VALUE-ADDED PRODUCTS FROM BEEKEEPING

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CHAPTER 1
INTRODUCTION

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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In some cases the traditional and early technological uses of primary bee products have been replaced by other (often synthetic products) because of better availability, lower cost and/or easier processing.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.

CHAPTER 2
HONEY 1

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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 25^0C, 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%): Fructose Glucose Disaccharides: Maltose Isomaltose Saccharose Nigerose Turanose Maltulose Kojibiose Neotrehalose Gentiobiose Laminaribiose 2 Ketoses, unidentified Higher saccharides: Melizitose Erlose 1-kestose Raffinose Panose Isopanose Maltotriose Isomaltotriose Isomaltotetraose Isomaltopentaose Centose	Gluconic acid (70-80 % of total acids) Acetic acid Butyric acid Citric acid Formic acid Lactic acid Maleic acid Malic acid Oxalic acid Pyroglutamic acid Succinic acid Fumaric acid Tartaric acid α-Ketoglutaric acid probably present: α- or ß-glycerophosphate glycolic acid glucose-6-phosphate 2- or 3-phosphoglyceric acid pyruvic acid	Different types of proteins of bee and plant origin Free amino acids: Proline Lysine Histidine Arginine Aspartic acid Threonine Serine Glutamic acid Glycine Alanine Cystine Valine Methionine Isoleucine Leucine Tyrosine Phenylalanine Tryptophan	Potassium Sodium Calcium Magnesium Iron Copper Manganese Chlorine Phosphorous Sulphur Aluminum Iodine Boron Titanium Molybdenum Cobalt Zinc Lead Tin Antimony Chromium Nickel	Ascorbic acid Riboflavin Pantothenic acid Niacin Thiamine Pyridoxine Biotin Folic acid **Enzymes** Diastase (α- and ß-amylase) Invertase (glucoinvertase, but also very small amounts of fructoinvertase) Glucose oxidase Catalase Acid phosphatase shown to be absent: Lactase Protease Lipase	Esters: Methyl formate Ethyl formate Methyl acetate Ethyl acetate Propyl acetate Isopropyl acetate Ethyl propionate Methyl butyrate Ethyl butyrate Isoamyl butyrate Methyl valerate Ethyl valerate Methyl isovalerate Methyl pyruvate Methyl benzoate Ethyl benzoate Methyl phenylacetate Ethyl phenylacetate Methyl anthranilate Diethyl ether	Ketones and aldehydes: Formaldehyde Acetaldehyde Propionaldehyde Butyraldehyde Isobutyraldehyde Valeraldehyde Isovaleraldehyde Capronaldehyde Benzaldehyde Methacrolein Acetone (dimethyl ketone) Acetoin Methylethyl ketone Diacetyl Furfural 5-hydroxymethyl furfural HMF) Alcohols: Methanol Ethanol Propan-1-ol Propan-2-ol Butan-1-ol Butan-2-ol Isobutanol 2-methyl-1-butanol 3-methyl-butan-1-ol 3-methyl-butan-2-ol Pentan-1-ol Pentan-2-ol ß-methallyl alcohol 2-phenylethanol Benzyl alcohol 3-phenylpropan-1-ol 4-phenylbutan-1-ol Furfuryl alcohol	Lipids: Glycerides Sterols Phospholipids Palmitic acids Oleic acid Lauric acid Myristoleic acid Stearic acid Linoleic acid Polyphenols Toxic substances (occasionally) Choline Acetyl choline Pinocembrin Traces of beeswax Microscopic particles: Pollen Fungal spores Bacterial spores Algal cells Yeasts

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
<u>Vitamins</u>			
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)	μg	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).

2.5.4 Products of honey fermentation

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.

