UFSM

CIÊNCIA e NATURA

ISSN 2179-460X
OPEN ACCESS

Ci. e Nat., Santa Maria, v. 45, e30, 2023 • https://doi.org/10.5902/2179460X72016
submitted: 18/10/2022 • approved: 06/06/2023 • Published: 06/11/2023

Chemical

Identity and quality standards for brazilian stingless bee honey based on physicochemical parameters – a review

Padrões de identidade e qualidade de méis de abelha-sem-ferrão brasileiros baseados em parâmetros físico-químicos– uma revisão

Débora Mayumi Sato[I], Jéssica Barrionuevo Ressutte[I], Marcos Aparecido Gonçalves[I] Wilma Aparecida Spinosa[I]

[I] Universidade Estadual de Londrina, Londrina, PR, Brazil

ABSTRACT

Honey from stingless bees has a physicochemical composition that varies according to the nectar source, climate, and bee species. Due to its unique flavor and aroma, stingless bee honey has become popular; however, the lack of regulation for this type of product makes its formal marketing and quality control difficult. Although Brazil does not have federal legislation that defines the physicochemical parameters for stingless bee honey, the states of Paraná, Santa Catarina, Rio Grande do Norte, Bahia, Amazonas, and São Paulo have established specific identity and quality standards. Thus, this study aimed to review the physicochemical parameters of stingless bee honey using data published between 2017 and 2022. The data from 34 studies were compared with existing state regulations for stingless bee honey, and in the absence of this, they were compared with the Brazilian legislation for *Apis mellifera* honey and with state regulations present in the same region. It was concluded that the physicochemical parameters are not in accordance with Brazilian legislation for *Apis mellifera* honey. On the other hand, when compared with state regulations, most of the data obtained are in accordance with the laws established for each state, also indicating the need for regulation at the federal level.

Keywords: State regulations; Stingless bee honey; Quality standard

RESUMO

O mel de abelha-sem-ferrão possui composição físico-química que varia de acordo com a fonte de néctar, clima e espécie de abelha. Devido ao seu sabor e aroma único, o mel de abelha-sem-ferrão tornou-se popular; no entanto, a falta de regulamentação para este tipo de produto dificulta sua comercialização formal e controle de qualidade. Embora o Brasil não tenha legislação federal que defina os parâmetros físico-químicos do mel de meliponíneo, os estados do Paraná, Santa Catarina, Rio Grande do Norte, Bahia, Amazonas e São Paulo estabeleceram padrões específicos de identidade e qualidade. Assim,

este estudo teve como objetivo revisar os parâmetros físico-químicos do mel de abelha-sem-ferrão utilizando dados publicados entre 2017 e 2022. Os dados de 34 estudos foram comparados com as regulamentações estaduais existentes para o mel de abelha-sem-ferrão e, na ausência desta, foram comparados com a legislação brasileira para o mel de *Apis mellifera* e com regulamentações estaduais presentes na mesma região. Concluiu-se que os parâmetros físico-químicos não estão de acordo com a legislação brasileira para o mel de *Apis mellifera*, por outro lado, quando comparados com as regulamentações estaduais, a maioria dos dados obtidos estão de acordo com as leis estabelecidas para cada estado, indicando também a necessidade de regulamentação a nível federal.

Palavras-chave: Regulamentação estadual; Mel de abelha-sem-ferrão; Padrão de qualidade

1 INTRODUCTION

Stingless bees are part of the Meliponinae subfamily, which is composed of different genera and a wide variety of species. Stingless bees are found mainly in tropical and subtropical regions of the world, and their main characteristic is the presence of atrophied stingers (Ávila *et al*., 2018). In Brazil, approximately 300 species of stingless bees have been described, which are distributed throughout all regions of the country, mainly in the north and northeast regions (Fernandes; Rosa; Conti-Silva, 2018).

Stingless bees are considered national heritage due to their role in maintaining the Brazilian flora, acting in the pollination of several native plant species (Fernandes; Rosa; Conti-Silva, 2018). In addition to being important for nature, stingless bees produce honey, propolis and pollen, which have relevant economic value and are used mainly as food and medicine due to their nutritional and therapeutic properties (Biluca *et al*., 2019; Ribeiro *et al*., 2018).

Honey is the most known and commercialized bee product, and honey from stingless bees, in particular, has a unique flavor and aroma that makes it highly appreciated (Ávila *et al*., 2018; Barbosa *et al*., 2018). However, unlike honey from bees of the genus *Apis*, which has the identity and quality standard defined and regulated by Instrução Normativa 11, of October 20, 2000 of Ministério da Agricultura, Pecuária e Abastecimento (MAPA) (Brasil, 2000), to date, honey from stingless bees does not have a federal regulation that defines its physicochemical parameters. This factor makes its

characterization, quality control and formal commercialization difficult. Because of this, the states of Paraná, Santa Catarina, Rio Grande do Norte, Bahia, Amazonas, and São Paulo have established specific identity and quality standards for stingless bee honey.

Therefore, the objective of this study is to carry out a review of the physicochemical parameters of stingless bee honeys from different states of Brazil, published between 2017 and 2022, and compare these data with existing state regulations and, in the absence of this, with the Brazilian federal legislation for *Apis mellifera* honey and with state regulations present in the same region.

1.1 Stingless bee

Stingless bees are social insects that live in large groups consisting of a queen, drones (males) and workers (ranging from 300 to 80,000 depending on the species). In the hive, each type of grouping has different functions. Stingless bees, unlike *Apis mellifera* bees, do not have the ability to sting. These bees inhabit tropical and some subtropical regions of the world, such as Latin America, Africa, southwest Asia, and northern Australia. In Brazil, a great diversity of species can be found scattered throughout the country (Braghini *et al*., 2020; Lavinas *et al*., 2019).

The genera that constitute Meliponini are separated into two large groups, Meliponas and Trigoniformes (ancient Trigonini tribe). The two groups differ in the size of the bees' body, in the geographical position where they are found and, in the material, used to prepare the entrance of their nests. While Meliponini (larger bees that are found in the Neotropics) use geopropolis (a mixture of clay and propolis), Trigonini (smaller bees that are located in the Tropics) use only wax (Ávila *et al*., 2018; Salatino; Pereira; Salatino, 2019; Silva; Ramos, 2021; Villas-Bôas, 2012). The taxonomic classification of stingless bees is shown in table 1.

Table 1 – Taxonomy of stingless bees

Kingdom	Animalia
Phylum	Arthropoda
Subphylum	Hexapoda
Class	Insecta
Order	Hymenoptera
Superfamily	Aipodea
Family	Apidae
Subfamily	Meliponinae
Tribe	Meliponini

Source: Integrated Taxonomic Information System – ITIS (2022)

According to Silva and Ramos (2021), approximately 400 species of stingless bees are currently described, of which approximately 250 species belong to the genus Melipona (Tribe Meliponini). Table 2 describes some scientific names of stingless bee species present in Brazil, with their respective popular names.

Bees are important for the maintenance of biomes, as they act as pollinators of various plants and vegetables (Rezende *et al*., 2020). Daily visits are made to several flowers to obtain pollen (source of protein) and nectar (source of energy) (Silva; Lima; Paz, 2012). During flower visitation, these insects transport pollen grains (male reproductive cells) from one flower to the stigma (female reproductive cells) of another, promoting cross-pollination and increasing the genetic variability of plants and vegetables (Dar *et al*., 2017). In Brazil, 90% of plant species in the Atlantic Forest and 30% of plant species in the Caatinga and Pantanal are pollinated by stingless bees (Silva; Ramos, 2021).

Table 2 – Meliponini species in Brazil and their popular names

Scientific name	Popular name
Cephalotrigona capitata Smith, 1854	Mombucão; Abelha-papaterra
Friseomelitta doederleini Friese, 1900	Moça-branca
Melipona asilvai Moure, 1971	Manduri rajada
Melipona bicolor Lepeletier, 1836	Guaraipo
Melipona bicolor schencki Gribodo, 1893	Guaraipo
Melipona capixaba Moure & Camargo, 1994	Uruçu capixaba
Melipona compressipes Fabricius, 1804	Jandaira-preta-da-Amazônia
Melipona fasciculata Smith, 1854	Tiúba
Melipona flavolineata Friese, 1900	Uruçu-amarelo; Iraçu
Melipona interrupta Latreille, 1811	Jupará
Melipona mandacaia Smith, 1863	Mandaçaia
Melipona marginata Lepeletier, 1836	Monduri; Mandurim
Melipona mondury Smith, 1863	Bugia; Tujuva
Melipona quadrifasciata Lepeletier, 1836	Mandaçaia
Melipona quadrifasciata anthidioides Lepeletier, 1836	Mandaçaia
Melipona quinquefasciata Lepeletier, 1836	Uruçu-do-chão
Melipona scutellaris Latreille, 1811	Uruçu verdadeira
Melipona seminigra Friese, 1903	Uruçu-boca-de-renda
Melipona subnitida Ducke, 1910	Jandaíra
Melipona (Michmelia) paensis Ducke, 1916	Uruçu-boca-de-ralo
Melipona torrida Friese, 1916	Manduri
Oxytrigona tataíra Smith, 1863	Cagafogo
Scaptotrigona bipunctata Lepeletier, 1836	Tubuna; Canudo
Scaptotrigona depilis Moure*, 1950*	Canudo; Tubiba
Scaptotrigona postiça Latreille, 1807	Mandaguari
Scaptotrigona polysticta Moure, 1950	Abelha-canudão; Mijui
Scaptotrigona xanthotricha Moure, 1950	Mandaguari-amarelo
Tetragona clavipes Fabricius, 1804	Borá
Trigona spinipes Fabricius, 1793	Arapuá
Tetragonisca angustula Latreille, 1811	Jataí

Source: Catalog of Moure (2022)

1.2 Stingless bee honey

Honey is a complex natural solution that is mainly composed of sugars obtained from the nectar of flowers or secretions and excretions from living parts of plants or insects. Its chemical composition varies according to the type of soil, climate, vegetation, and bee species. In addition to different sugars (monosaccharides, disaccharides and trisaccharides), honey also contains water, organic acids, enzymes, proteins, amino acids, vitamins, minerals, phenolic

compounds, pigments, and pollen grains (Nešović *et al*., 2020; Seraglio *et al*., 2019).

Beekeeping can be divided into Apiculture and Meliponiculture, which aim to create *Apis mellifera* bees and stingless bees, respectively, both having honey as the main product. Honey from stingless bees has a higher moisture content and water activity, which makes it more prone to the fermentation process due to the proliferation of bacteria, molds and yeasts (Ribeiro *et al*., 2018). Meliponiculture is an ancient practice carried out by indigenous people since pre-Hispanic periods, when honey was the main source of sugar for man (Silva; Ramos, 2021). Currently, honey is used as a natural option to sweeten foods and as a medicine due to its antimicrobial, antifungal and anti-inflammatory activity (Ali *et al*., 2020; Alves *et al*., 2011).

