*Asian Journal of Research in Botany*

***Volume 6, Issue 2, Page 261-268, 2023; Article no.AJRIB.105620***

# Quality Assessment of Some Nigerian Branded Honey

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***Author's contribution***

*The sole author designed, analyzed, interpreted and prepared the manuscript.*

***Article Information***

**Open Peer Review History:**
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/105620

***Original Research Article***

***Received: 02/07/2023***
***Accepted: 08/09/2023***
***Published: 07/10/2023***

## ABSTRACT

Three branded honey samples purchased from different supermarkets in Ekiti State, Southwest Nigeria were analyzed for their pollen contents and some physicochemical attributes. The pollen composition of the three branded honey investigated revealed important honeybee plants such as *Launea sp*., *Hymenocardia acida, Alchornea cordifolia, Phyllantus sp*., *Danellia oliveri* and the family members of Fabaceae, Myrtaceae and Combretaceae. The result of the proximate compositions revealed low moisture content, crude protein, crude fat, crude fibre, and high carbohydrate and energy content while the physiochemical parameters revealed that the specific gravity, pH, total acidity, HydroxyMethyl Furfural (HMF) and total sugar agreed with the international standard. Generally, the result showed that the three honey samples were rich in floral pollen types and equally removed doubt or suspicion on their acclaimed geographical origin. Also, the physicochemical results of the three branded honey samples prove that they are of good quality and are all suitable for human use.

*Keywords: Honey bee; pollen; physicochemical; floral; ekiti state.*

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## 1. INTRODUCTION

"Melisopalynology is an applied branch of palynology dealing with the study of pollen grains in honey samples and its application in apiculture. Honey is one of the major bee products obtained from nectar, sugary secretion and pollen as well as nectary. Honey is a highly valuable syrup and it is preferred to other sweetens because of its nutritional, medicinal and industrial purposes" [1]. Because of the various uses of honey from food to medicine, it is of great interest to carry out a complete evaluation of honey to formulate values and ranges of various honey characteristics.

Branded and unbranded honeys are available in the market. Most of the honey sold in grocery stores is not raw honey. In some cases, such honey has been heated or adulterated by the addition of syrup or other food ingredients. As an industry, it has become necessary to address what happens to honey after it has been removed from the bee hive, blended and filtered. Consumers are unaware of the quality of honey they consume and the imminent danger of adulterated honey. "Honey adulteration could result in serious health problems. To protect the consumers and also to give them quality for their money, several stringent measures have been set by various countries and organizations for accessing the authenticity and quality of honey produced for commercial uses. The International Honey Commission (IHC) has proposed certain constituent criteria, such as moisture content, electrical conductivity, reducing sugar, fructose and glucose content, sucrose content, minerals, free acidity and HydroxyMethyl furfural (HMF), as quality criteria for honey" [2].

In addition to these criteria, there is a need for melisopalynological analysis to determine the botanical and geographical origin of the honey. Authentication of honey origin through its botanical elements [3] provides reliable information which helps to curb the practice of wrong labeling of honey. "Also, information obtained from honey characterization allows the packaging and storage of honey in appropriate conditions to preserve their qualities and flavour of honey or savour" [4]. Lawal et al. [5] reported that honey is produced in bee hives in large quantities in Nigeria. However, Ayodele et al. [6] thought that "even though Nigeria has great potential for beekeeping, only a small quantity of honey produced is commercially important due to adulteration and poor handling during processing. Honey farmers are now branding and rebranding their products to build consumer confidence and enhance patronage of this highly valued commodity".

Albeit, many authors have conducted several research works on the quality assessment of Nigerian honey. Agbagwa et al. [7] carried out a comparative study on some honey samples in Nigeria and Manuka honey to establish the quality of Nigeria honey. Assessment of quality attribute of natural honey from Adamawa state, Northeastern Nigeria was reported by Igwe et al. [8]. Quality assessment of honey sourced from natural and artificial apiaries in Ekiti State, Nigeria, was investigated by Oyeyemi [9]. Data on a complete analysis of branded Nigeria honey are scanty. The need to restore consumer confidence and attract more patronage of Nigerian honey both at home and abroad prompted this study.

