DLG Expert report 5/2012

Sensory Analysis of Honey

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Per capita consumption of honey is approx. 1 kg per year in Germany, 1.3 kg in Austria and 1.2 kg in Switzerland. 63% of Germans, more in the east than in the west, state that they eat honey regularly. However, the performance of honey bees extends well beyond the production of honey. Worldwide about 80% of all blossoms are pollinated by insects, and the honey bee accounts for 85% of these. Above all fruit-growing and beekeeping are closely linked.

This DLG Expert Report looks at the special features in sensory analysis of honey. In order to understand these better, the making of honey and its composition are also explored.

1. The making of honey

Honey is a product made by honey bees (Apis Mellifera) from flower nectar or honeydew. The production of honey is a multi-phase process and strictly speaking begins with the photosynthesis of the plants, in which sugar is produced from water and CO_2 with the aid of chlorophyll and sunlight. The sugar is distributed in the plant through sieve tube elements (phloem).

Blossom honey

Flowering plants eliminate the sugary nectar from their sap glands in order to attract animals, so that these can carry the pollen to other plants for the purpose of reproduction. Most of the blossom honeys are mixed blossom honeys. If a honey originates from the nectar of chiefly one plant species, it can be sold as a single-variety or monofloral honey. Depending on the “harvesting period”, distinctions are made between:

- early forages: e.g. oilseed rape, dandelion
- early summer forage: e.g. robinia, raspberry
- summer forages: e.g. lime, sweet chestnut
- late forage: e.g. buckwheat.

However, nectar is only one possible way in which the bees reach the sugar.

Honeydew honey (forest honey)

The other way is when aphids, scale insects, psocids or cicadas suck in the sieve tube sap of the plants and pressure filter this in the filter gut. Amino acids and a part of the sugar and water then reach the mid-gut of the insect and are resorbed. The surplus filtered sugar water does not pass through the digestive tract, however, and is excreted as honeydew. The honey bees then collect this honeydew.

Whether plant nectar or honeydew, the bee carries both in its honey vesicle to the beehive where they are mixed with the bees’ saliva – and thus with enzymes. This brings about a change in the sugar spectrum. Water is withdrawn from the honey, which is stored in honeycombs. At a water content of less than 20%, the full honeycombs are closed. The honey can be extracted, i.e. harvested, by centrifuging.

2. Ingredients of the honey and their sensory significance

Honey is a supersaturated sugar solution, but also contains many secondary substances. The ingredients of the honey have an effect on the sensory properties.

- **Colour:** The colour of the honey correlates with its content of phenolic compounds, pollen and mineral substances. It changes in the course of storage.
- **Taste:** The carbohydrate content of honey is 80 to 85%. The greater part of this is accounted for by the two monosaccharides fructose (27 to 44%) and glucose (22 to 40%). However, the disaccharides maltose (3 to 16%) and sucrose (0 to 8%) or the trisaccharide melicitose also occur in honey. 20 different carbohydrates have been found in honey. In blossom honeys the sugar ratio is typical for the relevant plant species, with the emphasis on fructose and glucose, but in different ratios. As fructose tastes sweeter than glucose, not every honey is equally sweet. The composition of honeydew honey is different. Honeydew contains approx. 25 to 55 % sucrose and slight quantities of melicitose, a trisaccharide made from one fructose and two glucose molecules.
  The acids contained in the honey – gluconic acid, formic acid, oxalic acid, acetic acid, tartaric acid and others – also affect the taste. However, an acidic taste can also occur in the case of fermentation.
- **Consistency:** Due to the melicitose content, forest honey often has a firmer consistency. The crystallisation also depends on the sugar spectrum.

One of the tasks in sensory analysis of honey is to assess the variety typicity. This is also determined by the aroma analysis. As many as 300 aroma substances have been detected in honey so far.

3. Storage of honey and sensory significance

Honey is a product that can be stored for years. Ideally it should be stored in a dark room in odour-free vessels closed airtight at a temperature of max. 15°C and an atmospheric humidity of max. 60%. Changes with sensory relevance can occur during storage.

