Honey is a popular product consumed for its health benefits. It is an effective antimicrobial agent and an antioxidant. Globally, palynological and chemical methods are among the methods of authenticating honey quality, geographical origin and floral origin. Six honey samples from six Nigerian towns (Abi, Ikom, Lokpanta, Nsukka, Okigwe and Shaki) were subjected to the aforementioned tests. Eighty-six pollen taxa were recorded in all the samples. The richest sample with seventy-three taxa was from Nsukka, followed successively by Okigwe, Lokpanta, Shaki, Ikom and Abi samples with sixty-eight, sixty-seven, sixty-two, fifty-nine and fifty-seven pollen species respectively. The oil palm Elaeis guineensis pollen dominated the samples in different proportions except Shaki honey dominated by Acacia spp. The commonest plant family was Fabaceae (Caesalpinioideae, Mimosoideae, Papilionideae) with twenty-one taxa followed by Euphorbiaceae, Combretaceae, with four representatives and Rubiaceae with three taxa each. The physico-chemical analysis carried out were total moisture, total ash content, colour assessment, percentage of total solids, relative density, acidity, and Fischer’s Test. The samples were found to conform with the international standards for honey.

**Introduction**

Honey, a concentrated solution of a complex mixture of sugars dominantly fructose and glucose which is produced by honey bees *Apis mellifera adansonii* has been used by man for thousands of years both as a natural sweetener, source of energy, and a healing agent which suppresses disease causing agents (National Honey Board, 2002; Khalil et al., 2011; Aled et al., 2012; Maddocks et al., 2012; Nwankwo et al., 2014; Ng and Lim, 2015; Adeonipekun et al., 2016; Kaygusuz et al., 2016; Ng et al., 2017; Fatimah et al., 2018, 2019; Al-Kafaweem et al., 2020). Furthermore, it contains macro and microelements such as water, carbohydrates, minerals, amino acids, organic acids, proteins, volatile substances, enzymes, phenolic compounds, together with other compounds necessary for normal human growth and development (Jasicka-Misiak et al., 2012; Cimpoiu et al., 2013). The hygroscopic nature of honey which enables dehydrating bacteria by decreasing the moisture of the environment had been reported. Again, the high sugar content and low PH of honey has been documented to hinder the growth of bacteria (Eswaran et al., 2015; Nishio et al., 2016). Nolan et al. (2019) had attributed the antimicrobial potential of honey to its different components such as high sugar contents, low pH, polyphenolic compounds, hydrogen peroxide, 1,2-dicarbonyl compounds, and defensin-I. Good quality honey has been linked to the healing of injured intestinal mucosa as it stimulates the growth of new tissues and works as an anti-inflammatory agent (Kek et al., 2014). In addition, Afrin et al. (2017) had reported the ability of honey at low concentrations to inhibit colon cancer. Apart from these, honey also has the potential to serve as a natural food antioxidant (Saxena et al., 2010; Cimpoiu et al., 2013; Boukraâ, 2015). Nolan et al. (2019) who cited Esteraf-Oskouel and Najafi (2013), who highlighted the uses of honey in their review which included its use by the ancient Egyptians who had used it in embalmment, as a topical agent and for the dressing of wounds. Furthermore, the Greeks had used it also for wound healing, and a remedy for goit, pain, fever. In recent times, there has been high incidences of *Diabetes mellitus* which has promoted the use of natural honey in place of processed sugar and allied products. In Nigeria different honey samples are sold both in the open markets and supermarkets. These are sourced both from the wild and from apriaries. The quality of most of these honey samples need to be ascertained. Siddiqui et al. (2017) had reported that commercial honey is often...
adulterated or falsely labeled for economic gains. Presently no established standards exist for certifying the authenticity of these Nigerian honey samples.

Among the major ways of determining the botanical and geographical origin of honey is the assessment of its pollen content (Veitze, 1950; Anklam, 1988; Ghdini et al., 2008; Makhloufi et al., 2010; Jasicka-Misiak et al., 2012). In Nigeria, several authors have worked on different aspects of melissopalynology. The most popular published works are those of Afolabi (1974) and Sowunmi (1976) who set the pace for other researchers. In the last decade and half, honey studies in Nigeria has increase due to the global awareness about Diabetes mellitus (Ige and Modupe, 2010; Adeonipekun 2010, 2012; Agbagwa et al., 2011; Aina and Owombi, 2011; Ayansola, 2012; Agwu et al., 2013; Olugbemi et al., 2013; Kayode and Oyeyemi, 2014; Ndife et al., 2014; Nwankwo et al., 2014; Orijemie 2017; Kayefor et al., 2017; Oyeyemi, 2017).

