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Research Article

Physico-Chemical Analysis of Honey Produced in Bako-Tibe District, Western Showa Zone, Oromia Region, Western Ethiopia

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Abstract

Honey production is a long-standing practice in the rural communities of Ethiopia in general and Oromia regional state in particular. However, there is scanty information with regards to the quality of the honey produced in the most parts of Oromia. The study was conducted to assess the Physico-Chemical Analysis of honey produced around Bako Tibe district, western Showa, Ethiopia. A total of 13 fresh honey samples each weighing 50 gram were randomly collected from three agro-ecologies of the district. The collected honey samples were analyzed in the laboratory for their physico-chemical parameters. The average results indicated that 19.81%, 4.23, 21.43meq, 0.11 % for moisture, pH, free acidity and ash, respectively. According to this analysis, the results of all the samples fall within acceptable ranges for the national and international standards. This study investigated and availed the honey quality results of study area and ascertained all the values concur with local and international requisites. Owing to lack of testing facility, the information on the honey safety aspects still remain blurred, requiring further investigations.

Keywords: Moisture; Honey; Acidity; Quality; Standards; pH

Introduction

Ethiopia is blessed with adequate water resources and various honeybee floras, which create fertile ground for the development of beekeeping [1]. As a result, with over 10 million honeybee colonies, the country possesses the highest honeybee population in Africa and yearly produces about 54,000 metric tons of honey and this is only 10% of its production potential. With this, the country ranks 4th and the 10th largest producers of beeswax and honey in the world, respectively [2]. Honey production is a long-standing practice in the rural communities of Ethiopia and appears as ancient practice [3] and dominantly run by the small-scale farmers. Beekeeping is significantly contributing to the off-farm income and poverty lessening in rural areas [4].

According to Codex Alimentarius, 1989, honey that is produced by honeybees from the nectar of blossoms and/or secretion of living parts of plants is considered as a natural sweet substance and medicine. In terms of its uses honey is regarded as a nutrient and a drug [5] and source of carbohydrate.

The chemical composition of honey is mainly depend on the vegetation sources from which it derived, climate, harvesting and storage conditions. Honey consists primarily of simple sugars, water, minerals, and nitrogenous compounds [6].

The quality of honey is a key factor for both local and international markets for both to ensure premium prices and human health. The physical and chemical properties of honey are the most commonly monitored parameters as international quality standards for honey [6,7]. Sugars, water, proteins, enzymes, acids and minerals are the main constitutes of honey [6] and their quality affected by heating at high temperatures, high moisture content, adulteration, poor packaging and poor storage conditions.

However, honey quality issue is largely disregarded by producers and processors in most beekeepers of the country and reports are available only for limited places. To this fact, only quality aspects of honey from Burie district of Amhara Region [8], honey from Gomma district [9], and honey from Horo districts [10] and honey from Tigray region [11] have been studied so far.

Therefore, the present study is aimed at determining the quality of honeys produced in three agro-ecologies of Bako-Tibe district by comparing with local and international honey quality parameters and make an information contribution to what are available so far.

Materials and Methods

Description of the study area

Bako Tibe district is situated Ethiopia within Latitude: 9° 00' 0.00" N and Longitude: 37° 09' 60.00" E (Figure a). The district is categorized in to three agro-ecologies namely, highland (2400m to 3000 meter above sea levels), midland (1800m to 2400 masl), and lowland (1650 - 1800 masl) and each agro-ecology accounts 12%, 37% and 51% of the district, respectively. With cool to warm, the mean annual temperature of the district is 21.2°C with mean annual rainfall 1266 mm (Bako-Tibe district Agriculture and rural development office).

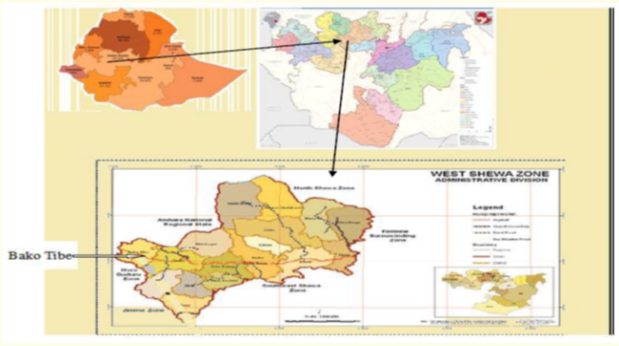

Figure a: Map of the study area.

Sample size and sampling technique

A total of 13 fresh honey samples each 0.5gr were purchased from the three agro ecologies harvested from different beehive types (Table 1). The honey collections were done from November to December at the times of peak honey harvesting season of the year.

