Elaboration and Harvest of Honey

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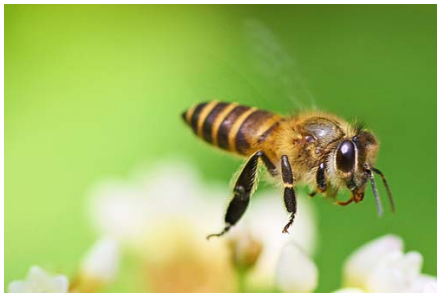
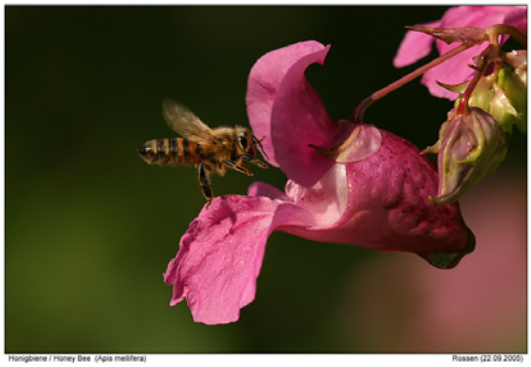


HONEY FORAGING

Honey bees gather their honey from two sources: nectar and honeydew. There are no official statistics as to the relative importance of these two honey sources. In some European countries like Greece, Switzerland, Turkey, Slovenia and Austria honeydew seems to be at least as important as nectar.

Nectar



The nectar is secreted in the flower nectary. It is a sugar solution of varying concentration, from 5 to 80 %. About 95 % of the dry substance are sugars, the rest are amino acids (ca. 0.05 %), minerals (0.02-0.45 %) and small amounts of organic acids, vitamins and aroma compounds. The value of a certain plant for bees is determined by its sugar value, measured by the sugar amount secreted by certain plants. The sugar value ranges widely, from 0.0005 to 8 mg [11]. The sugar composition is also typical for each plant species, the principal sugars being fructose, glucose and sucrose. Most plants have nectars consisting predominantly of fructose and glucose (rape, dandelion). *Fabiaceae* and *Labiateae* plants (acacia, clover, sage, lavendel) contain nectar containing mainly sucrose. The sugar concentration depends on different climatic factors as temperature, soil, humidity and season. When humidity is higher the nectar quantity is greater, but the sugar concentration is smaller. Temperature plays also a very important role. Optimum temperatures are 10 to 30 ^{o}C. Strong winds diminish nectar secretion. The nectar secretion depends also on the day time. Maximum secretion is at noon and in the early afternoon. Bees prefer nectar with higher sugar content, e.g. around 50 % and will not forage if it is below 5 %. Bees gather nectar for their energy needs. The greater the sugar value of a plant, the more it is visited by bees for foraging. Because of the different secretion factors it is not possible to foresee nectar production.

The botanical origin of nectar, used by bees to make honey can be determined by pollen analysis

Honeydew

Honeydew is the secretion product of plant-sucking insects (Hemiptera, mostly aphids). These insects pierce the foliage or other covering parts of the plant and feed on the sap. The ingested sap is passed through the insect's gut, and the surplus is excreted as droplets of honeydew, which are gathered by the bees. There are different sorts of honeydew producing insects. Most plants are trees, the coniferous trees yielding worldwide the highest amounts of honeydew. However, other plants, e.g. cotton, lucerne and sunflower can also provide honeydew.

Periphillus on Acer leaves

Cinara piceae on spruce

Honeydew is a solution with varying sugar concentration (5-60 %), containing mainly sucrose, besides higher sugars (oligosacharides). There are also smaller amounts of amino acids, proteins, minerals, acids and vitamins. In addition, honeydew contains cells of algae and fungi. Some insects produce high amounts of the trisaccharide melezitose which is only very slightly soluble in water, thus yielding honey which can crystallise in the combs.
Honeydew production is even less predictable than the nectar flow, as it depends on the build-up of plant sucking insects. By evaluating the populations of the plant-sucking insects before the honeydew flow, the potential for a possible honey flow can be estimated. However, the honeydew flow depends also on favourable weather conditions during the honey flow period. In countries like Germany, Switzerland, Austria and Slovenia, where honeydew honey is beloved by consumers, beekeepers optimise their honeydew honey crops by estimating the honeydew flow potential. This is done by counting the honeydew drops, falling on sheets, laid below the trees [8].