- **Colour:** In the course of storage the honey becomes darker due to Maillard reactions and the reaction of polyphenols. How quickly a honey darkens depends on the storage conditions. Higher temperatures promote darkening. If a honey crystallises, it appears lighter. These colour changes can be recorded and quantified by sensory analysis or using instruments.
- **Texture:** At low temperatures honeys with a low water content crystallise, with the glucose component developing a crystalline texture first. Blossom honeys that crystallise quickly are for example rape and sunflower honey. Honeydew honey, sweet chestnut honey and robinia honey remain fluid for longer. Forest honey crystallises much more slowly than blossom honey. Honeys that tend to crystallise quickly are generally stirred to produce a creamy honey after centrifuging. It is possible to freeze honey. The honey does not then turn candy. Coarse crystals are considered to be a fault in honey.
- **Aroma:** If the honey crystallises, water that was previously bound to glucose is released. The water activity (aw) – and thus the risk of fermentation which become noticeable in a fermentative off-aroma – rises.
  Heat also leaves detectable, undesirable traces in honey. For instance when heated, hydroxymethylfurfural (HMF) results, which gives the honey a caramel-type aroma. The HMF-content of honey is thus a measurable quality parameter.

4. Sensory analysis of honey

Both human sensory organs and instrumental methods are used with honey. Physical measuring methods are widespread above all when it comes to determining the colour. Many gas chromatography analyses are conducted to identify and quantify honey aromas. It has been possible to separate honeys in line with their varieties with the help of electronic noses and tongues.

Human sensory analyses of honey have different goals. Here the aim is to describe and communicate sensory properties, to assess the variety typicity, to determine the popularity among consumers, or to identify faults.

Here sensory analysis is an essential but not the only quality criterion for honey. Other criteria are the water content, the electrical conductivity (for categorising as blossom, forest blossom or forest honey), the hydroxymethylfurfural content and enzyme activities (invertase and diastase) to check for thermal damage, the pH value and pollen. A number of very different pollens are found in different honey varieties. For example sweet chestnut honey is particularly pollen-rich, while robinia honey or alpine rose honeys are considered to be low in pollen. Variety determinations are therefore carried out through a combination of pollen analyses, chemical parameters and sensory analyses.

At the International DLG Quality Tests, experts assess the quality of honey in extensive sensory tests.

4.1. Colour

The goal of measuring the honey colour can vary in practice.

- For large producers/exporters/fillers, it can be interesting to record the colour of honeys if these are to be mixed. This is relevant above all for international trade.
- Typicity: when distinguishing between single-variety honeys, the colour is a characterisation attribute. However, slight colour differences between years exist within the varieties.
- Terroir: colour analyses can be used in order to distinguish honeys on the basis of their geographic origin. For example, in the case of Argentine mixed blossom honeys, it was possible to separate on the basis of meadows, hillsides and agricultural land.
- Consumers have different preferences – and one feature influencing preferences is the colour. Communicating this to end consumers can also be the goal of a sensory colour analysis.
- Research: results of colour analyses are correlated with other measurement results. A large number of studies have shown, for example, that the anti-oxidative capacity in dark honeys is distinctly higher than that in light honeys.

Colour measurements can be carried out in various ways. In the “similarity method”, the colour of the honey product to be analysed is compared with that of comparison samples/colour standards. The measuring instrument here can be the human eye or a technical device. In the “tristimulus method” and the “spectral method”, on the other hand, physical measuring instruments only are required.

4.1.1. Instrumental colour measurement

Normally chromameters and spectrophotometers are used to measure colours. A new option is the use of digital cameras, with sections being cut out of the centre of the digital photos, cleaned and transformed into colour values.

Colour measurement results are often stated in **L*a*b*-units**. L*a*b is a colour spectrum that covers the entire zone of perceptible colours:

- a*: Green or red component of a colour, negative values stand for green, positive values for red. Positive a-values are found above all in forest and sweet chestnut honeys.
- b*: Blue or yellow component of a colour, negative values stand for blue, positive for yellow. High b-values (yellow) are found in mixed blossom, sweet chestnut, fir or spruce honey.
- L*: Lightness (luminance) from 0 to 100. Above all pale honeys such as robinia, lime or clover honey display high L-values, while buckwheat honey or honeydew honeys display low L-values.

