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Beeswax

Not Just Honey!

When you think of bees you think of honey, right? Did you know bees produce a variety of beneficial products other than honey? Read on for more information on these products.

Beeswax

The word wax describes a large variety of substances of plant and animal origin, as well as man-made products, which are mostly petroleum derivatives. Natural waxes are not single substances, but a mixture of various long-chain fatty acids and a variety of other constituents, depending on their origin. Wax from the honeybee has an extremely wide spectrum of useful applications and occupies a very special position among waxes.

For centuries, beeswax was appreciated as the best material for making candles. The wrappings of Egyptian mummies contained beeswax and beeswax has long found use in medicinal practices and in creams and lotions. Of all the primary bee products it has been, and remains, the most versatile and most widely used material.

Production of wax

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

Wax collection and processing

There are several ways of collecting beeswax. More commonly in frame hive beekeeping, wax is rendered from the capping removed during honey extraction. This produces a very high quality, light colored wax. Light colored broken combs provide the next quality of wax, whereas old black brood combs yield the smallest proportion and lowest quality of wax. Scrapings from sidewalls and the bottom board contain very high proportions of propolis and should not be mixed with better quality waxes. They can be used in swarm traps, for hive wood treatments, or in other preservatives for wood.

Different qualities of wax can be produced by separating new white honeycombs from darker ones or from those with portions of brood. Since whole combs are harvested and crushed or pressed, the proportion of wax per kilogram me of honey (10-15%) is much higher than with frame hive beekeeping, where the yield is only 1-2%. Before processing, all comb or wax pieces should be washed thoroughly to remove honey and other debris. Wax can be separated in solar wax melters, by boiling in water then filtering, or by using steam or boiling water and special presses.

Wax should never be heated above 85 C. If wax is heated directly (without water) or above 85 C

discolorations occurs. Direct exposure of wax to hot steam results in partial saponification.

Physical characteristics of beeswax

Virgin beeswax, immediately after being secreted, elaborated and formed into comb, is white. It becomes darker with use inside the hive as pollen, silk and larval debris are inadvertently incorporated. The melting point of beeswax is not constant since the composition varies slightly with its origin. Various pharmacopoeias give a range of 61-66C or more commonly, 62-65 C. Its relative density at 15 C is 0.958 – 0.970 g/cm3 and its electrical resistance ranges from 5×1012 to 20×1012 Ohm m. Its thermal conductivity coefficient is 2.5 x d10-3 Jcm/s°Ccm2. The saponification value of beeswax is 85-100.

Beeswax is an inert material with high plasticity at a relatively low temperature (around 32 C). Beeswax is also insoluble in water and resistant to many acids, but is soluble in most organic solvents such as ether, benzine, benzol, chloroform, and turpentine oil and after warming, in alcohol and fatty oils. Ghedda waxes from the Asian honeybee species are described as softer and more plastic. The melting point of wax from three Meliponid (stingless bee) species ranged between 64.6 and 66.5 C.

The composition of beeswax

Pure beeswax from Apis mellifera consists of at least 284 different compounds. Not all have been completely identified but over 111 are volatile. At least 48 compounds were found to contribute to the aroma of beeswax. Quantitatively, the major compounds are saturated and unsaturated monoesters, diesters, saturated and unsaturated hydrocarbons, free acids and hydroxy polyesters. There are 21 major compounds, each making up more than 1 % of the pure unfractionated wax. Together they account for 56% of the wax. The other 44% of diverse minor compounds probably account for beeswax's characteristic plasticity and low melting point (Tulloch, 1980).

Various plant growth-promoting substances, such as myricil alcohol, triacontanol, gibberellin GA3 and a rape oil steroid have been detected in and isolated from beeswax. They described at least 11 proteins in the freshly secreted wax scales of A. mellifera capensis worker bees and 13 proteins in the wax combs of A. m. scutellata and A. m. capensis.

Beeswax is considered safe for human consumption and has been approved as an ingredient in human food in the USA. It is inert, i.e. it does not interact with the human digestive system at all and passes through the body unaltered. However, substances dissolved or encapsulated in wax are slowly released. This property is exploited in many medicinal preparations.

The physiological effects of wax

Because it is inert, beeswax has no direct effect on humans or larger animals. However, its indirect effects can be very strong. If mixed with medicinal drugs or poisonous baits, wax preserves the active materials longer and releases them slowly. It can be used to create thin non-corrosive, non-allergenic protective films on many surfaces from metals to fruits and human skin. Thus it protects against external damage such as corrosion and abrasion as well as against moisture loss. It is a good electric insulator and, when saponified with borax, allows the mixture of very stable and smooth emulsions for cosmetics. Even in small concentrations it improves other formulations in the same way.

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

The uses of wax today

In the past, beeswax had a wide range of uses. Though in many cases beeswax can be replaced with cheaper, synthetic waxes, its very special characteristics, medicinal benefits, plasticity and aroma ensure its continuing use. The trend for more natural products in cosmetics may also increase its use. Presently, there is a scarcity of beeswax in industrialized countries, at least seasonally.

