Quality and Standards of Pollen and Beeswax

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ABSTRACT

Bee gathered pollen is regarded as valuable special food and is used also in apitherapy. A production method, that ensures good pollen quality is described, as well as the main quality criteria, that can be included in a future standard. There are sensory, microbiological and physico-chemical quality criteria. Most important for the pollen quality is the water content. It is proposed, that the water content of bee pollen, sold on the market be less than 6 %. Such pollen remains stable after storage of 15 months, but only fresh pollen has an optimum biological activity. If the humidity of pollen is higher pollen can ferment upon storage. There are no official international pollen standards. The Swiss Food Manual has proposed a standard for the quality of pollen with composition quality criteria for the content of protein, lipid, carbohydrates, crude fibres, minerals and vitamins. The contamination by pesticides and heavy metals is also discussed.

Apart from its use for foundations in beekeeping, beeswax is used in cosmetics, pharmacy, candle making, art and for many other purposes. The production methods, which are very important for a good quality of beeswax are described in view of obtaining maximum quality. Beeswax is an extremely complex material, containing many different substances. It consists mainly of esters of higher fatty acids and alcohols. The main quality issues are authenticity of origin and contamination. The composition of beeswax and its sensory characteristics, as well as the contamination sources for beeswax are discussed. The main contamination source is acaricides used in beekeeping.

Keywords: beeswax, pollen, quality, standard, composition

POLLEN

Bee gathered pollen is regarded as valuable special food, having different health enhancing effects, and is also used in apitherapy. There are no official international pollen standards. A standard for the quality of pollen has been proposed for the Swiss Food Manual. A production method, that ensures the best pollen quality is described, as well as the main quality criteria, that can be included in a pollen standard.

HARVEST

The pollen is collected by special pollen traps. Fresh, bee collected pollen contains about 20-30 g water per 100 g. This high humidity is an ideal culture medium for micro-organisms like bacteria and yeast. For prevention of spoilage and for preservation of a maximum quality the pollen has to be harvested daily and

immediately placed in a freezer. After two days of storage in the freezer, the pest insects will be killed (Moosbeckhofer, Ulz 1996). After thawing pollen can be kept only for a few hours and should be further processed as soon as possible.

Bee bread (partly fermented pollen stored in combs, mixed with bee secretions and honey) is harvested from brood-free combs for optimum quality.

Fresh, purified pollen can be frozen and stored under nitrogen until consumption for preservation of optimal biological and nutritive properties (Percie du Sert 1998, 1999). Thus, oxidation after thawing will be avoided, preserving optimally the enzymatic activity, necessary for beneficial nutritional effects on the intestine flora (Percie du Sert, 1998).

DRYING, PURIFICATION AND STORAGE

The pollen is best dried in an electric oven, where humidity can continuously escape. The maximum temperature is 40°C and the drying time should be as short as possible in order to avoid losses of volatile compounds (Collin et al., 1995), until the humidity is 6 % or lower. Such pollen remains stable during storage of 15 months. Pollen, containing more than 6 % of water will ferment upon storage. Storage for one year or longer will reduce the free radical scavenging capacity of pollen (Campos et al., 2003).

Mostly the collected pollen pellets contain impurities which should be removed, most efficiently by air with specially constructed purifiers. The air should be free of dust and bacteria. Store pure pollen in a cool, dry place, in well closed glass or plastic recipients.

COMPOSITION

Carbohydrates are the principal components, the main part being insoluble polysaccharides, besides some starch, fructose, glucose and sucrose. Pollen contains proteins (mainly enzymes), amino acids, and is the principal protein source for bee nutrition. The fat is composed of different lipids, fatty acids, sterols and hydrocarbons and many different minor components: minerals, flavonoids and vitamins.

Table I Pollen quality criteria, after the Swiss Food Manual, 2003

Component	**Content Minimum - Maximum**
Main components	*g/100g*
Carbohydrates	13-55
Protein	10-40
Fat	1-10
Dietary fiber	0.3-20
Minor components	*mg/100g*
Minerals	500-3000
Vitamins	20-100
Flavonoid glycosides	40-3000

QUALITY CONTROL

From the hygienic point of view the microbiological safety is the main quality criterion. It is important to control the microbiological quality of pollen, especially the absence of pathogenic germs and fungi.

Destruction of bacteria by irradiation, ozone treatments (Yook et al. 1998) or chemical fumigants (Serra Bonvehi, Gomez, 1987) is not necessary and leads to toxic residues.

For specific use the composition of biological active components e.g. flavonoids (Campos et al. 1997, Serra-Bonvehi et al., 2001) or vitamin content should be evaluated.

Table II Quality control of pollen

Analysis	**Quality criteria**
Sensory examination	Typical odour and taste, no visible contaminants
Microscopic examination	Origin test (botanical, geographical)
Microbiological testing	Bacterial load should be within legal hygienic limits
Chemical Examination	Water content: maximum 6 g/100 g pollen
	Content of main ingredients, carbohydrates, fat and protein, if labelled accordingly:
Contamination	Pesticides, heavy metals

CONTAMINANTS

Pollen is the bee product, least influenced by contaminants from beekeeping. However, it can be polluted by air contaminants, e.g. by heavy metals and pesticides. Thus, for optimum quality pollen should be gathered in areas which are at least 3 km distant from contamination sources such as heavy traffic and pesticide-treated agricultural areas.

BEESWAX

Apart from its use for foundations in beekeeping, beeswax is used in cosmetics, pharmacy, candle making, art and for many other purposes. The production methods are very important for a good quality of beeswax. Beeswax is defined according to the European Pharmacopoeia. The main quality issues nowadays are adulteration and toxic contamination. In the present article the main issues and problems, regarding wax quality and standards are summarised.

