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Stingless bees honeys': physical-chemical characterization, difficulties and challenges

Dificuldades e desafios da caracterização físico-química dos méis de abelhas sem ferrão

Dificultades y desafíos de la caracterización fisicoquímica de la miel de abejas sin aguijón

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Mayara Faleiros Quevedo
ORCID: https://orcid.org/0000-0001-7949-6392
Universidade de São Paulo, Brazil
E-mail: mayara.faleiros@usp.br
Tiago Maurício Francoy
ORCID: https://orcid.org/0000-0002-2413-966X
Universidade de São Paulo, Brazil
E-mail: tfrancoy@usp.br

Abstract

Stingless bees form a group of eusocial bees belonging to the tribe Meliponini (Hymenoptera: Apidae) and are distributed in tropical and subtropical regions of the planet. Brazil, the main territory regarding stingless bees' diversity, has a large variety of phytogeographic regions that can influence the physical-chemical properties of the honey. Currently, the country does not have a legislation that represents its territorial reality as a whole, making the parameters unattainable for producers to market stingless bees' honey. In addition to its economic importance for producers, this product has sensory characteristics that are different from those produced by *Apis mellifera*, making it a product with high added value. Additionally, honey production is a sustainable practice and increases bee conservation, which, in general, are mainly threatened by human interference. Thus, the objective of this work was to analyze the scientific productions published in consolidated databases to understand how bees deal with different environmental and geographic conditions and how this reflects on honey characteristics, in addition, to generate data to prepare a proposal to standardize and market the honey. For this, the StART software was used, with the elaboration of a systematic review protocol. A total of 93 articles were listed in the initial search in the Web of Science, Scopus and Google Scholar databases and after the selection and execution process, 50 articles were selected. In the summarization phase, it was observed that there is still no consensus among researchers on how to stipulate a standard and reference ranges for the analyses.
Keywords: Honey; Stingless bee; Physicochemical properties; Commercialization pattern; Sustainable practice.

Resumo

As abelhas sem ferrão formam um grupo de abelhas eussociais pertencentes à tribo Meliponini (Hymenoptera: Apidae) e são distribuídos nas regiões tropicais e subtropicais do planeta. O Brasil, principal território em termos de diversidade dessas abelhas, apresenta uma gama de regiões fitogeográficas que podem influenciar nas propriedades dos méis e atualmente não possui uma legislação que represente a realidade territorial como um todo, tornando os parâmetros inatingíveis para produtores comercializarem o mel. Além da importância econômica para os produtores, esse produto possui características sensoriais diferenciadas dos méis tradicionalmente consumidos no Brasil, tornando-o um produto com alto valor agregado. Somado a isso, a produção do mel é uma prática sustentável e proporciona a conservação das abelhas, que no geral, estão ameaçadas principalmente por interferência antrópica. Assim, o objetivo deste trabalho foi analisar as produções científicas publicadas em bases de dados consolidadas para entender como as abelhas lidam com as diferentes condições ambientais e geográficas e como isso reflete nas características do mel, ademais, gerar dados para elaboração de uma proposta de padronização do mel e de comercialização. Para isso, foi utilizado o software StART, com elaboração de um protocolo de revisão sistemática. Foram listados 93 artigos na busca inicial nas bases de dados Web of Science, Scopus e Google Scholar e após o processo de seleção e extração de dados, 50 artigos foram selecionados. Na fase de sumarização, foi observado que ainda não existe um consenso entre os pesquisadores de como estipular um padrão e faixas de referência para as análises.
Palavras-chave: Mel; Abelha sem ferrão; Propriedades físico-químico; Padrão comercialização; Prática sustentável.

Resumen

Las abejas sin aguijón forman un grupo de abejas eusociales pertenecientes a la tribu Meliponini (Hymenoptera: Apidae) y se encuentran distribuidas en las regiones tropicales y subtropicales del planeta. Brasil, el principal territorio en lo que se refiere a diversidad de estas abejas, posee una gama de regiones fitogeográficas que pueden influir sobre las propiedades de la miel y actualmente no cuenta con una legislación que represente la realidad territorial en su conjunto, tornando los parámetros inalcanzables para que los productores comercialicen la miel.

