Quality assessment of Nigeria honey and manuka honey

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ABSTRACT

Eighteen honey samples obtained from different locations in Nigeria and one sample (manuka), a product of New Zealand, obtained from Australia were analysed for physico-chemical parameters including pH, moisture content, ash, acidity, conductivity, sucrose, fructose, glucose as well as seven elements; K, Ca, Cu, Fe, Zn, Cr and Pb. The pH of the samples ranged from 2.90 to 4.26 while the moisture content varied from 16.12% to 34.67%, ash(0.357 and 4.187%), conductivity (10.0 – 47.97µs/g), glucose (39.97- 44.42%), sucrose (1.33 -1.94%) and fructose (35.00- 42.50%) were detected. Potassium was the most abundant element ranging between (0.487 and 1,705.99mg/L), followed by Calcium (0.136 and 78.73mg/l), Fe (0 and 104.14mg/l) and Cu (0.055-0.693mg/l). The elements Cr and Pb were largely not detected but occurred in very low concentrations in some samples. Results obtained from this study showed that commercial honey has higher than normal level of certain parameters suggesting some level of adulteration, but the parameters of honey obtained directly from source was comparable to that of manuka honey.

Key words: Honey, manuka, physico-chemical properties, quality

INTRODUCTION

Honey is a sweet viscous liquid that is composed of sugars, amino acids, proline, minerals, aromatic substances, pigment waxes and grains [1, 2]. Honey contains large amount of glucose but is low in sucrose (<8%) [3]. The precise composition of honey varies depending on the plant species on which bee forages, the main constituents are the same for all honeys [4, 5, 6,32].The differences in physicochemical properties of honey samples, such as ash contents, acidity, moisture contents and hydroxyl methyl furfural (HMF), conductivity and optical rotation are due to regional and floral differences [7]. Honey having high water content has the tendency to ferment; a maximum value of 21 g/100g is suggested. Fermentation increases acidity because of honeys maximum acidity [6]. Heavy metals in honey could be related to its geographical and botanical origin [8]. Since ancient times, natural unprocessed honey was used to prevent microbial infections and aid wound healing. Characterization of honey aids our understanding of its properties and medical applications. [9,33]. previously studies have been carried out on
physical and chemical properties of Nigerian honeys from different locations. Twelve elements (K, Ca, Mn, Fe, Ni, Cu, Zn, Se, Br and Rb) were detected and potassium was the most predominant. All the results obtained were comparable to equivalent values obtained from U.S. honey. [10]) reviewed the physico-chemical studies on adulteration of honeys sold in Nigeria, his studies included the determination of pH (4.6 - 5.06), colour, viscosity, sugar content, HMF (0.38 - 1.29%), ash content (0.60 - 0.84%), moisture content (16.00-20.00%) and microbiological analysis.

Honey has the ability to be spoiled by some osmophylic yeasts and moulds which reduces its large nutritive and high medicinal value [11, 12]. Manuka honey which is sold as a therapeutic agent worldwide originates from manuka tree (Leptosp erium scoparium). To date there are many publications on the therapeutic properties of manuka honey [13] Manuka honey is referred to as medical grade honey (MGH). In many honeys, heating at elevated temperature destroys the peroxide activity and it is lost in the presence of catalase (an enzyme that degrades hydrogen peroxide and is present in wound fluid), manuka honey retains activity in the presence of catalase and are known as non-peroxide honeys.

The present study is aimed at assessing the quality of various Nigerian honeys in comparison with manuka honey according to International honey standards of the Codex Alimentarius (2001) and EU (2002).

MATERIALS AND METHODS

Collection of honey samples: A total of 14 samples were obtained, two honey samples of international origin (blossom and freezfruit) were obtained from supermarkets. Commercial honey samples were obtained from seven states in Nigeria namely: Jalingo, Rivers, Jos, Nsukka, Warri, Yenegoa and Calabar. Three samples (UMU1, UMU2, UMU3) were obtained from Crop Research Institute (CRI) Umudike and one sample (IITA1) was obtained from International Institute of Tropical Agriculture, Ibadan. Manuka honey Watson and Son a product of New Zealand was obtained from Australia. Commercial honey samples were analyzed from original containers while the others were collected aseptically into sterile containers; all samples were stored in the dark.

