

Physicochemical attributes and quality of the *Melipona scutellaris* honey: comparison with Brazilian regulatory standards

Atributos físicoquímicos e qualidade do mel de *Melipona scutellaris*: comparação com os padrões regulatórios Brasileiros

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ABSTRACT

Objective: The aim this study was to compare the physicochemical characteristics of the honey of wild *Melipona scutellaris* with the standards determined by the technical regulations and honey quality of Ministry of Agriculture, Brazil. **Methods:** Honey of *Melipona scutellaris* was acquired from certified institution in Natal, RN, Brazil. The physicochemical analysis of honey was carried out so that all parameters were derived from the average of three replications. Moisture of the samples was determined by refractometer. The Hydroxymethylfurfural proof was determined by the absorbance using a digital spectrometer, with a range of 200-1000 nm and band crossing 5 nm. The ash content of the samples was determined in a muffle furnace. Digital pHmeter was used for measurement of pH and total acidity by the method of simple titration. Insoluble solids in water were determined by stove use. All these parameters were compared with those established by Technical Regulation of Ministry of Agriculture, Brazil, 2000, for honey identity and quality. Honey microbiological analysis was done using the blood agar and agar McConkey selective media. **Results:** The physicochemical analysis of the *Melipona scutellaris* honey demonstrated that all parameters were in accordance with the standards established by the Ministry of Agriculture, Brazil regulations, and could be considered of good quality for research and human consumption. The microbiological examination revealed that the honey had no bacterial contamination. **Conclusion:** Our findings suggest that the physicochemical composition of *M. scutellaris* honey is compatible with the Brazilian guidelines for the composition and quality of honey.

Keywords: Honey. Bee. *Melipona scutellaris*. Physicochemical characterization.

RESUMO

Objetivo: Comparar as características físico-químicas do mel da abelha silvestre *Melipona scutellaris* com os padrões determinados pelo Regulamento Técnico de Identidade e Qualidade do mel do Ministério da Agricultura, Brasil. **Métodos:** Mel de *Melipona scutellaris* foi adquirido de instituição certificada em Natal, RN, Brasil. A análise físico-química do mel foi feita a partir da média de três repetições. A umidade das amostras foi determinada por refratometria. A prova de hidroximetilfurfural foi realizada por determinação da absorvância da amostra, utilizando espectrômetro digital, na faixa de 200-1000 nm e banda 5 nm. O teor de cinzas das amostras foi determinado em forno de mufla. Medidor de pH digital foi usado para a medição do pH e da acidez total através do método de titulação normal. Sólidos insolúveis em água foram determinados em estufa. Todos os parâmetros foram comparados com os estabelecidos no Regulamento Técnico do Ministério da Agricultura do Brasil, de 2000, para uso e qualidade do mel de abelha. Análise microbiológica foi feita usando os meios de cultura agar sangue e agar McConkey. **Resultados:** A análise físico-química do mel de *Melipona scutellaris* demonstrou que todos os parâmetros estão de acordo com os padrões estabelecidos pelos regulamentos do Ministério da Agricultura, Brasil, e pode ser considerado de boa qualidade para consumo humano e uso em pesquisa. A análise microbiológica revelou que o mel não tinha contaminação bacteriana. **Conclusão:** Nossos resultados sugerem que a composição físico-química do mel de *M. scutellaris* é compatível com as diretrizes brasileiras para a composição e qualidade do mel.

Descritores: Mel. Abelha. *Melipona scutellaris*. Caracterização físico-química.

INTRODUCTION

Honey has been for centuries used as food, and in phytotherapy. One of the most important use is the prevention and limitation of bacterial infection derived largely from biochemical properties related to peroxide generation via glucose oxidase activity¹, nonperoxide effects such as osmolarity, acidity, aromatic and phenolic acids, and other phytochemical compounds such as methylglyoxal². Moreover, honey serves as a natural antioxidant and a rich source of minerals, carbohydrates, proteins, and vitamins with nutraceutical and probiotic properties³. The composition of honey depends basically of nectar production of each plant species, giving it specific characteristics according to the weather conditions. Among the existing sugars in honey, the monosaccharide is the most part, ranging from 85%

to 95% of its composition⁴. Another important parameter is the moisture that can influence the viscosity, specific gravity, maturity, crystallization, flavor, preservation and palatability⁵. After decrystallization, honey can form the hydroxymethylfurfural (HMF) which increases with temperature, storage time, and addition of invert sugar. It is also affected by acidity, pH, water and minerals⁶. The analysis of honey requires special and sophisticated methods such as those performed using spectrophotometric assays, particularly gas chromatography-mass spectrometer, liquid chromatography-mass spectrometer, nuclear magnetic resonance, etc. These techniques are used to assess contents of molecules and elucidate the structure of active molecules⁷.

Brazilian honeys have a wide range of color which can influence consumer preference, in most cases for the product looks. The honey color is correlated with its floral origin, processing storage, climatic factors during the nectar flow, and the temperature at which the honey matures⁸. The electrical conductivity can be used as a supplementary method to determine the botanical origin of the honey and has correlation with the ash content, pH, acidity, minerals, in addition to proteins and other substances found in honey⁹. International and Brazilian regulations about honey quality are available^{10,11}.

