Honey Quality and International Regulatory Standards: Review of the International Honey Commission

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International honey standards are specified in a European Honey Directive and in the Codex Alimentarius Standard for Honey, both of which are presently under revision. In this paper the present knowledge on the different quality criteria is reviewed and propositions for a new honey standard are made.

Honey quality criteria are specified in a European Directive[8] and in the Codex Alimentarius standard[5], both presently under revision[6,8]. The authors of this review are members of the International Honey Commission (IHC), which was formed in 1990 to revise the methods and standards for honey. The commission compiled the methods of analysis currently used in routine honey control and carried out ring trials in collaboration with the honey commission of the Swiss Food Manual (SFM). The methods were first published in the SFM[15] and then in a slightly modified form elsewhere[3]. The work of the commission, presented in the present review, was chaired by Stefan Bogdanov, with Cord Lüllmann as vice-chairman and Peter Martin as secretary. Presently, the IHC deals with compositional criteria for unifloral honeys under the chairmanship of Werner von der Ohe. The commission meets regularly once in a year. Representatives of other countries are welcome for the future work of the commission.

As new, better and faster analytical methods are available nowadays, introduction of new standards, using these new methods is necessary. In a recent publication we reviewed extensively the specific sugar content and the electrical conductivity of honey, as well as and the methods, used for the determination of honey quality[3] . In this paper we focus our discussions on the standard drafts of the Codex Alimentarius and of the EU.

DRAFTS FOR CODEX ALIMENTARIUS AND EU HONEY STANDARDS

In general, the Codex Alimentarius Standard is valid for honey trade in the whole world, while other regional norms, as the European Honey Regulation, can also be established, if there are regional quality requirements, differing from the Codex Alimentarius.

The proposed draft for a honey standard in the EU is very similar to the Codex standard, but it contains fewer specific details. The main similarities and differences can be outlined as follows:

1. The moisture content is the only composition criteria, which as a part of the Honey Standard has to be fulfilled in world honey trade. Honey having a high water content is more likely to ferment. A maximum value of 21 g/100g is suggested in the draft for a new standard. The exception for clover honey is not justified by measurements during recent years. Accordingly, the maximum water content for clover honey should also be 21 g/ 100 g. In practice, values as high as 21 g/100 g are very seldom attained. In routine honey control carried out by the IHA during the years 1989-97 on ca. 30,000 honey samples 91-95 % of all honeys had a water content of less than 20 g/100g[11] Also in Switzerland a standard of 20 g/100 g was successfully used in the past 20 years, until the last revision of the Swiss Food Ordinance, where the European Union maximum value of 21 g/100 g had to be accepted. Many national beekeeping organisations (e.g**.** Germany, Belgium, Austria, Italy, Switzerland, Spain**)** have moisture content maximum values of 17.5 to 18.5 g/100 g for special classes of quality honey.
2. With the exception of the moisture content, which is valid as a compositional criteria in both drafts, according to the European draft the general quality criteria, summarised in table one,

have to be fulfilled by all retail honeys, while according to the Codex, they can voluntarily be agreed upon.

3. Contrary to the EU draft, in the Codex draft there are specific paragraphs, dealing with contamination, hygiene and sugar adulteration, all of these being important quality factors nowadays. The microbiological honey quality is of special importance. In different countries cases of sudden infant death, due probably to honey consumption have been made public. The sudden infant death can theoretically be caused by the bacteria spores of *Clostridium Botulinum*, which can be found in honey. Due to these cases honeys in the UK and USA must carry the label ”not for the consumption by infants under 6 months old”. Also, the issue of honey adulteration is becoming increasingly important for honey control. Indeed, the problem of possible adulterated Chinese honey preoccupies presently the food control authorities in Europe and USA.
4. Only the EU proposal contains a definition of ”industrial” or ”bakery”-honey: ”Honey, which is convenient for human consumption, but which can have unspecific taste or odour, be fermented, was overheated or which has a lower diastase activity or higher hydroxymethylfurfural content than prescribed in the norm”. Such a paragraph lacks in the Codex. A paragraph for a separate quality of industrial honey is necessary, as honey for industrial use is often sterilized because of hygienic reasons.
5. Another important issue is the pollen content. Both the European and the Codex draft state, that no essential honey components can be removed from honey, but they do not say whether honey pollen is an essential honey component. While from nutritional point of view it is of no importance, as honey pollen content is less than 0.01 % of the total, it is important for the determination of the botanical and the geographical origin of honey. Also, honey is used in some cases for pollen desensitisation, due to its low pollen content. The argument of the honey industry is, that a fine filtration is often necessary for the removal of small foreign particles, impeding honey quality. The best solution would be to include a paragraph, stating, that honey should not be filtered with filters with a mesh-size, smaller than 0.2 mm. This practice will keep the pollen in the honey, but will remove most of the honey impurities. Different European beekeeping federations prescribe the use of such filters for their honey regulations.

