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Original Research Article

Comparative Nutritional Studies on Honey Samples in Ado Ekiti, Ekiti State, Nigeria

Oyeyemi S.D.*, Kayode, J. and Owolabi, M.O.

Department of Plant Science, Ekiti State University, P.M.B.5363, Ado-Ekiti, Nigeria.

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This study was undertaken to investigate parameters such as pH, Total titrable acidity, moisture content, ash content, fiber content, carbohydrate content, energy value, specific gravity as well as mineral compositions in order to ascertain the nutritional quality and extent of adulteration of the two honey samples obtained from two different sources in Ado Ekiti, Nigeria. These parameters were studied using standard methods of AOAC. The results obtained in honey collected from the bee farmer revealed the values of pH, Total titrable acidity, moisture content, ash content, crude fat, crude fiber, crude protein, carbohydrate content, energy value, specific gravity to be 4.50±0.00, 3.73±0.30, 20.50±0.21%, 0.58±0.09%, 1.23±0.03%, 6.25±0.09%, 66.04±0.40%, 300.16±1.48 (Kcal/100g) and 1.23±0.01 respectively. Honey sample from the street vendor had pH (4.65±0.07), Total titrable acidity (2.31±0.03), moisture content (21.78±0.06%), ash content (0.44±0.03%), crude fat (0.08±0.01%), crude fiber (9.08±0.06%), crude protein (5.65±0.60%), carbohydrate content (62.27±0.03%), Energy value (278.85±0.11 Kcal/100g) and specific gravity (1.21±0.01). Generally, the high carbohydrate, crude fiber, metabolizing energy and low crude fat contents in the honey samples irrespective of their sources together with appreciable amount of vital mineral elements confirm their nutritional quality and support their utilization in various food products.

Keywords: Honey, nutritional quality, bee farmer, adulteration, Ado-Ekiti.

INTRODUCTION

Honey is a natural sweet viscous liquid product produced by various honey bees from the nectar of blossoms or from the secretion of living parts of plants that has been consumed since early humans. Honey is noted for its high nutritional values and beneficial roles in human health. Honey is composed of a mixture of carbohydrates majorly fructose and glucose (Lawal *et al*, 2009) and other minor quantities of minerals, proteins, amino acids and other acids such as lactic, formic, pyruvic, etc. (Bogdanov, 2009).

It has been reported that the composition and the quality of honey depends on many factors such as, climatic condition during production, nectar composition, agricultural practices and handling of honey during extraction and storage (Marchini *et al*., 2006; Iglesias *et al*., 2012). Physicochemical characteristic of honey may also depend on the bee species as well as geographical origin. Traditionally, honey has been used as a medicinal remedy for the treatment of wound, various ailments and diseases (Abell *et al*., 1996 and Basualdo *et al*., 2007). Several authors reported that the healing capacity of honey is strongly influenced by the physical and chemical properties of honey (Mundoi *et al*., 2001; Adenekan *et al*., 2010; Uwako *et al*., 2014 and Copper *et al*., 2002a). Significant studies have been reported by Effem *et al*. (1988); Kingsley, (2000); Molan, (2000); Obi *et al*., (1994) on the antimicrobial activities of honey. Honey has been found in some instances by some researchers to possess antibacterial activities where antibiotics were ineffective (Strokes, 1993; Molan and Belt, 2000). The potent activity of honey against antibiotic- resistant bacteria has led to renewed interest for its application (Copper *et al*., 2002a; Effem *et al*., 1988). Honey can contribute to the health and nutritional status of human depending on its quality. It has several important qualities in addition to composition.

Honey's colour, flavor, viscosity and aroma are the first physical characteristics usually perceived by the consumer and play important role in honey acceptability/marketability locally. Other physicochemical properties such as pH, moisture content, sugar content, total acidity, proline content and ash content have been found to be of immense assistance for comparison and distinguish natural honey from artificial honey.

**Corresponding author: Oyeyemi S.D. Department of Plant Science, Ekiti State University, P.M.B.5363, Ado-Ekiti, Nigeria.*
Email: sundaydeleoyeyemi@gmail.com

These parameters have been suggested as criteria for the characterization and classification of honey. Knowing honey characteristics allow the packaging and storage of honey in appropriate conditions so as to preserve their quality and savour (Clement, 2002). The medicinal values of honey are also due to these constituents. Albeit honey are produced in large quantities in Nigeria, only a small quantity is commercially important due to adulteration, molasses (concentration juice from average sugar cane) (Ayodele *et al*., 2006) and poor handling during processing.

