Agrodok 42

Bee products

properties, processing and marketing

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Foreword

Keeping bees requires knowledge and experience if it is to be done well. This knowledge and experience can be obtained by observing and learning from an experienced beekeeper or through study and practice. Once this has been achieved, a well-qualified beekeeper can produce bee products.

Even if someone knows exactly how to keep bees, the products he or she produces may not meet market demands and thus may not be able to provide a sufficient income. It is important to realise that the products have to be bought by others, who determine what demands must be met in order for the products to be worth a certain selling price.

One of the most important market demands is quality. A product has to be consistently good. It also has to be free of impurities and additives. It also has to look good.

The authors of this booklet are all experts in their areas of beekeeping and are members of NECTAR. But this booklet is not a scientific publication. Its aim is only to show how it is possible to make good products with limited resources.

This booklet has been published simultaneously with the revision of Agrodok 32: *Beekeeping in the tropics*. Contributions to contents were made by Marieke Mutsaers, Henk van Blitterswijk, Jaap Kerkvliet, Leen van ’t Leven en Jan van de Waerdt.

Leen van ’t Leven

Chair of NECTAR
On behalf of all co-authors of this Agrodok

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1 Introduction

Honey bees live in colonies, as described in detail in Agrodok 32 *Beekeeping*. The worker bees in the colony collect various substances in nature, which their colony uses, for example to feed the adult bees and make the colony grow, as nesting material or to protect the colony. By collecting from the vegetation the bees also have an impact on the vegetation: cross-polination leads to better fructification and to seed formation by flowers that produce fruits or seeds.

Raw materials and the bee colony

Bees gather substances from the vegetation, add substances to them, process them and allow them to ripen. These then serve as raw materials for other bee products. With the help of specialised organs and glands, the raw materials are transformed into new, very different products. Figure 1 is a schematic drawing of the location of products in the beehive. When we speak of a beehive, we are referring to both the bees and the whole nest.

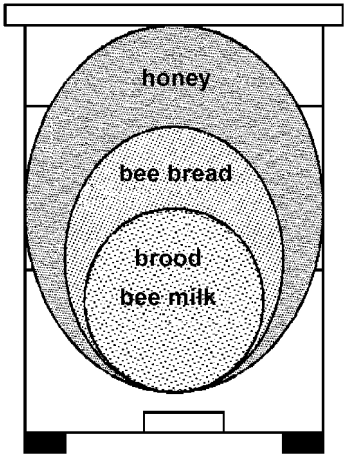

Figure 1: Location of products in a beehive

Bees collect substances from the vegetation and process these in the hive. The origin and composition of these substances are given in figure 2 with the same shading as in figure 1.

Since bees do everything together and pass the collected substances on to each other, called trophallaxis, substances from the bees' own saliva, stomach fluids and gland secretions are continually added. All

bee products also contain small amounts of other bee products. As a result, bee products can be made up of hundreds of different substances.

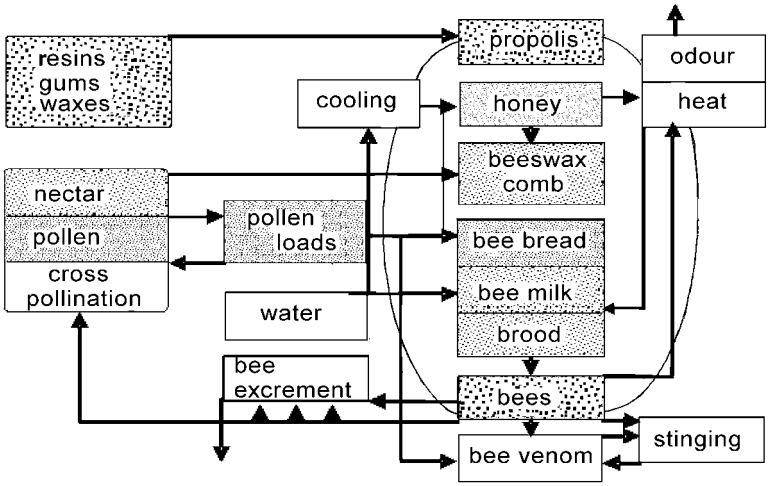

Figure 2: Substances from vegetation and the products bees make of them

Table 1 gives the same information as figure 2 but in different format.

This booklet covers all bee products in all stages of the production chain. The point of reference is always the beehive itself, including the use of the products by the bees. The beekeeper is also a central figure because the quality of the beehive's products depend on both the colony and the beekeeper who tends the bees and harvests their products. Further processing such as extraction and drying are also part of the beekeeper's job. Marketing is also usually most successful when it is done by the producer him- or herself.

This book was written by beekeepers for beekeepers and it aims to give information about good production and processing methods for bee products, but also about possibilities to earn good revenues. Pollination is thus also included as a product of beekeeping.

Table 1: *Raw materials and bee products*

Vegetation		**Inside the hive**		
substance	**how bees transport them**	**processing into …**	**location**	**function**
Pollen	In pollen baskets on the hind legs	Bee bread Bee milk Brood	In lower part of combs In brood cells with larvae In centre of brood	Food Food Food Development
	On breast hairs	---	Outside the hive	Pollination
Nectar	In honey stomach	Honey	On top and on outer combs of hive	Food Raw material for wax and warmth
		Wax	In the form of comb	Building of combs Nest for brood and food
Water	In honey stomach	Evaporation	Honey stomach of bees	Cooling Production of bee milk
Gum Resin Wax	On legs	Propolis	Wall of hive	Hive wall putty Heat regulation Cleaning of cells

2 Breeding and production

Keeping bees means that the colonies have an owner that protects them and cares for them, harvests their products at the right time and in such a way that enough is left over for the colony itself. The quality and volume of production can thus be increased and a greater number of products can be extracted. The colonies can also be moved, which is called migration. In this way the beekeeper can have the bees fly to various crops, create more bee seasons and increase production.

2.1 Production by a colony

- The bees collect nectar from flowers and make honey out of it. This is stored on the top and on the outer walls of the hive as a food supply and raw material for wax and heating.
- Beeswax is made by the bees in their wax glands. The energy source and raw material used to make beeswax is honey.
- When a bee sucks nectar out of a flower, pollen from the stamens sticks to the chest hairs of the bee. The bee combs this off and rolls it into pollen pellets with its hind legs.
- When the bees land on various flowers of one species, cross-pollination occurs. This leads to better fructifi-

Figure 3: Bees at work on a comb with larvae

cation and larger seeds and fruits.

- Pollen loads are pushed into the honeycomb cells where they are processed further and ripened into bee bread. This occurs on the inside of the comb nest.
- The young bees use secretions from their head glands to process bee bread into bee milk and royal jelly, which form, together with the eggs and pupae, the so-called brood: see figure 3.
- The brood is located in the combs on the inside and top of the bee bread, in the middle of the colony. It replaces as it were the bee bread formerly stored in the combs that was removed to make bee milk.
- The bees that emerge from the brood are workers, queens and drones (the males).
- Worker bees clean the cells for the brood with propolis, make honey from nectar, bee bread from pollen, and then in turn bee milk and royal jelly from the bee bread.
- The house bees sweat wax and make honeycomb out of it.
- Afterwards, the house bees become guard bees that guard the hive with their stingers by injecting bee venom into the skin of an intruder.
- The worker bees and the queen make bee venom in their venom gland, which is then stored in the venom sac located next to the stinger.
- The guard bees finally become forager bees, which collect nectar and pollen.
- The bees also collect waxes, gums and resins from trees and plants, which they mix into propolis by adding beeswax and saliva.
- Propolis plays an important role in keeping the hive warm because it is used to seal up holes in the walls of the nest.
- Heat is a product of the hive and the warm air released from a hive (bee odour) has therapeutic value.
- Sometimes water is collected for cooling. It is stored in the bees' honey stomach. Only bee milk and brood contain a lot of moisture. The other bee products are dry or concentrated.
- Bees, bee swarms, new bee colonies and queens are also products of the beehive.

- Bee excrement is a rich product that has not yet been processed into products. Bee excrement can, however, be a nuisance when it falls on clean laundry or windows, for example.

2.2 Harvesting and processing

The aim of beekeeping is to harvest products from the hive and to pollinate crops. A good beehive produces honey and this is of course its most well-known product. But honey is not the most important product. Pollination of crops and natural vegetation yields more than honey, both per hive and per hectare. Products such as honey and bee bread are harvested from within the beehive, but pollen loads and bee venom are collected outside the hives with special traps. To extract royal jelly, the hive has to be specially arranged. The beekeeper extracts propolis from the woodwork inside the hive.

Harvesting

It is important to harvest products at the right time in the bee season. Pollen transfer and pollination take place at the beginning of the bee season; bee milk is produced a little bit later but still in the colony's growing phase. While it is growing, the colony builds new comb. Later the colony may split into two or more colonies by swarming. Honey is stored mostly after swarming takes place, but it is not ripe until the end of the season or even later. The bees use propolis after the end of a season before the 'bee winter' begins. Moderate rather than complete harvesting of almost all bee products is better for the future performance of the colony. Agrodok 32 *Beekeeping* explains more about bee seasons and seasonal management.

Processing

In harvesting bee products, the beekeeper extracts the fresh, primary bee products. Because of their freshness, these products have the highest value for therapeutic applications. For consumption, preservation and marketing purposes, the beekeeper processes the products further, which usually (but not always) increases their market value. Honey is removed from the comb, whereby the honey and wax are

separated. This is called extraction. The honey is then put into jars and the pure wax is extracted from the empty comb. This wax is worth more and is less perishable than crude wax, but the honey in jars is worth less than well-produced fresh honeycomb.

2.3 Value chain and marketing

The production chain is a trajectory that begins with the bee cultivation, that is, with the colony and the beekeeper. This is where the quality of the products are determined. See figure 4.

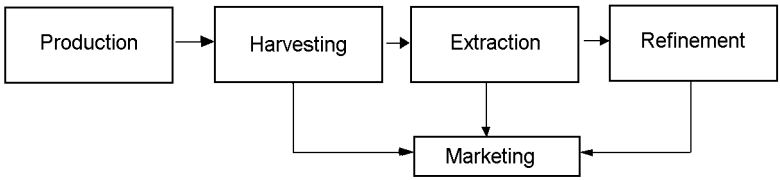

Figure 4: Value chain of bee products

If the bees are not tended well, very little can be done afterwards to improve the products. After harvesting, the products are usually extracted or dried, but the beekeeper can also sell the products directly without extracting them. Honey that is crushed, dripped or centrifuged out of the comb can be marketed easier and can thus provide a better income. For this and other reasons, such as the risk of crystallisation, the honey is marketed this way in most countries and preferably by the producer him- or herself. The added value of the extracted honey and beeswax processed in this way benefits the beekeeper. If he or she does not earn enough from these products, production will be reduced.

Marketing

The beekeeper sells the honey either directly to the user (see figure 5) (retail trade) or in large volumes to a trader (wholesaler) or a larger honey company (a honey packer). The latter refines the honey by heat-

ing, filtering and packing it into jars. In this way value is added again, although the honey is no longer raw and thus loses the properties of the fresh product. This type of processing is good if production is higher than local demand, because it increases the product's shelf-life, improves its presentation and makes export possible. If this is the case, it might be advantageous for the beekeeper or beekeepers' association to supply the honey to such a company. Chapter 14 discusses this issue further.

Figure 5: Honey sales at the market

2.4 Beekeeping projects

In recent years there has been increasing interest in the development of beekeeping projects in areas with production potential for honey and other bee products. The target group is normally beekeepers or a beekeepers' association, but it can also be a honey business that works together with beekeepers' organisations.

In developing a project it is important that it be well designed, that is, that the target group is really supported and the proposed objective can actually be attained. In many areas honey production is so low in volume and quality that the overly optimistic expectations created by marketing it cannot be met. It is therefore important already in the design stage to consult with experts who have practical experience in tropical beekeeping.

Beekeeping is one of the most difficult and complicated trades, but much too often non-beekeepers nevertheless think of it as a very simple job. Modernisation of the hives alone does not lead to sustainable improvement of production. There is actually no difference between traditional and modern beekeeping, only between traditional and modern equipment (figure 6 and figure 7). The knowledge that beekeepers have passed on for generations in a particular area should therefore always be used as a source of information in developing a regional beekeeping method.

Cooperation between various beekeepers and experts on beekeeping in the tropics is also very important. Agrodok 32 (*Beekeeping in the tropics*) focuses a lot of attention on this in its discussion of seasonal management in general and of the various types of hives.

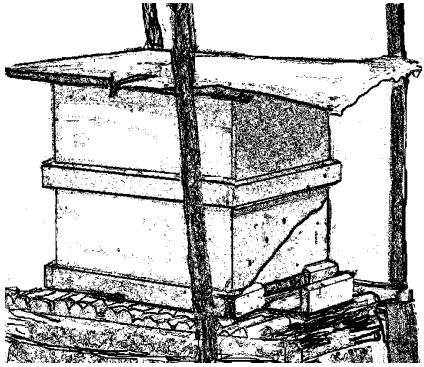

Figure 6: Langstroth hive

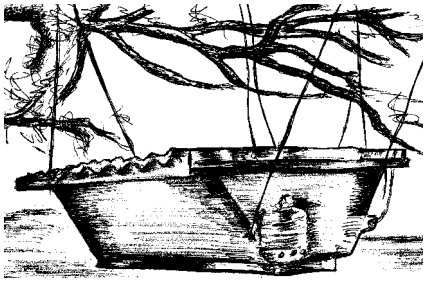

Figure 7: Top-bar hive

3 Pollination

If a bee sucks nectar out of a flower, pollen from the filaments of the stamen sticks to its hairs. When it lands on the next flower some pollen rubs off onto the stigma of the pistil. This is called cross-pollination.

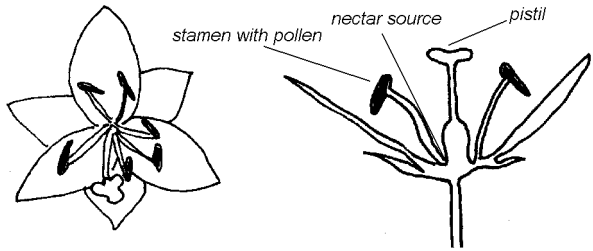

Figure 8: Schematic representation of a flower; left: top down view; right: side view

3.1 Principle and operation

The pollen grains, which have two nuclei, germinate on the moist stigma and grow through a pollen tube toward the ovary. This contains the unfertilised egg cells and the embryo sac, which will later become the endosperm of the seed or fruit. See figure 8.

One of the two nuclei in the pollen tube penetrates the egg cell or cells, which are then fertilised. This leads to the production of more fruit. The other nucleus penetrates the embryo sac. This leads to larger and better-looking fruits or seeds. These also grow into larger plants themselves. This effect is not achieved with self-pollination and in many cases self-pollination is not even possible. Bees fly from flower to flower. Since individual bees are true to one species of flower, cross-pollination occurs between different flowers of the same species.