Specific quality criteria

Table 1 summarises the composition criteria of the EU and the Codex drafts. According to Codex Alimentarius these quality standards are not compulsory for governments and can be voluntarily agreed upon, while according to the EU draft they have to be fulfilled by all commercial retail honeys. Evidently, there are only minor differences in both drafts and they both do not contain such important quality criteria as the specific sugar content and electrical conductivity.

Apparent sugar content

In most blossom honeys apparent reducing sugars” represent the great majority of honey sugars, but in honeydew honeys, the situation is often very different. Indeed, many honeydew honeys have high amounts of non-reducing oligosaccharides such as melezitose, maltotriose and raffinose. Because of these findings, the standard for apparent sugars has been modified in the Codex draft, compared with the previous standard: a minimum of 45 g/100 g has been proposed, compared to the old standard with a minimum of 60 g/100 g. The European draft keeps the old norm of 60 g/100g. ”Apparent sucrose” is measured indirectly as the difference between total and reducing sugars and can often be different from true sucrose. Here both drafts are similar, the Codex draft including more honey types than the European one.

The measurement of reducing sugars detects only the difference between blossom and honeydew honeys, but this difference can be determined much easier by other methods, e.g. by electrical conductivity determination. There are many arguments for replacing the measurement of the reducing sugars with that of specific sugars (see next section).

Water insoluble solids content

The measurement of insoluble matter is an important means to detect honey impurities that are higher than the permitted maxima. It was set in the times, when a significant portion of world honey was harvested by pressing the combs. However, nowadays almost all commercial honey is harvested by centrifugation. It seems to us that the permitted maximum in the Codex and European standards of 0.1 g/100 g is too high. Mostly lower values, in the range of 0.005 to 0.05 g/ 100 g are found. Wax, which is not determined by the Codex method, is a major source of water-insoluble contamination. For this purpose other filtration technique can be used, e.g. with paper filter, but such a method has not been officially proposed yet.

Mineral content (ash)

The ash content is a quality criterion for honey botanical origin, the blossom honeys having a lower ash content than honeydew honeys[17]. At present, this measurement is generally replaced by the measurement of electrical conductivity. The ash content could be kept as a quality factor during a transition period, until conductivity is accepted as a world-wide standard.

Acidity

Acidity is an important quality criterion. Honey fermentation causes an increase of acidity and because of this a maximum acidity value has proven useful, although there is a considerable natural variation. The old standard fixed a maximum of 40 milliequivalents/kg, which has been increased to 50 milliequivalents/kg in the Codex draft, as there are some honeys, which have a higher natural acidity[10] .

Diastase Activity

Honey diastase activity is a quality factor, influenced by honey storage and heating and thus an indicator of honey freshness and overheating. Although there is a large natural variation of diastase, the present standard of a minimum DN value of 8 has proven to be useful. In long-term routine honey control at the IHA more than 92 % of the raw honey samples (n = ca. 20,000) and more than 88 % of the retail honey samples (n = ca. 1000) had a DN greater than 8[11]. When interpreting diastase results one should take into consideration that certain unifloral honeys have a naturally low diastatic activity. Although the minimal requirements for diastase activity in the Codex and the EU drafts are the same, in practice there is an important difference between the two: while the Codex norm refers to honey after processing and blending, the EU norm is valid for the whole retail honey. In reality this means that the EU norm is more severe than the Codex norm, as diastase activity is expected to diminish upon storage.