Therefore, the study was carried out to assess the quality attributes of some branded honey samples in Nigeria.

## 2. MATERIALS AND METHODS

Three branded honey samples were purchased from the supermarkets in Ado Ekiti, Ekiti State, Nigeria. The branded honey samples were taken to the Department of Agricultural Extension Laboratory, Faculty of Agricultural Science, Ekiti State University for physicochemical analysis.

### 2.1 Physicochemical Analysis

Physicochemical parameters such as moisture content, pH, total acidity, specific gravity, HMF and total sugar were determined.

### 2.2 Determination of the pH

A pH digital meter was calibrated with buffers at pH 4 and 10. A sample solution was taken in the beaker and inserted. When the first reading was completed, the electrode was washed with distilled water and dried up with tissue paper. Similarly, as a continuous series, all other samples were determined accordingly [10].

### 2.3 Determination of Moisture Content

Two grams of each of the honey sample was weighed and transferred into a pre-weighed crucible. The crucible was kept in an oven at 100 - $105^0$ C overnight. After this, they were removed

and cooled in a desiccator and re-weighed. The loss in weight was then calculated as the percentage moisture content [11] using the following formula:

Moisture = Weight of fresh honey sample - Weight of dry honey sample / Weight of fresh honey

## 2.4 Determination of Specific Gravity

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

SG = Wsp –Wp / Wwp – Wp

Where;

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

## 2.5 Determination of HydroxyMethyl Furfural (HMF)

For HMF, 5 g of each of the honey samples was accurately weighed into a beaker dissolved in approximately 25 ml of water and quantitatively transferred into a 50 ml volumetric flask.0.5 ml of Carez solution I was added into the sample and mixed followed by further addition of 0.5 ml of Carez solution II, mixing and finally topping it up to the mark with water. The prepared sample solution was filtered through Whatman filter paper no. 42. The first 10 ml of the filtrate were rejected while 5 ml of the filtrate was transferred into each of the two test tubes. 5 ml of distilled water was added into one of the test tubes and mixed well (the sample solution). 5 ml of 0.2% sodium bisulphate was added into the second test tube and mixed well (the reference solution). The absorbent of the sample solution was determined against the reference solution at 284 and 336 nm in 10mm quartz cells within 1 hour. The determinations were done in triplicates. The HMF values were calculated using the formula shown below.

HMF in mg/kg = (A 284 –A336) ×149.7×5×D/W
Where A284 = Absorbance at 284nm
A336 = Absorbance at 336nm
149.7 = constant
D = dilution factor in case dilution was necessary
W = weight in g of the honey samples

The results were expressed in mg/kg to the nearest 1 decimal place.

## 2.6 Determination of Total Sugar

“For this solution, 5 g of sample was taken into a beaker and 100 ml of warm water was added to it. The solution was stirred until all the soluble matter was dissolved and filtered through Whatman filter paper into a 250 ml volumetric flask. 100 ml of the solution was pipetted and prepared into a conical flask, after which 10 ml of diluted hydrogen chloride (HCl) was added and boiled for 5min. On cooling, the solution was neutralized to phenolphthalein with 10%NaOH and kept in a 250 ml volumetric flask” [12]. This solution and the reading were calculated as follows:

Total sugar (%) = Factor (4.95) x dilution (250) x 2.5 / Titre x wt. of sample x10

## 2.7 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)

## 2.8 Pollen Analysis

The honey samples were subjected to qualitative and quantitative analyses following the methodology recommended by the International Commission for Bee Botany [13]. The examination and photomicrography of pollen grains were done using the Trinocular Olympus CH30 Microscope with X40 objective lens and a DE 1.3 MegaPixel Digital Camera attachment The pollen types were identified with the help of reference slides and relevant literature from Nigerian plants in the Palynology Laboratory of the Department of Archeology, University of Ibadan, Oyo State, Nigeria. The pollen types were identified to generic, species and in some cases to family level. Pollen grain numbers were quantified using the techniques put forward by [14] Results were expressed as frequency classes using the method suggested by Louveaux et al. [13].

