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Honey quality of *Melipona* sp. bees in Acre, Brazil

Calidad de miel de abejas *Melipona* sp. en Acre, Brasil

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Abstract

Honey from stingless bees (*Melipona* sp.) is a nutritious and medicinal product economically valued in the informal Brazilian market, driven by the growing demand for natural products; however, its physicochemical characteristics are still unknown. Thus, the aim of this study is to evaluate the physicochemical profile of the stingless bee honey produced in Cruzeiro do Sul, Acre. Honey samples were analyzed following the methodology recommended by Ministério da Agricultura, Pecuária e Abastecimento; the following parameters were established: moisture, total sugars, reducing sugars, apparent sucrose, ash, crude protein, diastase activity, Brix degrees, free acidity, lactonic acidity, total acidity, pH, hydroxymethylfurfural, electrical conductivity, color and Lugol, Lund and Fiehe reactions. Results show that these parameters are not suitable for all samples, being incompatible with established standards, indicating that the current legislation on *Apis mellifera* is not suitable for all characters analyzed, mainly moisture content, corroborating the need to standardize guidelines for honey from stingless bees. Moreover, there was no tampering in the honeys analyzed.

Keywords: Apiculture; income source; legislation; meliponiculture; physicochemical profile; stingless bees.

Resumen

La miel de abejas sin aguijón (*Melipona* sp.) es considerada un producto nutritivo, medicinal, económico y valorizado en el mercado informal del Brasil, impulsado por la creciente demanda de productos naturales. Sin embargo, las características fisicoquímicas del producto aún son poco conocidas. Por lo tanto, el objetivo de este estudio fue evaluar las características fisicoquímicas de la miel de abejas sin aguijón producidas en Cruzeiro do Sul, Acre, Brasil. Las mieles se analizaron de acuerdo a la metodología recomendada por el Ministério da Agricultura, Pecuária e Abastecimento, y los siguientes parámetros se establecieron: humedad, azúcares totales, azúcares reductores, sacarosa aparente, ceniza, proteína cruda, actividad de la diastasa, grados Brix, acidez libre, acidez lactónica, acidez total, pH, hidroximetilfurfural, conductividad eléctrica, color y reacciones de Lugol, Lund y Fiehe. Los resultados de este trabajo demuestran que estos parámetros no son adecuados para todas las muestras, siendo incompatibles con las normas establecidas, indicando que la legislación vigente para *Apis mellifera* no es adecuada para todas las variables analizadas, principalmente el contenido de humedad, lo que corrobora la necesidad de una estandarización propia para la miel de abejas sin aguijón. Se demostró también que no se encontró ningún tipo de adulteración en las mieles analizadas.

Palabras clave: Abejas sin aguijón; Apicultura; fuente de ingresos; legislación; meliponicultura; perfil fisicoquímico.

Introduction

Meliponiculture is the rational breeding of stingless bees or also called meliponines. Stingless bees belong to the Meliponinae subfamily, which is divided into two tribes: i) Meliponini, comprised by the sole genus *Melipona* found exclusively in neotropical regions, and ii) Trigonini, which groups several genera distributed throughout the tropics (Nogueira-Neto, 1997). Absence of sting is a specific feature of Meliponines. Although still little known about these stingless bees, they are very important because they have been carrying out their role as pollinators for millions of years.

These small insects have a singular importance in the maintenance of plant diversity in native Brazilian forests. Their work is essential for biodiversity maintenance, with a significant contribution to ecological balance worldwide. Furthermore, over 90 % of Brazilian trees depend on native bees, which are their main pollinators (Ballivián, 2008).

Honey composition depends mainly on plant sources from which is derived, but also of different factors such as soil, bee species, colony physiology, honey maturation, harvest, among others. In general, honey from meliponines has, as a main characteristic, different compositional contents emphasizing in water content (humidity), that makes it less dense than the honey of Africanized bees (*Apis mellifera*) (Campos & Della Modesta, 2000).

According to Silveira, Melo & Almeida (2002), there are ca. 192 species of indigenous stingless bees in Brazil, bred especially for honey production and its byproducts (Aquino, 2006).