The price of stingless bee honey on the market is higher than that of *Apis mellifera* honey, which is mainly justified by the low production of stingless bee honey. Despite this, the search for this type of product has increased in recent years. Thus, the quality control of stingless bee honey is extremely important for reliable commercialization, since physicochemical and sensory changes in the product can also be altered by human action (Ávila *et al*., 2018; Braghini *et al*., 2020; Schvezov *et al*., 2020).

1.3 Physicochemical parameters and Brazilian regulations for stingless bee honey

The identity and quality standard of honey produced by *Apis mellifera* bees in Brazil is regulated by Instrução Normativa n° 11, de 20 de outubro de 2000 do Ministério da Agricultura, Pecuária e Abastecimento (MAPA) (Brasil, 2000). The physicochemical parameters and their limits are shown in table 3.

Table 3 – Honey identity and quality standard defined by Brazilian legislation

Physicochemical parameters	Reference data
Reducing sugar (%)	Minimum 65.0
Sucrose (%)	Maximum 6.0
Moisture (%)	Maximum 20.0
Acidity (meq/kg)	Maximum 50.0
Hydroxymethylfurfural (mg/kg)	Maximum 60.0
Ash (%)	Maximum 0.6
Water-insoluble (%)	Maximum 0.1
Diastase activity (Göthe)	Minimum 8.0

Source: Brasil (2000)

Considering the growing demand for stingless bee honey in the national and international markets and the lack of comprehensive and adequate legislation, the regulation of this product is necessary. Although there is currently no federal legislation that defines the identity and quality standard of stingless bee honey, the States of Paraná (Paraná, 2017), São Paulo (São Paulo, 2017), Santa Catarina (Santa Catarina, 2020), Bahia (Bahia, 2014), Amazonas (Amazonas, 2016) and Rio Grande do Norte (Rio Grande Do Norte, 2021) have published specific state regulations, whose physicochemical parameters and reference values are shown in table 4.

These regulations classify the physicochemical characteristics of honey in terms of maturity, purity and deterioration. Maturity is measured by reducing sugars, sucrose, and moisture content. Purity is determined by the content of water-insoluble, ash, and pollen grains. The deterioration is determined by acidity, pH, hydroxymethylfurfural, diastase activity and water activity (Brasil, 2000; Paraná, 2017; São Paulo, 2017; Santa Catarina, 2020).

Differences in limits for physicochemical parameters established among the states can be attributed mainly to geographic and climatic differences, such as the type of vegetation and also the bee species (Ávila *et al*. 2018).

Table 4 – Reference data for the physicochemical parameters according to the Regulamento Técnico de Identidade e Qualidade do Mel de Abelhas Sem Ferrão established by the states of Paraná (PR), Santa Catarina (SC), São Paulo (SP), Bahia (BA), Rio Grande do Norte (RN) and Amazonas (AM)

Physicochemical parameters	PR	SC	SP	BA	RN	AM
Reducing sugar (%)	> 47	> 45	> 60	> 60	> 60	> 50
Sucrose (%)	< 5.0	< 6.0	< 6.0	< 6.0	< 6.0	< 6.0
Acidity (meq/kg)	< 60	< 100	< 50	< 50	< 50	< 80
Moisture (%)	< 35	< 40	< 40	< 35	< 40	< 35
Ash (%)	< 0.8	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6
HMF (mg/kg)	< 40	< 40	< 20	< 10	< 20	< 40
Water-insoluble solids (%)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.5	< 0.1
Diastase activity (Göthe)	< 40	-	-	< 3	-	< 3.0
Water activity	-	0.52-0.80	0.52-0.80	-	-	-
pH	< 4.7	2.8-4.8	2.9-4.5	-	2.9-4.5	-

HMF: hydroxymethylfurfural

Source: Paraná (2017); Santa Catarina (2020); São Paulo (2017); Bahia (2014); Rio Grande do Norte (2021); Amazonas (2016)

The regulations published by these states constitute a great advance for safer commercialization of stingless bee honey and future national standardization. Several studies have sought to analyze the nutritional and therapeutic properties and determine the physicochemical parameters of this product. Thus, a review of studies published from 2017 to 2022 was carried out considering the physicochemical parameters of honeys from 25 species of stingless bees from different locations in Brazil. Table 5 shows the species of stingless bees and their respective geographic locations in Brazil.

Table 6 shows the physicochemical parameters obtained for stingless bee honeys from the southern and southeastern regions of Brazil.

Table 5 – Species of stingless bees and their geographic location in Brazil

Abbreviation	Scientific name	Geographic location
FD	*Frieseomelitta doederleini*	BA, DF, MA, PB, RN
MA	*Melipona asilvai*	AL, BA, CE, MG, PB, PE, PI, RN, SE
MB	*Melipona bicolor*	ES, MG, MT, RJ, SP
MBS	Melipona bicolor schencki	PR, RS, SC, SP
MCX	*Melipona capixaba*	ES
MF	*Melipona fasciculata*	AM, AP, GO, MA, MT, PA, SP, TO
MFL	*Melipona flavolineata*	AC, AM, AP, MA, MT, PA
MI	*Melipona interrupta*	AC, AM, AP, MA, PA, PR
MM	*Melipona marginata*	AC, AL, AM, BA, ES, MG, PR, RJ, RS, SC, SP
MMO	*Melipona mondury*	BA, ES, MG, PA, PR, RJ, RS, SC, SP
MQ	*Melipona quadrifasciata*	AL, BA, MG, MT, PR, RS, SC, SE, SP
MQA	*Meliponaquadrifasciata anthidioides*	BA, ES, GO, MG, MS, PE, PR, RJ, SC, SP
MSB	*Melipona subnitida*	AL, BA, CE, MA, MS, PA, PB, PE, RN, SP
MS	*Melipona scutellaris*	AL, AM, BA, GO, MG, PB, PE, RN, SE, SP
MSE	*Melipona seminigra*	AC, AM, MA, MT, PA, PR, RO, RR, SP, TO
MSM	*Melipona seminigra merrillae*	AM, MT, RO, RR
MP	*Melipona paraensis*	AM, AP, MT, PA, RR, SC
MT	*Melipona torrida*	RS, SC
SB	*Scaptotrigona bipunctata*	AM, ES, MG, MS, MT, PR, RJ, RS, SC, SP
SD	*Scaptotrigona depilis*	DF, GO, MG, MS, MT, PB, RO, RS, SC, SP

Acre (AC), Alagoas (AL), Amazônia (AM), Amapá (AP), Bahia (BA), Ceará (CE); Distrito Federal (DF), Espírito Santo (ES), Goiás (GO), Maranhão (MA), Minas Gerais (MG), Mato Grosso (MT) Mato Grosso do Sul (MS), Pará (PA), Paraíba (PB), Paraná (PR), Pernambuco (PE), Piauí (PI), Rio Grande do Norte (RN), Rio Grande do Sul (RS), Rio de Janeiro (RJ), Rondônia (RO), Roraima (RR), Santa Catarina (SC), São Paulo (SP), Sergipe (SE) and Tocantins (TO).

Source: Catalog of Moure (2022)

Table 6 – Physicochemical parameters of stingless bee honeys from the south and southeast regions of Brazil

(Continued)

AB	ST	N	SR	Suc. (%)	Ac. (%)	pH (meq/kg)	HMF	Ash (mg/kg)	WI (%)	Moist. (%)	Aw (%)	AD	Reference Göthe
MB	RS	1	54.3 ± 0.5	8.6 ± 0.2	11.2 ± 0.1	4.2 ± 0.0	1.0 ± 0.0	0.07 ±0.0	-	32.3 ± 0.0	-	-	MARCOLIN *et al*. (2021)
MB	RS	1	51.3 ± 0.4	7.5± 0.1	47.3 ± 0.5	3.6 ± 0.0	< LOQ	0.07 ± 0.0	-	31.2 ± 0.2	-	-	MARCOLIN *et al.* (2021)
MM	RS	1	53.3 ± 1.3	10.4 ± 0.4	13.1± 0.8	4.3 ± 0.0	0.48 ± 0.2	0.08 ± 0.0	-	31.7 ± 0.5	-	-	MARCOLIN *et al.* (2021)
MM	RS	1	48.5 ± 1.8	5.4 ± 0.3	24.7 ± 1.1	3.9 ± 0.0	0.29 ± 0.0	0.05 ± 0.0	-	36.4 ± 0.0	-	-	MARCOLIN *et al*. (2021)
MQ	RS	1	58.3 ± 5.0	7.6 ± 0.6	17.6 ± 2.4	4.2 ± 0.0	1.9 ± 0.2	0.11 ± 0.0	-	28.2 ± 0.7	-	-	MARCOLIN *et al*. (2021)
MQ	RS	1	55.2 ± 0.8	4.0 ± 0.3	18.8 ± 0.5	4.6 ± 0.0	0.37 ± 0.1	0.25 ± 0.1	-	27.0 ± 0.2	-	-	MARCOLIN *et al.* (2021)
TA	RS	1	-	-	-	-	-	0.16 ± 0.03	1.71 ± 1.03	34.22 ± 6.39	-	-	SOUZA *et al*. (2021)
TA	RS	1	-	-	-	-	-	0.07 ± 0.0	2.4 ± 0.17	28.9 ± 0.12	-	-	SOUZA *et al*. (2021)
TA	RS	1	-	-	-	-	-	0.95 ± 0.02	6.28 ± 1.26	26.26 ± 0.13	-	-	SOUZA *et al*. (2021)
TA	RS	1	-	-	-	-	-	0.34 ± 0.04	4.33 ± 0.55	21.95 ± 0.21	-	-	SOUZA *et al.* (2021)
TA	RS	1	-	-	-	-	-	8.4 ± 0.37	4.36 ± 1.88	27.14 ± 0.19	-	-	SOUZA *et al*. (2021)
TA	RS	1	-	-	-	-	-	0.6 ± 0.00	5.38 ± 0.25	25.45 ± 0.0	-	-	SOUZA *et al*. (2021)
TA	RS	1	-	-	-	-	-	1.16 ± 0.36	1.85 ± 0.09	29.14 ± 0.55	-	-	SOUZA *et al.* (2021)
TA	RS	1	-	-	-	-	-	0.71 ± 0.05	5.38 ± 0.40	27.92 ± 0.05	-	-	SOUZA *et al.* (2021)
MBS	RS	1	61.70	-	7.30	-	10	0.10	0.10	18.60	-	15	KELLER *et al.* (2019)