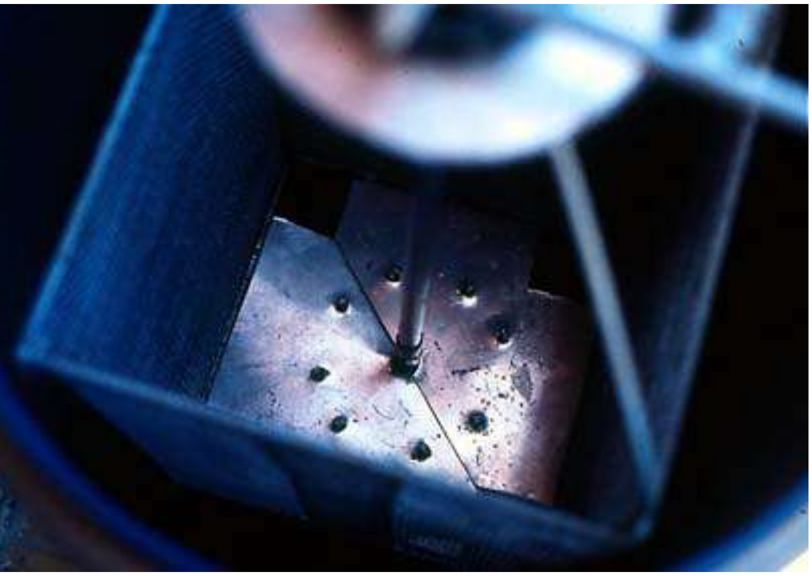
Figure 2.9: a) Small, common honey press in Zambia;
b) Larger honey press used to squeeze honey from cappings in Italy.

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.



d)

e) 

e 2.10: Manual 4 frame radial (medium size super frames), 4 frame tangential (2 deep and 2 medium size super frames) a honey extractor all in one made from construction steel, bicycle parts, 110 litre plastic drum and 5-mesh galvanized scre s a beekeeper's design (Mr Beizel, Formosa, Argentina) adopted and modified during an FAO sponsored beekeeping pro *RG/0051.*
w of top of extractor with basket modified for six shallow super frames or 2 deep super frames. Ideally, the gear and cha blage should have a plate below it to protect the honey from oil or other debris. The whole assembly can be easily remov ng or use of the drum for storage.
tom of wire basket with support for radial extraction, covered with aluminum (or wood) plate for broken comb extractio -frame (8-shallow) tangential extractor modified for radial 4-frame and broken comb extraction.
ormal tangiential extractor similar to
dified for broken comb extraction with solid bottom plate and a finer mesh screen (5-mesh) at the bottom 15-20 cm. e) A 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

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

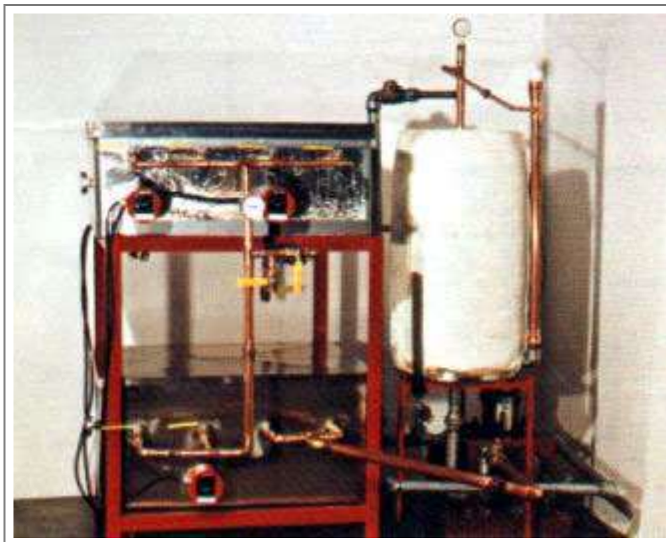


Figure 2.11 : Small to medium-scale vacuum drier for removing moisture from already extracted honey (courtesy of Dadant and Sons, Inc.).

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.