The use of palynological and physicochemical data in ascertaining how genuine or adulterated a honey sample is having been carried out and is still on in different parts of the world (Saxena et al., 2010; Anklam, 2010; Ramirez-Arriaga et al., 2011; Rateb and Hussein, 2012; Song et al., 2012; Cimpoiu et al., 2013; Jasicka-Misiak et al., 2012; Keke et al., 2014).

This present study was undertaken to enrich the published records of melissopalynological studies in Nigeria, assess the authenticity of honey from the rural areas of Nigeria and compare the results with those already reported from more urban areas like Lagos, Abuja etc and also infer whether their qualities fall within the international standards so as to pave way for export.

Materials and Methods

Honey Samples and Preparation

Six honey samples were sourced between July 2011 – October, 2011 from the open markets from six towns in six states in Nigeria viz: (Abi, Cross River State; Ikom in Akwa Ibom State; Lokpanta, Abia State; Nsukka, Enugu State, Okigwe, Imo State and Shaki, Oyo State). The honey samples were brought to the Biological laboratory of Redeemer’s University and stored prior to preparation. The different honey samples were subjected to palynological and chemical analysis. Standard palynological preparation methods as outlined by Louveaux et al. (1978), with minor modifications after Low et al. (1989) were adopted. The acetylosis were after Erdtman (1969). The prepared slides were analyzed and five hundred pollen grains were counted per sample (de Novaiz and Absy 2013). The inherent pollen was identified using (Sowummi 1973,1995; Bonnefile and Riollet, 1980; Willard et al., 2004; Gosling et al., 2013). In addition, fungal materials, charred Graminae cuticles, diatom frustules were all recorded as miscellaneous palynomorphs. These were not included in the total and percentage pollen calculations. Pollen types recorded per sample were classified (Table 1) as predominant pollen types (>45%), secondary pollen types (16-45%), important minor pollen types (3-15%) and minor pollen types (<3%) (Jasicka-Misiak, 2012; Rateb and Hussein, 2012; Schweizer et al., 2014; Sahney, et al., 2018). Photomicrographs (Figure 3 and 4) of the inherent palynomorphs were taken with a United binocular microscope with an inbuilt Motic-2 camera at the palynology laboratory of EarthProbe Nigeria Limited. The chemical analysis followed the International Honey standards (Bogdanov et al., 2009; IHC website) as no standards exist presently for Nigerian honey.

Physico-Chemical Analysis

The methods outlined in (Bogdanov and Martin, 2002; Bogdanov et al., 1999) were adopted as no standards exist presently for Nigerian honey. The different parameters investigated were i). Total Moisture (Refractometer Method) ii) Percentage of total solids, iii). Total Ash Content, iv). pH v). Relative Density, vi). Acidity (% Gluconic Acid), vii). Colour assessment and viii). Fischer’s Test.

All physicochemical parameters were done according to the harmonized International Honey Commission (Bogdanov et al.,2009: IHC website). An Abbe refractometer was used in determining the moisture content. Total Moisture (Refractometer Method).

Determination of total solids: the percentage total solid for each honey sample was determined using; Total solids (%) = 100-Moisture content

Total Ash Content

Determination of total ash content:

An ash dish was initially heated in the electric furnace for 500°C, it was later removed, cooled in the desiccator at room temperature and weighed to 0.001g and the weight (m2) of the empty dish noted. The other procedure outlined by Bogdanov (2009), was followed through for the ashing process until a constant weight was got (m1). Finally, the proportion of ash WA in g/100g of honey was calculated using the formula:

\[ WA = ((m1 – m2) + m0) \times 100 \]

Where:

m0 = weight of honey sample taken
m1 = weight of empty dish + ash
m2 = weight of empty dish

The answer is rounded to two decimal places

Relative density: Apparatus: specific gravity bottle, distilled water, water bath, honey sample

A clean and thoroughly washed specific gravity bottle was weighed and filled up with freshly boiled and cooled distilled water which has been maintained at 27°C ± 1°C. The water was removed and the bottle dried again and filled with the honey sample maintained at the sample temperature. The bottle was weighed again and the Relative density calculated thus:

\[ \text{Relative Density} = \frac{C-A}{B-A} \]

Where:

C = Mass of the specific gravity bottle with honey in (g)
A = Mass of the empty specific gravity bottle in (g)
B = Mass of the empty specific gravity bottle with water in (g)

Determination of pH: pH was measured using a pH meter, while the titrimetric method was employed in determining the total acidity.

