Bees make beeswax

Bees build their comb, the physical structure of their nest, from beeswax. Beeswax is produced by all species of honey bees, with each species having slightly different physical properties. In this Factsheet we are describing beeswax from Apis mellifera honey bees.

Young worker bees secrete wax from their eight abdominal wax glands, and can produce eight scales of wax every 12 hours. The size of the wax glands depends on the age of the worker bee: they are at their largest when the bee is 12-18 days old. Older worker bees can recover their ability to produce wax if the colony needs it.

About one million wax scales are needed to make one kilogram of wax – the amount needed for a small nest. Bees chew the wax, mixing it with salivary secretions, and when the wax is the right consistency, they use it for comb construction or to seal honey cells. Bees are stimulated to produce wax when there is a surplus of honey to be stored and a lack of honeycomb in which to store it. About eight kilograms of honey are consumed by bees to produce one kilogram of wax.

Newly produced wax is clear white, but after manipulation by the bees it soon turns pale yellow, as the wax takes up coloured compounds from pollen and propolis. If the wax is used only for honey storage it will retain its light colour. The presence of pollen, propolis and other substances cause it to darken. Brood comb darkens with use because of the gradual build-up of the larval cocoons spun inside the cells during pupation.

Beeswax provides the physical structure for the bees' nest.

Beeswax comb construction

The beeswax comb provides structure for the bees' nest and has multiple functions. It is most obviously used for storage of honey and pollen, for egg laying and raising brood. It forms an essential component of the honey bee colony. As well as providing the physical structure of the nest, the comb has important biological functions concerning the colony's communication, memory and immunity². The comb may in some ways be likened to the skeleton of a mammal – it is an indispensable part of the animal that is a honey bee colony superorganism.

Bees use their materials efficiently: the shape and dimensions of the cells in beeswax comb optimise the ratio of size to strength. The cells connecting the comb to the top of the nesting place can carry more than 1,300 times their weight. However, if the temperature inside the nest exceeds 35°C, the wax will begin to soften and melt; the combs will lose strength and may collapse. Understanding the properties of beeswax comb brings understanding of the great effort that bees make to maintain nest temperature. If a hive is situated without shade, bees must expend more effort to keep the nest cool.

On the left, old beeswax comb that is darkened from the cocoons of many generations of pupating larvae. Newer comb on the right.
Newly secreted wax scales – sometimes visible on the hive floor.

Comb functions and communications
Beeswax comb holds chemical memories for the bees: their family and nest odour, and the history of each cell's use. The cuticular wax covering bees' bodies shares compounds with the comb wax, resulting in the unique colony-specific identity that allows guard bees to distinguish strangers. Foragers leave temporary chemical markers on the areas of comb where they dance, informing other bees about the food source they have found. Propolis has antibacterial and antifungal properties, and is stored around the nest walls for use when necessary, and is used to line the rim of each brood nest cell. The bees use comb to communicate between themselves. The rims of cells of cavity-nesting bees are slightly thickened, creating a network of thicker wax, mixed with propolis, resting on thin cell walls. This is easily displaced by vibrations, transmitting signals along rows of cells. The bees use this mechanism to communicate in the darkness of the nest. The comb must be kept under 35°C or the wax will deform rather than transmit. Foragers vibrate the cell rims with their legs to alert other bees to their dancing to share information about the locations of nectar and pollen sources. Vibrations travel along the comb surface to free edges which can expand and contract: where the comb is attached to a frame or wall this vibration is restricted.