Determination of pH: The pH of honey samples were determined by measuring out 10 mL of each honey sample into a clean beaker and its pH was determined using a pH meter (Equip – Tronics, Digital pH meter model EQ-610)

Determination of moisture content: The moisture content of each honey sample was determined by measuring 5g of the sample and placed into a pre-weighed aluminium drying dish. The sample was dried to constant weight in an oven at 105°C for 4 h under vacuum [16].

\[
\text{Moisture content} = \frac{M_1 - M_2}{M_1 - M_0}
\]

Where:

\(M_0 = \text{Weight of aluminium dish}\)
\(M_1 = \text{Weight of the fresh sample + dish}\)
\(M_2 = \text{Weight of the dried sample + dish}\)

Determination of ash content: Five gram of each honey sample was separately weighed out into a porcelain crucible previously ignited and weighed. Organic matter was charred by igniting
the sample on a hot plate in the fume cupboard. The crucible were then placed in the in the muffle furnace and maintained at 600°C for 6 h. They were then cooled in a desiccator and weighed immediately (AOAC, 1990) The percent Ash was calculated as:

\[
\text{Ash} \, (\%) = \frac{\text{Weight of crucible} + \text{ash} - \text{Weight of empty crucible}}{\text{Sample weight}} \times 100
\]

**Determination of total solids:** Percentage total solids of each sample was determined using the following formula:

\[
\text{Total solids} \, (\%) = 100 - \text{Moisture content}
\]

**Determination of total titrable acidity:** Twenty five millilitre of each sample (diluted) was titrated against 0.1 N NaOH using mL phenolphthalein as an indicator. The relative amount of lactic acid was determined using the mathematical formulae:

\[
\text{Lactic acid} \, (\%) = \frac{\text{Titre value} \times \text{Normality} \times 9}{\text{Volume of sample}}
\]

**Determination of carbohydrates using Anthrone method:**

1.0g of honey sample was weighed and transferred quantitatively to a graduated 100mL cylinder. 10ml of distilled water was added to the sample and stirred with a long glass rod; 13ml 52% perchloric acid reagent was further added and stirred frequently for 20 minutes. The content was filtered into 250ml graduated flask and further diluted to the mark with distilled water and mixed thoroughly.

**Analysis:**

Ten milliter of the sample extract was diluted to 100ml with distilled water, and then 1ml of the dilute filtrate was pipetted into a test tube. Blanks were also pipetted using 1ml of distilled water. Further pipetting was done with the standards of the different sugars (glucose, fructose and sucrose) using 1ml of each. To all the tubes, 5ml of freshly prepared Anthrone reagent was added rapidly and the tubes stopped while mixing the contents thoroughly. They were then placed in a boiling water bath for exactly 12 minutes. At the end of the 12 minutes, they were cooled to room temperature and the solutions transferred to1 cm cuvet to read the absorbance at 630nm against the blanks. Results were calculated based on the following formulae.

\[
\% \text{glucose, fructose and sucrose} = \frac{25 \times B}{A \times W}
\]

Where \(B\) = Absorbance of dilute sample  
\(A\) = Absorbance of dilute standard  
\(W\) = Weight of sample used

**Determination of electrical conductivity:**

The electrical conductivity measurement was done at 25°C using pH/conductivity meter. The instrument was calibrated using potassium chloride (KCL) 0.01m. 0.7456g of dry KCL was dissolved in water and made up to 1 litre at 25°C. This was used as the standard reference solution at 25°C, this has an electrical conductivity of 1413mbos/cm, which is related to
concentration of dissolved mineral salts, thereby producing a rapid and convenient means of estimating the concentration of electrolytes.

**Elemental analysis**

Elemental analysis was carried out using the solution of the ash after ash determination. This was carried out by measuring 5mls of 10% HCL solution; this was added to ash and warmed in a water bath to dissolve. If ash has not dissolved, it will then be treated again with 5mls of 10% nitric acid and warmed in a water bath to dissolve. A stirring rod was used to transfer quantitatively through a funnel into a clean dry 50ml standard volumetric flask. This solution of ash was then used to check for the determination of elements: Cu, Zn, Pb, Cr, Ca, K and Fe by direct aspiration via atomic absorption spectrophotometer.

