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QUALITY PARAMETERS OF HONEYBEE *APIS MELLIFERA* IN  
APIARIES OF THE RURAL AREA MANABITA ECUADOR

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**ABSTRACT**

Beekeeping is an activity that complements agriculture. In order to determine the quality parameters in apiaries of 2 cantons of the province of Manabí, Ecuador, quality analyzes were carried out on 5 samples of honey from bees, which were selected by means of a stratified sampling scheme. As a result, physical and chemical quality parameters were obtained such as free acidity, total acidity, lactones, insoluble solids, total solids, electrical conductivity, pH; Chemical quality parameters of honey such as humidity, sugars, fructose, sucrose, glucose and ash, as well as honey freshness parameters such as hydroxymethylfurfural and diastatic activity, within the parameters established by the technical standard NTE INEN 1472, complying with the quality parameters established by the Ecuadorian standard and international CODEX. It is concluded that the bee production studied complies with the Ecuadorian regulations that regulate the production and marketing of honey from bees within the country.

## INTRODUCTION

The first record on beekeeping that we have corresponds to Egypt in the year 2400 BC, it details the use of hives, their management and harvesting of honey from bees melliferous. (Lino-Lazo, 2002). Honey-producing bees fall into two large groups, those with sting (ie, *Apis mellifera*) and bees without sting (ie, Meliponini). The product of bees, honey, is recognized for its antibacterial, antifungal, anti-inflammatory medicinal properties, among others. (Zamora & Arias, 2011). Honey is a natural product, its uses are varied, it is used as a very nutritious food, ideal to use in various meals; It has a high content of fundamental enzymes that promote good digestion, it is composed of simple sugars, these are glucose and fructose, 34% and 38% respectively, these substances do not require gastric juices to process them to be digested by the organism. In such a way that these sugars (sucrose, maltose, sweet), when ingested and assimilated, supply the body with the heat and energy it needs (Bianchi, 1990, cited by Subovsky, Sosa, & Castillo, 2003). The classification of honey is given both by the origin and by the treatment that has been provided; Regarding the botanical origin, there is honey from the nectar of the flowers, monofloral and polyfloral, the other type of honey is honeydew honey that comes from the exudation of the living parts of the plants or present in them (Subovsky, Castillo, Sosa, & Cano, 2002; Dharmayanti & Darma, 2020). Regarding its treatment, there are honeycomb honey, centrifuged honey and pressed honey; honeycomb honey is that which the bees place in newly built combs without larvae; The centrifuged honey is obtained by the beekeeper using a centrifuge where he deposits the uncapped combs without larvae; the pressed honey is finally obtained by the beekeeper by pressing the combs, without larvae, being able to use a light source of heat for this (Subovsky et al., 2002).

The chemical composition of honey depends to a large extent on the types of flowers visited by bees during the collection of nectar and pollen, likewise these plant species, depend on the regional climate conditions that prevail in the places where the bees are located. apiaries (Moo, Sauri, Moo, & López, 2015). Due to the advancement of beekeeping, for honey *A. mellifera* there are standard extraction procedures and regulations to control its quality, which are achievable due to its low moisture content on average of 18% (Olaya, Gutiérrez, & Hernández, 2014; Velásquez et al., 2013). The valid quality standards for the commercialization of honeys worldwide are established in the Codex Alimentarius (Food and Agriculture Organization of the United Nations [FAO], 2013).

The International Honey Commission (IHC, 1990) states that modern analytical methods allow for faster and better results (Bogdanov, Martin & Lullman, 2000; Widana et al., 2020). There are several methods to determine the quality of honey from bees, according to Missio et al. (2016, cited by Pineda, Castellanos, & Téllez, 2019), the sensory and physicochemical properties are defined by the color and the minimum or maximum amount related to the parameters of maturity, purity and deterioration of the honeys.

When talking about honey, it is important to determine the degree of maturity, for which the sugar content, hydroxymethylfurfural (HMF), acidity, diastatic

activity and humidity are established, as well as to determine purity, we proceed to analyze parameters such as electrical conductivity, ash content, and solids insoluble in water. In honey the color, flavor and geographical origin are present, which depend on the type of soil, since on these there is the flowering of the species from which the bees collect nectar and pollen (Bogdanov, 2018). In this way, honey can have a dark color because it comes from carob or cocoa flowers, but it can also develop during storage, due to the storage temperature or the composition of the honey (Bogdanov, 2018). The quantification of the solids insoluble in water allows to detect the impurities of the honey of bees higher than the maximum allowed (Bogdanov, 2018).