Bee breeding in Brazil is divided into two distinct practices: beekeeping and meliponiculture. Beekeeping is the most widespread and known practice, that consists in the management of *Apis mellifera* bees and products from their hives (Nogueira-Neto, 1997). In Brazil, there are laws advocating quality standards for honey, pollen, propolis and royal jelly (MAPA, 2000). On the other hand, we have meliponiculture or the rational stingless bees breeding (Aquino, 2006); it has however, still little technological development so it carried out by hand, and knowledge on practices has been passed down from one generation to another. However, meliponiculture has been gaining ground since the last decades, consolidating itself as a sustainable alternative for rural families in Brazil, and is growing in popularity as an income source (Souza, Carvalho, Sodré & Marchini, 2004). Breeding and management of these bees has been promoted by governmental and non-governmental organizations attracting the interest of farmers, mainly because these bees are non-aggressive and do not have a stinger. Rational breeding of these insects is an activity that generates employment and income, becoming an economically viable, sustainable and socially fair activity, which in turn is reflected in the improvement in the well-being and life quality of the meliponicultor or the small producer and his/her family.

Despite the high importance of this activity, honey studies from stingless bees are still insufficient, especially those on physicochemical characteristics that come from different species, soils and climatic conditions where this honey was produced. Moreover, this will help to establish quality standards for the marketing of this honey, because most of the work aimed at obtaining knowledge on this product, take into account standards and characteristics established by the Normative Instruction No. 11 for honey of October 20, 2000 (Souza *et al.*, 2004).

In addition, the physicochemical analysis of honey samples are performed in order to compare the results obtained with the standards established by national and international official bodies, showing not only a concern for honey quality produced in the country and its regions, but also as a way to supervise honey imported from other countries (Carvalho, Sodré, Fonseca, Alves & Souza, 2006). Therefore, considering the above mentioned, the aim of this study was to establish the quality profile of honey samples from stingless bees produced in Cruzeiro do Sul – Acre, Brazi.

Material and methods

Study site and samples

Honey samples were collected in Cruzeiro do Sul – Acre, Brazil. The region has a great diversity of plant species in primary and secondary forest in various development stages. Climatic conditions are tropical hot and humid, with an average annual temperature of 24 °C.

We assessed 16 honey samples from stingless bees collected between October and November 2014 in the area of Cruzeiro do Sul–Acre. Samples were collected as follows: eight samples were gathered in Station 3 (8° 01’ 13.70” S and 72° 24’ 05.71” W). Four samples were taken in the experimental meliponary at Campus Floresta of Universidade Federal do Acre (UFAC) (7° 33’ 38.63” S and 72° 43’ 02.84” W). The last four samples were collected in Paraná do Pentecostes (7° 31’ 17.54” S and 72° 54’ 19.64” W).

Moreover, samples 1 to 3, 5 to 7, 9 to 11 and 13 to 15 are from the species *Melipona scutellaris* (Uruçu), and samples 4, 8, 12 and 16 are from the species *Melipona* sp. (Jandaíra). Honey samples were collected from these two species mainly because they are the most common ones found the region and they show, according to beekeepers, better honey production.

Honey samples were collected carefully with the aid of 10 mL disposable syringes in which pieces of cannulas attached to the equipment; moreover, gloves were used when samples were taken. Honey samples were packed in glass jars of 300 mL with plastic hermetic closure lids previously sterilized in an autoclave. After collecting the honey samples, these were kept under refrigeration at 4°C (± 2) until they were analyzed.

Variables measured

When samples were analyzed these were taken out of refrigeration and were subject to homogenization and stabilization at room temperature. Then, the analyses were performed in triplicate for each sample.