Bees are essential for pollination of dioecious and monoecious plants. Monoecious species, such as papaya and kiwi, have flowers with either stamens (male part of the flower) or a pistil (female part of the flower). Only the real wind pollinators, such as grasses, have enough pollen to effectively pollinate themselves without the help of bees.

Bees and flowers

The optimal time for pollination (0) differs per plant species, but it is usually when the flower gives off the most smell. The bees therefore visit the flowers in great numbers at a certain time of the day. Nectar enters the flower before it opens. After the flower opens, the nectar begins to evaporate as the relative humidity decreases over the course of the day, especially in the tropics.

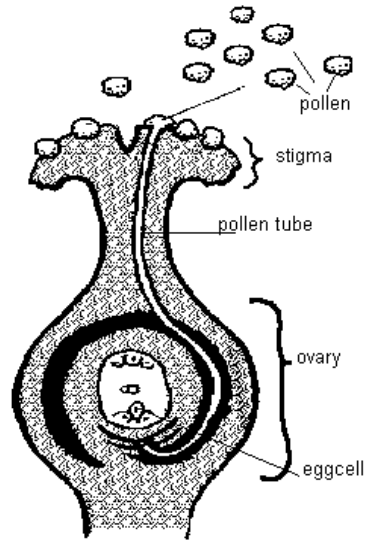

Figure 9: Pollination: pollen grain growing with tube into ovary

For each plant there is a certain species of bee that pollinates it best. Indigenous bee species, such as *Apis cerana* in Asia, which produce less honey than the exotic *Apis mellifera*, are usually the best pollinators and can be kept specifically for this purpose. Stingless bees can also be kept for this purpose. Other pollinators, such as bats and birds, can be competitors for pollen and nectar.

Plant species that are visited or pollinated by bees include citrus, nectarines, peaches, lychees, kiwi, papaya, mango, avocado, guava, coffee, tea, cotton, coconut, watermelon, calabash, beans and seed ba-

nanas. Some crops that are visited by bees do not profit from pollination, such as corn and bananas.
The effectiveness of cross-pollination by bees can be investigated by shielding part of the crop from the bees using fine netting.

3.2 Production

The effect of cross-pollination in natural vegetation is that the plants propagate themselves better. Seed and fruit-eating birds and animals, such as bats, squirrels and monkeys, also profit from the larger fruits and seeds. The pollination of crops usually requires more bees than are naturally present. The beekeeper, therefore, places a number of hives near or in the crop to ensure that there are enough pollinators in the area.

Number of bee colonies

The right number and size of the colonies is very important. If more colonies are present than is advantageous for the bees themselves and the honey yield, then the hives will have a shortage of pollen and nectar. The beekeeper has to then feed the colonies or replace them regularly. This is especially true in greenhouses, where the bees cannot venture outside to collect extra pollen and nectar. If the colonies are too small they will not be able to pollinate enough plants. For pollination in greenhouses, it is especially important that there not be too many colonies and that they are not too large. If there are not enough flowers, the bees may damage them. Stingless bees and bumblebees may chew off the flowers' anthers.

3.3 Pollination benefits

By adding bee colonies to increase pollination, farmers and beekeepers can gain much more than just the yield of honey. To give an idea of the economic value of pollination, we will give an example of the profits gained by the farmer and the beekeeper who hires his or her colonies out to the farmer.

The beekeeper can hire out his or her hives to a farmer for the duration of one crop cycle. A beekeeper places two hives per hectare in a field of sunflowers. Without bees the farmer yields 500 kg of sunflower seeds per hectare, and with the bees 850 kg, thus 350 kg more. The beekeeper yields 50 kg of honey per colony, which is 100 kg per hectare. The sunflowers yield € 1 per kilo, and the honey also about € 1 per kg, after expenses are deducted.

The farmer earns, therefore, 3.5 times more from the pollination than the beekeeper earns from the honey. The farmer pays the beekeeper € 25 per hive, which is a total of € 50 per hectare. The beekeeper thus earns € 150 per hectare. That is one and a half times what he earns from the honey alone. The farmer earns € (350–50) = € 300 per hectare extra thanks to the bees! This is 60% more than the yield without bees.

Table 2 shows these significant yield increases for seeds and fruits schematically per hectare and per hive, with pollination fee included.

Table 2: Extra income per hive through pollination

	Land area	**Hives hired**	**Crop yield**	**Honey yield**	**Profit farmer**		**Profit beekeeper**
	ha		kg/ha	kg/ha	total	per colony	
					€	€	€
Sunflower	1	0	500	100	500		100
Sunflower	1	2	850	100	850	(850-500) / 2 =175	100 + (2 x 25)
Watermelon	2	0	12,000	50	2,400		50
Watermelon	2	4	20,000	50	4,000	(4,000-2,400) / 4 = 400	50 + (4 x 25)

If the beekeeper is also the farmer of the crop, his or her income will be much higher. Beekeepers who are also farmers can thus earn the most by planting crops that profit from cross-pollination.

3.4 Pollination contract

Pollination is, as far as earnings are concerned, the most important product of beekeeping. This is true per hive as well as per hectare if a crop is cultivated that produces fruit or seeds and that benefits from cross-pollination. The one who benefits most from pollination is the farmer, who thus logically owes the beekeeper a share in this. The farmer should therefore be expected to pay a pollination fee to the beekeeper who supplies and tends the bees. The pollination fee is usually a small percentage of the farmers' increased earnings from the crop, but for the beekeeper it can be even more than the earnings provided by the honey.

By moving bees, a beekeeper can make pollination a lucrative business. The beekeeper can agree to a pollination contract with the farmer. This contract covers four aspects:

- the pollination fee (because the beekeeper creates more profit for the farmer)
- tending of the colonies
- transportation of hives to and from the crop
- risk insurance, in case of theft or damage for example.

The pollination fee has to cover the beekeeper's expenses for tending the hives. These can be considerable especially in greenhouses and other closed areas because the colonies have to be tended and fed regularly. The transportation of the hives to and from the crop also has to be paid, and the risk of damage has to be covered.

Importance of disseminating information

The farmer is often not the party who asks for the bees to be placed, primarily because of a lack of information. If the beekeeper is the one who asks to have the bees placed, he or she is often charged a placement fee by the farmer or land owner. Since the latter benefits by far the most from successful pollination (figure 10), even if the beekeeper harvests a lot of honey, this is very unreasonable. It is therefore impor-

tant that beekeeper associations and agricultural consultants disseminate information on the interests of both parties.

Some farmers buy hives for pollination in order to save money. Since they do not have the beekeepers' expertise they cannot tend the colonies well and the pollination is therefore not optimal. This also means that the beekeeper who sold the hives earns very little money for a good hive. Choosing to buy the hives is thus disadvantageous for both parties.

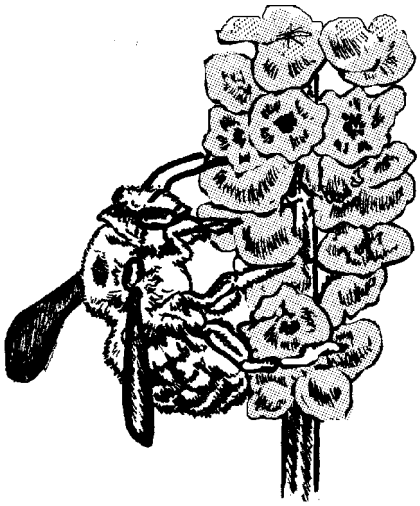

Figure 10: Foraging bee on flower, pollinating it at the same time

4 Honey

Honey bees collect nectar from flowers. Nectar is a sugary water that differs in composition per plant species. The forager bees bring the nectar in their honey stomachs to the hive and give it to the house bees. They process the nectar, thicken it, and fill the cells of the comb with it, where it ripens further into honey and then is sealed in with a wax capping.

Properties and composition

Honey originating from a single flower species is called monofloral honey, such as kapok honey, banana honey or coffee honey. If the nectar of more than one species is collected, then it is called multifloral or polyfloral honey.
Nectar contains a minimal amount of pollen, which can also be detected in the honey. Pollen is present on the anthers of all plants from which bees collect nectar. Only small traces of pollen are found in 'modern' honey. By observing pollen under a microscope, it is possible to identify its plant family, genus and species.

Bees also gather honeydew. These are droplets that hang on the flower in the morning, or extrafloral nectar from other plant parts such as the calyx, stalk or leaf. Honey made of honeydew and leaf honey contains substances found in the petals, plant stalk or leaves and a high concentration of yeasts and dust particles. This honey therefore crystallises sooner. It is also often cloudy and sour and does not keep as long.

Ripe honey is a strong supersaturated sugar solution that usually contains less than 20% water and more than 80% sugars. These sugars eventually crystallise and the product takes on a more solid form. The sugars are mostly monosaccharides such as glucose and fructose. A relative high concentration of glucose compared to fructose will make the honey crystallise sooner.

See chapter 13: Quality and regulations.

Some honey crystallises in the comb already before it is harvested. However, due to the higher temperature, it takes longer for the honey to crystallise in the hive than after harvesting. During harvesting, dust particles are introduced that function as extra crystallisation kernels (figure 11).

Figure 11: Crushed honey combs

The unprocessed product

Honey in the comb contains small amounts of pollen, wax, propolis and possibly also bee venom. The amount of these substances depends on how long the honey is left in the comb. If the honey comes from combs previously used for brood, it will contain propolis from the membranes of cocoons. However, only minimal amounts of pollen are contained in this honey. Other particles that the flying bees have caught while in the air and combed off with the pollen are also present in minimal amounts in the honey.

Honey contains enzymes, i.e. biologically active substances from the bees' saliva and stomach fluid, as well as short proteins or oligopeptides. Pure honey -has very little minerals, spore elements and vitamins.

The derived product

Honey that has been centrifuged is almost the same as honey in the comb. However, crushed or pressed honey can contain a large amount of pollen. If there is a lot of bee bread in the comb, this honey is actually a combination of honey and pollen. This 'enriched' honey contains, in addition to the nutrients in the pollen, a much higher amount of vitamins, minerals and biologically active substances.

If brood is also pressed along with the honey, the honey will have an even higher protein, vitamin, mineral and moisture content. Three or four products have then actually been combined: honey, bee bread, bee milk and brood. This is why pressed honey harvested from traditional hives is often of lesser quality and does not keep as long, but is much richer in nutrients.

It is possible, however, to harvest 'modern' honey and other products separately from simple and traditional hives. See the section below on production and processing.

Health value

Properties

Honey can be a lifesaver for people and animals in critical health. The simple sugars and especially the fructose content play an important role. Honey is absorbed very quickly into the tissues. It contains small amounts of other bee products such as pollen, bee milk, propolis and bee venom. These products together have a healing effect on the throat, the gastrointestinal tract, the skin and body tissues.

Glucose-oxydase is an enzyme that begins to produce hydrogen peroxide (H_2O_2) when the honey is diluted with water, saliva or fluid from a wound. This substance has a disinfecting effect. It is released slowly and is therefore more effective and does not bite as much as a 3% solution of hydrogen peroxide from a pharmacy. When honey is warmed the enzyme becomes denatured (see also 13.5), so fresh, raw honey is the most effective.

The honey from stingless bees (*Meliponini*) found in the tropics is more effective than the honey from true honey bees. This honey also has a higher moisture content (>24%) and is thinner, but it does not ferment quicker. It also has a higher content of antibiotic short proteins and enzymes, the latter of which inhibit fermentation.

Uses

Honey has traditionally been used to relieve the symptoms of asthma, hangovers and for diabetic comas. It is known to help induce sleep and to improve physical performance. Fructose is quickly absorbed by the tissues, without the intervention of the hormone insulin. Of course, this does not mean that honey can be added without caution to a diabetic's diet.

Honey is thinned for use as a cough syrup or it is added to improve the syrup's effectiveness. This is the most important use of honey in the food and pharmaceutical industries. The short proteins and propolis play an important role in the honey's effectiveness.

Honey is also used for burns and other wounds because of its osmotic cleansing effect and its healing properties. The hydrogen peroxide released when honey is thinned disinfects wounds and stings a bit. To reduce this discomfort, the honey is mixed with an equal amount of oil, butter or fat. As the wound heals, the percentage of fat is reduced.
Because of the minimal amount of pollen contained in honey, it is eaten to build up a resistance to hay fever or a pollen allergy. Honey from one's own region is particularly good for this purpose. Honey also contains other particles from the air because as the bees fly these particles stick to their hairs and they are eventually combed off with the pollen. See also chapter 5.

The honey of stingless bees is used for the same ailments as the honey from honey bees. In South America it is also used in pure form as eye drops to treat cataracts.

Traditional uses of honey are surprisingly similar in all parts of the world, but there are some regional differences. Beekeepers can play an important role in gathering together this type of information, which for the most part has not yet been documented.

Harvesting and extraction

Honey is best harvested after the peak of the bee season. The quality of honey changes during its production in the hive, so the selection of which combs to harvest determines in part the quality of the honey. All extraction is best done right after harvesting when the honey is still fluid. When removing combs from the hive, application of too much smoke should be avoided. Honey in freshly built combs can be packed and sold right away as cut comb honey, without extraction or processing.

It is important to separate combs before extraction, and harvesting of full combs is preferred. It is better not to harvest combs that contain unripe honey, bee bread and brood if pure honey with a low moisture content is desired. Separating combs with different honey colours and extracting the honey separately will enable a beekeeper to diversify his or her production. Honey in freshly built combs is often lighter in taste and colour.

Crushed honey (figure 12) is made by crushing and mixing the honeycombs. This is a traditional processing method. Crushed honey resembles creamed honey.

Figure 12: Retail sale of crushed honey

Extraction methods

Honey can be separated from the comb in various ways: through floating or dripping, pressing, or centrifugal extraction. The floating and dripping methods make use of differences in density. In the floating method the wax floats to the surface and in the dripping method the honey drips from the comb. Dripping, floating and hand pressing honeycombs are considered to be traditional beekeeping methods, but if

practised well they can be very effective and give good honey. Dripping and floating will often lead to a higher moisture content, especially in the rainy season. Before pressing, combs are wrapped with mesh material to retain the wax particles. The honey extracted in this way is less clear than with dripping or centrifuging. Plastic screening material and stainless steel sieves are better than cloth as they are more hygienic and leave no (cloth) particles behind that may serve as kernels for crystallisation. Agrodok 32 describes some methods for pressing manually and with pressing aids.

Centrifugal extraction using a centrifugal honey extractor (figure 13) is a good method for movable combs from chambered hives or top-bar hives. Agrodok 32 describes the centrifugal extractor in more detail and how to operate it optimally. Broken comb pieces can be put in a basket or a sack and be centrifuged as well.