Honey yield

The honey yield of a bee colony depends on different factors: weather conditions, nectar- and honeydew flow and colony strength. Assuming that a bee fills its stomach with 50 mg, 100‘000 flights would be necessary to harvest 5 kg nectar or honeydew, or about 1-3 kg of honey. For this purpose each forager of an average bee colony of about 10'000 workers makes about 10 forage flights. The greater part of the harvested honey is used to cover the energy needs of the bee colony, the smaller part only remaining for the beekeeper to be harvested.

HONEY HARVEST

A. melifera bee foragers collect nectar and honeydew from plants and carry it by means of their honey sac and bring it to their colony. On their way they already add enzymes from their hypopharengeal glands and transfer it to the colony bees. These nurse bees pass it over to each other and finally fill the honey into the combs. During this process the bees fan with their wings, thus lowering honey’s humidity, when the water contents reaches 30-40 % the honey is filled into the combs. During that time the bees add additional enzymes to the honey. The invertase transforms sucrose into fructose and glucose, while glucose oxidase oxidates glucose to gluconic acid and hydrogen peroxide, the latter acting as an agent against bacterial spoilage. The warm colony temperature (35^{o}C) and more fanning lower further the honey humidity. Bees also suck out the honey and deposit it back into the combs, and by this process further lower the water content of the honey. This transformation process takes place in 1 to 3 days. Generally, when honey is ripe, with a humidity of less than 20 %, the bees cap the combs, preventing absorption of moisture by honey. Only rarely, under very humid or tropical conditions can honey with more than 20 % be capped by bees. The aim of the beekeeper is to harvest honey with less than 18 % humidity.
The water content is of utmost importance for the quality and storage capacity of honey. It depends on many different factors such as humidity, temperature, colony strength, hive type and intensity of

honey flow. Some unifloral honeys, like sunflower, heather [13] and strawberry tree [5] tend to have a higher water content than others. The beekeeper can estimate honey ripeness by a simple test: a honey comb with open brood is punched by fist – if the honey does not splash out, the honey is ready for harvest. A more exact method is to measure the honey content with a hand refractometer.

Measuring of honey humidity by a hand refractometer

The hand refractometer is a simple and cheap instrument for the estimation of honey humidity. The hand refractometer should be calibrated (a calibrations liquid is generally provided by the manufacturer). A completely liquefied honey should only be used, as honey crystals can scratch the refractometer prism. The refractometer should be well cleaned after use.

Honey humidity can be lowered by passing warm air over the combs, mostly by placing them in special warm rooms, where the humidity of the rooms should be kept low with a dehumidifier. [4, 9, 12], preferably below 18 % [12]. This technique is close to what the bees are doing when dehumidifying their honey in the hive. Indeed, dehumidification leading to a loss of honey components is not allowed according to the Codex Alimentarius and other honey standards, it states than "no honey constituents may be removed from honey except where it is unavoidable in the removal of foreign inorganic or organic matter". Industrial removal of water from honey will lead to a loss of honey aroma.

Good apicultural praxis for harvesting honey with optimal quality

- Use of only prescribed bee drugs
- No use of antibiotics, chemical drugs for the control of the wax moth or chemical repellants
- No feeding of sugar until at least 1 month before the honey flow
- No use of excessive smoke
- No harvesting of brood combs or honey combs containing brood
- Harvest when most of the combs are capped
- Honey water content is as low as possible: lower than 20 %, if possible, lower than 18 %
- Place for honey centrifugation is clean
- Fresh and clean water is present
- All instruments, which are in contact with the honey are clean
- Mesh size of honey sieves not greater than 0.2 mm
- Honey is stored in tanks for several days for an optimal separation of wax, foreign particles and foam before filling it into containers or jars
- Storage of honey in the dark in air-tight containers and jars, safe from humidity and foreign odours at temperatures below 20 ^{o}C

Uncapping and centrifugation

When most of the honey combs are capped, they can be taken out for harvesting.
Use a water sprayer for keeping out bees instead of smoke for best honey quality.