Hydroxymethylfurfural content

This major honey quality factor is an indicator of honey freshness and overheating. In fresh honeys there is practically no hydroxymethylfurfural (HMF), but it increases upon storage, depending on the pH of honey and on the storage temperature. Some European bee federations (Germany, Belgium, Italy, Austria, Spain) market a part of their honey as ”quality honey”, having a maximum of 15 mg/kg. In international trade, a maximum value of 40 mg/kg has proven satisfactory. In long term routine honey control at the IHA during the last 10 years, more than 90 % of the raw honey samples (n = 30,000) and more than 85 % of the retail honey samples (n = 2000) had less than 30 mg HMF/kg[11]. The Codex proposal is a maximum of 60 mg/kg. The proposal for a higher maximum value is based on the experience that HMF increases on honey storage in warm climate countries. The latest EU standard proposal demands a maximum of 40 mg/kg, as under European conditions this standard has proven to be valid. Here too, as in the case with diastase, there is an important difference between the two norms: while the Codex norm refers to honey after processing and blending, the EU norm is valid for the whole retail honey. In reality this means that the EU norm is much more severe than the Codex norm, as HMF is expected to increase upon storage.

PROPOSAL FOR A NEW INTERNATIONAL STANDARD

Electrical conductivity

Conductivity is a good criterion of the botanical origin of honey and today it is determined in routine honey control instead of the ash content. This measurement depends on the ash and acid content of honey; the higher their content , the higher the resulting conductivity[17]. There is a linear relationship between the ash content and the electrical conductivity[14] :

$$C = 0.14 + 1.74\ A$$

where C is the electrical conductivity in milli Siemens cm^{-1} and A the ash content in g/100 g.

Extensive conductivity data on thousands of commercial honeys has been recently published[3]. Based on this data we propose that blossom honeys, mixtures of blossom and honeydew honeys should have less than 0.8 mS/cm and honeydew and chestnut honeys should have more than 0.8 mS/cm (see table 1). Exceptions are *Arbutus, Banksia, Erica, Leptospermum, Melaleuca, Eucalyptus* and *Tilia* honeys as well as their blends, having an extremely high variation in their conductivity.

The conductivity measurement is easy and fast and needs only inexpensive instrumentation. It is very widely used for discrimination between honeydew and blossom honeys and also for the characterisation of unifloral honeys. Thus an introduction of an international conductivity standard is recommended as urgent.

Specific sugar content

Based on the extensive data, that we published recently[3] , a general standard for a minimum content of the sum of fructose and glucose of 60 g/100 g for all blossom honeys and 45 g/100 g for all honeydew honeys can be proposed (table 2). This standard could be fulfilled in more than 99 % of the analysed honeys[3] For sucrose, the situation is more complex. Here the general standard of 5 g/100 g could be fulfilled in more than 99 % of the analysed honeys, with the exception of some unifloral honeys like *Banskia, Citrus*, *Hedysarum, Medicago*, *Robinia* and *Rosemarinus* honeys with up to 10 g/100 g and *Lavandula* honeys with up to 15 g/100 g sucrose[3] . The sum of the fructose and glucose content is very close to the sum of all reducing sugars, as fructose and glucose represent mostly more than 90 % of all reducing sugars. Indeed, the proposed minimum standard for the sum of glucose and fructose of 45 and 60 g/100 g for honeydew and blossom honeys is almost identical to the proposed standards for apparent reducing sugars of 45 and 65 g/100 g respectively. On the other hand, the proposed standard for true sucrose is very similar to the one for apparent sucrose. Exceptions are differences for honeydew honeys, where the ”apparent sucrose standard” is 15 g/100 g, while the specific sucrose standard is only 5 g/100 g and also some Australian and New Zealand honeys, which figure in the standard for reducing sugars (table 1), but not in the proposed standard for specific sugars (table 2) as no specific sugar data are available for these honeys.