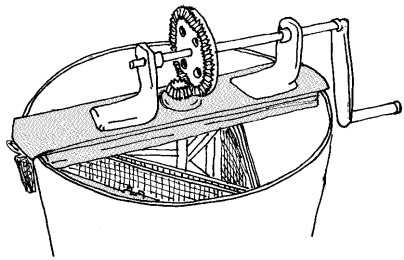

Figure 13: Centrifugal honey extractor

The capping with honey stuck to it should be kept separate, as it may contain smoke particles. The capping can be consumed as it is, or it can be saved for use as feed for the colonies. With centrifugal extraction more than 70-80 % of the honey can be extracted if it is fluid and has not crystallised in the comb.

Storage

The most important factors to consider in transporting, storing and processing honey are air humidity and temperature.

Conditioned environment

For the storage and processing of honey, it is best to have a honey house in which all the necessary conditions (cleanliness and dry air) can be created. All honey treatment must be done under dry air conditions. During transport and storage comb honey, even if it has been sealed, may absorb moisture from humid air. The time of exposure to humid air must be kept to a minimum. Honey containers should not be left open in humid air and combs must be covered.

Inside the honey house, air conditioning, fans for ventilation or other means to reduce humidity in the air can be installed and applied. Warming the processing room will help reduce relative air humidity and also make the honey less viscous, which will simplify processing. Hygrometers and thermometers should be present in every room of the honey house. A refractometer (see figure 28) to monitor moisture content of the honey at different stages is also useful.

Drying of honey

If honey has a high moisture content, this is usually caused by inadequate production, but it can also be a result of handling and transport after harvesting. Forced drying of honey after harvesting is a poor method. Water extraction or dehydration after processing will lead to evaporation of volatile substances, thus severely deteriorating the quality and taste of the honey. The best way to dry honey is to store the full honeycombs for several days in a dry room. The dry air will absorb water from the honey even through the capping.

Processing and packaging

Honey can be packaged raw. Fresh honey has the aroma of the flowers the nectar was collected from. The content of biologically active substances such as enzymes is highest in fresh and unheated honey.

Sooner or later honey will crystallise and become solid. The colour then becomes lighter. The honey can be creamed_by first heating it

slightly and then stirring it. Creamed honey made of fine crystallised honey tastes the best.

Within a few days after extraction, pour the honey into an airtight storage jar or containers. To fill small pots and jars easily, use a container with a valve (figure 14). Store honey in glass jars or plastic buckets with well-sealing lids or in metal containers that have been coated on the inside with liquid paraffin or plastic, or that have been treated with food-safe varnish.

Large honey companies warm the honey to keep or make it fluid and to prevent fermentation if the moisture content is too high. After heating, the honey is filtered and poured into glass jars. This process is also called refining. Through the heating process, however, the honey loses some of its quality. Its fresh character is gone but it does stay clear longer. This is an advantage if the honey is to be sold in stores.

The honey can start fermenting during storage if the water content is above 19%. Fermentation can be prevented by heating the honey to a temperature of 55 to 60 °C over a period of 8 hours, followed by rapid cooling. However, heating honey for much longer will diminish its taste, smell, enzyme content and health value.

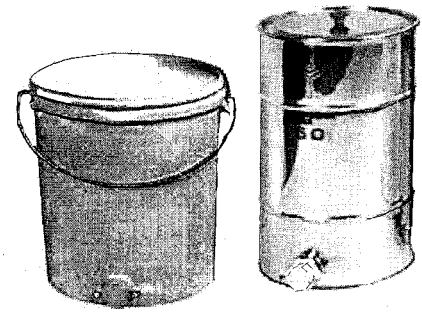

Figure 14: Metal and plastic honey bottling tanks with valves

5 Pollen

Honey bees collect pollen from the stamens of flowers. The pollen sticks to the bee's hairs while the bee is sucking nectar. The bee removes the pollen from its hairs using a comb on its forelegs and adds some saliva to help roll it into a ball. The bee flies with these loads in the pollen baskets on its hind legs to the beehive. House bees push these loads with their heads into the honeycomb cells, together with a small amount of honey and saliva. The bees then process this mixture and it ripens into bee bread.

Properties and composition

Pollen grains have a tough outer wall: the exine. This sometimes has barbs that allow it to stick well to the bee's hairs. This outer wall is covered in a layer of wax, which makes the pollen very difficult to digest and is also the reason pollen can become fossilised and remain intact in the soil for millions of years. Despite this hard outer wall bees make it slowly more digestible and eventually after several weeks make bee milk or royal jelly out of it for the young larvae.

Each pollen load comes from one plant species. The amino acid pattern of the proteins in pollen determines its biological value for the bees. Bees in a colony visit various plant species, so the multicoloured mixture of pollen loads usually has a good composition as long as it is not dominated by a deficient type, such as the pollen of corn. When the forager bees return to the hive, the beekeeper can usually recognise the origin of the pollen by the colour of the loads. The composition and health value of the pollen vary per plant species. By looking at the pollen under a microscope it is possible to identify its plant family, genus and species (see also section 13.6). This is called melissopalynology.

Pollen contains lipids, essential oils, vitamin E (tocopherol), carbohydrates, peptides, short proteins or oligopeptides, amino acids, pan-

tothenic acid, anthocyanins, carotenoids, flavonoids, ferulic acids and enzymes as well as many minerals such as iron, manganese, zinc and spore elements. See also table 3.

Table 3: Composition of several bee products

	Components and weight in %				
Product	Water	Protein	Fat	Carbohy-drates	Ash
Honey	17 - 21	0.4	0	79 - 83	0.1
Pollen	25 => 11	22	5	31	3
Bee bread	20 => 14	20	3	24 - 35	3
Royal jelly	67	11	6	9	1
	' => ' refers to the moisture content after drying				

Health uses

The biologically active substances, such as anthocyanins, carotenoids and flavenoids, in pollen help cleanse the blood by scavenging free radicals. Pollen improves people's strength and well-being, supports mental exertion and enhances the blood flow to the brains. It is a supplemental source of vitamins B_2, B_6 and B_{12}.

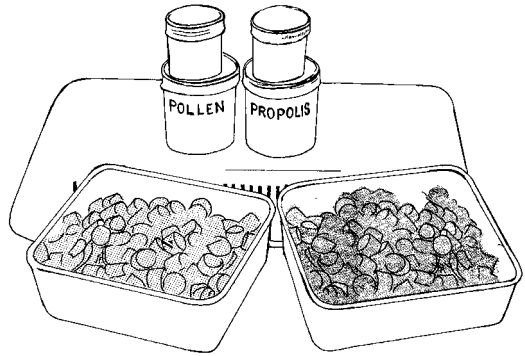

Figure 15: Pollen and propolis capsules

Pollen is used for improving fertility, relieving the discomforts of old-age, and combating the symptoms of menopause, an enlarged prostate, listlessness and stress. Due to the high amounts of micronutrients contained in pollen it is used by athletes to optimise their diet. Dry pollen

loads or pollen in the form of capsules or pills (figure 15) are also taken as a remedy for hay fever, asthma, soar throats and colds.

Because it is so difficult to digest, pollen is a good remedy for intestinal problems.

Extraction and storage

Production of pollen is only possible in the early part of a season, in an area with good vegetation made up of pollen-rich plants and with a strong colony. Harvesting pollen is not good for the development of the colony because the colony may not have enough pollen left to make bee bread and bee milk, which are needed to feed to the young bee larvae. Some pollen has to therefore be left behind, for example by not harvesting every day and by rotating the production colonies.

Harvesting

Pollen is harvested with the help of a pollen trap (see figure 16).

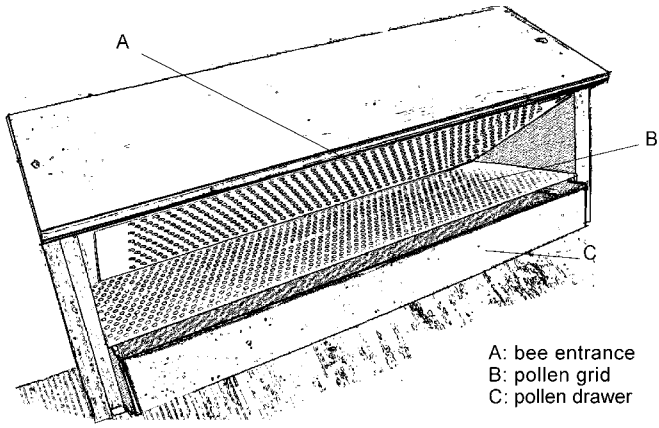

Figure 16: Pollen trap

This includes a grid that the bees have to pass through when they return to the hive. The entrance holes, which can be round or lobed, are so small that the loads are scraped off of the bees and fall through a

grid. The bees cannot get through the grid to pick them up again. The various colours of pollen loads are all mixed together in the collection drawer.

Wild races, such as the African and Africanised bees, can become very agitated by this process. They do not accept the theft of their collection. It is therefore much easier to harvest pollen once it is made into bee bread (see chapter 6).

Storage

Pollen spoils quickly and can therefore be left in front or under the hive for no longer than a day. The loads have to be dried immediately after harvesting to prevent mouldiness and extend their shelf-life. The moisture content decreases during drying from about 25% (fresh) to an average of 11%. Fresh pollen becomes mouldy after just one day, and these moulds can produce unhealthy aflatoxins. To keep it longer, fresh pollen can also be added to honey, but the concentration has to be no more than 10%.

Pollen has to be stored in a dry, dark place to retain its good properties. Brown glass jars are better for this purpose than clear glass jars.

6 Bee bread

Bees make bee bread out of the pollen that they have collected. In the previous chapter we described how house bees push these loads with their heads into the honeycomb cells, and press them into pellets with a small amount of honey and saliva. This undergoes biochemical processes caused by enzymes added through the bees' saliva and stomach fluids. Thanks to the work of micro-organisms and the influence of moisture and temperature in the beehive (35-36 ºC), the mixture ripens in two weeks into bee bread.

Properties and composition

Bee bread is a source of proteins, fats, micro-elements and vitamins for the bees. It is the raw material for production of bee milk and royal jelly, which the young nurse bees make with the help of secretions from glands in their heads (see also chapter 7). Bee bread has a different composition than pollen (see table 3 in chapter 5).

Bee bread contains fewer proteins than the original pollen, but they are easier to absorb. The moisture content decreases considerably to 13 or 14% through drying after the harvest. Bee bread also contains the following substances:

- proteins with essential amino acids
- vitamins C, B_1, B_2, E, H (biotin), K, P (rutin), nicotonic acid, folic acid and pantothenic acid
- pigments, carotenoids and anthocyanins
- the enzymes saccharase, amylase and phosphatase
- flavonoids
- more than 25 different minerals and spore elements such as iron, calcium, magnesium, phosphorus, potassium, copper, zinc and selenium.

Since the amount of lactic acid in bee bread is about six times greater than in pollen, it has a higher acidity and thus a lower pH value. This

acidity of bee bread makes it self-preserving: it inhibits the growth of moulds and other micro-organisms so bee bread does not become mouldy as quickly as pollen.

Health value

Properties

The combination of various biologically active substances in bee bread makes it effective for the prevention and treatment of various diseases. Its high B-vitamin content improves the metabolism and the functioning of the nervous system and it stimulates the production of red blood cells and the haemoglobin count of children as well as adults.
Both bee bread and pollen have a positive effect on the immune and anti-oxidant systems of healthy people. It can improve the physical performance of athletes by providing extra energy.

Bee bread also has antibiotic properties: it inhibits the development of bacteria and viruses and helps reduce fever. It also stimulates tissue growth and recovery and it cleanses the blood. Bee bread has a pleasant calming effect and it slows down the aging process. It helps increase a person's appetite, gives added strength to the elderly and speeds recovery.

Uses

In apitherapy bee bread is used quite successfully in combination with other methods to treat the elderly and children. The use of bee bread is recommended for anaemia, hepatitis, diabetes and gastrointestinal problems such as colitis, constipation and diarrhoea that is resistant to treatment with antibiotics. Bee bread reduces cholesterol, improves the lipid pattern and cleanses the blood; it also improves gallbladder and liver functions and reduces blood pressure. Bee bread, like honey, is recommended for the prevention of prostate problems.

Bee bread can also help strengthen someone who is generally worn down or who is recovering from an operation. It is also helpful in combating depression and memory or concentration loss, which makes it a good product for people who are active 'thinkers'.

Production, harvesting and storage

Bee bread is more easily digested than pollen loads and is also easier for the beekeeper to produce. If a good harvesting method is used, stress for the colony can be kept to a minimum.

The natural production of bee bread by house bees was explained above. Bee bread can be produced in larger quantities by making part of the colony 'queenless'. A surplus of bee bread develops in that part of the colony because there is no brood and no bee milk is made from the bee bread. The combs with ripe bee bread can thus be harvested. Less damage is done to the colony in this way than when pollen loads are harvested.

Bee bread can be peeled from the comb. A special instrument is available for this purpose, called a bee bread punch. In drying the bee bread its moisture content can be decreased from 20% to 14%. Due to the changed composition, bee bread can be stored longer than pollen loads. But it too will eventually become mouldy.

Fresh bee bread can be kept in the freezer, pressed together with honey or dried. The concentration of bee bread in honey cannot be more than 15%. Dried bee bread can be eaten in pure chunks or columns in the shape of the cell, or it can be added to foods. Bee bread is tastier and easier to digest than pollen loads.

7 Royal jelly

The young bees add secretions from glands on their heads to the ingested bee bread to make bee milk or royal jelly. They put this bee milk in cells that contain young larvae. The larvae of worker bees, drones and the egg-laying female (the queen) eat these products, which make them grow. The bee milk is made up of two components: a clear and a milky white fluid. Royal jelly consists of approximately equal parts of these two, whereas the bee milk for the drones and workers is made up mostly of the clear component. The bees produce the most bee milk when they are a week old; after three weeks the secretions stop and they go outside to collect nectar and pollen. For the production of royal jelly it is therefore important to have many young bees in the colony.

Properties and composition

The bee milk for the queen is the most nutrient rich and is therefore called royal jelly. The queen also gets much more than the workers. This is partly why the queen becomes much bigger and stronger than the workers. She can live for a few years, and thus much longer than the 4 weeks to 6 months, depending on the season, that the worker bees live.

The composition of bee milk depends partly on the bee bread and thus the pollen (see also table 3 in chapter 5). It is rich in vitamins B_1, B_2, B_6, folic acid, inositol, pantothenic acid, vitamin C and vitamin E (tocopherol). Royal jelly also contains peptides, lipids, sterols, aromatic oils, carbohydrates, enzymes, anthocyanins, carotenoids, flavenoids, ferulic acids, as well as minerals and spore elements from the bee bread.

The gland secretions needed to digest the bee bread give bee milk a lot more free amino acids and short proteins (oligopeptides) than the bee bread. These form in combination with the fatty acids an acidic frac-

tion, royalisin. Royal jelly is therefore acidic and tastes somewhat rancid, even if it is fresh. It stays good for only a limited time (5 days) without refrigeration or freezing, but it can be kept longer by mixing it with honey.

