Taylor & Francis
Taylor & Francis Group

Journal of Apicultural Research

ISSN: 0021-8839 (Print) 2078-6913 (Online) Journal homepage: http://www.tandfonline.com/loi/tjar20

Legislation of honey criteria and standards

Andreas Thrasyvoulou, Chrysoula Tananaki, Georgios Goras, Emmanuel Karazafiris, Maria Dimou, Vasilis Liolios, Dimitris Kanelis & Sofia Gounari

To cite this article: Andreas Thrasyvoulou, Chrysoula Tananaki, Georgios Goras, Emmanuel Karazafiris, Maria Dimou, Vasilis Liolios, Dimitris Kanelis & Sofia Gounari (2018) Legislation of honey criteria and standards, Journal of Apicultural Research, 57:1, 88-96, DOI: 10.1080/00218839.2017.1411181

To link to this article: https://doi.org/10.1080/00218839.2017.1411181

Journal of Apicultural Research, 2018
Vol. 57, No. 1, 88–96, https://doi.org/10.1080/00218839.2017.1411181

REVIEW ARTICLE

Legislation of honey criteria and standards

Andreas Thrasyvoulou[a]*, Chrysoula Tananaki[a], Georgios Goras[a], Emmanuel Karazafiris[a], Maria Dimou[a], Vasilis Liolios[a], Dimitris Kanelis[a] and Sofia Gounari[b]

[a]*Laboratory of Apiculture-Sericulture, School of Agriculture and Forestry, Aristotle University of Thessaloniki, Thessaloniki, Greece;* [b]*Laboratory of Apiculture, Institute of Mediterranean Forest Ecosystem, ELGO DEMETER, Athens, Greece*

(*Received 14 June 2016; accepted 27 August 2017*)

Differences between European legislation and revised Codex Alimentarius standards exist, and refer to the definition, the claim of the country of origin, honey of low enzymes and the adoption of Baker's honey. Furthermore, different countries maintain dated quality criteria that do not coincide with the provisions of Codex or EU directives. The parameters that vary are mainly the moisture content, HMF, diastase activity, electrical conductivity, sugars and the microscopical justification. The necessity to adopt national rules is imposed mainly by the absence of provisions regarding the characteristics of monofloral honey, the declaration of the geographical origin of the product, the natural deviation of different types of honey and the quality rating of domestic honey. To address the problem that exists in international legislation regarding honey, we propose adopting minimum requirements as mandatory for all countries that produce, import or export honey.

Legislación de criterios y normas de miel

Existen diferencias entre la legislación europea y las normas revisadas del Codex Alimentarius y se refieren a la definición, la alegación del país de origen, la miel de enzimas bajas y la adopción de la miel de Baker. Además, los diferentes países mantienen criterios de calidad anticuados que no coinciden con las disposiciones de las directivas del Codex o de la UE. Los parámetros que varían son principalmente el contenido de humedad, HMF, actividad diastásica, conductividad eléctrica, azúcares y la justificación microscópica. La necesidad de adoptar normas nacionales se impone principalmente por la ausencia de disposiciones relativas a las características de la miel monofloral, la declaración del origen geográfico del producto, la desviación natural de los diferentes tipos de miel y la calidad de la miel nacional. Para abordar el problema que existe en la legislación internacional sobre la miel, proponemos la adopción de requisitos mínimos como obligatorios para todos los países que producen, importan o exportan miel.

Keywords: honey; legislation; directive; Codex; national; global standards

Introduction

Honey is a natural product with a diverse composition affected by many factors such as the botanical and geographical origin, the intensity of nectar flow, the climatic conditions, the beekeepers' manipulations, the handling and packing procedure, the time of storage and the conditions of storage. Legislation cannot always follow the complexity of honey variations, and there are cases where the parameters of authentic and unprocessed honey fail to comply with the composition criteria of norms and also adulterated honey that had parameters within the established criteria (Thrasyvoulou & Manikis, 1995; Manikis & Thrasyvoulou, 1998; Tananaki & Thrasyvoulou, 2014). It is not uncommon for beekeepers to complain about wrongly judging their products from the market inspection bodies who forced them to pay penalties for natural diversion of particular characteristics that some monofloral honey has.

The situation with the honey legislation complicates even more if we consider that some countries issued national provisions, decisions, and guidelines to cope with the gap in the European and International legislation, despite the EU recommendations (EU, 2005). Most of them set limits to define the physicochemical, organoleptic and microscopic characteristics of monofloral honey, some have provisions regarding the country where the honey has been harvested, and several others are differentiated from the set criteria. The differences among the national provisions enhance the difficulties of the applicability of honey regulations and make the necessity of uniformity of honey legislation more urgent.

In this paper, we discuss the rules governing regulations of honey worldwide, compare the Council directives and regulations with the revised Codex and the national provisions of different countries, taking into account suggestions of experts from the International Honey Commission (IHC). Our objective is to show the differences in honey legislation among Codex, Directive and national provisions, indicate the problems created by the ambiguity of certain statutory standards and finally to propose amendments for improving the

*Corresponding author. Email: thrasia@agro.auth.gr

application of European and international regulations in order to increase their efficiency and enhance the international competitiveness worldwide.

