Melt the beeswax in a water bath, cool it until it is semi-soft, then add the remaining ingredients and finally, the aromatic essence. Store in an air-tight container.

Figure 4.11 : The various products sold by the Ruai Beekeepers' Cooperative in Kenya (from left to right): Honey, saddle soap (similar recipe as furniture polish paste, 4.11.5(1), without aromatic oil), candles, rendered wax, furniture cream polish and honey.

4.11.8 Waterproofing textiles and paper

In order to waterproof paper or textiles, an emulsion has been patented which also provides good air permeability and abrasion resistance. For this purpose, a colloidal emulsion is produced (see 9.4.3 and 9.4.4) by homogenizing melted beeswax (2 parts), fatty acids (3-5 parts) and paraffin wax (15-18 parts) in an alkaline solution of soapy water (Pan and Matsumoto, 1975). The paper or textiles can be brushed with the solution or dipped into it.

4.11.9 Paint

Beeswax has been used in paints since antiquity. The famous mirror wall at Sigiriya, in Sri Lanka was painted with a mixture containing resins, egg white and beeswax, polished to a very high sheen. It can still be observed after more than 500 years. Some of the wall paintings in Pompeii, Italy, prepared with coloured beeswax are still admirable after almost 2000 years.

A simple mix of 10% resin melted together with beeswax can be coloured according to need with natural dyes or oil soluble pigments and be painted while warm and liquid (Brown, 1989 see 1981). This provides a permanent, waternroof decoration.

4.11.10 Wood preservative

For beekeeping, hive boxes can be weatherproofed by dipping them in hot linseed oil to which 5 to 10% of beeswax have been added. A much cheaper method which is not recommended because it is so dangerous has been described by a beekeeper in Argentina. It involves heating petrol (gasoline) in which old combs and hive scrapings have been melted. The hive bodies can be dipped into the hot fuel or be brushed with it.

Heat petrol ~referably lead free petrol) to 70 or 80^{0}C in an old bucket or steel drum. Be very careflil to keep open flames and sparks under control, keep the container covered and use a large high sided container only halffull. Keep the fire small. For painting remove the container from the fire so that dripping gasoline does not spill near the flames. Only work in the open air and stay well away from housing.

Immerse at least 2 kg of old comb and hive scrapings per 20 litres of fuel and careftilly stir. After 15 minutes remove from the fire, skim the scum off the su~ace and start painting or dipping. If the liquid has cooled too much (to below 55 ^{0}C) reheat and continue. The proportion of comb can be increased and/or 5 to 10% of linseed oil may be added. Before use, allow the boxes to dry and air for a couple of weeks.

4.11.11 Swarm lure

Worker bees scouting for new home sites in preparation for, or during swarming, apparently react positively to the presence of wax and (to a lesser degree) to propolis. Smearing or melting beeswax inside a bait hive or swarm trap makes it more attractive. Only imitations of the Nasanov pheromone, a volatile attractant (hive odour) secreted by the honeybee workers, are more attractive. A successfully tested pheromone lure is made of equal parts of citral, geraniol, neuronic and geranic acids, preferably enclosed in slow release formulations.

4.11.12 Topical ointment for burns

Ingredients (in parts by weight) adapted from Gentry (1988):

1.8	*Beeswax*	*3*	*Soft water (rain)*
4	*Paraffin*	*0.1*	*Borax*
		1	*Pulverized aloe*

Melt the beeswax in a water bath, add the paraffin, mix until melted and remove from the heat. Mix the borax into boiling water, cool down to the same temperature as the wax, then stir while cooling. when the mixture starts to solidifr, add the aloe.

Instead of pulverized aloe, freshly squeezed aloe juice may be incornorated. Use 3 parts offresh aloe juice for each part of pulverized aloe and reduce the volume of the water by 2 parts. Add the aloe when the wax mixture has cooled below 40^{0}C. Store in tight, wide-mouthed glass jars. The ointment will keep better if it is stored in a refrigerator. It is better to make very small batches frequently than to make a large batch occasionally. No information is available on the safe shelf life of this product.

By adding a few drops of propolis extract with the aloe, preservation should be prolonged and healing of wounds may be improved.

4.11.13 Veterinary wound cream

A base cream for treating wounds and skin diseases in animals was described by Vidyaev (1968) as consisting of mineral oil (boiled in order to reduce the water content) to which pine gum resin was added together with beeswax. The mixture was filtered and powdered calcium carbonate added before cooling. No proportions were given in the English abstract, nor were results of application described. However, cream-like consistency can be obtained with proportions copied from the above recipes and resin content may be from 2 to 10%. Addition of propolis extract (at 1-2%) would probably increase the effects of this basic cream.

4.11.14 Adhesive

Beeswax itself, when slightly softened by kneading in ones hands, sticks to many materials and surfaces. It can therefore be used to temporarily hold light objects together.

The following recipe is referred to as Turners' cement and can be used with a variety of materials, wood, metal and clay pots. Its performance may not compete with other specialized adhesives, but is a cheap alternative when nothing else is available.

Ingredients (in parts by weight) adapted from Brown (1981):

2	*Beeswax*	*1*	*Pitch*
1	*Resin*	*4*	*Fine brick dust*

Melt the beeswax in a water bath and add the resin and the pitch. when everything has melted, stir in the brick dust and leave it to cool. Warm the adhesive before applying it.

4.11.15 Determination of saponification cloud point ((1uoted from ITCg 1978)

Apparatus:

A. lOOml Kjeldahl flask
B. Reflux condenser
C. Thermometer - certified at 63°C

Procedure:

Place 3.0 grams of wax in a 100 ml Kieldahi flask and add 30 ml of a clear ethanolic potassium hydroxide solution (for the preparation of the KOH solution follow the method described below) Connect the flask to a reflux condenser and boil gently for 2 hours. At the end of this period, disconnect the reflux condenser, place the flask in a water bath at 80^0C and insert a thermometer (ASTM designation E1-34C) into the solution. Rotate the flask in the bath while cooling and observe the temperature decrease. The temperature at which cloudiness or globule formation appears in the solution is the Saponification Cloud Point. For more accurate observation of the Cloud Point, place a printed card with broad black letters 1/4 ' high under the flask as it cools. The temperature of the solution when the printing observed through the flask becomes ha~, is to be taken as the Cloud Point.

Preparation of Ethanolic Potassium Hydroxide Solution

Rapidly weigh approximately 35 grams of pelletized potassium hydroxide (reagent grade) and transfer immediately to a bottle which contains 1 litre of pure aldehyde free, 94.9% by volume, ethyl alcohol. Shake the bottle occasionally until all KOH pellets are dissolved. Let stand for 24 hours, and decant or filter rapidly to remove carbonates that have formed. A yellow or brown discolouration of the solution indicates the presence of aldehydes. These can be removed by the following procedure: Add 5 grams of aluminum foil to 1 litre of the ethanolic potassium hydroxide solution and reflux for 30 to 60 minutes. Distill and collect the alcohol after discarding the first 50 ml. Prepare the ethanolic potassium hydroxide anew as described above.

Contents - **Previous** - **Next**

CHAPTER 5
PROPOLIS

Contents - Previous - Next

5.1 Introduction

Propolis is a mixture of various amounts of beeswax and resins collected by the honeybee from plants, particularly from flowers and leaf buds. Since it is difficult to observe bees on their foraging trips the exact sources of the resins are usually not known. Bees have been observed scraping the protective resins of flower and leaf buds with their mandibles and then carrying them to the hive like pollen pellets on their hind legs. It can be assumed that in the process of collecting and modelling the resins, they are mixed with some saliva and other secretions of the bees as well as with wax.

Figure 5.1 : Honeybees frequently use propolis to reduce the size of the entrance for better defence.

These resins are used by worker bees to line the inside of nest cavities and all brood combs, repair combs, seal small cracks in the hive, reduce the size of hive entrances (see Fig. 5.1) seal off inside the hive any dead animals or insects which are too large to be carried out and perhaps most important of all, to mix small quantities of propolis with wax to seal brood cells. These uses are significant because they take advantage of the antibacterial and antifungal effects of propolis in protecting the colony against diseases. Propolis has been shown to kill the bee's most ardent bacterial

foe, Bacillus larvae - the cause of American Foul Brood (Mlagan and Sulimanovic, 1982; Meresta and Meresta, 1988). The use of propolis thus reduces the chance of infection in the developing brood and the growth of decomposing bacteria in dead animal tissue.

The composition of propolis depends on the type of plants accessible to the bees. Propolis changes in colour, odour and probably medicinal characteristics, according to source and the season of the year. Moreover, some bees and some colonies are more avid collectors-generally to the dismay of the beekeeper, since propolis is a very sticky substance which, in abundance, can make it difficult to remove frames from the boxes.

Foraging for propolis is only known with the Western honeybee Apis mellifera. The Asian species of Apis do not collect propolis. Only Meliponine or stingless bees are known to collect similarly sticky resinous substances, for sealing hives and constructing honey and pollen pots for storage. In this bulletin, however, propoli shall refer only to resins collected by honeybees, since almost all of the research has been done on it. There may well be similar traditional uses for resins collected by Meliponids.

In the natural distribution ranges of Apis mellifera, a multitude of traditional uses are known for this versatile substance. The Greeks and Romans already knew that propolis would heal skin abscesses and through the centuries its use in medicine has received varying attention. The ancient Egyptians knew about the benefits of propolis and in Africa it is still used today, as a medicine, an adhesive for tuning drums, sealing cracked water containers or canoes and dozens of other uses. It has been incorporated in special varnishes such as those used by Stradivarius for his violins (Jolly, 1978).

An excellent review in Spanish on the production, characteristics and uses of propolis was published by Asis (1979 and 1989) another good overview (in English) was APIMONDIA (1978). A brief, more recent review in English is presented by Schmidt and Buchmann (1992).

5.2 Physical characteristics of propolis

The colour of propolis ranges from yellow to dark brown depending on the origin of the resins. But, even transparent propolis has been reported by Coggshall and Morse (1984).

At temperatures of 250 to 45 ^{0}C propolis is a soft, pliable and very sticky substance. At less than 150 C, and particularly when frozen or at near freezing, it becomes hard and brittle. It will remain brittle after such treatment even at higher temperatures. Above 45 ^{0}C it will become increasingly sticky and gummy. Typically propolis will become liquid at 60 to 70^{0}C, but for some samples the melting point may be as high as 100^{0}C.

The most common solvents used for commercial extraction are ethanol (ethyl alcohol) ether, glycol and water. For chemical analysis a large variety of solvents may be used in order to extract the various fractions. Many of the bactericidal components are soluble in water or alcohol.

5.3 The composition of propolis

In one recent analysis of propolis from England, 150 compounds were identified in only one sample (Greenaway, et al., 1990), but in total more than 180 have been isolated so far. It appears that with every new analysis, new compounds are found.

Propolis resins are collected from a large variety of trees and shrubs. Each region and colony seems to have its own preferred resin sources, which results in the large variation of colour, odour and composition. Comparisons with tree resins in Europe suggest that, wherever Populus species are present, honeybees preferably collect the resins from leaf buds of these trees.

A Cuban study suggests that the plant resins collected are at least partially metabolized by bees (Cuellar et al., 1990). The presence of sugars (Greenaway et al., 1987) also suggests some metabolization by bees, i.e. as a result of adding saliva during both scraping and chewing.

A list of the major classes of chemicals occurring in propolis is given below with references to some recent reviews and analyses from different countries (Table 5.1). The major compounds are resins composed of flavonoids and phenolic acids or their esters, which often form up to 50% of all ingredients. The variation in beeswax content also influences the chemical analysis. In addition it must be said that most studies do not attempt to determine all components, but limit themselves to a class of chemicals or a method of extraction. The selection of the studies presented here is based on the most recent publications with preference given to the most complete studies or to studies from countries where these are the only references.

5.4 The physiological effects of propolis

5.4.1 Unconfirmed circumstantial evidence

The following uses of propolis or its extracts have been found in literature, but without substantiating evidence or reference to scientific studies:
anti-asthmatic treatment in mouth sprays,
support of pulmonary system,
anti-rheumatic (Donadieu, 1979),
inhibition of melanoma and carcinoma tumour cells,
tissue regeneration,
strengthening of capillaries,
anti-diabetic activity,
phytoinhibitor,
inhibiting plant and seed germination (Donadieu, 1979) in general and potato and leaf salad seed germination (Bianchi, 1991) in particular.

Table 5.1:

The major compounds of propolis as analyzed in recent publications.

Class of components	Group of components	References
Resins	45 to 55 % flavonoids	Pápay et al., 1987 - Hungary Bankova et al., 1987 - Bulgaria Nagy et al., 1989 - Czechoslovakia Omar, 1989 - Egypt Greenaway et al., 1990a - UK Greenaway et al., 1990b - Austria, Ecuador, Germany, Israel, UK, USA Wang and Zhang, 1988 - China Mizumo et al., 1987 - Japan
	phenolic acids and esters	Nagy et al., 1985 - Hungary Wollenweber et al., 1987 - West Germany Bankova et al., 1992 - Bulgaria, Mongolia
Waxes and fatty acids	25 to 35 % most are usually from beeswax, but many are of plant origin	Pápay et al., 1987 - Hungary
Essential oils	10 % volatiles	Petri et al., 1988 - Hungary
Pollen	5 % proteins probably from pollen; free amino acids (AA): 16 AA's at more than 1 % of total AA's of which arginine and proline together make up 45.8 %, 8 AA's occur in traces	Gabrys et al., 1986 - Poland
Other organics and minerals	5 % 14 trace minerals of which Fe & Zn are most common, others e.g.: Au, Ag, Cs, Hg, La, Sb;	Scheller et al., 1989 - Poland
	ketones	Bankova et al., 1987 - Bulgaria
	lactones	Cuellar and Rojas, 1987 - Cuba
	quinones	Cuellar and Rojas, 1987 - Cuba
	steroids	Cuellar and Rojas, 1987 - Cuba
	benzoic acid and esters	Greenaway et al., 1987 - UK
	vitamins, only B_3	Greenaway et al., 1987 - UK
	sugars	Greenaway et al., 1987 - UK
General review		Walker and Crane, 1987 - World Asis, 1989 - World Crane, 1990 - World Inoue, 1988 - Japan

5.4.2 Scientific evidence

One of the most widely known and extensively tested properties of propolis is its antibacterial activity. Many scientific tests have been conducted with a variety of bacteria, fungi, viruses and other microorganisms. Many of the tests have shown positive control of the organisms by various extracts and concentrations of propolis. A synergistic effect has been reported for propolis extract used together with antibiotics (Chernyak, 1971). Whether propolis exhibits bactericidal or bacteriostatic characteristics often depends on its concentration in the applied extract. Sometimes, propolis extracts are more effective than commercially available drugs (Millet-Clerc, et al., 1987). In all cases, the specific conditions and extracts have to be closely considered. Proven effects of propolis on microorganisms are listed in Table 5.2.

Though there is a large variety of effects attributed to propolis, many of the reports are based on preliminary studies. If clinical trials were conducted, they were rarely based on large numbers of patients or rigorous test designs such as the double-blind placebo test (Table 5.3). The majority of the studies were conducted in East European countries. Much practical work and research is also being done in China, but information is difficult to obtain, not least because of the language barrier. Western European and North American medical research has largely ignored this source of milder and widely beneficial material. More detailed studies are warranted to determine the potential benefits from the medicinal use of propolis, particularly for intestinal, dermatological and dental applications.

In addition to the selected studies cited here, there have been over 500 publications in the last 18 years alone. Most were in vitro studies, but clinical trials were also conducted. These can be researched by those further interested in the uses of propolis in the collection of abstracts prepared by IBPA which is available from them.

5.5 The uses of propolis today

5.5.1 In cosmetics

Dermatological and cosmetic applications are at this time probably the most common uses for propolis and its extracts (Lejeune, et al., 1988). Its effects on tissue regeneration and renovation have been well studied. Together with its bactericidal and fungicidal characteristics it provides many benefits in various applications in cosmetics. For some recent specific references on scientific studies, the reader should refer to the section on the effects of propolis (5.4.2). More detailed information on practical application of propolis in cosmetics can be found in Chapter 9.

5.5.2 In medicine

General medicinal uses of propolis include treatment of the cardiovascular and blood systems (anaemia), respiratory apparatus (for various infections), dental care, dermatology (tissue regeneration, ulcers, excema, wound healing - particularly burn wounds, mycosis, mucous membrane infections and lesions), cancer treatment, immune system support and improvement, digestive tracts (ulcers and infections), liver protection and support and many others. Some references to these applications can be found in the list of scientifically proven effects of propolis (Table 5.3) otherwise one might refer again to IBRA's collection of abstracts, Apimondia and the American Apitherapy Society.

Table 5.2:

A list of microorganisms against which propolis or its extracts have been shown to have a positive effect.

Target organism	Comments	Reference
Bactericidal effects		
Bacillus larvae	causes American Foul Brood in honeybees	Meresta and Meresta, 1988
B. subtilis and others		Meresta and Meresta, 1985, 1986

B. subtilis and others		Meresta and Meresta, 1985, 1986
Bacillus de koch	tuberculosos	Karimova, 1975 Grange and Davey, 1990
Staphylococcus species	assiciated with pneumonia	Chernyak, 1973
Staphylococcus aureus	positive synergistic effect with action of 13 antibiotics against 10 strains	Kedzia and Holderna, 1986 Meresta and Meresta, 1988 Dimov et al., 1991
Streptococcus		Rojas and Cuetara, 1990
Streptomyces		Simúth et al., 1986
S. sobrinus, mutans & cricetus	dental caries in rats	Ikeno et al., 1991
Saccharomyces cerevisiae	brewer's yeast	Petri et al., 1988
Escherichia coli		Simúth et al., 1986
Salmonella and Shigella	review	Ghisalberti, 1979
Salmonella	potential use in salmonellosis treatment	Okonenko, 1986
Salmonella	reduction in pathological changes after Salmonella infections in mice	Okonenko, 1988
112 anaerobic strains	inhibitory effect on most	Kedzia, 1986
Giardia Lambia		Olariu et al, 1989
Bacteroides nodosus	reduction of foot-rot in rams	Muñoz, 1989
Klebsiella pneumoniae		Dimov et al., 1991
reduced or no bactericidal activity		Brumfitt et al., 1990
general	6 species of bacteria, major (4%) component - flavonoid, Cuba	Cuéllar et al., 1990

Fungicidal effects

Candida albicans	weak effect by ethanol extracted propolis (EEP) no effect by aqueous extracted propolis (AEP)	Valdés et al., 1987
	better effect in vitro	Petri et al., 1988
	in comparison with 10 antibiotics EEP had best effect in synergism with natamycin and flucytosine	Holderna and Kedzia, 1987
Aspergillus niger		Petri et al., 1988
Botrytis cinerea	in vitro EEP is fungicidal, but in vivo with strawberries has insignificant effect	La Torre et al., 1990
Ascosphaera apis	chalkbrood pathogen in honeybee colonies	Kedzia, 1986 and Ross, 1990
6 fungi infectious in humans	antifungal properties vary with different samples of propolis	Millet-Clerc et al., 1987

6 fungi infectious in humans	antifungal properties vary with different samples of propolis	Millet-Clerc et al., 1987
Plasmopara viticola	ineffective, greater leave damage by P. viticola with 1% propolis treatment	Hofmann et al., 1989
general	antifungal activity increased in presence of propylene glycol	Millet-Clerc, et al., 1987 Milena, et al., 1989
Antiviral effects		
Herpes	Herpes 1 and 2 in vitro anti-herpes ointment patent	Sosnowski, 1984 Popescu et al., 1985
Potato virus	EEP is effective, AEP less so	Fahmy and Omar, 1989
Influenza	reduced influenza mortality in mice with oral and injected propolis extracts	Maksimova-Todorova et al., 1985 Neychev, et al., 1988 Serkedjieva, 1992
Newcastle disease		Maksimova-Todorova et al., 1985
general	review	Benkova et al., 1988 König and Dustmann, 1989
Nematodicidal effect:		
Ascaris suum	in intestines of guinea pigs, assessed to be effective through immunostimulation	Benkova, et al., 1989

Table 5.3:

Medicinal and other effects described for propolis or its extracts.

Application	Comments	Reference
Allergen	some allergic reactions may be due to pollen content, but the majority of reactions have been shown to be related to pentenyl esters and phenylethyl esters of caffeic acid	Hashimoto et al., 1988 Hausen and Wollenweber, 1988
Irradiation protection	of mice against gamma radiation after intraperitoneal injection of EEP free radical scavenger	Scheller et al., 1989a Scheller et al., 1990
Anti-tumour (cancer)	review of anti-cancer, anti-viral, endocrinological and allergic activity of caffeic acid and derivatives extracted from propolis review, Ehrlich carrinoma cytotoxicity on cultures of human and animal tumour cells cytotoxic and cytostatic effects in vitro	König, 1988 Scheller et al., 1989e Grunberger et al., 1988 Ross, 1990

	cytotoxic and cytostatic effects in vitro against hamster ovary cancer cells and sarcoma-type tumours in mice	Ross, 1990
Ulcers	patient histories	Gorbatenko, 1971
	patient histories	Makarov, 1972
	beneficial for stomach ulcer cures, but not for ulcers of the duodenum	Gueorguieva and Vassilev, 1990
Leprosy	leprosy	Grange, 1990
Mammalian tissue regeneration	stimulation of various enzyme systems, cell metabolism, circulation, collagen formation; improved healing of burn wounds	various reviews
	as a result of arginine presence	Gabrys et al., 1986
	accelerated epithelial repair of skin wounds in rats, but not in dental sockets after tooth extraction	Filho and Carvalho, 1990
Anaesthesia	in strong concentrations, raw or extracted, review	Crane, 1990
	anaesthetic, anti-inflammatory, anti-bacterial, anti-fungal effect	Tóthné and Pápay, 1987
	anaesthetizing ointment for dentistry	Sosnowski, 1984
Dental care	less caries in rats	Ikeno et al., 1991
	subsidiary treatment for gingivitis (gum infections) and plaque (deposit on teeth)	Neumann et al., 1986
	pulp gangrene antiseptic (50 % EEP)	Gafar et al., 1986
Other medicinal applications	stimulation of immune response in mice	Manolova et al., 1987
	immune system improvement in 2 cases of alveolitis fibroticans with a preparation containing EEP, Esberitox N and a calcium-magnesium preparation	Scheller et al., 1989c
	bronchitis, best results with inhalation of EEP together with propolis tablets and application of dolomite	Scheller et al., 1989b
	in rats and mice, a concentrated EEP dose at 100-500 mg propolis per kg body weight, reduces blood pressure, produces a sedative effect, protects the liver against tetrachloride, the stomach against ulcers, forms and maintains serum glucose, but has no diuretic, anti-bleeding or anti-sclerotic activities	Kedzia et al., 1988
	strengthening capillaries	Budavari, 1980
	vaso-motor catarrh treatment with propolis ointment	Zommer-Urbanska et al., 1989

	vaso-motor catarrh treatment with propolis ointment	Zommer-Urbanska et al., 1989
	Legg-Calve-Perthes illness (hip joint disease in humans) by intra-articular injection of AEP	Przybylski and Scheller, 1985
	liver protection against alcohol (ethanol) in rats	Giurgea et al., 1987 and 1989
	liver protection against tetrachloride in rats	Coprean et al., 1986
Veterinary applications	improved weight gain and reduced diarrhoea in milk-fed calves with 5 ml of 20% EEP in morning and evening	Gubicza and Molnar, 1987
	mastitis, successful treatment even with antibiotic resistant infections	Meresta et al., 1989
	coccidiosis in rabbits with 3 % EEP orally	Hollands et al., 1988
	Eimeria (intestinal parasitic protozoa) in rabbits with 2-3 % EEP orally for 4 weeks	Hollands et al., 1984
Antioxidant	as a result of synergism between individual ingredients	Yanishlieva and Marinova, 1986
	oxidation at different speeds in different propolis types depending on presence of non-saturated compounds; with less contamination by wax, more non-saturated compounds are present	Omar, 1989
	in the presence of polyunsaturated fatty acids in animal feed, EEP is better than vitamin E	Okonenko et al., 1988
	stabilizing sunflower oil against oxidation	Yanishlieva et al., 1986
	as an anti-hypoxic in form of lyophilized phenolic polysaccharides	Tikhonov and Mamontova, 1987
	as food preservative in various reviews, but without reference to scientific studies	various
Pesticides	effective in vitro tests against strawberry pest Botrytis cinerea, but no statistical differences for in vivo tests	La Torre et al., 1990
Phytoinhibitor	inhibiting plant and seed germination	Donadieu, 1979 without research references
	inhibiting germination of potato and leaf salad vegetables	Bianchi, 1991 without research references

Direct external application of ethanol extracts or concentrated ointments (with up to 33% propolis) have given good results in veterinary use for wound healing and sores. Plastic surgery too, is using propolis extracts for improved

wound healing and reduced scar tissue development.

5.5.3 Traditional use

In Europe and North Africa, the special wound healing properties of propolis were already known to the Egyptians, Greeks and Romans and in ancient times. In records of the 12th century, medicinal preparations with propolis are described for treating mouth and throat infections, as well as caries. Propolis probably has been more commonly used in wood preservatives or varnishes than may be suggested by the single, frequently cited reference to Stradivarius (Jolly, 1978).

In sub-Saharan Africa, propolis is still used today in herbal medicines and the more mundane applications mentioned earlier such as waterproofing containers and wood, adhesive, bow string preparation and for tuning drums.

5.5.4 Food technology

The antioxidant, antimicrobial and antifungal activities of propolis offer scope for applications in food technology. One special advantage is that, unlike some conventional preservatives, the residues of propolis seem to have a generally beneficial effect on human health. However, only very few studies have been done on the possible side-effects of increased consumption of propolis. Individually, some of the components identified in propolis can be very damaging to human health.

Mizuno (1989), registered a patent which includes propolis as a preservative in food packing material.

Extension of frozen storage life of fish by 2-3 times is cited including Donadieu (1979), but without reference to original studies. propolis is permitted as a preservative for frozen fish. by various authors, In Japan, the use of Addition of only 30 ppm (parts per million) of propolis to the rations of laying hens increased egg production, food conversion and hen weight by S to 6% (Bonomi, et al., 1976). Ghisalberti (1979) reports additional weight gains for broiler chicken of up to 20% when 500 ppm of propolis was added to their diets.

5.5.5 Others

The search for new uses of propolis continues. Sangalli (1990) mentioned use of propolis for post-harvest treatment and conservation of fruits. Applications in pesticides and fungicides are still in the testing phase. However, for many of its traditional uses propolis is being replaced by more readily available, sometimes more effective but often also more toxic alternatives.

Beekeepers use propolis, melted together with wax or in an ammonia solution (Anon, 1982) to apply to the inside of hives or swarm traps to attract swarms. Adequate ventilation and aeration after painting with the ammonia solution are both necessary. Rubbing propolis or painting it (after melting with wax from old combs) works as well or better and avoids the use of noxious and toxic ammonia.

The current trend to return to environmentally safer and less energy intensive production methods in many developed countries, the increased buying power of consumers and growing markets for more expensive products may lead to considerable growth in the use and new applications of propolis, particularly in cosmetics and food technology.

5.6 Formulation and application methods for human and animal use

5.6.1 Raw propolis

Unprocessed propolis can be used in chunks, or it may be frozen and broken or ground to fine powder. Large pieces of pure propolis can be chewed, but it should only be consumed in small quantities, since it may cause stomach

upsets. Smaller pieces and powders can be taken in capsules or mixed with food or drinks.

5.6.2 Liquid extracts

Most commercial uses of propolis are based on preparations made from primary liquid extracts. The raw material is rarely suited for direct inclusion in final products. Similarly, for most private or small scale uses, raw propolis is usually treated with a solvent and only the resulting extract is used.

A large variety of organic solvents might be applied but only a few are non-toxic and can be used safely for internal and external applications with humans and animals. The most commonly used is ethanol. A knowledgeable pharmacist or cosmetic chemist can select a few other non-toxic solvents for special applications. In some instances, reduction or elimination of the solvent is necessary and either (on an industrial scale) by lyophilization, (freeze drying) or vacuum distillation and (in small-scale production) by evaporation or distillation.

5.6.3 Additives and tablets

Propolis or its extracts can be taken with, or be used as an additive to other medicinal, dietetic and cosmetic preparations. Ethanol extracts can be directly mixed with most foods, medicines or cosmetics. Less frequently, aqueous (water) or glycol extracts are used. Propolis extract paste can easily be included in tablets or sweets.

5.6.4 Injection

For experimental purposes with animals, special extracts of propolis were injected subcutaneously or intramuscularly. Results were positive and injectable extracts for humans may become feasible in the near future.

5.7 Extraction methods

There are a few basic extraction methods which can be varied by using different solvents. The selection of the solvent depends on the final use of the extract and on technical feasibilities. Most active ingredients seem to be soluble in propylene glycol and ethanol. Fewer ingredients are soluble in water, but even water extracts show at least some bactericidal and fungicidal effects, as well as wound healing properties. Acetone extracts have been used for production of shampoos and lotions. Once the specific chemicals or chemical groups and their biological effects are better understood, better and more specific extracts can be prepared for equally specific applications.

The antimicrobial action of alcohol extracts is influenced by the extraction method, e.g. the duration of the soaking period or the amount of heating The concentration of the alcohol used and nature of stirring during extraction seem to have less of an influence (Obreg6n and Rojas, 1990). Debuyser (1984) reports extractions with a 70% solution of alcohol as the most active, without stating what kind of activity is being referred to. In general, it can be said that the longer the propolis is soaked in alcohol the more ingredients will be dissolved. Soaking beyond two or three weeks however, does not seem to increase the extent of extraction.

In scientific and non-scientific literature alike, the method for determining propolis concentration in the extract is not always specified. A scientific method should consider the ratio of the dry weight of dissolved matter to the weight of the solvent (A) or quantify ppm (parts per million) of active ingredients. However, a more practical way appears to be using the ratio (by weight) of total propolis placed into the solvent to the weight of the solvent (B). The latter method is certainly less precise, because of the incomplete dissolution of propolis, and the final concentration therefore depends very much on the extraction method, the solvent and the quality of the propolis. Thus, for standardization, in addition to concentration, a description of the solvent, the temperature and the duration of extraction is required. However, the practical method (B) results in less active ingredients for the same concentration determined according to the scientifically measured concentration (A). Standardization will also require measurable parameters for control as for example, certain stable compounds which are extracted in proportions similar to the

total concentration of active ingredients (for other standards see section 5.11). A quantitative standardization is needed for future commercialization of propolis and its extracts.

Five and ten percent solutions using the latter method (B) i.e. the ratio of the total weight of propolis to the weight of the solvent, are most commonly used in small-scale production. Frequently however, the weight of alcohol is assumed to be equal to that of water, i.e. 1 ml of alcohol is assumed to weigh 1 g. Yet, absolute ethanol weighs approximate 20% less than the same volume of water These weight differences can also result in large differences in concentrations of active ingredients. Fortunately, the exact dosage of propolis is not usually of great importance. However, commercialization requires dealing with precise values. No uniformity exists yet in cosmetic applications either, since many recipes are based on propolis extract paste and others on liquid extracts of various concentrations. Cosmetic applications however, often contain not more than 1 % of the preferred propolis extract which can mean as little as 0.05 % to 0.06% of the active ingredients.

A few extraction methods for commercial use of propolis are described below. Additional solvents may be used in order to extract special components. Medicinal and food technology processes or studies are almost always conducted with ethanol or aqueous extracts. Glycol extracts are practical for many cosmetic applications because of their improved dissolution in water based emulsions.

Preuaration for extraction

The propolis should be prepared by removing coarse debris and excessive wax. It should then be broken into small pieces or ground to a fine powder. If the propolis is too sticky to be broken up, it should be placed in a refrigerator or freezer for a few hours. Alternatively, pull the pieces into thin sheets or strips in order to increase the contact surface between propolis and alcohol, to promote dissolution.

Choice of the correct solvent is very important if the product is to be used for human consumption. Normally, only ethanol or exceptionally, glycol (as in method 4) should be used. Other alcohols may be used only if their internal and external physiological interactions are sufficiently known and safe.

So-called denatured, rubbing or methyl alcohol should not be used. If the extracts are intended for external application only, rubbing alcohol may be used in some cases, but different countries use different chemicals to make pure alcohol unpalatable for drinking or internal consumption. Similarly, there are different types of denatured alcohols intended for different purposes. If cheap alcohol is used, care should be taken that the chemicals used for denaturing it are compatible with the planned end use. Chemicals added to denature alcohol may interact negatively with other ingredients so reducing their beneficial effects and may cause irritations, burns or even poisoning. There have been fatal accidents caused by extracts of propolis prepared with unsuitable alcohol.

For most preparations intended for internal use, gin, rum, cachasa, arrak or other clean, locally distilled liquors can be used. These liquors usually contain less than the optimal 70% of alcohol but for home processing, they produce acceptable results. However, for high quality commercial product, particularly for cosmetics or medicines, high quality laboratory grade or drinking alcohol (ethanol) should be used. 70% ethanol has given the best results in several studies which tested the extracts for their bactericidal and fungicidal effects.

Alcohols of different concentrations extract different compounds and influence the solubility of dried extracts. Thus, extracts made with higher concentrations of alcohol, when dried, are predominantly soluble in organic solvents and oils. But dried extracts from extractions with a very low concentration of ethanol are much more water-soluble. Sosnowski (1984) in a patent application described dried filtrates from 10-25 % alcohol extracts which are completely soluble in water.

In some, if not most countries, special laws apply to the manufacture of products containing alcohol. Information should be sought and a licence should be obtained, if necessary. For production and use within the home, most countries do not require a special licence.

Materials required

The basic requirements for small-scale processing are a large capacity bottle which can be tightly closed, a scale (more sensitive if working with smaller quantities) and a strainer (special filter paper, several layers of clean cotton cloth or cotton balls) - A refrigerator or freezer is useful, but not essential. A heat source is necessary to evaporate the solvent but it is better to use a distillation apparatus, vacuum drier or freeze drier (see also equipment for royal jelly).

Method 1: Ethanol Extracted Propolis (EEP) - the simplest method for extracting propolis

The exact concentration of the desired extract should first be decided. The initial concentration of propolis to be extracted should not exceed 30%, due to less efficient or less complete extraction at higher concentrations. The correct quantity of propolis is weighed and the right volume of alcohol measured. It would be easier to weigh the correct quantity of alcohol since alcohol is much lighter than water. The specific gravity of pure ethanol is 0.794 as compared to 1.00 for water. For reasons of simplicity one can assume that one litre of 100 % alcohol weighs 800 g, 11 of 70% alcohol approximately 860 g, 11 of 50% alcohol approximately 900 g, and so on. Other alcohols and solvents have different specific gravities and quantity measures will vary accordingly. Therefore, weighing both the propolis and the solvent is the preferred method.

Pour the alcohol and propolis into a container, seal the top and shake briefly. Repeat the shaking once or twice a day, but otherwise leave the mixture in a warm dark place for at least three days. To achieve the best results, the propolis should be extracted for one or two weeks. Soaking for more than one week, according to some authors and for two weeks according to others, provides no additional benefits.

Some producers boil the alcohol and propolis mixtures for eight hours in order to dissolve all the resins. If the propolis contains wax, most of this will be dissolved by heating or must be removed prior to extraction. For a high quality product, however, heating should be avoided.

After one or two weeks, the liquid is filtered through a clean and very fine cloth, paper filters or cotton ball. The cloth may be folded into several layers to increase its effectiveness. A second filtration may be advantageous and if the extract can be refrigerated to less than 4 ^{0}C but not freezing, for several hours or a day until filtration, better results are achieved. The filter should also be cooled prior to use. The remains of the first filtration can be washed or soaked in alcohol again.

The filtrate should be a clear liquid, free of particles and dark brown or slightly reddish in colour. It should be kept in CLEAN, dark, airtight bottles. If dark coloured bottles are not available, the bottles should be kept in a cool dark place or wrapped with a cloth, paper or straw, to keep out light.

Ingredients for a 10% extract:

Propolis	1 part	or	100 g	or	1 kg
Alcohol	9 parts		900 g		9 kg

or any multiple thereof.

Ingredients for a 5% extract:

Propolis	1 part	or	100 g	or	1 kg

Alcohol	19 parts	1900 g	19 kg

or any multiple thereof.

Since solvents are relatively expensive, consideration should be given to preparing a more concentrated first extract (< 30%) The final extract can be diluted or further concentrated depending on its intended use. Most extracts are used with reduced solvent content, i.e. very high propolis concentration. Starting with a concentrated solution will therefore require less evaporation, however, as also extracts all compounds less efficiently.

Higher concentration of the extracts can be achieved by simply leaving the extract in an open large mouth container, suitably protected against dirt, dust and insects for a while. Most of the alcohol will evaporate at room temperature in a few hours. For further drying and recuperation of the alcohol, see method 6 and 7.

Method 2: Quick extraction

For this extraction, finely broken pieces or powdered propolis are placed in a large filter or cloth bag and pure alcohol (over 95 % ethanol) is poured through the filter. This may be repeated several times. The resulting extract should be stored as described in method 1.

The extraction is much less effective with lower concentrations of alcohol. The extract, once finished, can later be diluted with water. However, concentration of active ingredients can hardly be compared to extracts achieved with method 1, because of the lesser degree of extraction.

No references could be found for a quantitative comparison of the effectiveness of this method with method 1. Since extraction efficiency increases with time in method 1, it may be assumed that for some applications method 2 is of limited use, particularly when the desired active ingredients are less soluble. Method 2 may be used with sediment from the filtration in method 1.

Method 3: Glycol extracted propolis (GEP)

This method is similar to method 1 and differs only in the solvent used. Instead of ethanol, glycol (propylene glycol) is used. However, the concentration of propolis should not exceed 10% and extraction is more efficient under partical vacuum (Sangalli, 1990) The disadvantage of glycol as compared to ethanol is the need for higher temperatures during evaporation of the solvent, which adversely affects many of the volatile compounds of the propolis extract.

Glycol is usually cheaper than drinking quality alcohol, because of lower taxes, but it may be more difficult to obtain in some countries. Some cosmetic producers prefer glycol extracts to ethanol extracts for certain preparations. Glycol extracts mix more easily with some lotions, particularly those with a large water phase. They are also easier to use with nasal or oral sprays, since the glycol evaporates slower and it is not toxic for external applications. However, it must always be taken into consideration that glycol is considered safe for human consumption, i.e. internal use only up to 1.5 g of glycol per day per adult (Sangalli, 1990).

Method 4: Aqueous (water) extracted propolis (AEP)

Aqueous extracts can be obtained by soaking propolis for several days or boiling it in water. The yield of active ingredients is lower than with alcohol, but aqueous extracts have been shown to exhibit bactericidal and fungicidal effects. All other processing, filtering etc., are the same as those in method 1.

Method 5: Oil extracted propolis (OEP)

Extracts prepared according to this method described by Marchenay (1977), and cited by Debuyser (1984) are less adaptable to commercialization, but present some simple ways of preparing inexpensively, small quantities of extract for internal as well as external application.

Mix 10 g of cleaned propolis with 200 ml (about 200 g) of olive or almond oil, or with 100 ml of quality linseed oil (refined food quality) or with 100 g of butter. Other edible oils can be substituted for the ones mentioned here.

Heat gently in a water bath for approximately 10 minutes to not more than 50 ^{0}C, stirring continuously. Filter and store the extract in well sealed containers in the dark. Refrigerated storage is recommended.

Method 6: Propolis paste

This method is the same as method 1 until the filtered liquid extract is obtained. The liquid is then partially evaporated to provide a product with paste-like consistency. The paste is well suited for mixing with various emulsifiers for applications in cosmetics.

Evaporation can be achieved by gently heating the extract in an open container over **low** heat. Alcohol is very flammable, so appropriate precautions should be adopted around open flames and abundant ventilation should always be provided.

A simple distillation apparatus, like the one used for preparing local distilled liquors, would allow the collection of most of the expensive alcohol for reuse. The most sophisticated and least damaging evaporation would, however, be accomplished with low pressure vacuum evaporators or freeze driers. If quality control is exercised, the propolis extracts in this paste form may become easier to market and should sell for a considerably higher price.

Method 7: Dry propolis extract

Dry extracts are those with a solvent content of less than 5 %. They are obtained from extracts according to methods 1, 2 or 3, followed by evaporation, freeze drying or spray drying (Sangalli, 1990). The last two drying methods require relatively expensive laboratory equipment (see Suppliers List in the Annex).

Drying does not result in powders is the propolis was extracted with highly concentrated alcohol. Instead, the residue is a sticky elastic paste. To achieve a dry powder which would be easier to use in most pharmaceutical or cosmetics applications, one of the following methods should be used. The problem is that the following methods may compromise the extraction process and have not been tested for their biological effectiveness, in contrast to extracts from Method 1.

Method 8: Water-soluble, dried powder ethanol extracts

Propolis is prepared and extracted as described in method 1 but using a 10-25 % ethanol solution, though many other solvents are mentioned in a patent application (Sosnowski, 1984). After 1 to 10 days at 0 to 37^{0}C (preferably towards the warmer temperature limit) with periodic agitation, the solution is filtered for the first time through Whatman No. 1 filter paper, or a double layer of very fine cotton cloth. The filtrate is cooled as much as possible (without freezing) for 24 hours and is then filtered again, cold, through a Whatman No.50 filter paper. A third and final filtration may be carried out cold or at room temperature with a 2 ~m filter. Finally, the solvent is removed by evaporation or freeze drying.

For extraction methods like this one and others, where the final product is a paste or powder, the initial proportions of propolis and solvent are not very important. Much larger quantities of propolis can be used for quicker extraction, e.g. 500 g propolis in 1000 ml solvent. However, sufficient active ingredients usually remain in the filter residues to justify another, longer extraction with clean alcohol.

A few recipes using the dried powder are mentioned at the end of this chapter. No scientific publications or studies were cited by Sosnowski (1984) concerning the efficacy or biological activity of this extract, though he claims that the antioxidant properties of the propolis extract from concentrated ethanol or diluted ethanol are the same.

Method 9: Free-flowing, non-hygroscopic propolis powder

For those who have access to the appropriate equipment and chemicals, propolis extracts can be made easier to handle and more heat stable by complexing with Bcyclodextrin. The result is a free-flowing, non-hygroscopic powder (Szente and Szejtli, 1987).

Method 10: Water soluble derivatives (WSD)

Water-soluble propolis extracts are important for some medicinal and cosmetic applications. Dimov et al., (1991) published a method patented by Nikolov et al., (1987) which produces a dry powder of lysine-complexed propolis extracts, known as the Water Soluble Derivatives (WSD). A translation of the Bulgarian Patent was provided by Dr.Ivanovska:

100 g of propolis are extracted three times with boiling methanol for one hour, using 800 ml of methanol each time. The extracts are filtered hot, stored overnight at 4 ^{0}C and filtered again. The precipitates, i.e. the filter residues of the cold filtration, are washed with cold (4 ^{0}C) ethanol and filtered. Both filtrates are combined and evaporated to dryness, giving 60 g of a resinous, brown product. 10 g of this dry product are gradually stirred into 150 ml of an 8% L-lysine solution at 50-60^{0}C. This solution is freeze-dried, resulting in 22 g of a dry, yellow-brown powder.

WSD 's are still being tested for their antibiotic characteristics. They were found to induce non-specific protection against gram-negative bacteria, i.e., Klebsiella i,neumoniae, Proteus vul~aris, Escherichia coli and Pseudomonas aeruginosa (Dimov et al., 1992).

Elaboration of any of the above-mentioned extracts often includes evaporation of part or all of the solvent. If concentrated extracts are required, it is better to use concentrated ethanol for extractions since it evaporates at a lower temperature than the other solvents mentioned. Thus, the risk of destroying some of the active ingredients through heat damage is reduced. This is important, even though some of the active compounds are thermostable (resistant to heat) since the synergistic forces of all the ingredients in propolis are not yet fully understood.

For large-scale operations, evaporation under low pressure (partial vacuum) or by freeze drying are preferred because any damage due to heating can then be avoided. However, a Hungarian study showed some antibacterial activity was still present in steam-distilled essential oils from propolis (Petri et al., 1988).

Other solvents can be used to extract propolis, for example many alcohols, ether, acetic acid, acetone, benzene, 2% sodium hydroxide and ammonia (common household cleaner) (Anon, 1982). These solvents should not however be used if the extract is intended for consumption by humans or animals.

5.8 Collection

The average production of propolis per colony per year has been described as 10 to 300g (Ochi, 1981 and Andrich et al., 1987) but the production depends on the bees, the climate, the forest resources and the trapping mechanism. According to personal observations, it may occasionally be considerably higher. If there is any selection by queen breeders and beekeepers, it has been against heavily propolizing bees, since they make work in the apiary more difficult. Bees which produce larger quantities of propolis could be selected if required.

Contamination of propolis with wax, pieces of wood, paint and other debris should be avoided. The cleanest

collection methods employ special traps placed on top of a hive, below the covers (see Fig. 5.2 to 5.5) or next to lateral walls inside the hives. Thus bees do not mix as much wax with the propolis and no contamination occurs during harvesting. Trap harvesting is also faster and may be more productive.

Traps are basically screens or special plates with small holes which simulate cracks in the hive walls (see Figure 5.2). Bees try to seal the holes and thus fill the trap with propolis. The most economic trap design is an inner cover with a large hole, covered with regular nylon fly screen, secured in place by the points of nails and a perforated frame (see Figure 5.5). However, to avoid contamination with wax, the screen should not touch the top of the frames. The total area exposed by a screen may have to be varied according to the bees and local conditions. Trap harvested propolis usually fetches a better price because of its cleaner and therefore of better quality.

Light, and in particular air circulation are important to stimulate propolis use. Accordingly, traps placed on top of hives should be covered but the hive cover needs to be propped opened slightly to increase air circulation and to allow in some light (see Fig. 5.4). In tropical regions it may be necessary to prevent the entry of too much rain. Also, when using a type of bee sensitive to disturbances or likely to abscond, the lid should not be opened too far otherwise bees might escape. Newly established colonies should be given some time to establish themselves before they are used for trapping.

Propolis is removed from traps by cooling the plastic sheets or fly-screens for a few hours in a refrigerator or freezer. Once cooled, the propolis becomes brittle and can be removed from the screens by simply flexing and brushing them, pulling over a table edge or by using a special high pressure air device designed by Pechhacker and Huettinger (1986). The trap is then ready for re-use.

Before the advent of recent trap designs, most propolis was collected by scraping the "bee glue" off walls, frames, entrances and covers. Marletto (1983) noted that the propolis collected from the cover or top frames was usually cleaner than that collected near the entrance. Even contaminated scraped material can be used and purified by repeated extraction and filtering.

In order to avoid contamination with too much wax, scrapings from frames or bottom boards and lids should be kept separate from each other and from propolis collected with traps. Chunks and pieces should never be combined into large balls. Enquiries should be made with potential buyers to see how they prefer propolis. Large pieces often have to be ground or broken into smaller chunks first.

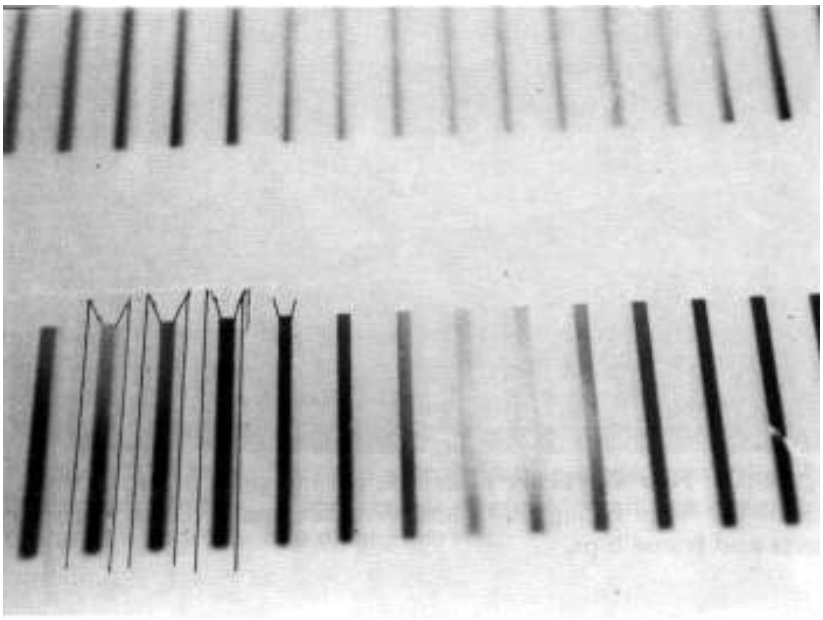


Figure 5.2*:* Flexible, 3 mm plastic sheets with rows of slots, 2 mm side on one side and 4 mm on the other

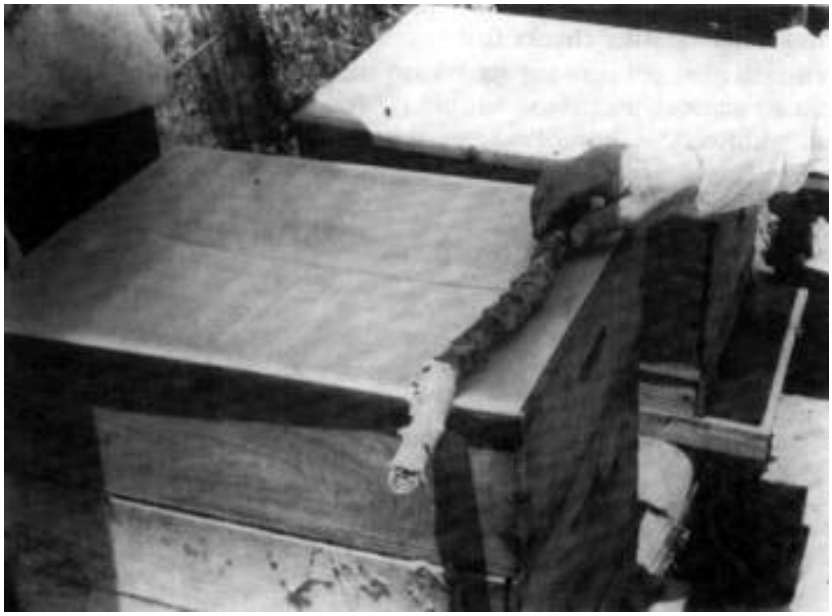


Figure 5.3: Four sheets are placed on the top super with the wider side of the holes facing down and with bee space (1 cm) between sheets and frame tops.

Figure 5.4: The cover is left open a little to increase ventilation and let light in. This stimulates the bees to seal the slots with propolis.

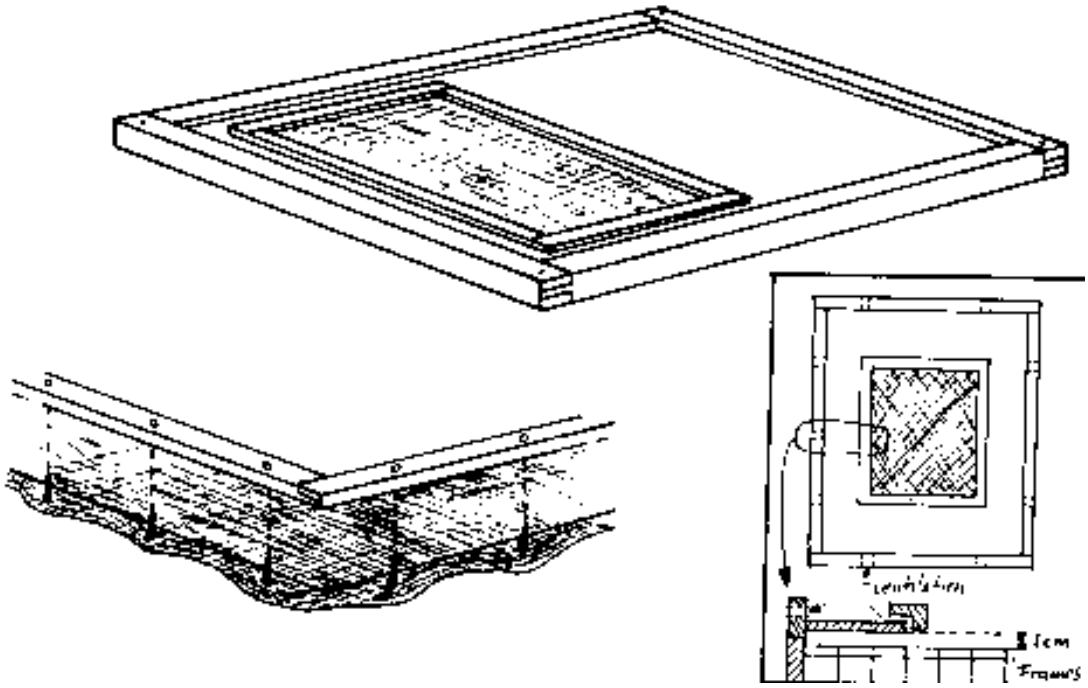


Figure 5.5: A simple design of a propolis trap made from nylon, fly or mosquito screen. The screen is removable and can be quickly replaced with a new one during harvest.