Health value

Properties

The acidic fraction royalisin makes royal jelly effective in combating a broad spectrum of bacteria, but not fungi. Royalisin contains gamma globulins, which are important amino acids in the immune system. This fraction also contains 16% asparagin, which is needed for tissue growth. About half of the fat fraction is made up of 10-hydroxy-2-decanoic acid (10-HDA), which plays a role in growth, the hormonal system and the immune system. Fresh royal jelly contains 2-15% 10-HDA, which determines its quality (>5% is preferred).

Uses

Royal jelly is recommended for stomach, liver and digestion problems, high blood pressure, loss of appetite, weight loss, fatigue, listlessness, insomnia, pregnancy, menopause, old-age problems, convalescence and athletics. Royal jelly can be viewed as a tonic to make you feel stronger, healthier and less tired. It can be eaten pure or mixed with honey. It is also often sold in glass tubes or capsules mixed with sorbitol or another sweetener. In many countries it is also added to energy drinks. Capsules with dried royal jelly are commonly used in apitherapy.

For external use, royal jelly is added to creams and salves, because it enhances or preserves the beauty of the skin. It stimulates the formation of healthy tissue and hair growth.

Production and processing

For the production of royal jelly there have to be many young bees in the hive; this is naturally the case at the beginning of a bee season. The beekeeper can increase the number of young bees in various

ways. He or she can add closed worker brood from another hive a few days before they hatch. Or he can shake bees off comb from another colony. The young bees that cannot fly yet stay behind on the combs, and the flying bees return to the hive they came from.
This makes it possible to have a production colony and one or more supporting colonies that will supply more young bees, honeycombs and bee bread. Enough bee bread, the main ingredient of royal jelly, and honey have to be available in the production colony to feed the young bees. Royal jelly production is most successful in a colony that has a queen, but the part of the hive where the production takes place has to be queenless.

Method 1: Cutting off the comb

Without the use of specialised materials, it is possible to have the bees make many new cups, in which they make royal jelly, by cutting a ragged edge on the underside of a comb that contains eggs in the queenless section. The bees will then make emergency queen cells on the cut edge where the eggs are located. The number of added cups varies between 10 to 50 depending on the strength of the colony, the number of young bees, the season and the surrounding vegetation.

Method 2: Artificial cups

The beekeeper can also use artificial cups made of PVC or beeswax. The latter can be made by inserting a stick of the right shape and diameter in the wax. These artificial cups are then glued or otherwise attached (see figure 17) to the underside of a frame (about 15 per frame) and the beekeeper inserts an egg or one-day old larva into each of them. This is called grafting and is done using a pen or other instrument. This has to be done carefully in order to not da-

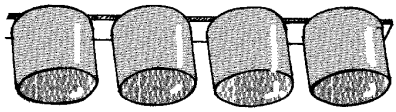

Figure 17: Grafting cups

mage the larvae. An egg or larva that was lying down has to be placed in the same position in the new cell to prevent it from drowning in the bee milk.

The final result is illustrated in figure 18: the bees then build queen cells for royal jelly.

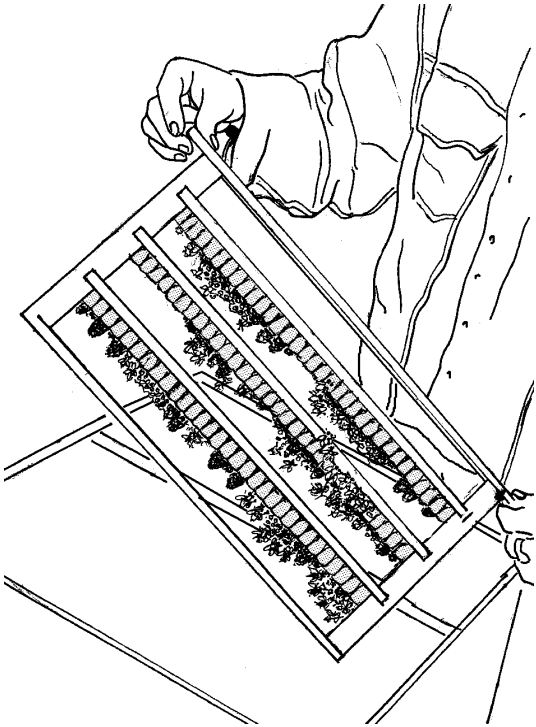

Figure 18: Bees put royal jelly into grafted cups

Method 3: The introduction cage

With a similar system using PVC cups it is possible to have the queen lay the eggs herself. Exactly 100 cups are placed in a square box, such as the Nicot-brand *cupularva*. The queen is confined inside this box. The worker bees can come in and out through a grate, i.e. queen excluder, to feed the queen. In a good colony it will take one to four days for all of the cups to be filled. These are then placed in corresponding holders that are already attached to the frame in the hive. This method ensures that the eggs will not be damaged.

Harvesting

If any of the methods described above are followed, it will take three days for the maximum amount of royal jelly (between 0.25 and 0.30

grams per cup) to be produced, and it can then be harvested with a pipette or a spoon (see figure 19). A special instrument with a suction pump is also available for this purpose.

Fresh royal jelly can be kept at room temperature for only a few days. Of course it can be kept longer in the freezer or by adding it to honey, but the concentration must not be more than 3-5% to prevent fermentation. After being freeze-dried, or lyophilised, it can be kept in powder form at room temperature.

Since the production of royal jelly is very labour-intensive for the beekeeper and the yield is very small this product is very expensive. The active involvement of the beekeeper makes it important to work with calm colonies.

Figure 19: Extraction of royal jelly with a plastic pipette

8 Brood

Bee brood is made up of eggs, larvae and pupae in the comb (figure 20).

The larvae and pupae are especially suited for consumption. Harvesting brood is bad for the development of the colony, so the larvae and pupae of drones are usually used because the colony is less dependent on them. Brood is also sometimes a by-product of the honey harvest, especially with wild colonies (figure 21).

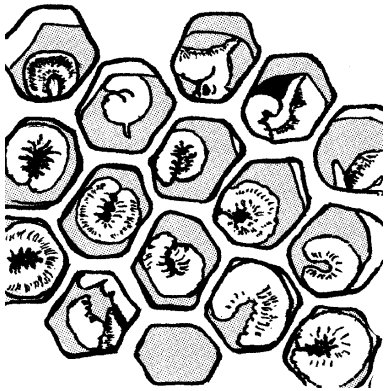

Figure 20: Brood comb with larvae

The composition of bee brood, especially in the larva-stage, is in part that of the bee milk. In the pupa stage many of the substances provided for growth become body proteins and fats.

Figure 21: Harvesting brood comb from traditional hive

Health uses

Bee bread is eaten in some countries as a traditional dish, either with the comb or separated as just larvae and pupae. In Africa the larvae and pupae are removed from the comb and used as an ingredient in various dishes. In Indonesia the sealed brood comb of *Apis cerana*, the indigenous honey bee, is sold at markets. The cocoons and brown membranes of the pupae plus added spices give the dish a tra-

ditional, strong flavour. In Eastern Europe beekeepers eat drone larvae because of their hormone-like strengthening properties. They are used to treat old-age ailments and to enhance convalescence. They also supply extra energy, for athletic competitions for example. Apitherapy products made of drone brood are found in Asia as well.

Production, harvesting and storage

The production of worker brood naturally takes place in the early part of a season. If there are already some combs with worker brood present and the supply of nectar and pollen continues to increase drone brood will also be made. This is normally no more than 10% of the total brood. After this, queen cells are made.

Since removing brood is bad for the colony's development and for its subsequent production of honey, it is best to harvest only drone brood and only a small amount. Drones mate with the young queens and have a function in the colony during the nectar- and pollen-collection period. Drones are not limited to one colony so drones from other colonies may also enter the hive. Drone brood can be harvested with a special unsealing tool, with which a whole piece of drone brood can be removed from the comb at one time.

Traditional beekeepers often harvest brood together with the honey. Most of the sealed honey is pressed out. The remaining honey is then used to make honey beer or wine.

The fresh, unprocessed brood can only be kept for one day. It can be added to honey, but the concentration may not exceed 5% for larvae and 10% for pupae. The larvae from harvested royal jelly are also processed by drying and then grinding them into powder.

9 Beeswax

Bees need wax to build their honeycomb nest. The building material and supply of energy for this activity is honey.

9.1 Production by the bee

The bees sweat wax out of four pairs of glands on the underside of their abdomens. The development of the wax glands depends on the pollen eaten by the young bees after they emerge from the cells. Rich pollen feed in this early phase ensures that the bees will later have an optimal capacity to build. Bees that are about ten days old sweat the most wax.

While producing and building with wax, the bees eat and digest a lot of honey. Their high metabolism leads to a high body and surrounding temperature, which is necessary to keep the wax fluid. The wax drips like a curtain out of the gland's narrow opening and hardens as it comes in contact with the air. It thus becomes transparent, white, ellipse-shaped scales. The bees then hold these scales with their forelegs and chew them into the right form to build a comb. If a bee swarm remains for some time in the same place the bees will start to produce these scales and build a comb. Fallen wax scales can then be found under the colony.
A swarm, i.e. a travelling colony that does not have a nest, will naturally build a piece of comb in or on the new nesting place. Sweating wax is an energy-consuming biochemical process. The required material and energy comes from honey the bee has brought along in its honey stomach or, if a bee nest is present – that is stored in the comb.

9.2 Properties and composition

The information provided below refers mostly to the honey bee *Apis mellifera*. Other *Apis* species produce wax that has a somewhat different composition. Stingless bees sweat very little wax but they collect

from nature gums, glues and resins to mix with. This makes the wax from these bees tougher and stronger.

Beeswax is a natural product that consists of a number of insoluble fractions. This gives wax a melting trajectory rather than a melting point. The melting trajectory lies between 62 and 65 ˚C and a relatively high level of energy is required to melt it. The melting trajectory offers a number of advantages. It makes the wax pliable: it already becomes soft at 35 ˚C. Beeswax can be extracted from the comb using the heat from the sun, steam or hot water.

Beeswax is chemically inert. It can therefore be used to protect materials from chemical substances and also from honey by covering them with a thin layer of beeswax. Wax is also suitable for uses in which the active ingredient has to be released slowly. Beeswax does not dissolve in water; this makes it suitable for waterproofing materials and cloths and for resist techniques. Beeswax does dissolve in organic solvents such as benzene, ether or chloroform, as well as in fats and oils through heating.

The colour of beeswax is determined by the pollen that the bees collect during the building process. New wax is usually white, but it can also be yellow to reddish-orange. With use, the combs become darker, even brownish-black after they have contained brood. Beeswax bleaches in the sun.

Cold beeswax is a brittle mass that crumbles apart easily. It has a density of about 0.95 kg/litre and it floats in water. Its density increases at lower temperatures, which makes it shrink. This is useful for processing in moulds because as the wax cools off after being melted it shrinks and comes loose automatically from the mould.

9.3 Uses

Beeswax has a wide variety of uses.

Wax in beekeeping and honey production

The most important use of beeswax is in beekeeping itself, namely for the production of artificial combs. Artificial comb foundation is made of moulded or pressed wax sheets with cells imprinted on them that the bees very quickly and economically (using very little honey) build into comb. A surplus of beeswax can be found mainly in countries where artificial comb foundation is not used.

New wax is much cleaner than old, melted combs. Beeswax, both from new and old comb, is edible but not digestible. If you eat comb honey you ingest a very small amount of wax, less than 2 to 3% of the honey's weight. Comb honey is therefore produced only in new comb. Honey from older combs or from built-up artificial combs does not taste as good.

In countries where traditional beekeeping is practised, people often eat honey in and from all types of comb. This gives the honey a strong membrane taste.

Traditional and industrial uses

Makers of musical instruments use beeswax because of its shaping, gliding and tanning properties on wood and leather. It is also used in the production of coloured crayons and paint. It is applied in wood-working, metal casting, printing presses, for carbon paper, waterproofing of textiles and in the electro-technical industry. It is also an important ingredient in polishing and furniture wax, shoe polish, car wax and lubricants and metal polish (together with calcium powder) as well as in resist techniques such as etching and batik. Beeswax has been used for centuries in engraving and batik techniques as well as in the casting of bronze hollow statues with the 'lost wax' or '*cire perdue*' method.

Thin straight candles are made by repeatedly dipping the wick in wax. In Europe, candle makers used pure beeswax to make candles for the church up until the mid-19th century. This is still practised in Ethiopia,

among other countries, although paraffin candles that are died yellow are becoming more common. Beeswax was seen as a symbol of virginity because of the worker bees that produced it.

In the food industry, beeswax is used as a polish and anti-adhesive for candy, such as liquorice and chewing gum. Liquorice pieces are coated with a thin layer of beeswax so that they don't stick to each other. Beeswax is used as an air-tight seal to preserve jams and fruits, and to cover honey that is separated from the comb through heating and then poured into a jar.

Beeswax also has applications in the sport world, such as in archery, and in horticulture, such as in the grafting of trees.

Cosmetic applications

The cosmetic industry uses beeswax as an emulsifier and binding agent in oils and fats because of the high amount of energy required to melt it and its melting trajectory. This makes these cosmetics hard when cold, and prevents them from melting too quickly in the sun like solid fats. Moreover, they react perfectly to human skin. Beeswax is therefore frequently added to creams, salves and lotions. Lipstick and mascara, which normally contain more than 30% beeswax, are both quantitatively and qualitatively important uses.

Beeswax is also used to remove hair by first pouring it over the skin in liquid form and then pulling it off once it has become solid.

9.4 Health uses

Beeswax does not contain any proteins, digestible fats or carbohydrates and is thus not really a foodstuff. But it can be an ingredient in foods. If you eat beeswax, for example as an ingredient in comb honey or candy, it is not digested but acts as a filler. As such it helps the food pass through the gastro-intestinal tract, but the beeswax itself is eventually excreted undigested.

The hardness and slow melting trajectory of beeswax make it an important addition to suppositories. Wax often has a lubricating and emulsifying effect. In pills and suppositories it functions as a carrier that slowly gives off the active substances. Other uses for beeswax are as coatings for pills and as dentistry aids. Beeswax is thus more often a carrier or binding agent for other medicines than a remedy itself. At the pharmacy and in pharmaceutical literature it is called *cera flava* (yellow purified wax) or *cera alba* (white, bleached wax).

Beeswax is used for rheumatic ailments, which require the transfer and retention of heat. In physical therapy and massage treatments pure beeswax is used as a compress on muscles and joints. It has a heat-regulating or balming effect, for example as a treatment for heel cracks.

Ear candles, which have no wick, are made of beeswax and are used in natural medicine. They are said to stimulate the blood and lymph circulation in the ears, throat, nose and sinuses and regulate the pressure in these areas. They also may stimulate the coordination of the brain hemispheres. Candles are also used as aids in rituals and in meditation.