Table 6 – Physicochemical parameters of stingless bee honeys from the south and southeast regions of Brazil

(Continued)

AB	ST	N	SR	Suc. (%)	Ac. (%)	pH (meq/kg)	HMF	Ash (mg/kg)	WI (%)	Moist. (%)	Aw (%)	AD	Reference Göthe
TA	RS	7	62.25 ± 0.93	-	22.94 ± 5.49	-	11.88 ± 6.95	0.05 ± 0.05	0.17 ± 0.07	16.95 ± 1.67	-	16.38 ± 2.44	KELLER *et al.* (2019)
MQ	RS	5	60.64 ± 1.90	-	27.12 ± 12.43	-	16.60 ± 8.32	0.08 ± 0.05	0.18 ± 0.04	15.56 ± 1.65	-	13.40 ± 2.30	KELLER *et al*. (2019)
SD	RS	4	60.82 ± 1.29	-	21.32 ± 5.98	-	6.67 ± 3.79	0.05 ± 0.05	0.15 ± 0.06	17.07 ± 2.57	-	13.25 ± 1.26	KELLER *et al.* (2019)
MT	RS	4	61.7 ± 0.41	-	18.35 ± 6.33	-	20.00 ± 2.58	0.05 ± 0.05	0.23 ± 0.05	17.02 ± 0.93	-	16.75 ± 2.98	KELLER *et al*. (2019)
SB	RS	4	61.50 ± 0.78	-	19.62 ± 4.80	-	16.00 ± 6.56	0.07 ± 0.05	0.25 ± 0.06	15.45 ± 2.24	-	15.75 ± 1.5	KELLER *et al.* (2019)
TA	RS	1	60.7 ± 0.5	-	34.7 ± 0.6	3.51 ± 0.07	-	0.127 ± 0.015	-	25.1 ± 0.1	-	-	ROÓS *et al.* (2018)
TA	RS	1	60.4 ± 0.4	-	59.7 ± 1.2	3.38 ± 0.10	-	0.215 ± 0.02	-	26.8 ± 0.2	-	-	ROÓS *et al.* (2018)
TA	RS	1	60.8 ± 0.4	-	61.3 ± 0.6	3.72 ± 0.05	-	0.157 ± 0.01	-	23.9 ± 0.1	-	-	ROÓS *et al*. (2018)
TA	RS	1	61.6 ± 0.2	-	48.7 ± 1.5	3.65 ± 0.03	-	0.288 ± 0.05	-	24.3 ± 0.1	-	-	ROÓS *et al.* (2018)
TA	SC	13	54.3	2.3	56.1	-	36.4	0.21	0.03	22.9	-	7.72	KASMIRSKI and TENFEN (2021)
MQ	SC	1	-	-	60.6 ± 0.7	-	< LOQ	-	-	43.5 ± 0.3	-	-	BRAGHINI (2021)
MQ	SC	1	-	-	22.4 ± 0.7	-	< LOQ	-	-	26.7 ± 0.2	-	-	BRAGHINI (2021)
MM	SC	1	-	-	35.5 ± 0.7	-	<LOQ	-	-	27.0 ± 0.1	-	-	BRAGHINI (2021)
MB	SC	1	-	-	32.9 ± 0.6	-	<LOQ	-	-	30.8 ± 0.1	-	-	BRAGHINI (2021)
MMO	SC	1	-	-	33.3 ± 1.4	-	< LOQ	-	-	27.4 ± 0.1	-	-	BRAGHINI (2021)
MS	SC	1	-	-	19.3 ± 0.6	-	< LOQ	-	-	24.6 ± 0.1	-	-	BRAGHINI (2021)

Table 6 – Physicochemical parameters of stingless bee honeys from the south and southeast regions of Brazil

(Continued)

AB	ST	N	SR	Suc. (%)	Ac. (%)	pH (meq/kg)	HMF	Ash (mg/kg)	WI (%)	Moist. (%)	Aw (%)	AD	Reference Göthe
MB	SC	1	61.20 ± 1.27	< LOQ	72.02 ± 2.39	3.77 ± 0.01	< LOQ	-	-	35.45 ± 0.75	-	< 3	BILUCA (2018)
MB	SC	1	60.99 ± 1.01	< LOQ	63.28 ± 2.39	3.67 ± 0.02	< LOQ	-	-	37.32 ± 0.25	-	< 3	BILUCA (2018)
SB	SC	1	67.77 ± 0.91	< LOQ	56.70 ± 0.01	4.20 ± 0.01	< LOQ	-	-	24.87 ± 0.25	-	< 3	BILUCA (2018)
SB	SC	1	58.79 ± 0.32	< LOQ	44.17 ± 2.75	4.50 ± 0.02	< LOQ	-	-	38.30 ± 0.25	-	6.40 ± 0.60	BILUCA (2018)
MQA	SC	1	60.57 ± 1.46	< LOQ	24.17 ± 0.61	3.64 ± 0.03	< LOQ	-	-	25.91 ± 0.24	-	< 3	BILUCA (2018)
MQA	SC	1	62.16 ± 0.60	< LOQ	38.83 ± 0.66	3.33 ± 0.01	< LOQ	-	-	35.58 ± 0.43	-	< 3	BILUCA (2018)
MM	SC	1	70.30 ± 0.64	< LOQ	73.32 ± 1.53	3.50 ± 0.01	<LOQ	-	-	28.25 ± 0.42	-	< 3	BILUCA (2018)
MM	SC	1	60.64 ± 0.29	< LOQ	42.44 ± 0.62	3.90 ± 0.03	< LOQ	-	-	38.20 ± 0.25	-	< 3	BILUCA (2018)
MM	SC	1	61.96 ± 0.00	< LOQ	70.80 ± 0.72	3.42 ± 0.06	< LOQ	-	-	32.03 ± 0.00	-	< 3	BILUCA (2018)
MM	SC	1	65.03 ± 0.30	< LOQ	56.39 ± 0.01	3.37 ± 0.03	< LOQ	-	-	30.35 ± 0.42	-	< 3	BILUCA (2018)
TA	SC	1	70.16 ± 0.73	< LOQ	31.43 ± 0.85	4.24 ± 0.06	< LOQ	-	-	23.74 ± 0.01	-	< 3	BILUCA (2018)
TF	SC	1	56.63 ± 1.61	< LOQ	46.71 ± 0.27	3.44 ± 0.04	< LOQ	-	-	34.44 ± 0.25	-	< 3	BILUCA (2018)
MQA	SC	1	58.97 ± 0.52	< LOQ	22.33 ± 1.00	3.60 ± 0.01	< LOQ	-	-	27.15 ± 0.23	-	< 3	BILUCA (2018)
MMO	SC	1	68.99 ± 0.10	< LOQ	16.20 ± 3.30	6.56 ± 0.03	< LOQ	-	-	29.92 ± 0.01	-	13.41 ± 0.53	BILUCA (2018)
TA	PR	8	64.59	-	68.99	3.87	-	0.27	4.54	25.74	-	-	LOPES (2019)
TA	PR	1	-	-	38 ± 2	3.82 ± 0.17	18.7± 0.3	-	-	21.80 ± 0.01	0.709 ± 0.005	-	GRANDO (2018)
TA	PR	1	-	-	75 ± 2	3.53 ± 0.10	21.0 ± 0.5	-	-	21.93 ± 0.47	0.718 ± 0.003	-	GRANDO (2018)
TA	PR	1	-	-	75 ± 3	3.55 ± 0.13	17.8 ± 0.3	-	-	21.07 ± 0.47	0.711 ± 0.001	-	GRANDO (2018)
TA	PR	1	-	-	55 ± 2	3.87 ± 0.04	21.5 ± 0.3	-	-	22.40 ± 0.23	0.691 ± 0.002	-	GRANDO (2018)

Table 6 – Physicochemical parameters of stingless bee honeys from the south and southeast regions of Brazil

(Continued)

AB	ST	N	SR	Suc. (%)	Ac. (%)	pH (meq/kg)	HMF	Ash (mg/kg)	WI (%)	Moist. (%)	Aw (%)	AD	Reference Göthe
MQ	PR	1	-	-	115 ± 3	3.21 ± 0.03	12.8 ± 0.5	-	-	30.87 ± 0.01	0.766 ± 0.001	-	GRANDO (2018)
SP	PR	1	-	-	114 ± 4	3.40 ± 0.06	15.9 ± 0.2	-	-	28.87 ± 0.62	0.744 ± 0.005	-	GRANDO (2018)
MQ	PR	1	-	-	118 ± 13	3.20 ± 0.08	17.8 ± 0.8	-	-	34.00 ± 0.01	0.809 ± 0.002	-	GRANDO (2018)
MB	PR	8	57.25	1.38	47.14	3.31	0.30	0.07	-	34.53	0.87	-	AVILA (2019)
MQ	PR	8	51.71	1.13	67.34	3.16	0.55	0.09	-	35.73	0.87	-	AVILA (2019)
MM	PR	8	52.02	1.63	59.21	3.40	0.49	0.15	-	35.06	0.87	-	AVILA (2019)
SB	PR	8	58.68	1.48	45.23	3.88	0.91	0.31	-	27.65	0.80	-	AVILA (2019)
TA	PR	1	60.53 ± 0.33	2.40 ± 0.06	25.66 ± 0.48	4.38 ± 0.04	0.77 ± 0.02	0.15 ± 0.03	0.25 ± 0.01	25.50 ± 0.10	-	-	BRAGHINI *et al*. (2017)
TA	PR	1	59.31 ± 0.18	4.35 ± 0.36	29.31 ± 0.88	4.01 ± 0.05	1.07 ± 0.01	0.15 ± 0.01	0.31 ± 0.02	25.00 ± 0.20	-	-	BRAGHINI *et al.* (2017)
TA	PR	1	61.78 ± 0.45	2.12 ± 0.02	26.78 ± 0.45	4.10 ± 0.03	0.53 ± 0.01	0.17 ± 0.02	0.34 ± 0.01	25.00 ± 0.00	-	-	BRAGHINI *et al.* (2017)
TA	PR	13	58.89 ± 3.26	1.32 ± 0.46	55.79 ± 36.66	3.90 ± 0.40	2.76 ± 1.65	0.19 ± 0.14	-	24.79 ± 0.87	0.71 ± 0.01	-	MONTENEGRO (2018)
TA	PR	27	-	-	55.58	3.95	-	-	-	24.64	-	-	GONÇALVES (2019)
TA	ES	1	58.18 ± 5.02	-	41.19 ± 11.51	4.0 ± 0.34	-	-	-	30.01 ± 1.50	-	-	FIOROTTI (2021)
TC	ES	1	36.22 ± 2.71	-	171.84 ± 3.7	3.53 ± 0.08	-	-	-	31.10 ± 0.85	-	-	FIOROTTI (2021)
MCX	ES	1	66.85 ± 1.40	-	54.88 ± 3.25	3.57 ± 0.26	-	-	-	27.67 ± 1.48	-	-	FIOROTTI (2021)