European directive 2001/110/EC and revised Codex standard for honey (Codex, 2001)

The Codex standard for honey adopted by the Codex Alimentarius Commission in 1981, revised in 1987 and 2001, has voluntary application and serves in many cases as a basis for national legislation (Codex, 2001). The European Council followed the recommendations of Codex, and issued Directive 2001/110/EC (EC, 2001), amended 2014/63/EU (EU, 2014) that laid down the production and trading parameters of honey within the Member States of the EU (EU, 2011, 2014).

Definition

According to Codex "Honey is the natural sweet substance produced by honey bees from the nectar of plants or from secretions of living parts of plants or excretions of plant sucking insects". The directive defines honey as "the natural sweet substance produced by *Apis mellifera* bees" differentiating it by this way from the honey that is produced by other species of bees (*Micrapis, Megapis, Meliponines*). Countries, where honey is produced by other species of bees, should adopt additional provisions regarding the definition since there are differences in physicochemical, microscopical and organoleptic properties of honey produced by these different species of bees (Souza et al., 2006). So far there is no official name for honey that is produced from other bees in food science.

Names of the product

Codex and Directive have the same provisions regarding the names of the product with the exception of baker's honey which is not cited in Codex.

Botanical origin

Both Codex and Directive provide supplemented information regarding the botanical origin of the product. Thus, honey can be labeled by floral or vegetable origin, if the product comes entirely or "mainly" from the indicated source and possesses the organoleptic, physicochemical and microscopic characteristics of the source. Filtered honey and baker's honey cannot be supplemented by information referring to the floral or vegetable origin.

The important provision regarding the trade of monofloral honey cannot be applied since the mentioned characteristics are not defined and are not given either by Codex or by the Directive. Without legislating the characteristics of monofloral honey, their trade is defective, uncertain and incorrect and the numerous scientific publications regarding the characteristics of monofloral honey remain unexploited.

Some countries perceived that necessity established national regulations or technical criteria regarding the characteristics of monofloral honeys. Greece has national limits regarding the characteristics of eight monofloral types of honey (AXS, 2004), Germany has legislation of organoleptic, microscopical and physicochemical characteristics of ten floral and three honeydew honeys (Leitätze, 2011), Serbia has legislated the pollen limits of eight monofloral honeys (Serbia Ordinance, 2003) and Turkey provides physicochemical characteristics of almost all the monofloral honey that are produced in that country (Turkish Food Codex, 2012). Traditionally, the botanical origin of honey is determined with the use of pollen analysis (melissopalynology). Although pollen analysis may have several limitations (Molan, 1998; Persano Oddo & Bogdanov, 2004), the combination of pollen analysis with physicochemical and organoleptic characteristics can overcome those limitations and give reliable results (Von der Ohe, Persano Oddo, Piana, Morlot, & Martin, 2004). Table 1 indicates the minimum amount of pollen that had been set so far in five European countries to define the word "mainly" regarding the determination of the botanical origin. Croatia defined twelve monofloral honeys (Croatia Ministry of Agriculture, 2009; Roberto Piro, Personal communication), Germany nine (Leitätze des Deutschen Lebensmittelbuches, 2011), Serbia eight (Serbia Ordinance, 2003), Greece six (AXS Decision, 2004) and Italy two. The numbers are disappointing if we consider that more than 100 different monofloral honeys had been stated so far only in Europe. The encouraging element is that in most of the cases there is an agreement regarding the minimum percentage of pollen content required for the characterization of a monofloral honey among the countries.

Geographical origin

Codex requires the indication of the producing country on the label. Similarly, the European Directive states that the country or countries of origin where the honey has been harvested shall be indicated. However, according to Directive, if the honey originates from more than one member state or from third country that indication may be replaced with the words "blend of EU honey", "blend of non-EU honey", or "blend of EU and non-EU honey". This provision is not valid in Codex.

We conducted an investigation in 31 supermarkets in Greece, and we found that in all of 116 imported honey samples the country of origin had been replaced by the word "blends", although some of them were monofloral honey (Thrasyvoulou, 2013). In addition the indication "blends" was written on the label, with very small letters among other information while according to Reg. 1169/2011/EU it should be conspicuous and place in such a way as to be easily visible, shall not in

Table 1. Minimum percentage of pollen required for the characterization of monofloral honeys in five European countries according to their national legislation: or provisions, decisions or guidelines.

Pollen grains	Croatia (%)	Greece (%)	Germany (%)	Italy (%)	Serbia (%)
Arbutus unedo	10				
Brassica napus	60	–	80		
Calluna vulgaris	20	–	–		20
Castanea sativa	85	87	90		85
Citrus spp.	10 (5*)	3	20	10	
Gossypium (cotton-		3			
Erica spp.		45	45		
Eucalyptus spp.			85		
General monofloral	45	45	45		
Medicago sativa					> 30
Lavandula spp.	10 (5*)				
Phacelia tanacetifolia	60				
Robinia pseudoacacia	20		–		20
Rosmarinus officinalis					20
Salvia officinalis	15 (10*)				
Satureja montana	20				
Taraxacum officinalis					20
Thymus spp.	–	18		15	
Tilia spp.	25 (10*)		20		25
Trifolium, melilotus			70		
Helianthus	–	20	50		40

*With characteristic organoleptic properties of honey for particular plant species (smell, taste, color).

any way be hidden, obscured, detracted from or interrupted by any other written or pictorial matter or any other intervening material (EU, 2011).