This research, developed with honey samples of *Melipona scutellaris*, a wild bee from Brazilian semi-arid region, aimed to compare their physicochemical characteristics to the specific Brazilian regulations for honey, which establishes its quality control.

METHODS

Honey physicochemical analysis

Honey of *Melipona scutellaris* acquired from certified institution in Natal, RN, Brazil was used. The physicochemical analysis of honey was carried out so that all parameters were derived from the average of three replications. Moisture of the samples was determined by refractometer. The Hydroxymethylfurfural proof was performed to verify the possibility of tampering by adding sugar, improper storage or overheating, by determining the absorbance of the sample, using a digital spectrometer, with a range of 200-1000 nm and band crossing 5 nm. The ash content of the samples was determined in a muffle furnace. A digital pHmeter was used for measurement of pH and total acidity was measured by simple titration. Insoluble solids in water were determined by stove use. All these parameters were compared with those established by the Technical Regulation of Ministry of Agriculture, Brazil,

2000, for honey Identity and Quality. Honey microbiological analysis was done using the blood agar and agar McConkey selective media.

RESULTS

The physicochemical analysis of the *Melipona scutellaris* honey demonstrated that all parameters were in accordance with the standards established by the Regulations of Ministry of Agriculture, Brazil 2000, and could be considered of good quality for human consumption and research (Table 1). The microbiological examination revealed that the honey had no contamination with Gram-positive and Gram-negative bacteria.

Table 1 - Parameters of physicochemical analysis of *Melipona scutellaris* (uruçu) honey compared with those established by the Regulations of Ministry of Agriculture, Brazil¹¹.

Samples	Humidity (%)	HMF (mg/Kg)	pH	Acidity (meq/kg)	Ash (%)	Insoluble solids (%)
Uruçu honey	18.06	23.90	3.85	41.66	0.1	0.06
Ministry of Agriculture, (Brazil)Regulations	Maximum 20	Maximum 40	3,3 - 4,6	Maximum 50	Maximum 0.6	Maximum 0.1

HMF, hydroxymethylfurfural

DISCUSSION

In this study, we studied the physicochemical composition of *Melipona scutellaris* honey, a wild stingless bee, known as Uruçu, common in semi-arid region of Northeast Brazil. Its honey has been used empirically in popular medicine to treat respiratory diseases, skin and soft tissue diseases, and little is known about its physicochemical composition. Microbiological and physicochemical analysis of *Melipona scutellaris* honey revealed that it is in accordance with the quality standards established by the Ministry of Agriculture, Brazil. According to Brazilian rules for use of honey in humans, it should be ensured good origin and safety of physicochemical and microbiological point of view, combined with being cost-effective¹¹.

Honey is a natural supersaturated sugar solution, which is mainly composed of a complex mixture of carbohydrates. In addition to carbohydrate content, it also

contains approximately 20% water as well as minor but important constituents such as proteins, enzymes (invertase, glucose oxidase, catalase, and phosphatases), amino acids, organic acids (gluconic acid, acetic acid), lipids, vitamins (ascorbic acid, niacin, pyridoxine), volatile chemicals, phenolic acids, flavonoids, carotenoid-like substances, and minerals^{12,13}. The composition of honey can be variable and is primarily dependent on its floral, geographical, and entomological source. Certain external factors, such as seasonal and environmental factors and processing, also play important roles^{14,15}. The quality of honey is determined by its sensorial, chemical, physical and microbiological characteristics¹⁶. The major criteria of interest are moisture content, electrical conductivity, ash content, reducing and non-reducing sugars, free acidity, diastase activity and hydroxymethylfurfural content. The comparative physicochemical characteristics of honeys from other regions of the world have been extensively studied¹⁷, but data on regional honey from *Melipona scutellaris* are scarce.

Study by Brazilian researchers indicated that the *Apis mellifera* honey is composed of about 40% fructose, 20% water, amino acids, vitamins (niacin, pyridoxine and thiamine), enzymes (diastase, invertase, catalase and glucose oxidase), hydrogen peroxide, and minerals (potassium, iron, magnesium, phosphorus, copper, zinc and calcium)¹⁸. Among the related properties of honey, antibacterial activity is very important: honey is a supersaturated solution with strong osmotic activity, the pH is between 3.2 and 4.5, and this acidity is sufficient to inhibit the growth of many microorganisms. By the way, the pH of *M. scutellaris* honey was 3.85. Hydrogen peroxide produced by the glucose-oxidase is certainly the most important antibacterial component of honey and several other phytochemicals and immunochemical factors have been evaluated^{19,20}. A study conducted in our laboratory with the use of honey *Melipona subnitida* (Jandaíra) showed significant antimicrobial effect in infected wounds of skin²¹.

In conclusion, our findings suggest that the physicochemical composition of *Melipona scutellaris* honey is compatible with the Brazilian guidelines for the composition and quality of honey. So, it is adequate for human consumption and research.

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