Quality
Beeswax is a very stable substance, resistant to natural oxidation and insoluble in water. It is a complex material with a characteristic odour mainly derived from the bees themselves and honey, pollen or propolis. Wax is solid at room temperature and becomes brittle below 18°C. It is soft and pliable around 35-40°C, and melts at 64.5°C. Beeswax can be any shade of yellow, orange and red through to brown. Colour does not affect the quality of the wax, unless it is dark from over-heating, when its value is much reduced. The finest beeswax is considered to be from wax cappings (the wax seal with which bees cover ripe honeycombs) because it is pure and white. The use of bleach (sulphuric acid or hydrogen peroxide) is unnecessary and damaging to natural wax. Contamination causes the main reduction in beeswax quality, primarily from residues of drugs introduced into honey bee colonies by beekeepers. Acaricides used to control mite predators are lipophilic and, because they are soluble in beeswax, they accumulate in it. Acaricide concentration in wax increases with the number of applications, but decreases very slowly after use has stopped, with a half-life of five years. Other chemicals, such as para-dichlorobenzene that is still used in some countries to control wax moth, and wood preservatives (used to paint hives) may also accumulate in wax. In industrialised countries, the widespread use of chemicals in beekeeping and subsequent contamination of beeswax, makes the beeswax harvested from disease-free colonies in Africa and other regions more precious and valuable. Pure beeswax has a good aroma, and when a wax block is broken, it shows a grainy surface. That is not the case if it has been adulterated with paraffin, fat or other oil. If pure beeswax is chewed, it does not stick to the teeth, and when rolled between fingers it softens but does not stick to the fingers. When paraffin wax is mixed with beeswax, the wax becomes more transparent and slightly greasy to the touch. Pure beeswax is relatively expensive, and so there has always been a tendency for people to try to falsify or dilute it with cheaper materials. Adulteration with paraffin wax depresses the melting point (64.5°C) and weakens the
material. It follows that using adulterated wax for foundation will weaken the comb and cause problems for the bees and the beekeeper.

**Wax production**
An important aspect of frame hive beekeeping is the reuse of empty combs after the extraction of honey, thus maximising honey production and minimising the production of wax. Therefore beekeeping using frame hives results in the harvesting of relatively little beeswax, and the production ratio of honey to beeswax production is approximately 75 : 1.

Beekeeping using local-style, fixed-comb hives, or movable-comb (top-bar) hives or Warré People's hives, results in greater yields of beeswax which is harvested along with honey. The delicate honeycombs are broken to enable the extraction of honey, and cannot be returned to the hive. The ratio of honey to beeswax production is about 10 : 1. For this reason, countries with fixed-comb beekeeping and honey hunting produce significant amounts of beeswax, which can provide a valuable crop for local sale or even export, if available in bulk. Beeswax rather than honey may be the most valuable product of beekeeping, although this value is not everywhere appreciated.

Beekeepers using frame hives require large quantities of beeswax for making foundation. Many beekeepers harvest, process and recycle their own beeswax, so this use is not evident in the trade statistics. In countries where frame hives are used, the major use of beeswax will be the beekeeping equipment sector manufacturing foundation. It is common practice for beekeepers to render the beeswax from their own bees into lumps of pure beeswax, and to exchange this for a smaller weight of ready-made sheets of foundation, made by commercial manufacturers of foundation.

Cappings are the best source of new beeswax, but scraps of brace or burr comb (bits of comb built by the bees as part of the nest structure), old honeycombs and old brood combs all yield a valuable beeswax harvest. The beekeeper with a just few hives can produce blocks of wax of excellent quality from these sources.

**Processing beeswax**
Whatever beeswax is to be used for, it has to be melted and filtered and turned into a solid wax block. Expensive equipment is available to achieve beeswax rendering, however most beekeepers achieve perfect results without spending money on equipment. There are a number of different ways to process beeswax, all of which involve a combination of melting the beeswax and filtering i. one way is to melt washed honeycomb in clean water and put the molten wax and water mix through a heavy cloth. The hot mixture may then be squeezed out of the bag using two sticks as shown. The receiving bucket can be made of tin, steel or enamel. Scraps of cocoon, wood, grass and other large particles are filtered out by this process. After squeezing the mixture, it is left to cool whereupon the wax and water separate to create a disc of wax floating on the water. This operation should be done in a clean environment and the hot mixture left for some hours for the wax to solidify. Any small impurities that passed though the cloth can be scraped off the bottom of the solid wax disc, and the filtering process repeated through finer cloth.

**References**