For better quality propolis, some authors recommend collection after the major nectar flow (Donadieu, 1979. This may be true in temperate climates where bees are preparing for over-wintering and therefore collecting more propolis. In tropical climates, no studies are available which demonstrate seasonal variation, or its absence. It is possible that at the beginning of the rainy season, propolizing will be more active. Internal traps may be more advantageous, but some experimentation is required. Tropical races of A. mellifera have also been reported as producing very little propolis.

5.9 Buying

Unprocessed propolis should always be acquired in the form of chunks or small pieces and never lumped into larger pieces or balls. Some buyers prefer large chunks and others like smaller pieces, but preference for the latter is usually related to trap collected propolis, since small scrapings often have a high level of contamination. Quality criteria are described in section 5.11.

Buying quality propolis extracts is difficult, because the brownish colour of alcohol extracts does not reveal the quantity and quality of the propolis nor the care taken in extracting it. Even chemical analyses can only provide a quantitative judgement with regard to the major compounds (for a simple antioxidant activity test see 5.16.13) and biological activity tests are slow and expensive. Extracts should therefore be bought only from producers whose methods and commitment are well known. For evaluating products derived from propolis, (5.16.13) tests and analyses become inevitable as well as a reliable and responsible manufacturer.

5.10 Storage

In general, propolis is fairly stable, but proper storage is important. Propolis and its extracts should be stored in airtight containers in the dark, preferably at less than 10^0C-12^0C and away from excessive and direct heat. For similar reasons, very old propolis from the hive should not be mixed with fresher propolis. Over 12 months of proper storage, propolis will lose very little or none of its antibacterial activities. Alcohol extracts may be stored even longer.

Lyophilization (freeze drying) of extracts has been described as a method which preserves the antibacterial characteristics, but nothing has been written about effects of long-term storage of such materials. This method may gain importance for larger scale use and certain formulations, but it is possible that some of the synergistic characteristics of propolis may be lost during lyophilisation.

The shelf-life of propolis containing products depends very much on their composition and has to be determined for each case. The more the other components of a product are susceptible to decomposition, the shorter will be the shelf-life of that product. This is the reason for compromises that are necessary in the selection of artificial and/or natural and traditional ingredients, preservatives and larger production for extended markets. However, propolis and its extracts function as a mild preservative due to their antioxidant and antimicrobial activities and thus may actually prolong the shelf live of some products.

5.11 Quality control

Since propolis comes in many colours, odours and composition, it is very difficult to give precise guidelines. Most fresh propolis has a pleasant resinous odour. Wax content and visual contamination should obviously be as low as possible. Old propolis becomes very hard and brittle and may also be very dark. However, frozen or recently frozen propolis is also very brittle.

Official quality standards exist for propolis in various East European countries, but most standards refer to the cleanliness or adulteration of the raw product and sometimes, its extracts. Maximum and minimum limits for certain chemical groups are set, but few standardised tests are available to determine the biological activities of various components. Tikhonov et al., (1978) describe the average contents of the principal ingredients as possible standards for raw propolis (Table 5.4). Official quality standards exist in Romania and the former USSR (Crane, 1990).

Franco and Kurebayashi (1986) suggested methods for quality control and Hollands et al., (1988) for testing coccidiostatic effects. Vakikonina et al., (1975), Petri et al., (1984) and Bianchi (1991), describe the discoloration of a 0. iN potassium permanganate solution as a reliable test for the antioxidant effect of propolis and its extracts, and the detection of some adulterants (see 5.16.13). Bacteriological tests can be carried out and the results compared with those from samples of known purity and origin, but these tests apply to only a small proportion of all the various beneficial activities of propolis. None of these tests have yet been widely accepted as providing a reliable evaluation of the overall quality of propolis or its extracts. Most likely, only a range of tests will ever give a reliable evaluation of the numerous diverse characteristics of propolis.

Because of its recent manipulation and harvesting by bees, fresh trap-collected propolis is of the highest quality and the least contaminated, if collected on a regular basis. Plant origin however, may be important for certain applications and therefore propolis collected in a certain region or during a certain season may be preferred.

Table 5.4:

Quality standards for propolis as suggested by Tikhonov et al (1978) and upper and lower limits as established by Russian Regional Standards (RSFSR, 1977).

	Tikhonov et al,	RSFSR
Extractable substances	21.93 +/- 2.22%	
Oxidizability value	17.08 +/- 5.52%	< 22.0%
Resinous-balsam substances	46.18 +/- 1.15%	

Waxes	27.11 +/- 7.68%	< 30.0%
Polyphenols	14.66 +/- 2.34%	> 20.0%
Plysaccharides	2.26 +/- 0.32%	
Mechanical impurities	9.76 +/- 1.81%	< 20.0%
Iodine number		> 35.0

After incorporation into other products, testing for propolis becomes even more complicated and overall product quality becomes important. Since there is a wide variety of products in which propolis can be included, the standards for each type of product need to be considered. In section 5.16.13 a method is given to evaluate propolis antioxidant quality in other products.

One easy way to determin a different kind of quality, particularly poor qualaity as a defect, is the homogeneity of products containing propolis extracts (see Figure 9.9). Without good equipment, a good and stable emulsion is difficult to obtain. Hand-mixed emulsions tend to be stable for shorter periods of time only. Separation after brief or inappropriate storage is unacceptable to consumers and also affect performance of the product. Thus special care needs to be taken to ensure the compatibility of the extraction method and ~e ingredients of the end product. Suitable emulsifiers and better mixing techniques, i.e higher speed, longer time, warmer temperatures and different mixing sequences would have to be determined by testing (see Chapter 9).

Contents - **Previous** - **Next**

5.12 Market outlook

It should be noted that the opinions expressed here are not based on extensive market surveys, but enquiries among a relatively few buyers and producers.

The market for raw material and secondary products containing propolis will probably continue to grow as they find more acceptance in medicinal uses and as more cosmetic manufacturers realize their benefits and marketing value. Improvements in the productionof water-soluble formulations of the active ingredients should further facilitate their wider use. Presently,, the demand is higher than supply in most countries. Unstructured and unorganized marketing, however, does not create much of a price advantage for the producer.

The difficulty of establishing uniform rules and quality control standards is probably a further impediment to market development. Concerns of importers or buyers about product effectiveness may be avoided by early collaboration with well established and reliable laboratories or researchers. Many of them will probably be glad to analyze and perhaps even test good samples of well documented origin.

International prices for raw propolis are going down. Having reached levels as high as US$160/kg or even US$300/kg, less than 20 years ago (Crane, 1990) prices of some buyers in 1992 are as low as US$4-12/kg. In several countries prices of US$30 could still be obtained in 1991. Some producers say there is a market for already fractionated extracts, i.e. extracts which are separated into various groups of components. These fractions are purchased by pharmaceutical companies and their market is most likely to increase. Though these special extracts bring a much higher price, producing them requires a well equipped chemical laboratory and trained staff for processing.

There is an opportunity produce for and develop local markets. The kind of products made and the extent of a local market will depend partly on the base ingredients available and the ability of entrepreneurs to adapt their products for local acceptance and use. Once quality standards of the large consumer nations are reached, exports may become feasible. Gaining market experience now, while competition is still relatively low will provide an advantage in the future when competition and quality control become more stringent. This should be true for raw materials as well as for manufactured products.

5.13 Caution

Hausen et al., (1987) cited almost 200 cases in which people have shown allergic reactions to propolis. In some cases of direct contact with propolis, this may have also been a result of contamination by other bee products such as pollen or bee hairs. However, extracts and products containing propolis extracts have been shown to cause allergic reactions as well (Hausen, et al., 1987, Hausen and Wollenweber, 1987 and Ko~nlg, 1988) mostly in the form of contact dermatitis. Hashimoto et al., (1988) identified caffeic acid and its derivatives as the major allergenic agents.

Therefore, with all preparations intended for human or animal luse, small quantities should be tried during the first days, slowly increasing to the full dosage (half for children) in order to test for the compatibility of the preparatino or allergic reactions. Equally, termination of medical treatments prescribed by a physician should be gradual, slowly reducing the daily dosage.

Prolonged chewing of large amounts of raw propolis may lead to nausea and stomach upsets. Donadieu (1979) recommended chewing one gram at a time, three times a day.

5.14 Patents including propolis

Since many of the formulations prepared with propolis are made by or for the pharmaceutical and cosmetic industries, they and their production processes are often protected by patent rights.

The following are a few patents which include propolis as an ingredient. Copies of patents can usually be obtained through the patent office of the country in which the patent has been registered. The addresses of the USA, European and World patent offices are listed in Annex 2. Those of other national offices can be obtained from the country's consulate or embassy.

Pharmaceutics

Anti-inflammatory (topical)	Busciglio, 1988
Antibiotic ointment (dermatitis)	Iwasaki, 1990
Anti-inflammatory and cell growth inhibitor	Nakanishi et al., 1989
Tissue regeneration agent (veterinary)	Dubaj et al., 1988
Propolis-stabilized vitamin C (Tablets of 91.5% glucose, 5% vitamin C and 3.5% ethanol exract of propolis)	Dubovsky et al., 1988
Drug for muscle hypoplasia in piglets	Musci et al., 1989

Cosmetics

Deodorant	Vol'Fenzon et al., 1989
Deodorant mouthwash	Cho et al., 1988

Other

Germicide, insecticide for food packaging	Mizuno, 1989a, b

Extraction methods

WSD - Water Soluble Derivatives	Nikolov et al., 1987

5.15 Information sources

Pharmaceutical, cosmetic, dermatological, medical and most beekeeping journals in different countries occasionally publish articles on propolis composition, uses and recipes for products. As a single source of information the IBRA has compiled a bibliography of all propolis-related articles which have appeared until recently in the Apicultural Abstracts. The American Apitherapy Society is collecting case histories of medical uses and continuously updates its database on research and other related publications.

Figure 5.6: Various products containing propolis (from left to right): extracts of various concentrations, revitalizing cream, extracts with dropper, caramels, soap, shampoo and night cream.

5.16 Recipes

As with all other recipes in this book, no guarantee is given that they will work under all conditions or that they will be effective for what their authors have claimed. They are meant as a basis for experimentation and adaptation to local conditions. When preparing a new formulation, notes of all environmental conditions, exact ingredient mixes and a precise description of every step in the process should be kept. These notes will allow the repetition of a successful trial and help avoid repeating those which have failed.

Propolis extracts or their dried residues (pastes or powders) are said to be beneficial if included in normal formulations of all kinds of creams, ointments, lotions, shampoos, lipsticks, anti-cellulite and anti-wrinkle preparations, mouth and nasal sprays etc. As a general guideline, propolis can be added to a product at 1 to 3 % by weight in the form of a 50% propolis-ethanol solution, i.e. 0.5 to 1.5% of extracted propolis. Up to

10% of less concentrated solutions are recommended by some authors which represents essentially similar amounts of extracted propolis dry weight. Only a few applications will benefit from much higher concentrations.

If the final product is an oil or fat-based product, a propolis solution prepared with highly concentrated ethanol will blend well with the final product. Glycol or less concentrated ethanol may be used for extracts that will be added to products which contain some water. For additional cosmetic recipes see Chapter 9.

5.16.1 Ointments

1) Simple Vaseline-based ointment

Ingredients (in parts by weight) after D. and G. Barral (1992):

1	*Propolis extract*
9	*Vaseline or other petrolatum*

Prepare a propolis extract in 96% ethanol to a concentration of 10% propolis (method]) then reduce the solvent to obtain 30% propolis content by weight. Mix the extract with a small quantity of the Vaseline. Once the mix is homogeneous or well emulsified the rest of the Vaseline can be added slowly. If not mixed well the propolis extract will separate and leave dirty looking droplets in the cream (see also Fig. 9.9). Slight warming in a water bath will improve mixing. Using an emulsifier or electric mixer makes mixing easier.

The propolis extract may make up to 10% (by weight) of the final ointment. 10% of lanoline can also be melted with the Vaseline (using a water bath) following the same procedures as for the propolis.

2) Simple ointment based on vaseline or animal fat

Propolish cream (in parts by weight) after Savina and Romanov (1956):

This cream can be used for application on cuts, abscesses and festering wounds in animals and external ulcers and burns in humans.

10	*Vaseline or animal fat*
1	*Propolis*

Bring the vaseline or fat to boiling point, cool to 50-60 ^{0}C, add propolis, heat to 70-80^{0}C, stir for 10 minutes and cover for 10 minutes. Filter through one layer of thin cloth into clean container and seal. ft is ready as soon as it has cooled, but will not stsore for very long, particularly if animal fats are used.

3) Simple oil-based ointment

Ingredients (in parts by weight) after Proserpio and Martelli (1986):

2	*Propolis ethanol extract, 20% (EEP, method 1)*
1	*Beeswax*
7	*Lanolin*
10	*Butter of palm, cacao, keraté or similar*

Melt the beeswax in a water bath, slowly stir in the melted lanolin and mix well. while the mixture is cooling mix in the butter. The propolis extract is best mixed with a small amount of butter and added to the rest of the mixture once the latter has cooled to less than 40°C.

5.16.2 Oral and nasal spravs

D. and G. Barral (1992) recommend preparing a 2 to 10% propolis solution in propylene glycol (Method 3). For flavour, an extract of some herbs in glycol or ethanol canbe prepared and filtered. Regalis, anis, eucalyptus and mint are among the many suitable herbs that can be used.

The two alcohol extracts are mixed using only a small quantity of the plant extract, according to taste. The alcohol solution can be further diluted before bottling in small mechanical sprays (vaporizers). Glycol is preferred over ethanol in this recipe because of its slower evaporation after application. A caution about excessive use of the glycol based spray should be included on the label (see Method 3 for reasons).

5.16.3 Suntan lotions

Select a suntan lotion and add sufficient propolis-glycol extract to make up 2-5% in propolis dry weight.

For basic suntan lotion formulations see the recipes in Chapter 9.

5.16.4 Propolis syrups or honeys

For syrups to be taken orally use the propolis in ethanol extract and mix it with a glucose/fructose syrup (e.g. honey or inverted sugar syrup). A sugar mixture is reported to work better than a syrup made from a single sugar. The alcohol acts as a preservative.

Mixing propolis extract with a slightly diluted honey should work even better, since they complement each other's function. To find a water-soluble extract with all the curative values of raw propolis would be best. One of the previous methods (7-10) could be tried.

The propolis extract, however, can also be mixed with undiluted honey. To make the mixing or emulsification easier, only a small quantity of honey should be taken and mixed with the extract. Once this mixture is homogeneous, it is easily mixed with the rest of the honey. Store this product in dark or opaque containers.

5.16.5 Propolis tablets

This basic formula can also be used to incorporate pollen, where most of the sugar can be replaced with it; but a 10 to 20% sugar (honey) content should be maintained. Unless the tablets can be coated with wax or a similar barrier, the use of honey ~hould be limited because of its hygroscopic nature. Thikonov, et al., (1991) describes another recipe for a sublingual tablet with propolis.

Ingredients (in parts by weight) after Bianchi (1990):

1	*Gum arabic*
1	*Water*
1	*Propoli paste (from an aqueous EEP)*
10	*Powdered sugar*
q.s.	*Flavouring (not essential)*

In a small container, mix the water with the gum arabic until a homogeneous mass is obtained. while stirring, slowly add the propolis extract and mix well. Then slowly add the powdered sugar and mix continuously. Add the flavouring if required.

Prepare a suiface for rolling out the dough, thinly cover it with powdered sugar and roll out the dough to a unijorm thickness. when the thickness is that of the desired tablets cut the dough with metal, glass or plastic rings of the desired diameter or shape. Unite the leftover dough, roll it out again and continue cutting pills until the dough is finished.

Dry the pills, suitably protected from dust, in the open air or in an oven or solar drier. The temperature should never exceed 40^0C. Store the product in clean, dark containers.

To protect against various infections and inflammations of the mouth and throat, particularly after tooth extraction, one pill may be slowly dissolved in the mouth 3 or 4 times a day. The exact size of the pill is not that important, since no precise dosage of the propolis is necessary. This medication should not be taken without consulting a doctor.

5.16.6 Propolis shampoo

Propolis shampoo has been described as having anti-dandruff properties. Formulations for other shampoos can be found in Chapter 9. Propolis extract prepared from diluted alcohol (less than 25 %) or glycol, can be mixed with many readily available shampoos. When mixed with alcohol, depending on the gel agent, some shampoos may loose viscosity.

Figure 5.7: Anti-dandruff shampoo with propolis.

Ingredients (in parts by weight) after Lejeune et al., (1984):

1	*Propolis extract*
20	*Texapon N40 (alkyl sulphate by Henkel, see Annex 2)*
3	*Comperlan KD (copper diethanolamide by Henkel)*
2.5	*Sodium chloride*
0.1	*Lactic Acid*
3	*Vegetable oil, preferably ricinus (castor) oil*

Add demineralized water or boiled rain water to make up 100 parts.

A 1 % propolis extract in 96% ethanol was found most cost-effective and compatible with other ingredients. The Henkel products are added to obtain a pleasant viscosity which might also be obtained using other emulsifiers and natural gels if the alcohol is eliminated from the propolis extract. The oil is needed for

protection of the scalp and hair.

Dissolve the sodium chloride in 20 parts of water, filter the solution and add the lactic acid. The oil phase is mixed after heating the Comperlan in a water bath to 40 ^{0}C. First add the Texapon and then the oil to the Comperlan. Mix careflilly and slowly to avoid the formation of too much foam. After, also the propolis extract is added the two liquids (oil and water phases) can be united and the volume is made up to 100 parts with water. The resulting shampoo is a clear brown colour with a pleasant aroma and it can be stored in dark bottles for at least 12 months.

5.16.7 Anti-dandruff lotion

This simple lotion is easy to prepare and, if stored in dark bottles away from heat, can be used for at least 12 months.

Ingredients (in parts by weight) after Lejeune et al., (1984):

1	*Propolis (50% EEP)*
5	*Sodium laurylsulphate*
37	*Ethanol (96 to 100%)*
57	*Rain water, boiled*

A 10% propolis extract is prepared according to method 1 and solvent reduced the to provide a 50% extract of propolis by dry weight.

Mix the propolis extract with 37 parts ethanol and the laurylsulphate with 57 parts of boiled rain water. Then mix the two solutions together.

If the propolis extract contains less than 50% dry weight, appropriate calculations can avoid solvent reduction and later addition of the same solvent, i.e. add Sparts of 10% EEP and only 32 parts of ethanol. On the other hand the exact concentration of propolis is not very important as long as the lotion contains at least 0.5% of propolis by weight. The alcohol content of the lotion should be about 45% by volume.

5.16.8 Propolis toothpaste

The antibacterial, wound healing and circulation improving characteristics of propolis can be used for daily tooth and gum care. Rather than making your own toothpaste, it is easier to add propolis to an existing formulation. For home use simply take a tube of toothpaste, open it at the folded end and spoon out the contents. Mix the contents well with 3 to 10% of propolis paste (method 6) refill the tube and close up the end again.

For small-scale commercial production find a supplier of the base formulation and add your own propolis extract, or ask a larger manufacturer to formulate and pack the paste for you with your own label.

Proserpio and Martelli (1982b) recommended the following base formulation for a toothpaste. Other toothpaste formulations can be found in Chapter 9.

Ingredients (in parts by weight):

2.5	*Propolis extract (10% EEP, method 1)*
25.0	*Boiled and cooled water*
1.0	*Carboxymethylcellulose (emulsifier)*
25.0	*Glycerol*
1.5	*Flavours and sweeteners*
40.0	*Calcium phosphate*
2.0	*Silica powder*
2.0	*Sodium laurylsulphate*
1.0	*Clear mineral oil*

The propolis can be extracted with ethanol or, alternatively, glycol. Borax can be used as the emulsifier, but it is harmffil to consume borax in appreciable quantities and its inclusion in products that might be consumed is illegal in the USA and some other countries.

Once the components are well mixed they should be packed as soon as possible. Tubes are the preferred containers for toothpaste, but (if consumers will accept them) alternative packaging could be soft squeeze bottles with a spout that can be closed.

5.16.9 Anaesthetic propolis paste

The major application for the paste is in dentistry. Propolis is supposed to give this paste anaesthetic and regenerative effects. It also contributes to antimicrobial and analgesic properties. Alternatively, the propolis extract can be mixed with ready-made benzocaine creams at a rate of 30% of a 50% propolis-ethanol solution. These pastes generally contain no water, so the propolis should be added in the form of a high-percentage alcohol extract.

The propolis solution should be prepared in advance to the right concentration. For this purpose the original extract prepared at a 10 to 30% propolis concentration should be evaporated until a 50% concentration is reached.

Ingredients (in parts by weight) after Sosnowski (1984):

10	*Lanolin*

10	*Unbleached beeswax*
10	*Petrolatum (or Vaseline, the trade name for a petrolatum)*
2	*Ethyl aminobenzoate*
3	*Clove oil*
15	*Propolis (50% EEP)*

Melt the beeswax and mix it with the petrolatum in a water bath, continue stirring during cooling and slowly mix in the lanolin. when the mixture has cooled to about 40 ^{0}C, start stirring rapidly while mixing in the propolis extract, followed by the other ingredients.

5.16.10 Creams

Propolis extract can be mixed with most creams. Moisturizing, rejuvenating or curative creams can be improved by adding 1 to 5 % (dry weight) propolis extract; many commercial preparations contain much less than this. Some extracts require ernulsifiers and others can be mixed directly depending also on the basic formulation of the cream. The antibacterial, antifungal, stimulating and rejuvenating effects of propolis are particularly welcome in certain skin and hair-care preparations. Pharmaceutical creams with propolis extract can be used by humans and for animals.

For basic cream recipes see Chapter 9.

5.16.11 Facial masks

1) Facial masks are intended either to moisturize or to cleanse and tighten ghe skin. The following recipe is for a cleansing mask and the propolis is said to help rejuvenate the skin.

Ingredients (in parts by weight) after Sosnowski (1984):

50	*Filler (this may be Fuller's earth, china clay, kaolin, bentonite or a mixture of any of them)*
44.0	*50% glycerol solution*
5.7	*50% propolis solution*
q.s.	*Perfume or essential oils*

Mix the glycerol and the propolis extract (made with high percent alcohol) well, heating slightly if necessary. Mix with the filler and the petyume. Other beneficial plant extracts in alcohol may also be added in small quantities.

2) A simpler cleansing mask for oily skin (modified from Krochmal)

The ingredients (in parts by volume) for this mask should not be mixed until immediately prior to use, since they do not contain preservatives and will spoil rapidly.

4	*Fuller's earth (or substitute)*
1	*Rose water*
1	*Lemon juice*
2	*Honey*
1	*5 to 10% propolis extract*

The propolis extract here should have been prepared with diluted ethanol (less than 25%) or glycol, so that it is more water-soluble, or one of the powdered formulations should be used. The rose water can be prepared by dispersing a few drops of rose oil in water or by preparing a cold infusion tea) from a few rose petals in clean water. Other water or alcohol based petyumes or aromatic extracts can be used.

5.16.12 Micro-encapsulation

Several authors have described the encapsulation of propolis extracts as a mechanism for prolonged, slow release. Micro-encapsulated propolis could also be used in food as a preservative against bacterial decay.

Pepeljnjak et al., (1981) has shown the prolonged antibacterial effect of propolis enclosed in soft gelatine capsules. Encapsulation techniques in general are highly advanced, but simple methods requiring less expensive technology are possible. Further details can be found in Kondo (1979)

5.16.13 Ouality tests for antioxidant activity

A very simple home test has been suggested in a Canadian bee newsletter (CHRA, 1988): "To know whether your propolis is still active, put half a tea spoon of ground propolis into a small cup of fresh milk and let the milk sit at room temperature for four days. If the milk is still fresh after that time, your propolis is O.K."

A more accurate, but still simplified method for testing containing propolis is described below (after Bianchi, 1990):

Ingredients required:

200 mg	*Propolis*
5 ml	*Ethanol*
100 ml	*distilled water (boiled and cooled)*
1 ml	*20 % sulphuric acid*

1 drop	*0.1N potassium permanganate solution*

Apparatus required:

1	*Scale, precise to at least +/- 10 mg*
2	*250 ml Erlenmeyer flasks or other clean glass containers*
1	*Filter paper, cotton balls, cotton cloth or coffee filter*
1	*2 ml pipette and syringe or medicine stopper for drop application*
1	*50 ml beaker or other clear, clean glass container of small diameter*
2	*Medicine stoppers*
1	*Stopwatch or watch which indicates seconds*

For raw propolis:

1) Place 200 mg of finely broken propolis into the Erlenmeyer flask and add 5 ml of ethanol.

2) Leave for one hour then add 100 ml of boiled and cooled distilled water, mixing all well.

3) Filter everything

4) From the filtrate (the clear liquid) take 2 ml with the pipette orthe syringe, transfer it into the 50 ml beaker and add 1 ml of the 20% sulphuric acid. Mix for one minute, then add one drop of the permanganate solution.

5) Watch the colour of the liquid closely; the liquid should turn colourless, i.e. no longer pink, within 11 seconds. If discolouration takes longer, the propolis is of lower quality, i.e. has less antioxidant activity.

For propolis extracts:

The reaction time for discolouration depends on the quantity of dissolved propolis in the reagent (test liquid). Therefore, for different concentrations of extracts the times will be different. The initial quantity mixed with the distilled water can (accordingly) be adjusted to a standard dry weight of propolis extract which then can be compared with a similar solution or raw propolis of known origin.

Mix 2 ml of a 10% ethanol extracted propolis solution (method 1) with 100 ml of boiled and cooled distilled water and follow the above test from step 3. Discolouration should occur within 20 seconds.

For propolis paste:

To 100 mg of paste add 5 ml of ethanol and then 100 ml of distilled water (boiled and cooled). Follow the

above test from step 3. Discolouration should occur in less than 20 seconds.

For other propolis containing preparations:

For preparations with approximately 3 to 10% of propolis dry weight per weight of the preparation the following test should work. Always try a standard product first for comparison, i.e. the same product containing a known quantity of guaranteed fresh propolis.

To 2 g of a product containing 3 to 10% of propolis on a dry weight basis, add 10 ml of ethanol and mix well until it is dissolved. Add 100 ml of boiled and cooled distilled water. Mix and if necessary filter and then proceed with step 4. Discolouration should not take longer than 50 seconds.

Contents - **Previous** - **Next**

CHAPTER 6
ROYAL JELLY

6.1 Introduction

Royal jelly is secreted by the hypopharyngeal gland (sometimes called the brood food gland) of young worker (nurse) bees, to feed young larvae and the adult queen bee. Royal jelly is always fed directly to the queen or the larvae as it is secreted; it is not stored. This is why it has not been a traditional beekeeping product. The only situation in which harvesting becomes feasible is during queen rearing, when the larvae destined to become queen bees are supplied with an over-abundance of royal jelly. The queen larvae cannot consume the food as fast as it is provided and royal jelly accumulates in the queen cells (see Figure 6.1). The exact definition of commercially available royal jelly is therefore related to the method of production: it is the food intended for queen bee larvae that are four to five days old.

The differentiation between queen and worker bees is related to feeding during the larval stages. Indeed, all female eggs can produce a queen bee, but this occurs only when, during the whole development of the larvae and particularly the first four days, they are cared for and fed "like a queen". Queen rearing, regulated by complex mechanisms within the hive, induces in a young larva a series of hormonal and biochemical actions and reactions that make it develop into a queen bee. A queen bee differs from a worker bee in various ways:

in its morphology: the queen develops reproductive organs while the worker bee develops organs related to its work such as pollen baskets, stronger mandibles, brood food glands and wax glands.

in its development period: on average the queen develops in *15.5* days while worker bees require 21 days.

in its life span: the queen lives for several years as compared to a few months for the worker bee,

and its behaviour: the queen lays up to several thousand eggs a day while workers lay eggs only occasionally. Unlike workers, the queen never participates in any common hive activities.

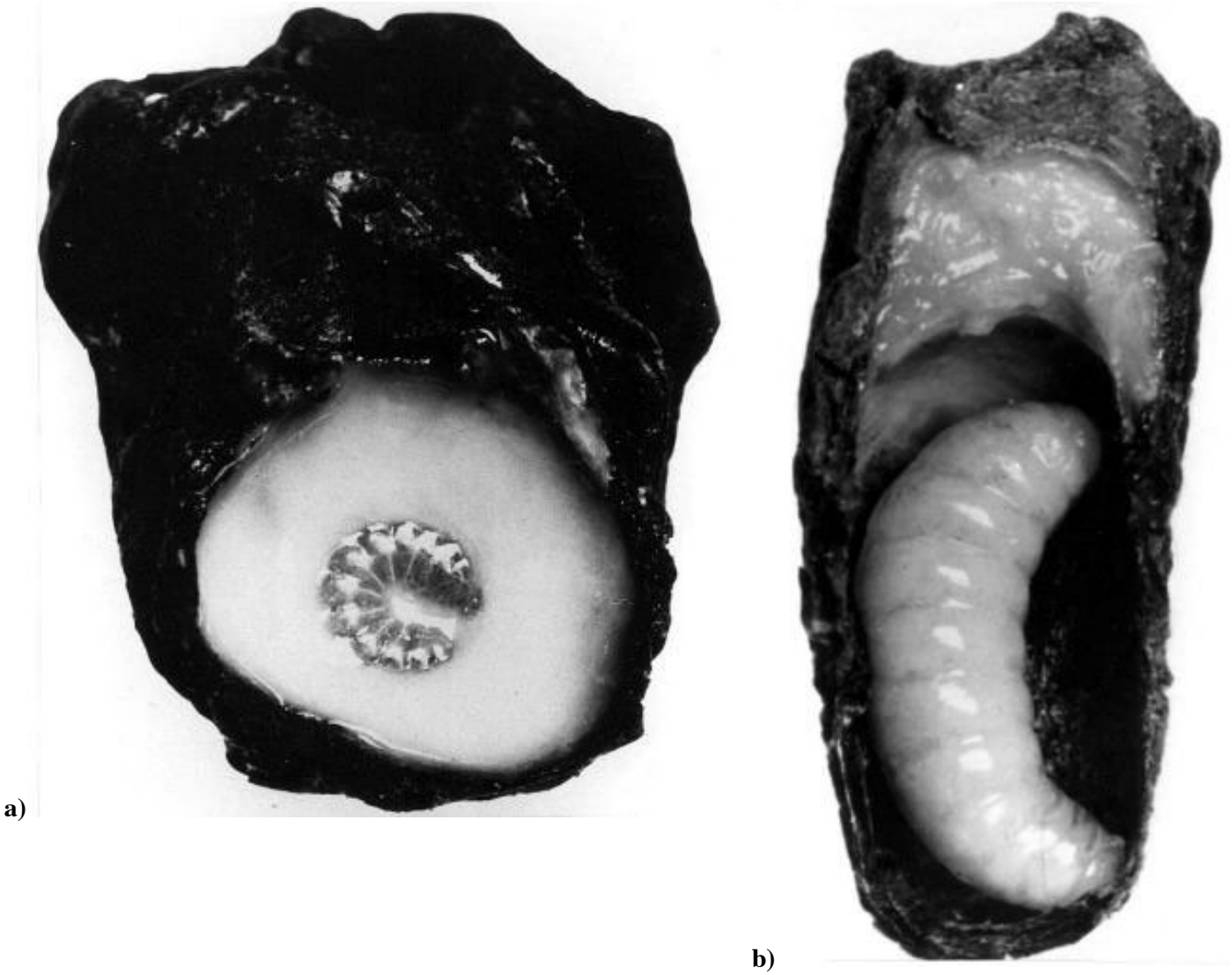


Figure 6.1: a) A 3-day old queen larva floating in royal jelly. The cell is almost ready for harvesting. b) A 5-day old queen larva in a newly sealed cell just before pupation. Not much royal jelly is left.

It is mainly the spectacular fertility and long life-span of the queen, exclusively fed on royal jelly, which have suggestively led people to believe that royal jelly produces similar effects in humans. In the early *1950's,* articles began to appear, particularly in the French beekeeping press, in praise of the virtues of royal jelly, referring to research conducted in several hospitals. Chauvin (1968) however, was unable to find the source of such information and therefore considered it unfounded.

The myth of royal jelly started with an amazing biological phenomenon on the one hand and commercial speculation on the other, which, on the basis of initial results obtained by entomologists and physiologists, exploited the suggestibility and imagination of consumers willing to be seduced by the fascination of this rare and unknown product was exploited. In fact, royal jelly was so rare and so little known that it was impossible to verify its actual presence in many products claiming its content.

In the years immediately following its first marketing, royal jelly quickly became widely known and consumed and the increasing demand motivated experts to refine production techniques and led more and more beekeepers to specialize in this activity. At the same time, research on quality control of the commercial product and identification of its biological and clinical properties found growing support.

Consumption of royal jelly has been growing ever since, even without its benefit to human health having ever been scientifically confirmed. The Western medical establishment has always been wary of the effects claimed for this product and in most cases refuses to consider it, largely because of the way royal jelly was initially promoted. In spite of a vast number of publications praising its virtues and the apparently abundant bibliography, there is still a serious lack of scientific data on the

clinical effects of royal jelly.

6.2 Physical characteristics of royal jelly

Royal jelly is a homogeneous substance with the consistency of a fairly fluid paste. It is whitish in colour with yellow or beige tinges, has a pungent phenolic odour and a characteristic sour flavour. It has a density of approximately 1.1 g/cm^3 (Lercker et al., 1992) and is partially soluble in water. Aqueous solutions clarify during basification with soda.

Viscosity varies according to water content and age - it slowly becomes more viscous when stored at room temperature or in a refrigerator at 5^0C. The increased viscosity appears to be related to an increase in water insoluble nitrogenous compounds, together with a reduction in soluble nitrogen and free amino acids (Takenaka et al., 1986). These changes are apparently due to continued enzymatic activities and interaction between the lipid and protein fractions. If sucrose is added, royal jelly becomes more fluid (Sasaki et al., 1987). Such changes in viscosity have also been related to the phenomena which regulate caste differentiation in a bee colony (see also 6.4.1).

Certain debris in royal jelly, is a sign of purity as, for example, the ever present fragments of laarval skin (see also 6.8). Wax fragments too, are encountered more or less regularly, but their presence is largely dependent on the collection method. Stored royal jelly often develops small granules due to precipitation of components.

6.3 The composition of royal jelly

Numerous chemical analyses of royal jelly have been published over the years. Only recently though, have highly refined technologies given detailed analyses of the unusual composition and complexity of this somewhat acidic substance (pH 3.6 to 4.2).

The principal constituents of royal jelly are water, protein, sugars, lipids and mineral salts. Although they occur with notable variations (Table 6.1) the composition of royal jelly remains relatively constant when comparing different colonies, bee races and time.

Water makes up about two thirds of fresh royal jelly, but by dry weight, proteins and sugars are by far the largest fractions. Of the nitrogenous substances, proteins average 73.9% and of the six major proteins (Otani et al., 1985) four are glycoproteins (Takenaka, 1987). Free amino acids average 2.3% and peptides 0.16% (Takenaka, 1984) of the nitrogenous substances. All amino acids essential for humans are present and a total of 29 amino acids and derivatives have been identified, the most important being aspartic acid and glutamic acid (Howe et al., *1985)*. The free amino acids are proline and lysine (Takenaka, 1984 and 1987). A number of enzymes are also present including glucose oxidase (Nye et al., 1973) phosphatase and cholinesterase (Ammon and Zoch, 1957). An insulin-like substance has been identified by Kramer et al. (1977 and 1982).

Table 6.1:

Composition of royal jelly (form Lercker et al., 1984 and 1992)

	Minimum	**Maximum**
Water	57%	70%
Proteins (N x 6.25)	17% of dry weight	45% of dry weight
Sugars	18% of dry weight	52% of dry weight
Lipids	3.5% of dry weight	19% of dry weight
Minerals	2% of dry weight	3% of dry weight

The sugars consist mostly of fructose and glucose in relatively constant proportions similar to those in honey. Fructose is

prevalent. In many cases fructose and glucose together account for 90% of the total sugars. The sucrose content varies considerably from one sample to another. Other sugars present in much lower quantities are maltose, trehalose, melibiose, ribose and erlose (Lercker et al., 1984, 1986 and 1992).

The lipid content is a unique and from many points of view, a very interesting feature of royal jelly. The lipid fraction consists to 80-90% (by dry weight) of free fatty acids with unusual and uncommon structures. They are mostly short chain (8 to 10 carbon atoms) hydroxy fatty acids or dicarboxylic acids, in contrast to the fatty acids with 14 to 20 carbon atoms which are commonly found in animal and plant material. These fatty acids are responsible for most of the recorded biological properties of royal jelly (Schmidt and Buchmann, 1992). The principal acid is 10-hydroxy-2-decanoic acid, followed by its saturated equivalent, lO-hydroxydecanoic acid. In addition to the free fatty acids, the lipid fraction contains some neutral lipids, sterols (including cholesterol) and an unsaponifiable fraction of hydrocarbons similar to beeswax extracts (Lercker et al., 1981, 1982, 1984 and 1992).

The total ash content of royal jelly is about 1 % of fresh weight or 2 to 3 % of dry weight. The major mineral salts are, in descending order: K, Ca, Na, Zn, Fe, Cu and Mn, with a strong prevalence of potassium (Benfenati et al., 1986).

The vitamin content has been the object of numerous studies, from the moment when the first research (Aeppler, 1922) showed that royal jelly is extremely rich in vitamins. Table 6.2 indicates the results obtained by Vecchi et al., (1988) with regard to water-soluble vitamins. Other authors report averages close to the minimum values of Table 6.2 (Schmidt and Buchmann, 1992). Only traces of vitamin C can be found.

As far as the fat-soluble vitamins are concerned, it was initially thought that, given the enormous fertility of the queen bee, royal jelly would contain vitamin E. But tests have shown that it does not. Vitamins A, D and K are also absent (Melampy and Jones, 1939).

During the first studies, much emphasis was placed on the search for sex hormones in royal jelly. The first positive tests were later proven wrong. Melampy and Stanley (1940) showed no gonadotropic effects on female rats and Johansson and Johansson (1958) clearly demonstrated the absence of any human sex hormones. Recently though, with much more sensitive radio-immunological methods, testosterone has been identified in extremely small quantities: 0.012 ~g/g fresh weight (Vittek and Slomiany, 1984). In comparison, a human male produces daily 250,000 to 1 million times the amount present in one gram of fresh royal jelly (Schmidt and Buchmann, 1992). No biological effect has been demonstrated for such small amounts.

Table 6.2 Vitamin content of royal jelly in μ g per gram of fesch weight (Vecchi et al., 1988)

	Thiamine	Riboflavin	Pantothenic Acid	Pyridoxine	Niacin	Folic acid	Inositol	Biotin
Minimum	1.44	5	159	1.0	48	0.130	80	1.1
Maximum	6.70	25	265	48.0	88	0.530	350	19.8

Numerous minor compounds, belonging to diverse chemical categories, have been identified in royal jelly. Among these are two heterocyclic substances, biopterine and neopterine at 25 and 5 ijg/g of fresh weight respectively. These compounds are found in the food of worker bee larvae too, but at about one tenth of these concentration (Rembold, 1965). Other substances identified include several nucleotides as free bases (adenosine, uridine, guanosine, iridin and cytidine) the phosphates AMP, ADP, and ATP (Marko et al., 1964), acetylcholine (1 mglg dry weight, Henschler, 1954) and gluconic acid (0.6% of fresh weight, Nye et al., 1973).

In all popular and scientific literature, there is a fraction of royal jelly described as "other, as yet unknown". This phrase not only emphasizes the incomplete state of analytical knowledge about the product, but also the lack of understanding of the biological activities (proven or presumed) of royal jelly. Up to now, despite many efforts, most of these activities have not been proven definitely, nor have they been attributed to any of the known components.

6.4 The physiological effects of royal jelly

6.4.1 On honevbees

The effect of royal jelly on honeybee larvae, for which it was originally intended as food, is briefly described since in addition to being a fascinating biological phenomenon, it is also the basis of the royal jelly "myth".

In the 1950's, in the wake of new discoveries in the medical field of such wonder drugs as penicillin, hormones and vitamins became "popular" and were seen by many as the simple answers to many biological questions. The elusive "hormonal" effect of royal jelly on honeybee larvae led to the belief that its almost miraculous action on bee larvae could be similar on humans.

By deduction these "hormonal" effects were not only responsible for the caste differentiation between worker and queen bee, but also for the enormous fertility of a queen genetically equal to a worker bee, distinguished apparently only by the food it ate. The same applies to the queen's longevity, unique for an adult insect. Though it is known that royal jelly is a necessary food for the queen's survival and productivity, it is not known which royal jelly fractions are essential, which ones can be replaced and what constitutes minimum or optimum requirements for a queen. Almost all the attention has been focused on the immature stages of development.

Numerous studies were carried out to discover hormones or other substances powerful enough to induce all the necessary changes and give the queen such "superior" qualities. Indeed, the initial studies led to the belief that a "queen determinator" did exist and was an extremely unstable substance (as elusive as eternal life). It appeared to be so unstable that one day after secretion, it was already ineffective. However, the results of other studies did not confirm this hypothesis.

In an attempt to identify the queen determinator, all the components of royal jelly, particularly the more unusual ones or those with known biological activity or present in greater quantity have been tested. In the late 1980's the mystery had still not been solved and a number of contrasting hypotheses had produced equally convincing explanations. Rembold et al. (1974) ware thought to have been close to identifying a specific substance with queen determinator activity which they had isolated; other researchers proposed a differentiation mechanism based on the different proportions of nutrients in the food of worker and queen bee larvae. Weiss (1975) and Asencot and Lensky (1975) believed it was the sugar content of larval food (higher for the young queen bee larvae) that was supposed to cause the differentiation into queens.

More recently, Sasaki et al. (1987) proposed yet another hypothesis incorporating the many contrasting results from other researchers and suggested the "correct" viscosity of royal jelly was a key factor together with higher consumption, but even this theory still has to be substantiated with proof. In other words, it is still not known how royal jelly works nor what is responsible for its amazing effects.

However, if parallels are still being drawn between honeybees and royal jelly, and humans and royal jelly, then they should serve to emphasize the complexity and interdependence of different therapies and factors such as who is taking what, when and how much. Eating royal jelly, or rubbing it into the skin will not make anyone younger or live for a thousand years. On the other hand, using it to supplement and support other diets, activities or medicines may have synergistic effects which cannot be explained by a list of compounds and their individual effects. Tests of such a hypothesis in clinical and scientific trials are needed. There is plenty of circumstantial evidence, reviewed in the following section, that leads us to believe that royal jelly might be highly beneficial to mankind.

6.4.2 Unconfirmed circumstantial evidence

Royal jelly was initially advertised for its rejuvenating effects (De Belfever, 1958). The activities most frequently reported in advertisements and constantly confirmed in the declarations of those who have taken royal jelly are indicated in Table 6.3, citing the contents of one of Europe's most widespread and popular publication on the subject (Donadieu, 1978). Royal jelly, taken orally for 1-2 months by swallowing or letting it melt under the tongue in doses of 200-500 mg a day, is said to act as a tonic and stimulant, with a euphoric effect on healthy humans.

In addition to these indications, users declared that royal jelly had solved most of their health problems. In many cases these were chronic or recurring disorders, for which other treatments did not lead to the desired results, so that the effects obtained by taking royal jelly have been considered "miraculous".

It must be emphasised that these claims are unconfirmed by any scientific studies or documentation. There is no proof that the effects are exclusively or even mostly attributable to royal jelly.

People who have taken royal jelly said that they soon experienced a feeling of general well-being, i.e. an effect on their physical output (resistance to fatigue), intellectual performance (greater learning capacity and better memory) and on their mental condition (greater self-confidence, feeling of well-being and euphoria). In other words, royal jelly appears to act as a general stimulant, improving immune response and general body functions.

Table 6.3:
A list of properties, benefits and improvements attributed to royal jelly quoted from personal case histories and non-scientific literature.

Internal Use	External Use
Tonic	Skin conditions
Stimulant - physical performance, better memory, learning capacity and self-confidence	Epithelial stimulation and regrowth
General health improvement	Anti-wrinkle
Anorexia	Sebaceous secretion (fat secretions of skin glands) normalized
Increased appetite	
Skin conditions	
Sexual desire and performance	
Influenza	
Increased resistance to viral infections	
High blood pressure	
Low blood pressure	
Anaemia	
Arteriosclerosis	
Cholesterol levels	
Chronic and incurable disorders	

6.4.3 Scientific evidence

Royal jelly is neither toxic when injected into mice and rats at high dosages of up to 3 g per kg body weight per day (Hashimoto et al., 1977) nor mutagenic, as tested on DNA of Salmonella typimurium (Tamura et al., 1985).

Takahashi et al., (1983) reported cases of allergic contact dermatitis in 2 out of 10 patients subjected to patch tests. In the context of allergic reactions it needs to be mentioned that intramuscular or intraperitoneal injections, the most common form of royal jelly administration in early years, have been completely abandoned (even under strict medical supervision) because of the risk of serious allergic reactions (Dillon and Louveaux, 1987) Today, royal jelly is most often administered orally and externally (in cosmetics).

In vitro studies have confirmed that lO-hydroxydecanoic acid in royal jelly has antibiotic activity. The antibiotic effectiveness is thermostable, i.e. is not destroyed by moderate heating, but it decreases with improper or long-term storage. Antibiotic action has been proven against the following microorganisms: Escherichia coli, Salmonella, Proteus, Bacillus subtilis and Staphylococcus aureus (Lavie, 1968; Yatsunami and Echigo, 1985). It shows one quarter of the activity of penicillin against Micrococcus pyrogens and is also fungicidal (Blum et al., 1959). In vitro, antiviral effects have been described (Derivici and Petrescu, 1965) and better resistance to viral infections has been observed in mice.

This same antibiotic action of fatty acids is neutralized by raising the pH above 5.6. Since injection into blood, muscle or the peritoneal cavity will raise the pH to 7.4, and the pH is above 5.6 in the intestines, the therapeutic value of the anti-bacterial activity of fatty acids is likely to be negligible for any internal applications, but will remain effective for topical use.

In studies on the internal effects of royal jelly with live animals or humans the jelly is usually administered either by mouth or by injection. The latter allows better assessment of hormonal activities ascribed to royal jelly but carries a substantial risk of allergic reactions.

Oral administration

Positive effects on reproductivity, though not necessarily due to hormone-like action, have been reported at least for chickens, quails and rabbits. Rabbits reacted to a normal diet supplemented with 100-200 mg of royal jelly per kilogramme of body weight with increased fertility and embryonic development (Khattab et al., 1989). Japanese quail reached sexual maturity sooner and laid more eggs after supplementation of diets with high doses (0.2 g) of lyophilized (freeze-dried) royal jelly (Csuka et al., 1978). Bonomi (1983) increased egg production, fertility and hatching in laying hens by using 5 mg royal jelly per kg of feed, but Giordani (1961) found no histological changes in male or female reproductive organs or weight gain with higher doses of 10 to 40 mg per day.

Growth rates of mice slightly increased with a dosage of 1 g of royal jelly per kg of feed, but decreased with higher dosages (Chauvin, 1968). Bonomi (1983) reported weight increases in chicken, partridges and pheasants with a supplement of S mg royal jelly per kg of feed and Salama et al. (1977) reported weight increases in rats when 10, 20 or 40 mg were injected directly into their stomachs. The administration of 0.02 g of royal jelly to calves less than 7 days old gave a weight gain of 11 - 13 % during the following 6 months in comparison with untreated controls (Radu-Todurache et al., 1978). They also mentioned that the treated calves showed lower mortality and higher resistance to infection.

Figure 6.2: Dark glass bottle with fresh royal jelly and miniature spatula for oral administration (human consumption).

Injections

Intravenous injections cause slight vasodilation (temporary enlarging of blood vessels) and have a hypotensive effect (lowering blood pressure); both due to acetylcholine in royal jelly (Jacoli, 1956; Shinoda et al., 1978).

Injections of royal jelly solutions induced higher blood sugar levels than oral applications (Chauvin, 1968). No hypoglycemic (insulin-like) reaction could be shown in rats (Fujii et al., 1990). Afifi et al. (1989) reported weight increases in guinea pigs after injection of 100-300 ing royal jelly per kilogramme of body weight. Small doses injected into cats raised haemoglobin and erythrocyte counts and repeated doses of up to 10 mg/kg of body weight stimulated motor activity and weight gains in mice. Repeated higher doses of 100 mg/kg in mice, however, caused weight loss and impaired cerebrocortical (brain cortex) cellular metabolism (Lupachev, 1963).

Animal tests

In other studies human diseases were simulated in animals in order to identify the mechanisms of royal jelly action. Thus it is known that royal jelly can reduce blood plasma levels of cholesterol and triglycerides (Cho, 1977) and cholesterol and arterial cholesterol deposits in rabbits when these disorders were induced experimentally (Carli et al. 1975). Nakajin et al., (1982) stated that although royal jelly has no effect on lipid levels in blood plasma in normal rabbits, it can reduce the cholesterol content in the blood of animals fed on a diet which induced high levels of blood cholesterol.

Vittek and Halmos (1968) found that royal jelly promoted bone healing in rabbits. The healing of skin lesions was accelerated and anti-inflammatory action was shown for rats by Fujii et al. (1990).

Other researchers tested royal jelly and some of its compounds on tumour cell cultures, showing the inhibitory action of lO-hydroxydecanoic acid (Townsend et al., 1960) and certain dicarboxylic acids. However, they also showed that the same acids could induce tumours in mice when royal jelly is mixed with the culture medium (several mg/ml at less than pH 5) prior to injection into the test animals (Morgan et al., 1960). Wagner et al., (1970) found no significant effects of prolonged survival in mice irradiated against experimentally induced tumours and treated with royal jelly (20 mg/kg of body weight) as compared to control mice which did not receive any royal jelly. More recently, Tamura et al., (1987) have shown tumour growth inhibition in mice with prophylactic and therapeutic oral administration of royal jelly. Inhibition of rapid-growth cancers (leukaemia) was insignificant but it was noticeable on slow-growing, solid tumours (Ehrlich and Sarcoma strains).

Human tests

Studies of the effects of royal jelly on humans are extremely numerous, particularly in Eastern Europe. A few early studies were presented in Russian by Braines (1959, 1960 and 1962). Most studies however, arc difficult to evaluate for the scientific value of the reported information. Although many are presented as scientific publications, they often lack details on test methods, use parameters difficult to quantify (well-being, euphoria and rejuvenation) do not entirely exclude effects from other concurrent treatments, or use subject numbers too small to exclude accidental effects or natural variation. Of all the works consulted and selected for this chapter, of which a few are summarized in Table 6.4, not one is totally without criticism. The information presented therefore must be considered only as an indication of possible effects requiring further clinical testing.

The mechanisms of royal jelly's activity is not known and none of the numerous hypotheses have been confirmed. An early explanation (Johansson and Johansson, 1958) claiming high vitamin content as a contributory factor can be refuted on the grounds that the same effects should then be achievable with vitamin supplements or a glass of milk, which contains amounts of vitamins similar to the usual dose of royal jelly. Beneficial effects on intestinal flora through selected anti-microbial action can mostly be excluded due to pH. The action of some compounds on endocrine glands, or becoming part of enzyme systems or directly affecting intermediate metabolism has been suggested by Bonomi (1983).

Table 6.4.:
A list of some effects of royal jelly on humans.