Además de la importancia económica para los productores, este producto tiene características sensoriales diferentes de aquellas de la miel consumida tradicionalmente en Brasil, lo que lo convierte en un producto con alto valor agregado. Sumado a esto, la producción de miel es una práctica sustentable y posibilita la conservación de las abejas, que en general se encuentran amenazadas principalmente por la injerencia humana. De esa forma, el objetivo de este trabajo fue analizar las producciones científicas publicadas en bases de datos consolidadas para comprender cómo las abejas se enfrentan a diferentes condiciones ambientales y geográficas y cómo eso se refleja en las características de la miel, además, generar datos para la elaboración de una estandarización. propuesta de miel y mercadeo. Para ello se utilizó el software StART, con la elaboración de un protocolo de revisión sistemática. Se listaron 93 artículos en la búsqueda inicial en las bases de datos Web of Science, Scopus y Google Scholar y, luego del proceso de selección y extracción de datos, se seleccionaron 50 artículos. En la fase de resumen, se observó que aún no existe consenso entre los investigadores sobre cómo estipular un estándar y rangos de referencia para los análisis.
Palabras clave: Miel; Abeja sin aguijón; Propiedades fisicoquímicas; Comercialización estándar; Práctica sostenible.

1. Introduction

The stingless bees are part of a group of bees belonging to the Meliponini tribe (Hymenoptera: Apoidea) and are distributed in the world tropical and subtropical regions. They are found in Central and South America, Southeast Asia, Africa and Australia, with more of 500 described species within about 64 genera. In South and Central America areas, the Meliponini are the most common social bees, playing an important role as pollinators (Michener, 2007). These distribution patterns may be related to the solar energy, floral resources and water availability (Orr et al., 2021). Because they are diverse and abundant in their distribution, the meliponicultura practice (stingless bees rational rearing) is more developed in tropical countries such as Australia, Malaysia, Thailand, Brazil, Venezuela, and Mexico (Nordin et al., 2018).

Bee populations are threatened by human activities that do not commit to keeping bee populations healthy. Climate change, invasive species, monocultures generating less floral resources diversity and nesting sites, as well as pesticide applications have a negative effect on bees (Potts et al., 2010). The understanding of ecosystem services brings the concern to demonstrate how the biodiversity disappearance directly affects the ecosystem functions that sustain the necessary services for humanity well-being (Braat & De Groot, 2012).

When compared to honey from *Apis mellifera*, the honey produced by stingless bees has several sensory particularities, like less sweetness, more acidic flavor and more fluid texture, as well as some different physicochemical properties, especially in sugars composition and amount, moisture and acidity (Nordin et al., 2018). Studies show that honey from stingless bees, in addition to having different nutritional properties, has therapeutic applications with promising results, with the presence of antioxidant capacity bioactive compounds (Ávila et al., 2018a; Biluca et al., 2016; Ooi et al., 2021), potential to antimicrobial (Khongkwanmueang et al., 2020) and antiproliferative cell activities (Ismail et al., 2018).

The diversity of geographic regions, soil characteristics, climate, and vegetation, in addition to the enormous the variety of stingless bee species impacts directly in the characteristics of the honey produced (Nordin et al., 2018) and studies of these different factors are essential for the development of specific laws and norms for stingless bee honey (Biluca et al., 2016; Marcolin et al., 2021). Meliponiculture is an activity with great growth potential and the management of improvements in beekeeping practices reflect the significant expansion of the market for stingless bees' products, with increasing numbers of consumers (Jaffé et al., 2015), in addition to already being recognized for its high medicinal content (Al-Hatamleh et al., 2020; Ooi et al., 2021).