Table 6 – Physicochemical parameters of stingless bee honeys from the south and southeast regions of Brazil

(Conclusion)

AB	ST	N	SR	Suc. (%)	Ac. (%)	pH (meq/kg)	HMF	Ash (mg/kg)	WI (%)	Moist. (%)	Aw (%)	AD	Reference Göthe
MMO	ES	1	66.61 ± 4.74	-	33.19 ± 15.79	3.37 ± 0.22	-	-	-	28.16 ± 0.80	-	-	FIOROTTI (2021)
MQ	ES	1	63.00 ± 2.52	-	20.96 ± 1.16	3.38 ± 0.21	-	-	-	28.48 ± 1.40	-	-	FIOROTTI (2021)
MMO	ES	1	-	-	34.78 ± 0.63	3.87 ± 0.02	0.00 ± 0.00	0.26 ± 0.01	-	32.83 ± 0.81	0.73 ± 0.01	-	SILVA (2021)

Mean values ± standard deviation. AB: abbreviation; ST: state; N: number of samples; SR: reducing sugar; Suc.: sucrose; Ac.: acidity; HMF: hydroxymethylfurfural; WI: water-insolubre; Moist.: moisture; Aw: water activity; AD: diastase activity; RS: Rio Grande do Sul; SC: Santa Catarina; PR: Paraná and ES: Espírito Santo. Species abbreviations: *Melipona bicolor* (MB), *Melipona marginata* (MM), *Melipona quadrifasciata* (MQ), *Tetragonisca angustula* (TA), *Melipona bicolor schencki* (MBS), *Scaptotrigona depilis* (SD), *Melipona torrida* (MT), *Scaptotrigona bipunctata* (SB), *Melipona mondury* (MMO), *Melipona scutellaris* (MS), *Melipona quadrifasciata anthidioides* (MQA), *Trigona fuscipennis* (TF), *Scaptotrigona postiça* (SP), *Tetragoa clavipes* (TC) and *Melipona capixaba* (MCX).

Source: Author

Comparing the parameters obtained for the honey samples from Santa Catarina (table 6), it is noted that Braghini (2021) obtained a moisture content of 43.5% for the honey sample of *Melipona quadrifasciata*, while Biluca (2018) obtained 106.01 meq/kg for acidity and 41.99 and 43.53% for moisture content in honey samples of *Melipona quadrifasciata anthidioides*. For *Melipona mondury* honey, the pH was 6.56, with all these values being above the limits allowed by state regulation.

Avila (2019) obtained an average moisture content of 35.73 and 35.06% for honey samples of *Melipona quadrifasciata* and *Melipona marginata*, respectively, whose values exceeded the maximum moisture content of 35% allowed by the regulation of Paraná. Lopes (2019) obtained an average concentration of 4.54% for water insoluble in samples of *Tetragonisca angustula* honey, whose concentration was much higher than the 0.1% allowed by the regulation of Paraná. Grando (2018) also obtained acidity values for honey from *Melipona quadrifasciata* and

Scaptotrigona postiça above the limit established by state regulations.

Analyzing the physicochemical parameters of stingless bee honeys produced in the State of Rio Grande do Sul (RS), it is noted that Marcolin *et al*. (2021) found sucrose values above those allowed by all existing regulations in Brazil. The highest concentration of sucrose in honey is related to premature collection, adulteration, or supplementation with commercial sugar (Bergamo *et al*., 2019). Souza *et al*. (2021) found values of 1.16 and 0.71% for ash content in samples of *Tetragonisca angustula* honey produced in RS; these values are not within the maximum limit of 0.6% for ash content required by federal law and existing state regulations.

Observing the physicochemical parameters of meliponini honey produced in the state of Espírito Santo (ES), analyzed by Fiorotti (2021), it is noted that the values for reducing sugars in two samples are below the limit established by Brazilian legislation, which is 65%. The value of 36.22% for the *Tetragona clavipes* honey sample may be related to its higher moisture content. Fiorotti (2021) also determined a value of 171.84 meq/kg for the acidity of *Tetragona clavipes* honey, which is very different from the limit value established by Brazilian legislation (table 3) and state regulations (table 4). Regarding the moisture content found for stingless bee honeys produced in Espírito Santo, the values were higher than the limit required by Brazilian legislation for *Apis mellifera* honey, as expected, but they are in line with values stipulated by state regulations for this type of honey.

The northern and northeast regions of Brazil include a wide variety of stingless bee species due to the diversity of the flora that guarantee abundant food resources to these bees to produce honey. The physicochemical parameters of stingless bee honey from these states are shown in Tables 7 and 8.

Table 7 – Physicochemical parameters of stingless bee honeys from the northern region of Brazil

(Continued)

AB	ST	N	SR (%)	Suc. (%)	Ac. (meq/kg)	pH	HMF (mg/kg)	Ash (%)	WI (%)	Moist. (%)	Aw	AD Göthe	Reference
MSM	AC	1	59.97 ± 0.684	-	-	3.05 ± 0.061	-	0.28 ± 0.118	-	21.42 ± 0.905	-	-	SANTOS; ÂNGULO; SANTOS (2021)
MSM	AC	1	66.66 ± 2.180	-	-	3.65 ± 0.074	-	0.46 ± 0.060	-	15.32 ± 0.700	-	-	SANTOS; ÂNGULO; SANTOS (2021)
MSM	AC	1	65.12 ± 2.583	-	-	3.83 ± 0.264	-	1.41 ± 0.459	-	14.10 ± 0.375	-	-	SANTOS; ÂNGULO; SANTOS (2021)
MSM	AC	1	62.62 ± 2.776	-	-	3.64 ± 0.197	-	0.41 ± 0.310	-	19.40 ± 1.048	-	-	SANTOS; ÂNGULO; SANTOS (2021)
MSM	AC	1	64.44 ± 0.929	-	-	3.89 ± 0.123	-	0.45 ± 0.356	-	17.23 ± 0.461	-	-	SANTOS; ÂNGULO; SANTOS (2021)
MSM	AC	1	67.75 ± 2.630	-	-	3.74 ± 0.095	-	0.14 ± 0.078	-	16.37 ± 0.893	-	-	SANTOS; ÂNGULO; SANTOS (2021)
MSM	AC	1	70.90 ± 0.398	-	-	3.91 ± 0.298	-	0.13 ± 0.067	-	16.68 ± 1.083	-	-	SANTOS; ÂNGULO; SANTOS (2021)
MSM	AC	1	69.95 ± 0.886	-	-	3.58 ± 0.208	-	0.09 ± 0.046	-	18.44 ± 0.575	-	-	SANTOS; ÂNGULO; SANTOS (2021)
MS	AC	1	47.1	5.0	-	-	-	0.24	-	45.8	-	16.7	VALE *et al.* (2018)
MS	AC	1	48.6	2.0	-	-	-	0.32	-	45.6	-	15.0	VALE *et al.* (2018)
MS	AC	1	51.1	1.4	-	-	-	0.29	-	41.9	-	23.3	VALE *et al.* (2018)
MSB	AC	1	53.7	6.1	-	-	-	0.46	-	36.5	-	20.0	VALE *et al*. (2018)
MS	AC	1	48.2	1.9	-	-	-	0.30	-	43.6	-	14.0	VALE *et al*. (2018)
MS	AC	1	47.3	4.4	-	-	-	0.42	-	43.9	-	16.7	VALE *et al.* (2018)
MS	AC	1	48.2	5.2	-	-	-	0.43	-	41.2	-	16.7	VALE *et al*. (2018)
MSB	AC	1	42.9	1.4	-	-	-	0.45	-	42.5	-	15.0	VALE *et al.* (2018)
MS	AC	1	44.6	5.4	-	-	-	0.42	-	42.8	-	13.0	VALE *et al.* (2018)
MS	AC	1	48.4	2.8	-	-	-	0.42	-	40.6	-	16.7	VALE *et al.* (2018)
MS	AC	1	49.2	2.5	-	-	-	0.37	-	36.1	-	14.0	VALE *et al*. (2018)
MSB	AC	1	54.6	4.5	-	-	-	0.46	-	30.3	-	18.3	VALE *et al*. (2018)
MS	AC	1	51.1	3.8	-	-	-	0.36	-	34.1	-	10.7	VALE *et al.* (2018)

Table 7 – Physicochemical parameters of stingless bee honeys from the northern region of Brazil

(Continued)

AB	ST	N	SR (%)	Suc. (%)	Ac. (meq/kg)	pH	HMF (mg/kg)	Ash (%)	WI (%)	Moist. (%)	Aw	AD Göthe	Reference
MS	AC	1	51.8	1.7	-	-	-	0.41	-	28.7	-	12.0	VALE *et al*. (2018)
MS	AC	1	48.1	5.8	-	-	-	0.30	-	38.2	-	16.7	VALE *et al.* (2018)
MSB	AC	1	55.6	6.0	-	-	-	0.49	-	27.7	-	11.3	VALE *et al.* (2018)
MF	PA	1	63.47 ± 0.24	3.89 ± 0.04	17.64 ± 0.75	4.59 ± 0.02	6.54 ± 0.14	-	-	24.33 ± 0.03	0.6884 ± 0.0007	Nd	MENEZES; MATTIETO; LOURENÇO, (2018)
MFL	PA	1	63.09 ± 1.55	2.12 ± 0.22	38.85 ± 0.58	4.28 ± 0.03	3.59 ± 0.14	-	-	28.53 ± 0.02	0.7459 ± 0.0012	6.31 ± 0.09	MENEZES; MATTIETO; LOURENÇO, (2018)
SPY	PA	1	73.24 ± 0.13	0.89 ± 0.1	1.80 ± 0.20	6.85 ± 0.15	0.40 ± 0.22	0.60 ± 0.00	-	28.37 ± 0.05	-	23.10	PIRES *et al.* (2020)
MFL	PA	1	84.77 ± 0.35	2.04 ± 0.33	4.15 ± 0.05	4.65 ± 0.00	0.80 ± 0.55	0.39 ± 0.00	-	28.37 ± 0.05	-	21.40	PIRES *et al.* (2020)
MI	PA	1	74.45 ± 0.27	1.19 ± 0.26	1.40 ± 0.10	6.85 ± 0.02	1.00 ± 0.66	0.40 ± 0.00	-	27.00 ± 0.00	-	12.00	PIRES *et al.* (2020)
MSE	PA	1	68.09 ± 1.49	2.23 ± 1.41	11.50 ± 0.10	3.68 ± 0.01	0.30 ± 0.22	0.45 ± 0.01	-	25.10 ± 0.24	-	1.60	PIRES *et al*. (2020)
SX	PA	1	78.19 ± 0.91	1.75 ± 0.86	9.90 ± 0.10	3.90 ± 0.00	13.62 ± 7.33	0.67 ± 0.01	-	24.70 ± 0.08	-	7.50	PIRES *et al.* (2020)
SPY	PA	1	76.13 ± 0.00	3.27 ± 0.00	9.65 ± 0.25	3.93 ± 0.01	31.64 ± 16.88	0.61 ± 0.01	-	24.60 ± 0.08	-	8.30	PIRES *et al.* (2020)
SX	PA	1	71.81 ± 0.00	2.25 ± 0.00	9.60 ± 0.40	3.95 ± 0.02	5.99 ± 3.52	0.67 ± 0.01	-	24.00 ± 0.00	-	8.80	PIRES *et al*. (2020)
SX	PA	1	72.45 ± 0.65	0.37 ± 0.62	12.55 ± 0.05	3.72 ± 0.02	0.35 ± 0.21	0.59 ± 0.00	-	25.80 ± 0.24	-	4.90	PIRES *et al*. (2020)
SX	PA	1	74.18 ± 0.54	2.09 ± 0.52	16.55 ± 0.95	3.72 ± 0.01	2.30 ± 1.34	0.69 ± 0.04	-	26.97 ± 0.05	-	5.70	PIRES *et al*. (2020)