In beekeeping

In countries with frame hive beekeeping, the majority of locally produced beeswax is consumed by beekeepers for the making of wax foundations. Bees will not accept foundation made of synthetic

waxes such as paraffin wax. In order to reduce damage during hive management and honey extraction in centrifugal extractors, foundation sheets are reinforced with wire either by the beekeeper (frame per frame) or by the manufacturer who embeds the wire into the foundation sheet.

For candle making

Beeswax was the major raw material for candles until the development of cheaper petroleum products such as paraffin wax. Since beeswax has a higher melting point than most paraffin waxes (most of which melt between 480 and 68C) beeswax candles remain straight at higher ambient temperatures. If wick size is correctly proportioned with respect to the diameter of the candle, they are less likely to drip than candles made from other materials. Waxes with a melting point above 88C do not perform well during burning.

For metal castings and modeling

Because of its plasticity, beeswax is easily formed and carved. It maintains its shape well even over very long periods of time as proven by wax sculptures found in ancient Egyptian graves. Its relatively low melting point permits easy and complete removal from casting moulds. The hollow space left in these moulds can then be filled with molten metal. Modeling in wax, or ceroplasty is a well developed art used also for scientific models in important collections around the world.

In cosmetics

The unique characteristics of beeswax give a certain solidity to emulsified solutions, facilitate the formation of stable emulsions and increase the water holding capacity of ointments and creams.

Beeswax not only improves the appearance and consistency of creams and lotions but is also a preferred ingredient for lipsticks, because it contributes to sheen, consistency and colour stabilization. Other cosmetic applications are found in cold creams (8-12% beeswax content by weight), deodorants (up to 35 %), depilatories (hair removers, up to 50%), hair creams (5-10%), hair conditioners (1-3%), mascara (6-12%), rouge (10-15%), eye shadows (6-20%) and others.
Borax is the classic emulsifier, available in most pharmacies. Today's "high-chemistry" cosmetics use a large array of other synthetic emulsifiers. The chemical process on which the emulsification is based is the saponification of the acids in beeswax, i.e. the result is technically soap. The associated cleansing effect is exploited in so-called cleansing creams, which are very much like simple skin creams.

Food processing

Beeswax has been used in a variety of products and processes from packaging to processing and preservation. It has also been used as a separation agent in the confectionary industry and in cigarette filters. A common application for beeswax is the protection of containers against the effects of acids from fruit juices or honey. Steel drums for storage and shipment of honey have to be treated to prevent corrosion and dissolution of iron. The treatment involves expensive food grade paint, a plastic liner made from a food grade plastic film or a thin coat of beeswax.

Industrial technology

A patent describes a material for encapsulating electrical and electronic apparatus for use in high moisture or chemically active environinents.
Another patent describes the preparation of a material for embedding or electrically insulating circuits of high and ultra-high frequency. The mixture of 10-30% ceresin wax, 55-65 % beeswax and 15-25 % ethyl cellulose has a high melting point, is very hard at high temperatures, very strong when cold and can be remelted. A patent for an anti-corrosion rust inhibitor describes the incorporation of one or more

different waxes, including beeswax. Other effective coatings contain beeswax; one such is composed of 90% mineral jelly and 10% beeswax. In other formulations, beeswax may be used as a binder, particularly if lubricant characteristics are required or if mixtures have to be ingested. Beeswax has also been used to decrease viscosity and improve slip-casting properties when casting glass under pressure. For agricultural pest control, beeswax has been an ingredient of slow release pellets of pyrethrum pesticides.

Textiles

Textiles and papers can be waterproofed with various products containing beeswax. Emulsions containing beeswax for leather treatment.

Varnishes and polishes

A varnish made from dammar resin and beeswax to be used for paintings and for art restoration. If propolis is included, the suitability of the locally available material should be tested.

Printing

In the old art of etching or engraving, beeswax was used as a protective surface coating. Wax was applied to a heated metal plate. The excess drained off while the remaining wax solidified into a thin film through which the design was drawn. The application of concentrated nitric acid or a mixture (1:8 by volume) of concentrated hydrochloric and nitric acids for a few minutes etched away the exposed metal and left the engraved part ready for negative printing. Today, liquid asphalt is normally used instead. Beeswax was part of a liquid protective coating for plastic lithography plates and also for automobiles. Glass can be etched with hydrofluoric acid after protecting those areas with beeswax, which are to remain clear.