Throughout history beeswax has also been used together with honey and propolis for embalming dead bodies.

9.5 Melting wax

Beeswax is extracted from various sources. The honeycomb in feral colonies can provide a lot of wax, approximately 1 kg per large bee nest. Old used honeycomb can also supply wax. Small pieces of comb can be collected and saved until the total amount is worth melting: these can be bits of comb from hives, frames and wax cappings that are removed before the honey is extracted from the comb. Wax from wax cappings is easy to extract and is often of high quality.

To get pure wax from the comb you have to separate the wax from various impurities. This can be done first of all by melting the wax out of the comb with the help of solar energy, hot water or steam. The wax is then cleaned. We will discuss below only a few techniques used in these processes. With the hot-water method, the residue after melting still contains 30% beeswax. For this reason it is more efficient to melt and press this residue a second time.

Sun

Wax can be melted by the sun through a slanted rectangular box covered with a (preferably double-paned) piece of glass or transparent plastic. A heat absorbing plate is placed on the bottom of the box (see figure 22).

Sunrays penetrate the glass and are absorbed by the plate. This plate transforms the sunrays into heat, which increases the temperature in the box. The wax, which is located on a grate in the box, melts and drips down the plate into a catch tray. This solar wax melter is very suitable for wax cappings and empty comb.

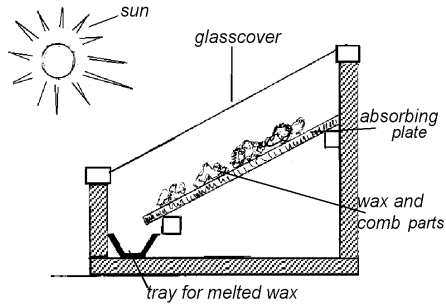

Figure 22: Solar wax melter

It is important that the sun shine as directly as possible onto the box to prevent the light from being reflected back by the glass. Place the box on a slant that corresponds to the position of the sun. The glass plate can be made of either single or double-paned glass or it can be made of transparent plastic. The heat-absorbing plate can be made of black stone or black-painted zinc. The catch tray is made of thin metal so that it is flexible enough for the hardened wax to be removed easily.

Hot water

In using hot water to melt wax, pieces of comb and wax cappings are bundled in a cotton or jute bag. The bag is submerged in a cooking pot filled with water and held under water with a press weight. The water is heated (see figure 23). When the temperature rises above 65 °C the wax begins to melt, filters throught the bag and floats to the surface. When no more wax floats to the surface, a little bit more wax can be extracted by pressing the bag with more weight. This method has to be repeated once or twice to remove the remaining wax, which can be as much as one third as much as was extracted in the first attempt.

The hot water wax melter is suitable for empty comb. Wax cappings can be melted directly in hot water without being bundled or pressed. Any honey still sticking to the cappings will be left behind in the water, which can be used later as a basis for feed.

The wax hardens in the water and can be removed in chunks to be processed further. It is important that the water not be allowed to boil. The bag cannot rest on the bottom of the pot, directly above the fire, because the temperature is too high there. The bag should therefore be placed on a wooden rack or bar.

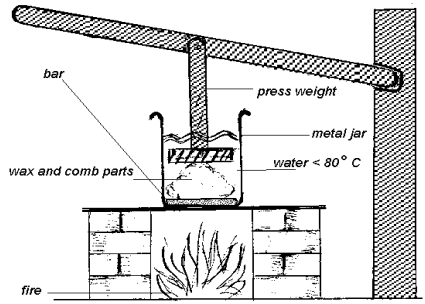

Figure 23: Hot water wax melter with press weight

Steam

Figure 24 shows a steam wax melter. This device produces steam from a separate boiling pot. The steam is guided with a valve to a perforated sieve or bag, that is attached in the wax melting chamber. The wax thus drips to the bottom and is tapped with a valve.

The steam master can process large amounts of comb efficiently and it is suitable for all sources of wax. But it is difficult to fabricate such a wax steamer on your own; which can be done with the sun and hot water wax melters.

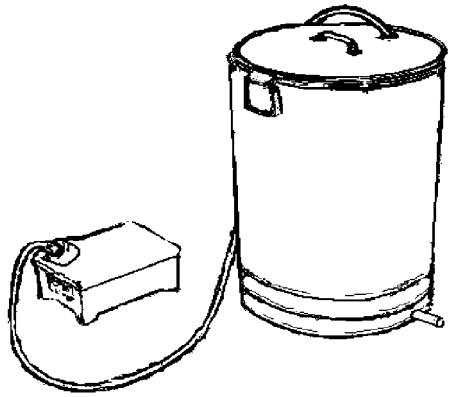

Figure 24: Steam wax melter connected to melting pot with valve

Another type of steam wax melter is heated from below e.g. by fire. Steam ascends from boiling water in a lower part, underneath a perforated holder full of comb or wax cappings. The wax in the upper part melts out of the comb and drips into a catch basin that can be taken out separately. The wax parts can be scraped from the bottom part once they have cooled.

Double-walled steam wax melters heat wax in a central body through a double wall that is surrounded by steam.

9.6 Processing and marketing

After melting, the wax still contains impurities, especially on the undersides of the wax sheets. These can be easily scraped off. The wax is then cleaned again in hot water or steam and poured into one or many smaller forms. These can be made of metal or even plastic, since the wax is not hotter than 70-80 °C. It is best to allow the form, with a warm closure, to cool off slowly in a draft-free area. Allow it to cool

for at least one day. The wax will now generally be free of organic impurities. The underside can be scraped again up to the pure wax.

For some uses the wax may have to be bleached, which can be done naturally or with chemicals. For beekeepers, only a natural method is recommended, preferably exposure to the sun. Grate the wax into fine pieces and spread them thinly over a mat, or make thin sheets by dipping a wet board in fluid wax and then scraping it off once the wax hardens.

If large amounts can be collected and processed, beeswax can be an attractive product for beekeepers in the tropics to trade and even export. Wax produced for the export market has to be cleaned as well as possible. After the cleaning process is completed, the wax can be poured into manageable blocks weighing 20 to 25 kg. To collect enough for a whole shipment, the wax production of many beekeepers can be combined. This can be done, for example, by a beekeepers' organisation or group.

Do not mix the wax with wax substitutes such as paraffin or oil residues. This diminishes its value and the buyer’s trust in the product.

10 Propolis

Propolis is made by bees out of tree gums, glues, waxes and resins. These can be found around the flower buds and are excreted as drops from the tree's bark if it is cut or cracked. The bees bring them on their hind legs, just like pollen, to the hive. They mix them with their own wax and saliva. This produces propolis.

Properties and composition

Propolis has its own specific properties: it is sticky, brown and fragrant. The bees use it to fill undesired holes or cracks in the walls of the hive and they polish their cells as protection for the future brood. Bees also use propolis to adjust the size of the opening into the hive. In a severe winter they will make it smaller. They also smear it on the inside of their hive and use it to stick loose parts of the hive together. This can be an advantage if the hive is moved. They use it to embalm undesired invaders, such as dead mice. Bees also mix a small amount of propolis with the wax used to cap the brood cells.

All honey bees produce propolis, but the substance is used differently by the Asian honey bee species and stingless bees. One colony will collect much more of the necessary ingredients than another, and the seasons can also play an important role. One can expect a production of 50 to 100 grams of propolis per colony per year.

The potent components of propolis are flavonoids, ferulic acid, resins, aromatic oils and carotenoids. Other ingredients include botanical waxes and beeswax (about 30%) and various other crude particles. The gums, resins and botanical waxes collected by the bees are always from a mixture of tree species, each of which has its own type of flavonoids. Propolis therefore varies with the vegetation and its geographic origin. The flavonoids from various origins all have a similar, but not identical, chemical formula. They are therefore used scientifically to identify the geographic and botanical source of the honey.

Propolis in moderate regions contains more than 50% active ingredients. In tropical regions propolis is dryer, harder, less sticky and less fragrant; it has less than 10% active ingredients. This is the case for the propolis of *Apis mellifera*. The propolis of stingless bee species is mixed with more beeswax and is therefore also called cerumen.

Propolis is not water soluble and does not allow air to get through. It is hard at low temperatures but flows out at temperatures above 35°C. The colour of propolis can vary from dark brown to reddish or yellow.

Health value

Characteristics

Propolis contains no proteins, carbohydrates or fats and therefore has no energy value. Since propolis is a mix of many substances, its effectiveness covers a broad spectrum. Due to its therapeutic qualities, it is used as a dietary supplement.

If a germ of a bacteria, mould, virus or yeast is encapsulated by propolis it will no longer be able to breath or take up water. The germ therefore shrinks and dies. This is an antibiotic effect and the reason propolis is often called a natural antibiotic. Human skin and bones can also be strengthened by propolis. Propolis enters the tissues through the skin and thus enhances the healing of broken bones and muscle ailments, such as a bursa infection. It is soothing to the skin and has a healing effect. When taken internally, propolis cleanses the blood, that is, it actively scavenges free radicals. Propolis also relieves pain when applied externally.

Some beekeepers are allergic to propolis; they can develop rashes in which the skin becomes red and scaly. If this occurs, avoid contact by wearing gloves.

Uses

Propolis is used for healing wounds, as a 'natural antibiotic' taken in addition to antibiotics and as a way to strengthen one's health and immune system. For external use, propolis is processed in nose drops, cough syrup, toothpaste, lotions, salves, creams, skin oils, shampoo and skin soap. Health care products that contain propolis are used for wounds, scars, infections, muscle ailments, eczema, psoriasis, warts, moulds and nail cuticles (fungi).

For internal use, propolis powder is often mixed with honey. To make tablets and capsules (figure 15), propolis has to first be purified because the botanical waxes and beeswax normally present make it difficult to absorb the propolis in the digestive system. For homeopathic uses, raw propolis is extracted with alcohol, or ethanol (see chapter 11), to make the so-called mother tincture. This is processed in nutrient supplements and health care products or diluted further for use as a tincture. Tincture does not dissolve in water, so the best way to take it is to drip it onto a crust of bread, a sugar cube or tablet. Drops of light tincture (10%) can be added to a glass of water. Chewing gum, capsules, tablets, cough syrup, and mouthwash are also available.

Further uses

In beekeeping

Beekeepers use propolis, sometimes mixed with wax, to make hives more attractive to swarms. Bees detect the smell of propolis from a great distance. A propolis wood stain can be made with ammonia or other alkaline solvent.

Traditional uses

Propolis has many different traditional uses. It can be used as an agent in a cast for splinting a broken leg and as a glue (with or without added wax), for example to repair broken earthenware. Propolis was once used as an ingredient in paints, but this method is not practised anymore and the old recipes are lost.

Propolis improves the quality of wood and thus used to be used primarily for polishing wooden musical instruments. Not only does it prevent moulding and rotting, but when mixed with beeswax it also tans or enhances wood and leather. It improves the sound of musical instruments, such as that made by the skin of a drum. African musicians press with their fingers onto a pellet of propolis mixed with beeswax on the skin of their drums to improve their tone.

Harvesting and processing

Various systems have been devised to collect propolis. One way to collect propolis is by using a net or a special propolis plate made of PVC, with variegated holes or slits 2 to 3 mm wide. The propolis plate is hung at the top of the hive on the frames or in the form of a frame hung between the other frames. Using propolis, the bees try to close them as quickly as possible to prevent draught. This is important for the thermoregulation of the brood nest.

After harvesting, the propolis trap is put in a cool place, or it can also be put in the freezer or in cold water. Once everything has become cold, the beekeeper can break the propolis off the plate in small chunks and if desired reuse the plate or net.

An easier and more common method is to scrape the propolis from old frames that have been removed from the hive. The propolis is found mostly on the top and the upper parts of the side slats. In top-bar hives, the propolis is scraped from the sides of the top slats. In the tropics it is also possible to hang calabashes or pots with a large bee entrance in the hive. The bees close the entire opening with propolis.

Processing

The propolis has to be cleaned. Bits of wax, paint chips, nails and other impurities have to be taken out. The concentration of pure propolis in the mixture in moderate regions has to be higher than 50%. Propolis can be ground, such as with an old coffee mill. The propolis should be as cold as possible, straight from a freezer for example, be-

cause it is then hard and not sticky. The best results are achieved by first putting the freezing cold propolis through a circular grater until it becomes a rough mixture and then grinding it.

The collected propolis can be stored in plastic buckets but not in cans. As propolis becomes warm, it flows out and eventually forms a hard block. It is then very difficult to get it out of a can. Adding a small amount (10%) of a different powder prevents it from coagulating. For this purpose you can use pollen, sugar, cassava or other type of flour, dextrin-maltose or magnesium stearate.

11 Bees

Origin and composition

On the outside bees have a chitin skin, legs and wings (figure 25). Their internal structure is made up of tissues and organs, such as glands and organs for endocrine (hormone) production. Bees' blood has a high concentration of short proteins. These are thus also found in their gland secretions.

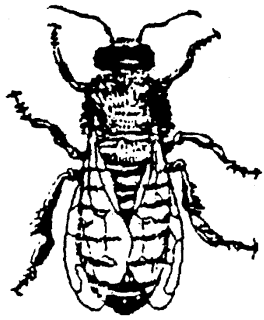

Figure 25: Worker honeybee

Health value and production

The health value of bees is recognised primarily in traditional medicine and homeopathy. The proteins in gland secretions have an antibiotic character and contain enzymes. An important gland is the venom gland, which contains the bee's venom. The digestive tract contains components of honey and pollen. All of these substances contribute to the therapeutic value of bee products.

Bees or parts of them are extracted with alcohol in natural medicine to make mother tincture. Homeopathic dilutions are made from this at a ratio of 1 part tincture to 9 parts alcohol (D_1), and again as 1 part to 9 (as D_2), etc. Diluted tincture is dripped onto a sugar cube and used for people who react strongly to a bee sting. Mother tincture and its dilutions are sold in the pharmacy as *Apis mellifica*.

Bee stingers are collected by cutting them off from the back of worker bees. They are then dried and ground, and mixed with sugar or a powder in the same ratio as noted above. This product, called *Apisinum*, is stronger than *Apis mellifica* and of course contains more bee venom.

12 Bee venom

Female bees, namely the worker bees or the queen, have a stinger on the end of their abdomen that they can extend. The queen usually only uses this to lays eggs, but she can also sting with it. Worker bees do not lay eggs usually, but only sting with it. A drop of fluid, the bee venom, hangs on the extended stinger. The stinger is also covered in barbs.

The bee venom is made in the venom gland and is stored in a venom sac at the base of the stinger. Young bees have little venom. Their venom sac is not filled until their 15th to 20th day, when it contains about 0.3 mg of liquid venom. The spring bees that are raised with a lot of pollen have the most and most effective venom.

Bee venom dissolves in water but not in oil. Alcohol is harmful to bee venom.