Table 7 – Physicochemical parameters of stingless bee honeys from the northern region of Brazil

(Continued)

AB	ST	N	SR (%)	Suc. (%)	Ac. (meq/kg)	pH	HMF (mg/kg)	Ash (%)	WI (%)	Moist. (%)	Aw	AD Göthe	Reference
SX	PA	1	69.36 ± 0.47	2.06 ± 0.44	23.05 ± 0.55	3.69 ± 0.01	1.45 ± 0.79	0.63 ± 0.00	-	28.17 ± 0.05	-	6.70	PIRES *et al.* (2020)
SX	PA	1	77.74 ± 0.29	0.70 ± 0.28	16.05 ± 0.55	3.68 ± 0.01	0.65 ± 0.36	0.61 ± 0.02	-	26.90 ± 0.00	-	4.50	PIRES *et al*. (2020)
MI	PA	1	76.13 ± 0.29	0.27 ± 0.27	9.00 ± 0.10	3.62 ± 0.00	1.75 ± 0.95	0.29 ± 0.00	-	26.20 ± 0.16	-	0.30	PIRES *et al.* (2020)
MP	PA	3	62.36 ± 1.14	-	27.80 ± 4.03	3.40 ± 0.092	-	0.04	0.76 ± 0.18	24.53 ± 0.46	-	-	CASTRO *et al.* (2022)
TA	RO	14	64.70 ± 6.47	0.68 ± 0.69	66.67 ± 16.14	3.99 ± 0.26	1.95 ± 1.13	0.37 ± 0.30	-	24.43 ± 2.06	0.69 ± 0.04	-	MONTENEGRO (2018)
MSM	AM	3	61.04 ± 0.38	0.86 ± 0.20	64.50 ± 11.90	3.77 ± 0.046	-	0.05 ± 0.03	-	30.40 ± 1.25	-	-	SILVA (2018)
MSM	AM	3	64.48 ± 1.75	2.00 ± 0.85	43.00 ± 12.60	3.88 ± 0.037	-	0.20 ± 0.06	-	26.47 ± 1.50	-	-	SILVA (2018)
MI	AM	3	52.23 ± 7.83	5.09 ± 3.08	74.60 ± 25.80	3.76 ± 0.020	-	0.17 ± 0.03	-	35.23 ± 3.82	-	-	SILVA (2018)
MI	AM	3	63.14 ± 7.18	2.00 ± 0.12	40.90 ± 16.30	3.95 ± 0.015	-	0.12 ± 0.02	-	25.47 ± 1.70	-	-	SILVA (2018)
MSM	AM	3	44.18 ± 19.8	3.98 ± 3.45	81.30 ± 48.10	3.68 ± 0.031	-	0.13 ± 0.11	-	44.73 ± 21.62	-	-	SILVA (2018)
MSM	AM	3	69.93 ± 6.42	1.05 ± 0.48	31.80 ± 13.0	4.16 ± 0.020	-	0.18 ± 0.08	-	28.47 ± 3.00	-	-	SILVA (2018)
MI	AM	3	64.88 ± 1.22	1.07 ± 1.14	59.80 ± 6.15	3.87 ± 0.078	-	0.12 ± 0.02	-	25.27 ± 2.46	-	-	SILVA (2018)

Table 7 – Physicochemical parameters of stingless bee honeys from the northern region of Brazil

(Conclusion)

AB	ST	N	SR (%)	Suc. (%)	Ac. (meq/kg)	pH	HMF (mg/kg)	Ash (%)	WI (%)	Moist. (%)	Aw	AD Göthe	Reference
MI	AM	3	68.75 ± 3.19	2.29 ± 1.27	30.60 ± 14.80	4.01 ± 0.025	-	0.15 ± 0.04	-	24.57 ± 2.46	-	-	SILVA (2018)

Mean values ± standard deviation. AB: abbreviation; ST: state; N: number of samples; SR: reducing sugar; Suc.: sucrose; Ac.: acidity; HMF: hydroxymethylfurfural; WI: water-insolubre; Moist.: moisture; Aw: water activity; AD: diastase activity; AC: Acre; PA: Pará; RO: Rondônia and AM: Amazônia. Species abbreviations: *Melipona seminigra merrilae* (MSM), *Melipona scutellaris* (MS), *Melipona subnitida* (MSB), *Melipona fasciculata* (MF), *Melipona flavolineata* (MFL), *Scaptotrigona polystica* (MPY), *Melipona interrupta* (MI), *Melipona seminigra* (MSE), *Scaptotrigona xanthotricha* (SX), *Melipona paraensis* (MP) and *Tetragonisca angustula* (TA).

Source: Author

Table 8 – Physicochemical parameters of stingless bee honeys from the northeast region of Brazil

(Continued)

AB	ST	N	SR (%)	Suc. (%)	Ac. (meq/kg)	pH	HMF (mg/kg)	Ash (%)	WI (%)	Moist. (%)	Aw	AD Göthe	Reference
MMO	BA	20	65.42 ± 1.89	2.14 ± 0.86	34.3 ± 3	4.06 ± 0.05	1.60 ± 1.06	0.18 ± 0.069	-	29.18 ± 1	0.73 ± 0.04	4.05 ± 0.915	ALVES *et al.* (2018)
MA	BA	1	71.99 ± 2.02	0.98 ± 0.60	25.00 ± 3.00	3.90 ± 0.06	2.10 ± 0.52	0.11 ± 0.00	-	28.80 ± 0.10	0.77 ± 0.01	0.10 ± 0.03	CALDAS *et al.* (2020)
MA	BA	1	70.49 ± 2.72	3.68 ± 0.63	31.30 ± 2.52	3.80 ± 0.00	0.75 ± 0.26	0.13 ± 0.00	-	29.00 ± 0.06	0.79 ± 0.01	0.16 ± 0.04	CALDAS *et al.* (2020)
MA	BA	1	72.5 ± 2.22	2.03 ± 2.16	38.30 ± 3.06	3.60 ± 0.00	2.74 ± 0.82	0.12 ± 0.14	-	28.70 ± 0.06	0.76 ± 0.01	0.06 ± 0.00	CALDAS *et al.* (2020)
MA	BA	1	67.75 ± 0.41	5.85 ± 1.43	48.00 ± 2.00	3.50 ± 0.00	5.29 ± 4.00	0.11 ± 0.00	-	28.90 ± 0.10	0.77 ± 0.02	0.07 ± 0.01	CALDAS *et al.* (2020)
MA	BA	1	69.00 ± 1.31	2.26 ± 1.32	46.30 ± 1.15	3.40 ± 0.06	2.64 ± 2.14	0.11 ± 0.00	-	29.70 ± 0.10	0.79 ± 0.02	0.08 ± 0.00	CALDAS *et al.* (2020)

MS	BA	-	-	-	-	5.52 ± 0.15	-	0.25 ± 0.01	-	25.00 ± 0.00	0.724 ± 0.009	-	CRUZ *et al.* (2020)
MQA	BA	1	62.51 ± 1.04	2.61 ± 0.99	15.83 ± 1.44	3.27 ± 0.06	7.09 ± 0.75	0.129 ± 0.00	-	28.50 ± 0.10	-	0.07 ±0.00	SILVA *et al.* (2020)
MQA	BA	1	63.86 ± 0.81	0.42 ± 2.45	15.50 ± 0.86	3.30 ± 0.00	1.25 ± 1.27	0.086 ± 0.00	-	> 30	-	0.10 ± 0.04	SILVA *et al.* (2020)
MQA	BA	1	63.32 ± 0.36	0.95 ± 1.02	15.50 ± 0.86	3.33 ± 0.06	2.89 ± 0.57	0.087 ± 0.00	-	> 30	-	0.09 ± 0.04	SILVA *et al.* (2020)
MQA	BA	1	66.15 ± 0.22	0.67 ± 1.31	18.33 ± 1.44	3.37 ± 0.06	1.80 ± 2.33	0.123 ± 0.00	-	28.13± 0.12	-	0.11 ± 0.00	SILVA *et al.* (2020)
FD	BA	3	60.76 ± 0.33	-	103.33 ± 1.40	3.68 ± 0.01	4.49 ± 0.29	0.25 ± 0.05	-	26.83 ± 0.28	0.75 ± 0.01	-	SANTISTEBAN (2019)

Table 8 – Physicochemical parameters of stingless bee honeys from the northeast region of Brazil

(Continued)

AB	ST	N	SR (%)	Suc. (%)	Ac. (meq/kg)	pH	HMF (mg/kg)	Ash (%)	WI (%)	Moist. (%)	Aw	AD Göthe	Reference
FD	BA	3	60.56 ± 0.33	-	94.16 ± 1.44	3.79 ± 0.01	4.13 ± 0.31	0.22 ± 0.01	-	26.66 ± 0.57	0.73 ± 0.01	-	SANTISTEBAN (2019)
FD	BA	3	60.00 ± 0.32	-	94.16 ± 1.44	3.82 ± 0.01	3.04 ± 0.17	0.18 ± 0.03	-	27.33 ± 0.57	0.76 ± 0.01	-	SANTISTEBAN (2019)
FD	BA	3	60.00 ± 0.32	-	90.00 ± 2.50	3.92 ± 0.01	5.23 ± 0.68	0.20 ± 0.03	-	27.33 ± 0.57	0.75 ± 0.01	-	SANTISTEBAN (2019)
FD	BA	3	59.44 ± 0.31	-	85.83 ± 1.44	3.91 ± 0.01	4.74 ± 0.22	0.26 ± 0.01	-	27.46 ± 0.05	0.70 ± 0.02	-	SANTISTEBAN (2019)
MSB	CE	18	-	-	-	3.32 ± 0.36	-	0.39 ± 0.25	-	> 20	-	-	BRAGA *et al.*, 2020