Applications	Description	References

Premature bebies and those with nutritional deficiencies of various origins	8-100 mg orally, improvement of general condition; increase in weight, appetite, red blood cells and haemoglobin	Malossi & Grandi, 1956 Prosperi and Ragazzini, 1956 Prosperi et al., 1956 Quadri, 1956
Elderly (70-75 years), anorexic, depressed and low blood pressure patients	20 mg injected every second day, improvements on all accounts 20 mg taken orally every second day, improvements as above	Destrem, 1956 Destrem, 1956
Psychiatry	Improvements of asthenia, nervous breakdown, emotional problems and counteraction of side effects of psychoactive drugs	Telatin, 1956
Chronic metabolism	Mixture or royal jelly, honey and ginseng, improvements in weight gain and psychological conditions, but changes of blood characterisics	Borgia et al., 1984
Stimulating metabolism	Stimulating effects comparable to that by proteins, effect assumed to be due to activity of enzymatic complexes	Martinetti and Caracristi, 1956
Wound healing	5-30 mg/ml injected into burn blisters, improved regrowth of skin	Gimbel et al., 1962

6.5 Uses and marketing of royal jelly

Royal jelly can be sold in its fresh state, unprocessed except for being frozen or cooled, mixed with other products, or freeze-dried for further use in other preparations. The fresh production and sale can be handled by enterprises of all sizes since no special technology is required. In its unprocessed form it can also be included directly in many food and dietary supplements as well as medicine-like products or cosmetics. For larger industrial scale use, royal jelly is preferred in its freeze-dried form, because of easier handling and storing. Freeze-dried royal jelly can be included in the same products as the fresh form. The production of freeze-dried royal jelly requires an investment of at least US$ 10,000 for a freeze-dryer, sufficient production volume and an accessible market for the raw material or its value added products. The discussion below describes some of the value added products in which royal jelly has been included in the past.

Since the assumed benefits of royal jelly have not been sufficiently proven, statements in advertisements and on package labels should be very careful to avoid suggestions which are not well-founded. Any kind of fraudulent or exaggerated statements and claims are in the long run more damaging than any short-term benefit that may be derived from, for example, an increase in the price of a product. Products containing royal jelly should be specially marked or packaged in order to distinguish them from similar products without it.

6.5.1 As dietary supplement

Royal jelly belongs to a group of products generically described as "dietary supplements" These are products which are consumed not for their caloric content nor for pleasure, but to supplement the normal diet with substances in which it might be

lacking. In reality, however, the use of royal jelly is not so much linked to its high content in "noble" substances, but to its assumed stimulant and therapeutic value. However, it cannot be defined as a medicine because the data required for classification in this category are lacking. If it were declared a medicine, its use would become dependant on medical prescriptions and the production and marketing of royal jelly-based products would become the exclusive domain of the pharmaceutical industry.

Figure 6.4: A package of 10 vials each with 166 mg of freeze-dried royal jelly (the equivalent of 500 mg fresh royal jelly) on a glycine base (filler or support) and 10 vials with 6 ml of a glucose flavoured solvent (water) preserved with ascorbic acid. The contents of the two vials have to be mixed before use.

A large amount of royal jelly is sold and consumed as it is harvested. In its unprocessed, natural state, it is preferred by most producers, because it does not require any special technology, and by consumers because of its unaltered "naturalness". The fact that its taste is not very pleasant, instead of deterring consumers appears to enhance its image as a "medicine". For those who do not appreciate this particular medicinal aspect, royal jelly can be mixed with a little honey, sugar syrup or water, or it may be encapsulated.

Unprocessed royal jelly is usually packaged in small, dark glass bottles of sizes that correspond to the duration of a "treatment" e.g. 10, 15 or 20 g. A tiny plastic spatula is usually included for the "correct" dosage of 250 - 500 mg (see Figure 6.2) Special isothermal packaging (usually a moulded polystyrene box) is sometimes used to make the product look even more precious and protect it perhaps from brief temperature fluctuations. In Italy, in the past, it was also sold in special glass syringes, allowing more precise dosages and giving greater protection against oxidation.

Producers also sell pure royal jelly in its original queen cells after having removed the larvae and sealed the cells. The cells may be sealed with another wax queen cell cup, with liquid wax or by squeezing the ends of the cell together. The queen cells thus prepared can be packaged in small plastic boxes or glass jars together with a small spatula. The main disadvantage of this type of packaging is that the royal jelly does not keep well (two weeks in a refrigerator or a few months when frozen immediately) and only sells well directly from the producer to the consumer. On the other hand such sales can be extremely profitable and are also attractive to consumers who can be sure that the product is untreated and fresh. Given the normal variation in content of queen cells the net weight must be given for the smallest possible quantity (e.g. minimum content 250 mg/cell).

Royal jelly sold in any of the above forms must always be kept at or below 5~ C during storage, during transportation and in the retail store. Empty packages can be displayed while full containers are stored in a refrigerator.

6.5.2 As ingredient in food products

A mixture of royal jelly in honey (1-3 % royal jelly) is probably the most common way in which royal jelly is used as a food ingredient. Among the advantages of this product are that no special technology is required and the honey masks any visible changes in the royal jelly. The final product is pleasant-tasting and it provides the beneficial effects of both products. One teaspoon of the mixture typically contains 100 - 300 mg of royal jelly, about the dosage of royal jelly that is most commonly recommended. Nothing is known however about the preservation of royal jelly in such a mixture. It should, therefore, be kept refrigerated.

Another food frequently enriched with royal jelly in some European countries is yogurt, which has an acidity similar to royal jelly and also requires refrigeration. Yoghurt is already a popular food for health-conscious consumers who often appreciate its further enrichment with royal jelly. The higher price that is usually charged reflects what the market will bear rather than the extra production costs, i.e. the market value added to such a product by the royal jelly is higher than the cost of the jelly and extra production costs.

Sometimes, vitamin supplements and fruit juices are enriched with freeze dried royal jelly. Royal jelly is widely used in beverages in Asia.

Royal jelly is also sold in a jelly made of honey, sugar, jam and pectin. Though simple enough to produce, there are no data available on the durability or residual efficacy of royal jelly presented in this way.

6.5.3 As ingredient in medicine-like products

This category of products resembles medicines as far as their form of presentation is concerned, but in other respects these products are no different from the dietary supplements and foods described in the two preceding sections. However, they require more advanced technology for production and packaging and make higher demands on product stability as well as quality control. For the same reasons, many of these applications use freeze dried royal jelly. Unfortunately, the pricing of these products does not always reflect the quality of the product and many are grossly overpriced.

In medicine-like formulations royal jelly is generally included for its stimulatory effects. However, it is also used to solve specific health problems. A variety of formulations are available, often containing ingredients otherwise used to alleviate particular afflictions. As has been seen in an earlier section, there is no solid scientific base for any such uses. Advertising or other popular information should therefore be treated with great caution and royal jelly should never be used as a substitute for other treatments unless the treatment has been approved by a competent physician.

Whether royal jelly is the only active ingredient, or is mixed with others, the basic forms of presentation remain the same and are adapted to the desired applications or consumer preferences. Dosages may be presented in any of the following ways (see Figure 6.3):

- as a single dose package of dry royal jelly with separate solvent,
- as a single dose of mixed pulverized ingredients with or without solvent and in tablet or capsule form,
- as a single or multiple dose liquid solution for oral administration or injection

Single-dosage packages generally have to use a filler to bring the dose of the active ingredient (royal jelly or the ingredient mix) to a volume that can be easily handled by the consumer. An envelope containing only 250 mg of freeze-dried royal jelly would look very empty and the powder it contained might easily be lost. Sugar, salt, aromas, citric acid, glycine, a.o. may all serve as fillers (see Figure 6.4). As well as being mere fillers, they often render the product more pleasant to taste. Additional ingredients mixed with royal jelly are often other food supplements like plant extracts (ginseng), yeasts, pollen extracts and others.

Most packages provide the dry phase in a separate package, envelope or vial and a solvent in an appropriate container. Not only does this separation allow more effective treatment of the liquid phase (such as pasteurization or sterilization) but it also improves storage life and therefore facilitates shipping and marketing. Some refined packaging contains the dry phase in a special lid which upon opening releases the powder into the solvent.

In tablet form, the principal excipient is usually a powdered sugar plus a binding agent such as gum arabic (for simple recipes see 5.16.5 and 6.11.7). For larger production, tableting machines are necessary which can sometimes be purchased second-hand at reasonable prices. Hard and soft gelatine capsules can be used for similar formulations. The hard capsules can be filled

by hand on a small scale or by machine on a more industrial level (see also Figures 3.10 and 3.11), but soft capsules and gelatine drops need expensive equipment and are usually manufactured only by larger enterprises or under contract by large enterprises for third parties.

Another form of presentation is in vials with a liquid solution of royal jelly. These are simple to prepare and can use fresh unprocessed royal jelly, but they present preservation problems both with regard to microbiological activity and the long-term stability of the royal jelly. The addition of a little alcohol or propolis extract increases protection against microbial growth. Such preparations are distributed widely and are now being imported mostly from Asia by Europe, the USA and some Latin American countries . One of the more common formulations contains honey, royal jelly and an alcohol extract of ginseng (see Figure 6.10). Since these products are not regulated as food or as medicines, they are not required to list all ingredients, particularly the different preservatives which are necessary in these liquid formulations.

The production of injectable royal jelly preparations must be left to qualified laboratories in order to avoid problems with contamination and toxicity. There are patents that protect the production of royal jelly extracts for human use (by injection), but up to now there is no actual production or use for these "medicines", at least in Western Europe.

The medicinal or pseudo-medicinal use of royal jelly is much more popular in Asia and Eastern Europe, where rules on medicinal formulations and applications are very different from those in Western Europe and North America. In Africa, very little use of royal jelly has been reported, either as a food supplement or as medicine.

6.5.4 As ingredient in cosmetics

Except in Asia, probably the largest use of royal jelly is in cosmetics. Royal jelly is included in many dermatological preparations, but mostly in those used for skin refreshing, and skin regeneration or rejuvenation. It is also used in creams or ointments for healing burns and other wounds. It is usually included in very small dosages *(0.05* to 1 %) but it is likely that it deteriorates relatively quickly. No precise data on loss of effectiveness are available. The freeze-dried form of royal jelly is usually preferred because of ease of handling. A royal jelly/lactose paste mixed at 0^0C is said to stabilize royal jelly (Rubinsstein, 1954). The paste can then be added to cosmetic preparations. More information and recipes can be found in Chapter 9.

6.5.5 Others

The only other known uses for royal jelly are in animal nutrition. In particular, royal jelly has occasionally been used (fresh or freeze-dried) to stimulate race horses. For experimental purposes it is also used as a food for rearing mites and insects.

6.6 Royal jelly collection

Royal jelly is produced by stimulating colonies to produce queen bees outside the conditions in which they would naturally do so (swarming and queen replacement). It requires very little investment but is only possible with movable comb hives. Expert personnel are required, who are able to devote considerably more time than is commonly required for the production of other bee products. Without this prerequisite it is possible to only occasionally collect the contents from cells of natural swarms - and this amounts to no more than a gram or two per hive.

A well-managed hive during a season of 5-6 months can produce approximately SOOg of royal jelly. Since the product is perishable, producers must have immediate access to proper cold storage (e.g. a household refrigerator or freezer) in which the royal jelly is stored until it is sold or conveyed to a collection centre.

The most rational and economic methods for large scale production are variations of the Doolittle method of queen rearing. Usually, the starter colony is omitted and cell cups, with transferred larvae, are directly introduced into the finisher colonies. Strong queenright colonies are preferred, in which the queen chamber is separated from the cell rearing chamber by a queen excluder. The only required adaptation is to shorten the cycle in the finishing colonies (3 days versus 10) before cells are removed for harvesting (Figure *6.5)*. For occasional and small scale production any other queen rearing method can be used. However, there are many queen rearing methods which differ only in hive design and the use of starter and/or finisher colonies. For more details, it is recommended that the reader consult a regular beekeeping text or better, one specialized in queen rearing. Recommended English texts are Laidlaw, 1979; Laidlaw, 1992 and Ruttner, 1983.

a)

b)

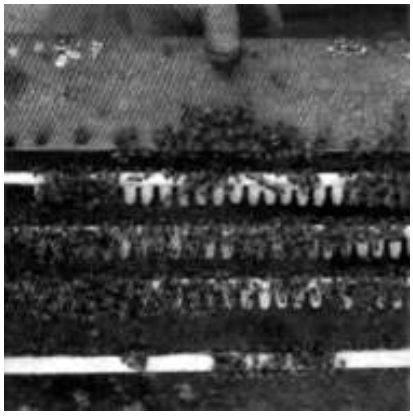


Figure 6.5 : a) Special frame with queen cells for queen rearing or royal jelly harvesting. These cells have already been sealed and are too old for collection of royal jelly. However, queens may be raised from these cells if they are introduced into queenless hives. b) Queen cells of the right age for royal jelly harvesting.

The basic requirements are movable comb hives, preferably some queen excluders, queen cups (made from wax or plastic), a transfer needle, a spoon or suction device to remove royal jelly, dark glass vials and a refrigerator. Special hive modifications may facilitate the work according to personal preferences, and centrifugal extractors for royal jelly may be used for large scale production. Feeding with sugar syrup (1:1 in sugar/water) increases cell acceptance, even when flowers are available.

Individual queen cells should not contain less than 200 mg of royal jelly. Low cell content means that there are too many cells for the finisher colony or that the colony is not in a condition to provide for queen rearing. There are racial differences in productivity and specially selected strains can be obtained. However, importing queens may not guarantee higher production in a different environment and carries a considerable risk of importing new or resistant diseases, thus reducing productivity and economic feasibility.

Mature queen cells, i.e. those with larvae four days old (3 days after grafting), must be brought quickly into the extraction room. The open, narrow part of the cells is cut to facilitate and speed up collection. Then the larvae are removed with a pair of soft forceps, taking care not to harm them and contaminate the jelly. The royal jelly is extracted by emptying each cell with a small spatula, by sucking it up with a special mouth operated device, with a pump operated device or by centrifugal extraction (see Figure 6.6). Following extraction, the cells are immediately ready for another rearing cycle.

The royal jelly must be filtered using a fine nylon net (nylon stockings are excellent) to eliminate fragments of wax and larvae. Metal filters should not be used. The jelly should be placed into dark glass vials or food-grade plastic containers, avoiding any excessive exposure to air. It should be refrigerated immediately. Any material or equipment contacting royal jelly - including hands - must be clean and disinfected using heat or pure alcohol. The laboratory must be kept impeccably clean and extraction should never be done outside or in sunlight.

The commercial production of royal jelly requires a methodical approach, good organization and precise timing. Constant

attendance is essential as one day off can eliminate two days of production. In order to have a weekly day of rest (e.g. Sunday) no queen cells would be introduced on Thursday, which means that there will also be no collection on the following Wednesday.

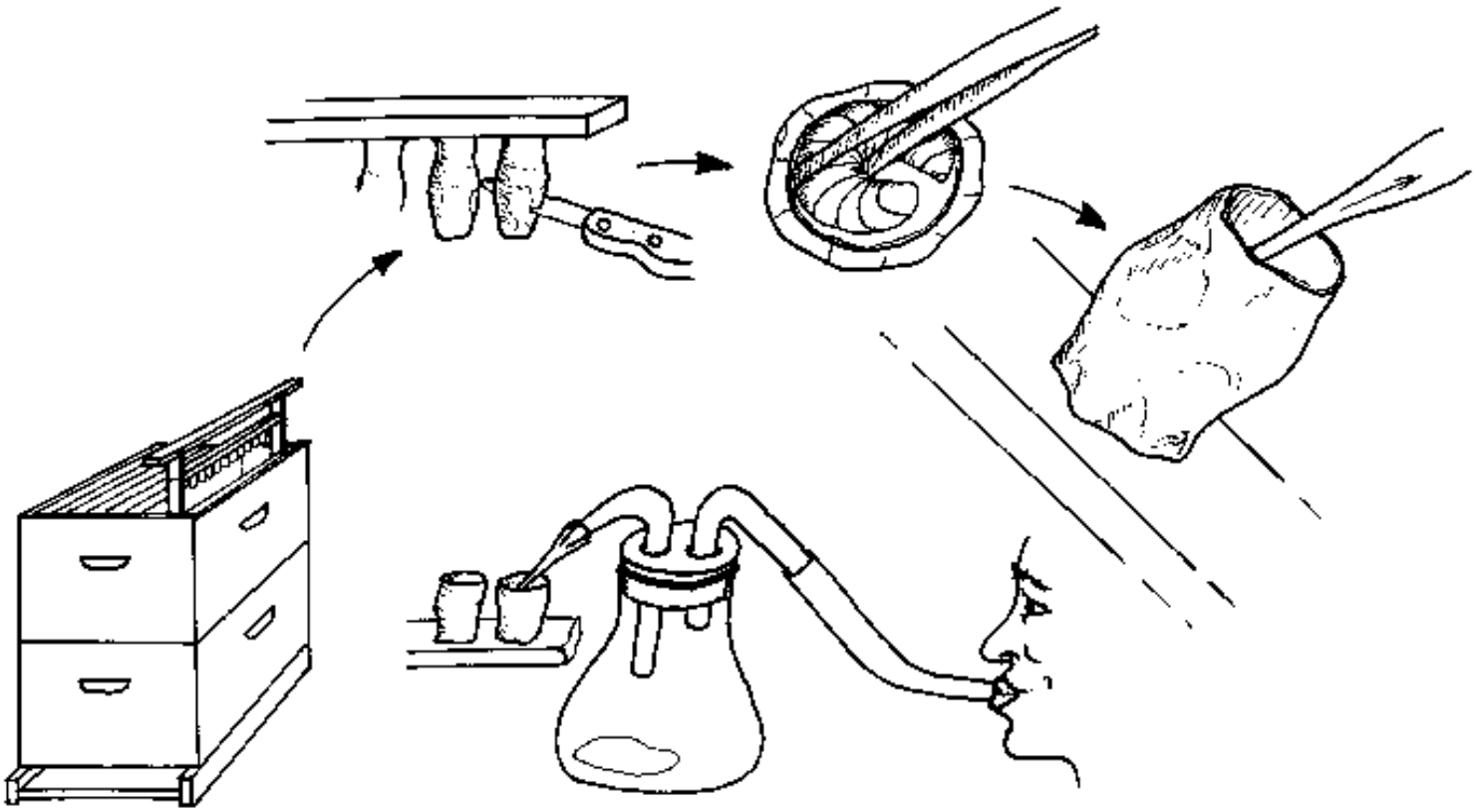
These techniques are suitable for both small and quite large enterprises. Depending on the intended market, the approach can be either one of low cost or one in which all collecting, processing and distribution takes place in highly controlled environments. The latter will result in a product which is better suited for industrial use (see also section 6.11.1).

6.7 Storage

Royal jelly has a limited shelf-life. Early beliefs in the extreme instability of royal jelly activity, based on the alleged rapid loss of the "queen determination" factor (see 6.4.1) have not been confirmed. Since neither the mode of activity nor the actual effects of royal jelly are known, there are no data available on changes in its biological effectiveness on humans after long term storage.

Information is, however, available on changes in composition due to long term storage, such as a higher acid titre, a large unsoluble protein fraction, less free amino acids, less glucose oxidase and others (Takenaka et., 1986 and Karaali et al, 1988). Such changes make it appear likely that also biological activity is influenced by storage. Refrigeration and freezing delay and reduce the chemical changes. Although freeze-dried jelly is the most staable form of royal jelly, some changes still take place.

a)



b)

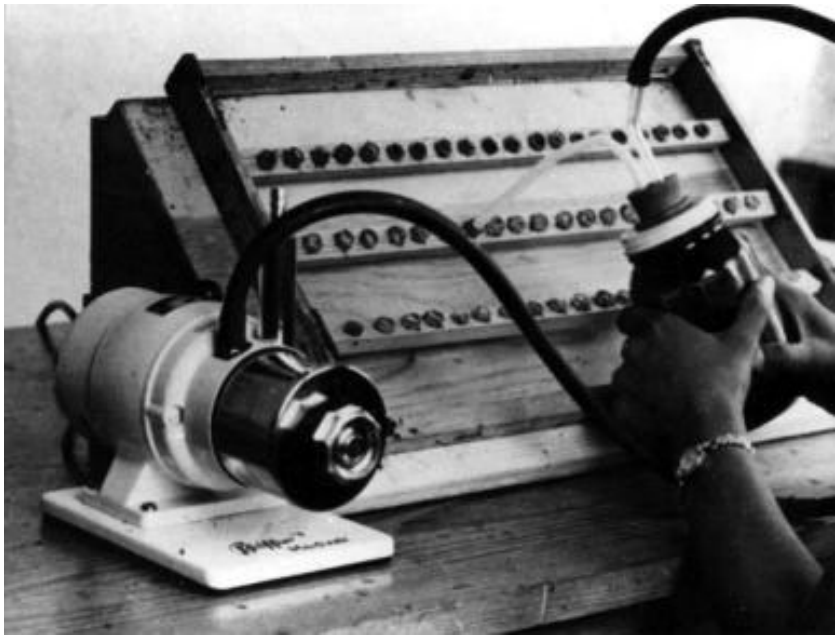


Figure 6.6: a) The steps for removing royal jelly from a queen cell and a diagram of a simple suction device for the collection of royal jelly from queen cups. b) A small vacuum pump can be adapted for the collection of larger quantities of royal jelly. Note that all the queen cells have been cut down in size to facilitate removal of the larvae and the royal jelly.

On the basis of the above, we can conclude that refrigeration of royal jelly at 0~ to 5 ^{0}C is a minimum precaution. Still better is storage, whenever possible, at temperatures below -17^{0}C, which is attainable in most household freezers. Since royal jelly is an emulsified product and not cellular tissue, freezing presents no particular problem and common household freezers can be used.

As there are no criteria for establishing "safety" limits for product activity, storage and shelf-life should be kept as brief as possible. For products sold in Europe, the average recommended storage time after production is 18 months under refrigeration. For products stored at - **170** C, storage can be extended to 24 months. After defrosting and packaging, the product should not be stored in a refrigerator for more than 12 months.

Freeze-dried royal jelly and royal jelly based products are generally stored at room temperature, sometimes for several years. Freeze-dried royal jelly is certainly more stable than the fresh product, but it was reported that only during the first two months of storage at room temperature no signs were observed of any deterioration (Okada et al., 1977). Therefore, also in this case cold storage is recommended to minimise changes and products should be kept on the shelf for as short a time as possible.

The storage recommendations for fresh and dried royal jelly are valid in the same way for all wet or dry products to which royal jelly has been added. Contrary to many recommendations on packages, these products should be stored in the same manner as the pure, fresh jelly.

In 1956, a French patent was granted for a method of stabilizing royal jelly by mixing it with an easily assimilable, adsorbent substance such as a carbohydrate or protein. A homogenised paste of 10 g fresh royal jelly with 100 g of lactose, mixed at 0^{0}C was proposed by Jean *(1956)*. However, no evaluation or verification of increased shelf-life is available. Such support substances, often sugars but also glycine are frequently used to increase the volume of single doses of freeze-dried royal jelly, to make handling easier for both packers (weighing of very small quantities is both difficult and imprecise) and customers.

Like all other bee products, royal jelly has its own microbiological protection and presents few microbiological storage problems when it is in its natural state. This protection however is not absolute and certain hygiene precautions must be observed during production (section 6.6) and storage. Hygienic working conditions and clean containers are a minimum requirement, and airtight containers should be used to provide additional protection not only against contamination but also against oxidation.

Contents - **Previous** - **Next**

6.8 Quality control

Contents - Previous - Next

Analytical techniques are sufficiently advanced to permit identification of pure, natural royal jelly and to reveal possible adulteration. They can also be used to determine the quantity of royal jelly used in combination with other products.

The analysis of royal jelly is generally based on the quantitative determination of the three principal categories of compounds (lipids, sugars and proteins), its water content and of other significant indices such as pH and total acidity. Lipids are the most important compounds in determining the authenticity or adulteration of royal jelly, since several of them are not found in any other natural products. The qualitative and quantitative analysis of the lipid fraction also makes it possible to determine the amount of royal jelly in a multi-component product (Pourtallier et al., 1990). Among the biologically active components, the vitamin content can give an indication of the corresponding (assumed biological) activity of royal jelly. The most important indicators and limits are presented in Table 6.5. For methods of analysis, the respective publications should be consulted. Apparently, there are no legally established standards or international agreements. Nakamura (1985) reports the standards required by the Japanese "Fair Competition" regulations and approved by the Fair Trade Commission of Japan (see Table 6.5).

In addition to scientific analysis, there are some simple tests that can be used to indicate whether royal jelly is of good quality. Royal jelly generally darkens with age due to oxidation, although some fresh royal jellies may already be quite dark. Experience makes it possible to distinguish the appearance, smell and taste of a well-preserved or fresh royal jelly from one that is neither. Other simple tests are listed below.

The appearance of a solution and the presence of exuviae (larval skin fragments):

1 g of royal jelly is diluted in approximately 20 ml of distilled water. An opalescent solution with suspended material results (Nakamura, 1985). Then a concentrated solution of caustic soda is added drop by drop until the solution becomes clear. The alkaline solution thus obtained is (more or less) dark yellow green, more rarely yellowish pink or pink (Chauvin and Louveaux, 1956). Fragments can be seen suspended in the liquid which may be decanted and filtered. Under a microscope, the filtered residues should be identifiable as larval exuviae or exuviae fragments.

Table 6.5

Quality control methods and proposed limits for pure, natural royal jelly

	Pourtallier et al., 1970		Pourtallier et al., 1990		Lercker, et al., 1984, 1986 and 1992		Nakamura, 1985	
Compounds	Methods	Limits	Methods	Limits	Methods	Limits	Methods	Limits
Water content, %	Freeze drying	60 - 70	Freeze drying	64 - 68	Freeze drying	62.5 - 68.2	low press. heat evaporation	62.5 - 68.5
Lipids, % dry weight basis	Selective extraction with methanol	12 - 18	Selective extraction with ethyl ether, followed by qual. & quant. GC of fatty acids	9-12.5	Qual. & quant. HRGC of fatty acids	6.2 - 13.6		
10-hydroxy-2-decanoic acid					as above, in % of free acids	51.6 - 62.6	Gas chromatography as % of fresh weight	> 1.40
10-hydroxydecanoic acid					as above, in % of free acids	15.3 - 20.9		
Proteins, % of dry weight	Selective extraction with methanol	35 - 45	Selective extraction with methanol	36 - 42	Total N, automatic Kjeldahl method	33.0 - 41.7	Crude proteins, Kjeldahl method, % fresh weight	11.0 - 14.5
Sugars, % of dry weight	Titration of reducing sugars	20 - 33	Qual. & quant. gas chromatography (GC)	38 - 43	Qual. & quant. HRGC	19.7 - 52.1		
Fructose, % of total sugars					as above	29.2 - 58.9		
Glucose, % of total sugars					as above	35.0 - 51.4		
Sucrose, % of total sugars					as above	0.1 - 35.8		
Total acid, meq %	Titration	110 - 150					Alkaline titr., ml eq./100 g	32.0 - 53.0
pH	in aqueous alcohol solution of 0.4 %	4 - 4.2					Vecchi et al., 1988	
Riboflavine µg/g							Difco microbiological method	5 - 25
Thiamin µg/g							as above	1.2 - 17
Niacin µg/g							as above	45 - 190
Folic acid µg/g							as above	0.1 - 0.55

GC = Gas chromatography HRGC = High resolution gas chromatography

Boiling test

Royal jelly boiled with a small piece of potassium hydroxide will emit the smell of ammonia.

Mercury chloride reagent test

A white sediment is formed when the mercury chloride reagent solution is added.

Iodine solution test

A red-brown sediment is formed when the iodine solution is added (Nakamura, 1985).

Pollen analysis

Microscopic analysis of the pollen content can be used to determine the origin of the royal jelly. This is a simple procedure, but it requires a great deal of experience in determining the pollen species and interpreting the results (Chauvin and Louveaux, 1956 and Ricciardelli D'Albore and Bernardini, 1978).

6.9 Caution

No toxic effects have been observed in royal jelly for external use, as food or for injection. Allergic reactions however, as a result of contact or injection, may occur. As with all other potential allergenic substances, small quantities should be tried for a few days before using full doses. In case of allergic reactions, its use should be suspended immediately.

Since none of the claimed therapeutic or other effects of royal jelly have been proven with certainty, any advertising or package labelling should, for legal as well as ethical reasons, be truthful and should not raise unjustified consumer expectations. In the long-term this will improve consumer confidence and ultimately, sales.

From the production and organizational point of view, the temperatures to be maintained during storage are the most restricting factor. It is therefore essential that production and marketing are extremely well-planned and appropriate storage facilities are available at the producer, distributor and retail level.

6.10 Market outlook

No official market statistics are available, only estimates (Nardi, 1986). China is unanimously recognized as the world's largest producer and exporter of royal jelly. Its estimated annual production is in the order of 400 to 500 tons, nearly all exported to Japan, Europe and the USA. China accounts for approximately 60% of world production. Other countries in the Far East (Korea, Taiwan and Japan) are also important producers and/or exporters. In the rest of the world, royal jelly is produced mainly in Eastern Europe and,

At the time of writing (April 1993) the international wholesale price of royal jelly, based on that of China, the largest supplier, was US$ 50-80 per kg. Local prices in different countries can still vary considerably and be much higher (the price in Argentina in 1992 varied between US$ 100 and 180/kg). Comparing these figures to the one reported by Inoue and Inoue almost 30 years ago (1964, US$ 180 to 400 per kg, in various countries) there has clearly been an enormous drop in price in real terms. Even without international competition, the decline in price was already obvious by the late 1950's in countries where the use of royal jelly started. The greater availability worldwide (particularly due to increasing Asian production) and the fact that the properties of royal jelly have not yet been determined conclusively, are probably the two main reasons for this drop in price.

In its processed form as tablets, capsules or vials, the equivalent of 1 kg of royal jelly may cost the consumer of some products as much as US$ 3,300. The price margin is similar to that of dried and processed pollen.

Japan has probably the highest domestic consumption of royal jelly (180 tons, Inoue, 1986) a large part of which is imported from other Asian countries. Outside Asia, the main markets for royal jelly are in the European and North American cosmetics industry and to a lesser extent, in the health food market. If therapeutic and other beneficial properties of royal jelly can be established scientifically, this market for royal jelly products (see Figure 6.7) with all its "value added", has the potential to explode.

Figure 6.7 : A variety of products containing royal jelly (from left to right): freeze-dried royal jelly with separate solvent in individual dosages, soap, individual liquid dosages, yoghurt, night and day cream, fresh royal jelly and shampoo with royal jelly.

The Asian market is potentially very large and with proper marketing should have tremendous value. In Asia, consumer preferences and traditions differ from those prevailing in Europe and North America and have facilitated marketing and increased production. Local cosmetic industries in particular, have very great potential for growth once quality and marketing (most of all packaging) approach the levels of Western competitors. The use of royal jelly in cosmetics has led to some very successful products. In one case (in Thailand) a business originally based on cosmetics with royal jelly and other bee products was so successful that it grew into a multimillion dollar enterprise.

While these successful companies became large operations, there is still plenty of room for small, local businesses (beauty parlours, vendors, pharmacies and others) to formulate articles containing bee products and in particular, royal jelly. These need to be adapted and selected according to local consumer preferences and customs. The need for high quality packaging and intelligent marketing, cannot be over-emphasised.

To conclude, a statement by Inoue and Inoue (1964) which unfortunately is still valid after 30 years, can be quoted: "We believe that the demand for royal jelly will increase again if, and only if, a reliable therapeutic value for humans can be established by further scientific research, and as a result official recognition is obtained from the Ministry of Health". The same might be said for its "added value" products.

6.11 Recipes

The proportions of royal jelly in a dietary product are usually adjusted to provide a dose equivalent to 200 to 300 mg fresh weight of royal jelly. Preparations such as soft gel capsules (also called gelatin drops or pearls) and those with freeze-dried granules (juice concentrates) which require higher and more expensive technologies, are not usually manufactured by small enterprises, but hired out to large companies specializing in this kind of work.

While the composition of the products can be varied and different formulations be tested, selected formulas need to be precise to allow consistent product quality between batches and the correct product consistency, where this is required.

The larger the production grows, the more important become hygiene, quality control, storage capacity and quick distribution and sale. Processes and ingredients may have to be adjusted slightly to accommodate larger scale production. Care should be taken however, not to alter or destroy the natural characteristics of the raw materials.

Certain types of packaging such as some automatic-mixing vials, blister packages for pills and capsules, and plastic and metal foil lined cartons or papers also require more expensive technology, but alternatives can be employed. For all preparations, the final presentation is very important. Unfortunately, presentation has sometimes become more important than the quality of the packaged product.

6.11.1 Freeze-dried (lyouhilised) royal iellvy

Freeze-dried royal jelly is a very hygroscopic powder. It is obtained by evaporating the water content from the frozen product in a vacuum. This is the drying process which best maintains the original characteristics of the product: it retains the volatile components which would be removed by evaporation at higher temperatures and does not damage nor denature the thermolabile components.

Freeze-drying requires special equipment, ranging from a simple laboratory freezedrier (see Figure 6.8) to large industrial plants (see Figure 6.9). Though the small laboratory models are normally used for analysis only, small volumes of royal jelly can be processed adequately with this size of equipment. Prices range from approximately US$ 10,000 for thc smallest drier system to several hundred thousand dollars for larger, industrial systems.

For drying, the royal jelly is first diluted with some clean water. This leads to a more regular and complete loss of water, particularly if large quantities are freeze dried in one batch. No such preparation is necessary if royal jelly is dried directly in the sales vial. During the final drying phase, in order to achieve more complete removal of residual water, the substrate can be warmed very slightly, but never above 35 ^{0}C.

Figure 6.8 : 4.5 Benchtop freeze-drier system (Courtesy of Labconco, advertised through Cole Parmer Instrument Company).

Figure 6.9: Industrial size freeze-drier in room with controlled environment (Courtesy of Ghimas SpA).

After freeze-drying, the royal jelly becomes extremely hygroscopic and must be protected from the humidity of the environment by storage in an airtight container. Larger processors handle freeze-dried royal jelly only in controlled atmospheres, i.e. air conditioned rooms with very low humidity. Depending on the final use of the dried royal jelly, a carrier base or stabilizer is added at this point, as described in section 6.7. This reduces the hygroscopicity of the dried product.

Freeze-dried royal jelly marketed directly to the consumer is usually presented in separate vials one or more for a liquid solvent and others containing the dry phase. This is the best solution for conservation without chemical preservatives. The liquid phase can be pasteurized and packed aseptically, without damaging the heat sensitive royal jelly (see also Figure 6.4).

Ingredients for one dose:

Liquid phase (6-10 ml)	***Dry phase***
5-8 g honey	*170 mg freeze-dried royal jelly*
q.s. water to fill vial	*130 mg glycine or other stabilizing support*

A typical package contains 10 glass vials with the sterilized water-honey solution. The dry phase is packed in separate, metal or gel capsules, which themselves are often packed in individual glass vials. If necessary, the proportion of stabilizing support can be increased to reach a volume or weight which is easier to process.

6.11.2 Honey with royal jelly

For this type of product both liquid and fast crystallizing honeys can be used. Preparation of creamed honeys with royal jelly is described in Chapter 2. If the moisture content of the honey is sufficiently low (<16%) there is no visible alteration even when the product is stored at room temperature, but there are no data available on the stability of the royal jelly components and in any case, consumers should be advised to store the mixture in a refrigerator (Contessi, 1990).

The honey must have a very low moisture content, since the added moisture of royal jelly (0.6 to 0.7 g of water per gram of royal jelly added) could cause the honey to ferment. If, for example, 3 % of royal jelly is mixed with the honey an additional 2% of moisture is added. To avoid such a problem, freeze-dried royal jelly could be used instead. Moreover, in honeys that are not dense, e.g. those with a higher moisture content, the royal jelly tends to separate from the honey and rise to the surface. The honey and royal jelly mix can be packaged in the same way as pure honey, since it has the same physical characteristics, but it is preferable to package it so as to differentiate it visually from pure honey (in a glass jar or bottle of different colour or shape, or in a tube or straw with an additional carton etc).

To prepare the mixture, the procedure described in section 5.16.4 is used, i.e. the royal jelly is blended into a small amount of honey and this pre-mix is then stirred into the rest of the honey. Royal jelly may be added to creamed honey before crystallization.

Similar honey-based products can be prepared by adding other products of the hive (pollen and/or propolis extract). In these cases, physically stable products are obtained only when crystallized (creamed) honey is used.

6.11.3 Yoghurt with royal lelly

Yoghurt, like royal jelly, has a low pH and requires cold storage, so a minimum of problems are encountered in storing and selling mixtures. A commonly used mixture is 2 g of royal jelly per kilogramme of yogurt, so that in a standard 125 g jar (one serving) there are 250 mg of royal jelly. Royal jelly is added to the yoghurt after fermentation and is thoroughly blended by homogenization. Except for industrial homogenizers, homogenization is best achieved by making a small pre-mix, followed by final blending of thc pre-mix with the whole batch.

6.11.4 Jellies and soft caramels

Ingredients (in parts by weight):

20-25	*Water*
up to 75	*Sucrose, glucose, honey or fruit purees*
1-1.5	*Pectin*
1	*Royal jelly*
q.s.	*citric acid, natural aromas*

The pectin should be dissolved in cold water before boiling it (see also sections 2.12.13 and 2.12.18). The ratio between sugars and honey can be varied, according to cost, flavour or other considerations. The total water content ranges between 20 to 25% and the quantity of pectin or other gum determines the final consistency. To the above base recipe, a number of other, aromatic agents can be added, such as fruit puree, essential oils and plant extracts.

These gelatinous caramels can be produced manually by pouring the solidijying jelly onto a flat table or metal tray or into moulds of different shapes. The royal jelly should be added just prior to the pouring at a temperature as low as possible. Once cooled and semi-hardened, small cubes are cut out and covered with fine sugar crystals or powdered (icing) sugar. The cubes are then individually heat-sealed into clear plastic bags or packed in clear plastic boxes and labelled. Similar formulas are marketed by various producers.

6.11.5 Liquid preparations

The following four products were selected as examples because of their form of marketing, as well as their distinct, but typical formulation. Packaging is often in small (single) doses, which is fairly expensive and may require special bottling equipment. Separation of the dry and liquid phases is partly for better conservation of the active ingredients, but probably just as important, it makes for special consumer appeal. Presenting it in this new form as if it were a medicine and requiring the consumer to actively participate by "mixing his/her own preparation" creates an important appeal for some markets and adds to ever increasing product diversity in what has become a highly competitive market.

Even considering the expensive packaging this is a very popular and profitable form of marketing royal jelly. Since these products only form a very small market, very little official quality control is exercised and consumer confidence is easily misused. Frequently, though not stated in formulations or ingredient lists, preservatives such as ascorbic acid or alcohol are added. The liquid phase always presents a preservation problem.

1) Ingredients for one dose:

300 mg	*royal jelly (fresh)*
	Honey and water to fill a 50 ml vial

A typical package contains ten 10 ml dark glass vials; each vial contains one dose. This formulation is not very stable unless all the ingredients have been pasteurized. Heating would however destroy much of the assumed beneficial activity of royal jelly. Ascorbic acid is frequently added for a more extended but still limited shei{life.

2) Ingredients for one dose:

Liquid phase		*Dry phase*
200-300	*mg royal jelly (fresh)*	*120 mg micro-encapsulated cod liver oil*
3.3 g	*Acacia honey*	
6.7 g	*Fructose*	
q.s.	*Vanilla essence*	
q.s.	*Citric acid (as preservative) water to fill 10 ml*	

Liquid and dry phases are maintained separately until use. The cod liver oil is contained in a special capsule from which it is released at the moment of use.

3) Ingredients for one dose:

4.0 g	*Honey*
0.5 g	*Ginseng extract*
0.3 g	*Royal jelly (fresh)*
q.s. to 10 ml	*Water (boiled or distilled)*

A typical package contains 10-12 heat-sealed glass vials (see Figure 6.10). The top of a vial is easily broken off and small straws are provided to drink the liquid directly from the vial. Other types of sterile seals can be employed to make use of cheaper and more common bottling equipment. Preservation is a particularly difficult problem, as the liquid should not be sterilized by heat. Chemical preservatives are needed. The alcohol in the ginseng extract is often sufficient.

4) Ingredients (in parts by weight):

40	*Honey*
10	*Royal jelly (fresh)*
q.s. to 100	*Water*

This product is fermented like mead, but the fermentation is stopped at a low alcohol content. Royal jelly is added after the fermentation. It is marketed as a special type of mead and bottled in dark, multi-dose bottles of 250 ml capacity.

Figure 6.10: Individual doses of a liquid formulation (3) presented in heat sealed glass vials and attractively packaged. The vial top can be broken off easily and straws are supplied to facilitate drinking.

6.11.6 Dried juice concentrate

Ingredients for one dose:

fructose
dried fruit juice powder
0.17 g freeze-dried royal jelly (equivalent to 0.5 g of fresh jelly)

A dried fruit juice powder, fructose (to taste) and the dry royal jelly are mixed. The dry powder is packed in plastic and aluminum lined paper envelopes in individual doses of approximately 4 g for one glass of reconstituted fruit juice. The production of good quality dried fruit juices requires expensive equipment. Pre-manufactured powders made from many different fruits may be purchased and enriched thus requiring only packaging equipment.

6.11.7 Tablets

Ingredients (in parts by weight) modified after Karaali et al., (1988):

10	*Freeze-dried royal jelly*
30	*Mannitol*
5	*Lactose*
8	*Gum arabic (binding agent)*
2	*Magnesium stearate (binding agent)*
1.5	*Sodium citrate (preservative and flavouring)*
q.s.	*Food dyes and other flavours*

A single tablet might contain 565 to 580 mg of ingredients, i.e. 100 mg of royal jelly.

Mannitol and lactose can be replaced by other powdered sugars. Glycine and the binding agents can be substituted with Agar Agar, pectin, gelatin, various gums, or beeswax. The sodium citrate can be replaced by citric acid. Flavours and dyes can be permitted natural plant extracts. Liquids (including water) should be added sparsely to obtain a thick gel, or an almost dry mass if the tablets are to be pressed. As with encapsulated formulations, freeze-dried royal jelly can be added to many herbal formulas.

6.11.8 Capsules

All the ingredients must be dry and in the form of a fine powder. They must be thoroughly mixed - the last ingredient to be added should be the royal jelly. Mixing and the final filling of the capsules should ideally take place in a room with very low humidity. For small quantities, a plastic bag provides a controlled atmosphere and can be shaken sufficiently. There are small electric ball mixers available which are well suited for medium to commercial quantities.

Final encapsulation into hard gelatin capsules can be done manually or with machines of varying capacities (see also 3.11.8). Dry powders are easiest to fill, but moist pastes such as those prepared with honey, can also be filled into capsules.

Formulations for soft gel capsules require oil based extracts, mixtures and expensive technology and are outside the scope of this bulletin.

Some possible powder mixes are (weights and proportions are only guidelines since no exact dosages are required):

1) Ingredients (in parts by weight):

1	*Freeze-dried royal jelly*

2-4 *Pulverized glucose, fructose or lactose. Be-collected pollen or dried propolis extract can be used to partially replace the sugars*

2) Ingredients (in parts by weight):

6 *Gingko biloba leaves*

4 *Ground Kawakawa root*

2 *Melilotus tips*

8 *Oyster shell powder, ultra fine*

6 *Freeze-dried royal jelly*

All need to be pulverized (dry powders), mixed and encapsulated, 300-350 mg per capsule.

3) Ingredients (in parts by weight - all dried):

7 *Gingko biloba leaves*

3 *Carrots*

3 *Rosehips*

1.5 *Ginseng root*

as ultrafine powders:

7 *Selenium yeast*

4 *Wheat germ*

3 *Freeze-dried royal jelly*

Again, all need to be mixed well before encapsulation. Exact proportions are not important for product consistency, but ingredient choice and quantities should be based on herbal characteristics. Other herbal formulations may be enriched with royal jelly and/or pollen, propolis etc. However, preparations with herbal extracts or herbal powders should be handled with caution and mixtures should only be designed by people with sufficient experience in herbal medicines.

6.11.9 Cosmetics

Royal jelly can be easily added to any creams or lotions, usually at a concentration of 0.1 to 1 % fresh or 0.03 to 0.3% freeze-dried royal jelly. The formulations generally do not have to be changed and thus any agreeable recipe can be adapted. Since royal jelly is already an emulsion, it can also be added to any existing cream providing the cream is not solely oil-based. Mix the royal jelly with a small quantity of the cream first and then add this mixture to the rest. For detailed recipes see Chapter 9.

[2] This chapter was written in Italian by Dr. Lucia Piana, translated by Lorenza Manzi and edited by R. Krell

Contents - **Previous** - **Next**

CHAPTER 7
VENOM

Contents - Previous - Next

7.1 Introduction

Among the many species of insects, only very few have the capability of defending themselves with a sting and venom injection during stinging. All insects that can sting are members of the order Hymenoptera, which includes ants, wasps and bees. Since the sting is believed to have evolved from the egg-laying apparatus of the ancestral, hymenopteran species, only females can sting. The sting is always at or near the abdominal end, rather than the head. Therefore the pain inflicted by a honeybee, defending its colony, is not caused by a bite, as is frequently said, but by a sting.

There are many other poisonous insects which secrete venom. They usually cover their body with it, spray it, create wounds and secrete it into the wound, or inject it via mouthparts or a sting. In some cases, the venom is used for defense of the individual or, in the case of social insects, the colony. But venom is also used in killing prey (as with some wasps or spiders) or for immobilizing and preserving prey (for their own or their developing offspring's consumption).

a) **b)**

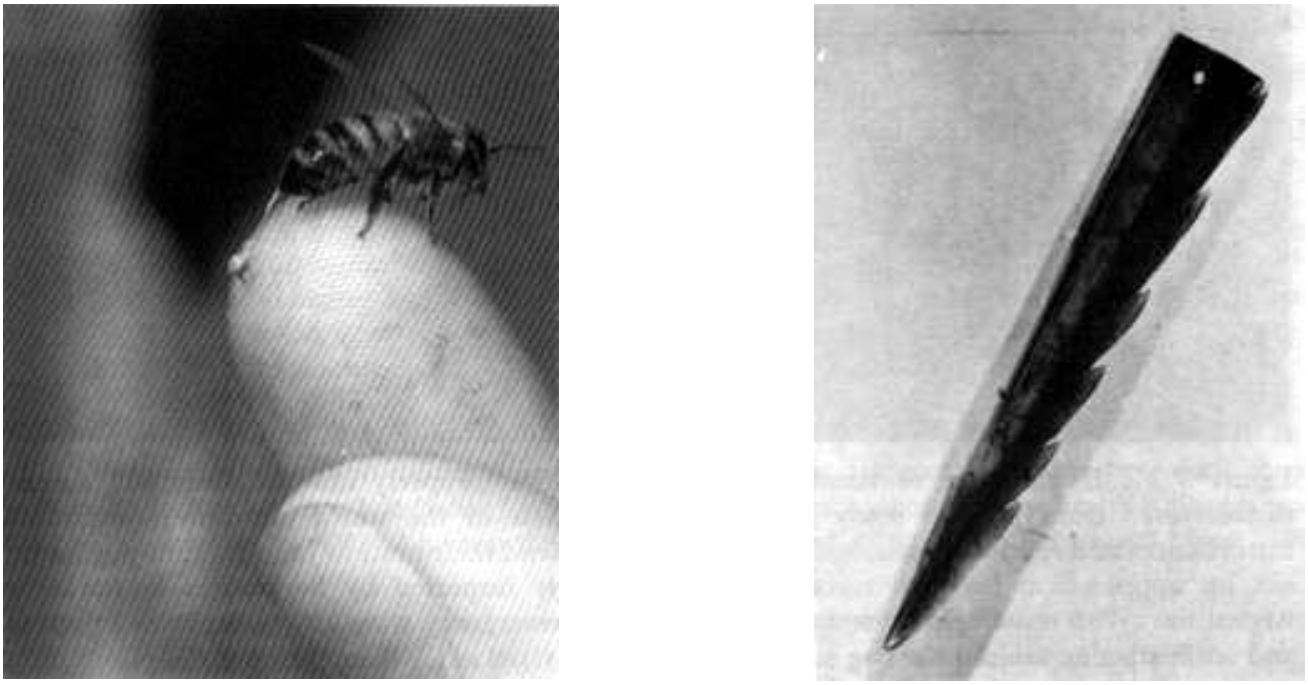


Figure 7.1 : A honeybee worker, stinging the relatively tough human skin, is unable to withdraw its sting lancets because of the fine barbs (a) unique to the honeybee sting. Once stung by a honeybee, the whole sting apparatus, venom sack and all, almost always remains (b). This occurs only with honeybees and with no other stinging insect.

Honeybee venom is produced by two glands associated with the sting apparatus of worker bees. Its production increases during the first two weeks of the adult worker's life and reaches a maximum when the worker bee becomes involved in hive defence and foraging. It diminishes as the bee gets older. The queen bee's production of venom is highest on emergence, probably because it must be prepared for immediate

battles with other queens.

When a bee stings, it does not normally inject all of the 0.15 to 0.3 mg of venom held in a full venom sac (Schumacher et al., 1989 and Crane 1990, respectively). Only when it stings an animal with skin as tough as ours will it lose its sting - and with it the whole sting apparatus, including the venom sac, muscles and the nerve centre (see Figure 7.1 and 7.2). These nerves and muscles however keep injecting venom for a while, or until the venom sac is empty. The loss of such a considerable portion of its body is almost always fatal to the bee.

Figure 7.2 : If disturbed or handled improperly most colonies will defend themselves. Honeybees in many parts of the world are very sensitive to disturbances and react *en masse* to defend their nest, as this innocent dog found out on approaching beehives recently inspected by beekeepers in northern Argentina. With some help from an emergency sting kit (epinephrine injection and antihistamine tablets) the dog survived more than 1000 bee stings.

The median lethal dose (LD_{50}) for an adult human is 2.8 mg of venom per kg of body weight, i.e. a person weighing 60 kg has a *50%* chance of surviving injections totalling 168 mg of bee venom (Schumacher et al., 1989). Assuming each bee injects all its venom and no stings are quickly removed at a maximum of 0.3 mg venom per sting, 600 stings could well be lethal for such a person. For a child weighing 10 kg, as little as 90 stings could be fatal. Therefore, quick removal of the stings is important. However, most human deaths result from one or few bee stings due to allergic reactions, heart failure or suffocation from swelling around the neck or the mouth.

Used in small doses however, bee venom can be of benefit in trcating a large number of ailments. This therapeutic value was already known to many ancient civilizations. Today, the only uses of bee venom are in human and veterinary medicine.

7.2 Physical characteristics of venom

Honeybee venom is a clear, odourless, watery liquid. When coming into contact with mucous membranes or eyes, it causes considerable burning and irritation. Dried venom takes on a light yellow colour and some commercial preparations are brown, thought to be due to oxidation of some of the venom proteins. Venom contains a number of very volatile compounds which are easily lost during collection.

7.3 The composition of venom

A large number of studies have been carried out on the composition of honeybee venom. Much of the basic identification of compounds, their isolation and the study of their pharmacological effects was done in the 1950's and 1960's. There are some comprehensive summaries in Piek (1986) which cover the morphology of the venom apparatus, the collection of venom, the pharmacological effects of bee venom and allergies to the Hymenoptera venom of bees, wasps and ants.

88% of venom is water. The glucose, fructose and phospholipid contents of venom are similar to those in bee's blood (Crane, 1990). At least 18 pharmacologically active components have been described, including various enzymes, peptides and amines. Table 7.1 lists the major components as summarized from Dotimas and Hider (1987) and Shipolini (1984). No further discussion of the detailed chemistry and various effects of individual components will be attempted here. Schmidt (1992) presents a comprehensive account of allergies to honeybee and other Hymenoptera venoms. Crane (1990), Dotimas and Hider (1987) and Banks and Shipolini (1986) give a very good overview of its composition, effects, harvesting and use.

Venom from other Apis species is similar, but even the venoms from the various races within each species are slightly different from each other. The toxicity of Apis cerana venom has been reported to be twice as high as that of A. mellifera (Benton and Morse, 1968).

Table 7.1:
Composition of venom from honeybee worker

Class of molecules	Component	% of dry venom[a]	% of dry venom[b]

Enzymes	Phospholipase A_2	10-12	10-12
	Hyaluronidase	1-3	1.5-2.0
	Acid Phosphomonoesterase		1.0
	Lysophospholipase		1.0
	α -glucosidase		0.6
Other proteins and peptides	Melittin	50	40-50
	Pamine	1-3	3
	Mast Cell Degranulating Peptide (MCD)	1-2	2
	Secapin	0.5-2.0	0.5
	Procamine	1-2	1.4
	Adolapin		1.0
	Protease inhibitor	0.1	0.8
	Tertiapin[c]	13-15	0.1
	Small peptides (with less than 5 amino acids)		
Physiologically active amines	Histamine	0.5-2.0	0.5-1.6
	Dopamine	0.2-1.0	0.13-1.0
	Noradrenaline	0.1-0.5	0.1-0.7
Amino Acids	τ -aminobutyric acid	0.5	0.4
	α -amino acids	1	
Sugars	Glucose & fructose	2	
Phospholipids		5	
Volatile compounds		4-8	

Dotimas and Hider, 1987; [b] Shipolini, 1984
This peptide may not be present in all venom samples

7.4 The physiological effects of venom

7.4.1 Unconfirmed circumstantial evidence

Bee venom has long been used in traditional medicine for the treatment of various kinds of rheumatism. Although venoms of the different honeybee species differ slightly, there have been reports of successful rheumatism treatment with Apis dorsata venom by Sharma and Singh (1983) and with A. cerana venom by Krell (1992, unpublished).

