AFRICA ENVIRONMENTAL REVIEW Journal
ISSN: 1727-8341

AER Journal Volume 4, Issue 2, pp. 227-233, Aug, 2021

RESEARCH ARTICLE
Available Online at *http://www.aer-journal.info*

Characterization of Honey from Marigat in Baringo County, Kenya, based on their Physical Properties

M. Chepkemoi*, J. Kollongei and D. Some
School of Engineering, University of Eldoret, P. O. Box 1125-30100 Eldoret, Kenya
**Corresponding Author's Email: mercyline.chepkemoi@uoeld.ac.ke*

Abstract

Marigat in Baringo County is among the Arid and Semi-arid Lands (ASAL) in Kenya where apiculture is the main source of income. Honey producers in the area keep their bees in the indigenous hives and natural colonies. Traditional methods are mainly used to harvest and process honey in the area. Honeycombs are crushed and mashed with bare hands to produce honey which is very unhygienic and not fit for human consumption. Honey produced by this method is of low quality hence sold in the local markets at a very low price. This contributes to high poverty levels and low living standards of honey producers residing in the area. However, this paper aims at characterizing honey based on its physical properties. These properties are significant in providing information regarding the quality of honey harvested from different locations of Marigat. This paper presents the physical properties of twelve (12) samples of honey collected from various locations of Marigat. The locations were Maoi Centre, Lopoi Junction, Marigat Town, and Koriema Centre. Honey samples from these locations were analysed based on their physical properties to determine the quality of honey produced in the area. The physical properties were moisture content, pH, relative density, and total water-insoluble solids content. Values of these parameters were compared with those of the set standards and requirements by the Kenya Bureau of Standards (KEBS) in Kisumu County. Results showed mean parameter values of moisture content, pH, relative density and total water-insoluble solids content of 18.05%, 3.9, 1.41 g/ml, and 0.22% m/m respectively. The range values of these parameters were 17.1% to 19.6%, 3.3 to 4.2, 1.4045 g/ml to 1.4343 g/ml, and 0.07% m/m to 0.61% m/m respectively. Moisture content and total water-insoluble solids content values of honey samples were within the maximum requirements of 22% and 0.5% m/m respectively as set by KEBS. However, results obtained from some locations for moisture content were not within the range of 14 to 18% as set by International Honey Commission (IHC) and Codex Alimentarius Commission (CAC). The total water-insoluble solids content of honey proved that honey was extracted by using the traditional method. The relative density of honey was slightly lower and higher than the set permitted limit of 1.42 g/ml, showing that moisture content in honey may be present in some locations. The pH values of honey were observed to be slightly higher and lower in some locations than the recommended value of 3.9. Hence, determining the quality of honey would ensure honey produced meets both local and international standards. This will attract higher profits and increased production rates. Hence, improving the standards of living of honey producers living in the area due to increased income from the sale of honey.

Keywords: Characterization, Physical Properties, Quality of Honey

INTRODUCTION

Physical properties of honey like moisture content, pH, relative density, and total water-insoluble solids content have been used to characterize honey and determine its processing, packaging, and storage

conditions. These are the most important quality parameters of honey (Adebiyi *et al.*, 2004). The quality of honey is greatly influenced by climatic conditions, floral sources and human factors e.g., traditions and know-how of producers during harvesting, handling, processing and storage techniques (Warui *et al.,* 2019). Properties and composition of honey vary across different regions (Silva *et al.*, 2013). International Honey Commission (IHC), the Codex Alimentarius Commission (CAC), and the European Community Council (ECC) are bodies involved in the regulation of international honey trade and have set strict conditions concerning honey quality standards for both export and local consumption (Bogdanov *et al.*, 2002; Codex *et al.*, 2001; Nzula, 2018). These standards are based on the physical properties of honey as well as extraction and processing methods.

Honey is produced naturally by bees from the flower nectars. Bees collect and transform honey by combining specific substances of their own. It is then deposited, dehydrated, stored, and left in the honeycombs to ripen and mature (Ishaq *et al.*, 2018). The colour of honey varies nearly from colourless to dark brown depending on the source. Honey is the key primary product of apiculture both quantitatively and economically. It was the first bee product consumed by humans in ancient times apart from wax and propolis (Abadariki *et al.*, 2013).