# 3. RESULTS

Results of the proximate composition of the three branded honey samples (A1, A2 and A3) are presented in Table 1. The moisture contents

ranged between 12.09 to 15.50%, crude fat (0.30-0.41%), crude protein (0.68-0.84%), crude fibre (0.12-0.25%), ash (0.44-065%), Carbohydrate (80.19-85.31%) and energy content (351.12-347.95 kcal/100kg). The physiochemical parameters of the three honey samples showed pH range between 3.48 to 4.39, specific gravity (1.28-1.41), total acidity (28.20-56.62meq/kg), HMF (34.92-135.70mg/kg) and total sugar (68.23-70.15g).

The pollen analysis results of the three honey samples are shown in Table 3. Seventeen different pollen types were identified among which the taxa were further identified to species level, 4 to generic level and 5 were identified to family level.

The quantitative pollen analysis of the A2 honey sample revealed 20 different pollen types belonging to 10 families and 15 of the pollen types were identified to species level, 7 to generic level and 4 to family level. The result obtained for honey sample A3 revealed that 17 pollen families were identified in the sample. A further identification revealed 11 pollen types (species level), 5 were identified at the generic level and 4 to the family level. The pollen frequency of the pollen types found in the three honey samples showed that none of the pollen types occurred in “very frequent” and “frequent” classes. However, seventeen pollen types were “sporadic” and ‘thirty-four were “rare”. Fig. 1. depicted the photomicrographs of some pollen grains identified in the three honey samples as shown under the microscope.

## 4. DISCUSSION

The physiochemical data of any honey sample is important for storage and marketing purposes. The results obtained for the three honey samples purchased from the groceries in Ado-Ekiti were compared with the EUC [15]. The results showed that the moisture contents of the three branded honey samples were low and were found to be within the limit of not more than 21% as prescribed by [16] and the European Union Standard of honey samples [15]. Moisture content is one of the basic quality characteristics of honey. It contributes to honey viscosity, density, specific gravity, refractive index, fermentation and savour [2]. The 3 branded honey samples investigated were found to be acidic. Their pH values are similar to the pH values of Nigerian honey (3.55-4.40) reported by Oyeyemi [9] and Ethiopia honey (3.82-4.45) reported by Nigussie et al. [17]. The observed pH values for these honey samples were within the acidic range of pH and low enough to inhibit the growth of microbial growth.

The results of the specific gravity of the three branded honey examined fall within the prescribed standard limit. Codex Alimentarius Commission [16] prescribed the specific gravity range of the honey sample to be between 1.38-1.45. The findings of this study conform to the study of Ndife et al. [18] who reported a specific gravity ranging from 1.41-1.44 for Nigerian honey. HMF content of A1, A2 and A3 honey samples was found to fall within the limit of 40 mg/kg prescribed in normal honey. HMF is a

**Table 1. Physicochemical composition of branded Nigerian honey samples**

| Parameters | A1 | A2 | A3 |
|---|---|---|---|
| Specific gravity | 1.41 | 1.40 | 1.38 |
| pH | 4.39 | 3.84 | 4.26 |
| Total acidity (meq/kg) | 28.20 | 56.62 | 30.10 |
| HMF(mg/kg) | 35.70 | 34.92 | 78.90 |
| Total sugar (g) | 70.15 | 68.23 | 69.28 |

*A1= Shalomisreal honey, Benue State, A2= Kingsway honey, Oyo State, A3= Afe Babalola University honey, Ekiti State.*

**Table 2. Proximate composition of branded Nigerian honey samples**

| Parameters | A1 | A2 | A3 |
|---|---|---|---|
| Moisture content | 12.09 | 12.63 | 15.50 |
| Crude fat (%) | 0.34 | 0.41 | 0.30 |
| Crude protein (%) | 0.84 | 0.76 | 0.68 |
| Crude fiber (%) | 0.12 | 0.25 | 0.20 |
| Ash (%) | 0.44 | 0.65 | 0.58 |
| Carbohydrate (%) | 80.19 | 85.31 | 82.74 |
| Energy (kcal/100g) | 351.12 | 347.95 | 336.38 |