It seems that some honey importers do not want to disclose the origin of the product especially when it is imported from third countries. The mask of the geographical origin of honey is contradictory to the following legislations of EU:

(a) Regulation 1169/2011/EU which describe that the place of origin, is a compulsory indication on the labeling and failure to provide such information might mislead the consumer about the true origin of the foodstuff (EU, 2011).
(b) Regulation 37/2010 EU that has established maximum residue limits (MRLs) in honey (EU, 2010). Some acaricides against varroa mites (*Varroa destructor* Anderson and Trueman) may be authorized in one European country and not in another. The acceptable limits of residues are legal only in countries where the substances in concern are authorized. By replacing the countries of origin with the word blend, the countries of origin remain unknown, residues' limits cannot be checked, and the legislation of Europe cannot be applied.

Composition criteria for honey

Compositional criteria of honey according to Codex and honey Directive are indicated in Table 2. Differences exist only in the provision regarding the baker's honey and the honey with a natural low content of enzymes.

Moisture content

Honey produced by bees has a moisture content that depends on flower sources, beekeeping manipulations, and climatic conditions. Usually, honey from well-sealed combs has the water content less than 18%. Codex and European Directive set limits for moisture content no more than 20% with the exception of heather honey (*Calluna vulgaris*) which is permitted having up to 23%. The following two reservations concern this provision:

(a) Very rarely the water content of honey exceeded 18%. The tolerability permits beekeepers to collect unripe honey which subsequently is subjected το fermentation and spoilage by the presence of several yeast species.
(b) Not only *Calluna* honey, but also other monofloral honey types such as *Erica arborea, Erica manipuliflora, Erica verticillata*, Clover honey (*Trifolium* spp.), *Arbutus unedo*, *Polygonum aviculare* may have the water content that exceeds 20%.

Fructose and glucose content

Both Codex and Directive required the sum of fructose and glucose content for blossom honey to exceed 60% and for honeydew honey and blends of honeydew honey with blossom honey to exceed 45%. According to the above, it is allowed to have blends of a forest with blossom honey but it is not permitted to have blends of blossom honey with honeydew honey. In practice, bees may collect nectar from blossom and honeydew secretions from plants that share the same flowering period and the same geographical origin. In case that blossom honey surpasses the honeydew honey, it should be

Table 2. Compositional criteria of honey.

Composition criteria	Directive 2001/110 EU			Revised CODEX 2001
	Blossom honey		Honeydew honey*	
	General	Exceptions	General	
Moisture %	<20	*Calluna* and baker's honey <23Baker's honey from *Calluna* <25	<20	The same No indication for baker's honey
Fructose + glucose %	>60	–	>45	The same
Sucrose %	<5	*Robinia, Medicago, Banksia, Hedysarum, Eucalyptus, Eucryphia*spp, and *Citrus* <10*Lavandula* & *Borago* <15	<5	The same
Water-insoluble %	<0.1	Pressed honey <0.5	<0.1	The same
Electrical conductivity $mS.cm^{-1}$	<0.8	*Chestnut*, *Arbutus, Erica, Eucalyptus, Tilia, Calluna, Manuka* and *Melaleuca*	>0.8	The same
Free acid $meq.kg^{-1}$	<50	Baker's honey <80	<50	The same
Diastase activity DN**	>8	baker's honey and honey with low natural enzyme content: >3 when HMF is less than 15 $mg.kg^{-1}$	>8	Honeys with low natural enzyme content: > 3 DN
HMF $mg.kg^{-1}$**	<40	baker's honey Honeys of tropical climate and blends of these honey <80	<40	Honeys of tropical climate and blends: < 80

*Honeydew honey and blends of honeydew honey with blossom honey.
**Determined after processing and blending.

allowed to have blends of blossom honey and forest honey, provided that glucose and fructose are more than 60% and electrical conductivity is less than 8 $mS.cm^{-1}$. Countries that have national provisions regarding blends of blossom and forest honey are Turkey, Poland, and Serbia.

To our knowledge, the sum of glucose and fructose is fulfilled by most of the floral honey. Lower values are mainly due to natural blends with honeydew secretions or mixtures after human intervention. Contrary to that, there are honeydew honey types from fir, pine, and spruce that may have the sum of fructose and glucose content lower than the standards and exceptions should be considered. For example, most of the Greek fir honey have the sum of fructose and glucose lower than 40% (Manikis, Vartani, Dimou, & Thrasyvoulou, 2011) and this is known to the Greek control bodies which show tolerance toward this discrepancy. Contrary to that, Greek pine honey some times may has lower than 45% fructose and glucose content and beekeepers are accused of having a non-compliant product simply because the control bodies were not informed.

Sucrose content

The general provision for sucrose content is less than 5% with the exception listed in Table 2 for both Codex and Directive. From these exceptions, only *Eucalyptus, Robinia, Citrus* and *Lavandula* are listed as important for honey production and can be found predominantly in honey (Persano Oddo & Piro, 2004). The sucrose content of honey from *Eucalyptus* generally is less than 4.2% (Persano Oddo & Piro, 2004) while honey from dandelion (*Taraxacum officinale*) may occasionally have sucrose more than 5% (Warnier Marie personal communication).

Electrical conductivity

Blossom and honeydew honey are differentiated by electrical conductivity. Electrical conductivity less than 0.8 $mS.cm^{-1}$ indicates blossom and more than 0.8 $mS.cm^{-1}$ indicates honeydew honey with the exceptions listed in Table 2. Additional blossom monofloral honey types with higher electrical conductivity that should be included in the list of exceptions are honey from *P. aviculare* (Knot weed), *Gossypium sp*. (cotton honey), *Paliurus spina-christi* (Jerusalem thorn) (Tananaki, 2015) and *Persea americana* (avocado honey) (Antonio Bentabol personal communication).

