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Predominant Flora and Honey Bee (*Apis Mellifera*) Production in Northern Manabí-Ecuador

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Abstract

Objective: to define the predominant flora, production and quality of bee honey in three localities in the northern zone of Manabí.

Methods: observations were made in three bee hives per zone, and in relation to the time and flowering of crops, honey production was obtained in the three places with time proximity. After harvesting, a record was kept of the quantity and the quality of the honey was determined. An ANOVA was applied to the values of quantity of honey produced per zone.

Results: showed that there were no significant differences between zones. To determine quality, physicochemicaland microbiological tests were carried out. In addition, they showed normality in the 3 zones; and an organoleptic acceptability test, organized by means of a Likert scale and the Chi^2 analysis showed that there were no differences in the organoleptic characteristics between the zones, with high acceptance of the honey.

Conclusion: in the study zones there is a predominance of vegetation with melliferous properties such as common flora, lemon and pitahaya crops, which maintain similar volumes of production and quality of honey bee honey. With the common flora, due to its continuous flowering, there is a tendency ($P<0.10$) to slightly increase production.

Keywords: common flora, lemon crop, pitahaya crop, honey.

Introduction

The northern zone of Manabí has little beekeeping development due to the centralism existing in the southern zone, clear examples are the different associations that have developed over the last decade in the cantons of Portoviejo and Jipijapa, where this activity has contributed to improve the quality of life of different communities and a considerable economic income for the whole sector [1].

Many people do not know the importance of environmental conservation and the contribution that bees provide. Apart from the welfare of the ecosystem, beekeeping as a farm generates a source of work, which can serve as a source of income in the province of Manabi, and unquestionably is an alternative business or employment.

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The knowledge of the existing flora in the Canton of Chone will be the starting point for productive strategies in the beekeeping sector. Chone, due to its geographical position, provides all the natural conditions to develop beekeeping on an industrial scale. This allows to investigate sites or communities where *Apis mellifera* will develop under normal conditions, thus maintaining the organization that this species presents, and with this the production of honey and its derivatives.

The present research constitutes an important challenge for the scientific community of this sector, since it is necessary to make known the importance of the existing flora in the country and its influence on the production of the quantity and quality of bee honey. This work is hoped to contribute to scientific knowledge on such an important area of study as beekeeping and its relationship with floriculture.

One of the most important goals among the seventeen sustainable development goals for 2030 or before is that people have a sustainable, dignified and fair quality of life. In addition, goal fifteen states that the life of the terrestrial ecosystem must be preserved, by virtue of which bees play an important ecological role such as pollination, a biological role conducive to the conservation of flora and other benefits derived from it, which is why it is essential to take care of them, protect them and facilitate their expansion[2].

Beekeeping represents, therefore, a livelihood alternative, because it allows rural communities to achieve economic autonomy, which strengthens the sense of empowerment in the region.

The environmental conditions of Canton Chone suggest the development of the proposed research and the need to take it to a larger scale that would involve different areas of this canton; however, for the level of complexity that it is intended to achieve, it has been proposed to develop it in its communities. For the above mentioned, it is relevant to carry out this research because it will allow characterizing the common flora at the canton level, which is undoubtedly the fundamental basis for an efficient beekeeping production to integrate it to sustainable and sustainable agricultural production systems.

Therefore, the objective of this research is to define the predominant flora of three localities of the Canton Chone, the production and quality of honey from bees (*Apis mellifera*).

Materials and methods

The research was carried out in three parishes of Cantón Chone, northern Manabí: Ricaurte Parish, La Gloria farm; San Antonio Parish, Horconcito site; Eloy Alfaro Parish, Eloy Alfaro site. Chone is between 1,230´latitude north and 45´ latitude south of the equator, and at 79°. Chone is bordered to the north by the province of Esmeraldas and the canton of Pedernales; to the south by the cantons of Pichincha, Bolivar and Tosagua; to the east by El Carmen, Flavio Alfaro and the province of Los Rios; and to the west by the cantons of Sucre, Junin, Jama and Pedernales.

Two methods were used to conduct this exploratory study: field and laboratory, and the research lasted 4 months, started on September 9, 2019 and concluded on January 9, 2020.

The common flora existing in the canton of Chone was identified and delimited by observing the crops. Visits were made to different places in the areas under study to identify species of bee-friendly flora.

Nine hives in productive phase were observed in the study, with a number of 25,000 to 30,000 units per hive, located in a number of 3 hives with 8 frames per hive, per place to investigate: Eloy Alfaro parish, the hives were placed in a farm of ten hectares where the bees were benefited by several

species of plants of which they were observed. In the parish of San Antonio, a five-hectare lemon plantation was occupied. In the parish of Ricaurte, seven hectares of pitahaya were planted and the hives were placed in the middle of these crops.