**RESULTS**

The results of metal characterization of the various honey samples are detailed in Figures 1-4. A total of seven elements (K, Ca, Cr, Pb, Fe, Zn and Cu) were detected and their concentrations determined. Potassium was the most abundant trace metal. The mean values for metal analysis of honey samples from North Central Nigeria (Kogi and Jos) are represented in Figure 1. Kogi has higher values of metals compared to Jos, the values for Kogi were; K (0.528mg/l), Zn (104.14ug/g), Cu (0.693mg/l) and Fe (1.044mg/l). Cr and Pb were not detected at all in this location; Zn was the most abundant metal and occurred highest. Results on the percentage mean metal composition for honey samples from South East Nigeria are represented in Figure 2. Potassium (K) 1705.99mg/l was the highest from location UMU 3, next to it was UMU 2(2266.85mg/l) and UMU 1(1834.21mg/l). The lowest occurrence of K was found in Owerri with K value of 1.035mg/l. Lead (Pb) was not detected in most of the locations in South East but occurred in little quantity in UMU 2 (0.01mg/l) which is of no significant value. Ca (78.73mg/l) and Fe (104.14mg/l) also occurred highest in UMU 3. Of all the metals detected the least occurrence was found in honey sample from Owerri. The metal composition of South South are shown in Figure 3.Calabar had the highest value in K and the lowest occurrence in Cu, Zn was highest in Port with value of 4.173mg/l. From the four stations in South South, the value of K ranged between 0.6263 – 3.1523mg/l, Ca (0.6337 -1.9073mg/l), Fe (0.3947 – 0.80mg/l), Zn (0 - 4.1733mg/l) and Cu (0.057 – 0.168mg/l). The presence of Pb and Cr was not detected at all in all locations while Zn was not detected in Port and Yenagoa. In the case of honey samples of international origin as represented in Figure 4, Pb and Cr were not detected at all; Fe was also not detected in HIS 1, HIS 2 and HIS 3. Manuka honey had the highest value for all the metal detected with respect to foreign honey. The values for manuka honey are as follows; K (376.723mg/l), Ca (17.4587mg/l), Fe (4.1733mg/l), Zn (1.5177mg/l) and Cu (0.2073mg/l). The values for HIS 1, HIS 2 and HIS 3 for the various metals were; K (2.174, 2.032 and 2.144mg/l), Ca (0.95, 0.132 and 0.1363mg/l), Fe (0), Zn (0.139, 0.2063 and 0.215mg/l) and Cu (0.076, 0.055 and 0.053mg/l).

Results of the physical parameters of the various zones are detailed in Figure 11. The parameters for North East (Jalingo) are represented in Figure 6. The pH (3.10), moisture content (34.7g/100g), ash (0.953%), acidity (1.90g/ml), conductivity (47.97ug/g), glucose (39.18%), sucrose (1.8%) and fructose (36.35%). With regards to manuka honey, pH (3.48), moisture (16.12mg/l), ash (1.16%), acidity (0.015%), conductivity (20ug/g), glucose (35.97%), sucrose (1.6%) and fructose (37.33%) as stated in figure 11. Comparing manuka honey to other foreign honey, it was noticed that HIS 3 had the highest glucose level of 39.3% next to it was HIS 1 and HIS 3 with 38% and 37% each. The pH values for the five locations from South East ranged between 3.037 – 3.953, moisture content (16.71 -30.5mg/l), ash (1.257 -3.613%). Acidity was
highest in Nsukka with value of 2.64mg/l and lowest in UMU 1 (0.015mg/l), conductivity ranged between 10 – 41.07ug/g.

From statistical analysis carried out, no significant difference (p< 0.05) was observed within the stations in the analysis of variance with respect to physico chemical parameters but their means significantly (p >0.05) differs.

