Honey Production

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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. Although there are no official figures concerning the importance of these two honey sources it seems that nectar is the more important honey source world wide. Only 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 sugar solution of varying concentration: form 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 sucrose, 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 noon and early afternoon. Bees prefer nectar with higher sugar content, e.g. around 50 % and will not forage if it is below 5 %.
The nectar production depends on the climate and on the environmental conditions like humidity, temperature, day-time and soil characteristics. Therefore it is not possible to foresee nectar production. Bees gather nectar for their energy needs. The greater the sugar value of a plant, the more it is visited by bees for foraging.
The origin of nectar, used by bees to make honey can be determined by melissopalynology.

Honeydew

Honeydew is the secretion product of plant-sucking insects (Hemiptera). 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: coccids, lachnids, aphids. Most plants are trees, the coniferous trees yielding 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, however there are are not specific for the honeydew origin. 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 and Austria, 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 drops, falling on sheets, laid below the trees, producing honey flow [8].

Honey Yield

The honey yield of a bee colony depends on different factors: Weather conditions, nectar- and honeydew flow and on the colony strength. Assuming that a bee fills its stomach with 50 mg of 100‘000 flights would be necessary to harvest 5 kg nectar or honeydew, or about 1-4 kg of honey. For that purpose each forager of an average bee colony of about 10'000 workers make 10 forage flights. The greater part of that harvest is used to cover the energy needs of the bee colony, the smaller part only remaining for the beekeeper.

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., and 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 aginst bacterial spoilage. The warm colony temperature (35^{o} C), further fanning lowers 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 the ripe honey has a humidity lower than 20 % the bees cap the combs, thus preventing an absorption of moisture by the ripe 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: 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 the honey ripens by a simple test: a honey comb with open brood is punched by fist – if the honey does not splash, then 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 58 % [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 hony 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 inroganic or organic matter”.

Good apicultural praxis for harvesting honey with optimal quality

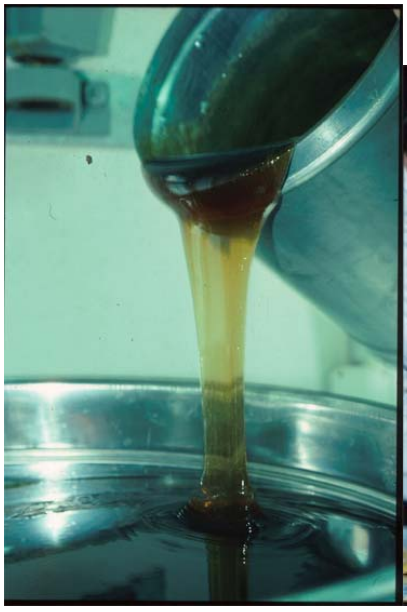
- Use of only prescribed bee drugs,
- No no use of antibiotics, chemical drugs for the control of the wax moth or chemical repellants
- No feeding of sugar until at least 1 month before the honey flow
- No use of excessive smoke
- No harvesting of brood combs or honey combs containing brood
- Harvest 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

HONEY PROCESSING

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.

Small scale extraction of honey by centrifugation
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 some countries filters with a small mesh size is used to filter off honey. 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.

Filling and Storage




The filtered honey is placed in a tank, which is kept at temperature of about 30^0. There the honey is conditioned for several days, which allows 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.

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 resistent to the action of honey. Containers and jars should be closed hermetically to exclude spoilage by humidity and foreign odours.

Honey can be stored for longer period of time, if stored under optimum conditions. Honey is very hygroscopic and should be thus stored in airtight containers to prevent damage due to odours and humidity. Optimum temperature is 10-16°. The relative humidity of the storage rooms should be less than 65 %. Honey quality decreases with increasing temperature: the 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 ^oC	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

The same rape honey was stored under different conditions: right: in the dark at 15°; middle: in the dark at ambient temperature (20-25°); right: at ambient tmeperature in the light.

The longer the storage in the light and the higher the temperature, the more rapid is the darkening of honey.

Further reading: [1-3, 7, 8, 10, 11, 14 15, 16]

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