The list of benefits to human beings as well as to animals is very long. Most of the reports of cures are of individual cases, though several unrelated patients have experienced the improvement or cure of similar ailments. Bee venom treatments are often accompanied by changes in life style, nutrition or other which may account for part, if not most of the benefits from treatments. Reported clinical tests were often conducted in countries with less rigorous methods than the standard Western, double-blind placebo tests. Despite these considerations, many patients did report positive results and many of the successful treatments occurred after established medical or surgical procedures had failed. However, there is a very real resistance in Western medical circles either to accept these results or to test bee venom treatments according to Western medical standards.

The diseases and problems which have been reported by patients or doctors as improved or healed with bee venom therapy are listed below (Table 7.2). This does not constituent an endorsement or recommendation for the treatments. Stinging should never be tried unless there is immediate access to emergency treatment in case of an allergic reaction.

Table 7.2 List of diseases and health problems improved or healed according to anecdotal reports

Humans		
Arthritis, many types[a]	Multiple sclerosis[a]	Premenstrual syndrome[a]
Epilepsy[a]	Bursitis[a]	Ligament injuries[a]
Mastis[a]	Some types of cancer[a]	Sore throat[a]
Chronic pain[a]	Migraine[b]	General immuno-stimulant
Decreases blood viscosity and coagulability[b]	Dilates capillaries and arteries[b]	Decreases blood cholesterol level[b]
Neruoses[b]	Rhinosinusitis[c]	Endoarteriosis[d]
Therosclerosis[d]	Polyneuritis[e]	Radicultitis[ef]
Infectious spondylitis[e]	Neuralgia[e]	Endoarthritis[e]
Infect. Polyarthritis[e]	Malaria[e]	Intercostal myalgia[f]

Myositis[f]	Tropical ulcers[f]	Slowly healing wounds[f]
Thrombophiletritis[f]	Cancer, temporary[f]	Keratoconjunctivitis[g]
Iritis[g]	Iridocytis[g]	Asthma[h]
Animals		
Arthritis		

BeeWell, 1993, 1992; [b] Kel'man, 1960; [c] Fotin & Gel'medova, 1981; [d] Poryardin, 1960; [e] Gaider, 1950; [f] Lavochev, et al., 1958; [g] Naum Iyorish, 1974; [h] Dutta, 1959.

7.4.2 Scientific evidence

During the last seven decades, over 1700 scientific publications on the composition and various effects of bee venom in animals and humans have been published. An overwhelming proportion comes from Eastern Europe and Asia. Most of them concentrate on demonstrating the site specific, physiological effects of individual components such as membrane destruction, toxicity, or the stimulation or blocking of enzyme reactions. This has largely increased our understanding of the processes occurring after a sting, the physiological effects of isolated venom compounds and the substances responsible for most of the allergic reactions. It has contributed little to verifying the increasing claims of different therapeutic values attributed to honeybee venom, however.

A study with whole bee venom on dogs (Vick and Brooks, 1972) and rats (Dunn, 1984) showed that melittin and apamine produce increased plasma cortisol. Together with various other arguments, this suggests that many of the curative effects of bee venom may work through stimulation of the body's enzyme and immune system, in a way similar to the common drug cortisone. Cortisone has been used in the treatment of many ailments, but it is also known to have strong, undesirable side-effects. Melittin also appears to have toxic side effects as do some of the other individual compounds in venom. When whole venom is applied however, no side-effects have been shown, other than in allergic patients (Broadman, 1962 and Weeks, 1992 personal communication).

The anti-inflammatory effects of bee venom are perhaps the best studied and the various mechanisms have been repeatedly described in scientific literature (Rekkaand Kourounakis, 1990; Kim, 1989 and others). The neurotoxic venom compounds have shown a potential benefit for epileptic patients (Ziai, 1990). The protective value of bee venom and melittin against the lethal or damaging effects of x-rays has been investigated (Shipman and Cole, 1967 and Ginsberg et al., 1968). Though these and many other results are encouraging, no clinical studies have been carried out to verify the effectiveness using tests accepted by the Western medical establishment. Nevertheless, more and more physicians and healers are experimenting with this benign treatment after they have tested the patient's allergic reactions to bee venom. Recently, after long efforts by the American Apitherapy Society and its members, some interest has been shown by national institutions in several Western European countries and the USA for clinical and large scale tests of bee venom therapy.

A good summary of the scientific studies, with further references can be found in Banks and Shipolini (1986) and Schmidt (1992). Summaries of some of the major specific effects of the various venom compounds that

are shorter and more easily understood, can be found in Mraz (1983), Dotimas and Hider (1987), Crane (1990) and Schmidt and Buchmann (1992). The American Apitherapy Society keeps records of scientific as well as anecdotal information on the use of bee venom. It is also probably the best source of information on any subject related to apitherapy (see Annex 2).

7.5 The use of venom today

No uses for venom, other than medical ones are known to the author. The only legally accepted medical use of bee venom in Western European and North American countries is for desensitizing people who are hypersensitive (allergic) to bee venom. Since the early 1980's, pure bee venom has been used for desensitization. The use of whole body extracts has been largely discontinued after a double-blind test proved the higher efficiency of pure venom (Hunt et al., 1978). In Eastern Europe and in many Asian countries bee venom has been used in official medical treatment of a large variety of ailments for a considerable length of time.

The use of pure venom injections and well placed bee stings is increasing in Western countries as an alternative to heavy (and soinetimes ineffective) drug use, which is often associated with numerous side-effects. This is particularly so for arthritis and other rheumatoid inflammations. A list of some other ailments for which successful treatments with bee stings have been reported has been given in section 7.4.1.

Application methods for venom include natural bee stings, subcutaneous injections, electrophoresis, ointments, inhalations and tablets (Sharma and Singh, 1983).

Since bee venom has both a local and a systemic effect, correct placement of injections, or stings and the dosage are very important. Therefore, bee venom therapy must be properly learned. Still, relief of some ailments can be obtained by simply applying a sting or two to the affected area, i.e. to some painful, immobile arthritic joints.

A society for api-acupuncture was formed in 1980 in Japan (see Annex 2). In the following years, many reports of experiences and successes in api-acupuncture appeared (in Japanese) in Honeybee Science (e.g. Ohta, 1983 and Sagawa, 1983). In the Republic of China, bee venom therapy is combined with a knowledge of acupuncture by many hospitals and physicians.

In the West, the American Apitherapy Society (AAS) is collecting case histories and information on bee venom therapy, together with medical uses of other bee products. There may be other national organizations, particularly in Eastern Europe and Asia. IBRA and Apimondia also have a wide collection of reference materials (see Annex 2).

7.6 Venom collection

Early collection methods required surgical removal of the venom gland or squeezing each individual bee until a droplet could be collected from the tip of the sting. Since the early 1960's, extraction by the electro-shock method has been continuously improved and is now standard procedure.

Different extraction or collection methods result in different compositions of the final products Venom collected under water to avoid evaporation of very volatile compounds seems to yield the most potent venom (Pence, 1981). Venom collected from surgically removed venom sacs showed different protein contents from that collected with the electroshock method (Hsiang and Elliott, 1975). Gunnison (1966) used a cooling

system with the standard electro-shock collecting apparatus in order to preserve more of the volatile compounds.

The standard electro-shock method (Morse and Benton, 1964a, b) cannot be recommended for venom collection from Africanized honeybees or the more defensive races in other parts of the world. Colony arousal can become so overwhelming that bees start killing each other and alert other colonies or attack the beekeeper and bystanders. The mass reaction of Africanized honeybees may also result in contamination of the collected venom. Nevertheless, venom is collected by this method in Brazil and Argentina, with only minor modifications.

Even European colonies remain disturbed for up to a week after collection (see Figure 7.5) and it is said by Mitev (1971) that colonies from which venom has been collected every three days produce 14% less honey. Morse and Benton (1964b) found no such evidence for reduced productivity, however. Galuszka (1972) found that when using electro-shock treatment, the most efficient collection cycle was three 15-minute stimulations at intervals of three days, repeated after 2 - 3 weeks. An Argentinean beekeeper found that by modifying the electric stimulus, his collection efficiency greatly increased and the bees remained disturbed for less time.

The various trap designs stimulate bees by applying a mild electric shock through wires above the collecting tray. The most widely-used designs are modifications of the one first presented by Benton et al., (1963). A review by Mraz (1983) discusses further developments. The trays are placed either between the bottom board and brood chamber at the hive entrance (see Figure 7.3) or in a special box between supers and the hive cover, (Palmer, 1961, USA Patent 3,163,871, 1965, as cited by Crane, (1990).

a)

b)

Figure 7.3 a) Mr. Mraz with an electro-shock venom collector in his beeyard. b) Placing the collector in front of the hive entrance. (Courtesy of B. Weeks)

When shocked, bees sting the surface on which they are walking. In some traps, this may be a glass plate or a thin (0.13 mm thick) plastic membrane, nylon taffeta or silicon rubber under which a collecting plate (preferably made of glass) or absorbent tissue receives the venom (see Figure 7.4). Venom dries rapidly on glass plates and can be scraped off with a razor blade or knife. Absorbent tissue is washed in distilled water to

extract the venom, which then should be freeze-dried. Collection on glass is generally easier and produces a product which is easier to store, ship and process. During handling of dry bee venom, protective gloves, glasses and dust masks should be worn to avoid any contact with, or inhalation of the highly concentrated venom.

It is unlikely that a bee will eject all the contents of its venom sac, even after repeated stinging. Therefore, typically, only *0.5* to 1.0 jil (0.2 j£l - Crane, 1990) of venom can be collected per bee, with an average of ten stings per bee (Mu~ller, 1939 and O'Connor et al., 1967). This results in less than 0.1 ijg (0.11 jig - Crane, 1990) of dry venom per bee. Consequently, at least 1 million stings are required to make one gram of dry bee venom. Dotimas and Hider (1987) report that 1 g of venom can be collected from twenty hives over a two hour period.

Figure 7.4 : Close-up of collecting device with stings. The steel wires are approximately 6 mm apart and suspended 1 to 3 mm above the thin silicon rubber film or directly above the glass plate in other models. The wires are alternately grounded and charged to a maximum of 33 volts. A lower voltage is effective, too. Preferably a collecting surface should be used which does not make bees loose their sting. (Courtesy of B. Weeks)

Instead of collecting bee venom, adult bees may be used to sting the patient directly. This is the way to apply the venom in its freshest, most complete and cheapest form. To collect the bees, a small hole is made in the brood chamber, super or inner cover. To avoid colony disturbance, the hole is opened and a collecting jar placed over it until a sufficient number of bees have come out. Small groups (10-100) of workers can be maintained at home for up to 2 weeks. They should be kept in the dark, in a small box (with one side made of fly-screen) and with access to sugar syrup. Care needs to be taken to keep ants away. Alternatively, bees can be collected from frames or the hive entrance by a suction device similar to the one described in Figure 6.6. However, a screen should be placed over the tube leading to the mouthpiece to prevent any bees from reaching the mouth.

7.7 Venom products

Bee venom may be sold as whole bee extract, pure lidquid venom or an injectable solution, but in either form the market is extremely limited. Most venom is sold in a dry crystalline form.

Figure 7.5: Honeybees outside of the hive shortly after electro-shock treatments. The venom extraction board is still leaning over the hive entrance. (Courtesy of B. Weeks)

Since venom does not need to be processed, it can be prepared wherever bee venom therapy finds sufficient support. Production in small quantities is easy, as long as stringent sanitary controls and aseptic working conditions can be provided. The beekeeper has to work under extremely clean conditions, since most of the venom preparations will later be used for injections into humans or animals.

For injections, the venom can be mixed at the time of injection with injectable fluids, such as distilled (sterile) water, saline solutions and certain oils, or it may be taken from prepared ampoules. Ampoules with set doses of ready-to-inject venom should only be prepared by certified pharmaceutical laboratories, because of the need to maintain stringent aseptic conditions and to measure the dosages very precisely.

There are creams available which include bee venom (e.g. Forapin and Apicosan in Germany, Apivene in France and Immenin in Austria) which are used for external application on arthritic joints (BeeWell, 1993 and Sharma and Singh 1983) but neither the ingredients nor their proportions are known to the author. A general recipe for bee venom ointments is given in section 7.13.

Tablets can be impregnated with quantities of bee venom, but Sharma and Singh (1983) recommended the removal of toxic proteins, such as Melittin and the use of colours to indicate different dosages. The tablets should be placed under the tongue, but no indication is given to the effect or usefulness of such a preparation.

Some specialized laboratories may be able to separate and purify different venom compounds and sell them to scientific and pharmaceutical laboratories. Phospholipase A_2 and highly active peptides are among some of the proteins purified from bee venom for scientific suppliers or laboratories (Schmidt and Buchmann, 1992). Entry to this limited market requires a highly sophisticated laboratory and very well-trained technicians and

chemists.

No further use or inclusion of venom in other products is presently known to the author.

Though not directly related, bee sting emergency kits can be sold in some countries, particularly to people who are allergic. They also should be at hand for any beekeeper working with Africanized honeybees and at training centres, police and fire departments, in areas with Africanized honeybees. In the USA, they are now available only against a prescription. Such a kit (e.g. Anakit by Hollister Stier, USA) should contain at least:

1) One syringe with a premeasured content of epinephrine (adrenaline) or atropine, for immediate intramuscular injection - usually 0. 3m1 of a diluted solution of epinephrine (1:1000) in saline solution. There are special, easy-to-use, syringes available from bee supply houses or through pharmacies, which can even be used through clothing (Epipen by Centre Laboratories, USA).

2. anti-histamine tablets.

3. tourniquet.

4. instructions about when, where and how to use the syringe and anti-histamine tablets; when not to use epinephrine, and where to seek medical help.

Epinephrine injections should be given only in extreme emergencies when no other medical help is available. The sting emergency kit has a limited shelf-life and should be kept refrigerated when not in use.

7.8 Buying

The best way to buy bee venom is in the crystallised form, since it is more stable, impurities are easier to detect and adulteration is less likely. The colour of both crystals and powder should be a very light yellow.

Liquid venom as mentioned in section 7.2 should be clear and colourless. Darker venom is slightly oxidized and may have lost some of its effectiveness.

As with all other products where immediate testing is not possible or is very expensive, the producer should be one who is well-known and who can be trusted to produce a high quality product. The producer as well as the buyer should have adequate storage facilities.

7.9 Storage

Even dried bee venom should be stored refrigerated or preferably frozen and it should always be kept in dark bottles in the dark. All producers and buyers should closely observe these conditions. Dried bee venom can be kept frozen for several months, but should not be kept refrigerated for more than a few weeks. Liquid venom and diluted venom can be stored for similar periods if maintained in well sealed, dark glass containers.

7.10 Quality control

There are no official quality standards, since bee venom is not recognized as an official drug or as a food. Purity analysis may be carried out by quantitative analyses of some of its more stable or more easily

measured components such as melittin, dopamine, histamine, noradrenaline or those for which contamination is suspected.

A nematode, Panagrellus redivivus was reported to react selectively and specifically to bee venom and a quantitative analysis of the venom in pharmaceutical preparations was developed by Tumanov and Osipova (1966) using this organism.

Pence (1981) describes a method for testing the biological activity of bee venom by measuring electric pulses from muscles of excised honeybee abdomens in response to the volatile materials from bee venom.

Guralnick et al., (1986) described standardization and quality control methods for purity and effectiveness of Hymenoptera venom, including honeybee venom.

7.11 Caution

Collecting bee venom requires careful work with the highest degree of cleanliness, since the venom will be injected directly without further processing or sterilization. Protection of the collector against the disturbed bees and highly irritative dry venom is very important, too. Since people up to several hundred meters away might get stung by the highly irritated bees, further precautions at the time of collection in the apiary must be considered.

When handling dry venom, laboratory gowns, gloves and face masks should be worn to avoid getting venom dust into the eyes and lungs. All equipment should be carefully washed afterwards. Contact between other people and contaminated material should be avoided People who do not regularly handle bees, who only get stung occasionally or are exposed occasionally to venom dust, run the risk of developing allergies.

Using bee stings for self-treatment of various diseases can be risky, because allcrgies to bee venom can be developed quickly even after long periods of use. An emergency kit (see section 7.7) or quick access to an emergency service should always be available. No other side-effects have been reported, but regular supervision, check-ups and controls should be continued with competent doctors trained in apitherapy.

Since severe allergic reactions are possible, bee venom should not be casually included in any health or medicinal products. Products containing bee venom need labels stating the contents and warning people of possible allergic reactions.

7.12 Market outlook

Bee venom is a highly specialized product with only very few buyers. The market volume is relatively small too, although there are no comprehensive surveys. The main venom producer in the USA has produced only about 3 kg of dry venom during the last 30 years (Mraz, 1982) but there is a large producer in Brazil and more or less significant amounts are produced in many other countries.

Prices in 1990 varied greatly between US$100 and US$200 per gram of dry venom (Schmidt and Buchmann, 1992). Prepared for injections or sold in smaller quantities, prices can be much higher. However, the beekeeper often does not get this price. The prevailing prices in European and Asian markets are generally slightly lower.

Local manufacturing of the pure venom however, is relatively easy and within the means of many beekeepers; no expensive or high technology processing is required except refrigeration, but its economic feasibility depends on access to the few specialized buyers. In contrast, the venom in less controlled dosages is available almost everywhere, from a beekeeper or one's own hives, free or at very low cost. Often, the only price is the life of the bee.

Though the fractionation of venom goes beyond the means of a small local enterprise, several people working in the field feel that, with further research, there will be a small market niche for specialized laboratories. Since there are several pharmacologically interesting substances in bee venom and since apitherapy may become officially accepted in the future, a better market for the whole product or for special fractions might develop. However, much depends on the official acceptance of bee venom therapy.

7.13 Recipes

Ointments can be prepared by thoroughly homogenizing bee venom with white Vaseline, petrolatum or melted animal fat, and salicylic acid, in the ratio of 1:10:1. The salicylic acid softens the skin, increases its permeability and is a treatment for rheumatism even on its own. The ointment may contain a small amount of silicate crystals to act as an abrasive (Sharma and Singh, 1983).

Other preparations consist of mixing bee venom with sterile, injectable fluids and packaging them in single dosages in glass vials or syringes. In some packages the dry venom is kept separate from the fluid and the two are mixed when the vial is broken.

Techniques for separating the different compounds in venom are far beyond the scope of this book. Such information can be obtained from properly trained chemists.

Contents - **Previous** - **Next**

CHAPTER 8
ADULT AND LARVAL HONEYBEES

8.1 Introduction

As adult honeybees are the producers of all the primary products of beekeeping, it is unlikely that a beekeeper will sell these adult bees when he or she is interested in production of primary products. Honeybees or their brood can however, constitute a primary product, and may be sold directly or be processed for other uses. Beekeepers can make a profit from selling their adult bees, often together with combs of larvae. Depending on market conditions, they can sell their bees in the form of package bees, nuclei or small starter hives and whole, full-size colomes

In many countries, bees are considered a nuisance when they nest in or near houses. This is particularly true when they are among the more defensive types. In such cases, beekeepers may be able to charge to remove the bees. If these bees are not used by the beekeeper to strengthen his own operation and were not killed with pesticides, they can be killed and fed to chicken or pigs. Otherwise, they can be composted. The same procedures are even easier with the brood frames of such colonies. Both adults and larvae are a good protein source.

In many African and Asian countries, brood combs are considered a delicacy and consumed immediately when available (see Figure 8.1). They are also particularly rich in protein since they usually contain quantities of beebread, i.e. the slightly fermented pollen stores of the hive. In some Asian countries, worker or drone pupae (in their white stage) are also prepared for human consumption by pickling or boiling. In canned form, they are found in some European or American specialty stores and can be considered a value added product, even if there is not much demand or a broad market perspective in the West.

8.2 The chemical composition of adult and larval honeybees

The chemical composition of mature and immature honeybees has not received as much attention as that of some other primary products. Only data with few details can consequently be presented (Table 8.1). The data for adult bees has been adapted in order to be comparable to the fresh weight data of immature bees. A 1 % glycogen content was estimated rather than the 9.08% sugar content found in the samples in the original analysis, which was probably due to honey in the bees' digestive tracts. On this basis, adults and immatures have very similar protein values. In adults, over 40% of the protein comes from the muscular tissue of the thorax, which is similar in protein to egg-white.

Figure 8.1 : Mr. Lusale, a Zambian beekeeping extension officer, demonstrating an alternative use for bee brood.

8.3 The uses of adult bees and larvae

8.3.1 For beekeeping

The major use of larval and adult bees is undoubtedly that made by the beekeeper for the production of primary bee products. While both can also be considered primary products, the production of complete colonies, starter colonies and packages of bees or queens, are usually not considered as beekeeping !?products' (see Figure 8.2). On the other hand, these activities can produce a considerable amount of additional income, or constitute a whole line of business on their own. A growing beekeeping industry, or growing interest in beekeeping, usually creates a demand for these products.

Their production requires hardly any additional investment if operated on a small scale and profitable sales can be made even if sold one-by-one. However, in many village environments in particular, sales communication between customer and producer often needs to be facilitated by an organization or extension service. A description of how to produce queens, package bees, divide and build-up colonies etc. can be found in all good beekeeping textbooks and manuals. The interested reader is urged to consult these.

Table 8.1:
Composition of mature and immature honeybees compared to beef and soybeans (in % of fresh weight; vitamins in International Units per g fresh weight) modified from Crane, 1990.

	Honeybee			Beef	Soybean[d]
	Mature larvae	Pupae	Adult[a]		
Water	77.0	70.2	72.1	74.1	70.0
Ash	3.0	2.2		1.1	1.5
Protein	15.4	18.2	17.9	17.7[b]	12.9
Fat	3.7	2.4	2.8	2.8	5.9
Glycogen	0.4	0.8	1	0.1-0.7	2.4[c]
Vitamin A	107	51.3		0	
Vitamin D	6863	5165			
Chitin/fibre			4.1		1.7

[a] *Data corrected for sugar/honey content of analyzed bees, from Ryan et al., 1983;*
[b] *Data from Krause an Mahan, 1979;*
[c] *Total sugars;*
[d] *Soybean data adapted from Smith and Circle, 1972.*

8.3.2 For pollination

In the widest sense, one might consider the pollination benefit for agricultural crops provided with honeybee colonies as a value added product. Such benefits increase with more intensive cultivation and more progressive destruction of the natural environment. When planted in monocultures over large areas, crops that require pollination need managed populations of pollinators for any significant production of fruits or seeds (see Figure 8.3). Smaller areas of the same crop may not need the introduction of managed colonies. If they are still surrounded by natural flora, or if alternative floral sources are available to wild pollinators during most of the year. Selection of varieties, and cultural practices such as interplanting can reduce "artificial" pollination requirements for some crops.

Beekeepers in industrialized countries usually charge for pollination services, because they bring the farmer a significant increase in production, are more work for the beekeeper and usually do not produce a honey crop while supplying the service. A detailed discussion of this subject - the different requirements in infrastructure, environment and agricultural practices - are discussed in another FAO publication (Roubik, 1994).

a)

b)

Figure 8.2 : (a) Packaged bees ready for shipment. (b) Caged, mated queen bee with attendant worker bees and sugar candy, ready for sale, shipment or introduction to a new colony.

Figure 8.3: Honeybee colonies, used for pollination, on the edge of a sunflower field.

8.3.3 As food

Adult and larval honeybees contain reasonable amounts of protein and are non-toxic (Table 8.1). They could therefore serve as a direct food source once the beekeeper has no more need for extra bees or brood, or when undesired colonies have to be removed. Honeybee brood of all ages is eagerly consumed by honey hunters in Africa and Asia and is generally considered a delicious treat. For several cultures, brood is said to form a considerable part of the diet (Hill et

al., 1984 and Bailey, 1989; as cited in Schmidt and Buchmann, 1992). In China and Japan, drone larvae are canned for export or, after being covered in chocolate, become a sweet treat. Bee brood is regularly sold alongside honey in markets in many parts of Asia (Schmidt and Buchmann, 1992).

Whether fresh, boiled or fried, larvae have a rich nutty flavour. When fried, they maintain their shape and become nice and crunchy. Eating insects in general is considered normal in many cultures, while others have developed strong inhibitions to this practice.

Development time from egg-laying to the adult larvae is 8 to 9 days. If the larvae are harvested right after the cells are capped, they will have increased in weight approximately 1000-fold. The protein content will have increased only slightly less. This growth rate is not as rapid as that of some fly larvae, but is still much faster than the growth rate of more traditional protein sources such as cattle or chicken. Many species of insect larvae are easier to grow, but of all the insects to eat, honeybees probably have the highest public appeal and are probably more acceptable than, for example fly larvae or crickets. While it is difficult to imagine that honeybee larvae will become a major source of protein, they are a special delicacy in some countries and may become so in others. Additionally, they can be a useful protein supplement in otherwise poor diets. Human consumption of adult honeybees is uncommon.

If a colony has to be killed, or the death of a colony is detected soon enough and is not due to pesticides, the fresh or dried bees may replace some of the regular feed for small mammals, birds, chickens (Witherell, *1975)* or pigs (Dietz et al., 1976). The author has heard testimonies that indicated both the presence and absence of benefits to poultry. In a similar way, unwanted bees removed from houses or swarm traps may be killed by overheating in a black plastic bag and be composted, or dried and powdered to feed to livestock. However, it is not economically feasible to grow bees for this purpose alone.

Mature drone larvae are in general the preferred choice, probably because of their larger size. In tests with bee larvae as a diet for insect rearing (Coccinellids), frozen drone larvae appeared to provide a more complete diet than worker larvae (Okada, 1971). Bee larvae have been shown to be an excellent food source for rearing insects, particular various beetles and lacewings (Chrysopidae) used for biological pest control (Okada and Matsuka, 1973; Matsuka et al., 1982 and Hasegawa et al., 1983). All kinds of bee larvae were suitable for rearing songbirds (Gary et al., 1961; Guss, 1967 and Lanyon and Lanyon, 1969). The feeding of dried A. cerana larvae to queens of the same species seems to maintain egg-laying, though no long-term tests have been done (Gondal and Hashmi, 1976). Unfortunately, the data are not sufficient to make any deductions as to whether dried larvae are as nutritive or stimulative as royal jelly.

The greater wax moth (Galleria mellonella), though not a bee product, is a very common pest, little appreciated by any beekeeper. It is very easy to raise, however and its eggs can be readily obtained by any beekeeper. The larvae can be stored alive for over a year at 15 ^{0}C and 60% relative humidity. When deep fried in oil, the larvae burst and look more like popcorn than insects, which may help in marketing. Simple rearing instructions and a "popmoth" recipe are included in the recipe section.

8.3.4 As medicine

Italian psychiatrists observed improvements in respect to the appetite, body weight, hepatic activity, digestion and haemopholetic functions of 15 female psychiatric patients who were suffering from loss of weight and appetite (Monteverdi and Reitano, 1972).

No other references to any medical tests regarding the consumption or the application of whole larvae, adults or their extracts are known to the author. Whole-bee extracts have in the past been used to desensitize people allergic to bee stings, though with unreliable results. This practice has been discontinued since Hunt et al., (1978) reported that whole-body extracts are no more effective for desensitization than no treatment at all. Pure bee venom has now become the standard for immunization therapy. The production of bee venom from adult bees is covered in Chapter 7.

8.3.5 In cosmetics

During the 1950's, when royal jelly was a "fashionable" product, several patents were registered for the use of queen larvae in cosmetics. References on the subject can be found in section 9.5, but no such current use of such applications is known.

8.4 Collection

8.4.1 Adult bees

Adult bees can be collected regularly from colonies during the growing season by shaking bees off the brood frames into packages (see Figure 8.4). This practice is described in all major beekeeping books on Apis mellifera which have a section on package bee production. Whole businesses have been founded on the production of these packages for beekeepers, but they also need to have a queen rearing operation, since bees should not be shipped without a queen. In Canada, a cotton ball wetted with synthetic queen pheromones has recently been tried successfully as a substitute for a queen, but this method has not been tested extensively for commercial applications yet.

Package bee production is suitable for areas that have an early flowering season, i.e. earlier than in the major honey producing areas. Beekeepers have to be willing to pay for bees and queens and transport has to be safe and quick. The same holds true for production and sale of nucleus starter hives and whole colonies, except that the sale of these is not as dependant on early nectar flows. Either are feasible on a large to very small scale.

If a colony has to be removed from a house or other inaccessible place and is intended for consumption by either human beings or animals, the bees should be sprayed with a mist of plain water or sugar water so that they are easier to bag and cannot fly off. Normally, soapy water is used to achieve this effect, but the soap is difficult to rinse out prior to consumption. They should then be either frozen or overheated to kill them. For storage and further processing see section 8.6 and 8.10.

Figure 8.4 : Using a funnel to shake bees into packages in a North American apiary.

8.4.2 Honeybee larvae

The removal of drone larvae will have less affect on colony performance than the removal of worker larvae. Though highly seasonal, drone production can be initiated through feeding and queen selection, and may be promoted further by providing drone size comb or foundation to the colony. In areas where Varroa is controlled by trapping the parasite in drone cells and removing the freshly sealed drone brood, the use of these otherwise discarded larvae may be considered.

Opened or unsealed cells can be shaken and larvae knocked out, but to avoid breaking the comb, it previously should have been reinforced by wiring. Older, dark-coloured combs should be selected. Ideally, most of the larvae should be of similar age. It is easier to use combs which have been sealed for only a few hours, but larvae should have finished pdupation. The cells are uncapped with a fine, serrated and preferably warmed knife, and the larvae and pupae shaken out onto a sheet of paper, aluminum foil, leaf or other clean surface (see Figure 8.5 to 8.8). If the brood need not be whole, a fork with very long, fine prongs (as also used for honey uncapping) can be used to uncap and retrieve the larvae. Since larvae defecate just before pupation, larvae and pupae should be washed in clean water before further processing. Pupae will have clean, empty intestines.

Another method (Schmidt and Buchmann, 1992) uses a small jet of water from a laboratory wash bottle to remove individual larvae from their cells. The author had reasonable success flooding one side of an uncapped comb. All the cells were filled with clean water, and then the larvae and pupae were shaken out (see Figure 8.8).

If combs are to be discarded after removal from a house or wild nest, the whole comb may be squeezed or boiled. The

latter works best with new combs, but cells should be uncapped prior to boiling. The melted wax will harden at the surface and larvae will sink to the bottom. Some larvae will still have to be removed from older combs and occasionally from cocoons. The flavour is affected by this method.

8.5 Buying

Before purchasing packaged bees, nuclei or full-size colonies, the buyer should first check for diseases, know the producer and/or require a health certificate, if appropriate inspection services are available. It is always risky to bring bees into new areas, no matter where they come from and how well they have been inspected. Importations of bees have spread all major diseases and may drastically change the resistance of local bees to indigenous varieties of disease organisms. Care should be taken that the full strength of the colony, or the number of bees paid for, is obtained.

When buying brood only, the buyer should make certain that live brood is obtained. The time between removal of brood from the colony and processing should be minimal, since unsealed brood away from the colony will soon die and larval protein will decompose very quickly. Brood should be eaten or processed (boiled, fried or dried) immediately after harvesting. Combs must not be left in the sun under any circumstances.

For larval processing, a comb should contain newly sealed brood of a uniform age. Both larvae and pupae are consumed. Whether there are any preferences and significant nutritional differences, remains unknown. From Table 8.1, it appears that pupae might have a slightly higher protein content. Though no evaluations are known to the author, the highest quantitative nutritive value of larvae is likely to be just before and after metamorphosis into pupae, i.e. a few hours after sealing of the cell.

If processed larvae are bought, it should first be certified that processing was carried out properly under clean conditions, with fresh larvae. Larvae should preferably be dried without exposure to sunlight. Indirect solar drying can be used if the temperature does not exceed 90 ^{0}C. Heat lamps and infrared drying will have the same limitations, but lyophilization will have the least degenerative effect. Particularly if powdered larvae are purchased, adulteration needs to be checked.

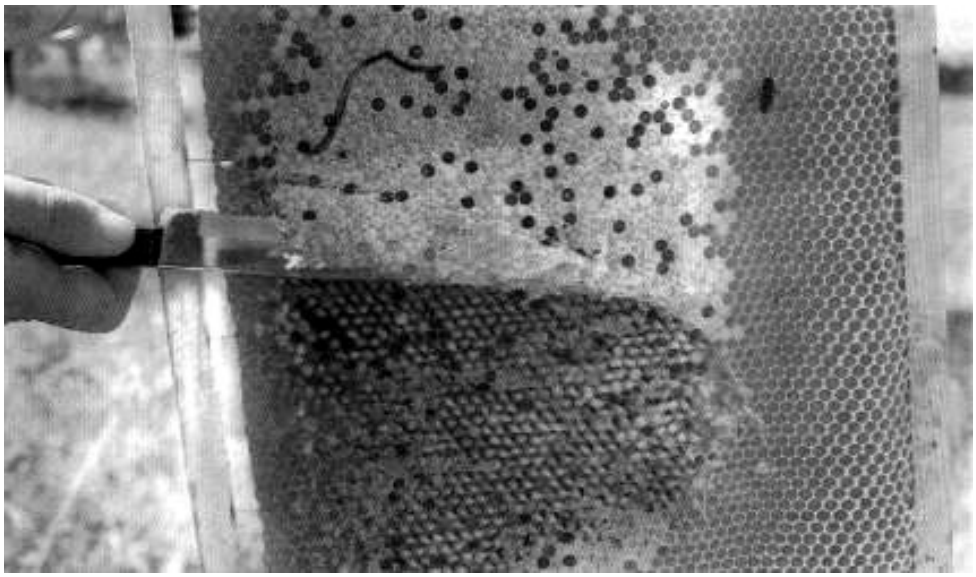


Figure 8.5 : Uncapping of recently sealed brood with a serrated knife. The comb is reinforced with wire but should be darker, i.e. older, to prevent breaking during shaking.

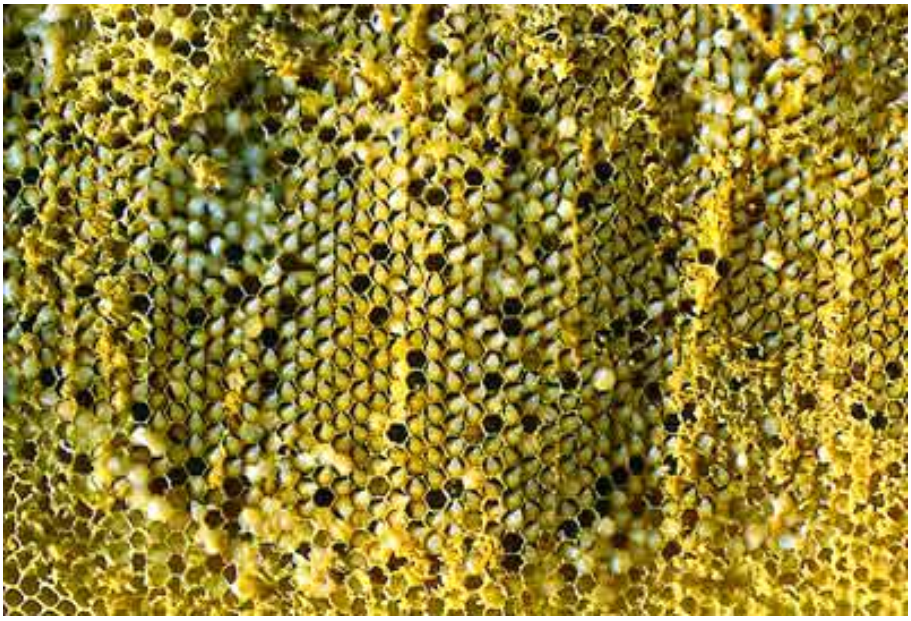


Figure 8.6: Uncapped comb of similarly aged larvae just prior to pupation. Larvae in slightly deformed cells are difficult to remove.

Figure 8.7 : Shaking out larvae on to a clean surface works best with a darkcoloured, wire reinforced comb.

8.6 Storage

Packages of live bees with a queen can be stored for several days more - and up to several weeks if stored with sufficient ventilation and food. In hot climates, bees need water and ventilation to stay cool. Overheating is a serious problem than exposure to cold temperatures. Bees should always have access to sugar syrup or honey. During transport, packages or colonies should not be left sitting in the sun for any amount of time. Transport at night is preferable where no other hazards exist.

Live brood should only be stored inside a hive. Sealed brood can also be maintained (kept alive) in a well regulated incubator, at a temperature of 32° to 35 ^{0}C (90° to 95 ^{0}F). Dead brood and bees need to be refrigerated immediately. All processing should be completed within 24 hours of killing and in hot and humid climates in less than 6 hours.

Larvae dried at 70° - *75* ^{0}C store well in sealed plastic bags at room temperature. Caramelization starts at higher drying temperatures. Drying under vacuum or reduced pressure may be advantageous. Deterioration is significant after 7 months of storage at room temperature, but storage deterioration over shorter periods has not been reported. Diets of dried, pulverized drone larvae performed well after storage for 7 months at either - 15~ or *5* ^{0}C and satisfactory after 7 years at *5* ^{0}C. Exposure to sunlight increased the rate of deterioration, as did heating to 120^{0}C (Sakai et al., 1978). Heating to 90^{0}C for 20 minutes had no noticeable deleterious effect, nor did y-radiation at a level of 2.5-3.5 x 106 rad (Sakai et al., 1978). This exposure kills many pathogens, including those of AFB. Fried or boiled larvae should be treated like other protein foods and should be consumed quickly, since even refrigerated they will keep only for a few days.

Figure 8.8: If brood cells are filled with water, most of the larvae can be dislodged much easier. This works even better with younger unsealed brood.

Preservation methods other than freezing and drying include smoking, pickling and canning. Smoked larvae were found to spoil after a few days unless the larvae were smoked for at least 12 hours at 60° - 90^{0}C and 30% relative humidity (Hocking and Matsumura, 1960). Pickling in 15 % and 20% salt solutions was unsatisfactory, mainly because the brood floated in a compact mass on the surface where decomposition was quiteadvanced after three weeks. Freshly killed larvae were pickled satisfactorily in a mixture of malt vinegar, whole mixed spices and 1 % salt. Brandy (alcohol) pickling was very effective with a 1:1 mixture of brandy and brood, changing the brandy after a few days. According to Hocking and Matsumura (1960) neither of the pickling methods produced a product of acceptable flavour.

Some of the above preservation methods and recipes described below lend themselves to canning. Standard canning methods and precautions should be observed.

8.7 Quality control

Quality control of purchased live bees and colonies should follow the guidelines given in the buying section. Beekeepers should ensure bees are healthy with young fertile queens.

Since there are no specific quality standards for honeybee larvae, national or international standards for similar foods should be applied, such as those for canned, dried or pickled meats. Even chocolate covered larvae are probably better treated as meats than sweets, because of their high protein content. Local laws and food standards have to be observed or exceeded. Because of the high protein content and perishability of the larvae and bees, good hygiene and attention to proper processing and handling conditions are essential more so than for most other bee products.

8.8 Caution

The greatest threat to live bees and colonies are diseases and overheating, both of which have to be carefully avoided.

For direct consumption of brood or larvae, care should be taken that no whole bees (alive or dead) are accidentally eaten, since the sting of even a dead bee can release venom when chewed. For the same reason, particular care should be taken when handling freshly frozen bees. Dried adult bees may be pounded or ground to avoid similar problems with livestock. Once the adults have been boiled or fried, the venom is no longer active.

8.9 Market outlook

As mentioned earlier, packaged bee production can be a considerable income source for beekeepers, as can the sale of queens, nuclei/starter colonies and full size colonies. Which of the forms of adult bees are most marketable in a country depends very much on the type of bees and the kind of beekeeping practised.

Nuclei colonies require frame hive beekeeping in standard sized bee hives. Whole colonies instead, can be sold in all sorts of traditional bee hives but buying or selling packaged bees only makes good sense in more intensive, frame hive beekeeping. These conditions, in addition to beekeepers' attitudes and the profitability of beekeeping vary too much from country to country to allow any valid generalizations. Markets, however can be tested easily since small scale sales and production do not require any additional investments.

For the consumption of larval and adult honeybees as food, specialized markets may be accessible where, for example, ethnic communities might consume such foods. Good tasting snacks can be prepared, packaged and sold where no prejudice exists against the consumption of insect larvae. For example, deep fried, salted or sweetened larvae can be packaged as special snacks and larvae flour can be used to enrich wheat flours, but local marketing will be very limited in size and external markets extremely difficult to reach and develop. The People's Republic of China, Taiwan and Japan have small local markets and there may be some trade between these countries (Crane, 1990). Cans of chocolate-covered honeybee drone larvae may be seen in some specialty Asian food stores in Europe and the USA, but according to recent enquiries they are rather difficult to find.

The sale of fresh combs with brood for consumption may be possible in some areas. Broken combs with brood and some pollen bathed in honey could be sold as a very nutritious snack in some local markets. The problem is that the removal of brood combs during honey harvest is destructive and can therefore adversely affect other aspects of beekeeping.

8.10 Recipes

Honeybee larvae or many other insect larvae can be grown cleanly and easily to enrich staple foods with protein. Many types of insect larvae are eaten in the world and most of them can substitute for honeybee larvae in the following recipes.

8.10.1 Preparation of mature and immature bees for human consumption

One way to kill adults or larvae is by freezing them, but if a large quantity of adult bees are placed in a freezer, many of them may still be alive after several days. Bees are much more sensitive to overheating than to cooling and when placed in the sun inside a plastic bag, will die within a few minutes. However, they must be removed from the sun as soon as they are dead since decay will quickly occur. Larvae should be kept alive as long as possible. Once dead, both larvae and adults need to be processed or eaten immediately (see also section 8.6).

After killing, and particularly if they have been killed by overheating, bees should be rinsed in cool, clean water. Once rinsed, they need to be patted dry and either be frozen, cooked or dried. Even when dead, adult bees can still sting and their venom remains active so that during washing and subsequent operations, the sting may penetrate the skin and inject venom. Dried adults should be ground to avoid any dangers of injury from stinging. The venom remains active after drying or freezing, but is deactivated by cooking or frying.

Once removed from the combs, the larvae are ready for processing and preservation, after a short rinse in fresh, clean water (see Figure 8.9).

If larvae are refrigerated immediately, freezing, drying, boiling or frying should be completed less than 24 hours after collection of larvae to avoid any spoilage since insect proteins decay much faster than those of beef, chicken, lamb or pork. Where no refrigeration is available, processing will have to be started immediately after collection. Cooked larvae or pupae can be preserved by freezing. If there is no freezer or refrigerator, the boiled larvae should be consumed within a day. Fried larvae will keep a little longer.

8.10.2 Bakutig traditional recipe from Nepal (Bur2ettg 1990)

Brood combs from traditional honey hunts in Nepal are placed into coarse woven fabric or bags and squeezed. The resulting juice is collected and heated over a fire while stirring. The result is described as having a texture similar to that of scrambled eggs but the flavour should be richer.

Figure 8.9: Bee larvae in a strainer for rinsing.

8.10.3 Frozen larvaeg pupae or adults

Fresh and clean larvae, pupae or adults are frozen in small batches or spread on metal sheets for faster freezing. If plastic bags are used, these should be half filled and flattened on the freezing trays. In larger scale bulk freezing, and especially with pupae or larvae that are already dead, the centre of a large volume freezes more slowly, leaving enough time for larvae or pupae to darken due to oxidation.

8.10.4 Rawg fried and boiled larvae

Honeybee larvae can be consumed like other insect larvae - raw, fried or boiled. The raw larvae can be chewed while still inside the comb or after removal. Chewing comb which also contains pollen further increases the nutritional value. The age of the larvae is not very important, but whiter or newer combs are preferred for chewing.

If skins of larvae are intact after collection, they may be rinsed briefly. Then, larvae can be boiled for 10 minutes (some people prefer 30 minutes) in salty or spiced water just like sea food. Once boiled, they can be added to other recipes or eaten as they are.

Like sea food, larvae may be deep-fried either plain (see Figure 8.10) or after being rolled in flour or dipped in batter. Deep-fat frying at 150^0C for only 1 minute is sufficient (Hocking and Matsumura, 1960). After one minute, the larvae should be removed and briskly shaken and drained on a slope, and/or covered with absorbent material to eliminate some of the excess fat. Frying in butter results in uneven browning and more broken larvae.

Figure 8.10: Frying bee larvae in oil.

8.10.5 Dried larvae and adults

Larvae and adults may be sun-dried in a solar drier. They should be kept out of direct sunlight and protected from dust and insects. If the weather is not favourable for quick drying, the insects may be roasted carefully to avoid deterioration. After drying, they may be chopped or ground to a powder. The powder may be used to enrich other meals or flours. If used as an additive to animal feed, they can be added whole. The flavour of these meals is not affected if the insects are used in moderate quantities.

8.10.6 Basic general recipes

The basic recipes and many of the following ones are adapted from Taylor and Carter's "Entertaining with Insects " (1976). Some modifications have been included to adjust the recipes for more general use and for readily-available ingredients. Once frozen, smoked, dry-roasted, solar-dried, or made into a flour, insects can be incorporated into basically any other food dish. In any of the dried forms, including the flour, they can also be readily marketed.

Dry roasted larvae or adults

Spread the cleaned, fresh or frozen insects on paper towels (not newspapers) on a cookie sheet. Bake at 70°0 - 94^0C for 1-2 hours until the desired state of dryness is obtained. Check the dryness by attempting to crush the insects with a spoon.

Alternatively, the insects can be roasted in a large frying-pan, pot or metal sheet over medium heat. If their temperature exceeds 100^0C they will caramelize. They should be stirred frequently to prevent them from burning. A coffee roaster could probably be used. Drying larvae by smoking did not produce a good, smoky flavour.

Bee flour

Bees should be dry-roasted or sun-dried as above and reduced (in an electric blender) to a fine powder. For those relying on manual skills, grind or pound until all insects are reduced to a fine powder. This powder can be further enriched with equally fine ground dry pollen pellets or can be mixed directly with any other flour, dough, bread, vegetable dish or soup. It thus remains unnoticeable by taste and texture, but enriches the diet. If kept dry and packed immediately in plastic bags, it should keep fresh long enough for local marketing and consumption. Cold storage is recommended and customers should be alerted to this and its short shelf-life. Do not process or package bee flour during the rainy season since the flour cannot be kept dry enough.

Basic cooked insects

1 cup	*Cleaned bees (adults or larvae)*
2 cups	*Water*
1 teaspoon	*Salt*
2 dashes	*Pepper*
1 tablespoon	*Butter*
½ teaspoon	*Sage*
2 table spoons	*Onions, finely chopped*

Quickly brown the onions in the butter or other available fat or oil. Then add all the other ingredients. Bring to a boil and simmer for 30 minutes or until tender. The sage can be replaced with other spices such as red peppers (chili peppers), laurel, thyme, rosemary or curry, according to local taste. For immediate consumption, boiling for 5 to 10 minutes is sufficient.

Bee stew

Prepare your favourite soup or stew with vegetables and, instead of meat, add a similar or slightly smaller quantity of whole or crushed insects. The cooking time does not need to be as long as with meat. Only boil until the vegetables have cooked, because the insects will be boiled sufficiently after 10 minutes. If you miss the familiar flavour of meat, add some animal fat or marrow bones - they do not require extra cooking time.

Garlic butter fried bees

¼ cup	*Butter or cooking oil*
6 cloves	*Garlic*
1 cup	*Cleaned bees (larvae)*

Heat the oil or butter over low heat in a frying-pan or pot. Slowly fry the garlic so that in about 5 minutes it is slightly brown. Add the insects and continue frying at the same temperature for another 10 to 15 minutes, stirring occasionally. Do not overheat or the garlic will burn.

The insects can then be included in rotis and tacos, used as condiments with rice and tortillas or be offered as appetizers (see Figure 8.11). If drained well, they can be served as snacks at any time or be packaged like nuts.

Figure 8.11 : Honeybee larvae prepared as appetizer in three different ways (from left to right): fried with garlic, boiled and fried in oil after covering with flour.

Insect marinade

A marinade can be prepared from a variety of ingredients to give the insects a stronger and spicier flavour and/or to preserve them for longer.

A very simple but tasty marinade is made of:

1	*Large clove of garlic, crushed or minced*
1	*Dried red pepper (chili pepper) crushed or minced*
2 tablesp	*Fresh ginger, minced or grated*
1 to 1.5 cup liquid	*The liquid may be soy sauce with a little sake (rice wine) or grape wine, salt and lemon juice, or other strongly flavoured juices or extracts with salt.*
2 table spoons	*Onions, finely chopped*

Once all the ingredients are combined, cover 1 cup of insects with the marinade and leave it for several hours. The process can be accelerated by simmering the mix for 20 to 30 minutes over low heat.

To pickle or preserve the insects, use a very thick soy sauce or, prepare a spicy and/or flavoured vinegar mixture with herbs and spices. Add the raw or cooked insects. Pickling arvae in vinegar or brandly alone does not produce a pleasant flavour. For long-term storage, some recipes recommend boiling after marination, others only use marination. Each region has its own way of pickling vegetables or meats, which can also be applied to insects. When adding large quantities of insects ensure the vinegar is concentrated enough and is not excessively diluted by water from the insects blood. Drain the vinegar after two days and replace it with fresh marinade. Chutney is a form of pickling where insects can be added, or used to replace one of the other ingredients.

8.10.7 Bee mango chutney

Principal ingredients:

15	*Medium size, peeled chopped mangoes*
8	*Medium size, chopped papayas*
1-2 cups	*Boiled bee larvae, chopped*
To be mixed with:	
3 tablespoons	*Chopped ginger candied if possible*
¾ cup	*Chopped citron or other candied fruit*
¼ cup	*Chopped candied lemon peel or ½ cup chopped, preserved kumquats*
Spice bag:	
2	*Cinnamon sticks*
30	*Whole cloves*
¾ teaspoon	*Coriander seeds*
Sweet vinegar:	
6 cups	*Sugar*
4 cups	*Cider vinegar*

Heat the sweet vinegar to boiling, add the other ingredients including the spice bag and simmer for 5 minutes. Remove the spice bag and pour the boiling mixture into clean, sterilized jars, seal and continue heating for another 15 minutes in a water bath. when filling the jars leave a few centimetres of empty space between the chutney and the lid.

Use vinegar of at least 5-6% acetic acid. Other spices such as red peppers, turmeric or curry may be added. When using other vegetables like tomatoes, apples or onions, simmer them first for ½ hour in an equal volume of sweet vinegar.

8.10.8 Bee chapattis

1 ½ cups	*Flour (all-purpose, white or whole grain from wheat or other grains)*
½ cup	*Bee flour (see recipes in 8.10.6)*
1 ½ cups	*Water*
q.s.	*Salt, to taste*
q.s.	*Melted butter, lard or oil*

Mix water and flours until a stiff dough is obtained. Add the salt. Knead the dough until it is smooth. Pinch off pieces of dough and mould into balls of about 4-5 cm in diameter. Roll each ball in flour and place it on a flour-covered board. Flatten the balls to approximately 5-6 mm thickness. Heat a large non-greased frying-pan. Place a flattened ball in the pan and fry for 2 minutes on each side. Remove the chapatti and apply a little melted butter or oil on each side and fry until dark brown spots begin to appear on the heated faces.

Contents - **Previous** - **Next**

8.10.9 Pastry

Add insect flour to make pastry for a pie crust or empanadas, to which fillings can be added made of fruits or vegetables.

1 ½ cups	*Flour*
¼ cup	*Bee flour (prepare as in 8.10.6)*
½ teaspoon	*Salt (to taste)*
½ cup	*Shortening, fat or cooking oil*
4 tablespoons	*water*

Mix all the dry ingredients well, then add the shortening and mix into a paste. Add the water slowly, to form a fairly dry dough but with all the flour moistened. Flatten the dough on a powdered suiface to a thickness of 3-4 mm and place in a baking form, pie pan or similar. Add a filling prepared according to your own recipe and bake. The baking temperature and time will depend on the filling and on the size and shape of the pastry.