DISCUSSION

Results of pH obtained in this study was however lower (3.10 – 4.20) compared to other reports for Nigerian honey from other locations [9] and Argentinean honeys [17], it was observed from the results obtained that pH is in accordance with the range specified by EU Council (2002) and the Codex Alimentarius (2001), it should be noted that the pH of honey has a pH that is low enough to prevent the growth of bacteria’ the acidic pH may be due to varying acids and minerals in the honey samples [18, 19, 20].

According to Codex Alimentarius [14] and EU[15] standard of honey samples, the maximum value of moisture content in honey is 21%, this is in contrast to our findings in the present work with high level of moisture content in most of the commercial honey samples which suggest adulteration or mixing with water after harvesting. The lowest moisture content was found in manuka honey and other honey samples obtained from research institute. The moisture content of the present study does not fall within range reported for floral honeys [21, 22, 23, 24]. Moisture content is the most important parameter, because it affects storage life and processing characteristics. Low moisture content of honey forms an important part of the system which protects honey from attack by microorganisms.

The floral origin has been reported to be responsible for the differences in ash content [25] and it is also a quality criterion for honey botanical origin [15]. Results of the ash content obtained in this study did not fall within the range reported for Nigerian honey from other locations [9, 25, 10]. The ash content of the samples investigated in this study was not within the acceptable range 0.04- 0.09% [27] but was comparable to the levels observed for manuka honey.

Determination of sugars in honey is a quality criteria which is influenced by honey storage and heating and thus is an indicator of honey freshness and overheating. The results obtained for glucose, sucrose and fructose of Nigerian honey are comparable to Manuka honey and is within the range required for international standards. According to EU (2001) the proposed standard for a minimum content of the sum of fructose and glucose is 60 g/100g for all blossom honeys and 45 g/100g for all honeydew honeys.

Similar to previous studies the predominant metals observed in honey samples investigated in this study were K, Pb, Cr, Fe, Ca and Zn (Figures 1- 4) [9, 27]. How ever in the study carried out by Adebiyi [9] where Cr was detected between the range 5 and 17, which is contrary to observations in the present study where the concentrations of Cr was very low and mostly not detected. Potassium accounted for the most abundant (0.585 -1705.8), this might be due to the levels of K in plant tissues. Nutritionally, the presence of these metals in honey makes it an excellent food supplement for humans. From our findings and other studies it appears that the elemental composition of the honey depends on the soil composition, plant type, season and environmental conditions.
Fig. 1: Mean values for metal analysis from honey samples of North Central Nigeria

Fig. 2: % metal composition from sample from the South East Zone of Nigeria
The levels of fructose, glucose, sucrose, pH, acidity, conductivity, ash, moisture content and the essential elements found in the honey samples indicates the quality of the samples. Also that all the parameters tested were comparable to the values of manuka honey and other honeys of international origin. Honey is produced from many floral sources and its content and activity vary with its origin and processing technique [28, 29], this shows that honey contains several
minerals and trace elements such as potassium, sodium, chlorine, calcium, magnesium and other elements [30].
**Fig. 7: Mean Values for Physiochemical analysis of Honey samples from Kaduna**

<table>
<thead>
<tr>
<th>Component</th>
<th>Mean Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>0.5</td>
</tr>
<tr>
<td>Moisture</td>
<td>15.2</td>
</tr>
<tr>
<td>Ash</td>
<td>2.3</td>
</tr>
<tr>
<td>Acid</td>
<td>0.7</td>
</tr>
<tr>
<td>Conductivity</td>
<td>0.4</td>
</tr>
<tr>
<td>Glucose</td>
<td>40.2</td>
</tr>
<tr>
<td>Sucrose</td>
<td>30.1</td>
</tr>
<tr>
<td>Fructose</td>
<td>25.3</td>
</tr>
</tbody>
</table>

**Fig. 8: Mean Values for physiochemical analysis of honey samples from the South East**

- **TREATMENT**
  - Umu1
  - Umu2
  - Umu3
  - Owerri
  - Nsukka

Graphical representations showing mean values for different components across various treatments.
Fig. 9: Mean values of physiochemical analysis of honey samples from the South South Zone

Fig. 10: Mean values of physicochemical analysis of honey samples from Ibadan (SW)
REFERENCES