During the first month, observations were made every 8 days. The above parameters were considered and with this the honey flow was determined. A record was kept in stages, and each month a report on the evolution of this research was submitted.

After the observation of the different crops and the common flora, the honey harvest was obtained, a record was taken of the time and quantity of the harvest in each of the three locations or zones under study, then a comparison of the three zones was made by means of an analysis of variance.

After harvesting, 200 mL of honey from each of the areas under study were taken as a sample in sterile urine containers for quality analysis in the Chemistry and Bromatology laboratory of the Technical University of Manabí (Chone extension).

The laboratory analyses performed were ashes, pH potentiometer, pycnometer density, humidity, total sugars, yeasts and molds. The methodology of the physical-chemical and microbiological analyses is described below:

Density: It was analyzed using the official AOAC 962.37 method detailed in NTE INEN 1632 (INEN, 2012) which is based on the determination of the weight of water and sample of a constant volume, keeping the pycnometer in a thermal bath at 27°C. 2.2 its minimum estimated range is 1.37 $g.mL.^{-1}$

Moisture: To determine moisture, the method is based on the determination of the refractive index of honey at 20°C, according to NTE INEN 1632. The reading was made using an ABBE refractometer with sodium light, Milton Roy Company brand. The percentage of moisture was reported using the ratio of refractive index and water content of the honey. According to the table indicated in the method, its estimated range is 0-20[3].

pH: The great sweetness of honey largely masks the taste of the organic acids present in honey, which represent approximately 0.5% of the solids of this food. Organic acids are responsible for the low pH (3.3 to 4.9) of honey and excellent stability, this determination was carried out under official AOAC 962.19 method described in NTE INEN 1634 (INEN, 2016). In order to measure the pH, a potentiometer was used [4].

Brix: Total soluble solids refer to the sugar content in honey and are expressed as a percentage or Brix (°Brix). A result of 80 °Brix represents that 80% of the honey is sugar. The total soluble solids content is related to the moisture content, since water is the second most abundant component in honey. It was carried out under the official method of the AOAC 962.19 described in NTE INEN 1634 (INEN, 1989) is calculated by means of a brixometer and its range starts from a minimum of 60°Brix [3][5].

Sugar content: It was carried out using the Luff-Schoorl method under the NTE INEN 1633 standard. The sample is previously subjected to hydrolysis by adding concentrated hydrochloric acid to the honey solution and mixing in a bath until the solution shows the first color change (more

intense color). It is neutralized with sodium hydroxide until the pink color persists. It ranges from 60% by mass class I minimum 65 class II minimum 60[3].

Ash: Based on the official method of AOAC 920.181, which consists of determining the weight of the dry residue of the sample, calcined in a muffle at 600 ºC until constant weight and presence of white ash by means of a pycnometer, as described in NTE INEN 1636 (INEN, 1989), its normal range is 0-0.5 [6].

Fungi and yeasts: Determination of molds and yeasts (Honey BMP Manual, 1998). The methodology is based on the International Standards of A. P. H. A. (American Public Health Association) (Method NTE INEN 1529-10, 2012) 10 g + 90 ml of 0.1% peptonized water Seeded on plates in YGC Agar Incubated at 22°C 72 h, its range is 0-1x10UPC^2 .mL^{-1} (colony propagating units per gram) [6].

Mesophilic aerobes: They were determined by the pour-plate seeding technique. Standard bead agar was used. The inoculated Petri dishes were incubated at 35°C for 48 hours. Their normal range is 10 CFU^3 .mL^{-1} (colony forming units per milliliter) [6].

Sensory analysis of quality and acceptability

Sensory analysis is the interpretation of responses to products perceived through the senses of sight, taste, hearing, touch and smell. The main tasks of sensory analysis are: identify, scientifically measure, analyze and interpret. Sensory analysis techniques seek to measure or describe organoleptic characteristics and satisfactory consumer evaluation of the product. Sensory analysis within the food industry is very varied, this analysis focused on quality control or consumer preferences [7].

A sensory acceptance analysis was carried out using a sensory panel with untrained tasters who worked with an edonic scale from one to fifteen.

Thirty untrained tasters were used to perform the analysis and the honey samples were placed in the following order: Group 1 belonged to the Eloy Alfaro area with the common flora of the area; Group 2 corresponded to the San Antonio area with a lemon crop; Group 3 belonged to the Ricaurte area with a pitahaya crop. Each group of samples was placed in a container labeled G1, G2 and G3.