Ekiti State has great potential for beekeeping (Kayode and Oyeyemi, 2014). Interestingly, a beekeeper with an average of 20 beehives made average revenue from sales of honey and other bee products amounting to about #42,148.42 per annum (Oluwatusin, 2008; Ja'afar-Furo, 2007). Lack of adequate information on quantity control/ authentication hinder the widespread uses of honey especially by the food industry. To date, some physicochemical properties of honey from Nigeria have been reported (Adebiyi *et al*., 2004; Lawal *et al*., 2009; Adenekan *et al*., 2010; Agbagwa *et al*., 2011; Buba *et al*., 2013; Kayode and Oyeyemi, 2014).

The aim of this work was to investigate and compare the proximate and mineral composition of honey samples obtained from beekeeper and street seller in Ado Ekiti, Nigeria.

MATERIALS AND METHODS

Samples collection

Two honey samples were collected (each) from an apiary, Pastorals Farm, Ado Ekiti (sample A) and a street vendor in Ado Ekiti (sample B). The honey samples were stored in clean airtight bottles at an ambient temperature to avoid moisture absorption. The honey samples were later taken to the laboratory of the Department of Biochemistry, University of Lagos, Lagos State for analysis.

Determination of Nutritional compositions

Determination of pH: The pH was determined using pH meter Model 610 by direct insertion into the honey sample.

Determination of moisture content: About 2.0 g of the honey sample each was weighed and transferred into a previously weighed crucible. The crucible was then placed into the drying oven at 105^0C for 5 hours. After this, they were removed and placed in a desiccator to cool. The cooled crucible was re-weighed. This was done in triplicate. The loss in weight after drying was then calculated as the percentage moisture (AOAC, 1990). The dried matter was used in the determination of the other parameters.

Determination of ash content: For each test, 5.0 g of each sample was separately weighed and oven dried to a constant weight at 70 ^{0}C and the moisture was calculated on a dry basis.

Determination of crude fat content: This was determined by extraction, using Majonnier fat extraction apparatus (AOAC, 2002).

Determination of the total titrable acidity: Twenty five milliliters of each sample (diluted) was titrated against 0.1N NaOH using mL phenolphthalein as an indicator (Jacobs, 1999). The relative amount of lactic was determined using the mathematical formula:

$$\text{Lactic acid (\%)} = \frac{\text{Titre value x Normality x 9}}{\text{Volume of sample}}$$

Determination of refractive index: The refractive indices were measured at wavelength = 589.3 nm, at temperature 20^oC and at atmospheric pressure of 1007 m bar using an Abbe refractometer. The temperature of Abbe refractometer is controlled by a circulating constant temperature bath and was calibrated and verified through measurement of refractive indices of ethanol and cyclohexane.

Determination of specific gravity: The specific gravity (SG) of the honey samples was obtained as the ratio of the weight of sample to that of equal volume of water.

$$SG = \frac{Wsp - Wp}{Wwp - Wp}$$

Where;
Wp = Weight of the pycnometer
Wsp = Weight of sample + pycnometer
Wwp = Weight of water + pycnometer

Determination of the energy values: The energy values of the samples were determined as follows:

Energy (Kcal/100g) = (% Crude Protein) x (% Crude Fat) x (% Carbohydrate)

Determination of Mineral Composition

The mineral composition present in the honey samples include Sodium and Potassium which were determined using flame photometer (Model: Buck VGP 410), others, such as Magnesium, Zinc, Calcium and Iron were evaluated using atomic absorption spectrophotometer (Model: Bulk VGP 210) while Phosphorus was determined calorimetrically (Gallenkamp UK.).

RESULTS AND DISCUSSION

The results of the pH, total titrable acidity, refractive index, specific gravity and proximate analysis of the two honey samples from sources (A and B) are presented in Table I. The pH values for the honey sample A and B were 4.50 and 4.65 respectively. The pH values obtained in this study agreed with the previous works of Adebiyi *et al*. (2004) whose values for some Nigerian honey ranged from 4.37-6.02 with a mean value of 4.70. Similarly, Kayode and Oyeyemi (2014) reported pH range from 4.10-4.65 for fifteen honey samples in Nigeria. Our findings fall within the prescribed acidic range of 3.54 to 5.5 reported by Bogdanov *et al*. (2004). Naturally, irrespective of its geographical origin, honey is acidic (Khalil *et al*., 2010 Adebiyi *et al*., 2004). Honey pH is important during its texture, stability and storage duration (Terrab *et al*., 2002).