Table 8 – Physicochemical parameters of stingless bee honeys from the northeast region of Brazil

(Conclusion)

AB	ST	N	SR (%)	Suc. (%)	Ac. (meq/kg)	pH	HMF (mg/kg)	Ash (%)	WI (%)	Moist. (%)	Aw	AD Göthe	Reference
MS	AL	1	-	-	40	-	-	0.30	-	33.4	-	-	CAVALCANTE *et al*. (2019)
MS	AL	1	-	-	22	-	-	0.30	-	26.8	-	-	CAVALCANTE *et al.* (2019)
MS	AL	1	-	-	16	-	-	0.20	-	27.6	-	-	CAVALCANTE *et al.* (2019)
MS	AL	1	-	-	8	-	-	0.47	-	24.3	-	-	CAVALCANTE *et al*. (2019)
MF	MA	20	50.1 ± 5.26	8.5 ± 4.76	30.58 ± 19.52	3.8 ± 0.34	-	0.12 ± 0.10	0.09 ± 0.07	27.2 ± 1.52	-	-	FERNANDES; ROSA; CONTI-SILVA (2018)
MF	MA	20	52.6 ± 6.44	7.2 ± 5.65	27.5 ± 20.45	4.9 ± 0.95	-	0.52 ± 0.26	0.11 ± 0.09	23.7 ± 1.86	-	-	FERNANDES; ROSA; CONTI-SILVA (2018)
MF	MA	1	70.27 ± 3.67	-	23.87 ± 1.21	3.73 ± 0.06	-	-	-	24.50 ± 0.36	0.6751 ± 0.0044	-	RIBEIRO *et al.* (2018)
MF	MA	8	71.11 ± 3.38	-	39.785 ± 2.313	4.569 ± 0.848	16.088 ± 0.898	-	-	22.33 ± 1.57	-	-	LIMA (2017)
MF	PI		69	1.74	23	3.5	2.0	-	-	27.2	-	0.04	SANT'ANA *et al.* (2020)
MS	PI		72	1	28	3.6	4.4	-	-	27	-	0.05	SANT'ANA *et al*. (2020)
MS	RN	4	60.48 ± 2.54	1.01 ± 0.18	66.18 ± 34.00	3.45 ± 0.10	48.78 ± 36.22	0.04 ± 0.0	1.05 ± 0.34	26.0 ± 0.47	0.771 ± 0.0	-	AROUCHA *et al.* (2019)
MS	RN	30	67.58	2.89	36.14	3.50	6.02	0.27	0.10	25.27	-	-	LUZ (2021)

Mean values ± standard deviation. AB: abbreviation; ST: state; N: number of samples; SR: reducing sugar; Suc.: sucrose; Ac.: acidity; HMF: hydroxymethylfurfural; WI: water-insolubre; Moist.: moisture; Aw: water activity; AD: diastase activity; BA: Bahia; CE: Ceará, AL: Alagoas; MA: Maranhão and RN: Rio Grande do Norte. Species abbreviations: *Melipona mondury* (MMO), *Melipona asilvai* (MA), *Melipona scutellaris* (MS), *Melipona quadrifasciata anthidioides* (MQA), *Frieseomelitta doederleini* (FD), *Melipona subnitida* (MSB) and *Melipona fasciculata* (MF).

Source: Author

Santos, Angulo and Santos (2021) found moisture content values for samples of *Melipona seminigra merrillae* honey produced in the State of Acre within the limit of 20% established by Brazilian law and values of reducing sugars close to the minimum established by federal legislation. In one of the samples, the authors found a concentration of 1.41% for ash content, higher than 0.6% permitted by existing regulations. Vale et al. (2018) also analyzed samples of stingless bee honey produced in Acre and found moisture contents higher than those found by Santos, Angulo and Santos (2021), whose values (27.0-45.8%) exceeded the limit permitted by federal legislation. In general, the moisture values shown in table 7 are higher than the 20% content established for *Apis mellifera* honey, while the values obtained for reducing sugars are close to the value stipulated by federal legislation.

Comparing the results obtained by Silva (2018) for stingless bee honeys analyzed in the State of Amazonas with the physicochemical parameters established by Portaria ADAF n° 253 de 31 de outubro de 2016 do Amazonas, it is noted that a sample of honey from *Melipona seminigra merrillae* presented a concentration of 44.18% reducing sugars, and another sample of honey of the same species presented values of 81.30 meq/kg acidity and 44.73% moisture content. These values are outside the quality standard determined by the state regulation of Amazonas, which stipulates a minimum of 50% for reducing sugars, a maximum of 80 meq/kg for acidity and a maximum moisture content of 35%.

Santisteban (2019) obtained concentrations of reducing sugars in samples of stingless bee honey from the state of Bahia within the requirements of the state regulation (Table 4), except for a sample of *Frieseomelitta doederleini* honey that showed a value of 59.44%, which was close to the minimum of 60%. All samples analyzed by this author showed acidity above the limit of 50 meq/kg allowed by the state regulation of Bahia. The regulation of Bahia determines a maximum limit of 3 Göthe for the diastase activity of stingless bee honey. Alves et al. (2018) obtained a value of 4.05 Göthe for *Melipona mondury* honey, which is above the allowed limit. The other values obtained

for the physicochemical parameters of honey from stingless bees from Bahia (table 8) are in accordance with state regulation.

Luz (2021) and Aroucha *et al*. (2019) analyzed samples of *Melipona scutellaris* honey obtained in the state of Rio Grande do Norte and found concentrations of 36.2 and 48.78 mg/kg for HMF, respectively. The values obtained are above the value of 20 mg/kg established by the Regulamento Técnico do Rio Grande do Norte. The other parameters determined by Luz (2021) are within the limits proposed by state legislation. The acidity (66.18 meq/kg) and water-insoluble (1.05%) parameters found by Aroucha *et al*. (2019) are above the limit of 50 meq/kg and 0.5%, respectively, stipulated by the state of Rio Grande do Norte.

The physicochemical parameters of stingless bee honey samples from the states of Alagoas (AL), Ceará (CE), Maranhão (MA) and Piauí (PI) are shown in table 8. These states do not regulate stingless bee honey. Thus, comparing the values obtained with the Brazilian honey legislation, the values for moisture content are above 20% established for honey from *Apis mellifera*, as expected, but they are in accordance with the state legislation of the states of Bahia and Rio Grande do Norte. Fernandes, Rosa and Conti-Silva (2018) obtained values of reducing sugars of 50.1% and 52.6% and sucrose values of 8.5% and 7.2% for *Melipona fasciculata* honeys produced in Maranhão, these values are not within the minimum of 60% for reducing sugars and maximum of 6% for sucrose established by Brazilian legislation. The rest of the physicochemical parameters analyzed in the scientific research shown in table 8 are in accordance with the federal legislation.

2 CONCLUSIONS

Analyzing the results related to the physicochemical parameters of honey from different species of stingless bees collected in different regions of Brazil, it was possible to observe great variability in the physicochemical composition of the samples. It was also possible to compare honey samples from the states of Amazonas, Bahia, Paraná,

Rio Grande do Norte and Santa Catarina with the regulations established for each state. Some parameters are not in accordance with the federal legislation (IN 11/2000) established for *Apis mellifera* honey, however, they are in accordance with specific state regulations. Thus, considering that not all states have their own regulations for this type of product, it is necessary to establish national parameters. A national legislation for honey from stingless bees must contain parameters to prevent fraud and ensure food safety, in addition to bringing broad reference values, capable of contemplating honeys from different species and Brazilian states. Another aspect to be considered is the method of extraction and conservation adopted by beekeepers, which are directly linked to the occurrence of contamination and deterioration of the product, that is, each processing unit must consider the risk of contamination in its operational manuals, depending on the methods adopted. Finally, new research on physicochemical parameters may be requested as needed, in order to improve national legislation for stingless bee honey.

REFERENCES

ALI, H.; BAKAR, M. F. A.; MAJID, M; MUHAMMAD, N. LIM, S. Y. In vitro anti-diabetic activity of stingless bee honey from different botanical origins. **Food Research**, v. 4, n. 5, p. 1421–1426, 2020. DOI: https://doi.org/10.26656/fr.2017.4(5).411.

ALVES, R. M. de O.; VIANA, J. L.; SOUSA, H. de A. C.; WALDSCHMIDT. Physico-chemical parameters of honey from *Melipona mondury* Smith, 1863 (Hymenoptera: Apidae: Meliponini). **Journal of Agricultural Science**, v. 10, n. 7, p. 196-205, 2018. DOI: 10.5539/jas.v10n7p196

ALVES, T. T. L.; MENESES, A. R. V. de; SILVA, J. N.; PARENTE, G. D. L.; NETO, J. P. de H. Caracterização físico-química e avaliação microbiológica de méis de abelhas nativas do nordeste brasileiro. **Revista Verde de Agroecologia e Desenvolvimento Sustentável**, v. 6, n. 3, p. 91–97, 2011. Disponível em: https://www.gvaa.com.br/revista/index.php/RVADS/article/view/735.

AMAZONAS. Agência de Defesa Agropecuária e Florestal do Estado do Amazonas - ADAF. Regulamento técnico de identidade e qualidade do mel de abelha social sem ferrão, Portaria n° 253 de 31 de outubro de 2016. **Diário Oficial do Estado,** 2016.

AROUCHA, E. M. M.; SILVA, M. C. de P.; LEITE, R, H, de L.; SANTOS, F. K. G. dos; OLIVEIRA, V. R. L. de; ARAÚJO, N. O. de; SILVA, K. N. de O. Physicochemical, antioxidants and sensorials properties of *Melipona subnitida* honey after dehumidifying. **Journal of Food Processing & Technology**, v. 10, n. 3, 2019.

AVILA, S. **Determinação de parâmetros de qualidade de mel de abelhas sem ferrão utilizando ferramentas quimiométricas**. 2019. 136 p. Tese (Doutorado em Engenharia de Alimentos) - Universidade Federal do Paraná, Curitiba, 2019.