In addition to the samples, cheese, coffee and coffee were placed and each taster was given a sheet on which a sensory analysis was placed with an edonic scale or Likert scale of 1-15, where one referred to*I dislike it* and 15 *I like it very much*, without conditioning the tasters. It was desired to determine the acceptance from the organoleptic point of view, where each taster took a piece of cheese, put it together with the first group, then tasted it and marked it on the Likert hedonic scale according to its acceptance, and so on with the other groups.

Once the results of quantity and quality were obtained, the values were compared and the research was concluded with the purpose of identifying the flora environment and the associated values of quantity and quality of honey.

The variability of production and quality was studied through an analysis of variance. The assumptions of homogeneity of variance (Bartlett's test) and normality were previously checked. If there were significant differences between the zones, means were compared using Tukey's test at 5%.

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Descriptive statistics were also performed on the dependent variables; measures of central tendency (mean) and dispersion (standard error of the mean, coefficient of variation, maximum and minimum values) were considered.

The results of the Likert scale in the organoleptic analysis were processed by Chi^2 analysis.

The analyses described above were performed under SAS statistical software (version 10, 2013), with results tabulated and plotted.

Results

The locality of Eloy Alfaro is characterized because its flora is dominated by heterogeneous forests and its most common vegetation is Laurel (*Laurus nobilis*), Fernán Sánchez (*Triplariscumingianafisch),* ovos (*Spondias purpurea*), botottillo (*Cochlospermun),* citrus *(Citrus),* Ceibos (*Erythrina crista-galli),* Carob trees *(Ceratonia siliqua*), Mangroves *(Rhizophora mangle),* Frutillo*(Fragaria),* Guasmos (*Guazumaulmifolia)* and different types of creeping plants (*Malvas*).

The flowering time of most of the plants observed is continuous, with peak flowering occurring from September to December and, consequently, bees have increased foraging activity. They report that, in order to identify the type of resource for which bees visit flowers, it is necessary to be aware of the characteristics of foraging behavior, such as collection of nectar, pollen or both. The flora constitutes one of the main considerations for the installation of an apiary. The flora found in the Province of Manabi is very varied. It indicates that Chone is a canton that has a subtropical climate with abundant and rich flora and fauna, so the city is identified with a territory very similar to the Ecuadorian jungle. The predominant climate is hot and dry in summer, from June to November, in normal times, giving favorable flowering results at this time, especially timber trees [8] [9] [10].

In the San Antonio area, the flowering of a lemon crop was observed. In the month of the beginning of this research (September), this crop showed favorable results in terms of the flowering-production relationship, resulting in the production of honey four weeks after the observation; that is, in the month of October, starting with its first production of the year, so the grazing in these months was incessant. The lemon crop adapts to areas of high temperatures, dry or extremely humid, emphasizing that some varieties can have continuous flowering throughout the year, giving gratifying results in the production of honey [11].

In the Ricaurte area, the pitahaya crop had a continuous flowering, giving results of honey production at the beginning of October. Therefore, the grazing time was more significant in the month of September, since the flowering peak of this crop occurs in the months of August to October. It is important to know and observe the flora to have an idea of the production to be obtained [12].

Table 1 shows the honey production (kg) of the study zones. The statistical results did not show any statistical significance ($P>0.05$) in the production per zone; however, the production data show a tendency ($P<0.10$) to be higher in zone Z1, where its production depended on a common flora of Cantón Chone.

Table 1. Honey production (kg) of bees from three zones in Chone Canton.

Studyarea	Production (kg honey)	DE Significance
Z1 Native	53.2	±0.6562
Z2 Lemon	45.6	± 0.6565 P<0.10
Z3 Pitahaya	41.7	± 0.5008

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SD = Standard deviation

The averages of honey production (kg) per hive in the study zones (Table 2) did not show statistical differences (P>0.05) among them, although it could be observed that the averages of Z1 showed a tendency (P<0.10) to show significantly elevated numerical values at the apiary level, coinciding with the results of production per zone.

Table 2. Average honey production per beehive (kg)

Studyarea	Average per hive (kg honey)	DE Significance
Z1 Native	17.7	± 0.5821
Z2 Lemon	15.2	± 0.6239 P<0.10
Z3 Pitahaya	13.9	± 0.6769

SD = Standard deviation

Table 3 shows the laboratory results of the physical-chemical and microbiological analyses of the three study areas.

Table 3. Physicochemical and microbiological properties of bee honey from three study areas in Chone Canton.