The refractive index determined for honey A and B were found to be 1.48 and 1.48 respectively. These results corroborated with the reports of Adebiyi *et al*. (2004) for honey samples obtained from five different locations in Nigeria, where he reported refractive index ranged from 1.440 to 1.489. Similarly, Pawan (2011) reported the refractive index of *Apis cerena* honey (1.466 to 1.492) and *Apis mellifera* honey (1.426- 1.440). These values were favourably compared with what was reported for *Apis mellifera* honey (1.426 to 1.440) by Pawan (2011). The level of adulteration of honey could be determined through the refractive index (Adebiyi *et al*., 2004).

Table I. Proximate composition of two honey samples obtained from Ado- Ekiti, Ekiti State

Parameter	Beekeeper honey (A)	Street vendor honey (B)
Carbohydrate (%)	66.04 ± 0.40	62.27 ± 0.30
Crude protein (%)	6.25 ± 0.09	5.65 ± 0.60
Crude fat (%)	1.23 ± 0.03	0.80 ± 0.10
Moisture content %	20.50 ± 0.21	21.78 ±0.06
Ash content (%)	0.58± 0.09	0.44 ±0.03
Crude fiber (%)	5.43 ± 0.22	9.08 ± 0.06
Energy (kcal/100g)	507.16± 1.48	281.45± 0.11
Specific gravity	1.23 ± 0.01	1.21 ± 0.01
Refractive index	1.48 ± 0.03	1.48 ± 1.41
pH	4.50 ± 0.00	4.65 ± 0.07
TTA	2.73± 0.30	2.31 ±0.30

Table II. Mineral composition of two honey samples obtained from Ado-Ekiti, Ekiti State

Mineral element (mg/100g)	Beekeeper honey (A)	Street vendor honey (B)
Sodium	123.20± 2.05	149.81± 0.39
Potassium	246.89± 1.22	223.25± 1.98
Zinc	124.24± 0.58	89.92± 3.37
Magnesium	72.29± 1.50	51.35± 2.40
Calcium	296.63± 4.07	262.00± 4.60
Iron	171.52± 1.37	239.12± 4.29
Copper	0.38± 0.18	0.92± 0.16
Manganese	1.02± 0.31	4.47± 1.19
Lead	0.04 ±0.01	0.92± 0.16
Nickel	0.32± 0.05	0.64 ±0.08

Our findings revealed specific gravity of 1.23 and 1.21 respectively for honey samples A and B investigated. These values were lower compared to the previous works of Ndife Joel *et al*. (2014) who reported a range of 1.42 to1.44 specific gravity for Nigerian honey. Specific gravity of honey is an important parameter for its quality evaluation.

The analyzed honey samples A and B had total titrable acidity of 2.73 and 2.31 respectively. Comparatively, these values were lower to the reports of Kayode and Oyeyemi (2014) on honey samples from Ondo State, Nigeria. However, the values were relatively higher than the range of 0.03 to 0.19 reported by Lawal *et al*. (2009). The honey samples investigated in this study were within the acidity range that improves the shelf stability of the honey and thus prevent spoilage by microorganisms (Willian *et al*., 2009).

The moisture content in the investigated honey samples A and B were 20.50% and 21.78% respectively. These were similar to the results of Ajao *et al*. (2013) who previously reported a range of 19.26% to 22.09% for honey samples in Nigeria. Also, Adeniyi *et al*. (2014) reported the moisture content of 19.93% and 20.14% respectively for bitter and sweeter honey samples from Ondo State, Nigeria. Moisture content was found to be one of the important parameter that contribute immensely to the quality of honey as it affects its shelf life and processing characteristics (Malika *et al*., 2005; Bogdanov, 2009a, b). Moisture content also play an important role in honey viscosity and savour (Kayode and Oyeyemi, 2014). Our results are within the limit (21%) recommended by the Codex Alimentarius Commission (2001).