Composition

The effect of a bee sting

When a bee stings, it pumps liquid venom through its stinger and injects it into its victim. If a bee stings another bee or wasp, a lizard or a snake, it can retract its stinger. However, due to its barbs the stinger stays in the skin of a person or other mammal. The stinger continues to pump venom for 10 to 20 minutes, whereby only one third of the venom from the venom sac is released. Most of the venom is released from the venom sac in the first minute. A bee or other insect can die from one sting and a chicken, horse or donkey from a few stings, but a person can tolerate many more. This differs of course per person and depends on how often a person has been stung before.

Someone who is attacked by a colony can have hundreds of stingers in his or her skin. These can be counted in a hospital in order to get a

better idea of how many stings it takes to make different people lose consciousness or die. On the skin of a person, a white ring about 1 cm in diameter will develop around the spot that was stung and then a larger red spot will develop leading to swelling. The first sting a person receives can cause a number of unpleasant symptoms, such as a headache, a large swelling and itch. Most people build up resistance, but some become allergic after a number of stings.

Bee venom is poisonous in very small amounts and some people can be allergic to it, particularly when it is injected through stinging. Within an hour of being stung, an allergic person's blood pressure may drop so severely that renal shock causes the person to die. Blood flows to the tissues, resulting in a shortage of fluid in the organs, especially the kidneys. Vomiting and drinking water can help to reverse this, since the blood is then pulled to the digestive system and other organs. Caution and precautionary measures are therefore extremely important when dealing with bees and extracting and processing bee venom.

Potency

The composition of the venom varies somewhat between the individual colonies or races of one bee species, and it varies considerably between various species of honey bees. Components of bee venom include, among many other substances, mellitin (40-60%), phospholipase A (10-12%), apamine (2-3%), MCD-peptide (2%), histamine (1%). The effectiveness of *Apis cerana* venom is twice as high as that of *Apis mellifera*, and the venom of *Apis dorsata* is about the same strength as that of *Apis mellifera*. The venom of *Apis florea* is less potent. Stingless bees do not have a stinger nor venom, but some species can bite and release irritating substances into the victim's skin.

The active ingredients in the venom are dissolved in the fluid in the venom gland. The venom contains five components from the bees' blood fluid, such as proteins. Someone who is allergic to bee stings, is not only overly sensitive to the venom, but also to this blood fluid.

The equivalent of one bee sting contains about 0.1 mg of dry material. For use in medicines, nutrient supplements and health care products, the liquid venom is dried and purified. It is then concentrated by more than three times.
The LD_{50}, or lethal dose, is equivalent to the amount it would take for 50% of people to die (calculated based on animal tests and conversion of the results to the average body weight of humans). The LD_{50} of pure bee venom is 2.8 mg per kg of body weight. For someone who is 70 kg, this would amount to 0.2 grams or about 2,000 bee stings. The effect of the venom can be intensified, however, by panic and fear when a person is attacked by bees.

A beekeeper who is stung often has an increased amount of immunoglobin-E in his or her blood. This is an antibody in the blood proteins. He or she would be able to tolerate being stung 40 to 100 times, but this would lead to problems for anyone else. An allergic person can die from just one bee sting, but this extreme reaction, or anaphylaxis, can only occur the second time an allergic person is stung.

Health value

Properties

In non-allergic people, bee venom stimulates the blood supply to the tissues and the permeability of the cell membranes. Blood vessels are widened and the blood pressure drops. Bee venom also relaxes muscles and can reduce muscle pain by dissolving the lactic acid in the tissues. A small amount of bee venom is invigorating, but too much can cause heart palpitations and sleeplessness, comparable to the effect of too much coffee. The production of more or less urine can also result.

According to available statistics, beekeepers are less likely to contract a number of diseases because they are continuously injected with bee venom. These include rheumatic ailments, such as arthritis, and cancer.

There are many documented cases of disabled multiple sclerosis patients who were able to walk again after receiving many bee stings. Bee venom induces production of cortisone, a hormone of the adrenal cortex. This affects the nervous system, namely the conduction in the myelin sheath of nerves. Bee venom is said to have a healing effect on damage to this area.

Uses

In traditional medicine in Africa finely ground bees were used as a salve or tea to combat various diseases including rheumatism. People also had themselves stung on specific places on their body.

Bee venom is used in various ways: it is inhaled, eaten in the form of bee venom honey, injected in the form of injection fluid or applied on the skin as a salve. It is also applied by being stung, either on its own or in combination with electrotherapy, acupuncture or acupressure. This is very painful and it can be dangerous. In China and Japan only the removed stinger is used as a needle on acupuncture points. This is felt by the patient, but it is not painful.

A minimal amount of bee venom is naturally present in honey. It is of course also present in the mother tincture *Apis*, which is used in homeopathy and natural medicine.

Production and preparation

Bee venom is a poison and it can kill both humans and animals! For its collection, harvesting and processing special precautions are needed like gloves, a mouth-cap, etc. Do not inhale or consume bee venom in any way without carefully following prescriptions and calculations regarding the dosage!

Production

Bee venom is harvested using a bee venom collector. This is a glass plate over which metal wires are strung that are electrified with one large battery or a number of small batteries. When the bees touch the

wire they empty their venom sacs. After a number of bees have released their venom, the colony as a whole attacks the collector plate so that thousands of bees empty their venom sacs onto it.

The venom dries up on the glass plate and the jelly-like powder can then be scraped off. Protect your hands with gloves to ensure that you do not come in contact with the venom and cover your face with a mask to keep from inhaling it. The bee venom collector is placed in the hive for an hour and is then taken away. During and after use of the collector the hive and other colonies in the area can become very agitated. It is therefore best to do this in an isolated area.

Venom from one hive can only be harvested a few times per year, otherwise it would weaken the colony too much. Harvesting bee venom can also reduce the production of honey. A strong colony can supply approximately one gram of bee venom each time.

The venom can be added in raw form to products or it can first be purified. Strict rules apply to this process, which have to be adhered to. Beekeepers can, however, supply the raw venom to recognised and certified laboratories.

Preparation

To ensure exact concentrations, bee venom is added to honey in stages. For example, 0.1 gram of bee venom is added to 1 kg of honey and then 100 grams of this mixture is again added to 1 kg of honey. This gives a concentration of 0.01 mg of bee venom per gram of honey.

To give a good idea of how much venom is involved and to prevent an overdose, the added amount is given as a sting equivalent (0.1 mg) per tablespoon (10 grams) of honey. In salve, the added amount is given as a sting equivalent (0.1 mg) per gram. The dosage is never more than 2 sting equivalents (0.2 mg) per gram.

13 Quality and regulation

13.1 Quality aspects

The quality of honey is determined primarily while it is being produced in the hive. The beekeeper plays an important role in this, as well as the size of the hive and the timing of the harvest. The quality of the products can scarcely be improved once they have been removed from the hive, but their quality can be diminished during harvesting (figure 26) extraction, further processing and storage. Preservability can be improved during further processing but this also diminishes the quality in certain ways: the product loses its freshness and its therapeutic value is reduced.

Figure 26: Top-bar comb with fully sealed honey and bee bread below

The edible products (honey, pollen, bee bread, bee milk and bee brood) all contain biologically active ingredients that can lose some of their effectiveness. Beeswax, propolis and bee venom, on the other hand, retain their original qualities much better after extraction and further processing.

Quality control by the beekeeper

Beekeepers do not really need to perform complicated tests to determine the quality of their honey, because they know whether the honey is fresh and raw and whether the moisture content is good. They can see this by looking at how syrupy it is, for example. The beekeeper has also been present during production, harvesting, extraction and any other further processing and thus knows the products' production history. Simple measurement techniques are also available for use in the field. These are recommended, especially for larger producers and beekeepers' associations, because by measuring the result the beekeeper can improve the quality of his or her production methods. This will also allow him or her to market the products better. Some tools and methods that can be used for quality assurance are discussed below. See table 4 for quality features of honey. We do not list specific norms here because they are too complex for a simple notation. Details can be found in the lists provided by the European Union and the FAO/WHO (see the Internet sources in the appendix).

Table 4: Quality indicators of honey

Indicator/ composition	**Parameter**	**Measurement/ reference**
Freshness	Smell and taste	Olfactory
	HMF	Laboratory tests
	Glucose-oxidase	H_2O_2 test strips
	diastase	Laboratory tests
Moisture content	Density	Measuring jug + scale
	Refraction of light	Refractometer
Fermentation	Alcohol	Foaming
	Acetic acid	Taste
	Fermentation	Microscope
Enzymes	Diastase	Laboratory tests
	HMF	
Electric conduction	Differs per honey	
Glucose / fructose	Differs per honey	Titration
		Polarisation glass
Pollen types	Differs per honey	Microscope and pollen collection or pollen atlas
No residues	Maximum Residue Limit	Laboratory tests

13.2 International regulations

The *European Community Council Directive on Honey* (EU) established the Guideline 2001/110/EG on 20 December 2001 for the European Union. This was incorporated in the individual countries' regulations in 2003. The Food and Agriculture Organisation (FAO) and the World Health Organisation (WHO) of the United Nations set the Standard for Honey in the *Codex Alimentarius*, which also came into effect about the same time. The underlying reasons were to protect public health and promote fair trade.

Both regulations replaced earlier similar regulations, but unlike before they now both have about the same requirements. The only difference at the moment is that honey intended for the EU can only come from *Apis mellifera*, while the Codex allows sweet substances from other bee species, such as *Apis cerana* and *Apis dorsata*, to qualify as honey. In addition, the European Union has set requirements to limit residues of pesticides and antibiotics: residues from agricultural pesticides and some agents used to combat the *Varroa* mite cannot be present in honey (or they are permissible only in very small amounts). Residues of antibiotics, such as those used against foul brood disease, are not allowed.

The *Codex Alimentarius* defines honey as 'a sweet substance prepared by bees using flower nectar, secretions from living plant cells or secretions from plant-sap sucking insects'. The EU and the Codex both recognise the so-called baker's honey, which is a lower quality honey that has been heated too high or that is fermented.

The labelling of the honey (figure 27) has to fulfil the following requirements. The label has to show the name of the product (honey), the volume in grams, the name and address of the producer or importer, a batch number, and a 'best-before' date. For good honey this is usually 18 months. The label may also include the botanical origin (e.g. citrus honey) if the honey is monofloral and this is reflected in its colour, smell and taste and its physio-chemical and microscopic char-

acteristics. It may also indicate the geographic area or the origin of the vegetation if the product contains only one type of honey.

Export to EU countries

Honey exported to EU countries falls under the regulation called *European Community health conditions for trade and importation of honey*, which includes a so-called list of third countries. To be added to this list a country first has to submit an application to the EU in Brussels, after which inspections will take place. The exporting company also has to be certified to export honey. The importer will generally first ask for and analyse samples. The importer can of course also make its own additional demands.

Other countries are free to incorporate the requirements of the EU policy in their own regulations. Most countries have a honey standard and a beeswax standard and some countries also have a standard for beehives.

Figure 27: Labeled and unlabeled honey in glass jars

The Bureau of Standards certifies the quality of honey from beekeepers, traders and honey packers who sell their honey at local markets. This standard usually conforms to foreign regulations but it differs on certain points. The international quality control standards apply primarily to packaged honey that is sold in stores, whereas in many countries there is an A and a B quality. Low-quality honey may be sold locally as B quality or as honey from traditional hives.

For pollen, bee bread, royal jelly, propolis and bee venom there are usually no acknowledged standards. An analysis certificate is therefore provided by the Bureau of Standards to show to the customs officer if the product is to be exported.

Import by third countries

For certain animal products or for all products from and for beekeeping a quarantine regulation may be in effect to prevent the import of diseases. Some countries, such as Kenya and Trinidad and Tobago, do not allow the importation of bee products or used materials for beekeeping. For further information see section 14.5.

13.3 Moisture content of honey

The moisture content of good honey can vary from 14-19%. Higher moisture contents, up to 30%, are the result of premature harvesting or mixing with water or watery ingredients such as bee brood.

Table 5 shows how long honey with various moisture contents will stay good. These numbers give a reasonable indication for honey in all areas, but they are specifically intended for moderate climates.

Table 5: Honey moisture content and its effects (in moderate climates)

Moisture content	<17%	18%	19%	20%	>21%
Effects					
Crystallisation of high glucose honey …	in beehive	right after harvesting	within 3 months	within 6 months	only at the bottom
Fermentation expected within …	18 months	12 months	6 months	3 months	Right away
Quality	Excellent	Good	Good	Inferior	Inferior
Eligibility for export	Good	Good	Fair	Poor	Not eligible

Honey can be kept for a long time as long as the moisture content is lower than 18%. If the moisture content is higher the honey will eventually ferment. If the moisture level is very low, the honey will

crystallise sooner, depending in part on the source of nectar and the glucose and fructose content, as well as the presence of crystallisation kernels, but this process can be slowed down through heating and filtering.

Measuring the moisture content

The moisture content of honey can be measured with a hand-held refractometer made especially for honey (see figure 28). This can have three scales: breaking index, percentage of sugar and percentage of water. Some hand-held refractometers have only one scale, namely the percentage of water in honey. Its range of measurement is about 13-28% moisture.

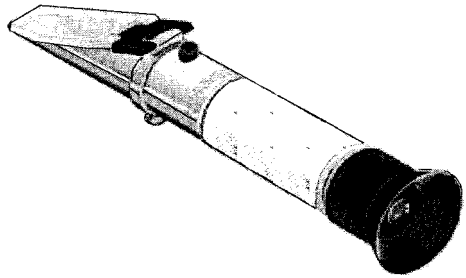

Figure 28: Hand-held refractometer

Refractometers are calibrated to measure at a temperature of 20 °C. To measure moisture at higher and lower temperatures a correction has to be calculated. For measurements above 20 °C : add 0,1% per °C to the read sugar percentage. For measurements below 20 °C: substract 0,1% per °C from the read measurement. Some refractometers have automatic temperature correction (ATC).

The moisture content of honey can also be measured by determining its density, that is, its weight per unit of volume. The precision of this measurement depends on the apparatus used and the amount. Honey has a density at 20 °C of 1.40 to 1.44 kg/ litre, depending on the moisture content.

13.4 Sugar content of honey

The sugar content of honey is almost the opposite of its moisture content: together they equal nearly 100%. Honey that contains 18% water thus contains 82% sugars, namely the simple sugars glucose (*dextrose*) and fructose (*laevulose).* These percentages depend on the honey's botanical origin: see table 6.

Table 6: Glucose and fructose contents of various honey types

Botanical origin	**% glucose**	**% fructose**
Rape (*Brassica napus*)	41	39
Lime (*Tilia* sp.)	34	41
Clover (*Trifolium repens*)	31	38
False acacia (*Robinia pseudoacacia*)	26	46

All honey types eventually convert into the solid state_when the glucose crystallises. The higher the glucose content, the faster the honey will crystallise, whereby fine and rough crystals develop and the honey becomes very hard. By stirring the honey it becomes creamy and a paste is formed rather than a hard block.