The combs should have a temperature of about 30^0 before extraction. Today honey is harvested mostly by centrifugation, except in most countries of Africa, where most of the honey is pressed out of the combs. The honey is cleaned by passing it through filters, generally with a mesh size not greater than 0.2 mm, in order that pollen are not filtered. In some countries filters with a small mesh size is used to filter off honey, the honey containing no more pollen. According to the Codex Alimentarius and the EU honey standards such honey should be labelled „filtered“ and cannot be labelled for a specific geographic and botanical origin.

Decapping and centrifugation of the combs, followed by a first filtration

Filling and storage

The filtered honey is poured in a tank, equipped with a filter. The tank is ideally kept at temperature of about 30^0 C and conditioned for several days, allowing the foam and small wax particles to diffuse up to the surface. The clear honey is best filled into jars for final consummation. In other cases honey will be filled in larger storage containers.

Honey bulk recipients




Storage containers should be made out of aluminium, stainless steel or plastic material. Corrosive metal containers should be coated with appropriate coatings, resistant to acidity.
Honey is offered in a great variety of jars. Glass is used mostly, but other materials, e.g. plastic, earthenware can be also used, provided that they are resistant to the action of honey. Containers and jars should be closed hermetically to exclude spoilage by humidity and foreign odours. Optimum storage temperature is 10-16° C, the relative humidity of the storage rooms should be less than 65 %. Honey quality decreases with increasing temperature: the hydroxymethylfurfural (HMF) content increases, while the enzyme activity decreases (see below). Prolonged storage at 50°C results in a decrease of aroma compounds [19]. Upon prolonged storage the colour of honey becomes darker due to building of Maillard products[6, 17].

Effects of storage temperature on honey HMF, diastase and invertase [18]

Storage temperature °C	Storage time to build 40 mg HMF /kg	Half-life* diastase	Half-life invertase
10	10-20 y	35 y	26 y
20	2 - 4 y	4 y	2 y
30	0,5 - 1 y	200 d	83 d
40	1 - 2 m	31 d	9,6 d
50	5 - 10 d	5,4 d	1,3 d
60	1 - 2 d	1 d	4,7 h
70	6 - 20 h	5,3 h	47 min

half-life: time, necessary for a 50 % decrease of the enzyme activity

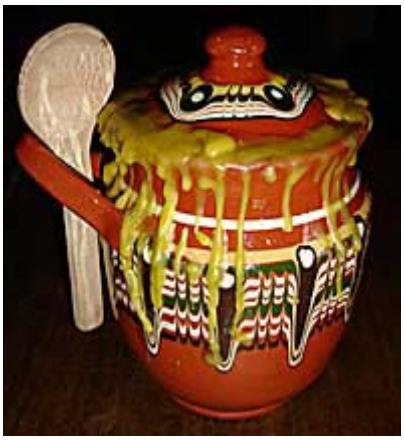
Storage in honey jars and pots

Honey quality is preserved best if it is directly filled in jars. Glass is the best material, due to its neutrality. Transparent glass has the advantage that the honey can be visualized. On the other hand, colour and the antibacterial activity can diminish upon storage. Amber glass jars are thus optimal.
Jars and pots should be closed hermetically to exclude spoilage by humidity and foreign odours. Food quality plastic material and jar pots are also possible, if they fulfil the quality criteria. Especially no foreign material should diffuse into the honey.

The longer the storage and the higher the temperature, the more rapid is the darkening of honey.
The same rape honey was stored under different conditions:
Left: at ambient temperature in the light. middle: in the dark at ambient temperature (20-25°); right: in the dark at 15° C.

Further reading: [1, 1-3, 7, 8, 10, 10, 11, 14-16]