Apiculture is the management of bee colonies for honey production, beeswax, and other bee products. It requires minimal space and no need for good soil hence complementing other farm activities (Carroll, 2006). Bees are characterized by their ability to collect large quantities of honey which can then be harvested for human consumption and generation of income from the sale of their products (Crittenden, 2011). Bees build their honeycombs and produce honey in three different types of hives: Indigenous, Kenya Top Bar hive (KTBH), and Langstroth hives (Carroll, 2006). They also build their honeycombs in natural colonies.

Honey has been appreciated as a source of food and is fit for human consumption (Ahmed *et al.*, 2007). It has been used as a sweetener in making cakes, bread, and drinks etc. It is the core ingredient in alcoholic beverages like wine and beer, normally made with a mixture of honey, water and addition of yeast to allow for fermentation (Akinnuli *et al.*, 2016). It contains antibacterial and antiseptic constituents essential in the treatment of several illnesses like stomach ache, injuries, sore throat, and burns (Vallianou *et al.*, 2014). It helps in increasing the production of milk in dairy cows and also used in most industries for making hand lotion and facial cleansers.

The production potential of honey in Kenya is estimated at 100,000 metric tonnes annually (Carroll *et al.*, 2013). However, current annual production is at 25 metric tonnes due to highly productive areas remaining unexploited. If the potential is fully achieved, it can earn the country a foreign exchange of about 15 to 20 billion dollars annually (Robert, 2010). In Kenya, honey production is concentrated in Arid and Semi-arid Lands (ASALs) (Warui, *et al.*, 2019). Therefore, Marigat in Baringo County was selected for the study because it is among the ASAL areas in Kenya. This study aimed at assessing the physical properties of honey harvested from various locations of Marigat to determine if they meet the requirements and standards set by the Kenya Bureau of Standards (KEBS). This would guarantee attraction of high profits from the sale of honey in the international markets and improved quality of life of those practising apiculture in the study area. The other aim was to detect if there are significant differences in honey harvested from the various locations.

MATERIALS AND METHODS

Study Area

This study was carried out in the Marigat settlement in Baringo County, Kenya. The

area is among the most popular honey-producing regions in Kenya. It is an Arid and Semi-Arid Land (ASAL) hence most farmers carry out beekeeping and livestock farming as their main source of income to improve their livelihood. Honey was collected from four centres of Marigat including Maoi Centre, Lopoi Junction, Marigat Town, and Koriema Centre. The coordinates of these locations where honey samples and honeycombs were collected as shown in Figure 1.

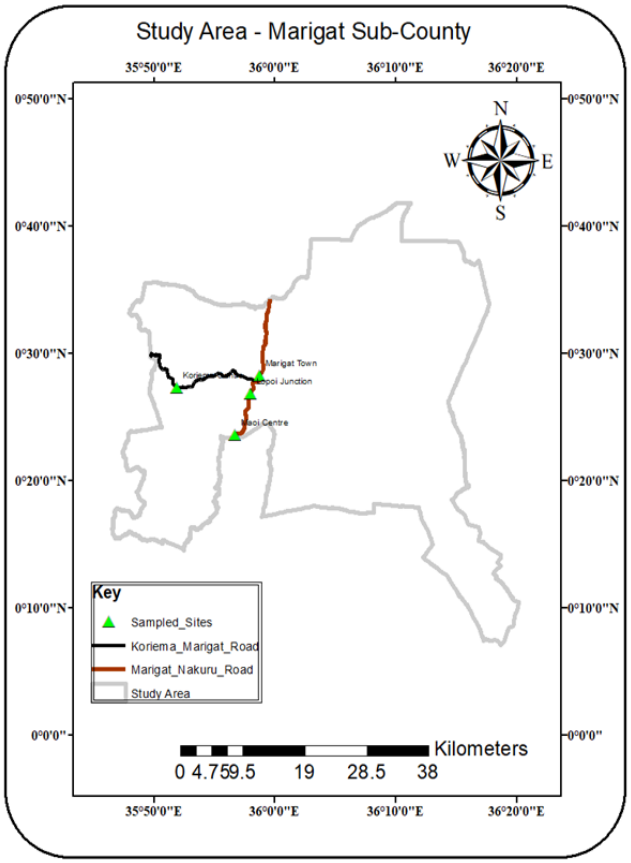

Figure 1: Selected locations in the study area of Marigat in Baringo County

Honey Sample Collection

Samples of honey were collected randomly from the beekeepers residing in different locations of Marigat which included Maoi, Lopoi Junction, Marigat Town, and Koriema centres. All samples collected were from honeycombs harvested from the indigenous hives and natural colonies and extracted using traditional methods. Three (3) samples of honey were collected randomly from each of the four (4) locations bringing the total to twelve (12) samples. Honey was poured into hygienically clean 400 ml food-grade containers with well-stoppered lids for uniformity since different beekeepers use different sizes of containers to store their honey.