Determination of acidity: The acidity is expressed as the percentage of gluconic acid.

Colour determination: The colour of the different honey samples, were determined, with the aid of a spectrophotometer (Spectronic 20 D). The procedure involved reading the absorbance of the honey against distilled water at a wavelength of 660 nm.

Fischer’s Test

Two g of the honey sample was dissolved in 10ml of water and extracted with 30ml ether in a separating funnel and the layer concentrated to 5ml. Later, 2ml of freshly prepared
resorcinol solution was added, the mixture was shaken, and the colour noted. A cherry red colour appearing in a minute indicated the presence of commercially invert sugar. Yellow and other colours were insignificant.

**Statistical Analysis**

Similarity and dissimilarity level (comparative analysis) between and among the samples from the different locations was determined by constructing a dendrogram (close neighbour analysis) with the physicochemical parameters using SPSS 23.0 (Figure 2).

**Results**

**Melissopalynology**

The occurrences of the recovered palynomorphs for each honey sample are highlighted in Table 1a,b below.

Table 1a: Percentage occurrences of the recovered pollen in the different honey samples. None of the samples fell within the dominant pollen type common in monofloral honeys. Nsukka, Okigwe and Shaki honeys fell within the secondary pollen due to the percentage occurrences of Elaeis guineensis with values above 16%

| Honey Sample: Ikom; Dominant pollen (DP) | Minor pollen <3% |
|----------------------------------------|------------------|
| Elaeis guineensis Jacq. (10.8%); Parinari kerstingii Engl. (5.6%); Rhizophora spp. (3.6%); Ratraceae spp. (4.8%); Poeaece (4.2%); Poaceae (3.6%); Paullinia pinnata Linn. (3.0%); | |
Table 1b: Percentages of the recovered pollen in the different honey samples. None of the samples fell within the dominant pollen type common in monofloral honeys. Nsukka, Okigwe and Shaki honeys fell within the secondary pollen due to the percentage occurrences of *Elaeis guineensis* with values above 16%

| Important minor pollen (IMP) | Minor pollen <3% |
|-----------------------------|-------------------|
| **Fischer’s Test**           |                   |
| Moisture content             |                   |
| Acidity                      |                   |
| Lannea acida A. Rich. (8.4%) |                   |
| Parinari kerstingii Engl. (5.0%) |                   |
| Rutaceae spp. (4.8%)         |                   |
| Combretum spp. (3.6%)        |                   |
| **Physicochemical Analysis** |                   |
| Results of the different physic secondary pollen due to the percentage occurrence of *Elaeis guineensis* with values above 16% |

Table 2. Results of the different physic-chemical tests on the different honey samples

| Parameters                  | Abi | Ikom | Lokpanta | Nsukka | Okigwe | Shaki |
|-----------------------------|-----|------|----------|--------|--------|-------|
| Relative Density            | 1.40| 1.39 | 1.39     | 1.38   | 1.37   | 1.38  |
| Total Ash                   | 0.59| 2.40 | 1.78     | 2.00   | 1.82   | 0.20  |
| $P_T$                       | 3.49| 6.14 | 6.18     | 6.71   | 6.24   | 3.49  |
| Acidity                     | 0.18| 0.07 | 0.17     | 0.07   | 0.17   | 0.24  |
| Colour                      | LA  | LA   | LA       | LA     | LA     | LA    |
| Moisture content            | 18.8| 18.9 | 19.0     | 18.9   | 18.8   | 19.0  |
| Total solids (%)            | 81.2| 81.10| 81.00    | 81.10  | 81.20  | 81.00 |