ÁVILA, S.; BEUX, M. R.; RIBANI, R. H.; ZAMBIAZI, R. C. Stingless bee honey: Quality parameters, bioactive compounds, health-promotion properties and modification detection strategies. **Trends in Food Science and Technology**, v. 81, p. 37–50, 2018. DOI: https://doi.org/10.1016/j.tifs.2018.09.002.

BAHIA. Agência de Defesa Agropecuária da Bahia – ADAB. Portaria n° 207 de 21 de novembro de 2014. Regulamento Técnico de Identidade e Qualidade do Mel de Abelha social sem ferrão, gênero Melipona. **Diário Oficial do Estado,** 2014.

BARBOSA, R. N.; BEZERRA, J. D. P.; SOUZA-MOTTA, C. M.; FRISVAD, J. C.; SAMSON, R. A.; OLIVEIRA, N. T.; HOUBRAKEN, J. New *Penicillium* and *Talaromyces* species from honey, pollen and nests of stingless bees. **Antonie van Leeuwenhoek**, v. 111, n. 10, p. 1883–1912, 2018. DOI: https://doi.org/10.1007/s10482-018-1081-1

BERGAMO, G.; SERAGLIO, S. K. T.; GONZAGA, L. V.; FETT, R.; COSTA, A. C. O. Physicochemical characteristics of bracatinga honeydew honey and blossom honey produced in the state of Santa Catarina: An approach to honey differentiation. **Food Research International**, v. 116, p. 745–754, 2019. DOI: https://doi.org/10.1016/j.foodres.2018.09.007.

BILUCA, F. **Caracterização química e bioativa de méis de abelhas sem ferrão (*Meliponinae*) produzidas no Estado de Santa Catarina**. 2018. 177 p. Tese (Doutorado em Ciência dos Alimentos) - Universidade Federal de Santa Catarina, Florianópolis, 2018.

BILUCA, F. C.; BERNAL, J.; VALVERDE, S.; ARES, A. M.; GONZAGA, L. V.; COSTA, A. C. O.; FETT, R. Determination of free amino acids in stingless bee (*Meliponinae*) honey. **Food Analytical Methods**, v. 12, n. 4, p. 902–907, 2019. DOI: https://doi.org/10.1007/s12161-018-01427-x.

BRAGA, D. C. ; LIBERATO, M. da C. T. C.; LIMA, V. L. F.; ARAÚJO NETO, J. A. M. de. Analytical study of the physicochemical characteristics from *Melipona subnitida* D. honey in adequation to Brazilian law. **Food Science and Technology**, v. 40, n. 1, p. 217-221, 2020. DOI: https://doi.org/10.1590/fst.08919.

BRAGHINI, F. **Efeitos do tratamento térmico e temperatura de armazenamento na qualidade e perfil de compostos fenólicos de méis de abelhas sem ferrão (*Meliponini*)**. 2021. 125 p. Tese (Doutorado em Ciência dos Alimentos) - Universidade Federal de Santa Catarina, Florianópolis, 2021.

BRAGHINI, F.; CHIAPETTI, E.; S. JÚNIOR; J. F.; MILESKI, J. P. F.; OLIVEIRA, D. F. de; MORÉS, S.; COELHO, A. R.; TONIAL, I. B. Qualidade dos méis de abelhas africanizadas (*Apis mellifera*) e Jataí (*Tegragonisca angustula*) comercializado na microrregião de Francisco Beltrão - PR. **Revista de Ciências Agrárias**, v. 40, n. 1, p. 279-289, 2017. DOI: https://doi.org/10.19084/RCA16039.

BRAGHINI, F.; BILUCA, F. C.; OTTEQUIR, F.; GONZAGA, L. V.; SILVA, M. da; VITALI, L.; MICKE, G. A.; COSTA, A. C. O.; FETT, R. Effect of different storage conditions on physicochemical and bioactive characteristics of thermally processed stingless bee honeys. **LWT - Food Science and Technology**, v. 131, p. 109724, 2020. DOI: https://doi.org/10.1016/j.lwt.2020.109724.

BRASIL. Ministério da Agricultura e do Abastecimento. Instrução normativa n° 11, de 20 de outubro de 2000. Regulamento técnico de identidade e qualidade do mel. **Diário Oficial da República Federativa do Brasil**, Brasília, DF, 23 out. 2000.

CALDAS, M. J. M.; SILVA, I. P.; MACHADO, C. S.; CARVALHO, C. A. L. De; SODRÉ, G. Da S. Qualidade e perfil antimicrobiano do mel de *Melipona asilvai*. **Brazilian Journal of Development**, v. 6, n. 5, p. 32760-32768, 2020. DOI: https://doi.org/10.34117/bjdv6n5-646.

CASTRO, L. de O.; SANTOS, C. C. dos; REBELO, T. R. L.; LOPES, J. A. C.; VIANA, A. F. da S.; ABREU, A. da S.; MOREIRA, D. K. T.; SILVA B. A. da. Determinação das propriedades físico-químicas e constituição melissopalinológica do mel de *Melipona (Michmelia) paraensis Ducke* (Jandaíra) originário de Mojuí dos Campos – PA. **Brazilian Journal of Development**, v. 8, n. 4, p. 23744-23758, 2022. DOI: https://doi.org/10.34117/bjdv8n4-066.

CATALOG OF MOURE (2022). **Catálogo de Abelhas Moure**. Available at: moure.cria.org.br/catalogue. Accessed on: May 5, 2022

CAVALCANTE, L. de S.; LIMA, C. T. ; SILVA, R. B.; AZEVEDO, A. C. O.; SOUZA, P. A. de. Qualidade físico-química do mel produzido por meliponas no Estado de Alagoas, Brasil. **Higiene Alimentar**, v. 33, n. 288/289, p. 1163-1166, 2019.

CRUZ, L. F. S.; SANTOS, T. de S.; SOUZA, C. O. de; SANTOS, L. S. M..; DURZIAN, J.; TAVARES, P. P. L. G.; NASCIMENTO, R. Q.; BULLOS, R. B. De A.; ALMEIDA, L. M. R. Determination of physicochemical characteristics and bioactive compounds in samples of pollen, geopropolis and honey from *Melipona scutellaris* bee species. **Brazilian Journal of Development**, v. 6, n. 4, p. 21484-21496, 2020. DOI: https://doi.org/10.34117/bjdv6n4-353.

DAR, S. A.; HASSAN, G. I.; PADDER, B. A.; WANI, A. R.; PAREY, S. H.. Pollination and evolution of plant and insect interaction. **Journal of Pharmacognosy and Phytochemistry**, v. 6, n. 3, p. 304–311, 2017.

FERNANDES, R. T.; ROSA, I. G.; CONTI-SILVA, A. C. Microbiological and physical-chemical characteristics of honeys from the bee *Melipona fasciculata* produced in two regions of Brazil. **Ciência Rural**, v. 48, n. 5, p. e20180025, 2018. DOI: https://doi.org/10.1590/0103-8478cr20180025.

FIOROTTI, L. L. **Caracterização físico-química e potencial bioativo de mel de abelhas sem ferrão e africanizada ocorrentes no Espírito Santo**. 2021. 89 p. Dissertação (Mestrado em Ciências Farmacêuticas) - Universidade Vila Velha, Vila Velha, 2021.

GONÇALVES, L. M. **Comparação físico-química entre amostras de mel de *Apis mellifera* africanizada e *Tetragonisca angustula***. 2019. 50 p. Monografia (Bacharel em Engenharia de Alimentos) - Universidade Tecnológica Federal do Paraná, Campo Mourão, 2019.

GRANDO, R. C. **Caracterização físico-química e perfil sensorial de méis de abelhas nativas, sem ferrão, oriundas da região centro-sul do estado do Paraná, Brasil**. 2018. 98 p. Dissertação (Mestrado em Ciência e Tecnologia de Alimentos) - Universidade Federal da Fronteira Sul, Laranjeiras do Sul, 2018.

ITIS (2022). **Integrated Taxonomic Information System**. Available at: https://www.itis.gov/. Accessed on: May 5, 2022.

KASMIRSKI, G.; TENFEN, A. Controle de qualidade de mel de Apis melífera scutellata e *Tetragonisca angustula* coletados em Massaranduba – SC. **Brazilian Journal of Development**, v. 7, n. 6, p. 60296-60310, 2021. DOI: https://doi.org/10.34117/bjdv7n6-422.

KELLER, O. D.; SANTOS, M. A. dos; AVANCINI, C.; KINDLEIN, L.; WAGNER, S. A. Caracterização físico-química do mel de abelhas sem ferrão. **Higiene Alimentar**, v. 33, p. 979-982, 2019.

LAVINAS, F. C.; MACEDO, A. H. B. C.; SÁ, G. B. L.; AMARAL, A. C. F.; SILVA, J. R. A.; AZEVEDO, M. M. B.; VIEIRA, B. A.; DOMINGOS, T. F. S.; VERMELHO, A. B.; CARNEIRO, C. S.; RODRIGUES, I. A. Brazilian stingless bee propolis and geopropolis: promising sources of biologically active compounds. **Brazilian Journal of Pharmacognosy**, v. 29, n. 3, p. 389–399, 2019. DOI: https://doi.org/10.1016/j.bjp.2018.11.007.

LIMA, K. S. **Análise de caracteres físico-químicos do mel de tiúba (*Melipona compressipes fasciculata*)**. 2017. 33 p. Monografia (Bacharel em Agronomia) - Universidade Federal do Maranhão, Chapadinha, 2017.

LOPES, A. E. P. **Caracterização físico-química e antioxidante do mel da abelha Jataí (*Tetragonisca angustula*) proveniente de diferentes regiões do Estado do Paraná**. 2019. 63 p. Dissertação (Mestrado em Tecnologia em Alimentos) - Universidade Tecnológica Federal do Paraná, Londrina, 2019.

LUZ, K. S. S. **Produtos meliponícolas de abelha jandaíra (*Melipona subnitida*) do semiárido Potiguar**. 2021. 137 p. Dissertação (Mestrado em Ciência Animal) - Universidade Federal Rural do Semi-Árido, Mossoró, 2021.

MARCOLIN, L. C.; LIMA, L. R.; ARIAS, J. L. De O.; BERRIO, A. C. B.; KUPSKI, L.; BARBOSA, S. C.; PRIMEL, E. G. *Meliponinae* and *Apis mellifera* honey in southern Brazil: Physicochemical characterization and determination of pesticides. **Food Chemistry**, v. 363, p. 130175, 2021. DOI: https://doi.org/10.1016/j.foodchem.2021.130175.

MENEZES, B. do A. D.; MATTIETO, R. de A.; LOURENÇO, L. de F. H. Avaliação da qualidade de méis de abelhas africanizadas e sem ferrão nativas do nordeste do estado do Pará. **Ciência Animal Brasileira**, v. 19, p. 1-3, e-46578, 2018. DOI: https://doi.org/10.1590/1809-6891v19e-46578.