Total acidity is the sum of the acidic substances that can be evaluated in a honey sample by adding an alkaline solution of known normality (Ecuadorian Institute of Normalization [INEN], 1989). The diastase number, also known as diastase activity, diastase index or diastase power, is the amount in cubic centimeters of a 1% starch solution hydrolyzed by the enzyme contained in 1g of honey in a period of one hour (INEN, 1989). Norm NTE INEN 1636 promulgated by the (INEN, 1989) establishes the method to determine the ashes in the honey of bees, this method consists of burning the honey until obtaining a non-combustible residue. The tests to determine the amount of ash allow estimating the mineral content present in honey, which can be an indicator of environmental contamination (Pineda et al., 2019). The NTE INEN 1635 Standard determines the method to determine the content of insoluble solids in honey, which consists of the elimination of the sugars contained in the honey to obtain a residue insoluble in water (INEN, 1989).

Hydroxymethylfurfural (HMF) is an aldehyde and a furan, it is a compound that is formed when sugary products such as fructose dehydrate or degrade (Villar, Villar, Rodríguez, Cobo, & Serrano, 2015; Sari et al., 2020; Diansari et al., 2020). HMF appears naturally in honey when it contains an acid pH, water and a composition rich in monosaccharides (fructose and glucose), increasing its concentration with time and other factors, therefore, fresh honeys, those recently harvested and the Flower nectar does not contain HMF (Villar et al., 2015). The HMF constitutes an indicator of the storage conditions, age and treatment received by honey (Villar et al., 2015).

Another indicator is the moisture content, it is one of the most important characteristics of honey, it directly affects the quality of its storage, and this parameter measures the percentage of water that a certain type of honey contains (Gómez, 1996; Graham 1993, cited by Soto, 2008). Electrical conductivity is an important physicochemical measurement for the authentication of honeys, its value depends on the content of ash and acids: the higher its content, the higher the resulting conductivity (Bogdanov, 2018).

Ecuador due to its climatic and geographical characteristics has great potential for beekeeping. Data from the Ministry of Agriculture and Livestock (2015) indicate that in 2015 there were 912 beekeeping farms with 12,188 registered hives, which are estimated to be 200,000 hives, which would increase the number of hives sixteen times and, therefore, their production (Velásquez & Goetschel, 2019; Suryasa, 2019). The Norm NTE INEN 1572 promulgated by

the (INEN, 1988) establishes that within the requirements for the commercialization of honey are total reducing sugars, sucrose, fructose-glucose ratio, humidity, insoluble solids, ashes, relative density, hydroxymethylfurfural, diastase, and acidity.

## MATERIALS AND METHODS

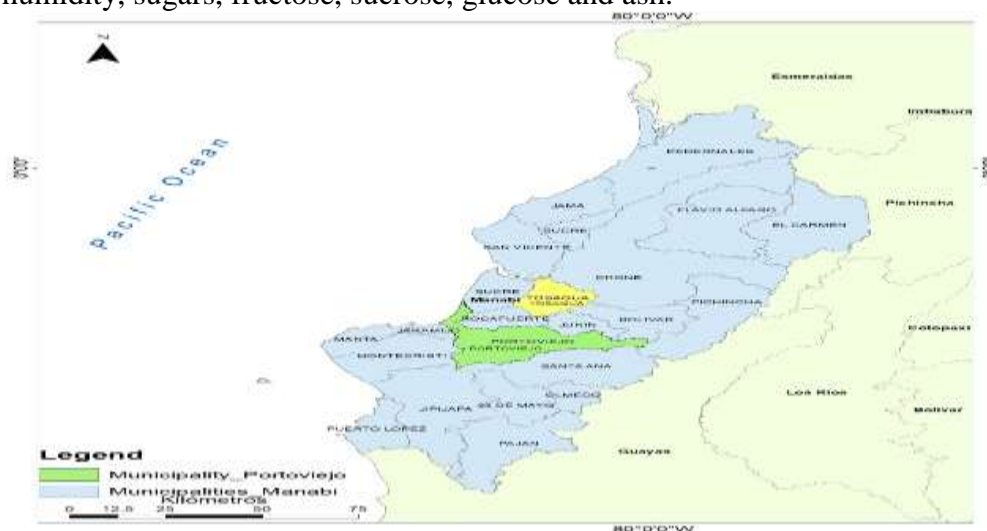
### *Location of the study area*

The study was carried out in two cantons in the province of Manabí, Portoviejo and Rocafuerte (figure 1). In the Portoviejo canton, 3 urban parishes were chosen, Picoazá, Portoviejo and Colón, which, although classified as urban, are home to rural and marginal urban communities, where beekeeping is carried out as a complementary activity to agriculture. These communes are El Limón belonging to the Picoazá parish, Mejía of the Portoviejo parish and Mapsingue belonging to the Colón parish. In the Rocafuerte canton, work was done in the Sosote commune. The canton Portoviejo it is located at  $01^{\circ} 03'16''$  S,  $80^{\circ} 27'16''$  W; and it is located 53 m above sea level The Rocafuerte canton is located at  $00^{\circ} 55'S$ ,  $80^{\circ} 28'W$  and it is located 115 m above sea level. The Rocafuerte climate is of 2 types, tropical mega thermal semi-arid in the extreme east and tropical dry mega thermal in the west (National Institute of Meteorology and Hydrology [INHAMI], 2012). Portoviejo's climate is semi-arid.

