Quality standards for medicinal uses of Meliponinae honey in Guatemala, Mexico and Venezuela

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Beekeeping with stingless bees (meliponiculture) is practiced in Guatemala, Mexico and Venezuela. In this article we review the medicinal uses of stingless bee honeys in these countries. We include honeys from 23 stingless bee species, review their use in the treatment of ocular cataracts and pterygium, fatigue, gastritis, ulcers, lung weakness, coughs, wounds and bruises; their use as laxatives and fertility enhancers, and their nutritional value. A proposal on quality standards for stingless bee honey is considered a contribution for further regulations.

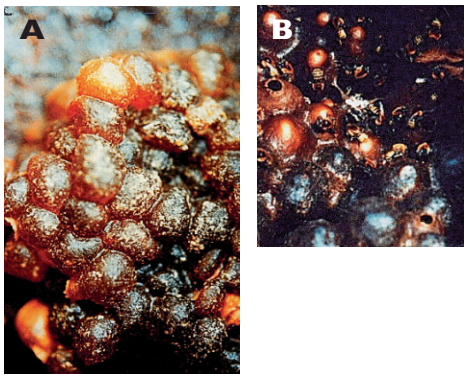

FIG. 1. *Trigona* (*Tetragonisca*) *angustula angustula* (a) and *Melipona favosa favosa* (b) honey pots in Venezuelan stingless bee hives.

FIG. 2. *Scaptotrigona pectoralis* double clay pot hives from Sierra Norte de Puebla, Mexico.

Beekeeping with honey bees belonging to the genus *Apis* is more widespread than meliponiculture – beekeeping with stingless bees (e.g. *Melipona* spp.) – which is a well known tradition in tropical countries. Both groups of bees belong to the family Apidae, order Hymenoptera. They are differentiated at the subfamily level, Apinae for honey bees and Meliponinae for stingless bees. The main structural differences between honey bees and stingless bees is nest construction: stingless bees construct horizontal combs made of cerumen (a mixture of propolis and beeswax) for their nests, and honey pots instead of honeycombs for storing honey (fig. 1).

More than 500 species of Meliponinae are distributed in the tropical and subtropical regions of the world.[6,11] These bees are native to the New World and were kept by ancient pre-Columbian cultures such as the Mayas and Nahuatls.[10] Weaver & Weaver report evidence of meliponiculture, local rituals and ceremonies with a *Melipona* species.[30] A rich figurative legacy can be found in the *Maya Codex* of Madrid, which has direct and indirect references to the life cycle of these bees.[7] *Bakabs* were the Mayan gods created to honour native bees, examples being *Ah Mucen Kab*, the god of honey and the most worshiped,[9] and *Balam Cab*, the queen name that refers to the jaguar bee, who was the divinity of the beehive.[8]

Few 'local' books exist on meliponiculture,[13,18] although the traditional hives have been improved with a variety of designs (rational hives),[19,23] and most rural and indigenous communities just harvest stingless bee honey from feral colonies.[5] Meliponiculture is facing cultural, economic and ecological challenges, demanding changes in the way it is exploited to avoid the disappearance of this native tradition.[20] *Melipona* species richness is dependent on forest cover, and therefore is a recommended indicator for landscape deforestation.[4] The idea of 'keeping gentle bees to protect forests'[25] promotes stingless beekeeping as a practice for maintaining floral diversity.

The First National Seminar on Stingless Bees was held in Mexico in July 1999,[15] and in the same year a session on meliponiculture was included in the Third Bolivarian meeting of the International Union for the Study of Social Insects (IUSSI), held in Colombia.[17] Also in 1999, chemical standards for stingless bee honey were suggested in a first draft during a specialized meeting of honey experts in France.[24]

The purposes of this study were: (1), to review the species frequently used in meliponiculture; (2), to explore the reported medicinal uses of stingless bee honey produced in Guatemala, Mexico and Venezuela; and (3), to suggest standards for stingless bee honey quality control.

Medicinal uses of Meliponinae honey

Stingless bee species used in meliponiculture are listed in table 1. *Scaptotrigona pectoralis* (fig. 2) and *Melipona beecheii* (fig. 3) hives illustrate the variety of local ideas for keeping stingless bees, that not only nest in hollow trees but also underground, e.g. *Trigona fulviventris* (fig. 4). A general comment on local names is that several different species of stingless bee may have the same local name, e.g. *Melipona compressipes, M. paraensis* and *M. trinitatis* are known as *guanota* in Venezuela. But also the same stingless bee species, e.g. *Trigona (Tetragonisca) angustula* has different names in the three countries, where it is known as *doncellita, señorita* and *angelita*.