MONTENEGRO, H. R. **Comparação das características físico-químicas e antioxidantes do mel de *Tetragonisca angustula* (Latreille, 1811) coletado nos Estados do Paraná e Rondônia**. 2018. 62 p. Monografia (Bacharel em Engenharia de Alimentos) - Universidade Tecnológica Federal do Paraná, Campo Mourão, 2018.

NEŠOVIĆ, M.; GAŠIĆ, U.; TOSTI, T.; TRIFKOVIĆ, J.; BAOŠIĆ, R.; BLAGOJEVIĆ, S.; IGNJATOVIĆ, L.; TEŠIĆ, Ž. Physicochemical analysis and phenolic profile of polyfloral and honeydew honey from Montenegro. **RSC Advances**, v. 10, n. 5, p. 2462–2471, 2020. DOI: https://doi.org/10.1039/C9RA08783D.

PARANÁ. Agência de Defesa Agropecuária do Paraná – ADAPAR. Portaria n° 63 de 10 de março de 2017. Regulamento técnico de identidade e qualidade do mel de abelhas sem ferrão para o estado do Paraná. **Diário Oficial do Estado,** 2017.

PIRES, A. P. ; SILVA, S. M. P. C. da; PACHECO, A.; AZEVEDO, H. H. F.; MORAES, J. R. da S. C. de; MOREIRA, D. K. T.; PENA, D. A. G.; CARVALHO, C. A. L. Physicochemical profile of honeys from different species of stingless bees from western Pará, Brazilian Amazonia. **Brazilian Journal of Development**, v. 6, n. 8, p. 59251-59268, 2020. DOI: https://doi.org/10.34117/bjdv6n8-370

REZENDE, A. C. C. ; ABSY, M. L.; FERREIRA, M. G.; MARINHO, H. A. Honey botanical origin of stingless bees (Apidae Meliponini) in the Nova América community of the Sateré Mawé indigenous tribe, Amazon, Brazil. **Grana**, v. 59, n. 4, p. 304–318, 2020. DOI: https://doi.org/10.1080/00173134.2020.1724323

RIBEIRO, G. P.; VILLAS-BÔAS, J. K.; SPINOSA, W. A.; PRUDENCIO, S. H. Influence of freezing, pasteurization and maturation on Tiúba honey quality. **LWT - Food Science and Technology**, v. 90, p. 607–612, 2018. DOI: https://doi.org/10.1016/j.lwt.2017.12.072

RIO GRANDE DO NORTE. Decreto nº 30.860, de 25 de agosto de 2021. Regulamenta a lei nº 10.479, de 30 de janeiro de 2019, que dispõe sobre a criação, o comércio, o transporte de abelhas sem ferrão (meliponídeas) no Estado do Rio Grande do Norte, estabelece os requisitos sanitários de produção/processamento e o padrão de identidade e qualidade do mel. **Diário Oficial do Estado**, 2021.

ROÓS, P. B.; SOARES, L. B.; RESMIM, C. M.; ROSA, F. P. da; FARINA, J. B.; VIELMO, N. I. C.; SISTI, J. N.; CAETANO, M. M.; TUSI, M. M. Avaliação de parâmetros físico-químicos e da atividade antimicrobiana in vitro de méis de Jataí (*Tetragonisca angustula*) provenientes do Rio Grande do Sul. **Perspectiva: Erechim**, v. 42, n. 159, p. 97-107, 2018.

SALATINO, A.; PEREIRA, L. R. de L.; SALATINO, M. L. F. The emerging market of propolis of stingless bees in tropical countries. **MOJ Food Processing & Technology**, v. 7, n. 2, p. 27–29, 2019. DOI: 10.15406/mojfpt.2019.07.00215

SANTA CATARINA. Secretaria de Estado da Agricultura, da Pesca e do Desenvolvimento Rural. Portaria SAR n° 37 de 04 de novembro de 2020. Norma Interna Regulamentadora do Mel de Abelhas Sem Ferrão no Estado de Santa Catarina. **Diário Oficial do Estado,** 2020.

SANT'ANA, R. S.; CARVALHO, C. A. L.; ODA-SOUZA, M.; SOUZA, B. A.; DIAS, F. S. Characterization of honey of stingless bees from the Brazilian semi-arid region. **Food Chemistry**, v. 327, p. 127041, 2020. DOI: https://doi.org/10.1016/j.foodchem.2020.127041

SANTISTEBAN, R. M. **Estudo químico de méis apícolas, meliponícolas e da resina *Mycrodruon urundeuva* coletados na Caatinga, nordeste do Brasil**. 2019. 206 p. Tese (Doutorado em Química) - Universidade Federal de Pernambuco, Recife, 2019.

SANTOS, F. C. F. dos; ANGULO, E. L. H.; SANTOS dos, M. E. C. Caracterização físico-química de amostras do mel de abelhas nativas. **Scientia Naturalis**, v. 3, n. 5, p. 2366-2382, 2021. DOI: https://doi.org/10.29327/269504.3.5-29.

SÃO PAULO. Agência de Defesa Agropecuária do Estado de São Paulo. Resolução SAA-52, de 03 de outubro de 2017. Regulamento Técnico de Identidade e Padrão do mel elaborado pelas abelhas da subfamília Meliponinae (Hymenoptera, Apidae), conhecidas por Abelhas sem Ferrão - ASF e os requisitos de processamento e segurança alimentar para seu consumo humano direto. **Diário Oficial do Estado,** 2017.

SCHVEZOV, N.; PUCCIARELLI, A. B.; VALDES, B.; DALLAGNOL, A. M. Characterization of yateí (*Tetragonisca fiebrigi*) honey and preservation treatments: Dehumidification, pasteurization and refrigeration. **Food Control**, v. 111, p. 107080, 2020. DOI: https://doi.org/10.1016/j.foodcont.2019.107080

SERAGLIO, S. K. T.; SILVA, B.; BERGAMO, G.; BRUGNEROTTO, P.; GONZAGA, L. V.; FETT, R.; COSTA, A. C. O. An overview of physicochemical characteristics and health-promoting properties of honeydew honey. **Food Research International**, v. 119, p. 44–66, 2019. DOI: https://doi.org/10.1016/j.foodres.2019.01.028

SILVA, G. V. da; RAMOS, T. de O. Meliponicultura: a sociedade e a geração de renda. In: SANTOS, F. L. dos (org.). **Estudos Avançados sobre Saúde e Natureza**. João Pessoa: Editora Acadêmica Periodicojs, 2021. p. 40. Disponível em: https://www.periodicojs.com.br/index.php/easn/article/view/318.

SILVA, I. P. ; CALDAS, M. J. M.; MACHADO, C. S.; NASCIMENTO, A. S. do; LORDÊLO, M. S.; BÁRBARA, M. F. S.; EVANGELISTA-BARRETO, N. S.; ESTEVINHO, L. M.; CARVALHO, C. A. L. de. Antioxidants activity and physicochemical properties of honey from social bees of the Brazilian semiarid region. **Journal of Apicultural Research**, v. 60, n. 5, p. 797-806, 2020. DOI: https://doi.org/10.1080/00218839.2020.1823671

SILVA, J. R. da. **Mel polifloral de *Apis Mellifera* e *Melipona Mondury*: manejo, beneficiamento associado a microbiota natural e potencial para desenvolvimento de alimentos funcionais anticariogênicos**. 2021. 147 p. Tese (Doutorado em Ciências de Alimento) - Universidade Estadual de Londrina, Londrina, 2021.

SILVA, M. Q. da. **Estudo físico-químico, químico e melissopalinológico de méis sazonais das espécies (*Melipona seminigra* e *Melipona interrupta* Latreille) de meliponicultores da mesorregião Amazônica - AM**. 2018. 108 p. Dissertação (Mestrado em Ciência e Tecnologia Para Recursos Amazônicos) - Universidade Federal do Amazonas, Itacoatiara, 2018.

SILVA, W. P.; LIMA, J. R.; PAZ, D. Abelhas sem ferrão: muito mais do que uma importância econômica. **Natureza on line**, v. 10, n. 3, p. 146–152, 2012.

SOUZA, A. P. C. de ; RUARO, E. L.; MEIRELLES, R. N.; LEÃES, F. L. Avaliação físico-química de mel de abelhas sem ferrão da espécie *T. angustula*, provenientes da região das missões - RS. In: SIEPEX, 10., 2021, Rio Grande do Sul. **Anais do 10º Siepex**, Rio Grande do Sul: Conexão Ciência, 2021. p. 1-4.

VALE, M. A. D. do; GOMES, F. A.; SANTOS, B. R. C. dos; FERREIRA, J. B. Honey quality of *Melipona sp*. bees in Acre, Brazil. **Acta Agronómica**, v. 67, n. 2, p. 201-207, 2018. DOI: https://doi.org/10.1s446/acag.v67n2.60836

VILLAS-BÔAS, J. **Manual tecnológico: mel de abelha sem ferrão**. Brasília – DF: Instituto Sociedade, População e Natureza, 2012. Disponível em: http://bibliotecadigital.abong.org.br/jspui/handle/11465/298.

Authorship contributions

1 – Débora Mayumi Sato

State University of Londrina – UEL, Bachelor's Degree in Chemistry from the State University of Londrina – UEL

https://orcid.org/0000-0002-8428-5378 • deboramayumi96@gmail.com

Contribution: Writing – original draft

2 – Jéssica Barrionuevo Ressutte

State University of Londrina – UEL, Master's degree in Food Science from the State University of Maringá – UEM (2019)

https://orcid.org/0000-0002-4057-0695 • jessicaressutte@gmail.com

Contribution: Writing – review and editing

3 – Marcos Aparecido Gonçalves

State University of Londrina – UEL , Master's degree in Agronomy from the State University of Londrina – UEL (2010)

https://orcid.org/0009-0000-4986-0587 • magagro35@gmail.com

Contribution: Writing – review and editing

4 – Wilma Aparecida Spinosa

State University of Londrina – UEL, PhD in Food Science from the State University of Campinas (2002)

https://orcid.org/0000-0001-9532-0135 • wilma.spinosa@uel.br

Contribution: Conseptualization, Writing – review and editing

How to quote this article

SATO, D. M.; RESSUTTE, J. B.; GONÇALVES, M. A.; SPINOSA, W. A.. Identity and quality standards for Brazilian stingless bee honey based on physicochemical parameters – a review. **Ciência e Natura**, Santa Maria, v. 45, e30, 2023. DOI 10.5902/2179460X72016. available in https://doi.org/10.5902/2179460X72016