No	Agro-ecologies	Beehives and number of sampled honey			Total
		Traditional beehive	Transitional beehive	Frame beehive	
1	Lowland	2	2	2	6
2	Midland	2	2	-	4
3	Highland	3	-	-	3
4	Total	7	4	2	13

Table 1: Honey samples from different agro-ecologies and beehives.

Physico chemical analysis

The honey compositions that included moisture content pH, acidity, ash (mineral) of the honey samples were determined according to the Harmonized Methods of the International Honey Commission done at Ethiopia quality standard Authority of Ethiopia, Addis Ababa.

Moisture content of honey

The moisture content of all the collected honey samples were determined using digital Abbe refractometer (*ATAGO*®1211 NAR-1T Liquid Abbe refractometer with Refractive Index 1.3000 to 1.7000nD, Brix 0.0% to95.0%, accuracy of refractive index (nD) ± 0.0002 and Brix ± 0.1%, made of Japan), thermo stated at 20^{0}C and regularly calibrated with distilled water (Figure 1). The refractive indexes after two minutes were read the corresponding moisture content and the content of each sample measured twice and the average value recorded [12].

Figure 1: Measuring moisture content of honey using digital Abbe refractometer.

pH content of honey

The pH of each honey sample was determined using digital pH meter (3100Janeway, England). A 10g of honey sample was dissolved in 75 ml of distilled water in 250 ml beaker. The solution was stirred with magnetic stirrer and the pH value was recorded [12].

Acidity of honey

Ten grams of honey were weighed with the help of electrical sensitive balance and poured in conical flask and 75 ml of distilled water. The solution was titrated against 0.1 N NaOH solutions in burette using phenolphthalein as indicator. The titration was carried out till the solution turns pink from colour less. The acidity was determined using the formula that is developed by Agbagwa., *et al* [13].

$$\text{Total Acidity} = \frac{\textit{Titration reading x Normality of NaOH}}{\textit{Weight of Sample}} \times 9$$

Ash content

Two grams of honey were weighed and taken in a silica crucible with 3-4 drops of olive oil added to avoid fluttering and kept in muffle furnace at 600 ^{0}C for 3-4 hours. The weights of the ash were determined by deducting the weight of empty crucible from the total weight of empty crucible and ash and the percentage of ash was calculated using the formula developed by Agbagwa., *et al* 2011.

Data analysis

All the data on the honey quality parameters were coded and tabulated for analysis using SPSS version 20.0. To test significance differences among variables, one way ANOVA was computed and means for honey composition of were compared.

Results and Discussion

The results of moisture content, pH, acidity and ash content of the honey against standards with other areas, different agro ecologies and types of beehives were analyzed and the results are depicted in table 2 and 3.

Moisture contents

As it greatly determines shelf life span and processing characteristics of a given honey, honey moisture content is the most essential quality component to be considered as honey quality aspect [11]. According to this study, the overall moisture content of the honey samples varied from 18% to 24% with the mean of 19.88 ± 1.98% (Table 2). From the total honey samples, 84.6% are with moisture content within the local and international standards the accepted range (17.5% - 21%). Moisture content of honey can ranges from 13% - 23% [14]. Separate analysis of honey samples from different beehives indicated 18.57%, 20.25%, 23.75% moisture contents for the honey from traditional, transitional and improved box beehives, respectively and the difference is statistically significant ($P < 0.000$). This suggests the impact of beehive type on the moisture content of honey [14]. The higher honey moisture contents in modern beehive might be attributed to harvesting of unripe honey and this influence honey moisture content [14].

Likewise, the moisture contents of honey samples varied based agro ecologies and 18%, 19.38%, 21.17 % were recorded for the highland, midland and lowland, respectively (Table 3). Environmental temperature and moisture content of original plant affect the honey moisture content [14].

pH

Lower content of pH in honey inhibits the presence and growth of micro-organisms and makes honey compatible with many food products in terms of pH and acidity. This parameter is of great importance during the extraction and storage of honey as it influences the texture, stability and shelf life of honey.

The overall mean result is 4.23 ± 0.14 pH content with 4.0 minimum and 4.40 maximum values for the honey samples collected from different beehives in the study areas (Table 2). There are variations among the honey samples in their pH based on the beehive types. To this fact, 4.26 ± .13, 4.15 ± 0.17 and 4.3 ± 0.00 were recorded for the honey from traditional, intermediate and modern beehives, respectively. There are also differences in pH contents of the honey samples based on their collection agro-ecologies. Accordingly, mean value of 4.23 ± 0.12, 4.08 ± 0.09 and 4.33 ± .05 were recorded for highland, midland and lowland areas, respectively (Table 3).

The recorded pH values are within the acceptable ranges of honey quality standards i.e., 3.2 and 4.5 [12] and agrees with result the results reported 3.2 to 4.5 Bogdano [15] and 3.47 to 4.24 and Jose., *et al*. [16]. This indicates the freshness of honey samples and absence of unwanted honey fermentation due to low pH microorganism inhabitance effect [8].

