

PHYSICO-CHEMICAL PROPERTIES OF HONEY PRODUCED IN MASHA, GESHA, AND SHEKO DISTRICTS IN SOUTHWESTERN ETHIOPIA

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ABSTRACT

The qualities of 36 selected honey samples from three locations of Southwest Ethiopia (Masha, Gesha and Sheko districts) were evaluated for six physico-chemical attributes namely total acidity, hydroxymethylfurfural (HMF), reducing sugars, sucrose, moisture and mineral content. The samples of honey were analyzed following the techniques proposed by the Quality and Standards Authority of Ethiopia (QSAE), European Union (EU) and Codex standards for honey. The results obtained showed that the overall analysis of honey total acidity, HMF, reducing sugars, sucrose, moisture and mineral content were found to be 28.32 ± 14.14 meq/kg, 19.52 ± 9.41 mg/kg, 66.79 ± 6.96 %, 4.46 ± 2.59 %, 22.86 ± 1.03 % and 0.22 ± 0.16 %, respectively. Almost all quality parameters of honey found to meet national and international honey specifications but not moisture for all samples and sucrose in the case of Gesha district. Therefore, further research is suggested to optimize the moisture content of honey in humid and sub-humid areas of the region.

Keywords: Honey, Total acidity, HMF, Reducing sugars, Sucrose, Moisture, Mineral content.

Contribution/ Originality

The study contributes in the existing literature to fill the gap of the current state of knowledge in physico-chemical properties of honey produced in humid and sub-humid areas of southwest Ethiopia.

1. INTRODUCTION

Honey is the most important primary product of beekeeping both from a quantitative and an economic point of view, the first bee product used by human kind in ancient times [1]. Honey is a sweet and flavorful product which has been consumed as a high nutritive value food [2]. It is essentially composed of a complex mixture of carbohydrates, of which fructose and glucose account for nearly 85–95%, and other minor substances, such as organic acids, amino acids, proteins, minerals, vitamins, and lipids [2].

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According to [FAO \[3\]](#) report 45,300 metric tons of honey is produced per annum in Ethiopia, makes the country to rank first honey producer in Africa and ninth in the world. However, the majority of honey is crude and poorly managed. Honey is of good quality as long as it is in the hive, but faulty handling from the time of its harvest until it reaches to market is responsible for its inferior quality [\[4\]](#). Several factors have contributed to its low quality among which high moisture content is the major quality problem in the country. Harvesting unripened honey, unsuitable honey storage container and storage places also attribute to high moisture content [\[5\]](#). The quality of honey relied to a great extent on the art of the producer in storing and blending the product [\[6\]](#). In marketing of honey, consumers should have confidence that they are getting good quality for what they are paying so that the country able to earn foreign currency to revamp the national economy [\[1\]](#).

The quality of honey is mainly determined by its sensorial, chemical, physical and microbiological characteristics [\[2\]](#). The physico-chemical properties of honey produced in different geographical locations of Ethiopia have been reported by several researchers [\[7-9\]](#). A quality product will go a long way in developing the confidence that encourages return, customers and efficient production of a product to any marketing scheme [\[1\]](#). South and Southwest region of the country particularly Kaffa, Sheka and Bench-Maji zones are highly potential in forest beekeeping and large volume of honey is produced per annum. In these areas the majority of household keep bees and honey serve as a source of cash incomes for many households [\[10\]](#). Despite the potentiality of the areas and large volume of honey production, information is lacking on quality perspective based on national and international standards. Therefore, the present study aimed to characterize physico-chemical quality of honey in different locations of Southwest Ethiopia.

2. MATERIALS AND METHODS

2.1. Honey Sampling

The honey samples were collected randomly from three districts of Southwestern Ethiopia. Accordingly, the most beekeeping potential districts namely Gesha, Masha and Sheko districts were selected. The sample preparation procedure was according to the [Codex Alimentarius Committee on Sugars \[11\]](#).

A total of 36 honey samples (12 from each location) were randomly collected from beekeepers in selected districts during 2008/9 honey harvesting season.