The two honey samples (A and B) were analyzed for ash content and the results obtained (0.58% and 0.44%, respectively) corroborated with the previous works of Adenekan *et al*. (2010) and Buba *et al*. (2013). These researchers reported the range of 0.12 to 0.50% and 0.37 to 0.54% respectively for some Nigerian honey samples. The values of our findings were low compared with the range of 1.18% to 1.73% reported by Ndife Joel *et al*. (2014). Codex Alimentarium Commission Standard (2014) proposed not more than 0.6% ash content for normal honey. The result for the two honey samples were within the acceptable ash content range.

Our results revealed the crude fat content of the honey samples from A and B to be 1.23 and 0.80% respectively. Several literature reported that honey has little or no fat (Tan *et al*., 1988 and Singh *et al*., 1997). The low crude fat content in the two honey samples indicated that they contain very little quantity of crude lipid and are not considered as adequate sources of lipid. The crude protein contents estimated were 6.25% and 5.65% respectively for honey sample A and B. These values were relatively higher compared with the value range of 1.43-2.72% reported by Agunbiade *et al*. (2012) for honey obtained from three states of Nigeria.

Honey proteins are mainly in the form of enzymes (White, 1975). Proteins are found in various honey (8-11 proteins) but

only four are common to all and appear to originate from the honey bees during honey formation rather than from plant nectar (Buba *et al*., 2013). The results of our findings showed that the two honey samples (A and B) contained 66.04 and 62.27% of carbohydrate respectively. The values were comparatively lower than the value range of 77.60% to 86.20% reported for honey samples from six states in Northeastern Nigeria by Buba *et al*. (2013). Carbohydrate are the main constituents of honey and constituted about 90% of honey dry weight (Doner, 1977 and Adeniyi *et al*., 2014)

The energy values of the honey samples (A and B) were 507.16 and 281.45 Kcal/100g respectively. Our findings were in agreement with the reported calorific values of about 303 Kcal/100g for honey (Blasa *et al*., 2006). The result for honey sample B was lower when compared to the earlier report of Adeniyi *et al*. (2014) who recorded 329.12 and 333.64 Kcal/100g for Nigerian bitter and sweet honey. The calorific values in the investigated honey samples could be an important source of dietary calories. Honey is primarily a high energy carbohydrate food and the honey sugars are easily metabolized by the body unlike the refined sugar. For this reason honey is regarded as a good food for both young and adults.

The results of the mineral content of the two honey samples analyzed was presented in Table II. The concentration of the minerals found in the two honey samples was in order of Calcium> Potassium> Iron> Sodium> Zinc> Magnesium while other minerals were Copper and Manganese. However, trace quantity of heavy metals, Lead and Nickel were detected in the honey samples. The results of our work showed that the two honey samples were quite rich in minerals. In comparison with other studies, the honey samples A and B having the highest Calcium content (296.63 and 262.00mg/100g respectively) agreed with the reports of Matinez-Gomez *et al*. (1993).

However, the results were not in conformity with the studies of Agbagwa *et al.* (2011) and Ndife Joel *et al*. (2014) who reported potassium dominance in honey investigated. The mineral contents of honey may vary as a result of the differences in plant species visited by the honey bees during nectar collection, and the types of the soil in which the floral were found. These minerals play a great number of physiological and biochemical functions in human health. Calcium is needed for growth and maintenance of bones, teeth and muscles (Tural *et al*., 2003).

Sodium and Potassium found in the intracellular fluid help to maintain electrolyte balance and membrane fluidity (Ahmed and Chandhary, 2009). Magnesium protects and manage high blood pressure and cardiovascular diseases (Vorman, 2003). Iron plays an important role in hemoglobin formation, normal functioning of the central nervous system and oxidation of carbohydrate, protein and fats (Adeyeye and Okokiti, 1999). Copper contributes to iron and energy metabolism. Manganese acts as a cofactor of many enzymes (McDonald *et al*., 1995).

CONCLUSION

The consumption and uses of honey in Nigeria has increased tremendously over the years. Most of honey consumed are sold by the roadside seller and street vendors. Our findings revealed that honey from the street seller can be from good source, but there is still need for consumer's enlightenment to always buy honey certified by National Agency for Food and Drug Administration to avoid danger of contamination and adulteration due to poor handling during harvesting and storage.

CONFLICT OF INTREST

Authors declare that there is no conflict of interests regarding the publication of this paper.

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