However, despite its potential, meliponiculture is still an undervalued activity (Jaffé et al., 2015). The absence of a more comprehensive legislation that regulates production and marketing is one of the limiting factors for the practice to expand (Braghini et al., 2021; Koser et al., 2020). Most studies do not consider the different geographic locations and vegetation characteristics as determinant factors in honeys physicochemical features (Maringgal et al., 2019; Shamsudin et al., 2019a; Wong et al., 2019).

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The physical-chemical analyses for stingless bee honey involve the verification of maturity, related to reducing sugars, moisture and apparent sucrose; deterioration, where free acidity, diastase activity and 5-hydroxymethylfurfural are tested, and purity analysis, where the contents of pollen, ash, minerals and water-insoluble solids are checked (Ávila et al., 2018a). When compared with honey from the *Apis mellifera* bee, they are characterized by having higher moisture content, acidity, ash and 5-hydromethylfurfural and lower total sugars levels (Biluca et al., 2016; Braghini et al., 2021; Chuttong et al., 2016).

Brazil is one of the countries with the greatest ecosystems variety, with six biomes covering around 8 million km². The Amazon corresponds to 49.29% of the area, Cerrado (Brazilian Savanna) with 23.92%, Atlantic Forest with 13.04%, Caatinga with 9.92%, Pampa with 2.07% and Pantanal with 1.76% of area (CBD, 2009). In this context, public policy actions are necessary to deal with economic problems and social and ecological impacts, however, researchers and legislators are out of step, perhaps due to divergent opinions or lack of knowledge on studies and needs between the parties. Articles published with quality information are not used by legislators, generating laws that do not provide protection to biodiversity or that meet social demand in a sustainable way (Hipólito et al., 2021). Attending to the necessity to have federal standards, there is a requirement for a research effort to outline the reference criteria, making the standard more comprehensive, which favors the product commercialization (Koser et al., 2020).

Based on the above, this study aimed to analyze the scientific productions published in consolidated databases to understand how different environmental and geographic conditions influence the physicochemical properties of stingless bees' honeys. In addition, generate data for a proposal preparation within public honey marketing policies, without failing to consider the variation in biomes environmental characteristics and species variation, making coherent legislation and within the region's quality and production standards.

2. Methodology

A Systematic Literature Review Protocol was developed, with the methodological structure to carry out the review step on the stingless bee honey physical-chemical characterization and its challenges, using the StArt - LaPES UFSCar software (Fabbri et al., 2016).

The protocol includes the planning, execution and summarization steps. In the planning stage, the protocol elaboration was carried out, in the execution, the search in databases and articles selection based on the exclusion and inclusion criteria and data extraction was carried out. In the summarization stage, graphs were drawn up and the discussion of the review developed.

Searches in electronic databases (Scopus, Web of Science and Google Scholar) were carried out with no publication year limit, articles written only in English, until June of 2021, using the following keywords: stingless bee, honey, physicochemical properties, biomes, thus generating the search strings: Stingless bees AND honey AND Physico-chemical properties AND biomes and a second search string: Stingless bees AND honey AND Physico-chemical properties.

A manual search and selection in Google Scholar were performed to supplement the other databases, using the same keywords. Search results within each database were exported in BIBtex format for import into StArt software. The articles found with the initial search strategy were listed and their titles, keywords and abstracts were read to verify their adequacy to the inclusion and exclusion criteria, according to Table 1.

Table 1: List of the criteria inclusion and exclusion for articles in the Systematic Literature Review Protocol.

Criterion	Inclusion criteria description
CI1	Articles using stingless bees honey
CI2	Articles published and available in full in the scientific bases
CI3	Articles that characterize the physicochemical properties of honey
CI4	Articles that reference the quality of stingless bees' honey
Criterion	**Exclusion criteria description**
CE1	Articles that not used stingless bees honey
CE2	Articles that do not characterize the physicochemical properties of honey
CE3	Articles that do not reference the quality of stingless bees' honey

Source: Authors.