**Table 3. Percentage pollen frequency class of branded Nigerian honey samples**

| Sample | Pollen type | %Frequency | Frequency class |
|---|---|---|---|
| **A1** | *Launea sp.* | 7.62 | Rare |
| | *Elaeis guineensis* | 5.71 | Rare |
| | *Tridax procumbens* | 2.86 | Sporadic |
| | *Danielia oliveri* | 2.86 | Sporadic |
| | *Combretum sp.* | 11.43 | Rare |
| | *Diospyros sp* | 3.81 | Rare |
| | *Alchornea cordifolia* | 9.52 | Rare |
| | *Hymenocardia acida* | 9.52 | Rare |
| | *Phyllantus sp.* | 8.57 | Rare |
| | *Tetrapleura tetraptera* | 3.81 | Rare |
| | *Mitrocarpus scaber* | 1.91 | Sporadic |
| | *Vitellaria paradoxa* | 3.81 | Rare |
| | Asteraceae | 4.76 | Rare |
| | Fabaceae | 5.71 | Rare |
| | Combretaceae | 7.62 | Rare |
| | Myrtaceae | 5.71 | Rare |
| | Solanaceae | 2.86 | Rare |
| **A2** | *Cocos nucifera* | 2.08 | Sporadic |
| | *Bombax sp.* | 1.62 | Sporadic |
| | *Daniella oliveri* | 3.01 | Rare |
| | *Dolenix regia* | 2.55 | Sporadic |
| | *Combretum sp.* | 3.94 | Rare |
| | *Terminalia sp.* | 1.16 | Sporadic |
| | *Diospyros sp.* | 2.08 | Sporadic |
| | *Alchornea cordifolia* | 10.64 | Rare |
| | *Bridellia sp.* | 5.32 | Rare |
| | *Hymenocardia acida* | 6.48 | Rare |
| | *Mallotus subutalus* | 2.78 | Sporadic |
| | *Phyllanthus sp.* | 15.57 | Rare |
| | *Acacia sp.* | 2.08 | Sporadic |
| | *Tetrapleura tetraptera* | 1.85 | Sporadic |
| | *Triplochiton scleroxylon* | 1.16 | Sporadic |
| | Fabaceae | 2.08 | Sporadic |
| | Combretaceae | 8.80 | Rare |
| | Myrtaceae | 7.87 | Rare |
| | Rubiaceae | 5.82 | Rare |
| **A3** | *Launea sp.* | 5.53 | Rare |
| | *Cocos nucifera* | 1.38 | Sporadic |
| | *Elaesis guineensis* | 14.29 | Rare |
| | *Hyphene sp.* | 1.38 | Sporadic |
| | *Aspillia Africana* | 3.69 | Rare |
| | *Tridax procumbens* | 2.76 | Sporadic |
| | *Emilia sp.* | 1.38 | Sporadic |
| | *Vernonia amygdalina* | 6.45 | Rare |
| | *Bombax sp.* | 1.84 | Sporadic |
| | *Alchornea cordifolia* | 10.60 | Rare |
| | *Phyllanthus sp.* | 15.67 | Rare |
| | *Parkia biglobosa* | 5.99 | Rare |
| | *Dombeya buetnerii* | 5.53 | Rare |
| | Asteraceae | 11.06 | Rare |
| | Combretaceae | 5.53 | Rare |
| | Fabaceae | 1.83 | Sporadic |
| | Solanaceae | 5.07 | Rare |

breakdown of fructose formed slowly during storage and very quickly when honey is heated. The amount of HMF found in the honey sample could be used as a guide to the storage period and the amount of heating which has taken place. High levels of HMF (> 100mg/kg) can also be an indicator of adulteration with inverted sugars. The low HMF in honey samples A1 and A2 indicated that they are fresh and of good quality.