2.2. Physico-Chemical Properties Analysis

Physico-chemical properties of honey were determined at Biochemical Laboratory of Quality and Standard Authority of Ethiopia (QSAE). The samples of honey were analyzed following QSAE [\[12\]](#), [European Union Directive \(EU\) \[13\]](#), and [Codex Alimentarius Committee on Sugars \[11\]](#) methods. The parameters of interest were: moisture content (%), reducing sugars

(%), sucrose content (%), total acidity (meq/kg), mineral content (%) and hydroxymethylfurfural (HMF in mg/kg).

3. DATA ANALYSIS

One way ANOVA was computed to compare means for each physico-chemical properties of honey samples collected from honey producing localities in the Southwestern part of Ethiopia. For all the computations, JMP-5 statistical software was employed [14] and tests were made at 95% level of significance.

4. RESULTS AND DISCUSSION

Results of physico-chemical property analysis of honey samples are reported in Table 1.

4.1. Total Acidity of Honey

The overall average acidity of honey samples analyzed in the present study was 28.32 ± 14.14 meq/kg (ranges between 15.05 - 56.7 meq/kg) which is acceptable range in the world honey market [11-13]. The honey samples from Gesha and Masha districts were significantly lower in acidity than honey samples from Sheko district ($P < 0.001$). Most of the samples, 32 (88.89%) met the requirement of an international standards [15], which indicates the freshness of honey samples and absence of unwanted honey fermentation [8], but the remaining 4 samples from Sheko district (11.11%) surpassed the limit. Differences in honey acidity could be caused by differences in geographical condition, harvesting procedure and storage conditions [16], which could be the reason in the case of Sheko district.

4.2. Hydroxymethylfurfural (HMF)

The overall average HMF value of honey samples analyzed in the present study was 19.52 ± 9.41 mg/kg (Table 1) ranging between 2.2 - 36.15 mg/kg which is acceptable range in the world honey market standard. HMF is defined as a breakdown product of fructose that is formed slowly and naturally during the storage of honey and much more quickly when honey is heated [17], and widely recognized as an indicator of honey freshness [2, 18]. The amount of HMF present in honey is the reference used as a guide to the amount of heating that has taken place: the higher the HMF value the lower the quality of the honey is considered to be [17]. The amount of HMF concentration increases with storage and prolonged heating of honey [2, 19]. Some countries set an HMF limit for imported honey (sometimes 40 mg/kg) and honey with an HMF higher than this limit will not be accepted. However, some honeys have a naturally high HMF level [17].

4.3. Reducing Sugars

The overall average reducing sugars value of honey samples analyzed in the present study was 66.79 ± 6.96 % (Table 1) ranges between 54.45% to 79.99% which fulfilled the requirements of Quality and Standards Authority of Ethiopia (QSAE) [12], Codex Alimentarius Committee on

Sugars [11] and European Union Directive (EU) [13]. Therefore, all honey samples qualify an international standard for content of reducing sugars in honey. There was no significant difference ($p > 0.05$) in the amount of reducing sugars among honey samples analyzed from all the three locations. Similarly, Gobessa, et al. [8] and Gebremedhin, et al. [9] reported 65 and 70 % reducing sugars content of honey on average in Western and Northern parts of Ethiopia, respectively.

4.4. Sucrose

The overall average sucrose content of honey samples analyzed in the present study was $4.46 \pm 2.59\%$ (ranges between 1.32 % to 10.98 %) which is acceptable range in the world honey market. The sucrose content of honey samples from Gesha district was significantly higher ($p < 0.05$) than honey samples from Masha and Sheko districts (Table 1). The sucrose content of honey depends on botanical origin of nectar [8], its level should not exceed 5% according to an International Regulatory Standards. The result of this study reveals that sucrose content of honey samples from Masha and Sheko districts qualify the requirement of an International Regulatory Standards but not samples from Gesha district. The higher sucrose content of honey could be the result of an early harvest of honey, in which sucrose has not been converted to fructose and glucose [20], which probably attributed to higher sucrose content in Gesha honey samples.