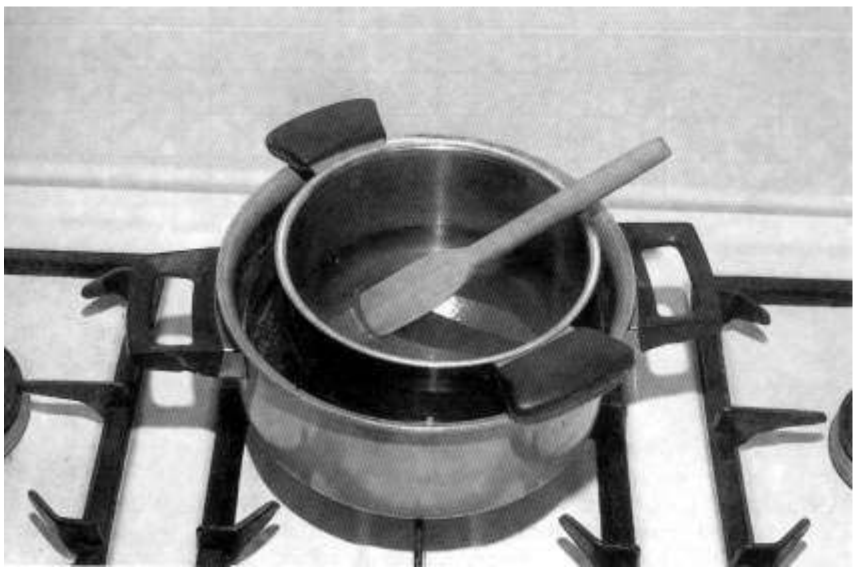


Figure 2.12 : Small-scale heating of honey in a water bath. The inside pot should not touch the bottom of the larger, water-filled pot. Wood blocks or stones may be used to support it.

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^{0}C, 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.

2.12.1 Liquid honey

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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 28^0C 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 14^0C 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 14^0C. Instead of bottling, the containers are then placed into a warm room at 28 to 30^0C 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 28^0C. 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 20^0C). 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.*

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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 ^{3}A 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^{0}C. 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^{0}C 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.

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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 (baking soda)*
0.05	*Malt extract*		
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 180^0C, 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).**

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CHAPTER 3
POLLEN

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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)**