After articles quality selection step and evaluation through title and abstract reading, relevant information was extracted from the data from a complete reading of the articles. For this, a table was created containing the following analysis criteria: authors, publication year, country, species evaluated, whether the study presented an *Apis mellifera* comparison, some type of legislation support and phytogeographic assessment.

In the investigation results analysis, data was generated on the countries that are developing studies regarding the characterization of stingless bees' honey and if the different phytogeographic regions are considered in the analysis.

3. Results

The Web of Science database search resulted in a list of 67 papers, in the Scopus database, 10 listed works and, in Google Scholar, 16 selected papers, totaling 93 articles. However, all these results were only possible after the removal of the "biome" keyword in the string search.

In the articles collection selection phase, 63 papers were accepted, 21 rejected and 9 duplicated and in the extraction stage preparation, 61 articles were accepted, 1 rejected and 1 duplicated. In the data extraction phase, after a more detailed analysis of the articles, 50 articles were accepted, 12 rejected and 1 duplicated, generating Table 2.

Table 2 – List of 50 articles analysed, according to autor/year criteria, country, species evaluated, comparisson with *Apis mellifera*, suport for legislation and phytogeographic evaluation.

Authors	Country	Evaluated Species	Comparison *Apis mellifera*	Support Legislaion	Phytogeographic Evaluation
(Vit et al., 1998)	Venezuela	Tribe Meliponini and Trigonini	No	No	Yes
(Bijlsma et al., 2006)	Trinidad & Tobago	*Melipona favosa, Melipona trinitatis, Plebeia tobagoensis, Trigona nigra, Apis mellifera*	Yes	No	No
(Rodríguez-Malaver et al., 2009)	Peru	*Apis mellifera, Melipona crinita, Melipona eburnea, Melipona grandis, Melipona illota, Nannotrigona melanocera, Partamona epiphytophila, Ptilotrigona lurida, Scaptotrigona*	Yes	No	No

		polystica, Scaura latitarsis, Tetragonisca angustula			
(Guerrini et al., 2009)	Ecuador	Unspecified	No	No	Yes
(Lage et al., 2012)	Brazil	*Melipona capixaba, Melipona rufiventris and Melipona mondury*	Yes	Yes	Yes
(Fuenmayor et al., 2012)	Colômbia	*Tetragonisca angustula*	No	Yes	No
(Silva et al., 2013)	Brazil	*Melipona seminigra merrillae*	Yes	Yes	Yes
(Almeida-Muradian et al., 2013)	Brazil	*Melipona subnitida, Apis mellifera*	Yes	Yes	Yes
(Chuttong et al., 2016)	Thailand	*Homotrigona fimbriata, Lepidotrigona terminata, Lepidotrigona flavibasis, Lepidotrigona doipaensis, Lisotrigona furva, Tetragonilla collina, Tetragonula fuscobalteata, Tetragonula laeviceps-pagdeni complex, Tetragonula testaceitarsis, Tetrigona apicalis, Tetrigona melanoleuca*	Yes	Yes	No
(Biluca et al., 2016)	Brazil	*Melipona bicolor, Scaptotrigona bicunctata, Melipona quadriasciata, Melipona marginata, Tetragonisca angustula, Melipona mondury, Melipona rufivestris mondory, Tetragona clavipes, Melipona scutellaris, Trigona fuscipennis*	Yes	Yes	Yes
(Jimenez et al., 2016)	México	*Scaptotrigona mexicana*	Yes	Yes	No
(Omar et al., 2016)	Malaysia	*Apis mellifera* and unidentified stingless bee species	Yes	No	No
(Chong et al., 2017)	Malaysia	*Heterotrigona itama, Geniotrigona thoracica*	No	No	No
(Ismail et al., 2018)	Malaysia	*Geniotrigona thoracica* and *Heterotrigona itama*	No	No	No
(Espinoza-Toledo et al., 2018)	México	*Melipona solan, Melipona beecheii* and *Scaptotrigona mexicana*	No	Yes	Yes
(Ij et al., 2018)	Malaysia	*Trigona thorasica, Trigona itama, Apis dorsata*	Yes	Yes	Yes
(Nordin et al., 2018)	Malaysia	Review	Yes	Yes	Yes
(Alves et al., 2018)	Brazil	*Melipona mondury*	Yes	Yes	Yes
(Martínez et al., 2018)	Argentina	*Tetragonisca fiebrigi*	No	No	No