Diastase activity and HMF

Diastase usually exceeds 25 DN in fresh unprocessed samples while HMF is virtually absent or very low. The higher values of HMF found in fresh, unprocessed samples were 10 to 15 $mg.kg^{-1}$. Diastase is inactivated and HMF is formed when honey is heated for processing and blending. Both changes occur also during storage. When the diastase drops below the limit of 8 DN or HMF exceeds 40 $mg.kg^{-1}$, the quality of honey is considered as degraded and the product should be designated as baker's honey. Diastase and HMF are also used to detect adulterated honey by excess feeding with syrup since diastase activity decreases dramatically and HMF remains unchanged.

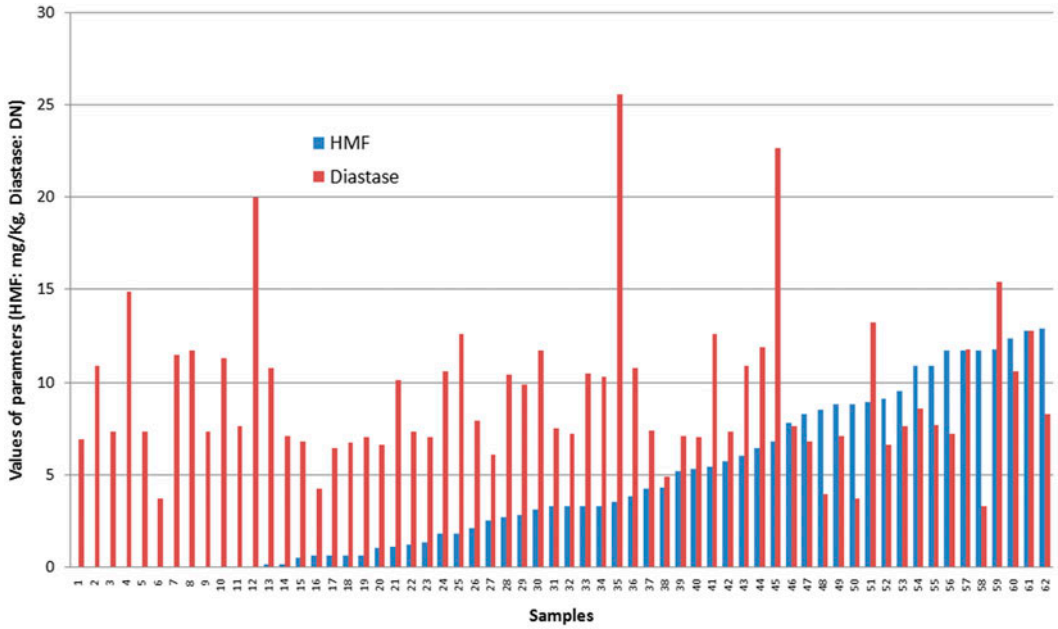

Figure 1. HMF and diastase activity of fresh unprocessed samples of citrus honey.

Both Codex and European Directive point out that there are honey types with low natural enzymes and as example Directive gives the citrus honey. According to the Directive, honey with low natural diastase activity should not have HMF more than 15 mg.kg^{-1}. This provision is unfair for honey types with low natural enzymes because HMF in fresh and unprocessed honey may reach 12–13 mg.kg^{-1}and with little processing the 15 mg.kg^{-1} HMF can easily be exceeded. Figure 1, indicates HMF and diastase of 61 samples of citrus honey that were collected directly from colonies and analyzed fresh and unprocessed (Tananaki, 2013). The first 15 citrus samples have zero HMF and the low diastase activity poses no problem to the marketing of the product. The last 7 samples (No. 54–61) have HMF more than 10 mg.kg^{-1}and with little processing, blending or storage, HMF can easily reach or exceed the limit of 15 mg.kg^{-1}. Thus, in this case, 11.5% of authentic and unprocessed citrus honey cannot be marketed. Codex doesn't connect the low content of diastase with the HMF and it doesn't give citrus as an example of such honey types. This is reasonable since there are many other honey types with low enzymes like *Robinia, Rosmarinus, Erica, Taraxacum, Arbutus spp.*, spring Pine honey and others that should be listed or be known to the control bodies. Other countries like Brazil, Canada, Russia, Turkey, and Serbia accept honey that have diastase more than 3 DN when HMF is less than 15 mg.kg^{-1}.

Both Codex and Directive require that diastase activity and HMF content should be determined after processing and blending. The word "after" should be further clarified since can be interpreted that honey should be analyzed for HMF and diastase activity right after processing and blending or anytime during storage. The question remains is whether beekeepers or Packers should be regarded responsible for changes that occur in the natural product during storage.

Differences between national provisions, Codex and European directive

Codex has voluntary application and in many cases, countries used it as a basis for their national legislations. In practice, the honey specifications of Codex are not always applied and many differentiations exist. Similarly, some member states of Europe in addition to the European directive, adopted their own diverse national provisions, or guidelines mainly to assist the trade of their domestic product. Table 3 shows the variations that different countries have from Codex and Directive.