Single-variety honeys can be distinguished instrumentally with the help of the **L*a*b*-system**. In one study Slovenian acacia, lime, mixed blossom and sweet chestnut honeys could be differentiated solely on the basis of their a-values and b-values. Fir, spruce and forest honeys were admittedly clearly separated from the said blossom honeys, but overlapped with each other. In another study, heather and buckwheat honey were distinguished from each other and from light honeys. However, the light honeys (robinia, lime, rape and goldenrod) were not separated from each other.

L*a*b*-units are not honey-specific, not even food-specific. What is specific for honey, however, is the colour assessment in **Pfund units**. The Pfund scale is a 140 mm scale. With the aid of comparisons the mm is determined and allocated to a colour printout: water-white (0 to 8 mm), extra white (> 8 to 17 mm), white (> 17 to 34 mm), extra light amber (> 34 to 50), light amber (> 50 to 85), amber (> 85 to 114), dark amber (> 114). Light robinia honeys display values in the range of 5 to 25 mm Pfund, forest honeys up to 120 mm. This method for routine examinations of honey originating from the USA was traditionally carried out by colour assessment with the human eye in a comparison with glass standards. Today, special Pfund colorimeters or photometers can measure Pfund units objectively. A German standard for determining the honey colour in mm Pfund degrees (DIN 10744) is currently being prepared.

4.1.2. Human sensory colour measurement

Sensory colour analyses involve either a description of the colour, classification of the lightness or darkness on a scale, or a comparison with colour standards ("similarity method").

Descriptions are generated by trained panels in descriptive analyses. Terms such as white, cream-coloured, pale yellow, yellow, green tone, dark brown, amber or the like are customary. Such terms used by trained panels are defined and are clear to all members of the trained group. However, for outsiders, such as consumers, it is not clear where pale yellow stops and what colour corresponds to amber.

The Austrian Beekeepers Association has produced colour charts together with the author for liquid honeys and cream honeys that cover the spectrum of Austrian honey varieties. Each colour is provided with a description (e.g. butter, Veltliner, espresso). The aim was to find terms that are attractive, typical of food, and that consumers will understand.

4.2. Aroma (pronasal, retronasal)

To date around 300 aroma substances have been detected in honey. These are above all acids, alcohols, aldehydes, esters, ketones, lactones, phenols, hydrocarbons, norisoprenoids, benzene compounds, furan and pyrene compounds. b-damascenone and phenyl acetaldehyde are responsible for the typical honey odour and taste.

While chemical analytical measurements concentrate on identifying and quantifying aroma substances, human sensory analyses focus on what humans can perceive with the aid of their sense of smell.

The goals of measuring honey aroma are:

- to determine/characterise the geographical origin
- to characterise varieties; to detect a variety typicity in conjunction with pollen analyses
- to detect undesirable heating or long storage
- to produce descriptions for communicating the sensory properties to consumers.

4.2.1. Chemical aroma measurement:

With the aid of gas chromatography analyses it is possible to distinguish single-variety honeys on the basis of their volatile compounds. While some compounds occur in many different honeys, isolated aroma substances are variety-specific, e.g.:

- sunflower honey: 3-Methyl-2-butanol
- lime honey: 2,4,5,7a-tetrahydro-3,6-dimethyl benzofuran
- eucalyptus honey: 2,3-Pentanedione
- heather honey: Isophorone and 2-Methylbutyric acid
- citrus and lavender honey: Anthranilic acid methylester
- honeydew honey: Guaiacol and p-Anisaldehyde

Numerous studies have demonstrated that selected aroma substances are suitable as evidence of the origin of single-variety honeys from different regions.