Crude protein determination gave results that were similar to those obtained by Adeniyi et al. [19] who reported protein content of 0.69% and 0.74% for bitter and sweet honey in Nigeria. Meanwhile, the obtained values were low compared to the report of Sohaimy and Shahata [20] for honey samples obtained in Egypt. The crude protein contents showed that honey is not an adequate source of dietary protein. It is well known that honey contains a trace amount of protein usually originating from pollens which is a natural and protein-rich food source [21]. The concentration of protein in honey varies depending on their botanical or geographical origin and storage period.

The range of ash content of the three honey samples was higher than 0.09%-0.021 % reported by Ouchemouki [22] for Algeria polyfloral honey. However, the results were within the limit of ash content proposed by the Codex Alimentarius Standards [23]. Honey ash content is a reflection of its richness in organic minerals and is determined by the botanical source [24].

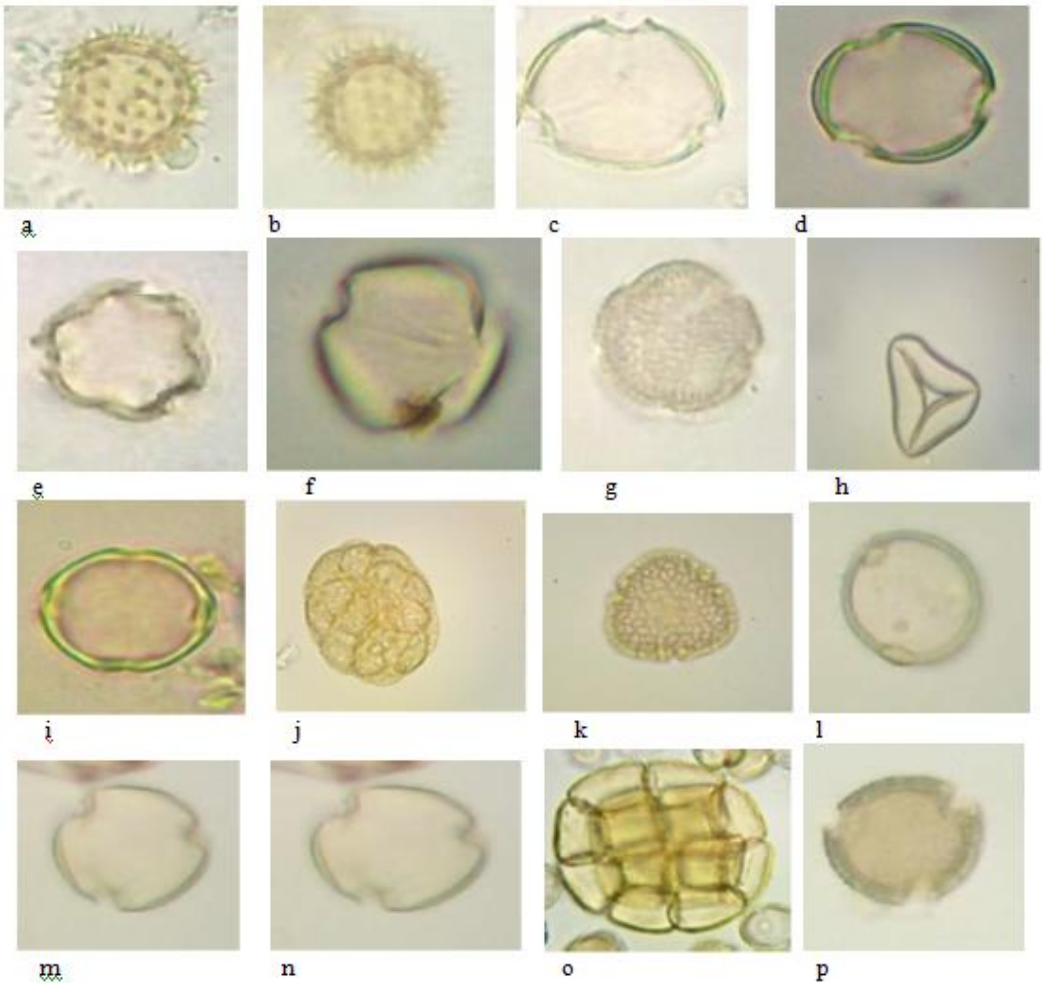


**Fig. 1. Photomicrographs of pollen types obtained from A1, A2 and A3 honey samples**
*a-b. Asteraceae, c-d. Caesalpinaceae, e. Combretum sp., f. Daniellia oliveri g. Microcarpus scabra, h. Elaeis guineensis, i. Vitallaria paradoxa. j. Parkia biglobosa, k. Bombax sp, l. Hymenocardia acida, m. Solanaceae, n. Mallotus sabulatus, o. Acacia sp. and p. Bridellia sp. Mag. X 400*

The result of the carbohydrate contents (80.19-85.31%) obtained in this study was higher than the earlier reports of Buba et al. [25] and Adeniyi et al. [19]. The higher carbohydrate content in the three honey samples analyzed could be a result of the wide foraging activities of the bees on varieties of nectariferous plants. Glucose and fructose are the major components of carbohydrates in honey. The total sugar content in honey samples analyzed was slightly higher when compared with the previous work of Abdulkhalia and Swales [26] who reported a range of 79.0-84.0% for some honey samples from the West Bank, Palestine.

The result of pollen analysis indicated that the honey samples were rich in different pollen types but were in low percentages. Also, the result is a reflection that the honey samples are produced from different pollen and nectar plant sources. Pollen grains of *Lannea sp*., *Elaeis guineensis, Phytallus sp*., *Combretum sp*., *Tridax procumbens, Daniellia oliveri, Diospyros sp, Alchornea cordifolia, Hymenocardia acida, Tetrapleura tetraptera, Microcarpous scabar*, Asteraceae, Fabaceae and Myrtaceae were identified in A1 honey sample.