Empress Barbara Tarts

Pastry:	*¾ cup*	*Flour*
	¾ cup	*Bee flour*
	½ teaspoon	*Salt*
	¼ pound	*Butter*
	3 tablespoons	*Heavy cream*

Sift both flours and the salt into a bowl or break up any lumps manually. Cut in the butter with a pastry blender or by stirring with a fork. Stir in the cream with a fork until a ball of dough can be easily formed. Wrap in waxed paper or foil and chill for 2 hours. The cream can also be replaced by 2 tablespoons of butter and 1 tablespoon of milk or water.

Filling:	*½ cup*	*Marinated bees (see basic recipe in 8.10.6)*
	1	*Egg, beaten*
	4 tablespoons	*Melted butter*
	3 cloves	*Minced garlic*
	2 tablespoons	*Corn starch, potato starch or other thickener*
	1 teaspoon	*Salt*
	q.s.	*Cayenne pepper to taste (or chili pepper, red peppers, etc.)*

Mix all the ingredients for the filling together. Roll out the dough extra thin and cut into circles of 8 cm diameter. Place a heaped teaspoon of filling in the centre. Bring opposite edges of the pastry to the centre and roll-up overlapping dough, sealing the edges well. Arrange on a baking sheet and cook in a preheated oven at 205 ^{0}C for 15 minutes. Serve with hot mustard.

Cheese tarts

Biscuit dough sufficient for about one dozen biscuits is required. One example of dough can be prepared as follows:

Pastry:	*1 ¾ cups*	*All-purpose Flour*
	½ teaspoon	*Salt*
	3 teaspoons	*Baking powder*
	4 to 6 tablespoons	*Chilled butter or shortening (lard, margarine etc.) or a combination of both*
	¾ cup	*Milk*
Filling:	*½ cup*	*Grated cheese (a rich, easy-melting cheese)*
	¼ cup	*Marinated artichokes, choopped*
	¼ cup	*Chopped garlic-butter-fried bee larvae, pupae or other insects*
	¼ cup	*Fresh, minced parsley*
	¾ cup	*Milk*

Sift the first three ingredients into a large bowl or manually remove lumps, then add the butter by cutting it into the dry ingredients with two knives or a fork until the mixture has the consistency of coarse cornmeal. Make a bowl in the centre of the ingredient mix and add all of the milk at once. Stir until the dough comes away from the sides of the bowl. Place the dough onto a lightly floured board and knead gently and quickly for ½ to 1 minute.

Roll or pat the dough until it is about 2-3 mm thick. Cut it into squares of 7 cm. Place in the centre of each square one teaspoon of the filling. Moisten the corners of the dough with water, fold up the corners and pinch them together to make a tart shape. Bake the tarts at 2200~235 ^{0}C for about 10 minutes.

Other ingredients that may be added to the biscuit dough include grated cheese, chopped bacon, ham, onions, parsley and other herbs. The artichokes in the filling can be replaced by other chopped, leafy vegetables. The tarts can also be filled with fruit fillings.

8.10.10 Popmoth

Heat some cooking oil and drop fresh (live) or frozen wax moth larvae into the hot oil. Their skin will break and the proteins will expand, making them look like popcorn. Remove them before they become too dark, let

the oil drip off them and salt or flavour them with other spice mixtures similar to popcorn, potato or banana chips. They might also taste good with honey, or quickly turned in the candy mix described below.

This product should be packaged attractively in clear plastic bags for sale in markets or stores. Once fried like this, it may be stored for some time without spoiling.

8.10.11 Bee sweets and chocolate coated bees

The following recipes can be easily adapted to accommodate various, similar ingredients and provide honey-based sweets, with or without bee and insect larvae. They are easily made in any pastry shop or home kitchen and preserve well for sale in markets and shops. Powdered pollen pellets can also be added. Neatly packaged, they provide an attractive and very nutritious snack.

Candybees

¼ cup	*Butter*
2/3 cup	*Brown sugar*
¾ cup	*Dark honey*
1 cup	*Cleaned bees (adults or larvae) or other insects*

Mix the butter, sugar and honey. Beat until smooth, then stir in the insects. Place in a baking dish in the oven at 190^{0}C for approximately 30 minutes. After cooling, break or cut into pieces. (See also candy recipes in Chapter 2.)

The butter can be replaced with another cooking oil; for an agreeable flavour try coconut, peanut or sunflower oil. Dark sugar gives a nicely coloured end product and is a little healthier than white sugar, but the latter can be used instead. With a little practice, the candy can also be made in a covered frying-pan over a low fire. Be careftil not to burn the sugar.

Carob Fudge

1 ½ cups	*Honey*
2/3 cup	*Milk*
2 tablespoons	*Butter*
1/3 cup	*Carob powder*
1 tablespoon	*Vanilla*
1/3 cup	*Dry roasted bees (adults or larvae, chopped)*

Place the honey, milk, butter and carob powder in a heavy saucepan or pot. Heat slowly until the mixture is well blended and then cook without stirring, until the temperature reaches 115 ^{0}C (at this temperature, the mixture will form a soft ball when a drop is placed in cold water). Cool to 50^{0}C and then beat until the mixture loses its glossiness. Add the vanilla and the insects. Pour into a greased pan of approximately 20 x 20 cm size. when set, cut into 5 cm squares or smaller.

The carob powder can be replaced with chocolate powder or instant cacao powder.

Chocolate larvae

1 ½ cups	*Honey*
2/3 cup	*Cream*
2 ounces	*Unsweetened or bitter chocolate*
1/8 teaspoon	*Salt*
1 tablespoon	*Butter*
1 teaspoon	*Vanilla*
½ cup	*Dry-roasted bees (adults or larvae)*

In a saucepan or small pot, mix the honey, cream, chocolate and salt. Cook over a medium heat, stirring constantly until the chocolate is melted and the honey has dissolved. Continue cooking over low heat (stirring occasionally) to a temperature of 112 ^{0}C or until a small amount of mixture forms a ball when dropped into iced water. Remove the mixture from the heat, add butter and cool to 50^{0}C without flirther stirring. Then add the vanilla and beat vigorously with a wooden spoon until candy is thick and no longer glossy - about 7 to 10 minutes. Stir in the insects and spread the mix evenly in a buttered flat pan. Cool until firm and cut into 5 cm squares.

Toffee

¾ cup	*Brown sugar (or ¼ honey plus ½ white sugar)*
½ cup	*Butter*
1 cup	*Dry roasted bees, coarsely chopped*
½ cup	*Semi-sweet chocolate, grated*

Butter a baking pan (about 20x20x5 cm). Heat the sugar and butter in a saucepan or small pot, to boiling. Boil over medium heat for 7 minutes, stirring constantly. Remove from the heat, stir in the bees and pour into the pan. Sprinkle the chocolate over the hot mixture and cover so that the contained heat will melt the chocolate. After a couple of minutes, spread the melted chocolate over the candy. while still warm, cut into 3-4cm squares. Refrigerate until firm.

This toffee can be sold easily as it is, but unfortunately the chocolate will hot climates or, if left in the sun.

Banana Sicle

¼ cup	*Peanut butter*
½ cup	*Powdered milk*
1 tablespoon	*Honey*

1/3 cup	*Light cream*
4	*Bananas, peeled*
1/3 cup	*Minced, dry-roasted bees*

Place the peanut butter, powdered milk, honey and cream in an electric blender and chop until smooth. Roll the bananas in the mixture and sprinkle with the insects. Freeze. This makes a very nutritious popsicle.

If cream is not available, use regular whole milk and boil slowly until it is reduced to ½ or [1]A of the original volume.

Popcorn Crunch

½ cup	*Butter, melted*
½ cup	*Honey*
3 quarts	*Popcorn, popped*
1 cup	*Dry-roasted bees, chopped*

Blend the butter (or vegetable oil substitutes) and honey together in a saucepan and heat gently. Mix the popcorn with the insects and pour the butter-honey mixture over

it. Mix well. Spread on a cookie sheet in a thin layer. Bake at 175 ^{0}C for 10 to 15 minutes or until crisp. Break into bite-sized pieces. Vanilla flavour can be added to the honey-butter.

Peanut butter squares

½ cup	*Powdered milk*
½ cup	*Peanut butter*
1 cup	*Shredded, unsweetened coconut*
½ cup	*Sunflower seed kernels*
¼ cup	*Honey*
¼ cup	*Water*
2 tablespoons	*Brewer's yeast*
½ cup	*Dry-roasted bees*

Combine all the ingredients in a large bowl and mix until they stick together. Press into a flat, buttered pan. Cut into squares and serve, or wrap squares in clear plastic (or waxed paper) for sale. A ¼ cup (?f dried, powdered pollen can also be added. The brewer's yeast is not essential and the nuts and seeds can be replaced by others (see also Chapter 2 recipes).

Peanut butter or any other oil-rich nut butter can be produced nuts and stirring the mixture well, in order to avoid separation of oil

Bee-Oatmeal Cookies

¾ cup	*Softened butter or oil*
2	*Eggs*
1 teaspoon	*Vanilla*
1 ¼ cups	*Honey*
¼ cup	*Water*
2 ½ cups	*Regular wheat flour (all-purpose)*
1 cup	*Bee flour (see section 8.10.6)*
½ teaspoon	*Baking powder*
1 teaspoon	*Baking soda*
1 teaspoon	*Salt*
1 teaspoon	*Cinnamon (powdered)*
½ teaspoon	*Cloves (powdered)*
2 cups	*Rolled oats*

Warm the butter until soft, and vigorously stir in the eggs and vanilla. Add the honey and the water. In a separate bowl blend all the dry ingrediends exept the oats. Join the liquid and dry portion, stir and add the rolled oats. Place heaped teaspoonfuls of the mix 5 cm apart on a lightly greased baking sheet (makes 70 to 80 cookies). Bake for 8 to 10 minutes at 175° C. This recipe is enough to make 70 to 80 cookies.

Honeybee granola bars

4 cups	*Rolled oats*
¾ cup	*Sunflower seed kernels*
¾ cup	*Shredded coconut*
½ cup	*Sesame seeds*
¾ cup	*Slivered almonds*
1 tablespoon	*Cinnamon, (powdered)*
1 cup	*Honey*
1/3 cup	*Oil*
2/3 cup	*Bee pollen ground. (This should be omitted if there is a risk that the product might be eaten by someone who is allergic to pollen).*
¾ cup	*raisins*

Mix the dry ingredients, except the raisins and pollen. Mix the honey and oil separately, then combine the wet and dry mixtures. Spread the granola mixture on a lightly greased cookie sheet, frying pan or flat metal sheet.

Bake at 160^{0}C for 35 minutes, stirring often for even baking. when partially cool, mix in the pollen, raisins or other dried fruits and press together into a layer about 1 cm thick. Allow to cool completely and cut into squares or strips.

These bars can be packed easily and will keep for several weeks in cool storage. Rolled oats can be replaced by other grains, e.g. puffed rice. To make rolled grains, soak whole grains in water for a few hours and/or briefly boil and drain them and then carefully pound or squeeze them under a heavy rolling pin or grinding stone.

Bee Bars

1 cup	*Honey*
1 cup	*Brown sugar*
½ cup	*Milk*
1/8 teaspoon	*Salt*
2 tablespoons	*Butter*
1 teaspoon	*Vanilla flavouring*
½ cup	*Dry-roasted bee larvae or pupae, finely chopped*

Mix the honey, sugar, milk and salt in a small pot. Boil over medium heat, stirring occasionally until a small amount makes a ball when dropped into cold water (or the candy thermometer reads 112 ^{0}C). Remove from the heat and mix in the butter. Cool the mixture to 50^{0}C, without ffirther stirring. Add the vanilla and beat with a wooden spoon until the mixture becomes thick and is no longer glossy. Shape the candy into a 30 cm roll, then roll it in the finely chopped bee brood. Wrap in waxed paper and chill until firm. Cut into 5 mm slices.

8.10.12 How to raise and harvest wax moth larvae

The requirements to raise wax moth larvae are minimal: several 3 - 4 litre containers (preferably glass), a diet medium, i.e. food, and a few wax moth adults to lay eggs.

The adult wax moth can be collected from any beekeeper. Several larvae or cocoons are suitable too if they are kept in a small breeder jar, a small *('A* litre) glass, metal or plastic container with a screened hole in the lid, covered with paper or cloth. The breeder jar should have some crumpled or folded paper in the bottom on which the moths can lay their eggs.

500 to 1,000 eggs can be placed into one of the larger 4 litre "growth" container. The "growth" container should have a lid with a *3-5* cm hole which is covered with fly screen and a thin cloth or paper towel, the latter to keep the dirt out and the former to keep the larvae in.

The eggs and the diet medium for the larvae are placed in the large "growth" jar and maintained at 30° to 34^{0}C, away from direct sunlight. At the lower temperature, cocooning begins after 6 weeks and at the higher temperature after 4 weeks, but wax moth larvae will survive well between 25° and 37 ^{0}C.

Harvesting can begin as soon as the larvae start cocooning. Then, every three days, the cocoons are removed from the jar walls. Removing the larvae after cocooning ensures that they will have eliminated all faecal matter and other wastes (this is true for honeybee pupae and all other pupating insects). At this stage, i.e. before pupating, but after cocooning, the wax moth larvae can be kept alive for over a year at 15 ^{0}C and 60% relative humidity. In order to perpetuate the culture, a few cocoons are allowed to pupate and hatch inside another breeder jar. Sixteen days after setting up the breeder jar, the eggs can be transferred into the larger, "growth" containers. After a few generations, a few newly collected females or males should be introduced into the breeder jar.

The survival and growth rate depends very much on the diet. Since wax moths are very adaptable in regard to their diet and since they are used worldwide in laboratories for all kinds of tests, there are many simple and more sophisticated diets. According to Eischen and Dietz (1990), however, have shown that even a good artificial diet can still be improved by adding a mixture of pollen and wax and (preferably) even honey. Adding of propolis However, reduces growth rate and survival (Eischen and Dietz, 1987). The following are a few diet recipes:

Diet recipes

1) After Taylor and Carter, 1976:

A technical diet medium is made up by boiling together ½ cup each of sugar, glycerol and water. when cool, mix quickly with ¼ teaspoon of a vitamin mixture (Meads Deca- Vi-Sol) and five cups of dry Pablum (Mead-Johnson mixed cereal). Survival rate on this diet is approximately 50% and 110 to 170 g of larvae can be grown on one cup of this diet.

2) A standard diet after Jindra and Sehinal, 1989:

Ingredients (in parts by weight):

40	*Cereal flour*	*15*	*Beeswax*
10	*Dry milk*	*20*	*Honey*
5	*Dry yeast*	*10*	*glycerol*

The cereal flour should ideally consist of a mix of wheat flour and maize and wheat meal in the ratios 1:2:1. The dry components are heated to gether for sterilization for 2 hours at 80 ^{0}C and mixed with the pre-heated wax, glycerol and honey. Once cool, 200 ml (or 250 g) of the mix is poured into each "growth" jar. If the diet cannot be refrigerated or frozen, a new batch has to be made every week.

The same amount of the diet (250 g) is fed to the larvae on day 1 and again, according to need, on either day 7 to 9, 13 to 15, 18 to 20 and 23 to 25 i.e. total of 1250 g per 1000 eggs. Different feeding regimes (such as supplying all the food at once) may be more practical, but this can only be done if the feed has been sterilized properly. Optimal growing conditions for Galleria larvae are also ideal for most microorganisms. Therefore, under most circumstances, frequent replacement of food is usually better than one large feeding.

According to Eischen and Dietz (1990), it should be possible to improve most standard diets by adding a

mixture of honey, pollen and wax. The pollen might function also as a feeding attractant and perhaps stimulant. Eischen and Dietz have improved the survival of larvae from 27.4% on a standard diet to 89.6% with only honey, pollen and wax. However, adding only ***5*** % of the honey, pollen and wax to the standard diet increased survival to above 80%. Survival to pupation was even better. Addition of propolis and very old brood combs should be avoided, since it strongly reduces survival and growth rates (Eischen and Dietz, 1987).

3) The honey/pollen/wax diet of Eischen and Dietz (1990)consists of:

63% pollen (dried or fresh trap collected bee pollen pellets) from different plant species and 37% of honeycomb (wet cappings from harvesting). The cappings contained about 50% honey and 50% new wax. The mix was not heated, but kept frozen until use. The economics of this diet were not considered and a compromise between maximum survival and growth, and an affordable diet will have be determined for a commercial grower.

4) A sufficient diet for which any beekeeper has the ingredients:

Take some comb (but not too old or black) break it into small pieces and measure about three to four times the amount suggested in the second diet recipe above. New comb or uncappings are better because they contain less propolis and a weight equal to the one required in the second diet recipe would be sufficient. Replace the milk and yeast powder with 20 parts of pollen pellets, or use extra broken comb with bee bread. Use 30 to 40 parts of any cereal flour or flour mix and 20 to 30 parts of honey or concentrated sugar syrup. Glycerol may also be added. Make small amounts fre quently, since the pollen should not be heated for steralization. Store all the ingredients dry and separately.

Keep the growing larvae in the dark and start harvesting when the first larvae start spinning their cocoons. Larval faeces still contain considerable amounts of nutrients and may be added to the feed for other animals.

Adapt the proportions of any of these diets to local ingredients and test for survival and growth. A survival rate from egg to pupation of above *50%* is acceptable, above 80% is very good. Final weight per larvae should be above 150 mg each. Larvae eating the second diet during their last 4.5 days reached an average body weight of 200 mg (from 50 to 65 mg per larvae at the beginning of the last instar). The diet for the earlier instars was a semi-artificial diet. An oversupply of proteins or carbohydrates does not increase growth. An optimal diet during the last instar made a difference of up to 35 % in body weight. Feeding the more expensive honey, pollen and beeswax diet only during the last instar, may therefore be more economical.

Contents - **Previous** - **Next**

CHAPTER 9a
COSMETICS

Contents - Previous - Next

9.1 Introduction

The origin of the word cosmetic lies in the ancient Greek word Kosmein, which means decoration. The desire of people to decorate themselves, be it for hunting, sexual attraction, social status, ritual purposes, special occasions, or just for simple expression of beauty, are probably as old as humanity itself. From adornments to paints, ointments, tattoos and perfumes, the array of materials and fashions not only seems endless but is also changing with time and culture. Although occasionally very damaging ingredients have been used,, e.g. lead (Pb) and mercury (Hg) for whitening in the Middle Ages in Europe and until today in parts of Africa, hygiene and the care of the body have usually been an essential part of such decoration.

While care for the body and hygiene flourished during the Roman Empire, were deplored as something sinful during the Dark and Middle Ages in Europe. The use of cosmetics was punished in much the same way as witchcraft was punished in Puritan England and soap was considered a sinister curiosity threatening the health of the human soul. Not until the end of the sixteenth century did the use of perfumes, powders, creams and colours, and in some European countries even baths, slowly become acceptable. Other cultures, particularly those in tropical climates, had a much more practical and healthy relationship to body care and hygiene. The continued disdain for baths in Europe, at least into the nineteenth century, made the developing cosmetic industry a necessity.

Today's cosmetic products however include in addition to perfumes, a vast and ever increasing range of products from simple skin creams, soaps and shampoos to special lotions, base creams, moisturizers, nourishers, cleansers, protectors, rejuvinators and conditioners for body, face, hands, eyes, lips, mouth, hair, nails and so on (see Figure 9.1).

As our knowledge of various afflictions of different parts of the body, particularly skin and hair, has increased, as well as our understanding of the action and interaction of various chemicals and plant extracts with different parts of the body, cosmetology has developed into a highly complex and specialized field of its own. The cosmetics industry has combined knowledge of pharmacology and dermatology, with traditional herbology, modern processing technology and most advanced marketing psychology in order to exploit one of the strongest instincts or needs of human-kind, namely that of being considered attractive and healthy in his/her narrower or wider social environment.

Though bee products are not essential to cosmetics, their characteristics add to the various care products in a way no other single product can. Many of today's commercial multichemical formulations are designed for marketing needs such as storage, or better appearance and consistency, rather than for the actual benefits of all these chemicals for the intended cosmetic application. At the same time, scientific and technological advances have reached a state of sophistication in which formulations can have real beneficial action on the skin, for preventative or restorative treatments. Thus, the distinction from pharmaceutical products, well defined by law, becomes less obvious.

Figure 9.1 : Display of various cosmetic products containing one or more primary bee products.

Using simpler formulations usually influences the consistency or durability of a product. However, a choice of simpler formulations and more natural products, variously considered an improvement or a regression, does not necessarily include a loss of benefits or quality. Many of the technological and scientific advances of the last decades can also be applied to such simpler formulations

Both high technology cosmetics and natural cosmetics have their drawbacks and benefits. High technology cosmetics are too expensive to produce on a small scale and many ingredients are too difficult and expensive to obtain, especially in many tropical countries. Natural products usually do not have as long a shelf-life as highly processed and preserved products, and are therefore also limited in their access to long distance markets. On the other hand, natural products can often be obtained locally - which often means lower prices with no need for foreign currency - their freshness may be easy to confirm and people are already familiar with such ingredients and know how to appreciate them. The freshness of such materials and of the final product, as well as their easier adaptation to local preferences can be additional selling points.

In order to produce products based on natural materials and to give them the appearance and consistency of high quality products, using a minimum of technology, high quality ingredients and specialised knowledge are required. Home-made, small scale production is possible, but will not usually achieve the same technical quality as products processed with better facilities.

Considering quality in the sense of effectiveness, it is possible that home-made products can be of superior quality, particularly if most or all of the ingredients such as herbal extractscan be produced under controlled conditions at home as well. Again, however, a basic understanding of the different ingredients is necessary, in order to treat each in an appropriate way and maintain those characteristics for which they were selected in the first place.

Going back to the basic benefits derived from cosmetics, a much simpler approach than the high technology, high sales "make believe" approach, is possible. The purpose of this chapter is to present some basic ingredients and formulations for the different cosmetic applications in today's market, selecting more natural ingredients and providing the choice of substitutes available in various countries. Emphasis is given to understanding fundamental production principles. Very simple basic techniques are presented and contrasted with some intermediate technologies available to improve product quality. Finally, some marketing aspects will be discussed in order to present the formulated products on a competitive basis.

The cosmetology presented here is adapted to cold climates and white Caucasian skin. Other cultures prefer different

colours and products - even requirements for skin or hair change between different climates and human races. However, it is assumed that such basic functions as moisturizing, nourishing, protecting, soothing and cleaning are similar enough to permit similar formulations. This is felt to be true particularly since the specific addition of bee products for such purposes adds a much broader spectrum of action than is possible with synthetic ingredients.

Discussion of the quality and other characteristics of various bee products as ingredients has been included in the individual chapters on each primary product. Other details necessary for the final products are included in the recipes. Every cosmetic product class is discussed briefly. General considerations on the actual manufacturing process are discussed in a separate section, detailing each production process and outlining the utility of appropriate equipment.

While there are many books and articles published on the various cosmetic formulations using beekeeping products, only a few recipes can be selected for this bulletin. More emphasis is given to methodology, technology and the understanding of basic needs, thus allowing replacement of various hard-to-come-by ingredients and encouraging experimental adaptation to suit local requirements.

9.2 Description of product types

9.2.1 Lotions

A lotion is a fairly liquid, i.e. acqueous, formulation with a high water or alcohol content, but still having many similarities with creams. In general, lotions are used for cleaning and for adding moisture to the skin or the hair. Many of the aromatic waters of the past were used like lotions. As lotions, however, they may also contain substantial amounts of emulsified oil, fat or wax (see Figure 9.2).

Figure 9.2 : Various lotions containing primary bee products and packed in dispensers for easy use.

An astringent lotion is useful for oily skin and causes pores to contract. The astringent ingredients can be one or more alcohols, witch hazel, citric acid (lemon juice), vinegar, alum, or a large choice of synthetic products. Friction lotions and

skin fresheners (containing up to *50%* and *15%* of alcohol, respectively) may also contain astringents, but they mainly serve to cleanse and moisturize the skin. Suntan lotions and after-shave lotions, for example, have very specific purposes and therefore specific ingredients. Various lotion formulations are listed in the recipe section.

9.2.2 Ointments

Ointments and lipogels are not really creams because they consist of a single phase (for example, only oil). The classic preparation, using Vaseline, lanolin (wool grease) beeswax, mineral oils and/or vegetable oils, has been "modernized" by incorporating modified vegetable and animal oils, preservatives and stabilizers (e.g. hydrogenated ricinus oil). The addition of stabilizers to ointments leads to the formation of lipogels.

New choices of oils, fatty acids and triglycerides can make ointments less greasy and easier to absorb, but they are not very common in modern cosmetics. Some are employed in pharmaceuticals, and the use of beeswax carries additional benefits in these. However, it must be pointed out again that by law, cosmetic products cannot contain any pharmacologically active substances, or claim any medicinal effects.

9.2.3 Creams

In technical terminology, there are clear and not so clear distinctions between a large number of different types of creams. They are classified by the nature of the emulsion (clear) and the purpose of application (not so clear, since very similar or equal formulations can have different applications).

The most common type of emulsion is oil emulsified (dispersed) in water (o/w) and water emulsified in oil (w/o) (see also section 9.4.3). Cold creams require beeswax and are the most basic, yet possibly the most important cosmetic creams. Being w/o or w/o/w (water in oil in water) emulsions, cold creams are oily or greasy to the touch and produce a cooling effect on the skin, as the water slowly evaporates. Incorporating new synthetics, water in oil emulsions have been developed for nutritive, restorative, protective, water-repellent and sun-protecting purposes, for all types of skins, baby care and massage. Modern cosmetics however, tend to replace these less stable w/o emulsions with w/o/w emulsions, on magnesium sulphate bases, or even with o/w emulsions with high lipid contents. The appearance and feel of a cream, its effectiveness as a moisturizer and carrier and adhesive for colours depends on the emulsion type and pH as well as the type of oils, fats, alcohols and esters used.

Some of the more generic creams currently in use include cold creams, emollient creams (for soothing and skin softening), hand creams (for moisturizing and protecting), face creams (for more gentle moisturizing, nourishing and cleansing), bath creams (slightly astringent, for moisture sealing and replacing lost lipids), moisturizing creams (for providing moisture, moisture sealing and soothing), nourishing creams (containing vitamin and protein complexes, oils and other nutrients) and cleansing creams. Creams for more specific applications include depilatory creams, foundation creams for use under make-up, night creams, rejuvenating creams, antiwrinkle creams, sun-protection creams, shaving creams and medicated creams (for applications in dermatological disorders, inflammations and wound healing).

The selection of ingredients depends very much on the final purpose and the desired consistency (creamy, hard, soft, greasy or dry) of the product. Changing one ingredient may require changes in many others if the physical characteristics of the product are to be maintained. The diversity of applications and the choice of ingredients (mostly synthetic or modified natural products) is simply too large and too complex to be discussed here in detail. As a general guideline, the different oils, fats and waxes are chosen for their consistency and absorption characteristics, their mixability with other ingredients and for their function in protecting and providing moisture to the skin. Some oils may also be nourishing for the skin, give it special elasticity and br readily absorbed. Different types of applications often require only slight changes in the proportions of ingredients, but sometimes, more specific ingredients have to be added to achieve the desired effect. Classifications often overlap and definitions are not used by everyone in exactly the same way (see Figure 9.3).

The aqueous (water) phase of the emulsion provides moisture to the skin, serves as a solvent or carrier for other ingredients including dyes, allows the use of gels or polymers and, in general, helps to determine the consistency and shelf life of the product.

Figure 9.3 : Various types of creams containing primary bee products.

Emollient creams in particular are used to soothe and soften the skin by providing substances the body normally produces through its skin gland secretions. Among these sebum, secreted by the sebaceous glands, is important for its protective function. Fatty acid glycerides are abundant components of human sebaceous secretions (50%) and skin surface lipids constitute 5.5 to 37.5 %. These can be provided through incorporating one or several of many vegetable oils such as peanut, safflower, olive, avocado, corn, castor, cottonseed, sesame, peach, apricot kernel, palm kernel, coconut and hydrogenated vegetable oils and cocoa butter. One problem is the rapid degradation of these oils - they quickly become rancid if they are not refrigerated. Addition of antioxidants such as propolis extract can retard such decay. Industrial synthetic substitutes exist and are continuously being improved. In addition to the above-mentioned fatty acids and lipids, sebum also contains 14% waxes, 2% free cholesterol, 2.1 % cholesterol esters, 5.5 % squalene, 8.1 % branched paraffins, 2% alkane diols and 5.1 % of unidentified substances (Wheatley, 1950).

9.2.4 Shampoos

Shampoos are liquid, creamy or gel-like, depending on the inclusion of traditional soaps saturated with glycerides and natural or synthetic fatty alcohols or on the thickening agents (e.g. gum, resins and PEG-600D5) that are used.

In general, a shampoo is a colloidal dispersion of surfactants (substances which reduce the surface tension of a liquid) in water. Shampoos can have other substances incorporated which have a restoring and protecting effect on hair, such as natural and modified lipids, amino acids and silicones, or have a reconstituting effect on the integrity and health of the hair and scalp - such as preventing dandruff and excessive sebaceous secretion.

The actual procedures and equipment to be used must be adapted to the type of product required. Some shampoos can be mixed at room temperature simply by adding the ingredients one after the other and mixing them well. In other shampoos, the dissolution of various components will require the use of heat.

The demands for mixing are similar to those for other preparations. The product should be mixed well, in a blender which leaves no "dead", i.e. non-agitated, spaces. Since shampoos are not emulsions, speed is not very important, but a mixture prepared slowly and reaching a uniform consistency without excessive inclusion of air, is better than one prepared quickly, with a lot of included air. If the product is very liquid, has a reliable anti-oxidant and there is enough time and storage space to wait until the air bubbles have separated and the air has escaped, there should be no problem with such aeration. Alternatively, if there is insufficient time or space, or the product is fragile, the following precautions can be taken to avoid inclusion of air. The product should be:

- mixed slowly by hand or at very slow speed with a blender, if the blades are not fully and continuously immersed in the liquid;

- thickened only after mixing and settling of air bubbles;

- heated to 30° or 35° C before draining.

Almost all primary bee products can be added to shampoo or after-shampoo balsams and conditioners, because of their beneficial effect on both the hair and scalp. Aqueous extracts of propolis however, mix better than those extracted with concentrated alcohol.

9.2.5 Soaps

Soaplike substances, usually extracts of special plants, have been used since ancient times. The Gauls of northwestern France prepared soap using animal fats, wood ash and calcium hydroxide (burned limestone plus water). However, they used it as a cosmetic. Galenus, a physician in the second century of the Roman Empire, apparently for the first time in Europe, indicated the use of this type of soap as a detergent in place of the lyes used previously. Until today, traditional soapmakers use the same three basic ingredients as the Gauls. Progress in the nineteenth century advanced the scientific understanding of soaps and led to industrial production and significant modification of the basic recipes. Today there are liquid soaps, bar soaps, powdered soaps, bath soaps, shampoos and medical soaps in all colours, shapes, consistencies and odours.

Making soap is fairly simple, but making coloured and perfumed soaps for various cosmetic applications is a little more complicated. Soaps made from animal fats rather than glyceric acids, are of higher quality. These soaps are re-melted several times to clean them and are finally dried to obtain a high content (72%) of fatty acids.

Industrial soaps for further processing are usually available in small pellets. Toilet soaps with a low glycerol (= glycerin) content (less than 1 %) are opaque, while those containing about 6% are translucent. This provides scope for the use of different pigments to achieve various colour effects. For large scale production, the pigments are mixed or tumbled with the soap chips before or after the addition of glycerol, fragrance, moisturizers and other additives. The mix is refined in a three-roller mill or "plodder", a special soap extruder and pelletizer. This is repeated several times if necessary. Refining is the dispersal of all the ingredients throughout the body of the soap. After refining, the soap is extruded and pressed into moulds.

For small scale production without extrusion, the soap should be melted for mixing with other ingredients and then be poured into moulds. Decorative moulds of different shapes (rather than the conventional square chunks) will look much more attractive (see Figure 9.4). This is particularly important if the soap is to be sold as a special beauty soap, and has to compete with others on the market. Adding pleasant fragrances will improve the attractiveness even further.

Most of the soap recipes given in this chapter begin with a prepared soap base. For small quantities, clean bar soap can be used. For medium and larger scale production, soap chips can be obtained from a local soap producer. For the addition of fragrances and colours, the most basic white or clear soap available should be obtained. However, white soap may already contain titanium oxide pigments, which may reduce the effectiveness of other added pigments. For simplicity, the colouring may be omitted or pre-coloured soap can be used.

Figure 9.4 : Various attractive and decorative shapes of soap formed in special moulds.

9.2.6 Toothpastes and mouth rinses

Toothpastes, by definition and common usage, are mild cosmetic detergents for cleaning teeth. Initially intended to freshen the breath and remove deposits from teeth, evolution of toothpaste has also made it a vehicle for the protection of teeth from caries and gum diseases.

The base recipe for toothpaste contains an abrasive, a detergent, a non-drying liquid, a binder, flavour, colouring and a few other additives such as preservatives, antiseptics and astringents. Formulations are relatively complex and poorly made pastes will separate, harden or liquefy.

Bennett (1970) describes the ideal abrasive as one that will not scratch the tooth enamel and yet will exert sufficient scouring action to clean and polish teeth. It should not react with the other ingredients, spoil the taste or appearance of the toothpaste nor segregate or lump with aging. Suitable abrasives include precipitated calcium carbonate, magnesium carbonate, bentonite, kaolin, chalk, silica, talc and tin oxide. Any abrasive that is used must be very finely ground. Because of the undesirable action of soaps on saliva, regular hard and soft soaps have largely been replaced by glycol, diglycol stearate and synthetic surfactants. Synthetic surfactants are usually also better emulsifiers, with better cleaning powers and lower alkalinity. Carriers and softeners, used to suspend the abrasive and prevent drying of the toothpaste, include alcohol, honey, glucose, invert sugars, mineral oil, water and calcium chloride. Binders, also incorporated as carriers and colloiding agents, include acacia, locust bean, India and Karaya gums, agar, colloidal clays, pectin, petrolatum, silica gel and starch. If binders are plant products, they must be adequately preserved.

Bad breath, caries and gum diseases are mostly a consequence of bacterial growth in the mouth. Therefore, an effective toothpaste should have an antiseptic component which preferably, should not destroy the beneficial mouth flora. Propolis is a mild antiseptic, well suited for this purpose and honey is a good sweetener, since it was demonstrated that artificial sweeteners have been shown to have non-beneficial side effects such as, for emample, the promotion of caries. The addition of fluoride for protection against caries, has been and still is controversial, but it is widely practised anyhow.

Mouth washes are mostly alcohol-based mixtures, with antiseptic, astringent, flavour and colour additives. While their purpose is primarily to freshen breath, they can only be effective if they destroy some of the bacterial flora of the mouth which caused the bad breath in the first place. Hence, propolis is an obvious and mildly flavoured choice ingredient.

9.2.7 Deodorants

Deodorants are designed to absorb, change, mask or prevent any unpleasant odours. Those used for cosmetic purposes are presented in soap, aerosol, cream and roll-on gel forms. The active ingredients comprise fragrances (or aromatic extracts), astringents, antibacterial agents and drying agents which interrupt the normal functions of sweat glands. A deodorant should dry quickly without leaving a greasy film. The solvents and thickening agents are selected for the method of application. One-time aerosol applicators using various driver gases should be avoided; they not only require expensive containers and filling equipment, but can also present an environmental risk. Mechanical dispensers for spray application work well and can be refilled by the customer or retailer.

Though less radical than most synthetic microbiocides, propolis extract is well suited as a deodorant ingredient, because of its bacteriostatic characteristics and for its pleasant smell.

9.2.8 Facial masks

Facial masks serve as many purposes as skin creams. Many preparations for easy application or home use are available on sale, but face masks are frequently prepared by beauticians themselves, just prior to use. Many of them have their own preferred recipes since it is possible to prepare them with a very wide variety of ingredients, particularly fresh ingredients which otherwise are too perishable. Less stringent restrictions in certain performance standards such as consistency and shelf-life, allow much freer use of primary bee products, all of which can be beneficially included in face masks. Thus, although it may be difficult to market the ingredients on a large scale, certain beauty salons and cosmeticians can prepare some of the formulas from the recipe section and all could include honey, royal jelly, propolis and pollen extracts in their own preferred formulas. However, precautions should be taken against any possible allergic reactions in customers.

Honey in these formulations serves as a moisturizing, cleansing and nourishing agent. For similar reasons, any of the other bee products can be included in those masks intended to refresh, nourish or cleanse the skin. Selection of the right be product for the right application can be made with the help of Table 9.1. Since the actual consistency or stickiness of many preparations is not very important, the precise proportion of bee products are not important either and there is plenty of scope for experimentation.

Table 9.1
Summary of the cosmetic functions of five primary bee products (modified from Proserpio, 1981 and 1988)

Product	**Cosmetic function**
Honey	Sweetener, emollient, moisturizer, humectant, tonic, refresher, anti-irritant, skin softener, epithelial reconstitution and soothing agent
Wax	Excipient, protectant, film formant, water repellent, sebum restorant, depilatory, anti-irritant and emollient
Propolis	Antidandruff and anti-wrinkle agent, hair conditioner, deodorant, purifier, tonic, disinfectant, antioxidant, preservative and UV screen
Pollen and royal jelly	Anti-wrinkle, anti-stretchmarks, elastifier, nutrifier, firmer, revitalizer, hair conditioner, tonic and sebum equalizer, tanning aid (pollen only)

9.2.9 Make-up

The use of make-up includes a wide variety of applications and can be understood in a very wide sense as referring to all facial cosmetics, including actors' face paints. The make-up referred to here however, will be those facial preparations

which temporarily change the appearance of part or all of the face, such as rouges, mascara and eye shadow. Lipsticks and various facial creams are considered separately.

Mascara is usually a black, sometimes bluish or dark brown paste or fast drying liquid, which is applied to eyelashes and eyebrows. Being one of the oldest make-ups, it was once prepared with oil and lampblack (from oil and later gas lamps). A sample formulation using beeswax is provided. Mascara is frequently packed with an applicator such as a special brush. Eyebrow sticks are generally simple in composition, but usually need to be heated and pressed into the right shape.

A good foundation cream protects the skin from the colouring of the make-up and makes it easier to apply, adhere and remove. Eye colouring can be applied in cream, stick (pencil) and powder form, each requiring essentially different formulations and processing. Creams use rather complex wax and oil mixtures to produce a durable, non-smearing, easy- to-apply colour. Pencils and sticks may be extruded, or poured into forms and dried, and powders are usually pressed with high pressure into pallets or containers.

As discussed in slightly more detail below (see section 9.4.5) pigmentation of cosmetics is quite complicated. The choice is also limited to a few types of permitted pigments and dyes. Pigment choice will depend on the type of formulation, i.e. a dry powder, cream or pressed cake. The preparation of make-up colours also requires a base which adheres well to the skin and spreads easily. There are innumerable patents for different formulations, some of them including low levels of beeswax (1 to 5 %) or other waxes which could be replaced by beeswax. One eye colouring cream formulation is described below (section 9.13.11), but its effectiveness in adhering to skin is based on two special chemicals. Pigment producers can sometimes help with certain formulation and production problems.

9.2.10 Lipsticks

It is known from archaeological discoveries that even before Egyptian times, people used red dyes to stain their lips. During the time of the Roman and Greek Empires, these stains were applied as lip pastes and liquids. Only after the beginning of this century did solid lipsticks come into limited use. Yet, only after colouring became more effective and allowing more permanent stains, but most of all permitting more natural colours than the bright carmine red, did lipsticks become socially acceptable. Since then, fashion and pigment development have determined the colours (even conspicuous ones again) which have led to today's lustrous, pearlescent and frosted shades.

Lipsticks are made of a relatively complex mixture of waxes and oils. Some of the ingredients are modified in order to obtain a soft lipstick which maintains its form even at warmer ambient temperatures and which forms a good base for the pigments. A modified beeswax (PEG-8) is used in one of the selected recipes, where the gel-forming characteristics of the modified beeswax is increased with triglycerides from fractionated coconut oil. The lipstick formulations given in the recipe section (9.13.12) involve base formulations with different degrees of complexity. The simplest are soft and creamy lip glosses, for which one recipe is given in section 9.13.12. Mixing these formulations is not very difficult and they can be poured into forms and mounted in typical lipstick dispensers. To market a product successfully however, the colour of the lipstick should be constant from batch to batch.

Mixing the correct amount of pigments every time and getting the desired colour is an art of its own and requires good laboratory equipment. There are colour chemists who specialize in only this aspect. Expensive measuring devices can be used to compare all aspects of a colour and to ensure exact correspondence between batches. Since lipstick or its ingredients must be non-toxic, not just any pigment can be used (see section 9.4.5).

9.2.11 Perfumes

Perfumes will not be discussed here as they do not normally contain beekeeping products and since they require production technologies and knowledge very different from those described here.

9.3 Sources of ingredients

9.3.1 Local sources

Extracts from many plants can be used as emollients which soften and soothe the skin, such as from cattail root (Typha) fig fruit (Ficus) Jimson weed seeds (Datura) locust flowers (Robinia) lotus root, leaves and seeds (Nelumbo) Hibiscus seeds (also used as an as astringent and various others (Krochmal, 1973). Synthetic emollients are extremely common, but beeswax, other waxes, vegetable oils, and animal fats and oils also perform very well.

Pigments and dyes, powdered or extracted from local plant resources can be included in coloured preparations, if they are soluble in at least one of the phases of the formulation. Natural dyes, while very attractive on their own, can hardly compete with the brilliance and variety of synthetic pigments. However, natural dyes and pigments are generally, though not always safer to use.

The European Union (EU) and the US Food and Drug Administration (FDA) have published lists of natural pigments and dyes which are allowed in food, pharmaceuticals and cosmetics. Care has to be taken that local dyes and pigments are not toxic and do not cause allergies or other irritations. Pigments should be of a sufficiently small size so that they do not separate in the final product. Dyes which are soluble in the liquid phase (unlike insoluble pigments) should not stain permanently. But, as in lipsticks, some lasting colouration of the skin is desired to achieve a minimum of durability. It is probably the easiest to find out which of the locally available natural dyes and pigments have already been tested for compatibility by the larger producers, and use these.

One of the problems associated with using natural plant or animal extracts is their often inconsistent composition or quality, together with the possibility of contamination and interactions of the complex ingredients. Side-effects on skin are rare, except for fragrances, there are also several plants known for their irritant reaction. Dorato (1987) gives a short discussion of various water-soluble plant extracts, though mostly of temperate climate origin. He describes the current trend in phytocosmetics (those using plant extracts) towards the use of standardized extracts or pure compounds for the simple reasons of more constant performance and less difficult analysis and quality control.

9.3.2 Imported

Although an attempt has been made here to provide some alternative formulations using commonly available products, specially refined raw materials are better for high quality production. Synthetic materials in particular need to be of a purity superior to that required for most other applications, so it is often best to obtain supplies from special cosmetic suppliers. Food quality products can usually be used safely in cosmetics.

A list of international suppliers of special ingredients, equipment and books should be consulted. The CTFA (Cosmetic, Toiletry and Fragrance Association) publishes the International Cosmetic Ingredient Dictionary with common, scientific and commercial names together with a list of suppliers. Information on "Emulsifiers & Detergents, Functional Materials" is published by McCutcheon's Division. The Cosmetic Bench References published by Cosmetics and Toiletries Magazine have a long list of suppliers of natural and synthetic and specialized materials, testing and formulation laboratories and equipment suppliers. Their addresses can be found in Annex 2. Other sources are the commercial attaches of various embassies, who can give information on suppliers from their respective countries. Many international suppliers have subsidiaries around the world. Purchases through these subsidiaries will eliminate most importation problems.

The first few importations will take a lot of time and effort to obtain all the necessary permits, letters of credit and of course the foreign exchange necessary has been obtained. Insurance of expensive shipments may not cover the merchandise after arrival in the local port harbour. These transactions might become smoother and quicker with experience and after regular trade with the suppliers. Orders for supplies should be timed carefully, in order to avoid unproductive periods because of the delayed arrival of one or more ingredients and spare parts.

The simpler the formulation used, the less need there should be for importation of ingredients. If the quality of the local ingredients is not adequate, the user should work with the producer to improve his quality of production.

9.4 Technical requirements

9.4.1 Raw materials

In general, only the cleanest and freshest products should be used. Vegetable oils, vitamins, proteins, royal jelly, pollen, some plant extracts and aromatic oils have limited shelf-lives, and need special storage (refrigeration) or should be used quickly. To save work when using only very small quantities, the oil and water phases of a product may be prepared in advance, minus the aromatic oils, herb extracts and royal jelly. The different phases are then mixed only when more product is needed. Once mixed, the emulsions provide a much better medium for bacterial or fungal growth. The addition of propolis extract to the water phase acts as a mild preservative and antioxidant.

Water should be distilled or soft (with insignificant levels of bicarbonates or sulphates) and clean, rain water is preferable. Under most circumstances the water should also be boiled prior to use. In cities with piped drinking water, such water is often treated with chlorine, fluoride and other additives which can react negatively in some preparations. Even after boiling and filtering, this water would be second choice to rain water. Rainwater collected in heavily polluted areas should not be used. Distilled or deionized water is used in many industrial products.

9.4.2 Equipment

For simple home made production, little more than normal cooking utensils are necessary. The following list describes the essential items of equipment, some of which are illustrated in Figure 9.5. An example of a small area devoted to cosmetics production is shown in Figure 9.6.

For slightly larger operations better mixing equipment is most essential, as is a refrigerator. A water jacketed mixer (see Figure 9.7) would be very helpful, providing better emulsions and mixing of creans during cooling. Better bowls and glass containers for measuring and mixing would also be required eventually (see Figure 9.6). Litmus paper for controling the pH will be needed for checking quality standards. A mortar and pestle are always useful, particularly for grinding pigments. Once serious marketing is considered, bottles and vials have to be selected in which each product type is adequately preserved and presented. Additional equipment (mills, driers and bottling machines) depending on the particular products to be produced may be needed. A battery heated wire or normal current operated machine to seal clear polyethylene bags may be useful for packing products such as individual doses of soaps, shampoos or bath foams and many other value added bee products.

Figure 9.5 : Basic kitchen equipment necessary for preparing simple cosmetic products.

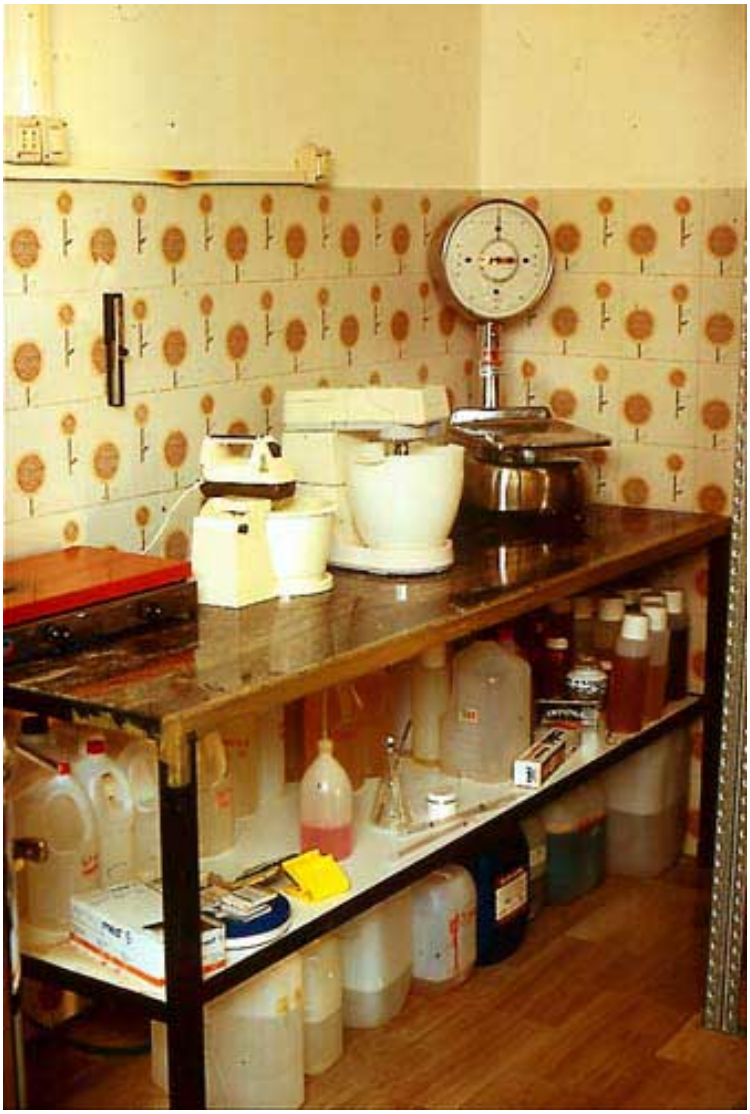


Figure 9.6: a) Working area with heating plates, mixing and weighing equipment for medium-scale operations.

Figure 9.6: b) Convenient containers, beakers and other wares for medium-scale operations.

9.4.3 Emulsions

An emulsion is a suspension of one material finely dispersed in another, but without the formulation of a conventional solution. Milk and royal jelly are natural emulsions in which an oil phase is dispersed in water. In cosmetic preparations with at least two non-mixable phases, such as oil and water, the two phases are mixed at very high speed with special blades (see Figure 9. 9d). In an oil/water emulsion, the internal phase (the oil) is broken by the high speed mixer or turbine into droplets so small that they remain suspended without uniting again to form larger droplets. This emulsification is facilitated by the addition of emulsifiers. The smaller these droplets are and the better they are mixed, the longer the two phases remain emulsified, i.e. the more stable the emulsion is. Industry standards generally require an emulsion to be stable for at least 1 or 2 years.

Such stability and the success of emulsification depends on a variety of factors such as the quantity and efficiency of the emulsifier (such as borax) temperature (during and after emulsification) the sequence of addition of other ingredients, mixing techniques and the design of the equipment.

Borax is a traditional emulsifier for oil-based creams and works best for all smaller operations and simple recipes. There is a very large number of other emulsifiers available, both synthetic and natural. For further information, Emulsifiers & Detergents, Functional Materials or other basic cosmetic textbooks should be consulted.

Figure 9.7: A simple, small to medium size paddle mixer with water jacketed bowl for temperature control of the mix. During operation, the paddles are equipped with plastic scrapers which allow very close contact between paddle and vessel, thus avoiding any "dead" spaces.

The emulsification processis one of the major difficulties encountered with small-scale production. Simple hand stirring may appear to be sufficient to disperse the two phases, but such emulsions are often unstable and can separate after a short period of time (see Figure 9.8). If parameters such as temperature of the two phases, choice of emulsifier and storage temperature are optimized carefully, product stability should be sufficient for local marketing. Numerous small batches, rather than one big one will reduce requirements for emulsion stability, but might raise marketing and distribution costs.

Figure 9.8 : On the left, a vaseline-propolis ointment which was not properly emulsified. Droplets of propolis extract are separating from the vaseline and give the cream a defective appearance. On the right, a well-emulsified cream (o/w) with emulsifier and proper processing, shows no sign of separation after more than one year of storage.

There are basically four types of emulsions: o/w, w/o, w/o/w and o/w/o:

In an o/w emulsion, oil droplets are dispersed in water and the water is referred to as the external phase. An o/w emulsion does not necessarily consist of more water than oil. The sensation of such an emulsion is "lighter", thinner and fresher, although the final sensation can be influenced by other ingredients such as resins, triglycerides, silicone oils and biological polymers. It is said that the finely dispersed oils and waxes, with their very large increased surface area, can penetrate the skin surface more effectively.

A w/o emulsion consists of droplets of water emulsified in oil. The oily or greasy external phase comes into contact with the skin first, resulting in the "richer" sensation given by such creams. However, today's cosmetic chemistry has evolved far from the classical Vaseline or petrolatum base, and fatty acid esters, triglycerides and oils can now be modified so much that the sensation and absorption by the skin can be accurately controlled. Evaporation of the water from w/o emulsions is slower and it is possible that some is absorbed into the outer layers of the skin.

The w/o/w and o/w/o emulsions are basically combinations of the previous two types. Such multiple emulsions are sometimes required to mix otherwise incompatible ingredients together.