### *Origin of the information*

We worked with a population of 5 apiaries, distributed in 4 apiaries of the Portoviejo canton and 1 of the Rocafuerte canton, of which 2 apiaries are established in the El Limón Commune, 1 in the Mejía commune and 1 in Mapsingue of the canton Portoviejo, the remaining apiary is located in the Sosote commune of the Rocafuerte canton, in figure 1, the location of the cantons where the study was carried out is shown.

The quality analyzes of the honey were carried out under physical-chemical quality parameters such as free acidity, total acidity, lactones, insoluble solids, total solids, electrical conductivity, pH, and chemical parameters such as humidity, sugars, fructose, sucrose, glucose and ash.



**Figure 1.** Location of the Portoviejo and Rocafuerte cantons (Manabí, Ecuador)

## ANÁLISIS Y DISCUSIÓN DE LOS RESULTADOS

5 samples of honey from the bee were analyzed *Apis mellifera* to establish physical-chemical parameters and determine the quality of the product. Table 1 shows the results of the physical-chemical quality parameters: free acidity, total acidity, lactones, insoluble solids, total solids, electrical conductivity, pH.

**Table 1.** Physical-chemical quality parameters of honey prepared, more information please

Parameters	A1	A2	A3	A4	A5
Free acidity (Meq / kg)	7.4	7.5	6.0	12.5	7.7
Total acidity (Meq / kg)	16.9	16.5	11.5	7.5	16.2
Lactones (Meq / kg)	9.5	9	5.5	6.5	8.5
Insoluble solids (%)	0.07	0.073	0.077	0.079	0.07
Total solids (%)	99	5	5	6	79
electrical conductivity (mS / cm)	0.93	1.031	1.089	0.845	0.98
pH	9	4.21	4.32	9.5	2
	4.14				4.34

The standard Ecuadorian technique NTE INEN 1572, establishes the degree of acidity up to 40 Meq / Kg, however, the FAO CODEX (2012) cited by (Contreras, Esteban, & Condori, 2016), standard up to 50 milli equivalents of acid per 1000 g. According to the results, the 5 samples analyzed comply with the parameter established by the standard. According to the CODEX of honey established in (FAO & WHO, 1999), the permissible limits for electrical conductivity are between 0.8-1.2 mS / cm, the results of the samples are within the permitted ranges; Regarding the insoluble solids in water for squeezed honeys, the International Honey Commission (1997, cited by Bogdanov, Martin, & Lullman, 2000) establishes  $\leq 0.5$  g / 100g. Table 2 shows the chemical quality parameters of honey (humidity, sugars, fructose, sucrose, glucose and ashes).

**Table 2.** Chemical parameters of honey quality

Parameters	A1	A2	A3	A4	A5
	%	%	%	%	%
Moisture	29.13	17.58	17.75	20.14	16.38
Other sugars	7.002	7.121	7.058	7.164	7.094
Fructose	37.12	37.84	38.54	39.21	38.73
Sucrose	3.42	3.58	3.65	3.61	3.49
Glucose	29.14	28.52	29.08	28.98	28.67
Ash	0.2017	0.3395	0.3352	0.2367	0.2727

In accordance with the Ecuadorian Technical Standard NTE INEN 1572, the humidity allowed in honey honeys is in the range of 20-23% of its mass, sucrose 5-7%, ashes up to 0.5%, total reducing sugars up to 65%, fructose-glucose ratio 1. Thus, it can be seen that apiary 1 has a humidity above the allowed ranges. The results for sucrose, glucose and minerals such as ash are within the allowable ranges. According to the results, there is no significance level of an out-of-range result, therefore, the samples analyzed from the 5

apiaries present chemical quality parameters in the honey they produce. Also, considering the Mexican standard NMX-F-036-1997-NORMEX cited by (Suescún & Vit, 2008), among the chemical quality parameters of honey, the sugars allowed are between 0.1-8%, the fructose 28-44%, glucose 22-38%. The results of the sugars, fructose and glucose of the 5 apiaries present chemical quality parameters, shown in table 3.

**Table 3.** Freshness of honey

Parameters	A1	A2	A3	A4	A5
Diastase number	7	7.1	7	7, 4	8
Hydroxymethylfurfural (mg / kg)	39.2	38.4	34.5	39.18	37.78
			4		

Regarding the parameters that determine the freshness of bees' honey, the Ecuadorian Technical Standard NTE INEN 1572 establishes that the allowed diastase number fluctuates between 7-8, and the hydroxymethylfurfural content up to 40 mg / kg. According to the results of the 5 samples analyzed, they comply with the quality parameters established in this standard.

## CONCLUSIONS

The quality of honey from bees has to do with the fulfillment of various parameters, physical, chemical and sensory, thus, both in Rocafuerte and Portoviejo, beekeeping complies with the Ecuadorian regulations that regulate the production and marketing of honey. of bees within the country, and which is in accordance with the Codex Alimentarius for the production of honey worldwide, promulgated by the FAO.

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