Moisture content

One of the most variable specification is the moisture content which usually is set to most strict criteria (<18%) and is associated with quality grades. For example the Canadian classification of quality grades designated for Canada No. 1 moisture <17.8%, for Canada No.2 <18.6% and for Canada No. 3 <20% (Canada Agricultural Products Act, 2011). These grades may be used only for honey that meets the color, the flavor, the purity, the packing, and labeling requirements and it concerns only domestic products. Similarly, the German guidelines for honey that classified honey into quality grades set moisture content <18% for both Auslese and Feine Auslese grades (Leitätze des Deutschen, 2011). Guidelines are not a law, but have the status of a legal norm and define additional criteria for different

Table 3. Comparison of national legislations to Codex and council directive.

Countries	Provisions/Stipulation/Decisions/Guidelines*
Argentina	Provisions: moisture <18%; ash <0.6% fl**, <1.0% hd***; apparent reducing sugars >65% fl, >60% hd; apparent sucrose <8% fl, <10% hd; dextrin <3% fl
Belgium	Stipulation: sucrose <10% dandelion honey
Brazil	Provisions: reducing sugars >65% fl, >60% hd; apparent sucrose <6% fl, <15% hd; minerals <0.6% fl, <1.2% hd
Canada	Provisions: apparent reducing sugars >65% fl, >60% hd; moisture <20%; apparent sucrose <5% fl, <10% hd; water insoluble solids <0.1% not pressed honeys, <0.5% pressed honeys; ash <0.6% fl, <1.0% hd; acid <40 meq.kg^{-1}; diastase > 8 DN; HMF <40 mg.kg^{-1}
China	Provisions: moisture <20% Grade A, <24% Grade B; fru+glu >60%; sucrose <5%; free acidity <4 ml/100 g; diastase >4 DN; HMF <40 mg.kg^{-1}; ash <0.4%; electrical conductivity <0.8 mS.cm^{-1}
Colombia	Provisions: HMF <60 mg.kg^{-1} honey from tropical areas; reducing sugars >65% fl; moisture <18%; free acidity <40 meq.kg^{-1}; diastase >3 DN, apparent sucrose <5%
Czech Republic	Decision: HMF <20 mg.kg^{-1}; moisture <18%; apparent sucrose <10%
Ethiopia	Provisions: apparent reducing sugars >65%; water insoluble solids <0.1%; minerals <0.6%; free acidity <40 meq.kg^{-1}; diastase <3 DN; HMF <40 mg.kg^{-1}; apparent sucrose <10%
India	Decisions: moisture <20% special grade, <22% grade A, <25% standard grade; reducing sugars <70%special grade, <65% grade A and standard grade; apparent sucrose <5%; fru/glu ratio >1; ash <0.5%; HMF <80 mg.kg^{-1}; acidity expressed as formic acid% <0.2; fiche's test negative
Germany	Guidelines: Characteristics of monofloral honeys: electrical conductivity mS.cm^{-1}, >1.0 pine, >1.1 fir, 0.8–2.0 castanea, >0.50 erica, 0.10–0.30 citrus, 0.20–0.40 helianthus, <0.20 robinia, >0.70 calluna, 0.20–0.30 trifolium, <0.22 brassica; fru/glu ratio >1.20 pine, >1.15 fir, >1.45 castanea, 1.00–1.30 erica, >1.10 citrus, <1.10 helianthus, >1.55 robinia, >1.20 calluna, <1.30 trifolium, <1.10 brassica, >1.05 eucalyptus spp., >1.10 tilia, >1.00 picea; HMF<15 mg.kg^{-1} Auslese grade, <10 mg.kg^{-1} Feine Auslese grade; invertase >60 U.kg^{-1} Auslese grade, >80 U.kg^{-1} Feine Auslese grade; moisture<18% Auslese grade and Feine Auslese grade
Greece	Decisions: electrical conductivity mS.cm^{-1} >0.9 pine, >1.0 fir, >1.1 castanea, <0.6 thyme, <0.45 citrus; moisture <18.5% fir
Japan	Decisions: fru+glu >60%; sucrose <5%; HMF <59 mg.kg^{-1} fair trade, <15 mg.kg^{-1} health and nutrition First grade, <40 mg.kg^{-1} health and nutrition Second grade; electrical conductivity <0.80 mS.cm^{-1}; starch and dextrin negative; heavy metals (as Pb) <20 mg.kg^{-1}
Poland	Provisions: electrical conductivity mS.cm^{-1} 0.2–0.6 fl, 0.6–0.8 fl+hd (natural mixed), >0.8 hd deciduous trees, >0.95 hd coniferous; proline >250 mg.kg^{-1}; HMF <30 mg.kg^{-1}; acidity >10–50 meq.kg^{-1}
Russia	Provisions: diastase: >7 DN; >5 DN acacian; >11 DN linden; >15 DN sunflower; >18 DN buckwheat
Serbia	Provisions: electrical conductivity mS.cm^{-1} <1,00 fl & blends, >1,00 hd & blends; reducing sugars >65% fl, >60% hd; sucrose <5% fl, <10% calluna and clover, <10% hd; minerals<1% fl, <1.2% hd; total acidity <40 mmol formic acid per 1000 g
Slovakia	Provisions: moisture <18%; HMF <20 mg.kg^{-1}
Turkey	Provisions: fru/glu ratio 0.9 – 1.4 fl, 1.0–1.85 castanea, 1.2–1.85 acacia, 1.0–1.65 thyme, 1.0–1.4 hd; difference between protein and honey delta C13 −1.0 or more positive; C4 sugars ratio calculated from difference between protein and honey delta C13 (max) <7%; prolin>300 mg.kg^{-1}, >180 mg.kg^{-1} canola, lime, citrus, lavender, eucalyptus honeys, >120 mg.kg^{-1} rosemary, acacia honeys, >180 mg.kg^{-1} bakery honey; sucrose <5%, <10% hd *P. brutia* and *P. pinea*; fru/glu1.0–1.4; water-insoluble solids <0.1%; free acidity <50 meq kg^{-1}; electrical conductivity <0.8 mS cm^{-1}, >0.8 mS cm^{-1} mixture of chestnut and hd; naphthalene <10 μg.kg^{-1}