Moisture content was determined in an oven at 105 °C until constant weight according to the AOAC method (2010). For sugars analysis we used the method recommended by IAL (2008). Apparent sucrose was measured after inversion by acid hydrolysis as recommended by the normative instruction of Ministério da Agricultura, Pecuária e Abastecimento (MAPA) [Ministry of Agriculture, Livestock and Food Supply] (MAPA, 2000). Ashes were quantified using the gravimetric method described by the Brazilian legislation for *Apis mellifera* honey based on the Codex Alimentarius (2001), as an adequate method recommended by MAPA (2000). Protein content was determined using the micro Kjeldahl method for total nitrogen, and using the conversion factor of 6.25 for crude protein according to AOAC (2010). Diastase activity analysis was carried out using the spectrophotometric method described by the Brazilian legislation (MAPA, 2000) based on the Codex Alimentarius (WHO, 2001). Establishment of °Brix for honey samples was carried out using the refractometric method of Chataway, which is an indirect method recommended by the Brazilian legislation (MAPA, 2000) based on the AOAC (2010). Free acidity in honey is the sum all free acid content expressed in meq.kg^{-1} (milliequivalents.honey kg^{-1}), as described by the Brazilian legislation (MAPA, 2000) and AOAC (2010). In addition, pH was measured with a digital pH-meter according to the methodology stated by MAPA (2000). Moreover, hydroxymethylfurfural analysis was conducted in accordance with Brazilian legislation (MAPA, 2000) and AOAC (2010). For electrical conductivity, readings were carried out in a digital display device. Furthermore, to establish color, data obtained in the spectrophotometer were transformed into color using the Color Range Pfund, in accordance with Brazilian legislation (MAPA, 2000). Moreover, color intensity will depend on the quality and quantity of dextrin or starch (MAPA, 2000). Lugol reaction indicates the presence of glucose or syrup. Furthermore, Lund reaction indicates the presence of albuminoids and its absence indicates tampering. In presence of pure honey, there will be presence of a precipitate in the bottom of the tube, which may vary from 0.6 to 3.0 mL. Lower or higher values indicate fraud or tampering (MAPA, 2000). In addition, Fiehe reaction in presence of commercial glucose or superheated honey, causes the solution to change from clear to an intense red color, indicating the presence of tampered honey (MAPA, 2000).

Statistical analysis

Data obtained were evaluated with an analysis of variance (ANOVA) and with the Scott-Knott test at 5 % of significance to compare means. The analyses were carried out using the computer package SISVAR.

Results

Results showing mean results obtained in the physicochemical analysis of 16 honey samples from Cruzeiro do Sul – Acre, are shown in Tables 1 and 2.

Table 1. Variables quantified in honey samples from stingless bees produced in Cruzeiro do Sul - Acre

Sample	Analysis						
	A (%)	TA (%)	RS (%)	AS (%)	ASH (%)	PR (%)	DA (Gothe scale)
1	45.8m	52.2b	47.1c	5.0f	0.24a	0.18a	16.7b
2	45.6m	50.6a	48.6e	2.0b	0.32c	0.21b	15.0a
3	41.9i	52.4b	51.1e	1.4a	0.29b	0.24c	23.3c
4	36.5e	59.9b	53.7g	6.1g	0.46g	0.17a	20.0c
5	43.6l	50.1a	48.2d	1.9b	0.30b	0.24c	14.0a
6	43.9l	51.6a	47.3c	4.4e	0.42f	0.19a	16.7b
7	41.2h	53.4b	48.2d	5.2f	0.43f	0.23b	16.7b
8	42.5j	44.3a	42.9a	1.4a	0.45g	0.24c	15.0a
9	42.8j	50.1a	44.6b	5.4f	0.42f	0.22b	13.0a
10	40.6g	51.2a	48.4d	2.8c	0.42f	0.28d	16.7b
11	36.1e	51.7a	49.2e	2.5c	0.37e	0.21b	14.0a
12	30.3c	59.1b	54.6h	4.5e	0.46g	0.25c	18.3b
13	34.1d	54.8b	51.1e	3.8d	0.36d	0.28d	10.7a
14	28.7b	53.5b	51.8f	1.7b	0.41f	0.29d	12.0a
15	38.2f	53.9b	48.1d	5.8g	0.30b	0.25c	16.7b
16	27.7a	61.6c	55.6j	6.0g	0.49h	0.29d	11.3a
Minimum	27.7	44.3	429	1.4	0.24	0.17	10.67
Maximum	45.8	61.6	55.6	6.1	0.49	0.29	23.33
Average	38.7	53.1	49.4	3.8	0.38	0.23	15.63
P.D.	5.9	4.2	3.4	18	0.07	0.04	3.27
C.V.	0.73	8.04	0.45	4.98	3.33	5.71	15.59

A: moisture content; TA: total sugars; RS: reducing sugars (RS); AS: apparent sucrose; ASH: ash; PR: proteins; DA: diastase activity

Same letters in the same column means that these do not differ from each other according to the Scott-Knott test at 5 % probability. P.D.: probability distribution; C.V.: Coefficient of variation.

Honey samples from stingless bee produced in Cruzeiro do Sul had average moisture content of 38.7 % ranging from 27.7 % to 45.8% (Table 1). Honey samples showed significant differences with the Scott-Knott test at 5%.