The medicinal uses attributed to stingless bee honey are presented in table 2. A wide range of attributes may suggest that stingless bee honey enhances several systems to control digestive, respiratory, female fertility, skin and visual disorders. *M. beecheii* is the most important stingless bee species in Mexico and Guatemala due to the honey yields and reported medicinal properties. Pollen and cerumen from the nests are also used in local therapies, and the larvae of *Melipona* and *Trigona* species are included in local diets.[21] *Trigona (Tetragonisca) angustula* is the most frequently reported species for cataract treatment in Guatemala, Mexico and Venezuela.

European data on honey (*Apis*) composition is extensive compared with the scarce information available in Latin-America on

TABLE 1. Species frequently used in meliponiculture.

Species	Local names of stingless bees		
	Guatemala	Mexico	Venezuela
Cephalotrigona zexmeniae	congo	-	-
Melipona beecheii	criolla	abeja real	-
Melipona compressipes compressipes	-	-	guanota
Melipona fasciata	tinzuca	abeja real prieta	-
Melipona favosa favosa	-	-	erica
Melipona paraensis	-	-	guanota
Melipona trinitatis	-	-	guanota
Melipona solani	criolla	-	-
Melipona yucatanica	tinzuca	-	-
Nannotrigona perilampoides	serenita	doncellita prieta	-
Oxytrigona mediorufa	pringador	-	-
Paratrigona guatemalensis	chelerita	-	-
Plebeia jatiformis	serenita	-	-
Plebeia sp.	-	-	mosquito
Scaptotrigona mexicana	congo negro	negrita	-
Scaptotrigona pectoralis	congo canche	tenchalita	-
Scaura latitarsis	-	-	pegoncito
Trigona (Tetragona) dorsalis	alazán	-	-
Trigona (Tetragonisca) angustula angustula	doncellita	señorita	angelita
Trigona (Trigona) fulviventris	culo de chucho	-	-
Trigona (Trigona) nigerrima	joloncán	-	-
Trigona (Trigona) silvestriana	homo	-	-
Trigonisca sp.	chelerita	-	-

FIG. 3. Traditional stingless bee hive of *Melipona beecheii* in Guatemala.
photo: C Monroy

FIG. 4. Underground stingless bee nest entrance of *Trigona* (*Trigona*) *fulviventris* in Guatemala.
photo: C Monroy

studies of local honey, that does not even include the botanical origin classification. Other information lacking is the identification of the active principles associated with the medicinal properties, and whether secondary metabolites of botanical origin originate in nectar, resins or residual pollen.

Quality standards for stingless bee honeys

Although several *Apis* species and stingless bees produce honey widely relished by humans as a food, the official definition of 'honey' is restricted to *Apis mellifera* by the Codex Alimentarius Commission. Imitations of Meliponinae honey have been found in local markets in Mexico,[16] Guatemala and Venezuela (unpublished data). Honey standards have been modified according to the botanical origin but not according to the species origin.[25] It is important that these factors are taken into account and quality standards set for other types of stingless bee honey.

A proposal of quality standards for three genera of Meliponinae (*Melipona, Scaptotrigona, Trigona*) honey is suggested in table 3; they are compared with the accepted standards for *Apis mellifera*. These three genera have been chosen as representatives for the wider subfamily because previous work found statistical multivariate differences between these three groups.[28] However, this table is not attempting to condense the characteristics of honey produced by different genera, as in the honey standards accepted for only one species, the commercial *A. mellifera*. With this non-exclusive approach, we suggest three genera to be considered for the proposal of further standards for stingless bee honey.

Official methods for honey quality control have been developed for *A. mellifera* honey standards, and these are periodically reviewed by the Codex Alimentarius, the International Honey Commission (IHC) and country health authorities. The IHC works with researchers from 18 countries and has published two technical reports with inter-laboratory data of honey analyses.[1, 2]

Water content, reducing sugars, sucrose, acidity, ash, hydroxymethylfurfural (HMF) and diastase activity are the seven honey standards chosen here to contrast differences between genuine *A. mellifera* honey and honey from the Meliponinae genera *Melipona, Scaptotrigona* and *Trigona*. Our proposal is as follows:

- Water content for Meliponinae honey should increase the maximum limit of 20 g/100 g allowed for *A. mellifera* up to 30 g/100 g.
- The standard for reducing sugars should decrease the minimum limit of 65 g/100 g for *A. mellifera* down to 50 g/100 g.
- For sucrose the *A. mellifera* honey standard has a maximum limit of 5 g/100 g. There is a difference between the three Meliponinae genera studied, and so for *Melipona* and *Trigona* a higher maximum limit of 6 g/100 g is suggested, whereas for *Scaptotrigona* a lower maximum limit of 2 g/100 g is proposed. In a previous study,[27] the higher maltose content observed in *Scaptotrigona* honey could explain the lower limit suggested for sucrose.

If, because of the regulations set down for *A. mellifera* honey, stingless bee honey cannot be called 'honey', then the term 'divine elixir' has been suggested for Meliponinae honeys

FIG. 5. *Scaptotrigona mexicana* honey fermentation prior to bottling, Sierra Norte de Puebla, Mexico.