Properties Physical and chemical	Zone 1Native	Zone 2Lemon	Zone 3Pitahaya
Humidity, %, %, %, %, %, %, %, %, %, %, %, %, %.	16. 08	18.6	16.9
Density, g.mL^{-1}	1.409	1.424	1.422
Ph	3.48	3.42	3.35
°Brix	78	81	81
Cenizas, %	0.38	0.4	0.13
Sugar Content, %, %, %, %, %, %, %, %, %, %, %, %, %.	63.9	64.2	63.2
Microbiological			
Fungiyeasts, UPC.g^{-1}	16	7	34
Mesophilicaerobes, CFU.mL^{-1}	19	19	7

In terms of quality, the three zones showed normal data; none of these zones showed any alteration in the physicochemical and microbiological analyses. Based on this, these results can be taken as a marketing reference for the honey produced in the Canton of Chone.

Table 4 shows the Likert scale and the organoleptic characteristics such as: flavor, odor, color, texture and general appearance. With this scale and the Chi^2 statistical method, it was possible to obtain as a result that there were no differences between zones in any of the characteristics studied.

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Table 4. Number of people who showed acceptability according to the organoleptic characteristics of bee honey (Apis mellifera) from three localities of the canton of Chone, according to the Likert scale.

Zones	Likert Scale	Taste	Odor	Color	Texture	General appearance
Eloy Alfaro Nativas	I dislike (1 - 5)	2	5	2	0	0
	Medium taste (5.5 - 10)	15	15	16	18	14
	I like it very much (10.5 - 15)	13	10	12	12	16
San Antonio Limón	I dislike (1 - 5)	1	1	0	1	1
	Medium taste (5.5 - 10)	13	19	17	13	10
	I like it very much (10.5 - 15)	16	10	13	16	19
Ricaurte Pitahaya	I dislike (1 - 5)	1	0	3	3	0
	Medium taste (5.5 - 10)	16	18	14	14	16
	I like it very much (10.5 - 15)	13	12	13	13	14
Chi^2		1.25	7.75	3.15	5.07	4.18
P-value		> 0.05	> 0.05	> 0.05	> 0.05	> 0.05

The organoleptic characteristics were established based on the acceptance and description of nature within the variable, which in this case is the flora. It should be noted that, although the organoleptic characteristics did not differ, they were highly acceptable in the three zones.

Discussion

The literature related to the study of the predominant flora for beekeeping production in Ecuador has been scarce. Ecuador is a country with a mega diversity of flora and fauna, which makes it one of the most biodiverse countries on the planet. The financial situation of beekeeping companies and their demands to meet their production needs, leaving aside the knowledge of honey production and the influence of the beekeeping flora [13][14][15][16].

Research on flora and its influence on honey bee production at the national level is short, it should be noted that there are studies on beekeeping, but they emphasize bee health, cost-benefit, biosecurity measures, and apitherapy. Several studies corroborate this, highlighting aspects such as socioeconomic development, the analysis of climatic conditions for the production of honey bee honey, and the generation of opportunities for small beekeepers in rural areas in Ecuador. In addition to studies on production costs and the creation of beekeeping enterprises, there are works on beekeeping and the development of rural tourism, mainly interested in making known the great variety of flowers that constitute the habitat for bees. In Paredes' work, it is interesting to talk about

apitourism and apitherapy, as well as the design of tourist routes for the knowledge of honey [17] [18] [19].

Honey naturally possesses natural pigments that provide color, odor, flavor and other characteristics according to its floral origin [20]. The organoleptic characteristics of honey are part of the parameters that allow us to differentiate the different types of honeys; therefore, a honey of adequate quality will obtain greater acceptability. Another research refers that the determination of honey quality is established through different criteria such as normality in physicochemical and palynological analyses and organoleptic properties, which will be reflected in the appreciation by tasters [21].

Conclusions

The characterization of the predominant flora for the production of honey made in parishes of Chone Canton, allows to corroborate how important and decisive is the observation of the flora before placing hives in a certain area.

In the parishes of Eloy Alfaro, San Antonio and Ricaurte, in the Chone Canton, there is a predominance of vegetation with melliferous properties such as common flora, lemon and pitahaya crops, respectively.

The observation of the flowering and foraging of bees in the study areas, allows planning the month of October as the beginning of the harvesting period by beekeepers, and the determination that with the predominance of common flora, the peak of flowering-production can be extended during the months of September to December and, consequently, the foraging activity.

The botanical diversity found in the parishes of Chone Canton maintains similar volumes of honey production, and with the predominance of the common flora, due to its continuous flowering, there is a tendency to increase slightly, so that the hive can be almost independent, which becomes of great importance for beekeepers.

The honey produced in the three study zones of the Chone Canton is within the norms and fundamental requirements of good quality, shows a high acceptance according to the organoleptic variables, so it can be consumed without concern by the client.

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