Analysis of the Physical Properties

Honey samples were taken to the laboratory within the testing department/ sample control centre, Kenya Bureau of Standards (KEBS) in Kisumu County, and the physical properties of honey determined. The properties tested included moisture content,

pH, relative density, and total water-insoluble solids content of honey. All samples were tested as per the methods and standards described by KEBS.

Moisture content of honey is a parameter that is influenced by climatic conditions of an area, season of the year, and the level of honey maturity. Honey with high moisture content stands the risk of fermentation during storage. Final moisture content in honey depends on various environmental factors like weather, humidity inside the beehive, nectar conditions, treatment of honey during processing and storage (Manyi-Loh *et al.*, 2011). This parameter was determined using Abbe 550 refractometer. The maximum limit permitted by KEBS is 22% moisture content of honey.

Determination of pH is significant during processing and storage because it affects the texture, stability, and shelf-life of honey (Gomes *et al.*, 2011). This parameter was measured using Hannah pH meter. The recommended pH value is usually 3.9.

Relative density of honey depends on the moisture content of honey. Different types of honey may have different densities because moisture content varies in honey. This parameter was measured using a thermostatically controlled water bath and a specific gravity bottle. The recommended relative density of honey is 1.42 g/ml.

Total water-insoluble solids content represents the suspended wax particles, insect parts, pollen, vegetable debris of honey, bee, and filth particles (Mesbahi *et al.*, 2019). Higher water-insoluble solids content in honey signifies poor collection, processing, filtration, low hygienic habit of bees in choosing the site for honeycomb deposition and honey storage (Aroucha *et al.*, 2019). It is therefore a criterion of honey cleanness. This parameter was measured using analytical balance-Shimadzu. The permitted maximum limit is 0.5% m/m for honey processed using traditional methods.

Data Analysis and Presentation

Means and standard errors of the physical property values for the honey samples collected in each study location were calculated as shown in Table 1. Analysis of Variance (ANOVA) was used to detect if there were significant differences at 5% level on the physical properties of honey obtained from the four study locations. The physical properties investigated were used to determine the quality of honey harvested from different locations.

RESULTS AND DISCUSSION

Physical Properties of Honey

Moisture content: From Table 1, the average moisture content of honey collected from Koriema Centre had the highest moisture content of 18.7% as compared to the others. Whereas, moisture content obtained from Lopoi Junction had the lowest moisture content of 16.7%. Therefore, we can conclude that all the results obtained were within the limits as set in the Kenya Standards (2020) i.e., 22% maximum. However, according to Yanniotis *et al.* (2006), the moisture content of honey usually ranges between 14 to 18%, but must not exceed the permitted limit of 21% (Bogdanov *et al.*, 2002; Codex *et al.*, 2001). Therefore, honey from Maoi centre, Marigat town and Koriema centre was slightly above the lower and the maximum value of the permitted range of 14% to 18%. Hence, they stand a risk of fermentation.

pH values of honey: From Table 1, it is evident that the average pH value of Maoi centre was 4.1, which is highest as compared to those from the other centres. Whereas, Lopoi Junction had the lowest pH value of 3.7. All the results obtained were tested as per the KEBS TES/ING/TM/46 Standards. However, the recommended pH value of honey is 3.9. From Table 1 all values were not within the limits.