Acidity (%)

High acidity makes the honey to be sour and honey acidity is usually less than 40 meq acid/kg of honey (Codex Alimentarius,

2001)). According to this study, the mean free acidity of honey samples is 21.43 ± 6.56 meq kg^{-1} ranged from 11.8- 30.4. Nuru [17] and Gebremedhin., *et al*. 2013 reported 39.9 and 29.5 ± 5.12 meq kg^{-1} as mean acidity for Ethiopian honey, respectively. The mean honey acidity varied based on beehive types with 22.46, 22.47 and 15.7 for the honey from traditional, transitional and modern/box beehives, respectively (Table 2). The lowest acidity of the honey from modern/box beehives could be attributed to its high moisture content and its is documented that high honey moisture content could cause fast fermentation and further oxidation to carboxylic acids and hence more honey acidity [18].

Similarly, the free acidity of honey samples varied based on agroecologies (Table 3) and it is reported the honey acidity is significantly influenced by agro-ecology. The lowest acidity values for the honey from lowland could be attributed to its high moisture content [18] and floral origin [11,14].

Type of hives	N=13	Value category	Measured parameters			
			Moisture content (%)	pH content	Acidity (meq/kg)	Ash content (%)
Traditional	7	Mean	18.57 ± .61	4.26 ± .13	22.46 ± 5.72	0.12 ± 0.07
		Minimum	18	4.10	16.20	0.03
		Maximum	20	4.40	30.40	0.20
Intermediate	4	Mean	20.25 ± 0.86	4.15 ± 0.17	22.48 ± 8.98	0.12 ± 0.05
		Minimum	20	4.00	11.80	0.07
		Maximum	21	4.30	30.40	0.18
Modern/box	2	Mean	23.75 ± 0.35	4.3 ± 0.00	15.7 ± .71	0.065 ± 0.02
		Minimum	24	4.30	15.20	.05
		Maximum	24	4.30	16.20	0.08
Overall mean			19.88 ± 1.98	4.23 ± 0.14	21.43 ± 6.56	0.11 ± 0.06
Minimum			18	4.00	11.80	0.03
Maximum			24	4.40	30.40	0.20
Standards*	National		17.5 - 21	-	<40	<0.6
	International		18 - 23	3.2 - 4.5	<50	0.25 - 1.0

Table 2: Physicochemical properties of the honey samples from different beehives.

*Source: Quality and Standards Authority of Ethiopia (2005).

			Measured parameters			
Agroecologies	N = 13	Value category	Moisture contents (%)	pH contents	Acidity (meq/kg)	Ash contents (%)
Highland	3	Mean	18.00 ± 0.00	4.23 ± 0.12	21.08 ± 3.52	0.15 ± 0.04
		Minimum	18	4.10	18.80	0.12
		Maximum	18	4.30	25.14	0.20
Midland	4	Mean	19.38 ± 0.25	4.08 ± 0.09	29.85 ± 0.64	0.16 ± 0.02
		Minimum	19	4.00	29.20	0.14
		Maximum	20	4.20	30.40	0.18
Lowland	6	Mean	21.17 ± 2.25	4.33 ± .05	15.98 ± 2.39	0.06 ± .03
		Minimum	19	4.30	11.80	0.03
		Maximum	24	4.40	18.30	0.09
Overall mean			19.88 ± 1.98	4.23 ± .14	21.4262 ± 6.56	0.11 ± 0.06
Minimum			18	4.00	11.80	0.03
Maximum			24	4.40	30.40	0.20

Table 3: Physicochemical properties of honey samples across agro-ecologies.

Ash (%)

The overall mean ash content of honey samples analyzed in the current study was 0.11 ± 0.06% and ranged from 0.03 % to 0.20 %). The obtained ash value is within the acceptable range between 0.01- 1.2% reported by the Codex Alimentarius Commission Standards [12], Ethiopia Quality Standards Authority of [19] and Bogdano [15].

The ash content of honey varied based on the agroecologies and the beehives (Table 2 and 3). It is reported that the ash content of honey varies based on the agroecologies [12] and beehives [11,20].

Conclusion and Recommendation

This study analysed honey physicochemical contents of Bako-Tibe districts based on four major honey quality aspects. According to this study, honey moisture contents, pH, acidity, and ash contents varies based on beehives types and agro-ecologies. This study ascertained that all the honey samples of Bako-Tibe district are within the acceptable physicochemical content ranges of national and international quality standards. Apart from contributing to the knowledge in physico-chemical properties of honey produced in such areas and in the country, this study pave way for GOs and NGOs to join hands for boosting honey production and honey quality promotion of the areas.

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