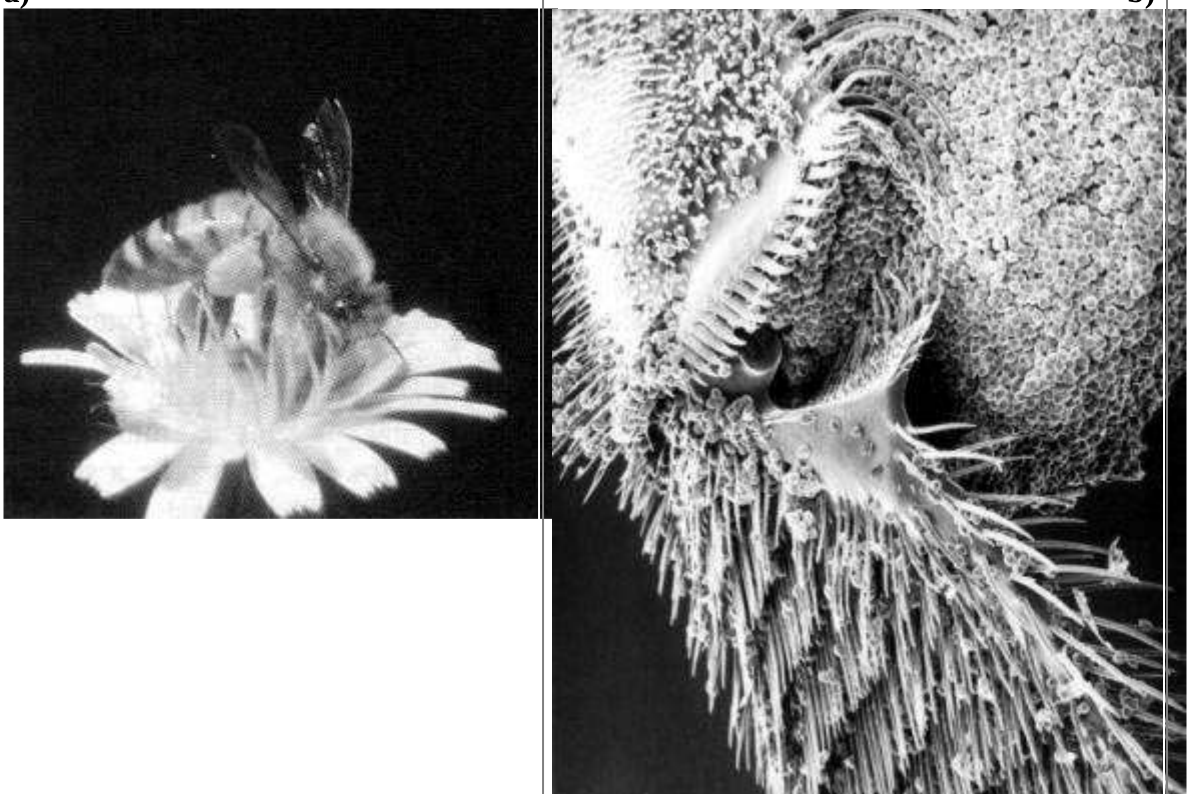


Figure 3.2: a) A honeybee forager collecting pollen from a composite flower. The pollen grains caught in the specially branched hairs of honeybees are brushed off with the legs, moistened with nectar or honey and compacted in the pollen pellets on the outside of the hind legs (photo courtesy of F. Intoppa). 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*

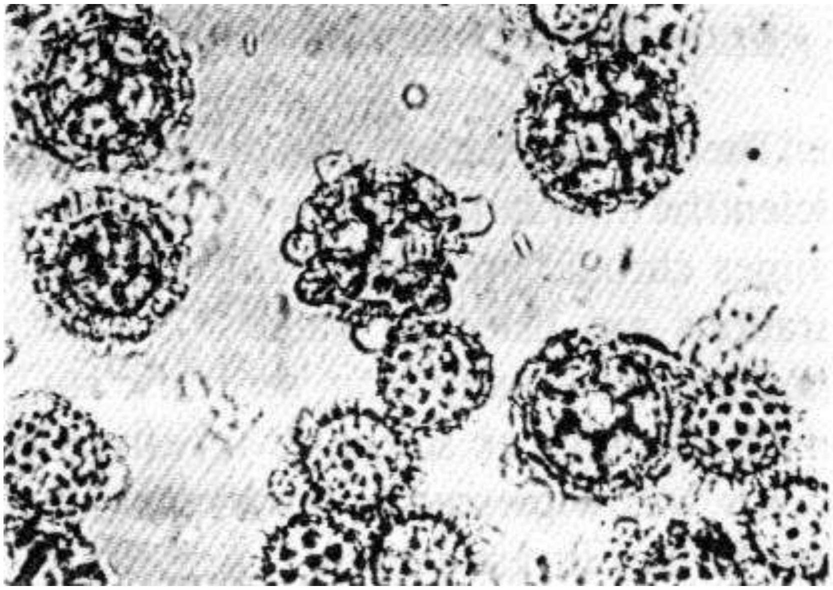
Table 3.2:
Minor components of bee collected pollen (Crane, 1990)

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

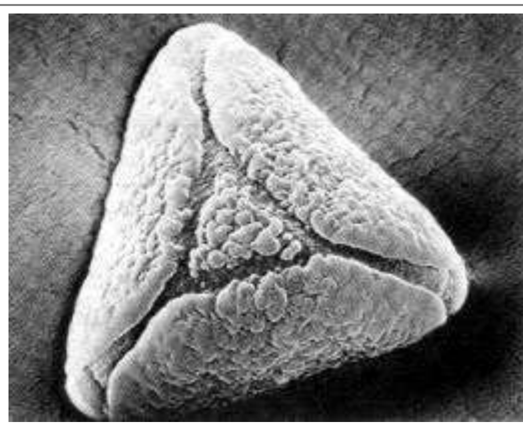
a) Anarcadium sp. From honey in Guyana

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

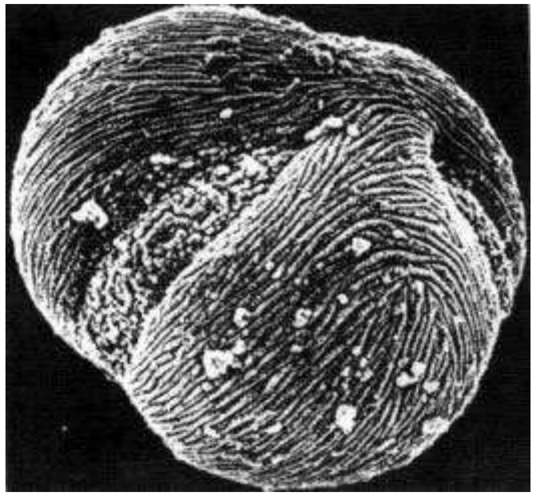


c) Eucalyptus camaldulensis, light microscope

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



e) Acerplantanoides (SEM, approx. 2600x)