A general problem with emulsions is that the more water they contain, the more susceptible they are to contamination with microorganisms. Very hygienic working conditions and in most cases, the addition of anti-microbial ingredients, are required to protect the emulsions from degradation by such organisms. Adding bee products such as royal jelly, pollen and honey, which cannot be effectively sterilized without losing their beneficial characteristics, also adds a wide array of microorganisms. Beeswax and propolis extracts however, provide some protection. Even royal jelly and honey have some antimicrobial activity, which are unfortunately, weakened by extensive dilution. A multitude of synthetic preservatives are available.

9.4.4 Mixing

Proper mixing of the ingredients is of the utmost importance in the production of stable cosmetic products. Whether it consists of an emulsion or not, the product should be homogeneous. This is often not easy and may require expensive equipment for medium to large scale operations. The sequence of adding ingredients to each other is, in many cases, also

very important because of differences in their compatibility. Adding thickeners, gels and resins affects the mixability and choice of equipment. Sometimes, the order of mixing ingredients must be changed to suit the type of equipment available.

Thus it is, for example, important to mix the various ingredients with their respective solvents prior to emulsification, particularly if the solvent is the dispersed (suspended) phase in the emulsion. Solubility is important for all ingredients, but particularly for ingredients such as fragrances, which have to be added after the emulsion has been formed.

For batches too large to handle efficiently in available mixers, smaller batches can be premixed and then combined. This is particularly useful for hand mixing or paddle mixing of viscous materials which require thorough emulsification.

The inclusion of air during stirring can cause problems, in the appearance and oxidation of the product. Slower stirring, assuring complete submersion of paddles, longer storage or expensive vacuum agitators are the solutions discussed in section 9.2.4 and below. Under high-speed mixing for emulsification, air inclusion is a serious problem than for liquid, non-emulsified, slow-stirred shampoos. Air enclosed in viscous creams will not easily settle out. Special mixer designs and mixing under vacuum are the primary means by which air inclusion is avoided without compromising the efficiency of mixing or emulsification. Mixers must not allow any "dead" spaces where the product receives no agitation. For this reason, mixing containers are usually bowl-shaped and mechanical mixers have plastic spatulas on the outer paddles to scrape the vessel wall with each rotation.

It should be apparent that choosing the right mixer for the right type of product is important, since it influences product performance, appearance and stability. A few alternative mixing systems are described:

Hand stirring

Hand stirring with a spatula is the simplest form of mixing. For hand stirring, a formulation providing easy dispersion is required. The ease of dispersion is not necessarily related to the stability of the product.

Aeration

Aeration or stirring by means of bubbling gas or air through the formulation is not much more efficient than hand stirring, unless extremely large volumes of gas are used. The use of air (or steam) is more practical in low-fragile, low-viscosity systems.

Paddle stirring

Mechanically rotated paddles or anchor type agitators are a suitable way of stirring. Mechanical rotation of paddles is usually slow and the efficiency of agitation is good only for very viscous emulsions, like those containing soap gells, resinous materials and large amounts of solids.

Planetary stirrer

In a planetary stirrer, the paddles rotate around their own axiswhile that same axis follows a circular movement around the container. In this way, a large batch may be mixed more thoroughly. The planetary stirrers, similar to the simple paddle stirrer, is especially suitable for the highly viscous fluids (honey) frequently also used in the food industry.

Propeller agitation

One or more propellers are mounted on a common shaft in a mixing tank. Modifications include variation in the location of the propellers in the tank, the use of two or more propeller shafts and the use of complex propellers. The inclusion of fixed baffles on the tank wall or adjacent to a propeller increases the efficiency. Propeller agitation is more commonly used for low and medium viscosity liquids. The system is also suited for small scale laboratory equipment.

Turbine agitator

Turbine type agitators are available in various sizes and designs, with different speeds and various rotor-stator clearances. Turbine type systems may be designed to give a very high degree of shearing action. Turbines may be used with higher viscosity fluids than propellers, but in high viscosity batches, the gross agitation may be insufficient and a combination mixer of various systems would be more effective.

Turbine-propeller combination agitator

A more complex mixer for producing better emulsions is pictured in Figure 9.9. In a water-jacketed bowl, several blades or paddles are slowly mixing the mass while a special high speed turbine at the base of the central axis agitates the mix at the bottom. The high speed rotor of the turbine hits the droplets of the internal phase and breaks them into much finer droplets for better emulsification. Droplet size is influenced by the turbine design, the rotor-stator clearance and the rotor speed.

Colloid and roller mills

Both types of mill are usually used for pigment dispersion and not for grinding or reducing pignment size. In the colloid mill, the product is forced past a fast spinning rotor. Clearance between the stator (the non-moving part) and moving rotor is usually a few hundredths of a millimetre. A roller mill often consists of three rollers which move against each other at different speeds. Clearance between these rollers is extremely small as between the rotor and the stator of a colloid mill. Today, this type of milling is avoided where possible for o/w emulsions, mascara and make-up foundations because of the relatively high moisture loss during processing. In such situations, a colloid mill or a turbine agitator are preferred, in combination with a mixer. If, for example, the latter attempts at mixing are not satisfactory, the pigments can be dispersed by hand or in one of the available mills in a small fraction of the oil phase, and then added to the res tof the mass shortly before or after the emulsification.

Homogenizer

In a homogenizer, emulsification is effected by forcing the two phases tpast a spring-seated value.

Pebble and ball mills

Pebble mills, ball mills and other grinding equipment are frequently used for pigment suspension. They represent a class of relatively low speed equipment both for emulsification and for mixing dry materials. A cone-shaped container containing the product and several ceramic or metal balls is agitated. The action of the balls breaks up the pigment agglomerations and disperses them.

Stirring under vacuum

Sometimes, mixtures are agitated under vacuum. This largely avoids inclusion of air bubbles which may themselves become emulsified in the liquid and therefore become very difficult to remove. As discussed in section 9.2.4 under shampoos, slower and more careful stirring and longer storage of low viscosity fluids can provide cheap alternatives for small operations.

9.4.5 Colouring

The US Food and Drug Administration has classified organic colours as Food, Drug & Cosmetic colours (FD&C) Drug & Cosmetic colours (D&C) and External Drug & Cosmetic colours (Ext D&C). Only FD&C and D&C certified colours can be used for lipsticks. Inorganic colours only need to conform to purity specifications. The EC uses the prefix E for all colours approved for food, pharmaceuticals and cosmetics which might come in contact with, or enter the digestive system. The Cosmetic Directive of the European Community (76/768/EEC) sets industry standards in Europe. The CTFA keeps updates on newly admitted dyes and pigments and their permitted uses. Some speciality suppliers of cosmetic pigments of all kinds can be found in Annex 2. Each country though, may have its own regulations and list of permitted substances. Before using any colouring, be it natural or synthetic, accurate information should be sought regarding the permissable uses. This is true for all ingredients and in particular for anti-microbial agents or other preservatives.

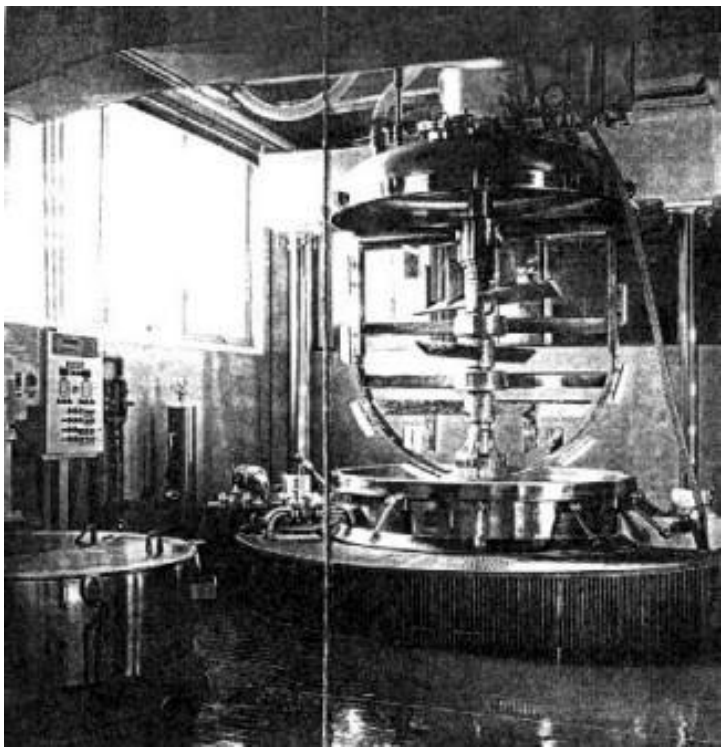


Figure 9.9: a) a large complex propeller and turbine vacuum mixer, removed from the vessel. The outer frame rotates to remove material from the vessel wall. The three horizontal propellers provide the main agitation and at the bottom is a high speed turbine mixer. These mixers come for batch sizes of 5 to 6000 litres.

Figure 9.9: b) Small desktop model of a vacuum mixer.

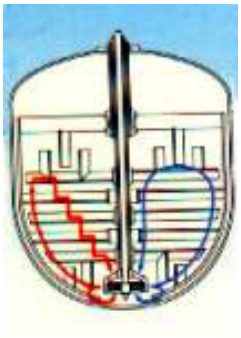


Figure 9.9: c) Diagram of product flow in a complex mixer.

Figure 9.9: d) The rotor (left) and stator (right) of a turbine mixer (All photographs courtesy of Pressindustria S.p.A.).

Since colouring cosmetics, particularly lipsticks and makeup is very difficult, experiments should first be made with very simple mixtures of dyes and pigments. A due is a colouring agent which dissolves in the base solvent of the product whiled a pigment remains partly, or completely, insoluble in the respective base material. Lipsticks, for example, require dyes or pigments which stain the skin, i.e. interact with the skin to form longer lasting colouring effects. Such interactions sometimes also change the colour. The degree of solubility of a dye or the dispersion characteristics of a pigment in the various solvents, are very important and have to be considered for any formulation.

Toners are pure, organic pigments, undiluted and without a substratum. Lakes are dyes precipitated onto a substratum which then becomes an integral part of the new pigment. Lakes are frequently used in lipsticks while both lakes and toners are commonly used in makeup.

Pigment powders range in size from 4 to 150 microns (~m); those above 90 microns, however, are considered large. These small particles often agglomerate, i.e. clump together. To improve dispersion, wetting agents and dispersants are used. Roller or colloid mills are used to break up agglomerations (rather than to reduce the size of the particles themselves) and thereby improve dispersion. Thinner oils are more effective in wetting the pigments, but if thickeners need to be added to the product, they are best added prior to milling.

Synthetic colours can be organic or inorganic pigments or dyes. Many of the inorganic colours are metal oxides and occur naturally. Their purification, however, at least in the case of the ubiquitous iron oxides, is very difficult. While some of these oxides can be easily manufactured and are the same as in regular paints (e.g. titanium oxide) cosmetic pigments have to be particularly pure, without the contamination by arsenic and lead found in industrial grade pigments. Carbon blacks and ultramarine blues are examples of colorants that are not metal oxides. Mica is used as a base for many pearlescent pigments. Alumina (aluminum hydroxide) is used as an extender for cosmetic pigments where opacity is not needed. Calcium carbonate, talc and various clays are also used as extenders.

Water-soluble dyes once in solution change colour when contacting certain metals such as zinc, tin, aluminum, iron and copper. Accordingly, only stainless steel, enamel or glass containers should be used. If not used immediately, water soluble dyes, such as natural dyes should be carefully preserved, using cold storage or preservatives.

Organic colours are much more complex and are often derived from plants or animals. Worldwide, natural colours are extracted from numerous plant and animal species, but only a few are approved by the FDA and EC for cosmetic use. For exports of finished products such regulations have to be strictly adhered to. Since they are safety guidelines, they should really be observed by all manufacturers. If there is local knowledge about compatibility and reactions to local natural colours, they can be confirmed with experiments. Extreme care in tests with small amounts is recommended.

Speciality suppliers for cosmetic pigments of all kinds are listed in Annex 2. Suppliers will also help with certain formulations of products; otherwise specialized cosmetic literature should be consulted.

To achieve colour consistency from one batch to the next, extremely precise measurements and formulations are necessary. Objective colour comparison according to international standards is possible with colourmeters.

Contents - **Previous** - **Next**

9.5 Benefits and applications of primary bee products in cosmetics.

Beeswax

The actual uses of beeswax in cosmetics are associated with its following characteristics:

- It is easily incorporated in w/o and o/w emulsions
- It is an excellent emollient and support for moisturizers
- It gives skin protective action of a non-occlusive type
- It gives good "body" (consistency) to emulsions and oilgels
- It reinforces the action of detergents
- It increases the protective action of sunscreens
- Its elasticity and plasticity improve product efficacy by allowing thinner films and
- It provides greater permanence on skin and lip surfaces
- It does not provoke allergic reactions[4]
- It is compatible with many cosmetic ingredients
- Even small quantities show the above effects of improvement

For all the above reasons beeswax is very frequently used in the following cosmetic classes (see also Table 9.1 and 9.2).

- cleansing creams
- cold creams and lotions
- emollient and barrier creams
- depilatories
- lipsticks - protective sticks in general
- nail creams
- sun protection products
- eye and face make up
- foundation creams

Even in foaming cosmetics such as skin and body detergents, beeswax improves skin compatibility and reduces the aggressive properties of surfactants, while in shampoos and hair conditioners it improves the condition and the manageability of the hair.

Because of solubility and dispersion problems, beeswax cannot be employed successfully in aqueous or very dilute alcohol solutions. Otherwise, its only major drawback is its limited availability and sometimes erratic supply.

Beeswax is most commonly used in its bleached form, in order to facilitate colour control of the final product. Bleaching, described in section 4.11.1, destroys, among other things, the pleasant aroma of beeswax. For many products such as creams, the light yellow colour of clean beeswax should not be unpleasant at all. Many consumers might even appreciate an explanation of this "more natural" colour.

Honey

The classical for honey in cosmetics during ancient times was for beauty masks (honey, almond oil and plant flours) and for cold depilatory waxes (honey, resin and beeswax).

Honey has an immediate moisturizing and soothing effect on dry skin and can reduce minor inflammations and itches. It also provides cutaneous relief, assists wound healing and restores natural skin moisturizing factors. Honey is also capable of retaining moisture content in a product over a wide range of relative humidities.

The possible microbiological decay of dilute solutions and the tacky feel of concentrated solutions pose the only limit to its wider use. Honey should not be sterilized or pasteurized prior to use since it will loose many of its beneficial characteristics. Variation in physico-chemical parameters with seasons and honey type are a minor drawback for industrial use. Dried, powdered honey is available for special applications.

Honey is used in the following types of cosmetics in the quantities (%) indicated (see also Table 9.1 and 9.2):

foaming products (soaps, shampoos, and foam baths)	0.5 - 5% and more
creams and other emulsions	1 - 4%
face packs and masks	3 - 8%
lip glosses, creams and sticks	1 - 3%
anhydrous (waterless) ointments and lipogels	5 - 15%

Any cosmetic formulation may be used as a guide, but it is a formulator's task to experiment until the optimal dose of each component (for product performance and quality) is reached. The addition of honey must be carried out at ambient temperatures with liquid honey in order to avoid degradiation of heat-sensitive substances. Heating to 40 or 42^0C is possible and facilites mixing substantially. Honey should be mixed homogeneously with a small portion of the product before it is added to the whole batch. Honey can be added to already prepared products or formulas, however changes in consistency and colour are to be expected. These may be corrected with appropriate changes in the formulation.

Propolis

The many beneficial characteristics of propolis, discussed in Chapter *5,* have attracted the interest of the cosmetic industry. They include anti-bacterial, anti-fungal, anti-viral, anti-acne, anti-inflammatory and anti-oxidant activities in addition to its wound healing, epithelial and micro-circulation stimulation properties and topical anaesthetic effects. Its industrial use is only constrained by standardization and quality, the same problems that affect most other natural products and extracts. However, low toxicity and good skin compatibility have been demonstrated, despite a small risk of allergic reactions.

As a consequence of the above-mentioned beneficial effects, propolis is used principally as a deodorant and skin purifying agent, but it is also used as a preservative (see Table 9.1 and 9.2).

Propolis is normally used in one of its extracted forms. The choice of solvent depends on the final application. Concentrated alcohol extracts (EEP) are used for inclusion in the oil phase of products, and dilute alcohol or propylene glycol extracts (GEP) for inclusion in the water phase, or in foaming preparations. Glycerol extracts are also used, as well as extracts prepared with other solvents. Sometimes the solvent should be eliminated or reduced in order to avoid changes in the consistency of the formulation, as for example in the case of alcohol extracts used in certain gels.

Some of the functions, and associated applications for propolis in cosmetics, are listed below.

FUNCTION	APPLICATION

Anti-bacterial agent	Deodorants and antiperspirants
Anti-dandruff and sebum equalizing agent	Shampoos and hair lotions
Anti-microbial and healing agent	Anti-acnes and after-shave products
Anti-irritant and antibacterial agent	Mouth rinses and toothpastes
Purifying agent	Cleansing crams and lotions
Preservative	In all of the above
Possibly as catching free radicals	Anti-aging cream

Propolis extracts can be formulated at 1-5 % concentrations in ointments, in o/w emulsions and most others, alcoholic solutions (mouth rinses) shampoos and foam baths. Higher concentrations can be used in toothpastes and soaps, but it should be noted that in alkaline environments, propolis will change the colour to dark grey. The possibility of allergic reactions should never be neglected and products should be marked accordingly.

Pollen

The functions and benefits of pollen in cosmetics are in some ways similar to those of royal jelly - they are still ill defined or unknown, but are generally accepted as nourishing and stimulating. However, because of the high allergy risk and its granular structure, unprocessed pollen is not favoured in the cosmetics industry. Glycol extracts or the lipid fractions of alcohol extracted pollen, and can also be employed in aqueous solutions and o/w emulsions (glycol extracts) or w/o emulsions and anhydrous formulations for lipid fractions (see also Table 9.1 and 9.2). Concentrations range from 1 to 5 %.

Where pollen is included directly (or alcohol extracts containing some of the colouring matter), the colour of the cosmetic may be affected. Treatment with diethylene glycol monomethyl ether may be used to discolour pollen and its extracts (D'Albert, 1956).

Table 9.2:
List of the various formulations to which primary be added (modified from Proserpio, 1981). (-possible, ** easy)

Formulation	Honey	Wax	Propolis	Pollen	Royal jelly
Waterless, lipid pastes (ointment plus pigment)	*	**	* EEP, pastes	* lipid fraction	-
Ointments and waterless lipogels	*	**	* EEP, pastes	* lipid fraction	-
Waterless lipid fusions (sticks)	-	**	* EEP, pastes	* lipid fraction	-
Creamy w/o emulsions	-	**	* EEP, pastes	* lipid fraction	*
Liquid w/o emulsions	-	-	* EEP, pastes	* lipid fraction	*
w/o/w emulsions (cold creams)	-	**	* EEP	* lipid fraction	*
Creamy o/w emulsions	*	*	* EEP, GEP	* glycol extract	*
Liquid o/w emulsions	*	-	* EEP, GEP	* glycol extract	*
Transparent o/w emulsions	*	-	-	-	-
Hydroglyceric pastes (tooth paste)	*	-	** GEP, (EEP)	-	*
Aqueous pastes	*	-	* GEP	* glycol extract	*
Soft monophase gels	**	-	- (GEP)	-	-
Silico-glyceric gels (transparent tooth paste)	-	-	*	-	-
Aqueous and dilute, alcoholic solutions	**	-	* GEP, EEP	* hydrol. or glycol extract	*
Solid gels (sticks)	-	-	*	-	-
Liquid surfactants (liquid soaps, shampoos)	**	-	** GEP, EEP	** hydrol. or glycol extract	*
Solid surfactants (soaps)	**	*	** EEP, GEP	* lipid fraction	*

Royal jelly

Royal jelly is used in its fresh or freeze-dried form, and also mixed with a stabilizer such as lactose or glycine (see also section 6.7). Any form of royal jelly can be mixed with cosmetic products at temperatures up to 30 to 35° C.

The percentage incorporated in mixtures many years ago, when royal jelly was much more expensive ranged from

0.05 to 1 %, while today the level commonly ranges from 0.5 to 1 %. Its ascribed beneficial characteristics (Table 9.1) can be exploited in all preparations with which it will mix easily (Table 9.2) and particularly for dry, relaxed and aged skin. The lack of scientific support for such functions does not necessarily disprove its benefits.

Queen bee larvae

Only one indirect reference to the use of larvae could be found in DeNavarre (1962). It describes how in 1955, De Bevefer stabilized royal jelly with 25 % of sterilized queen bee larvae. This addition to royal jelly was said to potentiate and stabilize its action. In addition, two patents were granted for the direct inclusion of powdered queen bee "embryos" which is said to have effects similar to royal jelly (Swiss patent, 1957; D'Albert, 1958). The same report by DeNavarre mentions Rovesti's (1960) discovery of a trephonic substance in queen larvae, said to result in effects equal to other embryonic extracts. These are very high priced ingredients for some cosmetic formulations. No use of queen bee larvae has been found in any of the reviewed formulations.

9.6 Buying

When buying ingredients for cosmetics, it is extremely important to obtain fresh, uncontaminated and clean products. It is usually difficult and expensive to sterilize a contaminated product without damaging at least some of its useful properties. Also, many contaminants cannot be cleaned sufficiently, particularly if the dirt has been dissolved in one of the ingredients. The buyer, therefore, often needs to supervise the production process of his raw materials, or give special advice on improvements to achieve the desired quality. In this respect, the processing and extraction of natural products can be particularly problematic.

Adequate testing facilities should be available and used for checking material, before buying and/or before using. This, of course, becomes more important and also more cost-effective when larger quantities are purchased. Reliable suppliers can save a manufacturer a great deal of time, effort and money. For addresses of some international suppliers, see section 9.3.2 and Annex 2.

9.7 Storage

In order to increase the useful life of a product under various circumstances, or in order to determine the possible shelf-life other than by experimentation, the following criteria have to be monitored:

- the condition of materials prior to manufacturing
- the composition of the product
- the conditions for production and packaging
- packaging materials
- storage conditions

These considerations are discussed in detail in the section on quality control (9.8) and in the section on packaging (section 9.9). Various forms of deterioration for the individual ingredients are summarized in Table 9.3.

Table 9.3
Degradation and preservation of cosmetic ingredients

Ingredients	Degradation	Prevention
Unsaturated lipids, natural and synthetic	Rancidification, oxidation	Addition of antioxidants, cold storage and exclusion of air

Proteins, vitamins, biological polymers, water-based products	Bacterial and fungal growth	Addition of antibiotics or fungicides and cold storage
Photosensitive material, enzymes, essences, vitamin, a.o.	Exposure to light	Addition of chemical UV filter, dark (opaque) containers and dark storage
Natural powders, gums and products rich in carbohydrates (starches, sugars, etc.)	Bacterial and fungal growth	Addition of antibiotics and fungicides, dry and cool storage
Vitamins and derivatives, enzymes, proteins, fragrances, aromas, etc.	Exposure to heat	Protection from heat, cold storage
All of the above	Aging	Rapid processing and consumption

Products in general should be stored for as little time as possible by the producer, the retailer and the consumer. Smaller batches made more frequently may therefore become necessary. Raw materials, each according to its requirements, can usually be stored separately better than they can be when combined in the final product. Storage temperatures for most final products should be within 5-30^{0}C. High quality emulsions with low water content may possibly be frozen, but each formulation will have to be tested for negative storage effects on stability and appearance of the product. Many products should also be kept in the dark or in dark containers, such as boxes. Containers need to be adequate for their purpose (see also sections 9.9 and 9.10). During distribution, the same criteria need to be observed. The retailer too, needs to be advised of proper storage, particularly in the case of preparations with a short shelf-life.

Industrial formulations, such as the more complex ones in the following recipes are designed to last for one to two years, observing the most stringent precautions during manufacture. The simpler recipes usually without preservatives and anti-oxidants will last between a couple of weeks and a few months, depending on the ingredients and temperatures conditions; water emulsions (o/w) being more fragile than oil (w/o) emulsions. Refrigerated storage will prolong their shelf-life considerably. In general, they should be treated in the same manner as perishable food items.

9.8 Quality control

Quality for the consumer means the performance of a product according to its purpose, and the lack of undesirable side effects. Manufacturers however, need an additional definition of quality which allows them to control the manufacturing process for uniformity of the end product, which then has to comply with the consumer's expectations of quality.

In such a definition for a manufacturer, quality is an inherent part of a product and is defined through characteristics that, when compared with a standard, serve as a basis for measuring the uniformity of the product and drawing conclusions as to its acceptability with set quality standards.

The minimum standards must consider at least the following points:

- the formula, with precise statements of the ingredients and the percentage or weight of each
- raw material specifications and compliance; guidelines, descriptions, composition and other specifications for cosmetic ingredients can be obtained from CTFA (see Annex 2)
- operating standards, set by the company internally according to equipment and product requirements

- finished product standards, which should cover all characteristics affecting product performance, longevity and safety. A sample of each product batch should be kept as a reference, stored at 4°C in the dark
- packaging material standards
- standard testing methods.

The standards themselves are set by law, industries, industrial organizations or according to the buyers' requirements. Beyond these generally minimum requirements, each company should set its own standards Adherence to the standards is effected by including adequate control of raw materials, packaging material, manufacturing and packaging procedures and the final product itself - such as its stability in end-use tests under various environmental conditions. Tests should compare product batches with a standard.

Since the different degrees of quality control are expensive, and better quality requires additional care, better equipment and better raw materials, there are also different levels of quality and, accordingly, different costs.

Of course, a product also has to fulfil the purpose for which it was made: soap, moisturizing cream or anti-wrinkle creams. Here, the small manufacturer, home-based artisan or producer may produce products as good or better than large international manufacturers. He can control the freshness and the purity of his ingredients better, can work with simpler formulations and use ingredients which the industrial producer cannot use without preservatives. This is possible since the small producer has to safeguard against less factors and can control many of them without having to change the product. The scale of production imposes more precautions at higher levels of production. Within legal and ethical limits, each producer and consumer should be able to decide how much of a compromise they are willing to make.

For practical purposes, in addition to more general and legal considerations, any cosmetic manufacturer whether for home use or retail sale on a small or large-scale should observe the following steps to assure the best possible product.

As discussed under the buying section, contaminated or unfresh raw materials not only spoil the end product or reduce its effectiveness and thus its quality, but also reduce its shelf-life.

The stability of individual ingredients in a product determines its shelf-life. Proteins, vitamins, unsaturated vegetable and animal oils (or fats), biological polymers (e.g. gels), particularly when they are suspended in a water phase are most vulnerable. These require refrigeration prior to use and after processing as well. The addition of adequate preservatives for proteins and vitamins, and anti-oxidants for unsaturated fats, e.g. propolis, further improves the longevity of the product. This is particularly important where retailers and shippers do not maintain optimal conditions for their merchandise. Alternatively, these ingredients can be replaced by more stable synthetic ones, though with some compromise in consumer appeal, and possibly effectiveness and price.

Processing needs to be done with proper equipment and the utmost care, by well trained technicians. During processing, temperatures for heating should not be exceeded nor should heating be prolonged for longer than absolutely necessary (or foreseen in the recipes). Equipment should always be kept clean and if necessary, should be sterilized. This is true for all apparatus and materials (tubes and pumps) in contact with the product - including peoples' hands. The processing room should be as clean as possible - this means much cleaner than most people's kitchens. After processing, the product should be put into clean containers which should be kept closed in a clean dry place at a suitable storage temperature as cool as possible between 5-30^{0}C. Many creams should not be bottled until 24 to 48 hours after processing.

During packaging, a high level of cleanliness should be maintained in the work place, in the bottling equipment, retail containers and among personnel. All personnel should be made aware of the need for cleanliness, which needs

to be strictly observed. Packaging materials have to be clean and adequate , i.e. compatible with their contents. Packages or containers must not discolour, crack, tear or deform and neither should the product ooze through the walls or lids of the container. Lids and seals should be tight and secure to avoid any leakage or contamination by dust or bacteria, which might lead to oxidation and discolouring.

Lastly, storage and distribution have to be handled correctly and quickly to reduce damage or deterioration to a minimum.

Creating this perception of value is sometimes achieved not by larger volume, but by higher weight, i.e. a very small container of very thick glass, or by using an especially decorative container.

Not all these conditions can be fulfilled 100% of the time under all circumstances, but quality production requires the best possible efforts. If something goes wrong, each step should be checked against the list of precautions and the recipe and any mistakes should be corrected accordingly. Prevention is generally cheaper than the loss of a batch or customers. New formulations or equipment modifications should be tested with small batches before attempting full scale production.

Figure 9.10: Very decorative bottles for honey shampoo and foam bath and other gift packages.

9.9 Packaging and presentation

For all practical purposes, the container for a product should be adequate. It should not break easily, it should protect the contents and contain them without leakage. A package is also the business card of the product. It is a way of presenting and recommending the product to the consumer. Product identification is important in a competitive market (see also section 9.10).

The requirements for an adequate container have, in part, already been discussed in sections 9.7 (storage) and 9.8 (quality control). The aspects not yet considered are those of shipping and presentation. Shipping is charged for by weight or by volume and thus, containers should be as light as possible while protected against breakage. For various reasons, this general rule is often completely disregarded when packaging cosmetics.

Because they are used in small amounts, many cosmetic creams and make-ups are packaged and sold in small quantities. This minimises problems of loss of freshness. Pricing considerations are also important. Containers would be very small. Consequently, many of the containers are double-walled, i.e. one small bowl-shaped container inside another compartment. This facilitates more complete removal of the product and better protection of the internal compartment. A much larger outside container also gives the impression of a substantial amount of product or more value. An important and understandable objective, given the often very substantial price of cosmetics. Creating this perception of value is sometimes achieved not by larger volume, but by higher weight, i.e. a very small container of very thick glass, or by using an especially decorative container. Of course, the net weight has to be stated correctly.

But apart from volume/price or weight/price considerations, a decorative or otherwise attractive package must be provided. While some may think this is deceptive, it is an important element of consumer satisfaction, relating to the high price and small volume of the product but also to one of the intrinsic purposes of cosmetics : to promote beauty and make the user feel good about him/herself.

Of course, it is possible to sell for a much lower price which most local and less famous manufacturers have to do. Many of the less famous brands are sold in simple, small tubes and cheaper plastic containers. Customers in many societies have become used to equating high price with high quality, expecting to get something better when paying a higher price. Particularly with cosmetics this is not necessarily true.

Special containeers made to order or purchased internationally, would have to be bought in large quantities, hardly affordable for a small part-time manufacturer. Suitable locally available containers may be available, but the practical considerations mentioned earlier must be observed. Unusual, yet still practical shapes or special cardboard packages (see Figure 9.10) can still be selected. A well designed label can also make a big difference even on a very simple container. While the decorative aspect of a label is very important, it still should supply all the information legally required for each product. For the introduction of a new product, an attractive card attached to the container or included in the package may explain the special benefits of the bee products added to it but without suggesting unrealizable medicinal or therapeutic benefits.

Printing costs for labels can be high, if only small quantities or many different types are needed. Effective black and white designs are possible and could even be photocopied. Natural health care products have different requirements for consumer appeal compared with products aimed at the higher priced luxury market. Small label printers at reasonable prices, directed at producers with a need for a few individualized or versatile labels, are marketed (see Annex 2).

Cheap plastic containers, with good sealing lids can be dressed up to look special by inserting them into well made or even carved wooden boxes, miniature woven baskets with colourful straw flowers, or fancy shaped clay pots. These could have the added attraction that their manufacture could employ local craftsmen. Here too, quality control is important. Tiny clay pots, if well closed by a cork and if glazed on the inside with low metal glazes, can also serve as very decorative containers (see top of Figure 9.3). Decorated, refillable containers with special dispensers are another possibility (see Figure 9.4). Attractive multi-shaped printed cardboard boxes can be an effective low cost alternative (see Figure 9.11).

If there is an active local tourist market, products packed in coloured containers in traditional shapes and labelled with a local name present something typical of the area and are often very attractive to tourists. Though tourists are most likely to be once only customers, they may still constitute part of a more or less regular market and they, too, are becoming more quality conscious.

Figure 9.11 : Attractive cardboard boxes can create a distinctive presentation at an affordable price.

An alternative for some products such as soap bars, liquid soap, shampoo, foam baths or toothpaste may be packaging in small portions in heat-sealed plastic bags. These may not be as attractive for shampoos as for soaps, but since they are single portions, they can be sold very cheaply in local markets. A simple paper label with name, address, product, quantity and other legal necessities can be stapled on or inserted into a section of plastic above the product. The label can be printed with a simple rubber stamp.

For wholesale packaging of larger quantities, fewer such aesthetic concerns have to be considered. Durable, cheap and safe packaging is important. Depending on the product, various containers are available, from 1 litre wide-mouthed or screwtop bottles, through 20 litre buckets to plastic drums with well sealing lids. While new containers are better, clean reused containers can be lined with food-grade plastic to protect the product from possible odours or interaction with the container. Recycled containers which have contained toxic or strong smelling materials might contaminate the product and should not be used.

9.10 Marketing

Profit margins for producers and retailers of industrial cosmetics are usually very high, but frequently more than half of all costs incurred by large international cosmetic brands is spent on advertising and promotion. The small local producer usually has neither the budget nor the need for such advertisement, because of the small production volume. Once production capacity has increased, as a consequence of experience and dedication, the advertising aspect of marketing too frequently neglected has to be seriously considered.

Next to quality control, presentation is probably the most important aspect of cosmetic manufacturing. Attractive package and label designs are the most important considerations. Though not directly contributing to the performance of the product, being a beauty product it has to appeal to the consumer also from an aesthetic point of view. Many consumers may be more practical and not be very influenced by packaging, yet if there is competition with equal or better products, most consumers will prefer the "nicer ~, "prettier' or simply better looking packaged product. This

aspect should not be neglected by any producer who has a choice in selecting from various package shapes, colours or imprinted cartons and labels.

The easier a certain label or shape is to recognize (assuming it is generally attractive) the more consumers will identify quality with this specific product (label), develop a trust and certain expectations for this brand. The reverse is of course true as well - once a bad batch or other defect is marketed with a label, the consumer will not quickly forget. The competition when introducing a new product has to overcome the positive identification of brands and products, which is why there is so much money spent on advertisement and getting consumers to try a product first.

In the beginning, discounted packages and special displays in stores are cheap and effective way of product promotion. Local fairs and shows, donating products to TV shows, raffles, charity sales, etc., are all inexpensive ways to promote a product, have people try it, see it and become familiar with its label and the name. Giving samples free or at reduced prices to beauticians and hair salons for trial, while simultaneously displaying a conspicuous sign with the product's name is yet another possibility. Free demonstrations of beauty care or make-up application using the new products may also be given. Of course, all such activities are worthwhile only if a resulting increase in demand can be satisfied with sufficient products.

Depending on the targeted market, other promotional alternatives may be chosen, such as mail order and distribution through supermarkets, pharmacies, speciality stores and speciality commercial fairs. The possibilities are many and need to be adapted to local situations, needs, capabilities and commonly used methods. Expensive advertisements in newspapers, radio and TV should be a last resort. Particularly for cosmetics including bee products, still a novelty for most people, there is always a possibility to invite reporters for a special story including stories about bees, their life and biology, other bee products, etc. Such articles and interviews are free advertisement just make sure that you, your store or the name of your product are mentioned. Those beekeepers good with a pen may actually write the article themselves for local newspapers, radio programmes, bee journals, etc. Do no expect miracles immediately.

These alternative sales and promotion methods are really not that different from those that can be used for all the other bee products as well, including of course home sales and signs at the road side. Small village communities often do not need any other promotion than the good reputation of the manufacturer.

Once all this effort has been spent on promoting the product line, special attention must be devoted to maintaining standards. Mistakes, including inadequate attention to quality, missing, damaged or delayed shipments, lack of regular communication, difficulties in collecting payments, late delivery and late or inadequate responses to orders can all contribute to loss of customers faster than the advertising can provide them. Reliability is a very important factor in marketing, and development of customer relationships. If he wants to remain in business, the producer has to have suppliers and transport at least as reliable as he himself wants to be. This is, potentially, one of the most difficult and expensive problems to overcome, but it is a basic requirement for success.

Though marketing and advertising are special professional fields, much can be done by the small entrepreneur himself. With some ingenuity, common sense and imagination, attractive presentations and displays can be designed. Marketing approaches or "strategies" can be developed by watching how other successful competing products are distributed and sold, and asking people why they use them, how they came to know about them and why they prefer one product over others and how they are distributed. Most of all, successful marketing requires active interaction with customers and continuous improvement.

If the product has a short shelf-life, emphasis should be put on improving production methods, in particular temperature and mixing controls and quality assurance of raw materials. If these improvements cannot prolong product durability, smaller batches should be manufactured and distributed more frequently. Several sub-distributors who have refrigerators for proper storage may have to be selected. After that, more complex formulations using preservatives and incorporating more synthetic products may be the next alternative for those who do not want to continue with natural products.

It is plausible that customers with a preference for cosmetics with bee products might also show interest in products made with other natural ingredients. Herbal cosmetics and traditional medicines or food supplements could complete a product line, thus by reducing marketing-related costs per item and reaching a larger clientele, product diversity can provide better security. Having one's own retail stores may increase the profit margin, but may also limit the market volume. A combination of direct retail and distribution is a solution for many circumstances, particularly for small, part-time or growing enterprises.

Most present beekeeping/cosmetic lines include a product range of 5 to 20 items in 3 or 4 types, such as creams, soaps, shampoos and depilatory waxes. The products usually require similar ingredients and production equipment. In addition, other items such as food supplements or sweets, containing one or more primary bee products are usually offered. Many of the producers involved have grown from small, home sale operations.

Beekeepers becoming involved in and thinking about cosmetics production in order to increase the marketability of their primary products will soon notice that the cosmetic side of their business requires increasing attention. Since good cosmetics are good business and produce considerable income, producing them may quickly become a major activity.

9.11 Caution

Once again it should be mentioned that cosmetics with one or the other bee products can cause allergic reactions in some people. Most commercial, highly processed products have been tested for allergic effects. However, each skin reacts differently and people's sensitivity changes due to internal and external influences. Additions of propolis or pollen increase the chance of someone having an allergic reaction. Though rarely required by law, consumers should be advised of such possibilities. A test which may be suggested to the consumer is to apply a small quantity to skin on the inside of the underarm. If the subject is allergic to the preparation, this very sensitive area will usually show a reaction within 24 hours. Pollen extracts can reduce the risk of allergic reactions.

The preferred use of propylene glycol in cosmetics for pollen and propolis extractions is due to its non-polar properties, which means it mixes easily in water and oil phases. Unfortunately, its extraction of active ingredients from propolis and pollen is not as complete as that of concentrated ethanol. However, it must also be remembered (see Chapter 5) that glycol is toxic when ingested and 1.5 g per adult per day is the maximum safe limit. External application is not toxic. Doses of glycol in toothpastes have to be low enough to avoid danger to children accidentally consuming larger quantities.

Since natural cosmetics are perishable, their freshness and special storage needs to be closely guarded. cleanliness in all processing and packing steps and quality raw materials are of the utmost importance in order to avoid spoilage.

9.12 Market outlook

From an economic point of view, cosmetics are probably the most versatile and most profitable, easy to produce and easy to market value added beekeeping products. Product value is generally very high and the product has both regular market and health market appeal. There are many small enterprises, most of them recently started, entering the market and occasionally there are exceptional multi-million dollar success stories, such as that of a Thai woman entrepreneur reported in Asiaweek (July 26, 1991).

The market for small entrepreneurs appears to be open, since the high priced international market leaves a large enough economic niche for local producers with good quality products. The product type is well suited for small-scale, self-taught starters. Quality and marketing are easily adapted to increasing experience and increased business size.

Markets with growing numbers of consumers and increasing buying power of consumers who are becoming aware of

health products, offer opportunities for many producers. In the author's opinion, there are plenty of opportunities in many countries for successful cosmetic producers with special lines based on bee products. Competition is growing though, and this makes product choice and marketing, but most of all quality ever more important.

Contents - **Previous** - **Next**

CHAPTER 9b
COSMETICS

9.13 Recipes

It should be recalled again that a very large percentage of modern cosmetic ingredients are simply to improve appearance, durability, emulsification and preservation of a much simpler and more natural formulation. it should not be neglected that many of these chemicals, though not proven to be directly damaging, are nevert~eless artificial and foreign to the system to which they are applied. Equally, it is known that many cosmetic products do not do what they claim to do and instead may be damaging skin, hair, eyes, etc., after prolonged use. In general, it is therefore recommended to resort to less complex and more natural ingredients wherever possible.

Figure 9.12 : Two attractive displays of various cosmetic items, all containing one or more primary bee products (left: Müngersdorff, Germany; right: La casa de miel Argentina).

Freshly prepared creams and other formulations, should not be poured immediately into their retail containers or, at least, sufficient time should be left after bottling for the product to cool before it is capped. If poured warm and capped immediately, water may condense on the lid and drop onto the surface of the cream. Some cold creams in particular maintain a smoother texture if filled cold, though this may require pressure fillers for the more viscous products.

If premanufactured cream or soap bases are purchased and mixed with bee products, advice on the correct addition of the various products should be sought from the formulator of the base.

The inclusion of herbal extracts, such as Aloe vera gels, powders or juice is possible in many products. Particularly the Aloe products are known for many benefits similar to those known for royal jelly and other bee products. Their synergistic interactions might further increase beneficial effects.

9.13.1 Lotions

Aqueous solutions are possible with all bee products except beeswax, but solutions might produce precipitates after shorter or longer periods of time. Even honey, in acqueous solution might eventually produce some precipitation. Adding some alcohol and a substance to facilitate or maintain dissolutions (such as ricinus oil) will make acqueous sollutions of propolis possible, up to a certain concentration.

The following five formulations have been described by Proserpio (1981) and can be mixed by just shaking the ingredients in a bottle or using any simple mixing device. The mixing sequence is not very important.

Ingredients (parts by weight)	**PRODUCT**				
	Hair Care	**After Shave**	**Skin Cleaner**	**Skin Softener**	**Skin Toner**
Ethanol (90% vol)	60	50	25	-	-
Ricinus oil (40) OE	2.75	7.5	3.75	2.25	2.25
Essential oil or fragrance	0.25	1	0.25	0.25	0.25
Water (boiled and cooled)	30	-	-	50	50
Witch hazel water extract	-	40	70	-	-
Rose water (also orange or camomile)	-	-	-	40	40
Glycerol	-	-	-	5	-
Honey	q.s.	-	-	2.5	q.s.
Propolis extract (20%, EEP)	5	1	1	-	-
Pollen (ethanol or glycol extract)	2*	-	-	q.s.	7.5
Royal jelly	q.s.	-	-	q.s.	q.s.

** Hydrolysed pollen is recommended because it has a protecting and nourishing effect on the hair.*

Other primary bee products can be added to the hair lotion to increase its beneficial effect. The skin softener for dry skin and the toning lotion for firming relaxed, stretched or stressed skin may benefit from the addition of royal jelly or honey.

Emollient lotion (o/w)

Ingredients (in parts by weight):

8	*Beeswax*
15	*Mineral oil (white petrolatum)*
2	*Isopropyl miristate*

10	*PEG 400 monostearate*
5	*Lanolin*
2	*Stearic acid*
0.15	*Propylparaben*
0.15	*Methylparaben*
0.7	*Borax*
56.75	*Water*
q.s.	*Fragrances*

Melt and mix like any other emulsion cream and add fragrances when cool.

Emollient mil for face and body (o/w)

Ingredients (in parts by weight) after Proserpio (1981):

3.5	*Sorbitan (20) OE stearate*	*75*	*Water (boiled and cooled)*
1.5	*Sorbitan stearate*	*0.5*	*Hydroxy ethyl cellulose*
2	*Stearic alcohol*	*0.25*	*Xanthan gum*
7.5	*Almond oil*	*1.5*	*Lauryl alcohol (25) OP*
0.5	*Silicones and antioxidants*	*2.5*	*Glycerol (=glycerin)*
		2.5	*Pollen extract (lipid extract)*
		2.5	*Honey*
		q.s.	*Fragrances*

Warm, dissolve and mix all the ingredients in the left hand column. Dissolve the gum in a small amount of water. Very slowly mix the cellulose into the rest of the water, stirring well. Heat while stirring, add the dissolved gum, alcohol and glycerol, then mix well. Bring the oil phase to same temperature (70-80^{0}C) and emulsijy for 10-15 minutes. Continue stirring while cooling. Once below 40^{0}C, the honey, pollen extracts and fragrances may be added.

Honey and lotion

Ingredients (in parts by weight) after Krochmal (1985):

8	*Petroleum jelly (Vaseline)*
2	*Honey*
3	*Glycerol*
1	*Liquid lecithin*
0.5	*Silicones and antioxidants*

Melt the petroleum jelly in a water bath. Add the remaining ingredients and heat (<42 ^{0}C) for several minutes until the mixture is smooth and well mixed. For very small batches, to be used at home, 1 part could be equivalent to one tablespoon.

Honey and Rosewater hand lotion

Ingredients (in parts by volume) after Krochmal (1985):

1	*Irish moss*
4	*Rosewater*
4	*Honey*
8	*Water*
5	*Glycerol*

Simmer the Irish moss in the water over low heat until the mixture is thick (about 10 minutes). Strain or filter and combine the cooled filtrate ~ltered liquid) with the remaining ingredients. Aqueous (diluted) alcohol extracts of propolis may be added to the warm filtrate or glycerol, but might discolour the solution.

Cleansing gel

Ingredients (in parts by volume) after Krochmal (1973)

24	*Glycerol*
3	*Honey*
48	*Water*
2	*Gelatin or pectin*
0.1	*Oil of lavender*

Moisturizing gel

Ingredients (in parts by volume) modified after Krochmal (1973)

24	*Glycerol*
4	*Honey*
12	*Water*
2	*Gelatin or pectin*
1	*Propolis extract (10% EEP)*
0.1	*Essential oil*

Soak the gelatin in the water and dissolve over a low heat. Add the glycerol. Cool until warm to the hand and add the other ingredients.

9.13.2 Ointments

Ointments are fairly easy to prepare and proportions can be varied easily, since little or no emulsification is necessary and consistency is not very sensitive to minor changes in proportion or substitution by similar substances. Their durability is limited by the choice of oils.

Beeswax and coconut hand cream (ointment)

Ingredients (in parts by volume) from Krochmal (1985):

4	*Beeswax*
3	*Baby (jojoba or mineral) oil*
4	*Coconut oil*
5	*Glycerol or mineral oil*

Melt the beeswax and coconut oil in a water bath. Stir and add the other ingredients until smooth. After 5 minutes take away from the heat and continue stirring. As the cream will become fairly hard when it is cool, pour it into containers while it is still warm.

To soften the ointment, add approximately 3 to S parts of water and up to 0.2 parts of borax.

Propolis ointment

Ingredients (in parts by weight) from Spitznagel (1985):

8	*Cold-pressed olive oil*
2	*Unbleached beeswax*
1.5	*35% propolis extract (35% EEP)*
q.s.	*Lipid extract of pollen*

The proportion of oil to wax should be 4.'] and the total propolis content near 5%. Any multiple or fractions of the above weights can be used as long as the right proportions are maintained. The wax is melted in a water bath. Once liquid, the oil is added slowly with continuous stirring until the mixture is very clear. The pot can then be removed from the heat, but stirring has to continue until the mixture is cold and creamy. During the last phase, the propolis solution needs to be mixed in gradually.

The warmer the mixture, the better the propolis will mix, but in a cooler mix the characteristics oftheпropolis will be better preserved. A compromise would be about 40^0C. The olive oil may be replaced with other plant oils such as coconut or palm oil, or animal fat. Since any of these oils can go rancid, such a cream has a limited shelf lift even in the presence of propolis. Lipid extracts of pollen can be added to this ointment, but other non-lipid products such as royal jelly will not mix well.

Ingredients (in parts by weight) from Proserpio (1981):

Propolis extract (20% EEP)	*10*	*10*	*5*
Beeswax	*10*	*5*	*-*
Pollen extract (lipid fraction)	*-*	*5*	*5*
Lanolin	*-*	*10*	*10*
Vaseline	*80*	*-*	*60*
Pork fat	*-*	*70*	*-*
Menthol or other aromatic oil	*q.s.*	*q.s.*	*q.s.*

The formulas are very similar to the previous recipe and the mixing instructions are the same. The similarity shows the flexibility in mixing different proportions and ingredients partially or wholly replaced by others.

Nourishing bee cream (oointment)

Ingredients (in parts by weight) after Dany, 1988.

5	*Beeswax*	*1*	*Royal jelly*
40	*Wheat germ oil*	*1*	*Honey*
1	*Raw propolis or extract*	*3*	*Pollen pellets or extract*
0.2	*Borax*	*q.s.*	*Water*
0.2	*Pine oil or other aromatic oil*		

Heat the wax, wheat germ oil and propolis in a water bath until they are all melted. Mix and grind the pollen, honey and royal jelly in a small bowl or mortar. Mix with a little water and warm to 36-38^0C, using a water bath. Dissolve the borax,

in afew drops of hot water, cool and add to the honey mix. The honey phase can also be prepared with very little or no water. Both phases will greatly improve in consistency it extracts of propolis and pollen are used instead of the raw materials. The solvent should be reduced as much as possible before use.

While the oil and wax are cooling, continue stirring without mixing in too much air. At about 40 ^{0}C, add the pollen, honey, royal jelly and borax mix (which should be about the same temperature) and continue to stir. when cooled to about 30-32 ^{0}C, add the aromatic oil. Continue stirring until the mixture is cool. If the mixture separates or the consistency is not correct, heat it again slowly until good mixing (stirring) is possible.

With good stirring the consistency should be creamy. Keep the cream in a well sealed storage vessel for 24-48 hours before filling into jars then label and sell. The cream may be kept for about 4 to S and it is better to refrigerate after preparation is completed.

Coconut hand cream (ointment)

Ingredients (in parts by weight) after Berthold, (1993).

3	*Beeswax*
3	*Coconut oil*
4	*Glycerol*
3	*Baby oil*
q.s.	*Honey, propolis or pollen etract*

Melt the beeswax in a water bath and slowly blend in the other ingredients except bee products. Continue stirring while cooling. The baby oil can be replaced by mineral oil, jojoba oil or other. Proportions can be varied and other bee products may be added at levels of 2 to 10%.

Aloe moisturizing cream (ointment)

Ingredients (in parts by volume) after Krochmal,(undated)

12	*Beeswax*
24	*Avocado oil*
6	*Coconut oil*
0.02	*Vitamin E oil*
0.25	*Chamomile extract*
24	*Aloe vera gel*

Heat the first three ingredients in a water bath until the wax is melted. Stir well, remove from the heat and while cooling, slowly add the aloe vera gel a drop at a time. Continue stirring and when the mixture thickens, add the vitamin oil and chamomile extract.

Insect repellent

Ingredients (in parts by volume) after Krochmal,(1991)

1	*Aloe vera gel*
1	*Citronella oil*
1.5	*Beeswax*

The most commonly used commercial repellent is N,N-diethyl-meta-toluamide. It can be added as well, but should be present at a fairly high percentage (15-25%).

Combine the aloe and citronella oil in a saucepan and heat slowly over a low heat for 3 minutes. Add the wax and stir until the wax melts. Remove the pan from the heat and stir until the mixture thickens. Pour into jars. The beeswax makes this cream water resistant.

Waterless paste (ointment to which zinc oxide has been added)

Ingredients (in parts by volume) after Proserpio,(1981)

5	*Beeswax*
20	*Cacao butter*
25	*Almond oil*
25	*Rice amides (rice starch)*
25	*Zinc oxide*

Melt the beeswax in a water bath and stir in the other ingredients. Continue stirring while cooling.

9.13.3 Creams

General operating instructions

Emulsions require an efficient mixing system and an emulsifier, to obtain a homogeneous product.

The oils, waxes and emulsifier(s) are melted together at *70-75* ^{0}C. The water and heat stable water soluble substances are heated to 75- 80^{0}C. The formation of an emulsion is likely to be easier and more successful if the temperatures of the two phases are about the same at the time of mixing. If borax is used as an emulsifier, it is usually mixed with the water phase. Each phase may have to be filtered before mixing.

The different phases are premixed and added to each other according to the emulsion type and specific formulation, using turbo-mixing and stirring to emulsify and homogenise. Stirring is continued for 10-15 minutes at the same temperature. After cooling to 60^{0}C homogenization is stopped and mixing is continued, if possible under vacuum.

At 30 to 40^{0}C, heat sensitive substances and fragrances are added, during continued mixing of the product. The cream should be mixed for a further 5 minutes after which physio-chemical parameters such as pH, viscosity, organoleptic aspects and colour should be adjusted. It may then be poured into a storage vessel.