*Provisions: Legal legislation of a country. Stipulation: is a formal acknowledgement and agreements without legal status. Decision: Specifications that are decided by control bodies. Guidelines: These are not a law, but have the status of a legal norm.
**fl: floral honey.
***hd: honeydew honey, when no indication means all kinds of honey.

quality grades or certain honey specialties. Also, Slovakia, which is a member of EU set moisture content <18% (Slovak norm 1/2006). Slovak Beekeepers Association has a protection mark "Slovak honey", where the product must have water content <18%. Provision for low moisture content (<18%) was also set from Argentina. This country in addition to the national legislation has a mutual agreement with Brazil (Brazil, 2000), Paraguay and Uruguay (ambito del Mercosur) with the maximum limit for moisture content 20%. Another country with such differentiations is Colombia which has both, official legislation (Colombia Codex, 2010) and National Standards (Norma Tecnica Colombiana NTC 1273). National standards set moisture content 18% while official legislation 20%.

In oppose to the above countries that set lower moisture content, two countries India and China raise the moisture limit above 20% and at the same time they designated grades: India has the special grade honey with moisture content <20%, the grade A with moisture <22% and the standard grade honey with moisture <25%. China has the grade A with moisture <20% and the grade B with moisture <24%.

HMF and diastase

Table 3 indicates that another criterion that is differentiated from Directive and Codex and mostly used to designate quality grades is HMF. More austere criteria were set by Czech Republic (<20 mg.kg^{-1}), Germany (Auslese

grade <15 mg.kg^{-1} and feine Auslese grade <10 mg.kg^{-1}); Slovakia (<20 mg.kg^{-1}), Poland (<30 mg.kg^{-1}) and Japan (<35 mg.kg^{-1}). Colombia adopted HMF <60 mg.kg^{-1} instead of 80 mg.kg^{-1} for honey from tropical countries. More loose criteria for HMF were set by Korea (>80 mg.kg^{-1}), and India (>80 mg.kg^{-1}) (Bureau of Indian Standards [BIS], 2002).

Polish Norm (Polska Norma Polish Norm PN-88/A77626) which has a "supporting character" to the Directive parameters laid diastase activity >8.3 DN, China lowers the standards to >4 DN with the exceptions of *Eucalyptus*, *Citrus sangria* and *Murasaki mokushuku* honey that may have >2 DN. Colombia accepted diastase >3 DN and India, South Korea and Japan have no provisions for diastase. Russia is the only country that has different limits of diastase for different kinds of honey. It has the "Honey natural-Technical Regulation" (Russia GOST 19792-2001) which is a set of technical regulations which contains characteristics of quality and safety of blossom honey and described at COST R 52451-2005. According to that regulation for all honey types, the limits are >7 DN, for acacia >5 DN, for linden >11 DN, for sunflower >15 DN, for buckwheat >18 DN and for honey types that are low in natural enzymes >3 DN providing that HMF is less than 15 mg.kg^{-1}.

Sugars

We found no differences in countries legislation regarding the specification of the sum of glucose and fructose either to flora or honeydew honey. An exception to this is the countries of China and Japan which set minimum 60% for all honey (including honeydew honey). In addition, these two countries set electrical conductivity <0.8 mS.cm^{-1} for all honey and by these two provisions honeydew honey would have difficulties to trade in China and Japan. Countries like Argentina, Brazil, Canada, Colombia, Ethiopia, India, Russia and Serbia continue using the parameter of apparent reducing sugars. All set >65% for floral honey and >60% for honeydew honey with the exception of Indian standards that set >70% for special grade and >65% for grades A and standard. The above countries kept also in their legislation the apparent sucrose content which has not the same conformity as reducing sugars have. Thus, apparent sucrose in Argentina is set <8% for floral and <10% for honeydew honey, in Brazil <6%, in Canada and Colombia <5%, in the Czech Republic, and Ethiopia <10%. Countries that follow the specifications of Codex and Directive and differentiated from the sucrose content are Colombia and Turkey. Turkey adopted <10% for honeydew honey from *Pinus brutia*.

Geographical origin

European countries with national decisions for declaration of country of origin for honey blends is Italy (Piro Roberto, personal communication), Greece (AXS Decision, 2015) and Cyprus (Cyprus, 2015). The decision is valid only for honey that is packed in those countries. If a company manufactures in another European country, it follows the requirements of EU Directive.

Other parameters

Specifications that have been legislated by different countries and differ from the established or suggested parameters of Codex and Directive are the ash content (Argentina, Canada, China, India), the starch and dextrin (Argentina, Japan) the fructose/glucose ratio (Germany, Turkey), the invertase (Germany, Turkey) and the proline (Poland, Turkey). In addition to that Turkish Food Codex Honey regulation (2012) legislated the difference between protein and honey delta CI3, the C4 sugars ratio and maximum limit for naphthalene while Japan set limits for heavy metals.