4.2.2. Human sensory analysis of the aroma:

The aroma of honey is perceived pro-nasally (conventional smelling) and retro-nasally (via the oral cavity during consumption as flavour). The latter is allocated to taste in everyday language use, although taste is limited to the basic taste types sweet, sour, salty, bitter and umami.

The perceptible honey aroma is described with the help of descriptive analyses. The vocabulary used is normally specified by the panel and adapted to the respective samples.

- Spanish sweet chestnut honeys were described as regards aroma with the descriptors candy-like, caramel/toasted, fruity, ripe fruits, liquorice, woody, spicy/clove/vanilla, herb-like, coffee/chocolate, pine/resinous and flowery.
- The odour of lavender honeys from Spain was described as balsamic, fresh, lavender-like, citric, jam/peach compote, flowery and caramel
- The flavour of Danish honey from various regions was characterised with the following terms on consumption of the honey: raisin, dried fig, dried apricot, malty, beeswax, hops, smoky, menthol, vanilla, marsh mallow, aniseed, perfumed, flowery, elder blossom, lemon.
- Alongside the sweetness and acid in the flavour, a Turkish panel characterised thyme honeys with the following terms: honey, ~~feathered~~, bitter almond, thyme, violet, waxy, ginger, caramel, rose, raisin, molasses, metallic, stable, cinnamon, camomile, cheese, eucalyptus, citrus peel, oily, paraffin, oxidised, cumin, mint, vanilla, cooked apple, saffron, earthy, resinous, lemon.

The International Honey Commission (IHC) has published a honey aroma wheel that displays the following aroma categories and aromas:

Main category	Sub-category	Individual aroma
Vegetal	green	raw bean, crumpled leave, vegetation after the rain
	~~dry~~	pale malt, straw, tea, dry hay
Woody	dry	leafy wood dust, walnut, hazelnut
	resinous	cedar, pine resin, propolis
	spicy	clove, nutmeg, coffee
Chemical	petrochemical	styrene, paint, solvent
	medicine	household soap, vitamin B1
Fresh	refreshing	mint, eucalyptus, aniseed
	citrus fruit	lemon, orange, grapefruit
Floral, fresh fruit	floral	orange blossom, violet, rose, hyacinth
	fruit	pear, apple, red fruit, blackcurrant, coconut, apricot, exotic fruit
Warm	burned	molasses, burned sugar
	of cooked fruit	dates, plums, figs, raisins, candied fruits
	caramelised	toffee, caramel, brown sugar
	subtle	fresh butter, vanilla, beeswax, almond paste
Spoiled	pungent	piquant cheese, vinegar
	animal	cheese, perspiration, cowshed, cat's urine
	mouldy	damp floorcloth, humus, stuffy
	sulphur	globe artichoke, cabbage

To ensure that such terms are understood uniformly, training sessions are necessary with references. Such reference samples may be chemical substances (aroma substances), essential oils or foods (spices, fruits etc.). For example, if a reference for dried fruit is sought, raisins can be soaked in honey for a day and after this the honey can be smelled. Liquid standards (e.g. solutions with eugenol for cloves, menthol for mint) are dripped onto cotton wool and placed in small, sealable tins or bottles.

The problem of training with references is that they must be repeatedly produced afresh and are only stable for a brief period. In the wine sector, separate smelling sets with varying numbers of aroma bottles have been developed to solve this problem. In Austria a smelling set for honey has been developed by the gastrosoph M. Mösl in cooperation with the Austrian Beekeepers Association and the author. The aromas were selected for terms that were developed in advance by the author together with experts from the Austrian Beekeepers Association.

4.3. Taste

Sweet, sour and bitter are the three basic taste types that occur in honey. Bitterness is a typical feature above all in sweet chestnut honey.

4.4. Sample preparation and presentation for sensory analyses

Honey samples are always analysed at room temperature. The samples are generally handed out in transparent containers in order to allow colour assessment. Sealable plastic beakers have proved successful in as far as preparation is possible a day before tasting and the honey has time to develop its aroma in the head space of the vessel. In literature, however, there is also mention of handing out samples in wine glasses.