Table 2. Variables measured in honey samples from stingless bees produced in Cruzeiro do Sul - Acre

Sample	Analysis						
	°BRIX (°Bx)	F.AC (meq.kg^{-1})	LAC.AC (meq.kg^{-1})	TOT.AC (meq.kg^{-1})	pH	HMF (mg.kg^{-1})	COND (µS.cm^{-1})
1	69.0i	25.3b	9.8f	35.2b	4.0e	12.3h	291.3c
2	67.3g	32.7e	8.3d	41.0e	4.3f	13.4i	419.7h
3	66.9f	35.2f	5.6b	40.8e	3.5d	13.2i	286.3b
4	6.,8h	26.2c	9.0e	35.3b	4.4h	3.5c	385.0g
5	69.2j	27.8d	9.5f	37.4c	4.3f	8.4f	462.7i
6	73.1k	26.8c	12.1h	38.9d	4.4g	9.2g	513.0l
7	66.4e	46.6h	8.8e	55.4h	3.1a	12.0h	380.7g
8	65.1d	52.3j	8.5d	60.8i	3.2b	13.2i	481.0j
9	61.8a	61.5l	9.1e	70.7j	3.2b	2.2b	469.0i
10	64.1c	43.6g	4.8a	48.4g	3.8a	15.3j	277.7a
11	65.1d	47.7i	8.5d	56.2h	3.0a	8.9g	301.7d
12	70.11j	35.8f	10.4g	46.2f	3.2b	0.8a	484.0j
13	66.3e	26.8c	8.3d	35.1b	3.4c	7.9e	324.0e
14	70.1lj	27.6d	12.4h	40.0e	3.5d	7.5d	351.7f
15	62.4b	32.3e	9.2e	41.5e	3.2b	9.0g	385.3g
16	76.1l	23.8a	7.2c	30.5a	3.3c	0.8a	463.0i
Minimum	61.8	23.8	4.8	30.5	3.0	0.8	277.7
Maximum	76.1	61.5	12.4	70.7	4.4	15.3	513.0
Average	67.5	35.7	8.9	44.6	3.6	8.6	392.3
D.P.	3.7	11.3	1.9	11.0	0.5	4.7	80.3
C.V.	0.14	1.71	2.58	1.51	1.00	2.65	0.95

Same letters in the same column do not differ from each other, by the Scott-Knott test at 5% probability.

°BX: Brix degrees; F.AC: free Acidity; LAC.AC: lactonic acidity; TOT.AC: total acidity; HMF: hydroxymethylfurfural; COND: electrical conductivity.

Total sugar concentrations in honey samples ranged from 44.31 % to 61.65 %, with a mean value of 53.16 %. There were no significant differences among each other using the Scott-Knott test at 5 %. Total sugars correspond to the result of the sum of reducing sugars and apparent sucrose; however, the Brazilian legislation does not establish standardized parameters for this variable. Moreover, reducing sugars found in samples of honey analyzed showed variation from 42.95 % to 55.60% with an average of 49.39%. In addition, apparent sucrose showed a variation from 1.36 % to 6.13 %, averaging 3.77 % and a coefficient of variation of 4.98 % (Table 1).

Ash content directly expresses the amount of minerals present in honey. Among the 16 samples analyzed, the variation ranged from 0.24 % to 0.49 %, averaging 0.38 %. Results in protein percentages showed an average of 0.23 % and ranged between 0.17 % and 0.29 % (Table 1). Results obtained for diastase activity in the 16 samples evaluated showed a range from 10.67 to 23.33 in Gothe scale with an average of 15.63 and a coefficient of variation of 15.59 (Table 1).

Regarding Brix degrees in honey samples evaluated, values ranged from 61.8 °Bx to 76.1 °Bx with a mean value of 67.5 °Bx (Table 2). Samples 8 and 11, 7 and 13, 1 and 5, 12 and 14 did not differ from each other, being statistically different from the other samples according to the Scott-Knott test at 5 % probability.

Results of free, lactonic and total acidities ranged from 23.37 to 61.54 meq.kg^{-1}, 4.79 to 12.41 meq.kg^{-1} and 30.53 to 70.66 meq.kg^{-1} respectively, with average values of 35.73 meq. kg^{-1} for free acidity, 8.86 meq.kg^{-1} for lactonic acidity and 44.59 meq.kg^{-1} for total acidity. Among the 16 samples analyzed, only the sample 9 showed values out of the pattern according to the national standards (MAPA, 2000) (Table 2).