Table 4: Summary of the Physical Property Values of Honey Samples from the Four Study Locations, their Mean and Standard Error

Study Area	Honey Sample	Moisture Content (%)	pH value	Relative Density (g/ml)	Total water-insoluble solids content (% m/m)
Maoi Centre	A1	18.4	4.0	1.4129	0.14
	A2	18.6	4.2	1.4123	0.30
	A3	18.4	4.1	1.4126	0.37
	Mean ± SE	**18.5±0.1**	**4.1±0.1**	**1.4126±0.0002**	**0.27±0.08**
Lopoi Junction	B1	15.0	3.3	1.4343	0.07
	B2	18.1	3.9	1.4154	0.11
	B3	17.1	4.0	1.4192	0.19
	Mean ± SE	**16.7±1.1**	**3.7±0.3**	**1.4230±0.0071**	**0.12±0.04**
Marigat Town	C1	18.4	3.6	1.4125	0.10
	C2	17.8	3.8	1.4160	0.29
	C3	18.8	3.9	1.4103	0.61
	Mean ± SE	**18.3±0.4**	**3.8±0.1**	**1.4129±0.0020**	**0.33±0.18**
Koriema Centre	D1	18.4	4.0	1.4128	0.17
	D2	18.0	3.9	1.4153	0.09
	D3	19.6	4.0	1.4045	0.15
	Mean ± SE	**18.7±0.6**	**4.0±0.1**	**1.4109±0.0040**	**0.14±0.03**
P-value		**0.64**	**1.67**	**-2000**	**2.25**

Relative density: Honey obtained from Lopoi Junction had the highest Average Relative Density of 1.4230 g/ml whereas honey obtained from Koriema Centre had the lowest Average Relative Density of 1.4109 g/ml. All the results were obtained as per the KEBS TES/F&A/TM/43 Standard methods. The recommended relative density of honey is 1.42 g/ml. Therefore, honey from Maoi, Marigat town and Koriema centres had their relative densities lower than the recommended value. Hence, showing that moisture content may be present in honey from these locations.

Total water-insoluble solids content: From Table 1, Marigat Town had the highest average total water-insoluble solids content of 0.33% m/m, as compared to the results obtained from Lopoi Junction with the least average total water-insoluble solids content of 0.12% m/m. All the results were tested as per the KEBS KS 05-344 Standard methods. The maximum permitted limit for this parameter is 0.5% m/m. From Table 1, we can conclude that impurities like insect parts, debris and wax may be present in honey. However, none of the locations had values exceeding the recommended KEBS standards.

In summary, the P-values of the physical parameters were lower than the critical F-value of 4.26 from statistical tables. Therefore, there is enough evidence to state that all treatment means produce similar results i.e., at 5% level, the locations selected in Marigat have no significant differences in their various physical properties of honey.

CONCLUSION

From the study, it is clearly shown that the physical properties of honey play an important role in determining the quality of

honey collected from different locations of Marigat. Results obtained from the analysis show that at 5% level, there are no significant differences in the quality of honey harvested from the various locations of Marigat. All physical properties of honey portrayed similar qualities. The moisture content of honey is slightly high because honey producers use water baths to melt wax present in honey hence increasing the moisture content if not carried out carefully. High water content in honey poses a high risk of fermentation upon storage, hence reducing the shelf life of honey and is a health hazard to the consumers. The maximum limit of moisture content present in honey as per the KEBS standard is 22% to ensure a better shelf-life of honey. However, the moisture content of honey should be within a range of 14% to 18% to meet international standards. The relative density of honey is slightly lower than the permitted limits of 1.42 g/ml due to the presence of moisture in honey. Different types of honey may have different densities depending on water content variation. Total water-insoluble solids content in honey showed that impurities were present in honey. The maximum limit of total water-insoluble solids content present in honey as per the KEBS standard is 0.5% m/m. Therefore, it is important to characterize the physical properties of honey in different parts of Kenya because it is significant in determining the quality of honey to meet both local and international market standards.

Recommendations for Further Research

Characterization should be done in various regions of Kenya, where honey production is carried out and should be based on the physical properties of honey.

Data Availability

The data used in developing this article is available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest in the publication of this paper.

Acknowledgements

This study was financed through a scholarship grant by the African Development Bank (ADB) to the first author. Staff from the Department of Agricultural & Biosystems Engineering and the whole of University of Eldoret fraternity are acknowledged for their support during the research.

References

Abadariki, S. O., Fasan, J. O. and Akinnuli, B. O. (2013). Design, fabrication and performance evaluation of an indigenous honey extractor. *Journal of Emerging Trends in Engineering and Applied Sciences*, *4*(1), 1-6.