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

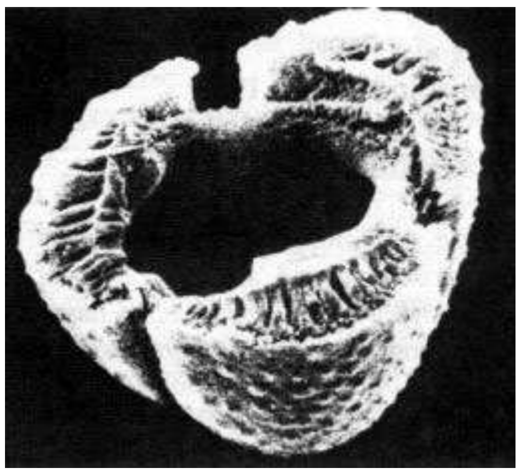


Figure 3.4: Pollen grains of various species. Photos courtesy of (a) L. Persano Oddo; (b and c) G. Ricciardelli d'Albore from Persano Oddo et al., (1988); (d) F. Intoppa; (e and f) S. Nilsson from Nilsson et al., (1977).

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^{0}C). 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.

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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^{0}C; 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.

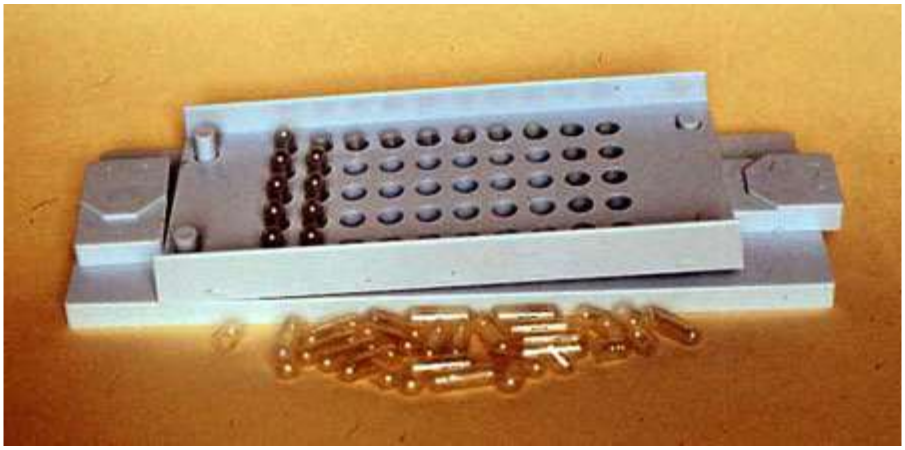

Figure 3.11: A small and cheap device for manually filling small quantities of hard gelatin capsules. With the top piece raised, as on the right, the pollen is brushed into the capsules. Once the top piece is lowered, as on the left side, the capsules can be closed.

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 70^0C 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 73^0C.

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

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 $74\text{-}78^0$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 $82\text{-}84^0$C. Other wax producing Coccoidea are Icerva purchasi and Dactylopius coccus whose waxes melt at 78^0C and 99-101 ^{0}C, respectively.

Other wax producing Coccoidea are Icerva purchasi and Dactylopius coccus whose waxes have melting points at 78^0C and $99\text{-}100^0$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$^\circ$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**

4.10 Market outlook

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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^{0}*C 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.

CHAPTER 5
PROPOLIS

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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
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

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	Scheller et al., 1989a
	free radical scavenger	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	König, 1988
	review, Ehrlich carrinoma	Scheller et al., 1989e
	cytotoxicity on cultures of human and animal tumour cells	Grunberger et al., 1988
	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-	Scheller et al., 1989c

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.

5.12 Market outlook

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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 40^0*C. 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.

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.