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

Medicine

As a coating for drugs or pills, beeswax facilitates ingestion but retards dissolution of the enclosed compounds until they reach the digestive tract. Beeswax can also be prepared as a mixture with the drug and then functions as a time-release mechanism, releasing the drug over a longer period of time. One such suppository base (a substance which allows slow release of another substance) has been developed on the basis of 5% beeswax, 5% palmitic acid and 90% of Nubon, a semi-synthetic hydrogenated vegetable oil. This was used initially with chloramphenicol. In another preparation, beeswax alone served as the carrier for the drug. On an experimental basis nalidixic acid suspended in beeswax remained longer in the blood of tested animals after oral application than when the acid was administered directly. With another drug, the antihistamine chlorpheniramine maleate, various mixtures of glyceryl monostearate, stearic acid, lactose and higher proportions of beeswax had been successfully tested as a base. Many more examples can be found in pharmaceutical and medical literature. Each drug application requires its own specific modifications of the rudimentary base formulation.

Chewing dark comb (but not the old, black brood comb) without honey, brood or beebread is known to be effective against colds. It was shown that even the wax fractions of propolis have antiviral activities. Older combs contain among many other things a good portion of propolis.

Beeswax can be used to fill capsules with equal amounts of drugs or other ingredients of various granule sizes. The granules of drugs are made adhesive by coating them with molten wax (about 90g molten wax for 3kg of granules), fat or glycerol, by spraying with liquid paraffin or by mixing them with powdered wax or fat and heating. After thorough mixing the hard capsules are pressed with their open end into an evenly spread layer of the mixture. This process can also be adapted to making pills with pollen. A mixture of equal parts melted beeswax and honey is recommended for treating cracked hooves of animals. It should be applied after the cracks have been thoroughly cleaned.

Others

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

The fact that plant growth stimulators have been isolated from beeswax favours it over synthetic substitutes for use as a grafting wax. An Indian study on A. cerana wax suggests that its triacontanol content may be an economical alternative source for this plant growth stimulator. Many other applications for beeswax, in cosmetics and pharmaceuticals may benefit also from the presence of minor components, which have not yet been thoroughly investigated.

Storage

Beeswax should only be stored in its rendered, clean form. Before rendering, it will quickly be attacked by wax moths, which are able to destroy large quantities of wax in short periods of time. Clean wax in large blocks is not attacked by wax moths.

Storage should be in cool dry places and never in the same room with any kind of pesticide. Wax will slowly crystallize over time and as a consequence become harder, but this process is reversible without any damage, just as with crystallized honey. Wax can be stored for very long periods of time without losing its major characteristics as items from Egyptian graves more than 2000 years old have shown. The added ingredients affect the storage requirements of products made with beeswax. Polishes containing only mineral or non-vegetable oils can last for years

Quality control

Beeswax, when sold in solid blocks should always both be clean and have the color and odor characteristics. Though adulteration is easy (usually with cheap paraffin waxes), its detection is only possible with chemical tests.

Quality standards for wax are set in most countries according to their pharmacopoeias. A few industries like the Japanese cosmetic industry but also the American Wax Importers and Refiners Association specify their own limits. These have to be obtained from the respective industry representations or trade publications. Such standards may vary considerably from country to country and manufacturer to manufacturer.

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

Determining the saponification cloud point is an officially accepted, sensitive method for determining adulteration. The method is limited to detecting quantities greater than 1 % of high melting (80-85 C) paraffin waxes, or more than 6% of low melting (50-55 C) paraffins. The test measures the amount of hydrocarbons, which saponify (turn into soap) in a specific amount of ethanol and give a clear solution. If the solution becomes clear at or below 65 C, the wax is probably unadulterated with paraffin. If it is adulterated, the solution will turn clear only at a higher temperature. The saponification cloud point is not suited to detect adulteration with carnauba wax, but gas liquid chromatography (GLC) can detect the 6% of free C32 alcohol (an alcohol molecule with 32 carbon atoms) contained in Carnauba wax. Beeswax only contains very little.

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

Pharmacopoeia list ester values from 66 to 82 but most beeswaxes range between 72 and 80. It was suggested that values of 70 to 80 are most typical. Acid values range from 16.8 to 24 and ratios between ester and acid values are fairly stable and narrow, mostly between 3 3 and 4.2. The ratios can change after excessive heating and can exceed 4.2 with heating to 100 C for only 24 hours, while the ester and acid values might remain within set limits. Ester and acid values in waxes from other Apis species may be significantly different.

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About Authors

Madhumathi SeshadriMadhumathi Seshadrib and Mrs. Lakshmi SivasubramaniamMrs. Lakshmi Sivasubramaniam
a Lecturer, Department of Pharmaceutical Analysis, College of Pharmacy,
SRM Institute of Science and Technology, Deemed University, Katangulathur, Chennai,
India.
b Department of Chemistry, Pharmaceutical Chemistry unit, Vellore

Institute of Technology, Vellore – 632 014, India.
* aAuthor for Correspondence: Lakshmi Sivasubramaniam, Lecturer,
Department of Pharmaceutical Analysis, College of Pharmacy, SRM Institute of
Science and Technology, Deemed University, Katangulathur, Chennai, India.