Countries like Bulgaria, Cyprus, England, France, Malta, Slovenia, Spain and Switzerland have been fully harmonized with EU legislation without different national decisions. Algeria has not legislation on bee product although this country has a very long tradition of beekeeping and USA is in the process to adopt new regulations on honey.

Concluding remarks

In this review, we have indicated that there are differences in legislation and standards that regulate honey in different countries. The causes of these differences are the diverse provisions in characteristics of honey that had been adopted by different countries, the geographical indication, the absence of characterization of monofloral honeys, the inconsistency of the parameters of monofloral honey, the grading of honey that promote domestic honey and the degrading of domestic honey that promote selling. The effects of these differences are unfair competition, misleading of consumers about honey quality and commercial barriers and obstacles in honey trading.

It is necessary to cope with the chaos that exists in international legislation by adopting minimum requirements as mandatory for all countries that produce, import or export honey. Some suggestion would be the amendment of the Codex honey definition to include the name species of *A. mellifera;* the European directive should adopt the country of origin, including blends, as one of the mandatory requirement of the label; The name of the product could be accompanied by botanical origin (optional) when the organoleptic, microscopical and physicochemical characteristics of each category of honey will be decided and legislated. Data published by IHC (Persano Oddo et al., 2004) could be useful for having an agreement for the major types of monofloral honey. Further work is needed for those monofloral honey types that are not included in the descriptive sheet of IHC.

Regarding the necessary criteria and standards, the set limits of HMF (<40 $mg.kg^{-1}$) and diastase (>8 DN) should be mandatory for all countries. In addition, all countries should have the right to optionally set stricter limits to a decided level, for all imported and domestic honey. The limit of not less than 3 DN diastase, when HMF does not exceed 15 $mg.kg^{-1}$ and no exogenous sugars are detected, could be adopted for honey with naturally low enzymes. Instead of sugars (sum of fructose and glucose, apparent reducing sugars, fructose/glucose ratio), a method of detection of honey adulteration with exogenous sugars (13C/12C isotopic ratio) would be more efficient to describe honey authenticity. We should further consider whether the limit of free acidity and water content should be decreased and the requirement of optical rotation in combination with the electrical conductivity for the differentiation of floral from honeydew honey.

Besides these minimum and obligatory norms, each country may adopt additional parameters which could describe the domestic honey types, providing that these parameters would not discriminate against imported honey and would not be mandatory.

Acknowledgements

We are grateful to the following members of IHC who kindly provided information regarding the legislation of their country: Andreja Kandolf Borovšak, Antonio Bentabol Manzanares, Asli Elif Sunay, Birgit Lichtenberg-Kraag, Carlos Alberto Fuenmayor Bobadilla, Dalibor Titera, Dinko Dinkov, Dragan Bubalo, Elena Zubova, Everaldo Attard, Gian Luigi Marcazzan, Gudrun Beckh, Jaume Cambra Sánchez, Katarina Bilkova, Kristina Lazarevic, Ligia Bicudo de Almeida-Muradian, Lutz Elflein, Maria Miquel, Marie Warner, Martha Quicazan, Mojca Korosec, Monique Morlot, Nuru Adgaba, Patricia Beaune, Peter Gallmann, Robert Chlebo, Roberto Piro, Smela Dana, Susanne Hanewinkel-Meshkini, Teresa Szczesna, Zheko Radev, Veronica Kmecl, Visnjia Radovic, Wahida Loucif, Werner Van Ohe, Wim Reybroeck.

Disclosure statement

No potential conflict of interest was reported by the authors.

ORCID

Andreas Thrasyvoulou http://orcid.org/0000-0001-6731-4184
Chrysoula Tananaki http://orcid.org/0000-0002-0056-483X
Georgios Goras http://orcid.org/0000-0003-0740-3454
Emmanuel Karazafiris http://orcid.org/0000-0002-7103-0288
Maria Dimou http://orcid.org/0000-0003-1482-8290
Vasilis Liolios http://orcid.org/0000-0001-7353-2364
Dimitris Kanelis http://orcid.org/0000-0001-7736-4783
Sofia Gounari http://orcid.org/0000-0003-3417-7800

References

AXS Decision. (2004). *Decision of the Greek Higher Chemical Commission regarding the characteristics of monofloral honey pine, fir, castanea, erica, thymus, citrus, cotton and helianthus*. No. 127/2004 (FEK 239/B/23-2-2005).

AXS Decision. (2015). *Decision of the Greek Higher Chemical Commission regarding the country or countries of origin*. No. 148/2015 (FEK 3854/B/30-11-2016.

Bureau of Indian Standards. (2002). *Extracted honey-specification (second revision)*. UDC638:16 (IS 4941:1994).

Brazil, Ministério da Agricultura, Pecuária e Abastecimento, Instrução Normativa No. 11. (2000, October 23). *RegulamentoTécnico de Identidade e Qualidadedo Mel. DiárioOficial da União*. Sessão 1. (pp. 16–17).

Souza, B., Roubik, D., Barth, O., Heard, T., Enriquez, E., Carvalho, C., … Vit, P. (2006). Composition of stingless bee honey: Setting quality standards. *Interciencia, 31*, 867–875.