PRODUCTION

Melting of combs is the production procedure of choice. Beeswax is processed in two steps: in a first step the wax is extracted and cleaned, in the second it is purified. Wax can be melted by: boiling old combs in water, by steam, by heat from electrical or solar power.

In order to produce high quality wax the following facts should be kept in mind:

- Heating at too high temperatures and for a too long time may damage the wax and darken its colour.
- Wax should not be heated in containers made of steel, aluminium, zinc or copper because these metals make the wax turn dark. Stainless steel is suitable.
- Combs containing fermented honey should not be melted in order to prevent wax off odour.
- Heat-resistant spores of *Paenibacillus larvae larvae* are not killed by normal boiling of wax. Only heating under pressure (1400 hPa) at 120°C for 30 minutes kills all spores (Machova, 1993).
- The formation of water-wax emulsions can occur, if hard water is used. Water with a low mineral content should be used if such problems arise.

After separating the pure wax from the comb debris and cooling down and the wax blocks are dried and stored in a dark and cool place. They can be stored in wrapping paper, placed on shelves or in containers made of stainless steel, glass or plastic, for best preservation of colour and aroma.

After melting and cleaning beeswax normally has a beautiful yellow colour. If it is dark for any reason (e.g. by the presence of metals or overheating) it can be brightened by chemical means, the simplest method is to boil wax with oxalic acid. For this purpose 1 kg of wax, 1 l of water, containing 2-3 g oxalic acid dihydrate or 1-1.5 ml concentrated sulphuric acid per litre water can be used (Stoeckli, 1997). The use of complexing agents which bind the metals has also been proposed (White 1967) but these chemicals are problematic from toxicological and ecological points of view.

ATTENTION: When using chemicals of the kind described above use protecting gloves and goggles, as well as protective clothing.

COMPOSITION

Beeswax is an extremely complex material containing over 300 different substances (Tulloch,1980). It consists mainly of esters of higher fatty acids and alcohols (see table). Apart from esters, beeswax contains small quantities of hydrocarbons, acids and other substances (see table). In addition, approx. 50 aroma components have been identified (Ferber and Nursten 1977). The wax produced by different species of *Apis mellifica* contain the same components but in a different proportion. The composition of the wax of different races of bees such as *Apis florea* and *Apis cerana* differs also qualitatively from that of the *Apis mellifica* wax (Brand and Sprenger, 1988).

Table III Composition of wax, after Tulloch 1980

Component	Quantitity %
Esters	67
Hydrocarbons	14
Free acids	12
Alcohols	1
others	6

QUALITY CONTROL

The sensory characteristics of beeswax are an important quality criteria. Beeswax is a natural product and no additives are permitted. Wax adulteration can be detected by different methods. Measuring of sensory and physico-chemical characteristics according to the Pharmacopoeia do not yield a safe adulteration proof. On the other hand adulteration can be detected very sensitively by gas chromatographical determination of wax components (Brüschweiler et al., 1989)

Also, beeswax should contain minimal amounts of contaminants, as it is used for in cosmetics, food and pharmaceutics. Unfortunately there are no maximum residue limits for contaminants. Thus, beekeepers should keep the use of synthetic chemicals at a minimum.

Table IV Quality criteria for beeswax after [1] Coggshall and Morse, 1984; Weber 1991; Pharmacopoe, 2002; [3]Brüschweiler et al. 1989; [4] Bogdanov et al., 2002.

PARAMETER	REQUIREMENTS
Sensory characteristics[1]	
Colour	Yellow to yellow-brown
Upon breakage	Fine-granular, blunt, not crystalline
Odour	Honey-like
Consistency	Should not stick upon cutting, Workable with fingers, should not stick to them. Upon chewing should not stick to teeth
Melting point	61-65 ^{o}C
Physical properties[2]	
Density	0.950-0.965
Refractive index (at 75^{o} C)	1.440-1.445
Acid value	18 – 23
Ester value	70 – 80
Saponification value	87-104
Peroxide value	At least 8
Test for paraffins	absent
Authenticity[3]	Typical gas chromatography pattern
Contamination[4]	Free of acaricide residues

CONTAMINANTS

Beeswax may contain fat-soluble pollutants. They originate either from the environment or from beekeeping. The main contaminants of beeswax are chemicals used in beekeeping while the contamination from the environment seems to be less important (Bogdanov et al., 2002). These are first of all lipophylic acaricides. Presently, acaricides are regularly used for Varroa control. Most synthetic acaricides are fat-soluble and accumulate therefore in wax (Bogdanov et al. 1998; Wallner 1999). The investigations show that the acaricide concentration in wax increases with increasing number of acaricide applications and decreases very slowly after the stop of acaricide use (Bogdanov et al. 1998). Other fat-soluble substances used in beekeeping, such as paradichlorbenezene, against wax moths and wood protectants can also contaminate beeswax (Wallner, 1991, Bogdanov et al. 2002).

PREVENTIVE MEASURES AGAINST CONTAMINATION

For best wax quality the use of synthetic chemicals in beekeeping should be kept minimal. The use of alternative varroa control prevents acaricide residues (Imdorf et al., 1996). Wax can be protected from wax moths by simple physical measures (Charriere et al. 1999): Keeping combs in the beehive; storage of combs in a cool bright place (5-15^0 C); at good air circulation; for more than 6 hours in a freezer; by heating combs for one hour at 50^0 C; or by using non-toxic chemicals against (sulphur, acetic or formic acid) or application of *Bacillus thuringiensis* for a successful wax moth control.

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