TABLE 2. Medicinal uses of stingless bee honey.

Species	Medicinal uses
Melipona beecheii	Digestive disorders, eye diseases, respiratory infections, wound healing, post-birth recovery, fatigue, casts for fractures, skin ulcers
Melipona favosa favosa	Delivery enhancer
Melipona paraensis	Post-birth recovery
Melipona trinitatis	Gastritis
Scaptotrigona mexicana	Respiratory infections
Nannotrigona perilampoides	Cataract and pterygion treatment, stomach aches, bruises
Plebeia jatiformis	Cataract, pterygion, external injuries on the head, stomach aches
Trigona (*Tetragonisca*) *angustula*	Stomach disorders, cataract and pterygion, respiratory infections, wound healing

TABLE 3. Suggested standards for stingless bee honeys, compared with official Codex Allimentarius Commission standards for *Apis mellifera* honey.

Honey composition	Standards			
	Apis mellifera	*Melipona*	*Scaptotrigona*	*Trigona*
Water content (g/100g)	max 20.0	max 30.0	max 30.0	max 30.0
Reducing sugars (g/100g)	min 65.0	min 50.0	min 50.0	min 50.0
Sucrose (g/100g)	max 5.0	max 6.0	max 2.0	max 6.0
Acidity (meq/100g)	max 40.0	max 70.0	max 85.0	max 75.0
Ash (g/100g)	max 0.5	max 0.5	max 0.5	max 0.5
HMF (mg/kg)	max 40.0	max 40.0	max 40.0	max 40.0
Diastase activity (DN)	min 8.0	min 3.0	min 3.0	min 7.0

- The acidity of stingless bee honey is very high compared with *A. mellifera*, which is also detected in the flavour. The standards should consider maximum acidity values of between 70 and 85 meq/100 g for non-fermented honey. Fermented stingless bee honey is believed to be more effective in treating respiratory diseases (unpublished data). However, this intentional fermentation, usually not controlled (see fig. 5), should be considered for processed honey, not for fresh honey. Fermentation is unacceptable in *A. mellifera* honey, but if it were shown to imbue medicinal properties in stingless bee honey, it should only be allowed as the result of a controlled fermentation process with a reproducible end product.
- The ash content and HMF can be kept the same as for *A. mellifera*, with a maximum of 0.5 g ash/100 g honey for all genera, and a maximum of 40 mg HMF/kg accepted in *A. mellifera* honey standards.
- *Scaptotrigona* honey has a low diastase activity, more similar to *Melipona* honey, while *Trigona* honey is more like *A. mellifera* honey. A reduced standard for diastase could consider minimum values of 3 DN (diastase number). Variations in diastase activity largely originate in the bees and were previously reported as lower in *Melipona* spp. honey;[12,26] this is not an indicator of heating the honey, but a result of its species origin.

We foresee that these proposed quality-control standards are a positive contribution to any modern medicinal practice promoting the health benefits of stingless bee products. *A. mellifera* honey is commercially more available because yields are much higher than in stingless bees. The medicinal properties of stingless bee honey should not be listed on *A. mellifera* honey labels. More specific honey standards could also be developed based on the physiological differences between the bees and their foraging behaviours. The statistical approach to discriminating the entomological origin of stingless bee honey at genus level, based on four chemical factors (reducing sugars, sucrose, diastase activity and nitrogen)[28] contributes to differentiate non-*Apis* honey standards.

As mentioned at the IHC meeting held in Athens in 2001,[14] the Codex Alimentarius Commission is considering the proposal to create a standard for honey produced by all species of bees, which would demand the establishment of an official methodology for identifying the species origin of honey in international trade. Cultural variations in plant- and animal-based folk medicines have so far been related only to idiosyncratic knowledge, available bioresources, education level, socioeconomic position, occupation and perception of the environment.[3] Not only the gap that exists between scientific research and empirical practice, but a conflict of interests, could delay the establishment of an expanded concept of what constitutes 'honey'. If, because of the regulations set down for *A. mellifera* honey, stingless bee

honey cannot be called 'honey', then the term 'divine elixir' has been suggested for Meliponinae honeys[28] as a possible alternative. Another approach could be to consider the less commercial non-*Apis* honeys under pharmaceutical regulations rather than those for food regulation, because these tropical honeys have a wider use as medicines than as sweeteners.

The raising of rural incomes by means of meliponiculture is not possible from honey profits unless strong co-operatives with good marketing strategies are established based on a public policy of environmental protection and sustainability. If stingless bee honey is to be promoted commercially, it is important to know its floral origin, and foraging behaviour in the different stingless bee species and floral sources vary widely.[22] Tropical bee floral resources have been less studied than the temperate ones,[29] and therefore unifloral tropical honeys and their active properties still require solid data to support their supposed medicinal properties.

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