In the case of emulsions or lipogels containing pigments or insoluble powders in suspension, adequate milling systems should be used in order to get a good dispersion, homogeneity of the colour and absence of lumps. Three roller mills, pebble mills or homogenizers (rotor-stator type) are normally used for this operation.

If the addition of propolis renders a product too dark, titanium dioxide can be added in order to lighten the final colour. Use

a mill or, if hand mixing, a mortar and pestle or preferably a mill to disperse the pigment in a small quantity of product before incorporating it into the bulk.

The following are four olw emulsion formulations. 01w emulsions are considered the most appropriate by some people, because of the ease with which they can dissolve both water soluble and fat-soluble ingredients. But formulations must be "correct" for the skin, i.e. optimum pH and without surfactants or Vaseline. All primary bee products can be mixed with these emulsions. Their incorporation in the following formulations can be varied considerably. Though beeswax can be incorporated in small quantities, it finds much less use than in the cold cream type formulations (w/o and w/o/w emulsions). When substituting or changing the proportions of ingredients, a few small batches should be tried first. In contrast to ointments, even small changes can cause significant differences in the consistency, shelf life and other aspects of the end product.

Cleansing milk (o/w)

Ingredients (in parts by weight) after Proserpio,(1981)

5	*Glyceryl (24) OE sterate*	*65*	*Water (boiled and cooled)*
5	*Glyceryl stearate*	*0.5*	*Hydroxy ethyl cellulose*
2	*Hydrogenated lanolin*	*2.5*	*Lauryl alcohol (25) OP*
12.5	*Vegetable oil*	*5*	*Propylene glycol*
0.5	*Silicones and antioxidant*	*0,5*	*Essential oils, fragrances*
		1.5	*Honey*
		q.s.	*Propolis extract (10% GEP)*

Mix the components of the oil phase (left column) according to standard procedures and heat to 70-75^{0}C. Slowly dissolve the cellulose in the cold water, then while stirring well heat to the same temperature as the oil phase. Add alcohols to the water phase. when mixed well, slowly add oil phase and emulsijy for 10-15 minutes. Continue stirring while the emulsion cools. Once cooled to below 40^{0}C, the honey, predissolved in a little water, proplis (10% or higher concentrated glycol extract) and essential oils are added. The amount of propylene glycol should be reduced in proportion to the amount of glycol contained in any added propolis extract.

Purifying cream (o/w)

Ingredients (in parts by weight) after Proserpio,(1981)

5	*PEG 8 - $C_{12\ 18}$ alkyl ester*	*65*	*Water (boiled and cooled)*
5	*Stearic alcohol (20) O"*	*5*	*Glycerol*
10	*Stearin*	*0.5*	*Essential oils, fragrances*
4	*Vegetable oil*	*5*	*Propolis (10%, GEP)*
0.5	*Silicones and antioxidant*		

Mix the ingredients of the oil phase (in the left hand column) and the ingredients of the water phase (in the right hand column) according to standard procedures. Add the essential oils or fragrances and the glycol extract of propolis once the temperature is below 40^{0}C.

Hand cream (o/w)

Ingredients (in parts by weight) after Proserpio,(1981)

2	*Beeswax*	*70*	*Water*
6	*Cetyl alcohol (20) OE*	*5*	*Glycerol*
4	*Cetyl alcohol*	*0.5*	*Essential oil, fragrances*
2	*Hydrogenated lanolin*	*2*	*Propolis (10% GEP)*
5	*Vegetable oil*	*2.5*	*Honey*
1	*Silicone and Antioxidant*		

Mix according to standard procedures, add the essential oils, the GEP and the honey (predissolved in a little of the water) once the temperature is below 40 ^{0}C. Propolis extracted in ethanol or hydrogenated lanolin can also be used, but glycol extracted propolis is better.

Reconstituting cream (o/w)

Ingredients in percent by weight after Proserpio,(1981)

10	*PEG 8 - $C_{12\ 18}$ alkylester*	*65*	*Water (boiled and cooled)*
5	*Glyceryl stearate and*	*5*	*Glycerol*
	PEG 100 stearate	*0.5*	*Essential oil, fragrances*
5	*Wheat germ oil*	*2*	*Pollen extract, lipid fraction*
2	*Unsaponifiable olive*	*4*	*Honey*
0.5	*Silicone and Antioxidant*	*1*	*Royal jelly*

Mix according to standard procedures, add the essential oils, honey, royal jelly and pollen extract at temperatures below 40 ^{0}C. The pollen extract should be fat soluble, i.e. made with concentrated ethanol or in glycerol (the former is preferred).

Beeswax-pollen cream (o/w)

Ingredients (in parts by weight), modified after Sato,(1977)

11	*stearic acid*	*1.5*	*Hydrophilic surfactants*
6	*Liquid paraffin*	*57.5*	*Distilled water*
4	*Solid paraffin*	*1*	*Triethanol amine (emulsifier)*
6	*Bees wax*	*8*	*Propylene glycol*
2.5	*Hydrophobic surfactants*	*2*	*Propolis extract (20%, glycol)*
		3	*Pollen or pollen extract*

0.5	*Fragrances*

Prepare like any standard emulsion and once cooled to below 40 ^{0}C, add propolis, pollen and fragrances. The content of pollen may vary from 0.1-10%, or its equivalent alcohol (glycol) extracts. The amount of glycol added should be adjusted to account for any glycol included in the extracts of pollen and propolis.

Hand creams (o/w)

Ingredients (in parts by weight)	*Hand cream (o/w)*	*Nourishing cream (o/w)*
OIL PHASE		
Mineral oil	*5-10*	*3-5*
Vegetable oil	*2-5*	*5-10*
Thickener	*0-0.5*	*0-0.5*
Silicone derivative	*0.5-1*	*0.5-1*
Fatty alcohols C16-C18	*1-3*	*0.5-1*
Long chain esters	*2-5*	*1-3*
Short chain, branched esters	*-*	*5-8*
Beeswax	*1-3*	*1-3*
Emulsifiers	*5-10*	*5-10*
Preservatives and antioxidants	*q.s.*	*q.s.*
AQUEOUS PHASE		
Humectants	*5-10*	*3-5*
Thickeners	*0-0.5*	*0-05*
Honey	*1-4*	*1-4*
Chelating agents	*q.s.*	*q.s.*
Preservatives	*q.s.*	*q.s.*
pH correctors	*q.s.*	*q.s.*
Fragrances	*q.s.*	*q.s.*
Primary bee products (propolis, pollen and royal jelly)	*1-3*	*1-3*
Water	*q.s. to 100*	*q.s. to 100*

Prepare like any emulsion, but watch for correct sequences in preparing each phase and the pH of the aqueous phase (according to the requirements of the chelating agents). For simplicity, these formulas can be reduced to their bare minimum of oils, beeswax, emulsifier (borax), water, fragrances and other primary bee products. For such a simple example, see the next recipe.

Nail cream (o/w)

Ingredients (in parts by weight):

25	*Lanolin*
16	*Mineral oil (white, liquid petrolatum)*
4	*Beeswax*
55	*Water*
q.s.	*Fragrances and preservatives*

Mix like standard o/w emulsion. One part of borax should facilitate emulsification of the cream.

Night cream (o/w)

Ingredients (in parts by weight) form Klein (1991):

A)	*43.45*	*Deionized water*
	0.7	*Sodium borate*
	2	*Glycerol*
	0.3	*Xanthum gum*
	0.1	*Terasodium EDTA*
B)	*2*	*Cetearyl alcohol*
	2	*Sorbitan sesquiolate*
	5	*Glyceryl monostearate*
	8	*Macadamia nut oil*
	0.2	*Vitamin E acetate*
	12	*Beeswax*
	15	*Mineral oil*
	8	*Octyl palmitate*
C)	*1*	*Hermaben II (propylene glycol, diazolidinyl urea and parabens)*
D)	*0.25*	*Fragrance*

Mix the ingredients listed under A and heat them to 75 ^{0}C. Mix those under B and heat them also to 75^{0}C. Mix B into A, emulsijy, cool to 40^{0}C, then add the hermaben and the fragrance. Stir throughout the process and homogenize. This oil-in-water cream utilizes an anionic/nonionic emulsijjcation system. The Macadamia nut oil helps to reduce any greasiness of the mineral oil.

Modern cold cream (w/o/w)

Ingredients (in parts by weight) after Proserpio (1981):

2.5	*Beeswax*	*55*	*Water,boiled and cooled*
2.5	*Glyceryl stearate*	*0.5*	*Hydroxy ethyl cellulose*
5	*Stearic alcohol*	*0.5*	*Magnesium sulphate*
5	*Hydrogenated lanolin*	*6*	*Glycerol*
1	*Phytosterols*	*0.5*	*Essential oils,fragrances*
1	*Ethoxylated phytosterol*	*1-2*	*Pollen extract (10%)*
0.5	*Silicone and antioxidatns*	*1-2*	*Propolis extract (20%)*
20	*Vegetable oils*	*1*	*Royal jelly, fresh*

Heat the oil phase to 70 or 75 ^{0}C, then add and mix all the oil phase ingredients (in the left hand column) into the melted beeswax in the above sequence. Slowly dissolve the cellulose in the water and heat, stirring well. Add the water phase ingredients (the glycerol and magnesium sulphate), dissolve and homogenize, bring to the same temperature as the lipid phase and combine slowly. Emulsijy for 10 to 15 minutes and continue stirring while the liquid starts to cool. At less than 35^{0}C, add the fragrances, propolis, pollen extract and royal jelly.

Glycol or ethanol extracts of propolis and pollen can be used. Royal jelly can also be used in its freeze-dried form if weights are adapted accordingly, i.e. 0.35 parts of freeze-dried royal jelly if no carrier substance has been mixed with the royal jelly and 0.65 parts added to the water.

Cleansing creams (w/o) and ointment

Ingredients (in parts by weight)	*Emulsion (w/o)*	*Ointment*
Beeswax	*10.0*	*6.2*
Mineral oil, liquid paraffin	*57.0*	*62.5*
Petroleum jelly (Vaseline)	*-*	*18.8*
Paraffin wax	*-*	*12.5*
Borax	*0.7*	*-*
Water	*30.3*	*-*
Preservatives, antioxidants	*q.s.*	*-*
Fragrances, propolis extract	*q.s.*	*q.s.*

Cleansing creams (w/o)

Ingredients (in parts by weight)	*Cold creams*		*Emollient cream*
	w/o	*w/o*	*o/w*
Beeswax	*7*	*15*	*15*
Mineral oil, liquid paraffin	*50*	*20*	*20*
Almond oil	*-*	*10*	*-*
Sesame oil	*-*	*10*	*-*
Hydrogenated vegetable oil	*-*	*-*	*10*
Petroleum jelly (Vaseline)	*-*	*10*	*10*
PEG 40 sorbitan lanolate	*-*	*-*	*10*
Borax	*-*	*1*	*0.7*
Tween 40	*2*	*-*	*-*
Atlas G1726 (emulsifier)	*8*	*-*	*-*
Water	*33*	*33*	*q.s. to 100*
Antioxidant, preservative	*q.s.*	*q.s.*	*q.s.*
Fragrances	*q.s.*	*0.50*	*0.25*

The waxes and oils are heated to 75 ^{0}C together with the emulsifiers which can be substituted by a much smaller quantity of borax, i.e. 0.5 to 1 part. The water is also heated to 75 ^{0}C and added slowly to the wax-oil phase while emulsijying, stir thoroughly until it has cooled to room temperature. Below 40^{0}C, the pe~me and other heat sensitive ingredients may be added and everything is stirred to a homogeneous cream. After 24 hours the product can be filled into retail containers.

Classic cold creams (w/o with borax)

Ingredients (in parts by weight) after Proserpio (1981)

Ingredients	*Cold creams*

Beeswax	*10*	*12*	*15*
Vaseline	*12*	*-*	*-*
Mineral oil	*50*	*-*	*50*
Almond oil	*-*	*67*	*-*
Water (boiled and cooled)	*27*	*20*	*34*
Borax	*0.4*	*0.7*	*1*
Essential oils	*0.6*	*q.s.*	*q.s.*
Propolis extract	*q.s.*	*q.s.*	*q.s.*
Pollen extract	*q.s.*	*q.s.*	*q.s.*
Royal jelly	*q.s.*	*q.s.*	*q.s.*

The emulsions are prepared according to the standard procedure described previously. Essential oils (according to preference) concentrated and evaporated ethanol extracts of pollen orpropolis (at 0 to 5%) and fresh or freeze dried royal jelly (0-3%), can be included at varying concentrations individually or in various combinations. The almond oil and mineral oil can be replaced by other vegetable oils. In general, these formulations are very flexible and different proportions can be tried. Other waxes and, of course, other emulsifiers can be used. The water content generally ranges from 20 to 37%, but as in the case of ointments may be reduced to 0% thus influencing the consistency. Any modifications can influence the consistency of the product, trial batches should be made to confirm the acceptability of the new consistency.

Berthold (1992) lists 11 basic recipes for creams (w/o emulsions with borax) in a comparative table. The basic ingredients varied from 5 to 17 parts of beeswax, 40 to *56* parts mineral oil, 5 to 35 parts of water and 0.4 to 1 part borax. This again demon~trates the great flexibility of this type of emulsion in simple recipes, where itis easy to change ingredients unlike in more complex formulations.

Moisturizing cream (w/o)

Ingredients (in parts by volume) after Krochmal (1973):

1	*Honey*	*8*	*Almond oil*
1	*Glycerol*	*0.1*	*Oil of rose*
8	*Olive oil*	*1*	*water*

Combine the honey and glycerol, then stir in the oils. Afterwards, stir in the water. This cream does not require heating, but will not be stable for very long and might separate. Its storability should be tested.

Aloe cream (w/o) for general cosmetic purposes or for burns

Ingredients (in parts by weight) form Gentry (1988):

18	*Beeswax*
40	*Paraffin*
30	*Water*
0.6 to 1	*Borax*
10	*Pulverized aloe*
2	*Propolis extract (10%, EEP), optional*
2	*Honey, optional*

Grate and melt together the beeswax and paraffin in a water bath (maximum 75 ^{0}C). Warm the water to the same temperature and dissolve the borax. Slowly pour the water into the wax with rapid stirring. Remove from the heat and continue to stir until thickened. Stir in the aloe powder while the mix is still liquid. Propolis extract and honey may be added, particularly if the cream is to be used for treating burns, even 2 parts of honey could be very beneficial.

Multipurpose cream

Ingredients (in parts by weight) form Dany (1988):

60	*Butter or hydrogenated vegetable oil (margarine)*
50	*Pollen or pollen extract*
40	*Honey*
30	*Propolis extract (10% EEP)*
10	*Royal jelly*

Gently melt the butter, then remove it from the heat, add the propolis extract. Stir the pollen extract into the honey and add this to the cooled (but still warm) butter. Add the royal jelly, mix well and store in a refrigerator in a well sealed glass jar

Though mentioned here as a cream, this product can be eaten and used as a home remedy for relief (not cure) of any illness. To guard against allergies, use pollen extract (or beebread extract) instead of pollen.

Contents - **Previous** - **Next**

9.13.4 Sun protection

Sun cream

Ingredients (in parts by weight):

10	*Beeswax*
2	*Ozocerite*
2	*Glyceryl monostearate*
20	*Isopropyl*
2	*Sun filter*
2	*Isopropyl lanolate*
22	*Lanolin alcohol ethers (20 OP)*
3	*Hydroxylated lanolin*
0.6	*Borax*
33.4	*Water*
q.s.	*Perfume and preseratives*

Sun cream (w/o)

Ingredients (in parts by weight) after Proserpio (1981):

5	*Beeswax*
5	*PEG 2) dodecyl glycol copolymer*
2.5	*Sorbitan oleate*
5	*Sterol alcohols*
2.5	*UV filter*
2.5	*Pentaerithritol ether*
15	*Squalene*
5	*Fat-soluble walnut extract*
1	*Hyfrogenated ricinus oil*

Follow instructions for mixing the copolymer or mix it very slowly with the melted beeswax. Add other ingredients while stirring.

Suntan oil

Ingredients (in parts by volume) modified from Krochmal (1973):

8	*Olive oil*	*or*	*16*	*Olive oil*	*or*	*16*	*Vaseline*
1	*Sesame oil*		*16*	*Peanut oil*		*3*	*Beeswax*
4	*Peanut oil*		*0.25*	*Oil of jasmine*		*0.1*	*Oil of rose*
0.2	*Pollen extract (20% GEP)*					*1*	*Propolis (GEP)*

Combine all the ingredients. Other oils such as coconut or palm oil may also be used. It is better to use refined rather than regular cooking oil, though the latter can be used for products consumed at home. Different essential oils may be added as well. Either pollen extracted can with propylene glycol or with concentrated ethanol (with the ethanol largely evaporated or replaced by glycol) can be used. Pollen is said to promote tanning and propolis (ethanol or glycol extract) can be added to increase sun protection. For additional protection against UV radiation, special synthetic UV filters can be included. These may require an additional agent to dissolve or suspend them in the oils. Such information can be obtained when purchasing the raw material. Commercial formulations generally do not contain much more than has been listed in this recipe.

For personal use, ready-made suntan lotions may be purchased and the pollen or propolis extracts be added directly to them.

Sun gel (lipogel – an ointment to which a stabilizer, in this case hydrogenated ricinus oil has been added)

Ingredients (in parts by weight) after Proserpio (1981):

2.5	*Beeswax*	*2.5*	*UV filter*
50	*Sesame oil*	*5*	*Hydrogenated lanolin*
25	*Vegetable oil*	*2*	*Liquid jojoba wax*
2.5	*Unsaponifiable olive oil*	*0.5*	*Essential oils*
5	*Lipid-soluble walnut extract*	*5*	*Hydrogenated ricinus oil*

Melt the beeswax in a water bath and add the other ingredients. The fragrances and ricinus oil are added last. Ricinus oil (castor oil) is extracted from Ricinus communis seeds.

The product will be improved by the addition of propolis as a weak UV screen, and pollen extract (2 parts) for its effect on tanning, will ffirther improve the product.

After sun gel (monophasic gel)

Ingredients (in parts by weight) after Proserpio (1981):

10	*Honey*
50	*Water (boiled and cooled)*
30	*Witch hazel (aqueous extract)*
1	*Carbopol 940*

5	*Glycerol*
2.75	*Ricinus oil (40) OE*
0.25	*Chamomile oil*
1	*Neutralizing base*
1-2	*Propolis extract*

Dissolve the honey in a little water. Premix the neutralizing base in a little glycerol or water. At room temperature, mix the rest of the water and the witch hazel and add the carbopol very slowly while stirring vigorously. Stir until everything has dissolved. Mix the oils in the glycerol. Add the glycerol/oil phase to the carbopol/water phase. Mix carejully without incorporating air. when homogeneous, add the premixed base and stir slowly for another 30 minutes.

A glycolic propolis extract, preferably in paste form can also be added. It should be mixed with the glycerol before adding to the carbopol/water.

9.13.5 Shampoos

Generic ingredients (parts by weight)	*Shampoo*	*Bath foam*
Anfoteric surfactant	*25-30*	*5-10*
Anionic surfactant	*5-10*	*35-40*
Non-ionic lather booster	*1-3*	
Thickener	*0-0.5*	*0-0.5*
Alkyl glucoside C_8-C_{10}	*1-3*	
Restoring, conditioning agents	*1-5*	*1-3*
Honey and other be products	*0.5-5*	*0.5-5*
Preservatives and chelating agents	*q.s.*	*q.s.*
Fragrances and antioxidants	*q.s.*	*q.s.*
Water	*q.s. to 100*	*q.s. to 100*

Without heating, mix all the ingredients, except the thickener, water and pe~me. Use a slow moving blade mixer and mix until a homogeneous mixture is obtained, avoiding as much as possible the trapping of air. Slowly add the water and mix until homogeneous. The thickener is heated slightly and added to the main mass. Shampoos with a glycerol or oil phase can also include a small percentage of beeswax.

Fragrances and other additives can be added shortly before pouring into storage vessels and before control and/or adjustment of physical characteristics.

The following two shampoos have been described by Proserpio (1981):

For dry hair		**For oily hair**	
15	*Coccoilamido propylbetain*	*25*	*Lauryl ethoxy sulphate MEA*
10	*Cocoimidazolin*	*5*	*Lauryl sulfur succinate NA*
4	*Glucose $C_{8\ 10}$ alkylether*	*2*	*Coccoilamid*

1	*Lecithin amide*	*2*	*Abietoil polypeptide*
0.5	*Essential oils or fragrances*	*0.5*	*Essential oils or fragrances*
65	*Water (boiled and cooled)*	*45*	*Water (boiled and cooled)*
2.5	*Hydrolysed pollen*	*0.5*	*Citric acid*
2	*Honey*	*2*	*Hydrolysed pollen*
		2.5	*Propolis extract (10%, GEP)*

The following two formulas are adopted from Krochmal (1985). They are very simple and use relatively common materials. However, they do not produce a very stable product for marketing in most stores.

Ingredients (parts by volume)	
Honey-pollen shampoo	***Honey-egg shampoo***
12 honey *24 glycerol* *3 witch hazel* *12 cologne* *1 liquid soap* *2 alcohol* *6 pollen extract*	*12 honey* *3 almond oil* *3 witch hazel* *3 cologne* *6 liquid soap* *6 water* *1 large egg per 60 ml honey*

Cologne (perfumed aqueous alcohol) can be used, but rose water, orange flower water or other aqueous aromatic extracts which are much cheaper than cologne can also be used. If a glycol extract of pollen is used, the shampoo will have a smoother texture. Propolis extract can be added to treat dandruff The honey content may be reduced in order to reduce costs.

For very small quantities, when 1 part is equivalent to one teaspoon (and 24 parts to ½ a cup), the ingredients may be put in a bottle and shaken until a more or less homogeneous solution is obtained. For larger quantities dissolve the honey in the cologne and the soap in the alcohol. After glycerol is mixed into the honey and the cologne, the witch hazel, pollen and soap are added.

The problem for marketing is the lack of preservatives (and consequently the short shelf-life), and the possibility of separation of the ingredients after a short time. The honey-pollen recipe already has an alcohol content which functions as preservative, but the egg in the second recipe makes it very perishable. If sold without the egg, the shampoo should keep for many weeks. Customers might be advised to add an egg themselves.

After- shampoo balsam

Ingredients (in parts by weight) after Proserpio (1981):

2.6	*Cetyl alcohol*
2.5	*Jojoba oil*
1.0	*Cetyl polyethoxy ammonium phosphate*

4.0	*Tallow (15) OE polyamine*
80	*Water (boiled and cooled)*
1.0	*Citric acid*
0.5	*Essential oils of fragrances*
3.5	*Hydrolysed pollen*
5.0	*Propolis extract (10%, GEP)*

The thickeners (phosphate and polyamine) also junction as emulsifiers and can be replaced by other, more readily available thickeners and emulsifiers. Beeswax can be included at a very small percentage (1-2%).

Foam baths (with honey or propolis)

Ingredients (in parts by weight) after Proserpio (1981):

50	*Lauryl ethoxy sulphate (sodium salt)*
10	*Lauryl sulfur succinate (sodium salt)*
5	*Glucose $C_{8\ 10}$ alkylether*
2.5	*Coccoilamid*
7.5	*Coccoilamido betaine*
2.5	*Essential oils or fragrances*
20	*Water (boiled and cooled)*
2.5	*Honey and/or propolis extract (10%, GEP)*

In addition to three variations distinguished by the addition of honey, propolis or both, herbal extracts to promote relaxation and stimulation of circulation may be added to this kind of formulation.

Figure 9.13 : A simple, attractive gift package

9.13.6 Solid soaps

The addition of propolis to any soap products will cause a strong greyish colouring.

Basic beeswax soap

Ingredients (in parts by volume) after Berthold (1992):

72	*Tallow, clean, rendered*	*36*	*Water (soft, rain water)*
24	*Vegetable oil*	*12*	*Lye flakes (potassium hydroxide or sodium hydroxide)*
9	*Beeswax*	*1*	*Citronella oil*
		0.25	*Lemon oil optional*
		6	*Honey, optional*
		5-10	*Propolis extract 10% EEC, optional*

Melt the beeswax in a water bath and stir in the vegetable oil. In a separate pot, melt the tallow and measure the right quantity. Dissolve the lye flakes in cold water, then thoroughly mix the lye solution with the melted tallow and add the melted beeswax-vegetable oil mixture in a thin stream. Beat mixture vigorously until blended thoroughly. Add honey (if desired), the propolis extract, citronella and the lemon oil or other essential oils (rose, sandalwood or lavender) and pour into greased moulds. The soap will take a while to harden. Protect it from dust.

Scented honey-propolis-beeswax soap

Ingredients (in parts by weight) after Dany (1988):

180	*Beeswax*	*50*	*Rosewater*
80	*Bar soap, milk*	*20*	*Honey*
30	*Almond oil*	*1*	*Propolis extract*

Melt the beeswax in a water bath and slowly add small chunks of the soap. Remove the hot waxAoap mix and gently heat the almond oil, rosewater and propolis in a separate pot to 40^0C, while stirring. The rosewater can be replaced with other preferred fragrances. when the wax and soap mixture has cooled to about the same temperature, add the two liquids together and stir well. Before it cools completely, stir in the honey. Then pour into oiled (mineral or vegetable oil) forms. It will take a while for the soap to harden. Lightly cover to provent dust and dirt settling on top of the soap, but do not close hermetically because of continuing evaporation of water when hard, remove, wrap in paper, label and box in a nice carton. If the soap is of pleasant colour and shape, it may also be packed in clear plastic and sealed.

Honey-propolis soap

Ingredients (in parts by weight):

100	*Soap base (chips or bar soap)*
5	*Honey diluted with 2 water*
2	*Propolis in 18 parts glycerol or equivalent of 10% GEP*

The honey needs to be diluted with the water prior to jurther mixing. The propolis can be extracted in glycerol directly (though not very efficient) or an alcohol extract may be thickened by evaporation and mixed (emulsified or dispersed) in the glycerol at a concentration of 10% paste.

The soap chips can be tumbled in the two liquids and then refined and extruded as described in 9.2.4 or the soap may be careffilly melted. Shortly before hardening, the warmed honey - water (35 - 40^0c) and proplis are stirred in.

Honey-beeswax soap

Ingredients (in parts by weight) after Proserpio (1981):

90	*Soap base (chips or bars)*
5	*Glycerol*
0.5	*Beeswax*
2.5	*Essential oil (or propolis extract)*
2.5	*honey*

This is another very simple formula in which essential oil is added for fragrance. Pigments can be added alone to the formula or accompanied with a specljic dispersing agent, if necessary. Melt and blend the soap, glycerol

and beeswax. when the mixture starts to thicken during cooling, add the honey and essential oils. Pour into greased or oiled moulds.

9.13.7 Liquid soaps

Honey, pollen and propolis can be easily incorporated into liquid soaps. The polypeptide and amino acid components of hydrolysed pollen are thought to reduce the irritant and defatting action of the surfactants (soaps). In hygiene products for women, propolis has proven particularly effective.

Intimate soap (liquid)

Ingredients (in parts by weight) after Proserpio (1981):

15	*Coccoilamid betaine*
10	*Coccoimidazolin*
5	*Glucose C_{8-10} alkylether*
1	*Coccoilamid*
1	*Essential oils of fragrances*
65	*Water (boiled and cooled)*
2	*Citric acid*
1	*Propolis ectract (10%GEP)*

The ingredients are mixed careffilly at room temperature.

Aloe and honey soap

Ingredients (in parts by volume) after Krochmal (undated):

24	*Aloe vera gel*
1	*Chamomile extract*
1	*Calendula extract*
12	*Glycerol*
12	*Liquid castile soap*
q.s.	*Honey, pollen or propolis extract*

Combine all the ingredients except the soap and stir or shake well in ajar. Then add the liquid soap. Pour into a soap dispenser or storage vessel. Honey, lipid pollen extract and EEP propolis extract can be added in small percentages, as well as special herb extracts.

9.13.8 Toothpaste and mouth rinses

From an economic and manufacturing point of view, large batches of toothpaste will be difficult to make in

many countries. Obtaining the printed tubes and packing them requires special non-versatile expensive machines. Buying a base and adding flavouring, colouring, propolis and honey still leaves a packing problem, unless everything is done by a third party to specific specifications. This might only be feasible to complete a product line. For improving toothpaste for home use, and a recipe which contains propolis, see *5.16.8*. Adding beneficial products, however, does not remove less desirable ones already part of the base product. Mouth rinses are easier to prepare and package. The first three recipes use three different thickening agents.

Toothpaste (calcium carbonate base)

Ingredients (in parts by weight) after Proserpio (1981):

60	*Water (boiled and cooled)*
2	*Hydroxy ethyl cellulose*
0.5	*Xanthum gum*
5	*Propolis extract (10%, GEP)*
60	*Glycerol*
3.5	*Sweetener and aroma*
60	*Calcium carbonate*
5	*Pyrogenic silica*
4	*Sodium laurysulfate*

Mix the propolis with the glycerol. Heat the water slightly and slowly add the cellulose. when dissolved, add the xanthum gum and then the glycerol. Stir carefully without mixing air into the paste. Continue stirring, while letting it cool and adding the other ingredients.

Toothpaste (phosphate base)

Ingredients (in parts by weight) after Proserpio (1981):

50	*Water (boiled and cooled)*
2	*Sodium carboxymethyl cellulose*
5	*Propolis extract (10%, GEP)*
50	*Glycerol*
3	*Sweetener and aroma*
80	*Dibasic calcium phosphate*
6	*Pyrogenic silica*
4	*Sodium laurylsulfate*

Mix the cellulose slowly into the water without heating. Mix the propolis with the glycerol then add the glycerol to the water. Stir well for 15 minutes (avoid trapping air) then add the other ingredients and continue stirring slowly for 20 to 30 minutes.

Clear gel

Ingredients (in parts by weight) after Bennet (1970):

40	*Glycerol*
282	*Water*
0.6	*Sodium saccharin **ate? or q.s. honey*
6.6	*Carbopol 940 resin*
0.4	*Duponol C*
40	*Water*
28	*Sodium hydroxide (10%solution)*
1	*Propolis paste*
q.s.	*peppermint*

Prior to processing, dissolve the propolis paste in the glycerol. If the liquid is not clear, leave for 24 hours, refrigerate and filter. The saccharin sweetener may be replaced with about 3 parts of honey, or according to taste. Take a small portion from the 282 parts water and dissolve the honey in it.

While stirring the 282 parts of water, add the glycerol. Then sprinkle in the saccharin (or add honey) and mix for two minutes. Very slowly add the carbopol, mix for ten minutes and deaerate (in a vacuum) or with time for settling.

Dissolve the su~actant (Duponol) in the 40 parts of water and add to the Carbopol solution. Mix slowly for 60 minutes. Add the sodium hydroxide solution and stir for another 30 minutes. Finally, mix in the peppermint oil and stir for another 15 minutes.

Classic Toothpaste

Ingredients (in parts by volume) after Krochmal (1731):

9	*Soap flakes*
64	*Precipitated fine chalk*
12	*Glycerol*
0.5	*Oil of peppermint*
1	*Ethanol (70% by volume)*
q.s.	*Propolis extract and honey*

Combine the chalk and the soap flakes. Add the glycerol and stir until smooth. Dissolve the oil in the alcohol and add to the soap mixture. Propolis extract can be added to the alcohol part, but in the alkaline environment (soap), the propolis will discolour the toothpaste to a dark brown. Today '5 pastes do not use soaps any more, but other surfactants.

Aerosol mouthwash

Ingredients (in parts by volume):

12	*Propolis extract, 10 - 20% in ethanol*
q.s.	*Honey to taste*
2	*Peppermint oil*
1	*Coumarin (food spice)*
20	*Water*
40	*Glycerol*
325	*Ethanol (complete to 100%)*

Mix all the ingredients together until dissolved. The mixture can then be filled into a mechanical mister and used as a mouth spray. Other flavours can be used such as eucalyptol, menthol, cinnamon oil, citric acid or clove oil and mixed according to taste.

Water soluble peppermint extracts can be used and the propolis precipitate filtered out, or a more aqueous extract of propolis can be used. Glycerol in such a preparation, though preferred technically, should be minimized (or avoided) because of its relative toxicity.

Water content can only be increased slightly, before causing precipitation of the propolis extract, once the peppermint oil is added.

Aerosol mouthwash

Another aerosol mouthwash has been described as an oral spray in section 5.16.2.

9.13.9 Deodorants

A warning should be given here about adding alcohol extracts to preformulated bases or those prepared with certain gels and thickeners. The alcohol may have a strong thinning effect. The alcohol may have to be evaporated first or be replaced with another compatible liquid. Alternatively, a different thickener may be chosen. Very simple basic cold creams (section 9.13.3) or lotions (section 9.13.1) with an increased content of propolis work well and are less irritant.

1) Cream deodorant

Ingredients (in parts by weight):

1-3	*Beeswax*
8-15	*Isoparaffins (C_{10}-C_{11})*
3-5	*Vegetable oils*
0-2	*Fatty alcohols (C_{16}-C_{18})*

0-2	*Fatty acids or long chain fatty esters*
1-2	*Thickeners*
5-10	*Emulsifying agent*
q.s.	*Antioxidants*
8-12	*Zinc oxide*
1-3	*Enzyme inhibitor (triethylcitrate)*
1-3	*Zinc ricinoleate*
1-3	*Propolis glycerol extract (20%)*
q.s.	*Perfume, preservatives*
q.s. to 100	*water*

Melt the first 8 ingredients and mix them together. The next four are mixed in water and heated to 50^0C at which point they are mixed with the oil phase heated to the same temperature. During cooling and continuous stirring the perfumes, preservatives and propolis extract are added (at 30 to 40°C).

Emulsifiers include a wide range of cosmetics ingredients: sorbitan esters and sorbitan polyoxyethylenated esters are extensively used. Glyceryl monostearate is also useffil in many cases, when blended with alkaline soaps.

The glycerol extract can be made in the same way as the ethanol extract, by using glycerol instead of ethanol (see section 5.7). This type of extract is not expected to be as effective as ethanol extract even if the glycerol solution is heated to 40 ^{0}C. If this extract is replaced by an EEP, the alcohol should be eliminated as much as possible and the thick paste added at 0.3 to 1 parts.

2) Liquid (alcoholic) deodorant

Generic ingredients (in parts by weight):

50-70	*Ethanol**
1-3	*Glycol extracts*
0.1-0.5	*Allantoin*
1-3	*Enzyme inhibitor*
0.5-1	*Antibacterial agent**
q.s.	*Antioxidant*
1-3	*Propolis extract (10-20% EEP)**
q.s.	*Perfume*
q.s. to 100	*water*

All ingredients can be mixed at room temperature with a paddle or propeller mixer, careffilly avoiding incorporation of air.

9.13.10 Face packs Honey face pack

Honey face pack

Ingredients (in parts by weight)

Lipid phase		**Aqueous phase**	
8-15	*Vegetable and/or ineral oils*	*0.5-2*	*Thickener*
1-3	*Beeswax*	*3-8*	*Humectants (polyalcohols)*
1-3	*Fatty alcohol (C_{16}-C_{18})*	*3-8*	*Honey*
5-10	*Emulsifiers*	*q.s.*	*Preservatives*
0.5-1	*Polysiloxantes*	*q.s.*	*Fragrances*
q.s.	*Antioxidants*	*q.s. to 100*	*Water*

Heat and mix both the ingredients of each phase separately; then combine, homogenize and stir while cooling. Add fragrances when almost cold. This face mask can be packaged and sold. Storability in a refrigerator without preservatives and antitoxidants is several weeks. With preservatives, it should last as long as any other emulsified industrial creams.

Face mask gel (monophasic gel)

Ingredients (in parts by weight) after Proserpio (1981):

10	*Honey*
75	*Water*
5	*Hydroxymethyl cellulose*
2.25	*Ricinus oil (40) OE*
0.25	*Essential oils of fragrances*
2.5	*Pollen, glycol extract*
5	*Glycerol*

Dissolve the honey in 10 parts of water, then add to the rest of the water at room temperature. Rapidly stirring the honey water, add the cellulose very slowly. Stir until completely dissolved and avoid aerating the solution too much. Mix the pollen extract with the glycerol and add all the oils one after the other to the cellulose, honey and water mix. Stir for a few more minutes to ensure homogeneous distribution.

This face mask can be stored refrigerated over a long period. For regular marketing it should keep at least a few months. Glycol extract of propolis may be added too, and will increase the cleansing power of the mask.

9.13.11 Make-up

Eye colouring cake

Ingredients (in parts by weight):

4	*Glyceryl stearate SE*
1	*Propylene glycol stearate SE*
2	*Stearic acid TP*
1	*Beeswax*
1	*Isopropanolamine*
1	*Pigments*
q.s.	*Preservatives*

Mix and heat until a homogeneous mass is formed. Before completely cool, fill into trays or small forms in which the various coloured cakes are to be sold.

Eye colouring cream

Ingredients (in parts by weight):

8	*Propylene glycol*
3	*Cetyl alcohol*
9	*Beeswax*
7	*Isopropyl miristate*
8	*Glyceryl stearate and laureth-23*
1.3	*Cetyl lactate*
2	*Polyglyceryl-r oleate and PEG-8 propylene glycol cocoate*
9	*Pigments*
0.2	*Calcium stearate*
q.s.	*Preservatives*
q.s. to 100	*water*

Melt, mix and emulsijy like other w/o creams.

Eye shadow

Ingredients (in parts by weight) after Brown (1981):

1	*Beeswax*	*4*	*Liquid paraffin or mineral oil*
2	*Lanolin*	*2*	*White petrolatum (Vaseline)*

2	*Paraffin wax*	*4*	*Pigment*
		q.s.	*Essential oils*

This is a much simpler recipe than the preceding one and is said to work well.

Melt the ingredients in a water bath and mix well. Disperse the pigment in part of the liquid paraffin using a mortar and pestle or mill, then add it to the melted waxes. Stir very well and continue stirring during cooling but avoid aerating the mixture. Essential oils may be added for fragrance.

Eyelid make-up crayons

Ingredients (in parts by weight):

20-40	*Ceresin wax*
10-22	*Petrolatum (Vaseline)*
1-12	*Lanolin (or beeswax)*
10-20	*Castor oil*
5-23	*Pigments*

The ingredients are warmed and thoroughly mixed together. The oil and waxes can be varied in type and quantity to achieve the right consistency. This recipe cited by Fox (1992) has been described in a Polish patent awarded to Pruszkowskie Zaklady Materialow.

Eyebrow pencil

Ingredients (in parts by weight):

	I		***II***
15	*Lanolin (or beeswax)*	*20*	*Japan wax (or beeswax)*
15	*Stearic acid*	*10*	*Stearic acid*
20	*Carbon black (lamp black)*	*25*	*Carbon black*
10	*Titanium dioxide*	*5*	*Titanium dioxide*
20	*Talc*	*20*	*Talc*
17	*Sericite (mica)*	*14*	*Sericite (mica)*
3	*Sodium carboxyl-methyl-cellulose (as binder)*	*6*	*Hydroxyethyl cellulose as binder*
24	*Water*	*42*	*water*

The water-soluble binder is mixed with water and added to the rest of the ingredients. The mix is heated and moulded into rods which are dried. A proper wrapping or other protective shell should be applied. As can be seen from the second, similar formulation other aqueous binders can be used and the proportion and types of

wax may be changed. The base recipes (without beeswax) are from a patent of the Tombow Pencil Co., Ltd., as reported in Fox (1992).

Mascara (o/w, water and smudge proof)

Ingredients (in parts by weight) after Cosmetics and Toiletries (1992):

A)	*1*	*Carnauba wax*
	5	*Candelile wax*
	5	*Beeswax*
	2	*Ozocerite*
	5	*Stearic acid*
B)	*54.25*	*Deionized water*
	3	*Propylene glycol*
	3	*Cetyl alcohol*
	3	*Lanolin oil*
C)	*5*	*Dermacryl 79, Acrylates/t-octylpropenamid copolymer*
D)	*5*	*Iron oxide (7133 Purified Black Oxide)*
E)	*1*	*Propylene lycol, diazolidinyl ure, methylparaben propylparaben*

Combine the ingredients listed under A and heat to 85 ^{0}C. Mix the ingredients listed under B in a separate vessel. While maintaining good agitation, without aeration, slowly add the Dermacryl 79 (C) to the mixture B. Heat to 85^{0}C. When uniform, add mixture A to mixture BC, then add the iron oxide (D) and continue mixing. Cool to 50^{0}C and add the ingredients listed under E. Cool to room temperature. The final pH should be approximately 7.8.

Black mascara (simple recipe)

Ingredients (in parts by weight) after Brown (1981):

6	*Beeswax*	*16*	*Triethanolamine*
20	*Paraffin*	*5*	*Carbon black*
4	*Lanolin*	*q.s.*	*Essential oils*

Melt the waxes and mix well. Take two or three parts of the melted waxes and mix with the carbon black with a mortar and pestle or ball mill. Stir well during and after adding the premixed pigment. If necessary, mill using a pebble or ball mill. Continue stirring during cooling. Below 40^{0}C, add the essential oils, pour into shallow tins or jars and allow to set before sealing.

Contents - **Previous** - **Next**

9. 13.12 Lipsticks and glosses

Contents - Previous - Next

Lipstick

In general, lipsticks are composed of variable proportions of the following ingredients (in parts by weight):

15-30	*Plant and mineral waxes*
3-8	*Beeswax*
2-5	*Fatty alcohols (C_{16}-C_{18})*
5-10	*Liquid, branched chain alcohols/esters*
15-30	*Mineral oil (white petrolatum)*
5-10	*Rosin methyl ester*
1-3	*Honey*
q.s.	*Perfume*
q.s.	*Antioxidant*
q.s.	*Sunscreen (micronized Ti02)*
q.s. to 100	*Castor oil*

-

are base formulations for lipsticks:

Ingredients	F1 (in parts by weight)	F2 (in parts by weight)	F3 (in parts by weight)
Beeswax	*15*	*10*	*6*
Carnauba wax	*10*	*3*	*3*
Candelille wax	-	*8*	*7*
Ozocerite	-	*4*	*5*
Lanolin	*5*	-	-
Acetylated lanolin	-	-	*5*
Lanolin alcohols ricinoleate	-	*5*	-
Isopropyl lanolate	-	*10*	-
Lanolin alcohols ethers (2 OP)	-	-	*5*
Lanolin alcohols	-	*5*	-
Cetyl alcohol	*5*	-	-
Isopropyl palmitate	-	-	*25*
Miristyl lactate	-	-	*5*
Castor oil	*65*	*55*	*28*

Pigments	*q.s.*	*q.s.*	*11*
Perfume	*q.s.*	*q.s.*	*q.s.*
Antiodisants and preservative	*q.s.*	*q.s.*	*q.s.*

The waxes, alcohols and oil are mixed together one after the other into the melted beeswax, at a temperature of about 70^0C. Depending on the pigments and antioxidants used, they' can be added at this stage (hot) or once the mix has cooled. The pigments may have to be premixed in the castor oil. Pe~mes are added at approximately 40^0C or before the mass becomes too viscous. The final mix is poured into forms, or extruded for large scale production.

Lipstick

Ingredients	***Lipstick (parts by weight)***	***Lucid lipstick (parts by weight)***
Beeswax	*7.5*	*7*
Carnauba wax	*12.5*	*8*
Candelilla wax	*2.5*	*5*
Cacao butter	*15*	*10*
Hydrogenated lanolin	*12*	*30*
Ricinus oil	*50*	*39.5*
Sweeteners and aromas	*0.5*	*0.5*

Both formulations are after Proserpio (1981). If the sweetener is honey, its quantity should be increased. Melt the ingredients and mix them well. Pour into forms before hardening. This is a more protective type of lipstick (rather than a fashion, coloured one) but some pigments or a Uvfilter can be added.

Simple lipstick

Ingredients (in parts by weight) modified from Brown (1981):

3	*Beeswax*	*6*	*White petrolatum (Vaseline)*
6	*Ceresin*	*2*	*Liquid paraffin*
1	*Lanolin*	*1*	*Cetyl alcohol*
2	*Pigments**	*q.s.*	*Essential oila**
		q.s.	*Honey**

** optional*

Prepare moulds of small diameter, similar to wax candles, using plastic tubing, PVC or metal pipes and metal foil tubes. Clean plastic syringes of the right diameter work very well. Leave the plunger, but the tip of the syringe should be cut off. The plunger will also help in removing the stick.

Melt the wax and stir in the other products. If so desired, pigments can be predispersed in the liquid paraffin and essential oils and honey should only be added below 50^0C. Pour into the moulds when almost cool. Once hardened, place into the lipstick holders and pass the tip quickly through a low flame to give it a glossy finish.

Protective lipstick

Ingredients (in parts by weight) after Proserpio (1981):

25	*Beeswax*
5	*Cetyl alcohol*
30	*Oleic alcohol*
25	*Mineral or ricinus (castor) oil*
15	*Paraffin*
q.s.	*Aromatic oils and sweetener (honey)*

Heat wax in a water bath (70 – 75°C) add other ingredients and mix well. Before hardening, add aromatic oil and pour into forms. Sweetner can be honey and, for some applications, a UVfilter and some pigments can be added as well.

Moisturizing lipstick

Ingredients (in parts by weight) after Cosmetics and Toiletries (1992):

A)	*14*	*Lanolin (an hydrous Lanolin P95)*
	5	*Lanolin oil (Argonol 50)*
	40	*Mineral oil*
	6	*Cetyl alcohol*
	2	*Ozocerite*
	8	*Candelilla wax*
	q.s.	*Preservative*
B.	*Pigments dispersed in castor oil:*	
	10	*Titanium oxide*
	8	*Mica (and) titanium dioxide (Timica Pearl White)*
	6	*D&C red 6 barium lake*
C)	*q.s.*	*Fragrance/flavour*

Heat the ingredients listed under A and mix until clear. Add premixed B and mix well. Adjust the temperature

to 60^{0}C and add C. Pour into moulds. This formulation makes an elegant glossy lipstick, which spreads easily and conditions the lips.

Anhydrous (waterless) lip ointment

Ingredients (in parts by weight):

2-5	*Beeswax*
2-5	*Hydrogenated castor oil*
10-20	*Polydecene*
20-40	*PEG 22 dodecylglycol copolymer*
5-10	*Mineral oil (white petrolatum)*
5-15	*Honey*
q.s.	*Sunscreen*
q.s.	*Fragrance*
q.s. to 100	*POE 20 castor oil*

Mix like any other ointment.

Lucid lip ointment

Ingredients (in parts by weight) after Proserpio (1981):

5	*Beeswax*	*10*	*Hydrogenated lanolin*
10	*Honey*	*5*	*Hydrogenated ricinus oil*
60	*Ricinus oil*	*q.s.*	*Fragrances*
10	*Cacao butter*		

Mix like other ointments in section 9.13.3.

A very simple lip gloss can be made by melting 12 parts of cocoa butter with 1 part beeswax (Krochmal, 1973).

Tinted lip gloss

Ingredients (in parts by volume) after Krochmal (1973):

12	*Beeswax*
24	*Almond oil*
0.25	*Carmine*

0.05	*Oil of rose*

Melt the wax over a low heat in a water bath and stir in the carmine. Gradually add the almond oil and the oil of rose

9.13.13 Depilatory waxes

Depilatory waxes are made using various proportions of resins, beeswax and oils. To obtain a low melting point near 40 to 45 ^{0}C, honey is sometimes included. No other ingredients are essential for this mixture. The liquified waxes are applied in a thin film on the skin and covered with a strip of muslin cloth pressed firmly to the skin. When cooled, the skin is pulled taut and the cloth strip is pulled against the direction of hair growth.

A French patent describes aromatic oils and resins added to beeswax as analgesics or perfumes and triethanolamine as an emulsifier. The final mixture is spread on a siliconized paper. According to Anon (1965) it consists of the following (in parts by weight):

20	*Beeswax*	*1*	*Benzoin*
170	*Resin*	*0.5*	*Lemongrass oil*
90	*Vegetable oil*	*1*	*Butyl p-aminobenzoate*
10	*Triethanolamine*	*0.5*	*Jaborandi alcohol*
1	*Tolu balsam*		

Depilatory cream

Ingredients (in parts by volume):

42	*Rosin*
37	*Beeswax*
6	*Carnauba wax*
15	*Mineral oil (white petrolatum)*
q.s.	*Preservatives, antioxidants and perfume*

Melt the beeswax and the carnauba wax and mix in the resins and oil. When cooled to below 40^{0}C add the other ingredients. If preservatives and antioxidants are heat stable, they can also be mixed earlier

9.13 14 Shaving preparations

Shaving cream (o/w)

Ingredients (in parts by volume) after Krochmal (1973):

4	*Stearic acid*
4	*Mineral oil*
6	*Beeswax*
4	*Soap flakes*
16	*Water (clean)*

Heat the water to 70^{0}C and dissolve the soap. Melt the stearic acid and beeswax in a water bath to 75 ^{0}C and stir this into the soapy water Oand emulsift. Stir and mix well. When homogeneous, stir in the mineral oil. The mix might also be scented with 0.1 part of an essential oil.

After shave lotion

Ingredients	***I (parts by weight)***	***II (parts by weight)***
Ethanol (96% volume)	*50*	*50*
Sorbitol	*2.5*	*-*
Fragrance (aromatic oil)	*0.5*	*0.5*
Menthol	*0.1*	*0.1*
Methyl paraben (preservative)	*0.2*	*-*
Witch hazel extract	*5*	*5*
Propolis extract (10% EEP)	*1*	*1*
Water	*q.s. to 100*	*q.s. to 100*

Dissolve all the ingredients completely in the alcohol and dilute with the water, mixing thoroughly. Leave to stand for 1 to 2 days with adequate chilling or 1 week without chilling, then filter to clear and bottle.

After shave cream (o/w)

Ingredients (in parts by weight):

3.0	*Glyceryl monostearate*
0.5	*Beeswax*
1.5	*Stearyl alcohol*
2.5	*Sorbitol*
2.5	*Lapyrium chloride (Emcol 607 Witco)*
1.0	*Steapyrium chloride (Emcol E 607 S Witco)*
0.1	*Sodium benzoate*
0.3	*Fragrances*
q.s. to 100	*Water*

Heat the first three ingredients together to 70°C. In another vessel dissolve the next four ingredients in water and heat to 70°C. Add the oil phase to the aqueous phase with good agitation and continue stirring while cooling. Add the fragrances, at or below 40°C. Continue stirring slowly until the mix reaches 25°C. Bottle after 24 hours.

After shave gel

Ingredients (in parts by weight):

0.25	*Carbomer 941*
q.s. to 100	*Water*
2.0	*Glycerol*
50.0	*Ethyl alcohol*
2.5	*TEA 10% aqueous*
0.1	*Menthol*
0.1	*Propolis extract (EEP)*

Under rapid stirring, slowly add the carbomer resin to the water - glycerol mix. Continue mixing until free of undispersed particles. Dissolve menthol and propolis in alcohol. Mix the two phases (aqueous and alcohol). Add the TEA slowly, with good agitation.

For simpler production the resin and gel agent may be replaced with locally available gel forming substances (pectin or agar), but compatibility with the alcohol has to be tried first and different ratios tested. The final consistency will be different. Propolis content can be increased considerably.

[3] Dr Luigi Rigano assisted in the preparation of this Chapter with technical advice and provision of formulations.

[4]Beeswax is completely non-allergenic, but possible contamination with pollen may cause allergic reactions in extremely sensitive persons. Such effects are reduced or eliminated by bleaching (almost all cosmetically used beeswax is bleached) and otherwise freeing beeswax from pollen by filtering.

Contents - **Previous** - **Next**

ANNEX 1
BIBLIOGRAPHY

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Contents - **Previous** - **Next**

ANNEX 2
LIST OF ADDRESSES

Contents - Previous - Next

Most countries have directories of their manufacturers, exporters and importers which can be consulted in most embassies and consulates. They are the best source of information, particularly for neighbouring countries or those with which your country has special trade relationships or with which trade is easier or transport costs are lower. Also, many international suppliers or manufacturers have branch offices which are closer than their headquarters. Purchases from these offices may be easier, cheaper and/or quicker.

The following list of addresses does not represent any endorsement of the products of the listed companies or organizations nor any recommendation, nor can any responsibility be taken for changes in addresses, phone or fax numbers etc. The list is also not complete and only represents a very small selection of suppliers, manufacturers, organizations etc. active in these respective fields. Selection of those listed represents no judgement or comparison to other non-listed manufacturers or suppliers.