(Ávila et al., 2018b)	Brazil	*Melipona quadrifasciata, Melipona marginata, Melipona bicolor and Scaptotrigona bipuncata*	No	No	Sim
(Ávila et al., 2018a)	Brazil	Review	Yes	No	No
(Razali et al., 2018)	Malaysia	*Heterotrigona itama, Geniotrigona thoracica, Tetrigona apicalis*	No	No	Yes
(Tuksitha et al., 2018)	Malaysia	*Geniotrigona thoracica, Heterotrigona itama, Heterotrigona erythrogastra*	No	No	No
(Alvarez-Suarez et al., 2018)	Cuba	*Apis mellifera* and *Melipona beecheii*	Yes	No	Yes
(Fuad et al., 2018)	Malaysia	*Heterotrigona itama, Geniotrigona thoracica*	No	No	No
(Mail et al., 2019)	Malaysia	*Trigona* spp. and *Apis mellifera*	Yes	Yes	No
(Cardona et al., 2019)	Colombia	*Trigona nigra, Trigona angustula, Scaptotrigona* spp., *Nannotrigona* spp., *Melipona compressipes, Melipona favosa* and *Melipona fuscipes*	Yes	No	Yes
(Shamsudin et al., 2019b)	Malaysia	*Heterotrigona itama*	Yes	No	Yes
(Ávila et al., 2019a)	Brazil	*Melipona bicolor, Melipona quadrifasciata, Melipona marginata, Scaptotrigona bipuncata*	No	No	No
(Ávila et al., 2019b)	Brazil	*Melipona bicolor, Melipona quadrifasciata, Melipona marginata, Scaptotrigona bipuncata*	Yes	Yes	No
(Selvaraju et al., 2019)	Malaysia	*Heterotrigona itama, Geniotrigona thoracica,*	Yes	No	Yes
(Wong et al., 2019)	Malaysia	*Heterotrigona itama, Tetrigona binghami*	Yes	No	Yes
(Ya et al., 2019)	Malaysia	*Trigona* spp.	No	No	No
(Maringgal et al., 2019)	Malaysia	*Heterotrigona itama, Geniotrigona thoracica*	No	No	Yes
(Shamsudin et al., 2019a)	Malaysia	*Heterotrigona itama, Geniotrigona thoracica, Apis mellifera*	Yes	No	Yes
(Schvezov et al., 2020)	Argentina	*Tetragonisca fiebrii*	Yes	Yes	Yes
(Khongkwanmueang et al., 2020)	Thailand	*Tetragonula laeviceps*	No	Yes	No
(Fernandes et al., 2020)	Brazil	*Melipona fasciculata, Apis*	Yes	Yes	Yes