A: Amber; LA: Light amber; CRC: Cherry red colour; N: Negative

**Physicochemical Analysis**
The presence of abundant pollen taxa (Tables 1) attests to the good quality of the analysed honey samples (Selvaraju et al., 2019; Rodopoulou et al., 2018; Shubharani et al., 2012). The pollen content of the current Nsukka honey closely resembled those of Njokuocha and Ekweozor (2007) in being multifloral. Again, most of the pollen recorded for Nsukka, Lokpanta and Okigwe all in south eastern Nigeria especially *Elaeis guineensis*, *Parinari kerstingii*, *Hymenocardia acida* /*Combretum spp.*, *Alchornea cordifolia*, *Daniellia oliveri*, *Melastomataceae: Dissotis* sp., closely resembled those they recovered. Majority of these same pollen were later reported by Njokuocha (2019) from his study of seven honey samples from seven towns in three local governments areas of Anambra state south eastern Nigeria. A critical analysis of the recovered pollen clearly reflected the dominant vegetation and nectar sources of the honey bees. For the Okigwe and Lokpanta sample from south eastern Nigeria Samples from Okigwe and Lokpanta which are closely located, showed over 95% similarity (Figure 2), possibly due to similarity in flora which is dominantly rainforest with elements of derived savanna due to over cultivation and high population density, the pollen assemblage contained *Ceiba pentandra*, *Pentaclethra macrophylla*, *Pterocarpus santalaloides*, *P. soyauxii* (common vegetables in the south east) *Irvinga gabonensis*, *Berlinia grandiflora* and *Alchornea cordifolia*, with common fungal spores, Charred Graminae Cuticle and rare *Poaceae*. The comparative analysis of the samples from the different locations revealed an interesting trend (Figure 2). Abi and Shaki honeys showed 75% similarity, while Ikom and Nsukka samples showed 62% similarity. However, honeys from Ikom and Nsukka had some inherent qualities that differed from the other four samples. Furthermore, savanna pollen characterized the Shaki honey which appeared slightly similar to the results of Ige and Modupe (2010) from Abuja. *Acacia* spp. pollen dominated the assemblage possibly from the *Acacia* trees which are common around the Shaki-Ogbomosho area. Other pointers to the savanna vegetation were *Cassia senegalensis*, *Khaya senegalensis*, *Combretum* spp., *Parinari kerstingii*, *Tephrosia* spp., *Terminalia* spp., *Isobellinia doka*, *Bombax buonopozense*, *Sterculia* sp., *Hymenocardia acida*, *Gardenia imperialis*, *Heliotropium* spp., among others.

The moderate records of fungal elements and Charred Graminae cuticles indicated savanna fires and preponderance of fungal elements in the air. The common recovery of *Ceiba* pollen further attest to its being a common source of nectar for honeybees in Nigeria just as (Ramirez-Arriaga et al. 2011) had reported from Mexico.

Generally, the common records of *Elaeis guineensis* and other forest species in these samples contrasts the reports of Adekanmbi and Ogundipe (2009) and Adeonipekun (2012) who reported the preponderance of *Asteraceae* and other pollen in the Lagos and Ibadan samples they studied. These differences could have arisen from the fact that these samples from the rural areas reflected the more closed forest canopies compared to Lagos and Ibadan where the main vegetation cover had been cleared for construction and other developmental purposes. The results of the present study further revealed the common occurrence of *Elaeis guineensis* pollen in Nigerian honey samples just as (Afolabi, 1974; Njokuocha and Ekweozor, 2007; Ige and Modupe, 2010) had all reported. Moreover Njokuocha (2019) had reported a 43.45% *Elaeis guineensis* for the Nsukka honey samples. This is close to 45%, the acceptable quantity for branding unifloral honey samples (Jasicka-Misiak et al. 2012). Should the percentage of *Elaeis guineensis* exceed 45%, then such honey sample will be branded as oil palm honey. Selvaraju et al. (2019) had reported the preponderance of pollen of oil palm *Elaeis guineensis* and coconut *Cocos nucifera* in honey samples from the west coast of Malaysia.

The results of the melissopalynological assessment coupled with the results of the Physico-chemical analysis (and Table 2). These values for the relative density conformed to international standards. Total ash: The ash content of the honey samples were measured by incinerating 3g of each honey overnight at 550°C in a furnace (Carbolite, Sheffield, U.K.) until a constant weight is reached (Stefan 2009). The pH values of the six samples which ranged from 3.49 to 6.71 (Table 2), revealed that they were all acidic which concurs with the assertion of Saxena et al. (2010) that honey is normally acidic no matter where it came from. However, the Abi and Shaki samples with pH of 3.49 were more acidic than those with values above 6.0 for the Ikorn, Lokpanta, Okigwe, and Nsukka with the highest value of 6.71. According to Khalil et al., (2012) the Abi and Shaki samples were fresh compared to the rest as pH values between 3.4 and 6.1 indicated freshness of honey. However, higher acidic values suggest possible fermentation of sugars into organic acids. They pointed out that pH influences honey texture, stability and shelf life.