In relation to pH value found in honey samples assessed, values varied between 3.04 and 4.42 with an average value of 3.59 (Table 2). Samples 03, 13, 14 and 16; and the samples 08, 09, 12 and 15 did not differ statistically from each other by the Scott-Knott test at 5 % of probability.

HMF analysis results ranged from 0.8 to 15.3 mg.kg^{-1} with an average of 8.6 mg.kg^{-1}. Additionally, the analysis of the 16 honey samples showed a conductivity ranging from 277.7 to 513.0 µS.cm^{-1}, averaging 392.3 µS.cm^{-1} (Table 2). Samples 03 and 10; 01 and 03; 04, 07 and 15; 05, 09 and 16; 08 and 12, do not differ among each other by the Scott-Knott test at 5% probability.

Color classification in the samples analyzed were framed in only two colors, ranging from an extra light amber color to a light amber color, with 31 % of the samples having an extra light amber color and most of the samples (69 %) had a light amber color.

Furthermore, reaction with Lugol indicates the presence of commercial sugar. In the study, 100% of the samples tested negative, indicating that there was no tampering with commercial sugar in the samples analysed. Moreover, Lund reaction has the purpose of indicating honey purity through tannic acid precipitation, which is added to the sample during the test. When honey is free from adulteration, it forms a precipitate of ca. 0.6 to 3.0 mL in the bottom of the test tube. When values are higher than 3.0 mL this indicates that the honey was tampered with artificial honey. In all the analyses, the results showed a precipitate ranging from 0.6 to 0.9 mL, indicating that samples were not tampered. In addition, Fiehe test indicates honey overheating or that the product was rigged, e.g. addition of sugar or sugar cane honey. However, all 16 samples tested were negative for tampering. Honey heating is performed in an attempt to reuse a product that is in the process of fermentation, or to decrease crystallization. Honey overheating is prohibited by Brazilian legislation according to MAPA (2000).

Discussion

Honey samples evaluated for moisture content did not meet the regulations established by MAPA (2000), Due to values that are above from the maximum allowed value that is 20 % for quality control in honey. It must be noted that limits for honey are the ones already established for honey produced by bees from the *Apis* genus, and there is still not a standard for honey from stingless bees. High moisture content found in the honey from stingless bees is related to the low nectar dehydration rate during the transformation process in honey and wetland habitat (Alves, Carvalho, Souza, Sodré, Marchini, 2005). Moisture above the recommended 20 % can increase the risk of honey sugar fermentation caused by osmophilic microorganisms. Another factor that was observed during collection is that meliponiculture has no way to gauge the degree of honey maturity; in addition, there are no registration dates and procedures performed in nests and hives. In some cases, the boxes did not have any identification at all.

According to Souza *et al.* (2004), in a study including several species of stingless bees, the authors obtained variations between 19.90 % to 41.90% of humidity. Moreover, in a work carried out by Alves *et al.* (2005), all samples obtained values that were higher than 20%, showing moisture contents above the ones specified as standard. Furthermore, results of works carried out in dry environments, also kept water levels above 20 %, featuring honey from stingless bees as having high percentage of moisture products, which can contribute to the growth of yeasts, reducing its useful life (Souza *et al.*, 2004).

Reducing sugars in 16 analyzed samples of honey showed variation from 42.95 % to 55.60 %. MAPA (2000), has suggested a value of at least 65 % of reducing sugar to the technical quality standards for *Apis* honey. We noted that none of the samples fit these standards as we found values lower than what current regulations have suggested. Results found are similar to those mentioned by Carvalho *et al.* (2006), who found variations from 42.55 % to 55.61%, and lower than those found by Souza *et al.* (2004), i.e. values between 58.0 % and 75.7%.

Apparent sucrose showed a variation from 1.36 % to 6.13 %, however, results registered by Carvalho *et al.* (2006), with honey from meliponines, found a range from 0.85 % to 2.15 %, and Souza *et al.* (2004) that compiled analyses from eight countries in the Americas, found values ranging from 1.1 % to 4.8 %. Technical honey quality standards established by MAPA (2002), state a maximum value of 6 % of sucrose. Our results show that only one (1) out of 16 samples showed values above the maximum allowed limit, although the surplus value is only 0.13 %.