		mellifera			
(Braghini et al., 2020)	Brazil	*Melipona quadrifasciata, Melipona marginata, Melipona mondury, Melipona scutellaris, Melipona bicolor*	No	No	No
(Delgado et al., 2020)	Peru	*Melipona ebúrnea*	Yes	Yes	Yes
(Chen, et al., 2021)	Malaysia	*Heterotrigona itama*	No	No	No
(Gela et al., 2021)	Ethiopia	*Meliponula beccarii*	Yes	Yes	Yes
(Marcolin et al., 2021)	Brazil	*Apis mellifera, Melipona bicolor, Melipona marginata, Melipona quadrifasciata, Scaptotrigona bipunctata, Tetragonisca angustula, Scaptotrigona Depilis*	Yes	No	Yes
(Carina Biluca et al., 2021)	Brazil	*Melipona quadrifasciata, Melipona mondury, Melipona bicolor, Tetragonisca angustula, Melipona marginata, Scaptotrigona bipunctata*	No	Yes	Yes
(Echeverrigaray et al., 2021)	Brazil	*Melipona scutellaris, Melipona seminigra, Plebeia droryana, Plebeia emerina, Plebeia nigriceps, Plebeia remota, Plebeia saiqui, Scaptotrigona bipunctata, Scaptotrigona depilis, Scaptotrigona tubiba, Tetragonisca fiebrigi*	No	Yes	No
(Sharin et al., 2021)	Malaysia	*Heterotrigona bakeri, Geniotrigona thoracica* and *Tetrigona binghami*	No	No	Yes
(Mohamad Ghazali et al., 2021)	Malaysia	*Geniotrigona thoracica*	No	Yes	No
(Braghini et al., 2021)	Brazil	Review	Yes	Yes	No
(Umaña et al., 2021)	Costa Rica	*Tetragonisca angustula* and *Melipona beecheii*	Yes	Yes	No
(da Costa & Toro, 2021)	Brazil	*Apis mellifera, Plebeia flavocincta, Melipona* spp.	Yes	No	No

Source: Authors.

Regarding the number of publications, it was found that Malaysia and Brazil were the countries that conducted the most research with international publications on the subject, with 18 and 16 publications respectively, followed by Thailand, Mexico, Peru, Argentina and Colombia with two publications each and finally, Costa Rica, Cuba, Ecuador, Trinidad and Tobago, Venezuela and Ethiopia, with 1 publication each.

In the publication year evaluation, we verified a greater representativeness of studies from 2018, with 12 publications, a decrease in the 2020 year, with 5 publications and in the year 2021, until the middle of the year, there have been 10 published papers.

In the profile of the two countries that published the most, Malaysia had the highest publications number in 2018 and 2019, of the 12 papers published in 2018, 6 are from Malaysia and of the 10 published in 2019, 7 are from Malaysia. In 2021, there have been 3 papers published.

Brazil presented to be more distributed over the years, having its first international publication on the subject in 2012. In 2018, Brazil published 3 papers, 2019 and 2020 with 2 publications each year. The year 2021 is being an expressive year, because there have been 5 publications until June.

When evaluating the studies, 58% compared honey from *Apis* genus bees, 52% took into consideration different regions in the study, but only 46% suggested that the results could serve as basis for stingless bees' honey legislation.

4. Discussion

Even considering the favorable climate and the development potential of meliponiculture in the country, Brazil still does not have all the necessary government support to expand the activity and its market share, even though it is considered a sustainable practice (Barbiéri et al., 2020). It is important to recognize the importance of these pollinating insects, which, in addition to being directly linked to the effects of climate change and biodiversity loss, are essential for ecosystem services continuity, food production and balance in the functioning of terrestrial ecosystems and human well-being.

Research in Brazil has contributed to the discussion about pollinators importance and the need for more comprehensive and interdisciplinary legislation (Hipólito et al., 2021), which encompasses adequate parameters for the production and marketing of stingless bee honey. Brazil and Malaysia are the countries that have published the most research on stingless bees' honey characterization, especially from the year 2018, being the countries more advanced in regulation terms. Even though it is not yet a comprehensive and inclusive regulation, the first steps have already been taken to mature and adjust the elaboration of more coherent norms.

It is necessary to create a more sustainable vision of meliponiculture, including the awareness of various actors, such as society, beekeepers, farmers, legislators, for the need to create coherent laws to reality, thus boosting honey production together with conservation of natural areas that sustain production (Koser et al., 2020). At this point, Brazil is evolving a lot, with initiatives from various organizations to offer extension courses for both producers and society in general, and projects aiming at citizen science and popularization of meliponiculture (Koffler et al., 2021).