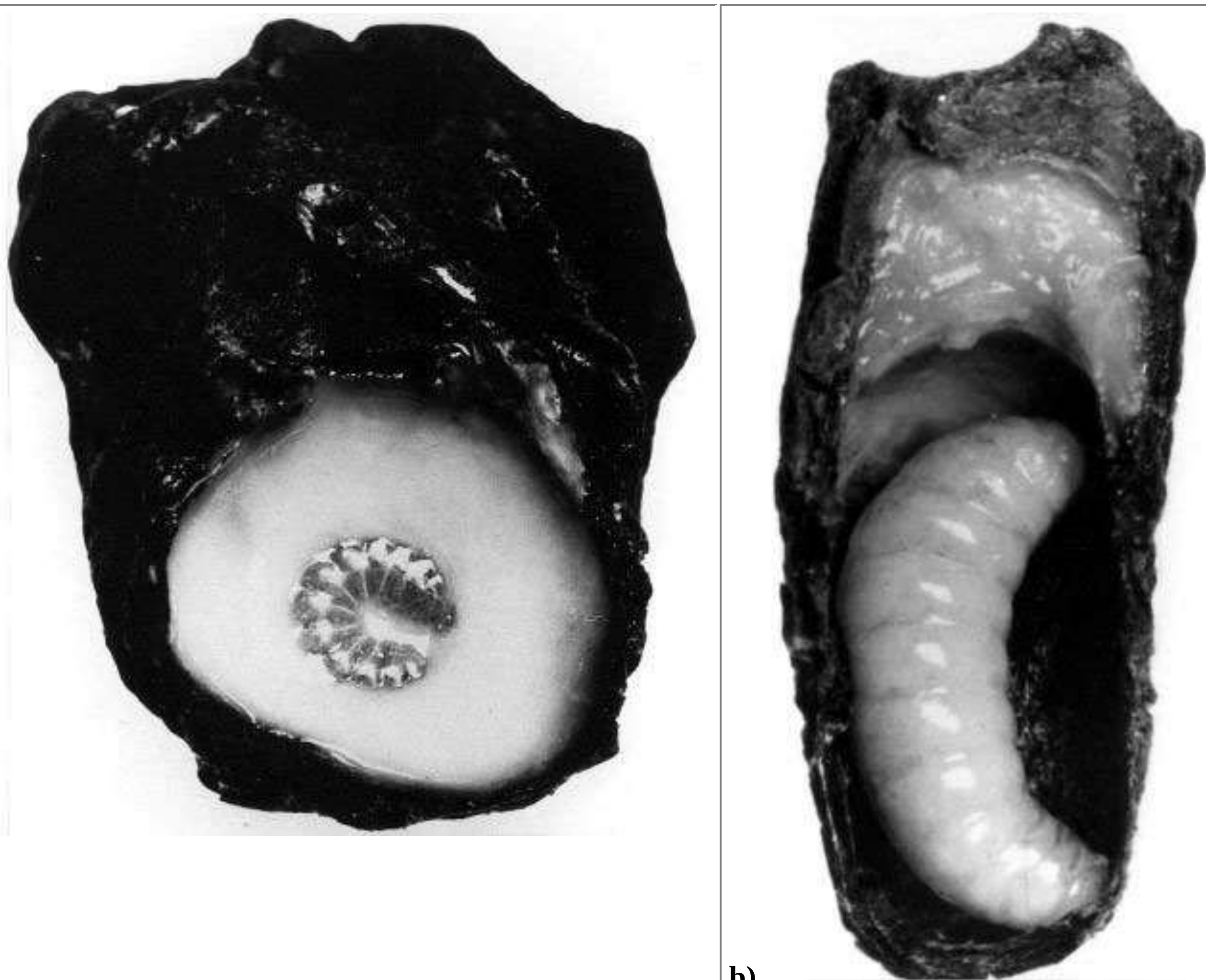
The differentiation between queen and worker bees is related to feeding during the larval stages. Indeed, all female eggs can produce a queen bee, but this occurs only when, during the whole development of the larvae and particularly the first four days, they are cared for and fed "like a queen". Queen 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.



a) b)

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.