Honey is generally tasted pure. Sometimes, however, honey samples are diluted for sensory analysis with distilled water in the ratio 1:5 = water : honey and the mixture is homogenised.

Plastic spoons are provided for tasting. The palate is generally neutralised with water. A minimum of 10 g per sample and per person is generally considered to be the sample quantity. The number of samples within a session depends on the level of experience of the testers and the taste intensity of the honeys. Piana et al (2004) recommend a maximum of seven samples per session. After this a break of 30 minutes must be provided. In practice, however, the number of samples is frequently much higher.

Depending on the goal, different human sensory methods are used in practice: descriptive analyses and sorting methods with trained panels, as well as acceptance and preference tests with consumers. Furthermore, there are award schemes for honey.

Prüfschema für Honig

5 Punkte-Skala und Bewertungstabelle

Punkte	Qualitätsbeschreibung	allgemeine Eigenschaften
5	Sehr gut	Keine Abweichung von d. Qualitätserwartungen
4	Gut	Geringfügige Abweichungen
3	Zufriedenstellend	Leichte Abweichungen
2	Weniger zufriedenstellend	Deutliche Abweichungen
1	Nicht zufriedenstellend	Starke Abweichungen
0	Ungenügend	nicht bewertbar

1. Farbe / Aussehen					**Bewertung:**	**5**	**4**	**3**	**2**	**1**	**0**	**X 2**	*** Bemerkungen:**
2155 Farbe uneinheitlich	4	3	2	1	**Kristalliner Zustand**							Gewichtungs-Faktoren	**** unbedingt erläutern**
2294 Farbe zu hell / blass	4	3	2	1	4027 Oberfläche feucht	-	4	3	2	1	-		
2340 Farbe zu dunkel	4	3	2	1	4028 Oberfläche schief	-	4	3	2	1	-		
5490 Verunreinigungen	4	3	2	1	4026 Oberfläche schaumig	-	4	3	2	1	-		
Flüssiger Zustand													
2961 Honig schaumig	4	3	2	1	4710 sonstige Mängel*	-	4	3	2	1	0		
					9998 nicht bewertbar**	-	-	-	-	-	0		
2. Konsistenz					**Bewertung:**	**5**	**4**	**3**	**2**	**1**	**0**	**X 2**	
3046 inhomogen	4	3	2	1	**Kristalliner Zustand**								
					3218 grobe Kristalle	-	4	3	2	1	-		
					3214 Kristalle vorhanden (cremige Honige)	-	4	3	2	1	-		
Flüssiger Zustand					6431 zu hart	-	4	3	2	1	-		
6213 zu dünnflüssig	4	3	2	1	2076 Entmischung	-	4	3	2	1	-		
3214 Kristalle vorhanden	4	3	2	1									
					4710 sonstige Mängel*	-	4	3	2	1	0		
					9998 nicht bewertbar**	-	-	-	-	-	0		
3. Geruch					**Bewertung:**	**5**	**4**	**3**	**2**	**1**	**0**	**X 2**	
3917 nicht honigtypisch	-	-	2	1									
2190 Fremdgeruch*	4	3	2	1									
2585 gärig	4	3	2	1									
3853 nicht sortentypisch (außer Mischhonige)	4	3	2	1	4710 sonstige Mängel*	-	4	3	2	1	0		
					9998 nicht bewertbar**	-	-	-	-	-	0		
4. Geschmack					**Bewertung:**	**5**	**4**	**3**	**2**	**1**	**0**	**X 4**	
3917 nicht honigtypisch	-	-	2	1									
2585 gärig	4	3	2	1									
2195 Fremdgeschmack*	4	3	2	1									
3853 nicht sortentypisch (außer Mischhonige)	4	3	2	1									**Reserveproben beantragt**
					4710 sonstige Mängel*	-	4	3	2	1	0		haben vorgelegen □
					9998 nicht bewertbar**	-	-	-	-	-	0		fehlen □

Stand: Januar 2015

In the DLG Test the sensory expert analysis of the honey is conducted on the basis of the DLG 5-point scheme®.

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