1. Industrial Equipment Suppliers

1.1 Cosmetics

CO.M.ER. s.r.l.
Via Brescia 10
200636 Cernusco S/N (Milano), Italy
Tel: 39-2-9240445; Fax: 39-2-9249252
- cosmetic and pharmaceutical equipment

Mambretti & Co.
Via Bertola da Novate 11
20157 Milano, Italy
Tel: 39-2-306937; Telex: 321497; Fax: 39-2-66982979
- cosmetic and pharmaceutical equipment

Pressindustria Chemical Equipment s.p.a.
Via Porta d'Arnolfo 43
20046 Biassono (Milano), Italy
Tel: 39-39-49831; Fax: 39-39-2753330; Telex: 333322 P IND 1
- emulsifiers, mixers, whole plants for cosmetic, pharmaceutical and food industries

SOTECO Export s.r.l.
Via Tosarelli 184
40055 Bologna, Italy
Tel: 39-51-785151; Fax: 39-51-784422

- automatic bottling or packaging machines for the pharmaceutic, cosmetic and food industry

1.2 Lyophilization - freeze drying

Cole-Parmer (registered trade mark) International
7425 North Oak Park Avenue
Niles, Illinois 60714, USA
Tel.:1-708-647 7600; Fax.: 1-708-647 9600
Telex: 28-9405; Cable: 'COLEPARMER"; Easylink: 6293 9214
- laboratory freeze driers, 4.5 to 18 litre models with 2 to 12 litre drying capacity per day, and many other laboratory equipments.

Costruzioni Meccaniche Terruzzi S.r.l.
Via Ernesto Breda 176
20126 Milano, Italy
Tel.: 39-2-2572391
- industrial freeze driers

Kohlensa~urewerk Deutschland GmbH
5462 Bad Hoenningen, Germany
- industrial freeze driers

Edwards High Vacuum Ltd
Manor Royal
Crawley W Sussex RHIO2LW, United Kingdom
Tel.: 44-1293-28844
- industrial freeze driers

1.3 Food processing

Alberto Bertuzzi S.p.a.
Viale Europa 11
20047 Brugheno (Milano), Italy
Tel: 39-39-870553; Fax: 39-39-883205
- machines or whole plants for the processing of fruits and vegetables but also honey, mead, jams and sweets

For honey and pollen processing equipment see also beekeeping suppliers

1.4 Capsule fillers

MACOFAR CEM S.p.a.
Via Nazionale *55*
40067 Rastignano (Bologna), Italy
Tel.: 39-51-743350; Fax: 39-51-744255

- encapsulation equipment of industrial and artisanal capacity

MG2 S.p.a.
Via del Savena 18,
40065 Pianoro (Bologna), Italy
Tel.: 39-51-777043; Fax: 39-51-777521
- encapsulation equipment of industrial and artisanal capacity

Nuova Zanasi S.p.a.
Via 1 maggio 14
40064 Ozzano Emilia (Bologna) Italy
Tel.: 39-51-799431; Fax: 39-51-799348
- encapsulation equipment of industrial and artisanal capacity

S.L. Sanderson & Co.
Star Route 104N
(173 Sandy Springs Lane)
Berry Creek, CA 95916, USA
- makes "Cap M Quick", very small hand operated trays for encapsulation

Feton International
Chaussee de Louvain 799
Steenweg of Leuven
1140 Bruxelles
Tel: 32-2-734 5295
- Capsule filler, small ones for 5000 to 7000 BFr.

1.5 Elaboration and manufacture for others

RP Scherer S.p.A.
04011 Aprilia (Latina), italy
Tel: 39-6-9205431
Fax: 39-6-9205435
- production of gelatinous capsules, encapsulation and other pharmaceutical forms (pills) for third parties.

Pharmagel S.p.A.
Viale Europa 3
20075 Lodi (Milano), Italy
Tel: 39-371-36041
- production of gelatinous capsules, encapsulation and other pharmaceutical forms (pills) for third parties

Ghimas S.p.A.
Via Fucini 2

40033 Casalecchio di Reno (Bologna), Italy
Tel: 39-51-575353
- freeze drying in contract for third parties

Piana Apicoltura
Via G.P. Piana 1450
40024 Castel San Pietro Terme (BO), Italy
Tel: 39-51-941205
Fax: 39-51-944652
Telex: 512447 APIS I
- manufacture of cosmetics and complete line of beekeeping products and value-added products

Apicoltura Marcolini & C.sas
Via G. Gastianelli 61
00133 Roma, Italy
Tel: 39-6-7232131 or 2050316
- bee cosmetics and soaps in contract for third parties

1.6 Beekeeping

Directory of beekeeping suppliers, published in 1982 by IBRA.
Dadant & Sons, Inc.
51 South 2nd St
Hamilton, Illinois 62341, USA
Tel: 1-217-847 3324; Fax: 1-217-847 3660
- equipment for beekeeping and elaboration of beekeeping products, publishers of Amer. Bee Journal and Hive and the Honey Bee, plus other books

Lega S.r.l., Costruzioni apistiche
Via de Crescenzi 18
48018 Faenza (Ravenna), Italy
Tel: 39-546-26834; Fax: 39-546-28279
- equipment for beekeeping and elaboration of beekeeping products

Apicoltura Vangelisti
Viale Roma 82
52017 Stia (AR), Italy
Tel: 39-575-582150
- equipment for beekeeping and complete line of beekeeping products and value added products

Thomas
86 Rue Abbe Thomas
45450 Fay aux Loges France
Tel: 33-38595620; Fax: 33-38592828
- equipment for beekeeping and elaboration of beekeeping products

Herzog
Postfach 146
7230 Schramberg, Germany
Tel: 49-7422-4240
- equipment for beekeeping and elaboration of beekeeping products

E.H. Thorne Ltd.
Beehive Works
Wragby, Lincoln LN3 5LA, UK
Tel: 44-1673-858555
- honey presses as commonly used in East Africa and other beekeeping equipment

SONY EZ-Label Printer from any SONY dealer or through
FAI, Federazione Apicoltori Italiani
Corso Vittono Emmanuelle 101
00186 Rome, Italy
Tel: 39-6-6877175 or 6852276; Fax: 39-6-6548578
- sells label printer, many other information and Italian beekeeping industry contacts

Cylindro Alveolador Apic. Ltva.
Cristiansen Hordao
CX Postal 455, R. Bernardino di Maraes 1467
Belo Horizonte, MG, Brazil
Tel: 55-31-2262190
- manufactures cheap, plastic foundation rollers (US$100) for hand operated press

More expensive foundation rollers and complete manfuacturing lines can be obtained from all major beekeeping suppliers.

Centre Laboratories
35 Channel Dr.
Port Washington, NY 1 10Sf), USA
Fax: 1-516-767 4229
- makes and distributes "Epipen", emergency injection pen/syringe for treatment against allergic reactions to bee stings

Honeystix
1443 45th Ave. N.E.
Salem, OR 97301, USA
Tel: 503-581 5805
- Marketing and processing honey filled straws. Sale of straw filling machines

2. Raw materials

2.1 Cosmetics

Desert King Corporation
3802 Miami Street
Chula Vista, CA 92011, USA
Tel: 1-619-4277121; Telex: 857267 Desert King
- producer of and information on Jojoba oil

Chemetics Laboratories Inc.
2954 Congressman Lane
Dallas, TX 75220, USA
Tel: 1-214-3512434; Fax: 1-214-3580426; Telex: 734037 Chemetics
- produces aloe vera based products, raw materials

Meer Corporation
9500 Railroad Ave.
P.O. Box 9006
North Bergen, NJ 07047, USA
Tel: 1-201-861 9500; Telex: 219130
- produces aloe vera in various preparations and consistanciesActive Organics Inc.

Corporate Office
11230 Grader Street
Dallas, TX 75238, USA
Tel: 1-214-3482015; Fax: 1-214-3481557
- produces non-preserved botanical extracts

Henkel (Suppliers)
140 Germantown Pyke
Suite 150
Plymouth Meeting, PA 19462, USA
Fax: 1-215-9411185 or

Henkel (Suppliers)
Henkelstrasse 67
P.O. Box 1100
4000 Du~sseldorf 1, Germany
Tel: 49-211-7970; Telex: 85817144
- all kinds of soap bases and other cosmetic ingredients

Koster Keunen, Inc.
P.O. Box 383
Sayville, NY 11782, USA
Tel: 1-516-589 0456; Telex: 645946
- large wax buyer, processor and seller of wax related cosmetic ingredients

British Wax Refining Co.
29 St. John's Road
Redhill
Surrey RHi 6DT
- wax refining mostly

2.2 Pigments and dyes

Warner Jenkinson Europe
Oldmedow Road, Kings Lynn
Norfolk PE3O 4JJ, United Kingdom
Tel: 44-1553-763236 and 770550; Fax: 44-1553-766891/ 770707
Telex: 817144 WJEUR G
- cosmetic colours

Mallinckrodt Inc.
P.O. Box 5439
St. Louis, Missouri 63147, USA
- cosmetic pigments

The Mearl Corporation
41 East 42nd Street
New York, NY 10017, USA
Tel: 1-212-573 8500; Fax: 1-212-557 0742; Telex: 421 841
- cosmetic pigments

Sun Chemical Corporation
Pigments Division
441 Tompkins Avenue
Staten Island, NY 10305, USA
Tel: 1-718-9811600; Telex: 125063; Fax: 1-718-720 6480
- cosmetic pigments

Kingfisher Colours LTD
124/6 Cardiff Road
Reading, Berkshire, RG1 8NH, UK
Tel: 44-1734-588661; Telex: 849054 Fishing
- cosmetic pigments

2.3 Food additives

Kelco International
Westminster Tower
3 Albert Embankment

London SEl 7RZ, UK
Tel: 44-171-735 0333; Fax: 44-171-735 1363
- various food additives, colours, gums etc., but also cosmetic and pharmaceutical ingredients and products

2.4 Others

Candle Makers Supplies
28 Blythe Road
LondonWl4, UK
- candle making supplies

Association of German Candle Manufacturers
Karlstrasse 21
6000 Frankfurt/Main, Germany
- information on producers and suppliers, market etc.

Bee Health Ltd
1 Racecourse Road
East Ayton
Scarborough
North Yorkshire Y013 9HT, UK
Tel: 44-1723 864001
FAX: 44-1723 862 455
- Propolis buyer, processor

3. Information sources

3.1 Organizations

3.1.1 Beekeeping

Directory of institutions and organizations in developing countries concerned with beekeeping published in 1980 by IBRA (98 pp.).

National Honey Board
422 21st Street, Suite 203
Longmont CO 80501-1421, USA
Tel: 1-303-776 2337; Fax: 1-303-776 1177
- provides information and technical assistance to industrial users of honey, small and large scale

or

National Honey Board
c/o TJP Market Development

500 Airport Blvd., Suite 336
Burlingame, CA 94010 USA

Bees for Development
N. Bradbear, edit.
Troy, Monmonth ND54AB, UK
Tel: 44-1600-713648; Fax: 44-1600-716167; E-mail: 100410.2631@compuserve.com
- publishes newsletter "Bees and Development", other information on tropical beekeeping, books, consultations, etc.

IBRA, International Bee Research Association
18 North Road
Cardiff CFI 3DY, UK
Tel: 44-1222-372409; FAX: 44-1222-665522; E-mail: MUNNPA@Cardiff. AC. UK
- largest beekeeping library, publishes several scientific journals andtechnical information, book sales, can make copies of articles, consutlancies.

Wicwas Press
P.O.Box 817
Cheshire, CT 06410-0817, USA
Tel: 1-203-250 7575; Fax: 1-203-621 7325
- distributor and publisher of beekeeping books, videos, slide series etc., also publishes Beescience

ICON Development
Viale Regina Margherita 239
00198 Rome, Italy
Tel & Fax: 39-6-4402802
- general information, consultancy services, project formulations, execution, management and evaluation especially in beekeeping and tropical environmental issues

Apimondia
Vittono Emmanuelle 101
00186 Rome, Italy
Tel.: 39-6-6868465
- international beekeeping organization, information, publications, congresses, published volumes on apitherapy

Peace Corps
Office of Training and Program Support, or Information Collection and Exchange
1990 K St, NW
Washington, DC 20526, USA
- publishes beekeeping manual with very simple techniques and illustrations, (Gentry, 1988), other information and assistance

GATE, GTZ

Dag Hammarskjo~ld Weg 1-2
6236 Eschborn, Germany
Tel: 49-6196-790; Fax: 49-6196-794820; Telex: 407501-0 GTZD
- variety of appropriate or alternative technology information, including beekeeping and some of the processing techniques, solar as well as regular publications

ITDG, Intermediate Technologies Development Group
Myson House, Railway Terrace
Rugby CV21 3HT, UK
Tel: 44-1788-560631; Fax: 44-1788-540270
- regular journals (intermediate technologies, a.o.) and many books as publisher and distributor also on beekeeping, candle making, other hive products

American Wax Importers and Refiners Association
225 West 34th St
New York, NY 10001, USA

A description of wax standards and testing methods as prepared by the American Wax Importers and Refiners Association of the USA in 1968 can also be found in the ITC Unctad/Gatt publication on "The World Market for Beeswax" (1978).

BeeNet, an electronic network from which information can be retrieved or requested by computer through electronic networks such as Internet - commercially available in a growing number of countries. A publication "Electronic Delivery of Apicultural Information" (Bee Science 3(1): 10-15, 1993) gives detailed information. Reprints can be obtained from one of the authors:

T.M. Sanford
Bldg 970, Box 110620
University of Florida, Gainesville, FL, 32611-0620, USA
Tel: 1-904-392 1801, ext. 143
Fax: 904-392 0190
E-Mail (Internet): MTS@GNV. IFAS . UFL. EDU

Regularly, updated information on electronically accessible beekeeping, bee research and related topics can be obtained from IBRA or at the WWW site:

http//www cardiff. ac .uk/ibra/index. html

3.1.2 Apitherapy

American Apitherapy Society
P.O. Box 74
North Hartland, VT 05052, USA
Tel & Fax: 1-802-295 8764
- publishes "BeeWell" newsletter (subscription and membership US$30) and collects case histories,

scientific publications, organizes workshops and training, proceedings of annual apitherapy meetings, bibliographies, promotes apitherapy, etc.

Ho Shin, Nihon-Yoho-shinbun
Chuou 2-chome, 1-8 Matsumoto-shi
Nagano-ken, 390, Japan
- Api-acupuncture society of Japan, for information, research, training etc.

Chinese Beekeeping Institute
Sihai Agricultural Techniques Development Research Institute
30 A Baishiqiao Road
Beijing 100081, China
Tel: 86-1-831 4433 and 831 2997
FAX: 86-1-831 6545; Telex: 222720 CAAS CN
- for further information on apitherapy in China and about specialized institutes and research hospitales etc.

3.1.3 Cosmetics

Facolta' di Medicina e Chirurgia, Univ. Cattolica del Sacro Cuore
Largo Francesco Vito 1
00168 Rome, Italy
Tel: 39-6-33051
three year course (in Italian) for cosmetic technician (minimum requirement: secondary school diploma)

In many countries cosmetic technicians and beauticians can study in evening courses.

Asociaci6n Argentina de Quimicos Cosmeticos
Thames 265
1414 Buenos Aires, Argentina
- publishes "Cosmetica - Revista de ciencia y tecnologia cosmetica", a technical and scientific publication on raw materials and formulations

I.F.S.C.C. Secretariat
Delaporte House
57 Guiidfort Street
Luton, Bedfordshire, LUl 2NL, United Kingdom
Tel: 44-1582 26661; Fax: 44-1582 405217 information about cosmetic study courses, schools and journals

Japan Cosmetics Industry Assoc.
17 Mishikuba - Akefunecho
Minato-ku, Tokyo, Japan

McCutcheon' 5 Division
McPublishing Company
175 Rock Road
Glen Rock, NJ 07452, USA
Tel: 1-201-652 *2655;* Fax: 1-201-652 3419; Telex: 130559
- journals and manuals on emulsifiers, detergents and functional materials.

CTFA, The Cosmetic, Toiletry and Fragrance Association
110117th Street, N.W., Suite 30
Washington, DC 20036, USA
- publishes International Cosmetic Ingredient Dictionary, information on approval and safety of various cosmetic ingredients, source for further information sources and industry referrals

Toilet Preparations Federation Ltd.
35 Soho Square
London W1V 5DG, UK

Cosmetic Industry Buyers and Suppliers
c/o James Feigin Almay, Inc.
562 Fifth Avenue
New York, NY 10036, USA

Association of Manufacturers of Cosmetics, Toiletries and Soap
Karlstrasse 21
6000 Frankfurt/Main, Germany

3.1.4 Food processing standards

Joint FAO/WHO Expert Committee on Food Additives (JEFCA)
Via delle Terme di Caracalla
00100 Rome, Italy
Tel: 39-6-52251
- information on status (approval), safety etc. of all food additives, colours etc. on international level

Scientific Committee for Food (SCF)
European Community
200 Rue de Ia Loi
1049 Bruxelle, Belgium
- information on safety and approval of food ingredients and additives

United States Food and Drug Administration (US FDA)
5600 Fishers Lane
Rockville, MD 20857, USA
Tel: 1-301-443 1544
- information on approval and safety of ingredients and additives for drugs, cosmetics, food etc.

Director, Beekeeping Extension Service
Ministry of Agriculture, Land and Marine Resources
St. Clair Circle
Port of Spain, Trinidad and Tobago, West Indies
- information on rules, standards and hygienic conditions of honey processing rooms, etc.

3.1.5 Others

UNCTAD/GATT
International Trade Centre
Palais de Nation
1211 Geneva 10, Switzerland
- trade statistics, market surveys, directories, bibliographies, laws and other trade related information

US Dept. of Trade and Commerce
Patent and Trademark Office
Washington, DC 20231, USA
- information on US registered patents

Third General Directorate
European Community
200 Rue de la Loi
1049 Bruxelles, Belgium
- information on patents registered for the European Community

WIPO, World Property Organization
34 Chemin de Colombettes
CH - 1211 Geneva 20, Switzerland
Tel: 41-22-730 9111, Telex: 412912
Fax: 41-22-733 5428
- national patents can be registered, information on inteynational patents is available **if patent numbers are known**

European Patent Offices in:
P.O.Box 5818
Patentlaan 2
2280 H Rijsvijk, NL
Tel: 70-340 2040
Fax: 70-340 3016
- for registration and information on various patents

or

Erhard Str. 27

D-80331 Mu~nchen, FRG
Tel: 089-23990
Fax: 089-23994465
- for registration and information on various patents

CBI
P.O. Box 30009
3001 DA Rotterdam, NL
Tel: 31-10-413-0787; Fax: 31-10-411 4081; Telex: 27151
- information for import development (into EEC) from developing countries, training and also as intermediary

3.2 Publications

3.2.1 Periodicals

World wide list of beekeeping journals, published in 1983 by IBRA

See also "Bees for development" under Beekeeping

Soap, Perfumery and Cosmetics (SPC)
Wilmington House, Church Hill
Wilmington, Dartford, Kent DA2 7EF, United Kingdom
Tel: 44-1322-277788; Fax: 44-1322-27674
- technical journal

Euredit S.A.
9, Avenue de Friedland
75008 Paris, France
Tel: 33-1-42893466; Fax: 33-1-42893473
- publishes EUROPAGES, annual of European industrial suppliers

Gruppo Editoriale Faenza Editrice S. p. a.
P.O. Box 68
48018 Faenza (Ravenna), Italy
Tel: 39-546-663488; Fax: 39-546-660440
- publishes "1MB Catalogue guide to the Italian packaging industry, producers of equipment and machines for the manufacture of package material and packing, bottling plants for the food, pharmaceutic and cosmetic industry

Chiriotti Editore S.p.a.
Viale Rimembranza 60
10064 Pinerolo (Torino), Italy
Tel: 39-121-794493; Fax: 39-121-794480
- Italian Journal of Food Science and other technical publications.

Allured Publishing Corporation
2100 Manchester Rd.
Building C, Suite 1600
P.O.Box 318
Wheaton, IL 60189-0318, USA
Tel: 1-708-653 2155; Fax: 1-708-653 2192
- special documentary and formulary issues, also bimonthly "Cosmetics & Toiletries" and other journals, Who's Who of cosmetic research and development laboratories, etc.

3.2.2 Catalogues and directories

Beekeeping

The "Bibliographie d'apiculture de langue francaise", published in 1983 (106 pp.) by C. de Casteljau lists 1607 books and is available from IBRA.

A rather old review of US and Canadian books on beekeeping lists 613 books and 689 Federal and State publications and was published in 1972 by T.S.K and M.P. Johansson (104 pp.).

IBRA has probably the most complete library of beekeeping related publications and can provide copies as well as catalogues of available books and journals.

Much information can be obtained by writing to national research institutes; some contact addresses can be obtained from IBRA.

Cosmetics

Cosmetic Bench Reference (US$ 95,- + 20, for shipping)
Allured Publishing Corporation
P.O.Box 318
Wheaton, IL 60189-0318, USA
Tel: 1-708-653 2155; Fax: 1-708-653 2192
- Over 6000 chemical names, CTFA names, trade names and synonyms of raw materials, supplier lists etc.

Guide International de la Parfumerie (350,- FF)
Editions Publi-Guide,
195 Quai de Ia Gourdine
77400 Lagny, France
Fax: 33-1-64024881
- Biennual directory of companies producing raw materials, packaging or components, plus manufacturing and chemical assistance laboratories and list of suppliers of perfumes, cosmetics, toiletries for consumer and beauty salons.

Emulsifiers & Detergents, Functional Materials
MC Publishing Company
175 Rock Road
Glen Rod, NJ 07452, USA
Tel: 1-201-652 2655; Fax: 1-201-652 3419; Telex: 130559

International Cosmetic Ingredient Dictionary, see 3.1.3 CTFA

Books

References given in the text can be found in the bibliography. For purchase of mamny of the books check also with IBRA, Bees for Development or Wichlas Press. For copies of articles check with IBRA.

Electronic Information see also 3.1.1

"Browsing" on the Internet with programmes such as Netscape or Mosaic, allows searches for certain keywords. The available information is developing rapidly and commercial suppliers of access to the Internet are now operating in many countries.

WWW pages are information documents available to anybody with proper Internet access and one of the above programmes. One such example is a WWW page on various recipes using all kinds of insects:

http: //www.public. instate.edu/ entomology/insectsasfood.html

or

http : //www. atd/ncar. edu/rdp/gfc/mead/mead . html

for mead makers, who also have an electronic discussion group at meadrequest@talisman.com. Subscription requests can be sent via E-mail by typing: subscrib mead-request firstname. lastname.

Contents - **Previous** - **Next**

ANNEX 3
WEIGHT AND VOLUME CONVERSIONS

Contents - Previous - Next

Most recipes in this book contain measures given in parts by weight or volume, in order to avoid problems with conversion from one measuring system to another. In order to convert volume measures to weight measures the specific weight of a substance has to be known. This is very difficult for powdered substances, but generally, the finer a powder is, the smaller is its volume for a defined weight.

The volume ratios in the recipes are usually based on the ratios of teaspoons or tablespoons to cups in the US system.

1 cup (US) = 235 ml = 8 fl. ounces = 16 tablespoons = 48 teaspoons

1 cup (UK) = 284 ml

1 kg 0 2.2 lbs. (US) = 35.2 oz. (US)

1 lb (US) = 454 g = 16 ounces

1 cup honey (18% moistrue)	= approx. 335 g	= 0.74 lbs.
1 cup sugar	= approx. 227 g	= 0.50 lbs.
1 cup flour	= approx. 114 g	= 0.25 lbs.
1 cup oil (veget.)	= approx. 227 g	= 0.50 lbs.

To convert °C into °F: Multiply by 9, divide by 5 and add 32.

To convert °F into °C: Subract 32, multiply by 5 and divide by 9.

	°F	°C
Freezer temp.	0	-17
Water freezes	32	0
Best storage temp. (honey, cosmetics)	41	5
Best crystallization temp.	57	14
Liquid storage of honey (min. temp.)	77	25
Max. temp. For honey treatment w/out flash heating and cooling	108	42
Pasteurization, wax melts	149	65
Water boils (sea level)	212	100

Contents - Previous - Next

ANNEX 4

Contents - Previous - Next

Joint FAO/WHO Food Standards Programme
Codex Alimentarius Commission
Codex Standards for Sugars (Honey), Second Edition
Volume 11, 1994

EXPLANATORY NOTES

This section contains the Codex World-Wide Standard for Honey adopted by the 17th Session of the Codex Alimentarius Commission. The World-Wide Standard supersedes the European Regional Codex Standard for Honey (Ref. CODEX STAN 12-1981) contained in Volume III of the Codex Alimentarius, First Edition (Ref. CAC/VOL. Ill-Ed. 1).

Methods of Analysis and Samplin~

The methods of analysis included in Codex Standards are of three types: "Defirnng" (Type I), l!Reference!l (Type II) and 'Alternative approved" (Type III). The nature and purpose of these types of Codex methods of analysis and the obligations falling on Governments in accepting Codex Standards with respect to methods of analysis has been clarified by the Codex Alimentarius Commission (See General Principles for the Establishment of Codex Methods of Analysis, Procedural Manual of the Codex Alimentarius Commission, 6th Edition; report of the 17th Session of the Commission, para 139, ALINORN 87/39; and report of the 8th Session of the Codex Committee on General Principles, para 22 and Appendix IV, ALINORM 87/33).

Contents - Previous - Next

CODEX STAN
12-1981 Rev. 1 (1987)

Contents - Previous

CODEX STANDARD FOR HONEY
(World-wide standard)[5]

1. SCOPE

1.1 This standard applies to all honeys produced by honeybees and covers all styles of honey presentation which are offered for direct consumption.

1.2 The standard also covers honey which is packed in non-retail (bulk) containers and is intended for re-packing into retail packs.

2. DEFINITION

2.1 Definition of Honey

Honey is the natural sweet substance produced by honeybees from the nectar of blossoms or from secretions of living parts of plants or excretions of plant sucking insects on the living parts of plants, which honeybees collect, transform and combine with specific substances of their own, store and leave in the honey comb to ripen and mature.

2.2 Description

Honey consists essentially of different sugars predominantly glucose and fructose. The colour of honey varies from nearly colourless to dark brown. The consistency can be fluid, viscous or partly to entirely crystallized. The flavour and aroma vary, but usually derive from the plant origin.

2.3 Subsidiary Definitions and Designations

2.3.1 Origin

2.3.1.1 Blossom Honev or Nectar Honey is the honey which comes from nectaries of flowers.

2.3.1.2 Honeydew Honey is the honey which comes mainly from secretions of living parts of plants or excretions of plant sucking insects on the living parts of plants. Its colour various from very light brown or greenish to dark brown.

2.3.2 Methods of Processing

2.3.2.1 Extracted Honey is honey only obtained by centrifuging decapped broodless combs.

2.3.2.2 Pressed Honey is honey obtained by pressing broodless combs with or without the application of

moderate heat.

2.3.2.3 Drained Honey is honey obtained by draining decapped broodless combs.

2.3.3 Styles - Honey which meets all the compositional and quality criteria of Section 3 of this standard may be presented as follows:

(a) Honey which is honey in liquid or crystalline state or a mixture of the two;

(b) Comb Honey which is honey stored by bees in the cells of freshly built broodless combs and which is sold in sealed whole combs or sections of such combs

(c) Chunk Honey which is honey containing one or more pieces of comb honey;

(d) Crystallized or Granulated Honey which is honey that has undergone a natural process of solidification as a result of glucose crystallization;

(e) Creamed (or creamy or set) Honey is honey which has a fine crystalline structure and which may have undergone a physical process to give it that structure and to make it easy to spread.

3. ESSENTIAL COMPOSITION AND OUALITY FACTORS

3.1 Honey shall not have any objectionable flavour, aroma, or taint absorbed from foreign matter during its processing and storage. The honey shall not have begun to ferment or effervesce.

3.2 Honey shall not be heated to such an extent that its essential composition and quality is impaired.

3.3 Apparent reducing sugar content, calculated as invert sugar:

(a)	Honey not listed below	-	Not less than 65%
(b)	Honeydew honey	-	Not less than 60%
(c)	Blackboy (Xanthorrhoea preissii)	-	Not less than 53%

3.4 Moisture Content

(a)	Honeys not listed below	-	Not more than 21%
(b)	Heather honey (Calluna)	-	Not more than 23%
(c)	Clover honey (Trifolium)	-	Not more than 23%

3.5 Apparent Sucrose Content

(a)	Honeys not listed below	-	Not more than 5%

(b)	Honeydew honey, blends of honeydew honey and blossom honey, Robinia, Lavender, Citrus, Alfalfa, Sweet-clover, Red Gum (Eucalyptus Camaldulensis), Acacia, leatherwood (Eucryphia Lucinda), Menzies Banksia (Banksia menziesii)	-	Not more than 10%
(c)	Red Bell (Calothamnus sanguineus), White stringy bark (Eucalyptus scabra), Grand Banksia (Banksia grandis), Blackboy (Xanthorrhoea preissi)	-	Not more than 15%

3.6 Water Insoluble Solids Contents

(a)	For honeys other than pressed honey	-	Not more than 0.1%
(b)	Pressed honey	-	Not more than 0.5%

3.7 Mineral Content (ash)

(a)	Honeys not listed below	-	Not more than 0.6%
(b)	Honeydew honey or a mixture of honeydew honey and blossom honey	-	Not more than 1.0%

3.8 Acidity	-	Not more than 40 milliequivalents acid per 1000 grammes

3.9 Diastase Activity

Determined after processing and blendig in accordance with Section 7.7	-	Not more than 3

3.10 Hydroxymethylfurfural Content	-	Not more than 80 mg/kg

4. FOOD ADDITIVES

4.1 None permitted.

5. HYGIENE

5.1 It is recommended that the product covered by the provisions of this standard be prepared in accordance

with the appropriate sections of the General Principles of Food Hygiene recommended by the Codex Alimentarius Commission (Ref. No. CACIRCP 1-1969, Rev. 2 (1985)).

5.2 Honey should be free from visible mould and, as far as practicable, be free from inorganic or organic matters foreign to its composition, such as, insects, insect debris, brood or grains of sand, when the honey appears in retail trade or is used in any product for human consumption.

5.3 Honey shall not contain toxic substances arising from microorganisms or plants in an amount which may constitute a hazard to health.

6. LABELLING

In addition to Sections 2, 3, 7 and 8 of the General Standard for Labelling or Prepackaged Foods (CODEX STAN 1~1985)6 the following specific provisions apply:

6.1 The Name of the Food

6.1.1 Subject to the provisions of 6.1.4 products conforming to the standard shall be designated "honey".

6.1.2 No honey may be designated by any of the designations in Section 2.3 unless it conforms to the appropriate description contained therein. The Styles in 2.3.3 (a), (c), (d) and (e) shall be declared.

6.1.3 Honey may be designated by the name of the geographical or topographical region if the honey was produced exclusively within the area referred to in the designation.

6.1.4 Honey may be designated according to floral or plant source if it comes wholly or mainly from that particular source and has the organoleptic, physicochemical and microscopic properties corresponding with that origin.

6.1.5 Honey complying with Sections 3.3(b) and (c), 3.4(b) and *3*.5(b) and (c) shall have in close proximity to the word **YY~~~~yI** the common name or the botanical name of the floral source or sources.

6.2 Labelling of Non-Retail Containers

In addition to Sections 2, 3 and 8.1.3 of the General Standard the following specific provisions applies:

6.2.1 Information on labelling as specified in this Section shall be given either on the container or in accompanying documents, except that the name of the product, lot identification, and the name and address of the manufacturer or packer shall appear on the container.

6.2.2 Lot identification, and the name and address of the manufacturer or packer may be replaced by an identification mark provided that such a mark is clearly identifiable with the accompanying documents.

6.2.3 Outer containers holding prepackaged foods in small units (see Section 6 of the General Standard) shall be fully labelled.

7. METHODS OF ANALYSIS AND SAMPLING

7.1 Determination of reducing sugar content (Type I Method)

7.1.1 Principle of method

The method is a modification of the Lane and Bynon (1923) procedure involving the reduction of Soxhlet's modification of Fehling's solution by titration at boiling point against a solution of reducing sugars in honey using methylene blue as an internal indicator.

The maximum accuracy for this type of determination is attained by ensuring that the reduction of the Fehling' 5 solution during the standardization step and in the determination of the reducing sugars in the honey solution are carried out at constant volume. A preliminary titration is, therefore, essential to determine the volume of water to be added before the determinations are carried out to satisfy this requirement.

7.1.2 Reagents

7.1.2.1 Soxhlet's Modification of Fehling's Solution

Solution A: Dissolve 69.28 g copper sulphate pentahydrate ($CuSO_4.5H_20$; MW + 249.71) with distilled water to 1 litre. Keep one day before titration.

Solution B: Dissolve 346 g sodium potassium tartrate ($C_4H_4K\ NaO_6.4H_20$; MW + 282.23) and 100 g sodium hydroxide (NaOH) with distilled water to 1 litre. Filter through prepared asbestos.

7.1.2.2 Standard Invert Sugar Solution (10 gIL)

Weigh accurately 9.5 g pure sucrose, add *5* mL hydrochloric acid ca. 36.5 percent wiw pure HC1) and dilute with water to about 100 mL, store this acidified solution for several days at room temperature (ca. 7 days at 120 to 15^0C, or 3 days at 200 to 25˚C), and then dilute to 1 litre. (N.B. Acidified 1.0 percent invert sugar remains stable for several months). Neutralize a suitable volume of this solution with iM sodium hydroxide solution (40 gIL) immediately before use and dilute to the required concentration (2 gIL) for the standardization.

7.1.2.3 Methylene Blue Solution

Dissolve 2 g in distilled water and dilute to 1 litre.

7.1.2.4 Alumina Cream

Prepare cold satured solution of alum ($K_250_4A1_2\ (50_4)_3.24H_20$) in water. Add ammonium hydroxide with constant stirring until solution is alkaline to litmus, let precipitate settle and wash by decantation with water until wash-water gives only slight test for sulphate with barium chloride solution. Pour off excess water and store residual cream in stoppered bottle.

7.1.3 Sampling

7.1.3.1 Liquid or Strained Honey

If sample is free from granulation, mix thoroughly by stirring or shaking; if granulated, place closed container

in water-bath without submerging, and heat 30 mm. at 60^0C; then if necessary heat at 65 ^{0}C until liquefied. Occasional shaking is essential. Mix thoroughly and cool rapidly as soon as sample liquefies. Do not heat honey intended for hydroxymethylfurfural or diastatic determination. If foreign matter, such as wax, sticks, bees, particles of comb, etc., is present, heat sample to 40^0C in water-bath and strain through cheesecloth in hot-water-funnel before sampling.

7.1.3.2 Comb Honey

Cut top of comb, if sealed, and separate completely from comb by straining through a sieve the meshes of which are made by so weaving wire as to form square opening of 0.500 mm by 0.500 mm[7] when portions of comb or wax pass through sieve, heat sample as in 7.1.3.1 and strain through cheesecloth. If honey is granulated in comb, heat until wax is liquefied; stir, cool and remove wax.

7.1.4 Procedure

7.1.4.1 Preparation of Test Sam~le - First Procedure (applicable to honeys which may contain sediment)

(a) Transfer an accurately weighed sample of approximately 25 g (W_1) from the homogenized honey to 100 mL volumetric flask, add *5* mL alumina cream (7.1.2.4) dilute to volume with water at 20^0C and filter.

(b) Dilute 10 mL of this solution to 500 mL with distilled water (diluted honey solution).

OR

7.1.4.2 Pre aration of Test Sam le - Second Procedure

(a) Weight accurately a representative quantity of about 2 g (W_2) of the homogeneous honey sample, dissolve in distilled water and dilute to 200 mL in a calibrated flask (honey solution).

(b) Dilute 50 ml of the honey solution to 100 mL using distilled water (diluted honey solution).

7.1.4.3 Standardization of the Modified Fehlin~'s Solution

Standardize the modified Fehling' 5 solution A so that exactly 5 mL (pipette), when mixed with approximately 5 mL of Fehling's solution B, will react completely with 0.050 g invert sugar added as 25 mL dilute invert sugar solution (2 gIL).

7.1.4.4 Preliminary Titration

The total volume of the added reactants at the completion of the reduction titration must be 35 mL. This is made up by the addition of a suitable volume of water before the titration commences. Since the compositional criteria of the honey standard specify that there should be more than 60 percent reducing sugars (calculated as invert sugar) a preliminary titration is necessary to establish the volume of water to be added to a given sample to ensure the reduction is carried out at constant volume. This volume of water to be added is calculated by subtracting the volume of diluted honey solution consumed in the preliminary titration (c mL) from 25 mL.

Pipette 5 mL Fehling's solution A into a 250 mL Erlenmeyer flask and add approximately 5 mL Fehling's

solution B. Add 7 mL distilled water, a little powdered pumice or other suitable antibumping agent, followed by about 15 mL diluted honey solution from a burette. Heat the cold mixture by boiling over a wire gauze, and maintain moderate ebullition for 2 mm. Add 1 mL 0.2 percent aqueous methylene blue solution whilst still boiling and complete the titration within a total boiling time of 3 minutes, by repeated small additions of diluted honey solution until the indicator is decolorized. It is the colour of the supernatant liquid that must be observed. Note the total volume of diluted honey solution used (x mL).

7.1.4.5 Determination

Calculate the amount of added water necessary to bring the total volume of the reactants at the completion of the titration to 35 mL by subtracting the preliminary titration (x mL) from 25 mL.

Pipette *5* mL Fehling's solution A into a 250 mL Erlenmeyer flask and add approximately 5 mL Fehling's solution B.

Add (25-x) mL distilled water, a little powdered pumice or other suitable antibumping agent and, from a burette, all but 1.5 mL of the diluted honey solution volume determined in the preliminary titration. Heat the cold mixture to boiling over a wire gauze and maintain moderate ebullition for 2 mm. Add 1.0 mL 0.2 percent methylene blue solution whilst still boiling and complete the titration within a total boiling time of 3 mm. by repeated small additions of diluted honey solution until the indicator is decolorized. Note the total volume of diluted honey solution (y mL). Duplicate titrations should agree within 0.1 mL.

7.1.5 Calculation and Expression of Results

7.1.5 Calculation and Expression of Results

Where the First Procedure (7.1.4.1) has been used:

$$C = \frac{\quad}{\quad} X \frac{\quad}{\quad}$$

Wher the Second Procedure (7.1.4.2) has been used:

$$C = \frac{\quad}{\quad} X \frac{\quad}{\quad}$$

Where
- C = g invert sugar per 100 g honey
- W_1 = weight (g) of honey sample taken according to sub-section
- W_2 = weight (g) of honey sample taken according to sub-section 7.1.4.2
- Y_1 = volume (mL) of diluted honey solution consumed in the determination carried out according to the First Procedure (7.1.4.1)
- Y_2 = volume (mL of diluted honey solution consumed in the determination carried out according to the Second Procedure (7.1.4.2)

7.1.6 Notes on the Procedure

It is essential to the accuracy and repeatability of the determination that the volume of water necessary to bring the reactant mixture to a total volume of 35 mL be determined for each individual sample; the following table gives typical volumes which may be encountered at the preliminary titration stage for the incremental contents of invert sugar shown, assuming the test sample (7.1.4.1) weighs about 25 g or test sample (7.1.4.2) weighs about 2 g.

Invert Sugar content **%**	**Volume of Distilled Water to be Added** **mL**
60	8.3
65	9.6
70	10.7
75	11.6

7.2 Determination of Apparent Sucrose Content (Type I Method)

7.2.1 Principle of the Method

Based on the Walker (1917) inversion method.

7.2.2 Reagents

7.2.2.1 Soxhlet modification of Fehling's solution (7.1.2.1)

7.2.2.2 Standard invert sugar solution (7.1.2.2)

7.2.2.3 Hydrochloric acid (6.34 M aqueous)

7.2.2.4 Sodium hydroxide solution 2 gIl litre (7.1.2.3)

7.2.2.5 Methylene blue solution 2 gIl litre (7.1.2.3)

7.2.3 Sampling

The honey is prepared for sampling as in 7.1.3

7.2.4 Procedure

7.2.4.1 Preparation of test sample

Prepare the honey sample as in 7.1.4.1(a). Dilute 10 mL of this solution to 250 mL with distilled water: honey solution (for sucrose determination) OR prepare the honey solution as in 7.1.4.2(a).

7.2.4.2 Hydrolysis of the test samnle

The honey solution (50 mL) is placed in a 100 mL graduated flask, together with 25 mL distilled water; heat the test sample to 65 ^{0}C over a boiling water-flask. The flask is then removed from the water-bath and 10 ml of 6.34 M hydrochloric acid added. The solution is allowed to cool naturally for 15 minutes, and then brought to 20^{0}C and neutralizing with *5* M sodium hydroxide, using litmus paper as indicator, cooled again, and the volume adjusted to 100 mL (diluted honey solution).

7.2.4.3 Titration

As in 7.1.4.4 and 7.1.4.5.

7.2.5 Calculation and expression of results

Calculate percent invert sugar (g invert sugar per 100 g honey) after inversion using the appropriate formula as percent invert sugar before inversion in 7.1.5.

Apparent sucrose content	=	(invert sugar content after inversion minus invert sugar content before inversion) X 0.95

The result is expressed as g apparent sucrosell00 g honey.

7.3 Determination of Moisture Content (Type I Method)

7.3.1 Principle of Method

Based on the refractometric method of Chataway (1932), revised by Wedmore (1955).

7.3.2 Apparatus

Refractometer

7.3.3 Sampling

The honey is prepared for sampling as in 7.1.3.

7.3.4 Procedure

7.3.4.1 Determination of the Refractive Index

Determine the refractive index of the test sample using a refractometer at a constant temperature near 20^{0}C. Convert the reading to moisture content (percent mim) using the table given below. If the determination is made at a temperature other than 20^{0}C, convert the reading to standard temperature of 20^{0}C, according to ~he temperature corrections quoted. The method used is to be noted in the test report.

TABLE FOR THE ESTIMATION OF MOISTURE CONTENT

Refractive Index (20°C)	Moisture Content (percent)	Refractive Index (20°)	Moisture Content (percent)	Refractive Index (20°C)	Moisture Content (percent)
1.5044	13.0	1.4935	17.2	1.4830	21.4
1.5038	13.2	1.4930	17.4	1.4825	21.6
1.5033	13.4	1.4925	17.6	1.4820	21.8
1.5028	13.6	1.4920	17.8	1.4815	22.0
1.5023	13.8	1.4915	18.0	1.4810	22.2
1.5018	14.0	1.4910	18.2	1.4805	22.4
1.5012	14.2	1.4905	18.4	1.4800	22.6
1.5007	14.4	1.4900	18.6	1.4795	22.8
1.5002	14.6	1.4895	18.8	1.4790	23.0
1.4997	14.8	1.4890	19.0	1.4785	23.2
1.4992	15.0	1.4885	19.2	1.4780	23.4
1.4987	15.2	1.4880	19.4	1.4775	23.6
1.4982	15.4	1.4875	19.6	1.4770	23.8
1.4976	15.6	1.4870	19.8	1.4765	24.0
1.4971	15.8	1.4865	20.0	1.4760	24.2
1.4966	16.0	1.4860	20.2	1.4755	24.4
1.4961	16.2	1.4855	20.4	1.4750	24.6
1.4956	16.4	1.4850	20.6	1.4745	24.8
1.4951	16.6	1.4845	20.8	1.4740	25.0
1.4946	16.8	1.4840	21.0		
1.4940	17.0	1.4835	21.2		

7.3.4.2 Temperature Corrections - Refractive Index:

Temperatures above 20˚C - Add 0.00023 per ˚C
Temperatures below 20˚C - Subtract 0.00023 per °C

7.4 Gravimetric Determination of Water-insoluble Solids Content (Type II Method)

7.4.1 Sampling

The honey is prepared for sampling as in 7.1.3.

7.4.2 Procedure

7.4.2.1 Preparation of Test Sample

Honey (20 g) is weighed to the nearest centigram (10 mg) and dissolved in a suitable quantity of distilled water at 80^0C and mixed well.

7.4.2.2 Gravimetric Determination

The test sample is filtered through a previously dried and weighed fine sintered glass crucible (pore size 15.40 ~m) and washed thoroughly with hot water (80^0C) until free from sugars (Mohr test). The crucible is dried for one hour at 135 ^{0}C, cooled and weighed to 0.1 mg.

7.4.3 Expression of Results

The result is expressed as percent water-insoluble solids (m/m).

7.5 D~ination of Mineral Content ash (Type I Method)

7.5.1 Sampling

Honey is prepared for sampling as in 7.1.3.

7.5.2 Procedure

7.5.2.1 I~mtionofthe Honev

Honey (5010 g) is weighed accurately into an ignited and pre-weighed platinum or silica dish and gently heated in a muffle furnace until the sample is black and dry and there is no danger of loss by foaming and overflowing. An infra-red lamp can also be used to char the sample before inserting into the furnace. If necessary, a few drops of olive oil may be added to prevent frothing. The sample is then ignited at 600^0C to constant weight. The sample is cooled before weighing.

7.5.3 Expression of Results

The result is expressed as percent ash *(mim)*.

7.6 Determination of Acidity (Type II Method)

7.6.1 Sampling

The honey is prepared for sampling as in 7.1.3.

7.6.2 Reagents

7.6.2.1 Sodiumhdroxide0.1N (carbonate-free)

7.6.2.2 Phenolnhthalein indicator 1 percent *(mlv)* in ethanol, neutralized.

7.6.2.3 Distilled Water made carbon dioxide free by boiling and subsequent cooling.

7.6.3 Procedure

7.6.3.1 Preparation of Test Sample

Honey (10.0 g) is weighed accurately and dissolved in 75 mL distilled water

(7.6.2.3).

7.6.3.2 Titration

The test sample is titrated against carbonate-free 0.1 M sodium hydroxide solution using 4-5 drops of neutralized phenolphthalein indicator. The end-point colour should persist for 10 seconds. For darkly coloured samples, a smaller weight should be taken. As an alternative, a pH meter may be used and the sample titrated to pH 8.3.

7.6.4 Calculation and Expression of Results

The result is expressed as millival (milli-equivalents acid/kg honey and is calculated as follows:

Acidity = 10 v

where v = the number of mL 0.1 M NaOH used in the neutralization of 10 g honey.

7.7 Determination of Diastase Activit (Type I Method)

7.7.1 Principle of the Method

Based on the method of Schade et al., (1985) modified by White et al., (1959) and Hadorn (1961).

7.7.2 Reagents

7.7.2.1 Iodine Stock Solution:

Dissolve 8.8 g of iodine analytical grade, in 30-40 mL water containing' 22 g potassium iodine, analytical grade, and dilute to 1 litre with water.

7.7.2.2 Iodine solution 0.0007 N:

Dissolve 20 g potassium iodine, analytical grade, in 30-40 mL water in a 500-mL volumetric flask. Add 5.0 mL iodine stock solution and make up to volume. Make up a fresh solution every second day.

7.7.2.3 Acetate Buffer - pH 5.3 (1.59M):

Dissolve 87 g sodium acetate.$3H_20$ in 400 mL water, add about 10.5 mL glacial acetic acid in a little water and make up to 500 ml. Adjust the pH to 5.3 with sodium acetate or acetic acid as necessary, using a pH meter.

7.7.2.4 Sodium Chloride Solution 0.5M:

Dissolve 14.5 g sodium chloride, analytical grade, in ;boiled-out distilled water and make up to 500 mL. The keeping time is limited by mould growth.

7.7.2.5 Starch Solution:

(a) Preparation of soluble starch

In a conical flask immersed in a water-bath and fitted with a reflux condenser, boil 20 g of potato starch for one hour in the presence of a mixture of 100 mL of 95 percent ethanol and 7 mL of 1 M hydrochloric acid. Cool, filter through a filtering crucible (pore size 90 - 150 ~m) and wash with water until the wash/water ceases to give any chloride reaction. Drain thoroughly and dry the starch in air at 35 ^{0}C. The soluble starch must be stored in a well stoppered flask.

(b) Determination of moisture content of soluble starch

Accurately weigh a quantity of approximately 2 g of soluble starch and spread in a thin layer over the bottom of a weighing bottle (diameter *5* cm). Dry for one and a half hours at 130^{0}C. Allow to cool in a dessicator and re-weigh. The weight loss with respect to 100 g represents the moisture content. The moisture content of such starch should be 7-8% mlm depending on the humidity of the air in which the sample has been dried.

(c) Preparation of starch solution

Use a starch with a blue value between *0.5-0.55* using a 1 cm cell, as determined by the method below. Weigh out the amount of starch which is equivalent to 2.0 g anhydrous starch. Mix with 90 mL of water in a 250 mL conical flask. Bring rapidly to the boil, swirling the solution as much as possible, heating over a thick wire gauze preferably with an asbestos centre. Boil gently for 3 mm., cover and allow to cool spontaneously to room temperature. Transfer to a 100 mL volumetric flask, place in a water bath at 40^{0}C to attain this temperature and make up to volume at 40˚C.

Method for determining blue value of starch

The amount of starch equivalent to 1 g anhydrous starch is dissolved by the above method, cooled and 2.5 mL

acetate buffer added before making up to 100 mL in a volumetric flask.

To a 100 mL volumetric flask add 75 mL water, 1 mL M hydrochloric acid and 1.5 mL of 0.02 N iodine solution. Then add 0.5 mL of the starch solution and make up to volume with water. Allow to stand for oneJIour in the dark and read in 1 cm cell using a spectrophotometer at 660 nm against a blank containing all the ingredients except the starch solution. Reading on the absorbance scale = Blue value.

7.7.3 Apparatus

7.7.3.1 Water-bath at 40 $\pm$ 0.2^{0}C.
7.7.3.2 Spectrophotometer to read at 660 rim.

7.7.4 Sampling

The honey sample is prepared as in 7.1.3 without any heating.

7.7.5 Procedure

7.7.5.1 Preparation of test sam les

Honey solution: 10.0 g honey is weighed into a 50 mL beaker and 5.0 mL acetate buffer solution is added, together with 20 mL water to dissolve the sample. The sample is completely dissolved by stirring the cold solution. 3.0 mL sodium chloride solution is added to a 50 mL volumetric flask and the dissolved honey sample is transferred to this and the volume adjusted to 50 mL.

N.B.: It is essential that the honey should be buffered before ;coming into contact with sodium chloride.

Standardization of the starch solution

The starch solution is warmed to 40^{0}C and *5* mL pipetted into 10 mL of water at 40^{0}C and mixed well. I mL of this solution is pipetted into 10 mL 0.0007 N iodine solution, diluted with 35 mL of water and mixed well. The colour is read at 660 nm against a water blank using a 1 cm cell.

The absorbance should be 0.760 $\pm$ 0.020. If necessary the volume of added water is adjusted to obtain the correct absorbance.

7.7.5.2 Absorbance determination

Pipette 10 mL honey solution into 50 mL graduated cylinder and place in 400 $\pm$ 2^{0}C water-bath with flask containing starch solution. After 15 minutes, pipette *5* starch solution into the honey solution, mix, and start stop-watch. At *5* minutes intervals remove 1 mL aliquots and add to 10.00 mL 0.0007 N iodine solution. Mix and dilute to standard volume (see 6.7.5.1). Determine absorbance at 660 nm in spectrophotometer immediately using I cm cell. Continue taking 1 mL aliquots at intervals until absorbance of less than 0.235 is reached.

7.7.6 Calculation and expression of results

The absorbance is plotted against time (mm) on a rectilinear paper. A straight line is drawn through at least the

last three points on the graph to determine the time when the reaction mixture reaches an absorbance of o.235. Divide 300 by the time in minutes to obtain the diastase number (DN). This number expresses the diastase activity as ml 1 percent starch solution hydrolysed by the enzyme in 1 g of honey in 1 h at 40^0C. This diastase number corresponds with the Gothe-scale number.

Diastase activity = DN = ml starch solution 1 percent)/g honey/h at 40^0C.

7.8 Spectrophotometric determination of hydroxymethylfurfural (HMF) content (Type II Method)[8]

According to the AOAC method (AOAC, 14th Ed., 1984, Hydroxymethylfurfural in Honey, Spectrophotometric Method, 31.153).

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[5] Supersedes the Codex European Regional Standard for Honey (CODEX STAN 12-1981).

[6] Hereafter referred to as "The General Standard"

[7] Ref. ISO 565-1983. Such sieve could be replaced by U.S. sieve with No.40 Standard screen (size of opening 0.420 mm).

[8] Adopted by the 17 Session of the Commission.

Contents - **Previous**