Ash content expresses directly the amount of minerals present in honey, and the variation found in this study varied from 0.24 % to 0.49 %. When we compared ash values among bee species, we found that ash in *Melipona* sp. honey varied from 0.43 to 0.49 %, while the one in honey from *Melipona scutellaris* showed values ranging from 0.23% to 0.45%. The work published by Carvalho *et al.* (2006), with honey samples from different bee species, found levels ranging from 0.04 % to 0.50 % of ash. Moreover, Silva, Queiroz & Figueiredo (2004), found a mean percentage of 0.10 % for a range from 0.06 % to 0.14 %. The standard maximum allowed limit by Brazilian law regarding ash is 0.6 % (MAPA, 2000), framing all samples in this variable.

Protein percentages found ranged between 0.17 % and 0.29 %. Values differ statistically from each other by the Scott-Knott test at 5 % probability. Protein values are lower than the honey values found by Souza *et al.* (2004), who found values ranging from 0.04 % to 1.21 % protein; on the contrary, Carvalho *et al.* (2006), found much higher protein levels ranging from 0.4 to 2.84 %. Brazilian law does not have standards for protein amount that must be found in honey. This analysis can be used to detect possible tampering with commercial products (Crane, 1983).

Results obtained for diastase activity showed a range from 10.67 to 23.33 in Gothe scale. Fonseca *et al.* (2006), analyzing honey from different species of stingless bees and found a much bigger range from 0.67 to 19.78 in Gothe scale.

Color classification in the samples analyzed were framed in only two colors, ranging from an extra light amber color to a light amber color, with 31 % of the samples with an extra light amber color and most of the samples (69 %) had a light amber color. According to Souza *et al.* (2004), there was a color change from white-water to dark amber. Moreover, in honey analyzed from stingless bees, they noted predominance of lighter tones.

Analyzes showed that the Brix degrees in honey samples evaluated ranged from 61.8 °Bx to 76.1°Bx. A study carried out by Silva *et al.* (2004), showed Brix values ranging from 76.07 °Bx to 80.80 °Bx, analyzing honey samples from *Apis* bees from the state of Piauí. The average value found by Silva, Aquino, Rodrigues & Souza (2009), was 83.28 °Bx. Moreover, in an analysis of 15 samples collected in different cities in the state of Goiás, the average was 81.04 °Bx, being 78.3 °Bx the lowes value and 85 °Bx the highest result

(Silva, Monteiro and Alcanfor, 2003). However, current Brazilian legislation does not require the completion of ºBrix analysis to establish honey quality.

In relation to pH value for the honey samples assessed, values varied between 3.04 and 4.42. In a work carried out by Souza *et al.* (2004), which compiled the results of 152 honey samples from several species of stingless bees, the authors obtained a pH range from 3.15 to 4.66. The analysis of pH is not provided as a requirement and the Brazilian or international legislations do not standardize it; however, it is performed as an auxiliary parameter for evaluating the acidity. Moreover, the pH value in honey can be influenced by the botanical source and soil (Crane, 1983).

Additionally, HMF analysis results ranged from 0.8 to 15.3 $mg.kg^{-1}$ indicating that all samples have values below the maximum value established by the Brazilian legislation, which has a maximum of 50 $mg.kg^{-1}$, and is also below the value expected by the Codex Alimentarius (WHO, 2001), which is 40 $mg.kg^{-1}$. Moreover, samples 04, 12 and 16, belonging to the species *Melipona* sp., showed statistically the lowest levels of HMF. Research conducted by Carvalho *et al.* (2006), obtained values ranging from 3.14 to 6.64 $mg.kg^{-1}$ when analyzing different honey samples.

Furthermore, conductivity ranged from 277.7 to 513.0 $\mu S.cm^{-1}$. Although this parameter is not required by Brazilian standards, European legislation established 800 $\mu S.cm^{-1}$ as the maximum acceptable value; therefore, all the samples of this study are in accordance with the values required by the Codex Alimentarius (2001). In addition, in a study carried out by Carvalho *et al.* (2006), analyzing honey from different species of stingless bees, authors found a range from 384.78 to 954.95 $\mu S.cm^{-1}$, while Souza *et al.* (2004), found a mean value of 1,362.67 $\mu S.cm^{-1}$, i.e. values higher than the average found in this work. Low electrical conductivity values may be related to low levels of mineral matter previously found.

Conclusion

None of honey samples met all quality criteria determined by Ministério da Agricultura, Pecuária e Abastecimento (MAPA), Brazil as honey suitable for table consumption. Given these concerns, excess of moisture in samples is primarily responsible for marketing failure. In this study, all samples were negative to adulteration test. However, there is a need to adapt the Brazilian legislation to include values for honey from different species of stingless bees.

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