6.8 Quality control

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 .
Compounds	Methods	Limits	Methods	Limits	Methods
Water content, %	Freeze drying	60 - 70	Freeze drying	64 - 68	Freeze drying
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. HR fatty acids
10-hydroxy-2-decanoic acid					as above, in % of f
10-hydroxydecanoic acid					as above, in % of f
Proteins, % of dry weight	Selective extraction with methanol	35 - 45	Selective extraction with methanol	36 - 42	Total N, automatic method
Sugars, % of dry weight	Titration of reducing sugars	20 - 33	Qual. & quant. gas chromatography (GC)	38 - 43	Qual. & quant. HR
Fructose, % of total sugars					as above
Glucose, % of total sugars					as above
Sucrose, % of total sugars					as above
Total acid, meq %	Titration	110 - 150			
pH	in aqueous alcohol solution of 0.4 %	4 - 4.2			
Riboflavine µg/g					
Thiamin µg/g					
Niacin µg/g					
Folic acid µg/g					

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.

CHAPTER 7
VENOM

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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)

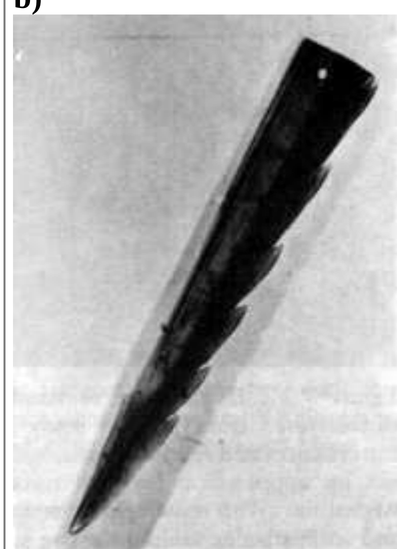

Figure 7.1 : A honeybee worker, stinging the relatively tough human skin, is unable to withdraw its sting lancets because of the fine barbs (a) unique to the honeybee sting. Once stung by a honeybee, the whole sting apparatus, venom sack and all, almost always remains (b). This occurs only with honeybees 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 α -amino acids	0.5 1	0.4
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).

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.

CHAPTER 7
VENOM

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)**

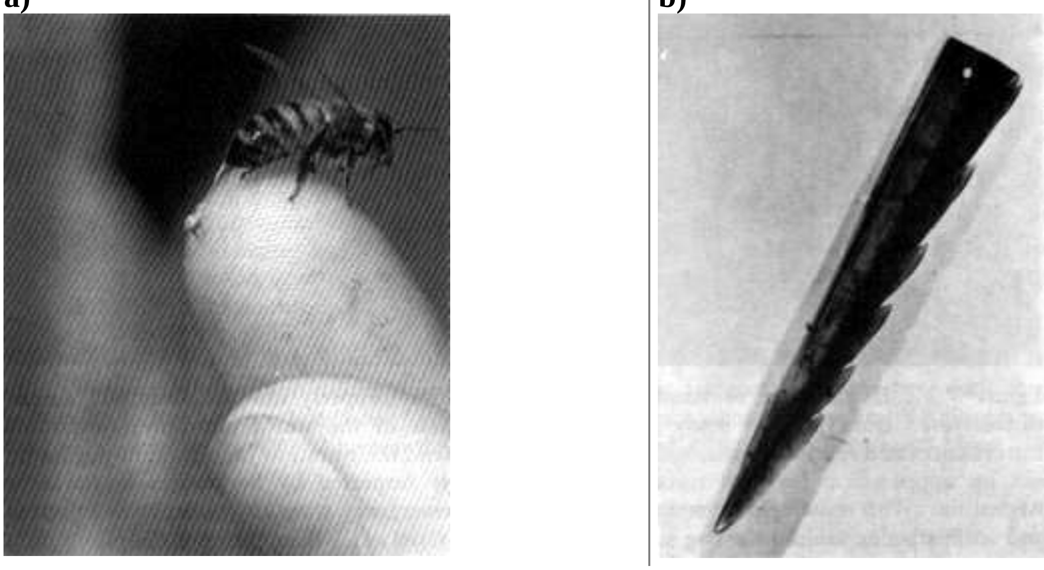

Figure 7.1 : A honeybee worker, stinging the relatively tough human skin, is unable to withdraw its sting lancets because of the fine barbs (a) unique to the honeybee sting. Once stung by a honeybee, the whole sting apparatus, venom sack and all, almost always remains (b). This occurs only with honeybees 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 α -amino acids	0.5 1	0.4
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).