**Discussion**

![Figure 1. Map of Nigeria showing the location of the Sources of the Honey Samples](Image)

![Figure 2. Comparative Dendrogram of the chemical parameters](Image)
Acidity

The colours which ranged from Amber to light amber especially for the samples from Abi, Nsukka, and Shaki denotes good quality as lighter colours are caused by over mixing with water or other materials (White, 1975, Crane, 1980).

The moisture contents which ranged from 18.8% to 19.0% agreed with the reports of Saxena et al. (2010), from India in which the moisture content of six out of the seven samples they studied ranged from 17.2% to 21.6%. Khalil et al., (2012) had also documented moisture contents which ranged between 11.59-14.13% for four honey samples from Algeria. These values they pointed out were below the maximum prescribed limit for moisture content according to Codex standard for honey (Saxena et al. 2010). Khalil et al., (2012) had reported (≤ 20%) as the limit of the International quality regulations (Codex Alimentarius, 2001). They further asserted the importance of water content for the shelf life of honey in storage. High levels of water encourages fermentation due to osmotolerant yeasts.

The result of the total solids which ranged between 81% for Lokpanta and Shaki to 81.20% for Okigwe and Abi fell within the Codex Alimentarius (2001) and European Union Standard Reports (2001). This implies that that the honeys have not undergo further processing as all the organic and inorganic contents were still intact (Kayode and Oyeyemi, 2014). The total solids were highest in the Abi and Okigwe samples with values of 81.20%, followed successively by 81.10% for the Ikom and Nsukka samples while the lowest values of 81.00 were obtained for the Lokpanta and Shaki samples. These results fell within the acceptable range indicating that the samples were not subjected to further processing (Khalil et al. 2012).

Conclusion

The honey samples were all multifloral as no single species had values above 45%. The pollen contents point to the geographical origin of the honey as they reflected different vegetation zones of Nigeria. Those from Southeastern Nigeria were dominated by rainforest species (E. guineensis, Bombax, Cellula, etc while those from the derived savanna and savanna regions were dominated by savanna species (Acacia spp., Combretum spp., Terminalia spp., Khaya senegalensis, and Tephrosia spp.). The Nsukka samples yielded an admixture of rainforest and some savanna species which is characteristic of a derived savanna due to over cultivation in the area possibly brought about by high population density. Chemical analysis revealed that the honey samples were of moderately good quality when compared to international standard and their acidic pH values reveals that they are unadulterated and have potentials to stay long as suggested by Lawal et al. (2009).

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References

Adekanmbi OH, Ogundipe OT. 2009. Nectar sources of the honeybee (Apis mellifera adansonii) revealed by pollen content. Notulae Botanicae Horti Agrobotanici Cluj-Napoca, 37(2): 211-217. http://dx.doi.org/10.15835/hbna3723245.

Adeonipekun PA. 2010. Investigating pollen pellets and honey sample from an apiary in Ibadan, Southwest Nigeria. Journal of Biological Sciences and Biodiversifications, 2:71-88.

Adeonipekun PA. 2012. Palynology of honeycomb and a honey sample from an apiary in Lagos, Southwest Nigeria. Asian Journal of Plant Science and Research, 2(3):274-283

Adeonipekun PA. Adeniyi TA, Eden D. 2016. Antimicrobial and Melissopalynology, Proximate and Elemental Analysis of Honey from Three Different Ecozones in Nigeria. Notulae Scientia Biologicae, 8(3): 326-333.

Adenekan MO, Amusa NA, Okpeze VE, Owosibo AO. 2012. Nutritional and microbiological components of honey samples obtained from Ogun State, Southwestern Nigeria, European J. of Nutr. 1(2): 271-286.

Aghagbe WA, Otokunefor TV, Frank-Peterside N. 2011. Quality assessment of Nigerian Honey and Manuka honey. Journal of Microbiology and Biotechnology Research, 1(3):20-31.