4.5. Moisture Content

The overall average moisture content of honey samples collected in the present study was $22.86 \pm 1.03\%$ (ranges between 20.4 % to 24.8 %) which is not acceptable range in the world honey market. The moisture content is the most essential quality component of honey, because the rate of fermentation, its shelf life span and processing characteristics are greatly determined by the amount of moisture content [9]. The different moisture content of honey depends on harvesting season, the degree of maturity that honey reached in the hive, type of hive used, environmental temperature and moisture content of original plant [8, 21]. Moisture content of honey can naturally be as low as 13 % or as high as 23 % depending on the source of the honey, climatic conditions and other factors [17]. In areas of high humidity, it can be difficult to produce honey of sufficient low water content [17]. To keep moisture content acceptable for export standard combs with more than 75% of the honey cells sealed should be harvested. High moisture content could accelerate crystallization in certain types of honey and increases its water activity of the honey to ferment [2, 17], and deteriorate its quality [22]. Therefore, the higher moisture content of honey samples in the present study could be due to higher humidity of the study areas, inappropriate honey harvesting time before ripening and storage conditions.

4.6. Mineral Content

The overall average mineral content of honey samples analyzed in the current study was 0.22 ± 0.16 % (ranges between 0.02 % to 0.55 %) which is within the acceptable range between 0.01-1.2% reported by the [Quality and Standards Authority of Ethiopia \(QSAE\)](#) [12] and 0.6% maximum limit reported by the International Honey Commission [15], and European Honey Directive for mineral content of honey. The mineral content of blossom honey ranges between 0.1 and 0.3% [19], which is related to the geographical areas, seasons and botanical origin of the honey [8, 23]. The amount of mineral content is among various factors in determining honey color, the higher mineral amount of honey usually observed in dark color honey types [24]. This supports the present study, as Sheko honey samples were dark colored with higher amount of mineral content but Gesha and Masha honey samples with lighter color with significantly lower amount of mineral content. Mineral content of honey is highly dependent on the soil type where the nectar producing plant is located [25], and the type of flower used by bees for nectar [26].

5. CONCLUSION

The result of the present study indicated that most honey quality parameters analyzed from three different locations of Southwest Ethiopia fulfilled international honey quality standards but not moisture content (all samples analyzed (100%)) and sucrose content (in the case of Gesha: 33.3%). Extensive research is required to optimize the moisture and sucrose content of honey in humid and sub-humid areas of the region to improve honey quality. Besides, beekeepers should be well trained on the quality standards and the ways how to improve and assure the quality parameters.

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Table-1. Physico-chemical properties of honey samples from Gesha, Masha and Sheko Woredas (Mean \pm SD).

Parameters	Gesha	Masha	Sheko	Overall Average	Satisfactory limit by EU and Codex
Acidity (meq/kg)	20 \pm 4.89 ^a	18.35 \pm 2.28 ^a	46.62 \pm 7.11 ^b	28.32 \pm 14.14	At most 50
HMF (mg/kg)	15.32 \pm 7.32	21.76 \pm 4.35	21.49 \pm 12.62	19.52 \pm 9.41	At most 40
Reducing sugars (%)	69.27 \pm 9.33	66.32 \pm 3.42	64.78 \pm 5.67	66.79 \pm 6.96	At least 60
Sucrose (%)	6.37 \pm 2.88 ^a	3.99 \pm 1.55 ^b	3.01 \pm 1.68 ^{bc}	4.46 \pm 2.59	At most 5
Moisture (%)	23.52 \pm 0.83 ^a	23.21 \pm 0.47 ^a	21.84 \pm 0.78 ^b	22.86 \pm 1.03	At most 20
Minerals (%)	0.14 \pm 0.09	0.11 \pm 0.05	0.4 \pm 0.12	0.22 \pm 0.16	At most 0.6

Means with different letters in a same row are significantly different from one another (P < 0.05).

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