Addition of sugars

Honey can be tampered with by adding refined sugars, such as maltose and saccharase, or fruit syrup. In a simple laboratory the glucose content can be determined through titration. This method is difficult to carry out in the field however. Direct screening for glucose and fructose is also possible using simple tools to determine the rotation of the polarisation plane of light shining through the honey.

13.5 Enzymes in honey

Honey contains the enzymes diastase, invertase and glucose-oxidase. These enzymes are denaturated and damaged when heated. The norms for invertase and glucose-oxydase are only seldom applied.

Diastase-index

The enzyme diastase, also called amylase, breaks starch down into maltose. The diastase index is used as a parameter for the freshness and rawness of honey. If honey is heated for 24 hours at 50°C this enzyme will still be sufficiently intact to meet the requirements.

HMF content

Together with the moisture content, the HMF content is one of the most important quality criteria for honey. HMF is the abbreviation for hydroxymethylfurfural, a substance formed by one of the sugars in honey when it is heated or warmed for a long time. HMF is also found in large amounts in heated cane sugar and inverted sugar syrups. Presence of HMF can therefore also be an indication of tampering or mixing with sugars. The substance is not toxic for people, but it is for bees.

The norm

Both the EU and the *Codex Alimentarius* have determined that the HMF content in honey may not be higher than 40 mg/kg. Comb honey and freshly centrifuged honey have an HMF content of less than 5 mg/kg. If honey is stored, the HMF content increases by 1-2 mg/kg per month at a temperature of 20°C. After two years the maximum value of 40 mg/kg has usually been reached. In tropical conditions it will probably be reached even quicker. Honey from tropical areas is therefore permitted by law to have a maximum HMF content of 80 mg/kg as long as it is labelled as tropical honey.

Indirect measuring with the peroxide test

It is not easy to test for diastase and HMF in a small laboratory. A different method, the peroxide test, can be used instead if the necessary test strips are available. These strips cost about € 50 per pack and they have to be kept refrigerated. They are used to indirectly measure the activity of the glucose-oxydase enzyme instead of diastase. The principle is as follows: While the honey is being thickened by the bees, it is protected from fermentation by hydrogen peroxide, which is pro-

duced by enzymes in the glucose-oxidase group. The activity of this enzyme stops when the sugar content becomes higher than 80%. If the honey is diluted with water, the enzymes become active again. By measuring the hydrogen peroxide concentration one hour after diluting the honey with an equal amount of water this activity in the honey can be demonstrated on peroxide indicator sticks.

13.6 Microscopic analysis

Nectar in a flower contains a small amount of the flower's own pollen. This makes it possible to identify the source of the nectar in honey. The vegetation the bees flew around in and from which they also collected pollen loads is also represented to some extent by their pollen. Each plant's family, genus and species can thus be identified through microscopic analyses. It's not good to have too much pollen in honey, but filtration is not allowed.

Preparations on microscope slides can be made of the plants' pollen from their stamens, from pollen loads transported on the bees' legs, from bee bread out of the comb and from honey out of the comb or after extraction. Analysis of the pollen is used as a way to confirm the geographic and botanical origin of the honey. Monofloral honey should contain a certain percentage of the given nectar source. This is important for correct labelling. To carry out pollen research or analysis it is helpful to have some botanical knowledge.

It is easy to see when honey has fermented, because of the foam layer that develops on top and the smell of alcohol. Chains of yeast can also be seen if a drop of the honey is viewed under a microscope.

13.7 Colour, smell and taste of honey

We call the colour, smell, taste and viscosity of honey its organoleptic or sensory characteristics. The taste and smell of honey are primarily determined by the flowers and plants the honey is made from. But

these characteristics can be influenced by changes that take place in the comb, especially in combs that once held brood if honey is stored in them for a long time.

The norm

The law only stipulates that honey can vary in colour from almost colourless to dark brown and that it must not have a strange taste or smell. Some countries have requirements for the colour of honey to be sold. Colour charts are available on the market to help identify the colours, such as light white, medium white, dark white, light amber, amber and dark amber. The colour of crystallised honey is much lighter. The value placed on certain characteristics varies between countries but also between people.

13.8 Quality of other bee products

Pollen

Pollen (in the form of pollen loads) has to be dried within one day after harvesting and stored in a dry, dark place to retain its favourable characteristics. Nutritional composition and caloric value are given in grams per 100 grams of pollen (or a percentage) after drying. The moisture content decreases during drying from about 25% (fresh) to less than 12%. Other ingredients such as wax cappings and debris from the bottom of the hive should not be present. Pollen must always be dried to prevent the growth of moulds. Aphlatoxin, which is formed by some fungi, should not be detectable in the pollen.
Pollen that is collected from sprayed crops may contain pesticide residues. Other powdered ingredients, such as cassava flour, are also collected by the bees. The producer has to monitor the content of these foreign particles in the pollen.

Bee bread

Bee bread has to be dried within a few days after harvesting or stored in the freezer before being ground.

Table 7: Quality of other bee products

Product	Property / composition	Parameter	Measuring method
Pollen	Moisture content		Moisture meter
	No moulds		Microscope
Bee bread	Moisture content		Moisture meter
	No moulds		Microscope
Royal jelly	Moisture content		Moisture meter
	10-HDA (hydroxy-2-decenoid acid)		Laboratory tests
	No residues		Laboratory tests
Beeswax	Purity	Melting trajectory	Laboratory tests
	No residues	Sulphonamides	Laboratory tests
Propolis	Flavonoid content		Laboratory tests
	No residues		Laboratory tests
Bee venom	Purity		Laboratory tests
	Mellitin content		Laboratory tests

Royal jelly

Fresh royal jelly can be kept at room temperature for only a few days. It is therefore best to freeze it. One of the active and measurable nutrients in royal jelly is 10-HDA (hydroxy-2-decenoid acid), which accounts for 2-11% of its content. The 10-HDA content is indicated on an analysis certificate. Good royal jelly contains more than 5% 10-HDA. Royal jelly should also be free of residues such as antibiotics.

Fresh brood

Fresh brood can be kept for only one day and must therefore be immediately consumed, dried, salted, smoked or roasted. It can also be stored in the freezer or mixed with honey.

Beeswax

Beeswax should be melted at a relatively low temperature (< 80%). If the wax is overheated it will turn brown and its quality will deteriorate. Simple extraction methods are suitable to retain the quality of the wax. An important quality indicator for beeswax is purity. Beeswax mixed with paraffin, solid fat or oil is not good enough to be sold and

certainly not to be exported. The additives can be detected by measuring the melting trajectory of the product.

Propolis

Propolis scraped from the woodwork in the hive normally contains pieces of beeswax, bees or bee legs, hair, wood shavings and other additives or impurities. These have to be removed if the product is to be consumed right away. After this point, it doesn't matter very much for the quality of the propolis whether or not it is purified, for example through alcohol extraction.

Propolis from tropical regions has a low content of active ingredients. This can be less than 10%, whereas purified propolis from moderate climates can contain as much as 50% active ingredients. Other ingredients may include botanical waxes, beeswax and course substances such as wood fibres and hair from plant parts, sheep's wool or particles of paint or varnish. These stick to trees or other objects where sticky substances are collected by the bees.

Bee venom

Bee venom that is dried on a glass plate and then scraped off looks like a cream to grey-coloured gummy powder. The quality of the bee venom is determined among other things by its mellitin content. Good quality dried venom contains 40 to 60% of this compound.

Purified bee venom is listed in many volumes of the Pharmacopoeia as *Apium venenum*, but it is also used in apitherapy as an additive to foods or as a nutrient supplement. The status of this product is not clear in every country. In many countries bee venom can only be purified in certified laboratories.

Bee venom is poisonous in very small amounts and some people can be allergic to it. Caution and precautionary measures are therefore extremely important in the production and processing of bee venom.

14 Marketing

Honey, pollen, bee bread, brood, whole comb and royal jelly are nutritious primary products from the beehive. They can be eaten fresh or in a processed form.

- Honey is usually extracted fresh from the comb.
- Pollen is dried right after harvesting.
- Bee bread is peeled out of the comb and dried.
- Bee brood is eaten fresh or dried and made into food supplements.
- Whole comb is eaten fresh or made into various dishes.
- Royal jelly is eaten fresh or is preserved in a frozen or dried form.

Beeswax, propolis and bee venom are also primary products, but they are not edible as such. They can be part of edible products or processed into food supplements or therapeutic products. After harvesting (or extraction, in the case of beeswax), these products can be kept for longer periods without preservation. Quantities can be built up, collected from a number of beekeepers, and stored for several years. Most products are best marketed locally in small packages, while beeswax can also be exported in bulk.

The quality of products is determined at different stages in the value chain as shown in chapter 2 and in the table in appendix 2.

14.1 Primary products

Characteristics

The nutritious bee products have caloric value through their content of protein, fats and carbohydrates. They also contain vitamins and minerals as well as other ingredients, some of which have therapeutic value. Beeswax, propolis and bee venom have no caloric value and are low in minerals and vitamins and hence do not serve as a foodstuff or food supplement in a pure form except propolis. The bees themselves are another primary product, and they are used for the preparation of natural medicines.

Production

Most primary products are harvested from inside the hive, like honey, pollen, bee brood, whole comb, beeswax, royal jelly and propolis. Others, like pollen loads and bee venom, are collected from the bee colony by the beekeeper, with special tools like a pollen trap and a bee venom collector at the outside of the hive. Bees are collected from a beehive by the beekeeper or from a feral colony by a honey hunter.

14.2 Derived products

Primary bee products can be part of other products, added to other products or they can be manufactured into other products. These derived products fit in various categories: food, health food, food supplements, apitherapy, drugs and medicines, cosmetics, health-care products or products for industrial uses. Appendices 1 and 2 list primary products and derived products for internal and external use, respectively.

Pollination

Another product is pollination of seed and fruit plants, by setting a bee colony in or close to a plantation or crop. Normally pollination is the most important product of the beehive. The increase in fruit and seed yield is often many times greater than the honey production from the same field. As noted in chapter 3, the crop owner is the first beneficiary of this product of the bee colony. Therefore payment to the beekeeper can be arranged contractually. Pollination can be marketed but not exported. Trade in different species of pollinating insects, however, is increasing and breeding of special species thus presents an opportunity for beekeepers.

14.3 Local marketing

Quality

The key factors in marketing bee products are quality, continuity and sustainability. Demand for honey is usually high and therefore not a limiting factor for profitable marketing. Quality is the first require-

ment. If a product is good, a customer will be more likely to keep coming back and not buy it elsewhere, even at lower prices. The best conditions for high-quality production, harvesting, transport, storage, processing and packaging are described in chapters 2 - 12 for the respective products.

Generally, each product should be free of residues from organic or inorganic chemicals, like antibiotics, acaricides or insecticides, and free from foreign particles. To avoid such contamination, organic or biological beekeeping methods are preferred. Apart from the advantage of having no chemical residues and foreign substances, like sugar for example, certified organic products can be sold for a better price in the niche market for organic or bio-products. The world market with its ever-increasing demand for ecological products pays a better price for organic bee products.

Primary products

Honey, pollen, bee bread, brood, royal jelly, beeswax, propolis, bee venom and pollination are suitable for local marketing. Retail sale, as shown in figure 5, is always the best option as it gives the highest price. The demand is sometimes high compared to production. Wholesale marketing of small packages or semi-bulk to resellers or hotels is the next best option.

Because of low export prices, export is usually not a sound option for small-scale producers. With large-scale production that exceeds the local demand, however, surpluses can be traded in bulk or exported.

Local marketing of honey

Usually, a beekeeper or beekeepers' association produces different honey types. Light and dark-coloured honeys can best be separated at harvest time or be extracted separately. Monofloral honeys can be kept separate to obtain a variety of honeys.

Honey can be sold fluid, creamed, as comb honey, as chunk honey or as crushed honey (figure 29). Combined packages with three different honey types with contrasting colours are very attractive too. Glass or transparent plastic bottles are another option as the customer can recognise the colour from the outside. A glass bottle can be put into a basket and traditional decorations can be used on the label. Fresh royal jelly can be marketed as a pure product or mixed in honey for preservation.

Figure 29: Traditional way of selling crushed honey

Derived products

Marketing derived products is another way of diversifying. Adding derived bee products to honey adds value to them. For example, honey with royal jelly or honey mixed with pollen or propolis powder can fetch a better price than the two separate products. Products made with wax, honey, pollen, royal jelly, propolis and bee venom are all good for local marketing, particularly retail. Appendices 1 and 2 give a lot of suggestions and ideas.

14.4 Pricing

The price setting of a product is determined by demand, availability, quality, special character, package, local or foreign origin, function or use and all possible other factors. Demand for bee products is usually high. Local prices are similar all over the world, no matter the value of the currency. In the case of primary bee products it is useful to determine whether the product is mainly used as a food, food supplement or for therapeutic use, and whether it is accordingly sold in the food market, in dispensaries or in pharmacies. This varies largely for differ-

ent areas in the world and their traditional background. Products with therapeutic value are obviously higher in price than foodstuffs.

With the development of beekeeping methods and the introduction of exotic bee species resulting in increased production in some areas there is a trend to higher consumption of honey with a lighter colour and taste.
In countries where honey is used mainly as a medicine, the consumption of honey can be less than 10 grams per person per year; while in countries where it is mainly used as a food it can be 500 to more than 1,000 grams per person *per annum*. This is called *per capita* consumption.

Retail pricing

All over the world honey is sold directly from the producer to the customer. The producer is too proud of his or her product to allow others to sell it, and the customer trusts the product better if the producer is known personally. However, with the production of large quantities or the combined production of cooperatives, honey is sold like other products through resellers and shops. The large-scale packing of honey requires industrial methods like heating and cleaning, which turns it into a kind of manufactured product. This does not much affect the retail price. Therefore, small producers may prefer to sell the product raw, directly to customers or through resellers, with a high turnover, instead of taking the effort of advanced processing methods and selling the honey bottled in supermarkets with a much lower turnover (figure 30).

Wholesale pricing

The first reseller of packed honey may get a discount of 20% off the retail price. If there are two intermediate sellers, the first reseller usually buys larger quantities, and therefore has a higher discount, like 30 to 40% of the retail price. The buyer of bulk honey may have a discount of 50% off the retail price. In the case of one or more intermediate buyers or a processing and packing company, it may be up to 80% less than the retail price. The world market price of € 1.0 to 1.5 per kg

for honey exported in bulk fluctuates annually. It is usually low compared to the local prices. For example, around 2003 the price was more than € 3 per kg but in 2005 honey prices dropped dramatically to less than € 1 per kg on the world market. On the other hand, local wholesale brings in € and retail € 6 to 8 per kg. Therefore, export is rarely profitable for the small producer.