Biomes need to be preserved for sustainable ecological processes such as pollination to occur, and so that we can enjoy its benefits. This is only possible with specific legislation on cities environment biodiversity protection and for production practices (Hipólito et al., 2021). A curious fact observed in databases search was that articles did not appear when the word "biomes" was inserted in the search string, not even in works related to the Brazilian region, which has a great diversity of biomes. This fact is an indication that the enormous diversity of biotic and abiotic features in different biomes are not being considered in stingless bees' honeys characterization.

Knowing that honey physicochemical characteristics are directly influenced by the geographic position, bee pasture, and bee species involved (Nordin et al., 2018), that the incorrect honey processing and storage are possible conditions for changing the properties (da Silva et al., 2016), and that possibly the variation in honey characteristics does not depend on the time of year (Cardona et al., 2019), continuous efforts to produce reliable data directed at these issues will serve as a basis for the elaboration of more comprehensive and adequate legislation.

Studies with stingless bee honey characterization show that there is still no consensus among researchers on how to stipulate a standard, with its reference value ranges (Braghini et al., 2021) and exactly the lack of more comprehensive data allows that recognition of possible fraud and adulteration to become more difficult to be implemented (Omar et al., 2016). In addition, there is a mismatch between researchers and legislators (Hipólito et al., 2021), so it is necessary to create a proposal to mitigate this issue in Brazil. Due to the numerous variables involved, the standardization of honey on a global scale is unfeasible, but the determination of local standards for each country or geographic region is possible.

Among the actions to mitigate the legislative bottleneck, we highlight the importance of evaluating what is feasible or not. For a producer, the simple fact of sending the material for analysis already presents a certain degree of resistance, due to the lack of appropriate places for the analyzes in Brazil and the analyses value, which becomes high, considering the necessary volume of sample that must to be sent. Legislation needs to be as viable and practical as possible, encompassing quality research.

Other studies, in addition to the physicochemical properties, were carried out to be alternatives for honey traceability, such as proposals for biomarkers identification by metabolomics (Razali et al., 2018; Selvaraju et al., 2019), honey origin determination by entomological origin (Sharin et al., 2021), floral origin (Ávila, et al., 2019a), and melissopalynological analysis (Guerrini et al., 2009). Studies for adulteration verification analysis, involving false honey labeling (Siddiqui et al., 2017), water addition (Ávila et al., 2018a), adulterants analysis (corn syrup or sugar cane, vinegar) in honey by FTIR spectroscopy analysis (Mail et al., 2019), analysis of the honey dilution effect by VIS-NIR spectroscopy (Omar et al., 2016) were performed and may be useful to ensure product reliability.

Although there are studies involving improvements in honey processing, such as spray drying process (Cuevas-Glory, et al., 2017), thermal dehydration (Chen et al., 2021), pasteurization (Schvezov et al., 2020), moisture reduction by alternative technique in unglazed clay pots with different areas of surface diffusion (Mohamad Ghazali et al., 2021), thermosonication (Chong et al., 2017), among others, we do not advocate the use of processing techniques, thus maintaining the true honey identity, with its own contents and sensory characteristics, without processing to increase its shelf life. Indeed, a study carried out by Braghini and collaborators showed that honey storage from stingless bees at 4° for 365 days maintained its stability, with preservation of bioactive characteristics and physicochemical properties (Braghini et al., 2020) and that stingless bees honey, when stored in good conditions, maintains its stability for up to three years (Jimenez et al., 2016).

5. Final Considerations

We conclude that it is possible to transform meliponiculture into a sustainable (Barbiéri et al., 2020) and profitable activity, motivating breeders with extension courses, showing in practice the result of all the research involved, thus generating improvements in management techniques and consequently the production of honey (Jaffé et al., 2015). The increased production and marketing of this honey requires an official standard, helping the producer to maintain honey sensory and nutritional character, also preventing possible adulteration (Ávila et al., 2019b).

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