The pollen analysis revealed that honey sample A2 composed of pollen grains of *Daniellia oliveri, Delonix regia, Alchornea cordifolia, Mallotus subulatus, Combretum sp, Terminalia sp, Bridellia sp. and Diospyros sp*. The pollen grains of *Lannea sp*., *Cocos nucifera*, *Elaeis guineensis*, *Tridax procumbens*, *Emilia sp*., *Vernonia amygdalina*, *Bombax sp*., *Alchornea cordifolia*, *Phyllanthus sp*., *Pakia biglobosa*, *Dombeya buetnerii*, Fabaceae, Solanaceae and Combretaceae were recorded in the honey sample A3.

The pollen identified in the honey samples revealed the botanical and geographical origin of the branded honey samples. The results portrayed the true vegetation types of the three honey samples and gave credence to the acclaimed labeling of the honey samples by the respective producer. For many consumers, good quality honey is expected to be visually clean and clear. Honey that contains good pollen appears cloudy hence making it look unappealing to consumers. Identification and quantifying of pollen in honey is one of the best ways to determine the range of nectar types used by the bees to produce honey and therefore label it correctly based on actual foraging resources. The botanical source may be labeled if the honey is obtained mainly from a particular source. Such honey must also have the organoleptic, physicochemical and microscopic characteristics of the acclaimed origin.

## 5. CONCLUSION

A complete analysis of honey that involves pollen and physiochemical investigation is needed before any honey sample can be certified as suitable for human use. There is a need for the consumers to request certificates or analysis results to prove the origin and composition of the honey. Adulterated honey does more harm to their consumers, hence, the need for honey authentication no matter its brand and acclaimed source.

The results of the pollen analysis indicated that these branded honey samples are rich in pollens which confirmed that they are produced from different types of pollen and/or nectar plant sources (floral origin). The results also affirmed their geographical origin as claimed by their respective producer. The data obtained from the proximate and physiochemical compositions of the branded honey samples fall within the limit of international standards which prove that these branded honey are of good quality and are suitable for human use.

## COMPETING INTERESTS

Author has declared that no competing interests exist.

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