Afolabi AO. 1974. A palynological investigation of various Nigerian honey samples. B.Sc. (Hons) Project. Department of Botany and Microbiology, University of Ibadan, Nigeria. 38 pp.

Afrin S, Forbes-Hernandez TY, Gasparinni M, Bompard S, Quiles JL, Sanna G, Spano N, Giampieri F, Battino M. 2017. Strawberry-tree honey induces growth inhibition of human colon cancer cells and increases ROS generation: A comparison with Manuka honey. International Journal of Molecular Science, 18(613): 1-19.

Aghagbe WA, Otokunefor TV, Frank-Peterside N. 2011. Quality assessment of Nigerian Honey and Manuka honey. Journal of Microbiology and Biotechnology Research, 1(3):20-31.

Agwu COC, Essien BC, Badmus SA. 2013. Honey Samples from Four localities in Dekina Local Government Area of Kogi State, Nigeria. Journal of Biological and Chemical Research, 3(2):921-928.

Aina DO, Owonibi K. 2011. Beekeeping Prospects: Palynology and the environment. Advances in Applied Science Research, 2(4):79-85.

Aled E. L. Roberts, Sarah E. Maddocks and Rose A. Cooper (2012). Manuka honey is bactericidal against Pseudomonas aeruginosa and results in differential expression of oprF and algD. Microbiology, 158, 3005–3013. DOI 10.1099/mic.0.062794-0.

Alvarez-Suarez J, Gasparinni M, Forbes-Hernandez T, Mazzioli L, Giampieri F. The composition and biological activity of honey: a focus on manuka honey. Foods. 2014;3(3):420. DOI: 10.3390/foods3030420.

Ankam E. 2010. A review of the analytical methods to determine the geographical and botanic origin of honey. Journal of Food Engineering, 96(3): 469-479. doi: 10.1016/j.jfoodeng.2009.08.008.

Ayansola AA. 2012. Honeybee Floral Resources in Southwestern Nigeria. Journal of Biology and Life Sciences 3(1): 127-139. doi: 10.5296/jblls.v3i1l.1720.

Bogdanov S, Martin P. 2002. Honey authenticity. Mitteilungen Aus Leb. Und Hyg. 93, 232 –254.

Bogdanov S, Lüllmann C, Mße B., D’Arcy BR, Russmann H, Vorwöhl G, Oddo L, Sabatini AG, Marczanz GL, Piro R, Flaminio C, Morlot M, Lheretier J, Borneck R, Marileas P, Tsigouri A, Kerkvliet T, Ortiz A, Ivanov T, Vit P, Martin P, and von der Ohe W. 1999. Honey quality and international regulatory standards: Review by the international honey commission. Bee World, 80: 61–69.

Bonnefille R, Riollet G. 1980. Pollen des savanes d’Afrique Orientale. Paris: Centre National de la Recherche Scientifique, (CNRS).

Boukraa L. 2015. Honey in Traditional and Modern Medicine. Traditional Herbal Medicines for Modern Times. CRC Press, Taylor & Francis Group, New York.

Cimpoue C, Hosu A, Mieclus V, Puscas A. 2013. Determination of the floral origin of some Romanian honeys on the basis of Physical, biochemical properties. Spectrochimica Acta Part A: Molecular and Chemical Spectroscopy, 100: 149-154. http://dx.doi.org/10.1016/j.saa.2012.04.008.

Codex Alimentarius 2001. Rome. Alinorm. 1, pp. 19-26.

De Noivas JS, Absy ML. 2013.Palynological examination of the pollen pots of native stingless bees from the Lower Amazon region in Pará, Brazil. Palynology, 37(2): 218-230. doi:10.1080/01916122.2013.787127

Eleazu CO, Iroaganachi M, Okoronkwo J. 2013. Determination of the physico-chemical composition, microbial quality and free radical scavaging activities of some commercially sold honey samples in Abia, Nigeria; ‘The effect of varying colour’. International Journal of Biomedical. 4(1):32-41.

Erdtman G. 1969. Handbook of Palynology. An introduction to the study of Pollen grains and Spores. Hafnar Publishing Company, New York. 486 pp.

Esteraf-Oskouel, T. Najafi, M. 2013. Traditional and modern uses of natural honey in human diseases. A review. Iranian Journal of Basic Medical Sciences,16,731-742.