The introduction of a standard for specific sugar contents will have other positive consequences for routine honey control. Thus, the fructose/glucose ratio and the sucrose concentrations are good criteria for differentiating between different unifloral honeys. Also, the content of different higher sugars as melezitose, maltotriose is a good indicator of the honeydew content of honey. The specific sugar spectrum yields also information on honey authenticity and sugar adulteration.

ADDITIONAL QUALITY FACTORS OUTSIDE THE STANDARDS

There are some useful quality criteria, used for the determination of honey quality outside the international honey regulations.

Invertase activity

Invertase activity is particularly sensitive to heat and storage damage and is used as a freshness indicator. It was proposed that fresh and unheated honeys should have an invertase number (IN) more than 10; for honeys with low enzymatic activity a IN of more than 4 is recommended[7]. Although, like honey diastase, the activity of invertase has a great natural variation[12] its use has been proven in honey quality control. A freshness invertase standard is also used in the honey standards of the beekeepers associations of Germany, Belgium and Spain.

Proline content

The honey proline content is a criterion of honey ripeness and in some cases, also of sugar adulteration[16]. A minimum value for genuine honey of 180 mg/kg is accepted in honey control laboratories. However, it should be taken into account that there is considerable proline variation, depending on the honey type[4].

Specific rotation

The overall value for the optical rotation is a resultant of the values of the different honey sugars. The measurement of specific rotation is currently used in Greece; Italy and UK to distinguish between blossom and honeydew honeys. In Italy it was found that blossom honeys[1,13] have negative values of optical rotation, while honeydew honeys have a positive one[13]. Theoretically, these differences are due to the higher content of glucose and lower content of fructose in blossom honeys. Whether this method is capable of differentiating these honey types also in other geographic regions, remains to be examined in future studies.

CONCLUSIONS

The present review summarises the present state of knowledge on the quality factors, which should be used in the international honey regulations for the determination of honey quality. As these quality factors are valid all over the world, it is not possible that they satisfy the quality standards of all countries. For the majority of European consumers, honey is regarded as a valuable natural food, which should be fresh and unheated. This notion results in an European standard draft, which has more severe requirements for freshness indicators as HMF and diastase than the ones proposed in the Codex draft. Also, some European beekeeper's associations specify more severe quality criteria for the honey sold under their label than the ones valid for general retail honey. For instance, maximum values of 17.5 -18.5 % for humidity and 15 mg/kg for HMF content and a minimum value of 10 invertase number units are specified.

Apart from the composition criteria, discussed in this review, specialised honey laboratories use also a number of other quality criteria to determine the botanical and geographical origin of honey, especially the characterisation of unifloral honeys. In its further work the IHC is going to compile and harmonise the methods and criteria, used for this purpose. Indeed, up to now chemical quality criteria for unifloral honeys are valid only in separate countries, but they are not officially recognised in the international honey trade.

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Table 1. **Sugar content and electrical conductivity: proposal for a new honey standard**

Suggested New Quality Criteria	Proposed Value
Sugar Content	
Sum of fructose and glucose	
blossom honeys	≥ 60 g / 100 g
honeydew honey or blends of honeydew honey and blossom honey	≥ 45 g / 100 g
Sucrose	
honeys not listed below	≤ 5 g/ 100 g
Banksia, Citrus, Hedysarum, Medicago, Robinia. Rosemarinus	≤ 10 g/ 100 g
Lavandula	≤ 15 g/ 100 g
Electrical Conductivity	
Blossom honeys excepted the honeys listed below and blends with them; blends of honeydew and blossom honey	≤ 0.8 mS/cm
Honeydew and chestnut honey, excepted the honeys listed below and blends with those	≥ 0.8 mS/cm
Exceptions: *Arbutus, Banksia, Erica, Eucalyptus, Eucryphia, Leptospermum, Melaleuca, Tilia.*	