Different honey pots (photos courtesy Gilles Ratia, except Nr. 3, 7, 8, 9: courtesy E.M. Spolders)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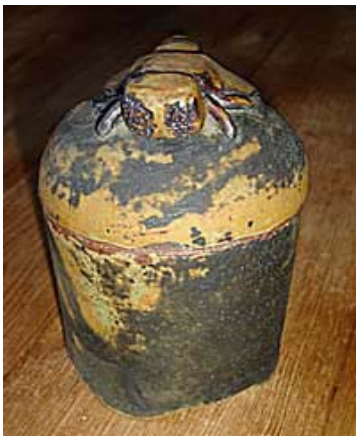
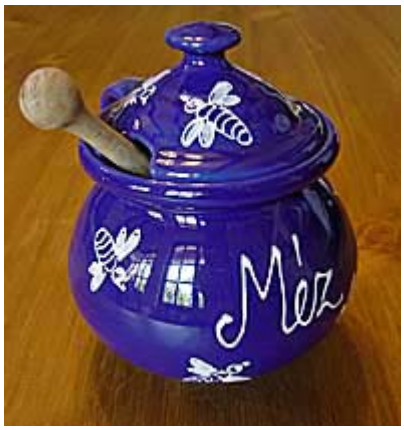
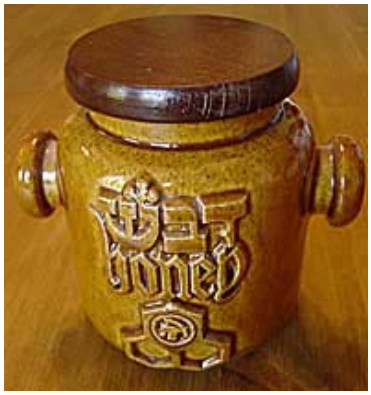

Greece



Hungary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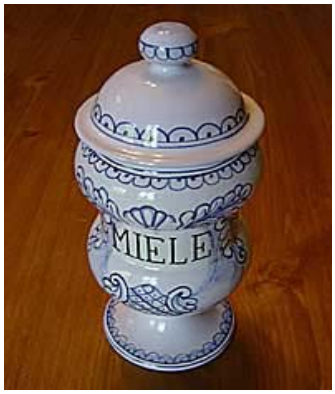
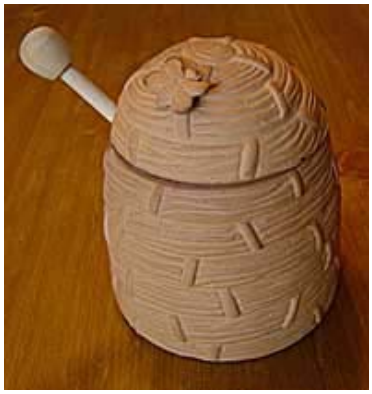
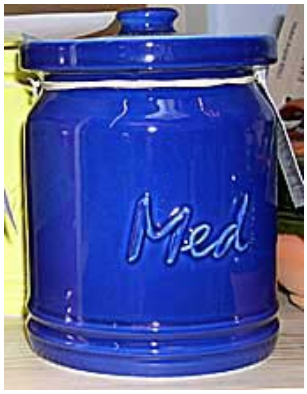
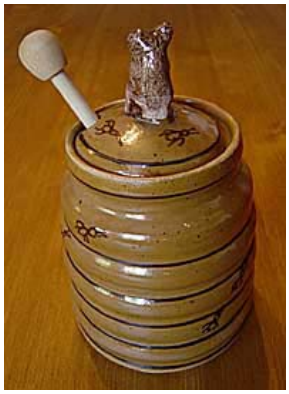


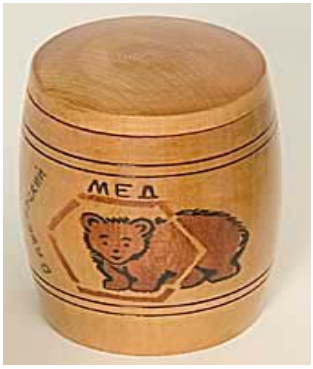
Italy


Japan

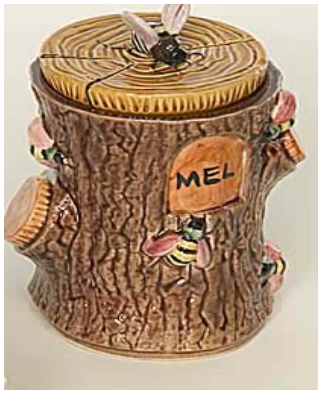


Poland


Romania

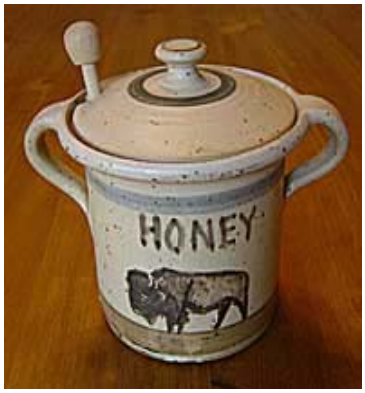


Russia



Spain


Uganda



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