Gosling WD, Miller CS, Livingstone DA. 2013. Atlas of the tropical West African pollen flora. Review of Palaeobotany and Palynology, 199:1–135. doi: 10.1016/j.revpalbo.2013.01.003.

Ige OE, Modupe TO. 2010. Pollen characterization of honey from north central Nigeria. Journal of Biological Sciences, 10:30-37. doi: 10.3923/jbs.2010.43.47.

Jasicka-Misikia I, Poliowski A, Deren M, Kafarski P. 2012. Phenolic compounds in a d asbidential acid as potential markers for the floral origin of two Polish unifloral honeys. Food Chemistry, 131:1149-1156. doi:10.1016/j.foodchem.2011.09.083.

Kayefor EJ, Egbe AA, Eyoma JD. 2017. Botanical Affinity and Physico-chemical Parameters of Honey Samples Obtained from Bee Hives in Cross River State Nigeria. Journal of Scientific Research and Reports, 14(6): 1-23.

Kaygusuz H, Tezcan F, Erim FB, Yildiz O, Sahin H, Can Z, Kolayi S. 2016. Characterization of Anatolian honeys based on minerals, bioactive components and principal component analysis. LWT Food Science Technology, 68: 273–279.

Kayeke J, Oyeyemi SD. 2014. Physicochemical investigation of honey samples from bee farmers in Ekiti State, Southwest, Nigeria. J. Plant Sci. 2(5): 246-249. doi.org/10.4236/fns.2015.615140

Kek SP, China N.L, Yusofa YA, Tan SW, Chua LS. 2014. Total Phenolic Contents and Colour Intensity of Malaysian Honeys from the Apis spp. and Trigona spp. Bees. Agriculture and Agricultural Science Procedia, 2:150 – 155.

Lawal RA, Lawal AK, Adekalu JB. 2009. Physico-Chemical Studies on Adulteration of Honey in Nigeria. Pakistan Journal of Biological Sciences, 12:1080-1084. doi: 10.3923/pjbs.2009.1080.1084.

Maddocks SE, Lopez MS, Rowlands RS, Cooper RA. 2012. Manuka honey inhibits the development of Streptococcus pyogenes biofilms and causes reduced expression of two fibronectin binding proteins. Microbiology, 158: 781–790. doi:10.1099/mic.0.053990-0.

Makhloofi C, Kerkvliet JD, D’Albore GR, Choukri A, Samar R. 2010. Characterization of Algerian honeys by palynological and physico-chemical methods. Apidologie, 41:509-521. doi:1051/apido /2010002.

National Honey Board 2002. Honey, Health and Therapeutic qualities. http://www.nhb.org/ infopub/month/2002/10_2002 monthly report pdf. Retrieved February 18th 2018.

Ndife J, Kida F, Makarti T. 2014. Quality assessment of Nigerian honey sourced from different floral locations. Journal of Food and Nutritional Sciences,2(4):162. doi:10.11648/j.fj.fns.20140204.20.

1869
Ng WJ, Lim MS. 2015. “Anti-staphylococcal activity of Melaleuca honey”, Southeast Asian Journal of Tropical Medicine and Public Health, 46(3): 472-479.

Ng WE, Chan YJ, Lau ZK, Lye PY, Ee KY. 2017. Antioxidant Properties and Inhibitory Effects of Trigona Honey against Staphylococcus aureus Planktonic And Biofilm Cultures. International Journal of Geomate, Sept., 2017, Vol. 12. Issue 37, pp. 28-33. Special Issue on Science. Engineering & Environment, ISSN: 2186-2990, Japan Doi: http://dx.doi.org/10.2660/2017.37.2703

Njokuocha RC 2019. Evaluation of Pollen and Chemical Composition of Honey Samples Sourced from Open Markets in Anambra State, Nigeria to Ascertain their Authenticity. Journal of Applied Life Sciences International, 22(3), 1-12. https://doi.org/10.9734/jalsi/2019/v22i330128

Njokuocha RC, Ekweozor CC.2007. Pollen contents of commercial honeys of Opi Nsukka, Enugu State, Nigeria. Plant Product Research Journal, 11:5-11. http://dx.doi.org/10.4314/pprj.v11i1.35258

Njokuocha, RC, Dim, KL, Onyejekwe, OK, Nwokorie, VU. 2019. Determination of the concentration of some mineral elements and pPollen spectra of Apis Mellifera L. honeys from different locations in Nigeria. Animal Research International, 16(1): 3186 – 3197.