Adebiyi, F. M., Akpan, I., Obiajunwa, E. I. and Olaniyi, H. B. (2004). Chemical/physical characterization of Nigerian honey. *Pakistan journal of Nutrition*, *3*(5), 278-281.

Ahmed, J., Prabhu, S. T., Raghavan, G. S. and Ngadi, M. (2007). Physico-chemical, rheological, calorimetric and dielectric behavior of selected Indian honey. *Journal of Food Engineering*, *79*(4), 1207-1213.

Akinnuli, B. O., Awopetu, O. O., Ikubanni, P. P. and Agboola, O. O. (2016). Development of Pedal Operated Honey Extractor. *Current Journal of Applied Science and Technology*, 1-10.

Aroucha, E. M., Silva, M. C., Leite, R. H., Santos, F. K., Oliveira, V. R., Araújo, N. O. and Silva, K. N. (2019). Physicochemical, antioxidants and sensorial properties of Melipona subnitida honey after dehumidifying. *Journal of Food Processing and Technology*, *10*(3), e1000781.

Bogdanov, S., Martin, P. and Lullmann, C. (2002). Harmonised methods of the International Honey Commission. *Swiss Bee Research Centre, FAM, Liebefeld*.

Carroll, T. (2006). A beginner's guide to beekeeping in Kenya. *Baraka Agricultural Training College: Nakuru, Kenya*.

Carroll, T. and Kinsella, J. (2013). Livelihood improvement and smallholder beekeeping in Kenya: the unrealised potential. *Development in Practice*, *23*(3), 332-345.

Codex, A. C., Commission, J. F. W. C. A. and Programme, J. F. W. F. S. (2001). *Codex Alimentarius Commission* (Vol. 9): Bernan Assoc.

Crittenden, A. N. (2011). The importance of honey consumption in human evolution. *Food and Foodways*, *19*(4), 257-273.

Gomes, T., Feás, X., Iglesias, A. and Estevinho, L. M. (2011). Study of organic honey from the northeast of Portugal. *Molecules*, *16*(7), 5374-5386.

Ishaq, R., Azmat, H., Omair, M., Sheikh, A. K. and Tanwani, A. K. (2018). Comparison of honey with alcohol as a fixative in fine needle aspiration cytology. *International Journal of Pathology*, 15-18.

Kenya Standards, E. A. S. (2020). *Honey Specification*. Nairobi: Kenya Bureau of Standards (KEBS).

Manyi-Loh, C. E., Clarke, A. M. and Ndip, N. (2011). An overview of honey: Therapeutic properties and contribution in nutrition and human health. *African Journal of Microbiology Research*, *5*(8), 844-852

Mesbahi, M. A., Ouahrani, M. R., Rebiai, A., Amara, D. G. and Chouikh, A. (2019). Characterization of Zygophyllum album L Monofloral Honey from El-Oued, Algeria. *Current Nutrition & Food Science*, *15*(5), 476-483.

Nzula, M. C. (2018). Evaluation of Apiculture in the context of food security and environmental management in Kathonzweni Division, Makueni County, Kenya.

Robert, B. M. (2010). *Characterization of Kenyan Honey and a Design Model for Processing Equipment.* Doctor of Philosophy in the School of Pure and Applied Sciences, Kenyatta University, Nairobi.

Silva, T. M., dos Santos, F. P., Evangelista-Rodrigues, A., da Silva, E. S., da Silva, G. S., de Novais, J. S. and Camara, C. A. (2013). Phenolic compounds, melissopalynological, physicochemical analysis and antioxidant activity of jandaíra (Melipona subnitida) honey. *Journal of Food Composition and analysis*, *29*(1), 10-18.

Vallianou, N. G., Gounari, P., Skourtis, A., Panagos, J. and Kazazis, C. (2014). Honey and its anti-inflammatory, anti-bacterial and anti-oxidant properties. *Gen Med (Los Angel)*, *2*(132), 1-5.

Warui, M. W., Hansted, L., Gikungu, M., Mburu, J., Kironchi, G. and Bosselmann, A. S. (2019). Characterization of Kenyan honeys based on their physicochemical properties, botanical and geographical origin. *International journal of food science*, *2019*.

Yanniotis, S., Skaltsi, S. and Karaburnioti, S. (2006). Effect of moisture content on the viscosity of honey at different temperatures. *Journal of Food Engineering*, *72*(4), 372-377.