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.

CHAPTER 8
ADULT AND LARVAL HONEYBEES

Contents - Previous - Next

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.

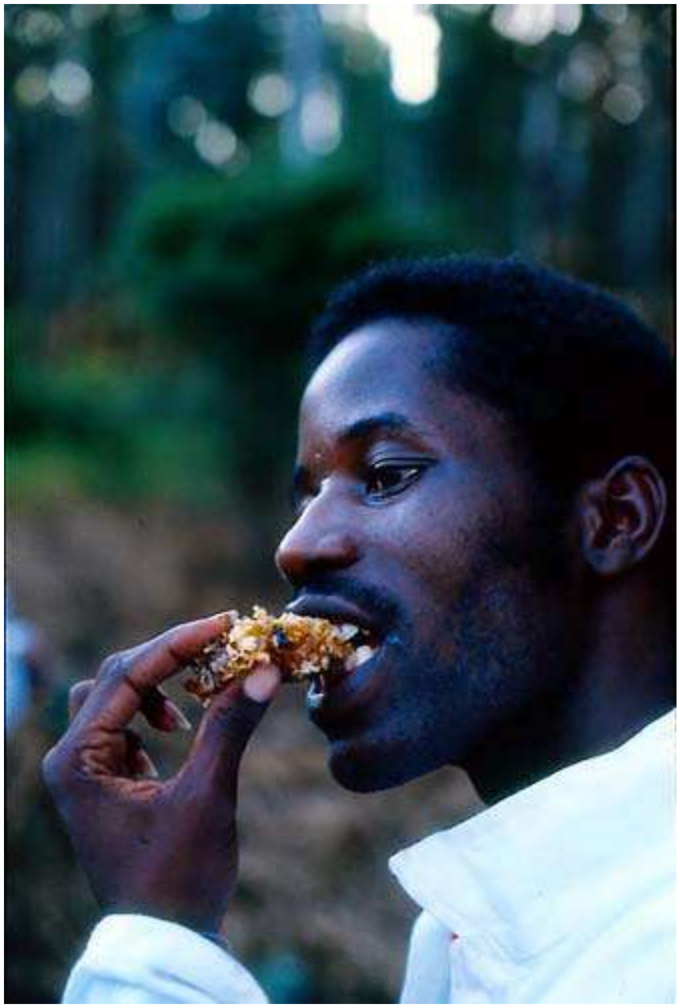

Figure 8.1 : Mr. Lusale, a Zambian beekeeping extension officer, demonstrating an alternative use for bee brood.

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[t] (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.

8.10.9 Pastry

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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.

<u>Cheese tarts</u>

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.

CHAPTER 9a
COSMETICS

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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.

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 Anti-dandruff and sebum equalizing agent Anti-microbial and healing agent Anti-irritant and antibacterial agent Purifying agent Preservative Possibly as catching free radicals	Deodorants and antiperspirants Shampoos and hair lotions Anti-acnes and after-shave products Mouth rinses and toothpastes Cleansing crams and lotions In all of the above 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

CHAPTER 9b
COSMETICS

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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	-	-	-	40	40

camomile)					
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)*

9.13.4 Sun protection

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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 preservatives*

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):

9. 13.12 Lipsticks and glosses

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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	-	-	*5*
OP)	-	*5*	-
Lanolin alcohols	*5*	-	-
Cetyl alcohol	-	-	*25*

Isopropyl palmitate	-	-	5
Miristyl lactate	65	55	28
Castor oil	q.s.	q.s.	11
Pigments	q.s.	q.s.	q.s.
Perfume	q.s.	q.s.	q.s.
Antiodisants and preservative			

The waxes, alcohols and oil are mixed together one after the other into the melted beeswax, at a temperature of about 70^{0}C. 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^{0}C 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^{0}C. 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.**

CODEX STAN
12-1981 Rev. 1 (1987)

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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.