Canada Agricultural Products Act. (2011). *Honey regulations* C.R.C., c. 28730/9/2011.

Codex. (2001). *Codex Alimentarius standard for honey 12-1981. Revised Codex standard for honey. Standards and standard methods* (Vol. 11). Retrieved December, 2014, from http://www.codexalimentarius.net

Colombia Codex. (2010). *Ministerio de Protección Social de Colombia, Requisitos sanitarios que debe cumplir la miel de abejas para consumo humano* [Ministry of Social Protection of Colombia, Sanitary requirements that honey must meet for human consumption] (pp. 1–9). [Resolución 1057/23-3-2010].

Croatia Ministry of Agriculture. (2009). *Ordinance on honey*. Pursuant to Article 94, paragraph 2 of the Food Act (Official Gazette 46/07, 155/08).

Cyprus. (2015). *Regulatory Administrative Acts of Cyprus 394/2015*.

EC. (2001). Council directive 2001/110/EC of 20 December 2001 relating honey. *Official Journal of the European Communities* 12.1.2002 L10/47-52.

EU. (2010). *Commission regulation no 37/2010 of 22 December 2009 on pharmacologically active substances and their classification regarding maximum residue limits in foodstuffs of animal origin* JO, 2010 (pp. 1–72). Retrieved from http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010R0037&from=EN (2015)

EU. (2011). Regulation (EU) No 1169/2011 of the European parliament and of the council of 25 October 2011. *Official Journal of the European Union*. L 304/18-63.

EU. (2014). Directive 2014/63/EU of the European parliament and of the council of 15 May 2014 amending council directive 2001/110/EC relating to honey. *Official Journal of the European Union, L164*, 1–5.

EU. (2005). *Explanatory note on the implementation of council directive 2001/110/EC relating to honey*. Brussels, D (2005) 9538 Note expl.61913.Oct.2005.

Leitätze des Deutschen Lebensmittelbuches. (2011, May). Bekanntmachung von Neufassungen bzw [Guiding principles of the German foodbook]. *Anderungen bestimmter Leitsatze des Deutschen Lebensmittelbuches, 30*. ISSN 0720-6100.

Manikis, I., & Thrasyvoulou, A. (1998). Η ποιότητα του ελληνικού μελιού [The quality of Greek honey]. *Melissokomiki Epitheorisi, 12*(7–8), 339–345 (in Greek).

Manikis, I., Vartani, S., Dimou, M., & Thrasyvoulou, A. (2011). Sugar analysis of "Menalou vanilia" fir honey. *Journal of ApiProduct and ApiMedical Science, 3*(2), 101–103. doi:10.3896/IBRA.4.03.2.06

Molan, P.C. (1998). The limitations of the methods of identifying the floral source of honeys. *Bee World, 79*(2), 59–68. doi:10.1080/0005772X.1998.11099381

Persano Oddo, L., & Bogdanov, S. (2004). Determination of honey botanical origin: Problems and issues. *Apidologie, S35*: European unifloral honeys, S2–S3. doi:10.1051/apido:200404

Persano Oddo, L., & Piro, R. (2004). Main European unifloral honeys: Descriptive sheets. *Apidologie, 35*, S38–S81.

Persano Oddo, L., Piana, L., Bogdanov, S., Bentabol, A., Gotsiou, P., Kerkvliet, J., … von der Ohe, K. (2004). Botanical species giving unifloral honey in Europe. *Apidologie, 35*, S82–S93. 10.1051/apido:2004045

Serbia Ordinance. (2003). *Official Gazette of Serbia and Montenegro*, No. 45/2003 17.10.2003.

Tananaki, C., & Thrasyvoulou, A. (2014). Ποιότητα μελιού και ποιοτικός έλεγχος των φυσικοχημικών χαρακτηριστικών τους [The quality of honey and quality control of the physicochemical characteristics]. *Melissokomiki Epitheorisis, 28*(7–8), 256–258 (in Greek).

Tananaki, C. (2013). Το μέλι πορτοκαλιάς [The citrus honey]. *Melissokomiki Epitheorisis, 27*(5–6), 148–150 (in Greek).

Tananaki, C. (2015). Τα χαρακτηριστικά του μελιού από Πολύκομπο και από Παλιούρι. [The characteristics of *Polygonum aviculare* (knotweed) and *Paliurus spina-christi* (Jerusalem thorn) honeys]. *Melissokomiki Epitheorisis, 29*(5–6), 167–169; (9–10), 326–327 (in Greek).

Thrasyvoulou, A., & Manikis, I. (1995) Η ποιότητα του ελληνικού μελιού [The quality of Greek honey]. *Melissokomiki Epitheorisi, 9*(1), 3–6 and (2), 45–47.

Thrasyvoulou, A. (2013). Σε αναζήτηση της εφαρμογής της εθνικής απόφασης που αφορά τα ελληνικά μέλια [In searching of the validity of the National decision regarding the imported honeys]. *Melissokomiki Epitheorisis, 27*(4), 250–251 (in Greek).

Turkish Food Codex. (2012). *Ministry of food, agriculture and livestock: Turkish food codex bal communication* (communication no: 2012/58).

Von der Ohe, W., Persano Oddo, L., Piana, M.L., Morlot, M., Martin, P. (2004). Harmonized methods of melissopalynology. *Apidologie, 35*, S18–S25. doi:10.1051/apido:2004050