Nolan VC, Harrison J, Cox J. AG. 2019. Review. Dissecting the antimicrobial composition of Honey. Antibiotics, 8 (351): 1-16. MDPI

National Honey Board 2002. Honey, Health and Therapeutic qualities. http://www.nhb.org/ infopubs/month/2002/10_2002 monthly report pdf. Retrieved February 18th 2018.

Nwankwo CM, Ezekoye CC, Igbokwe SO. 2014. Phytochemical screening and antimicrobial activity of apiary honey produced by honey bee (Apis mellifera) on clinical strains of Staphylococcus aureus, Escherichia coli and Candida albicans. African Journal of Biotechnology, 13(23): 2367-2372.

Odugbemi O, Ikeme CH, Dioha IJ. 2015. Physico-chemical analysis of honey from Umualia Abia State, Nigeria. Research Journal in Engineering and Applied Sciences, 2(3):199-202.

Omode PE, Ademunkola SA. 2008. Determination of Trace Metals in Southern Nigerian Honey by use of Atomic Absorption Spectroscopy. Spectroscopy Letters, 41(7):328-331. doi: 10.1080/00387010802371239.

Orijemie EA. 2017. Comparative Pollen analysis of honeys from apiary and open markets in Nigeria and Bénin Republic. Ife Journal of Science, 19(2):217-225. https://dx.doi.org/10.4314 /ijfs.v19i22.2.

Oshima MU, Agbaji EB. 2015. Physicochemical assessment of commercial honey from Edo- State, Nigeria. Int. J. Appl. Sci. Eng. Res (IJASER) 4(1): 151-159.Doi: 10.688/jfaser.04015

Oyeyemi SD. 2017. Quality Assessment of honey sourced from natural and artificial apiaries in Ekiti State, Nigeria. Turkish Journal of Agriculture - Food Science and Technology, 5(10): 1125-1129. doi: https://doi.org/10.24925/turjaf.v5i10.1125-1129.991.

Ramirez-Arriaga E, Navarro-Calvo LA, Diaz-Carbalaj E. 2011. Botanical characterization of Mexican honeys from a subtropical region (Oaxaca) based on pollen analysis. Grana, 50, pp. 40-54. doi:10.1080/00173134.2010.537767.

Rateb SH, Hussein MH. 2012. Pollen spectrum of some Libyan honeys. Journal of Applied Sciences Research, 8(5): 2659-2663.

Sahney M, Rahi S, Kumar A, Jaisswal R. 2018. Melissopalynological studies on winter honeys from Allahabad, Uttar Pradesh, India, Palynology, 42(4):540-552. Doi: 10.1080/00173134.2014.896941.

Saxena S, Guatam S, Sharma A. 2010. Physical biochemical and antioxidant properties of some Indian honeys. Food Chemistry, 118: 391-397. doi:10.1016/j.foodchem.2009.05.001.

Siddiqui AJ, Musharraf SG, Choudhary MI, Rahman AU. 2017. Application of analytical methods in authentication and adulteration of honey. Food Chemistry, 217: 687–698.

Silva APC, Dos Santos FAR. 2014. Pollen diversity in honey from Sergipe, Brazil. Grana 53(2): 159-170. doi: 10.1080/00346677(16)301174-8.

Song XY, Yao YF, Yang WD. 2012. Pollen Analysis of Natural Honeys from the Central Region of Shanxi, North China. PLoS ONE 7(11): e49545.doi:10.1371/journal.pone.0049545

Sowunmi MA. 1976. The potential value of honey in palaepalynology and archeology. Review of Paleobotany and Palynology 21:171-185. https://doi.org/10.1016/0034-6667(76)90017-8.

Sowunmi MA. 1973. Pollen grains of Nigerian Plants. I. Woody species. Grana 13: 145–186. doi.org/10.1080/00173137309429891.

Sowunmi MA. 1995. Pollen of Nigerian Plants II Woody Species. Grana 34:120-141. doi.org/10.1080/00173139509430002.

Stefan B. 2009. Harmonised Methods of the International Honey Commission. World Network of Honey Science, 63 pp.

Willard DA, Bernhardt CE, Weimer L, Cooper SR, Gamez D, Jensen J. 2004. Atlas of Pollen and Spores of the Florida Everglades, Palynology 28:175-227. doi:10.1080/01916122.2004.9989597.