Advertising

Advertising the products means drawing the attention of wholesale traders, retail shops and customers or consumers to the special properties or quality of one's product. Why should they buy yours? Key issues are identity, diversity, taste, health value and quality, more than the price of the products. Information for the customers about the value of the product is a must. A vast range of marketing instruments and ideas for advertising exist, which can be applied specifically to bee products. See also Agrodok 26 *Marketing for small-scale producers*.

Figure 30: Honey repacking at wholesale market

Places to sell

Depending on the information collected locally you may decide to target a number of selling points. Resellers like mini-markets and pet-

rol stations with a good turnover can be chosen. In the case of supermarkets or hypermarkets you may have to offer your products on consignment with a minimum quantity of each different product. In this case you may start by offering just one product until it sells well and then expand the assortment. You further need to know the preferred sizes of packages, packing material and the frequency of buying. Excellent places to sell and create a sustainable market are organised honey shows.

14.5 Product standards and certification

As we have seen in section 13.2, in most countries a Bureau of Standards sets the requirements in a legal Honey Standard, Beeswax Standard and Standard for Beehives. The latter is usually not subject to control but meant to stimulate uniformity in view of exchangeability of hardware materials like top-bars, frames etc. A producer is free to construct a beehive according to his or her own design.

Certification

Standard certification

As described in section 13.2 an analysis certificate is important for the export market. It is also possible to get other certifications that coincide with different regulations, such as certification for organic production. The norm in this case is focused not on whether the honey contains residues but whether it has been produced in accordance with the requirements for organic production.

Organic certification

For trade in organic products, both the producer and the importer have to be specially certified. The most important requirements for organic production of bee products are:

- the environment has to be free of chemical pesticides and genetically modified crops;
- diseases may only be treated with allowable, natural agents;
- the bees can only be fed with their own honey;

➢ only organically produced artificial comb foundation may be used.

Organic certification is very costly, but these expenditures are generally compensated by the higher consumer price paid for organic products. However, it is only cost-effective for larger quantities.

Fair trade certification

With the creation of a fair trade certification, fair trade organisations want to limit the involvement of intermediaries in the trade of products from developing countries. By eliminating the middlemen, who often earn more from a product than the producers, the latter can get a better price for their products. The consumer price generally stays the same, or is slightly higher due to the high costs of the certification itself. But the intended objective is often achieved in many cases and this certification does indeed lead to a 'fair' trade.

Export

To be cost effective in exporting honey or beeswax, products which are commonly traded separately can be combined to fill up a shipping container. Such a container can hold about 70-, 200-, 205- or 210-litre drums of honey, containing about 300 kg each. Beeswax can be transported in blocks of 20 to 50 kg, up to 18 tons in one container. Surpluses have to be planned beforehand and set aside to prevent the honey and wax from being sold to others before it can be shipped, as the local demand is usually very high.

Another way to export honey products is through people who are travelling out of the country. When they visit relatives, they often carry original products from their country. This is an important niche market. An advantage is that standard regulations can be disregarded, because smaller quantities are not subject to quality control or customs duties.

Appendix 1: Use of bee products

A For internal use

Product	Diversification	Internal uses	Derived products	Added to other products
Raw honey	Fluid honey Creamed honey Jellied honey Comb honey Honey with comb Crushed honey	Home remedy Health food Ceremonial food Religious food Delicacy Aphrodisiac		Milk, Tea, Pan-cakes, Sweet/sour dishes Peanut butter Turkish delight Baklava Nougat
Heated honey			Mead Cough syrup Lozenges Confectionary	Energy drinks Alcoholic drinks Chocolate
Honey mixed with … (as paste)	Nuts and dried fruits	Delicacy		
Honey mixed with … (as paste)	Pollen Royal jelly Propolis Bee venom	Natural medicine		
Honey mixed with … (as paste)	Herbs, spices Flavouring Lemon juice Garlic	Natural medicine Home remedy		
Pollen	Fresh Dried Fermented	Health food Food supplement Natural medicine Aphrodisiac	Pollen tablets Pollen capsules	Honey
Bee bread	Fresh Dried	Health food Food supplement Natural medicine Aphrodisiac		
Royal jelly	Fresh Lyophilized	Health food Food supplement Natural medicine Aphrodisiac	Capsules Tablets	Honey Energy drinks
Bee brood	Worker brood Queen pupae Drone brood Fresh or dried	Health food Natural medicine Aphrodisiac	*Apilarnil* tablets *Apilarnil-prop*	Honey
Whole comb	Cooked	Food	Various dishes	

Product	Diversification	Internal uses	Derived products	Added to other products
Beeswax	Crude Refined Modified	Emulsifier Emollifier Binding agent Coating	Comb honey Honey with comb Pills	Pills Chewing gum
Propolis	Crude Crude powdered Extracted	Chewing chunk Lozenges	Mouthwash Capsules Tablets	Cough syrup Nose drops
Bee venom	Crude Refined	Food supplement Natural medicine	Capsules Tablets	Honey
Bee stingers	Powdered	Homoeopathic and natural medicine	*Apisinum*	Powder
Bees (dead)	Powdered Extracted	Homoeopathic and natural medicine	*Apis* (mother tincture)	Drops
Bees (alive)	Foraging	Pollination	Improved fruits and seeds	

B For external use

Product	Mixed with	External use	Derived products	Added to other products
Raw honey		Wound dressing Burns and sores Eczema		
Raw honey	Oils, fats and wax		Cream	
Honey		Wound dressing		Soap Face cream
Dried honey	Honey powder Honey jelly	Cosmetic		Shampoo Face mask
Honey flavour		Cosmetic Tobacco Tea		
Pollen	Extracted	Cosmetic		Cream
Bee bread				
Royal jelly	Fresh Lyophilised	Cosmetic Natural medicine		Cream
Beeswax	Crude (raw) Refined Modified	Natural medicine Moulding Resist technique Lost wax casting Binding agent Emulsifier Emollifier	Wax foundation Candles Wax figures Batik, etching Bronze figures Lipstick, mascara Face mask Ear candles	Polish Varnish Cream

Product	Mixed with	External use	Derived products	Added to other products
		Depilation Lubricant	Suppositories Warm beeswax	
Propolis	Crude Extracted	Natural medicine	Plaster Stain Polish Varnish Tuning (music instruments) Gel Cream Shampoo	Beeswax Alcoholic drinks Nose drops Lip balm
Bee venom	Bee stings Bee stinger Crude venom Purified venom	Bee venom Therapy (natural medicine)	*Apireven* (cream) Cream liniment, Ointment *Venex* (injection fluid) Inhalation	
Bees (dead)	Powdered	Natural medicine	Cream	
Bees (alive)	*Apis mellifera* *Apis cerana* *Apis laboriosa* *Apis dorsata* *Apis florae* Stingless bees	Pollination Indicator of air pollution Hobby beekeeping Research		Animal farm

Appendix 2: Value chain

Product	Production by the colony	Harvesting by the beekeeper	Extraction by the beekeeper	Processing and preservation
Pollination	Foraging bees in the field	Fruits or seeds from the crop		
Honey	Processing of collected nectar into honey and storage in the comb	Honey combs from inside the beehive	Draining, pressing or centrifugal extraction from the comb	Heat and filter; cream (optional)
Pollen	Foraging on nectar and pollen or pollen only	With pollen trap at entrance or hive bottom	Remove impurities	Dry right after harvesting or mix into honey
Bee bread	Pollen loads are stored in the comb and processed	Remove bee bread combs from queen-less part of the hive	Peel out of the comb	Dry right after harvesting
Bee brood	Eggs are laid by the queen and worker bees feed them	Remove brood combs from the hive	Remove from comb	Freeze, dry or mix into honey
Whole comb	Brood is produced in the comb	Remove brood combs from the hive	Cut brood comb in pieces	Eat fresh or prepare as dish
Royal jelly	Workers feed royal jelly to the queen larvae	Remove combs or frames with queen cups temporarily and extract royal jelly	Strain to remove larvae	Freeze, dry or mix into honey
Beeswax	Excreted from wax glands and built into combs	Remove from beehive and extract honey from comb	With solar wax extractor or melt in hot water or steam and separate the beeswax	Repeat the extraction with water or steam
Propolis	Collected from trees and mixed with beeswax	Scrape off the wood or use propolis collection frame	Remove foreign particles	Grind in coffee mill, mix into honey or make capsules; extract with alcohol
Bee venom	Kept by the worker bees in their venom sac; they sting intruders and release the venom	With electric bee venom collector at hive entrance	Scrape dried venom from glass of collector	Purify in laboratory or mix into honey or cream

Product	Production by the colony	Harvesting by the beekeeper	Extraction by the beekeeper	Processing and preservation
Bees (dead or alive)	A bee colony consists of bees and also breeds bees	Collect from the beehive or from a feral nest	Freeze to kill them or put them in alcohol	Drain and filter the bees out of the alcoholic mixture
Odour	The colony generates warm air with volatile agents	Open the hive and inhale the warm air flow	Screen off the hive top to avoid attack and inhale the warm air flow	

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Useful addresses

Organisation addresses

NECTAR
Netherlands Expertise Centre for (sub)Tropical Apicultural Resources (NECTAR) is the association of tropical beekeeping experts in the Netherlands. Members of NECTAR have practical, worldwide, working experience in beekeeping with different bee species and are able to advise on a wide range of topics in (sub)tropical beekeeping.
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Objectives:
- coordinate support to and centralise expertise on (sub)tropical beekeeping in the Netherlands
- answer questions and give advice on (sub)tropical beekeeping activities to interested parties
- establish a reference network on (sub)tropical beekeeping that is intended for professional use
- make expertise available on specific topics by organising seminars and publish the proceedings
- advise development organisations concerning: beekeeping projects
- emphasise the importance of socio-economic aspects and research in beekeeping development.

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Internet sources

www.beekeeping.com : international virtual beekeeping gallery with a vast range of internet references

www.fao.org : displays accessible publications and a range of pictures on beekeeping and honey.

European Community Directive on Honey (2001) :
www.apis.admin.ch/host/doc/pdfhoney//HoneyDirective2001.pdf

FAO Codex Alimentarius - Revised Standard Honey (2001) : **www.codexalimentarius.net/web/standard_list.do?lang=en** : find Standard 212 – Sugars and honey (adopted 1999, amended 2001)

EC health conditions for trade and importation of honey
www.apiculture.com/_menus_us/index.htm?home_info.htm&2

Harmonised methods of the International Honey Commission 2002
www.apis.admin.ch/host/doc/pdfhoney/IHCmethods_e.pdf

Honey Quality, Methods of Analysis and International Regulatory Standards: Review of the Work of International Honey Commission
www.apis.admin.ch/host/doc/pdfhoney/HonigkontrIntern_e.pdf

www.triticum.nl/english/home_fr1.html : information on apitherapy

Glossary

Table 8: Terminology of bee products

This glossary consists of common beekeeping terms and does not define terms that are the theme of a chapter or section.

Term	Section	explanation
anthocyanin	5, 6, 7	pink, red, blue and purple pigments in pollen and other plant parts
antibiotic activity	6, 10, 13, 14	killing, or inhibiting growth of micro-organisms such as yeasts, fungi, bacteria and viruses
aromatic or essential oils (flavour, fragrance oils)	7, 10	volatile (evaporating fully) oils from plants with aroma and bio-active properties
carotenoids	5, 6, 7, 10	yellow to red pigments in pollen; active against free radicals in human body; much valued in natural medicine
cross pollination	3	fertilise with pollen from another plant
density (specific density)	4; 9.2; 13.2; 13.3	mass per unit of volume, expressed as kg/dm^3; specific or typical density of honey is 1.40-1.44
decreasing season	2.2, 5, 7, 8	seasonal decrease in nectar flow
dioecious	3	plant species in which male and female flowers are found on different plants.
essential amino acids	6	structural units of proteins; essential means that the human body needs them but cannot synthesize them
flavonoids	5, 6, 7, 10, 13	group of pigment compounds present in resins, fruits and vegetables; predominant bio-active compound in propolis with anti-inflammatory, anti-allergic and antibiotic activity; active against free radicals
folic acid	6, 7	B-complex vitamin that is important for the functioning of the human nervous system
honeydew	4	extra-floral nectar or drops of sweet water on various plant parts
10-hydroxy-2-decenoid acid (10-HDA)	7; 13	major compound in royalisin: 10-HDA content is an indicator of royalisin quality; bio-active ingredient of royal jelly
hydroxymethyl furfural (HMF)	13.1; 13.5	substance formed by a sugar in honey that is heated or kept for a long time; indicator of freshness of honey and therefore HMF content is an important quality criterion
immune- and anti-oxidant system	6	system of specialised cells and organs that protects an organism from foreign biological agents

Term	Section	explanation
immunoglobulin E (IgE)	12	antibody in serum (blood fluid); beekeepers have relatively high levels in their blood as a result of bee stings
LD_{50} ('lethal dose, 50%')	12	dose of a substance administered to a population of defined test animals that kills half of them
palynology (melissopalynology)	5	study of pollens and other minuscule parts such as yeast and spores in honey or other bee products, to determine its origin
mellitin	12	major compound in bee venom; mellitin content is a measure for the quality of this bee product
migration	2, 3.4, 9.2	colonies of bees moving from one location to another in order to take advantage of several honey flows
monoecious	3	plant species in which male and female flowers are found on the same plant
monofloral honey	4	honey which originates predominantly from nectar of one plant species
mother tincture	10, 11, 12	extract in alcohol of a non-volatile substance, e.g. plant, animal, mineral; used in homeopathic medicine
multi- or polyfloral honey	4	honey which originates from nectar of several plant species
nectar flow; honey flow	2.2, 8	period during which plants produce nectar; honey flows thus determine bee seasons during which bees forage for nectar
nicotinic acid (niacin or vitamin B3)	6	assists in the functioning of human digestive system, skin and nerves. Also important for the conversion of food to energy
pantothenic acid	5, 6, 7	also called vitamin B_5; important in natural medicine as a substitute for cortisone
pigments	6	colour and staining compounds; bee products derive their colour and bio-activity partly from pigments
pollination	1, 3	transfer of pollen from male parts to female parts of flower, leading to fertilisation
pollination contract	3	contract between a farmer and a beekeeper for setting beehives near a crop for pollination purposes
pollination fee	3	payment by a farmer to a beekeeper for setting beehives near a crop for pollination purposes
royalisin	7	antibacterial protein found in royal jelly
seasonal management	2.2, 2.4	management method where bee colonies are managed by season, also anticipating the following season (natural: by swarming; management by beekeeper: moving of hives
self pollination	3	fertilise with pollen from the same plant
trace elements or micro-minerals	4, 5, 6, 7	micronutrients that are needed by all living organisms (including bees and humans) in minor quantities
trophallaxis	1	regurgitation of food by one animal for another
upgoing season	2.2	seasonal increase in nectar flow
wax cover (wax seal or capping)	4	wax cover on brood cells or cells ripe with honey