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# Comparative Analysis of Nutrient Composition of Honey Harvested From Forest and Farmland in Imo State, Nigeria

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## Abstract

*The study evaluated the nutrient composition of honey harvested from forest and farmland in Nwangele, Imo State Nigeria. A total of 8 honey samples (i.e. 4 from each habitat) was collected from the hives of the selected beekeepers within the study area. The honey samples collected were analyzed for proximate composition and minerals. Results showed that there were higher moisture (P = 0.0286) and Crude fibre (P = 0.0275) content in forest honey samples than in farmland honey samples. Although, the differences were not statistically significant (P > 0.05). Zinc (Zn), Nickel (Ni), Manganese (Mn), Lead (Pb), Chromium (Cr) and Iron (Fe) concentrations were higher in honey samples collected from the farmland than in the forest. Mercury (Hg) and Copper (Cu) were higher in forest honey samples than in farmland samples. The result of macro mineral showed that Calcium (Ca), Magnesium (Mg), Sodium (Na) and Phosphorus (P) were higher in the forest honey samples than honey samples from farmland, thus, the differences were not statistically significant, except for Iodine (P = 0.0284). The study concluded that honey from forest and farmland in Nwangele Imo State, Nigeria has distinct nutrient profiles, with forest honey having higher macro mineral and nutrient content. The development of habitat-specific standards for honey quality and safety is recommended to ensure authenticity and consistency in honey products.*

**Keywords:** Honey, Imo State, Farmland, Forest, Mineral

**Introduction**: Honey is a sugary and thick material formed by bees (Olatunji, Aboh and Oladosu, 2018). It is a natural product valued for its nutritional and medicinal properties, which are influenced by the floral sources and environmental conditions where it is produced. Honey is made up of flower nectars (floral honey) and sweet plant deposits (non-floral honey), as well as an enzyme secreted by honeybees. These sugary substances are gathered by bees, who then improve them through their own materials before processing them in beehives (Süerdem and Akyalçin, 2017). Honey is a popular sweetener, non-toxic, non-irritant and a common household product (El-Sohaimy, Masry and Shehata, 2015). According to Chaiyasut, Kesika, Peerajan and Sivamaruthi (2018), typical honey has the following composition: fructose (38.0%), glucose (31.0%), sucrose (1.0%), water (17.0%) and others (3.3%). Honey also contains minerals and heavy metals, which play important roles in determining honey qualities. The mineral content varies, ranging from 0.04% in pale honeys to 0.20% in darker honeys (Bogdanov, Jurendic, Sieber and Gallmann, 2008). The major minerals are mainly derived from the soil and nectar producing plants, but they may also come from anthropogenic sources, such as environmental pollution. The physicochemical properties of honey are the quality parameters which include the pH, acidity, moisture, electrical conductivity, ash content, total dissolved solids (TDS), hydroxymethylfurfural (HMF), sugar content (glucose, fructose, and sucrose), and enzyme activity (diastase and invertase). The chemical composition of honey refers to the chemical constituents that are responsible for the biological activities of bees honey such as the proteins, phenols, flavonoids, and vitamins (Alvarez-Suarez, Giampieri, Brenciani, Mazzoni, Gasparrini, Gonzalez-Paramas, SantosBuelga, Morroni, Simoni and Forbes-Hernandez, 2018). Forest habitats are characterized by a diverse range of plant species, including trees, shrubs, and herbs, which provide a rich source of nectar and pollen for bees (Ghazoul, 2005). In contrast, agricultural habitats are dominated by crops such as corn, soybeans, and sunflowers, etc. which may provide a more limited range of nectar and pollen sources for bees (Kremen, 2002). The uses of honey cannot be over emphasized. It span across nutritional, medicinal and industrial uses. This is supported by the huge botanical endowment and the natural biodiversity, which makes the production very lucrative. The impact of habitat type on the nutritional composition of honey is not well characterized. This knowledge gap hinders the development of evidence-based standards for honey production, processing, and utilization. In Imo State, honey is harvested from various ecosystems including forests and farmlands. However, limited studies have systematically examined how these differing environments affect the nutrient composition and quality of the honey produced. This poses significant challenges for consumers, apiarists and policymakers. Consumers lack reliable information on the quality and nutritional differences in honey from these two sources which may impact their choices and health outcomes. Apiarists and producers may not be aware of the environmental factors that enhance honey quality, limiting their ability to optimize production. Without this knowledge, the potential economic and ecological benefits of honey production in these habitats remain under-explored. Also, medicinal benefits of honey have eclipsed its value as a nutritious food, and most literature focused on its alternative medicine, backed by clinical evidence, while overlooking its nutritional importance.This study therefore provides valuable insights into the

nutrition composition of honey samples collected from forest and farmland habitats, which will help to ensure the quality and authenticity of honey products, and promote the sustainable use of honey resources. The study aimed to analyze and compare the nutrient composition of honey harvested from forest and farmland habitats in Imo State, Nigeria. The research aims to understand how the environmental factors associated with forest and farmland habitats influence honey quality by identifying differences in the biochemical and nutritional profiles of the honey. This information is essential for assessing the potential health benefits, economic value and environmental sustainability of honey production in the area.

Materials and Methods: Study Area: Nwangele is strategically located along the Ihiala-Orlu-Anara Road. It shares boundaries on the North with Nkwere Local Government Area, on the South with Isiala Mbano Local Government Area, on the East with Ideato-South Local Government Area and Onuimo Local Government Area, and on the West with Isu Local Government Area. It is located within latitudes 5º 42' 37"N and longitudes 7º 7' 33"E. the temperature ranges between 20 ºC to 36 ºC daily. It is characterized by dry dust-laden north easterly winds, which blows across the country during the dry season (November to March). There are rainy season and dry season. The rainy period is from April to October, during which period the moisture – laden south westerly wind blow, bringing with it the rains (Imo State Government, 2005). The rainy season finally gives way to the dry season that last from November to march of the next year (Ihenetu, Njoku and Ibe, 2021). It has an area of 63km$^2$ and population of 127,691 (Nigeria population commission figure, 2006). It is made up of ten autonomous communities which include Amaigbo, Abba, Ogwuaga, Ekitiafor Abba, Umuopara Abba, etc. The people of Nwangele are predominantly farmers who trade in various farm products such as cassava, palm oil, palm kernels etc. Two types of land forms characterize the topography of the area; they include high undulating ridges and nearly flat topography (Ihenetu *et al.*, 2021).

Sample Collections: A total of 8 honey samples (4 from each habitat) was collected from the hives of the selected beekeepers within the study area. The location of the collection area was determined with the aid of Geographical Positioning System (GPS) and the coordinates were used to generate the map shown in (Figure 3.I). The honey samples were collected during the months of March and May in a sterile container. Samples collected after extraction was stored at 4°C until use. The quality of the honey was ascertained using the method described by Nwankwo, Ezekoye and Igbokwe (2014), and Elijah, Imohiosen, Lamidi and Umar (2015).

**Proximate Analyses:** The proximate analysis conducted in this research was aimed at determining the nutritional compositions of honey samples collected from forest and farmland. The crude fibre, ash content, crude protein, moisture content, dry matter, fat and carbohydrates were determined based on the official analysis method of association of analytical chemists (AOAC). Protein was determined using the micro - Kjeldahl method by Onwuka (2018). The fat content of the honey samples was determined by the Soxhlet extraction method by Onwuka (2018). Vacuum oven method as described by Onwuka (2018), was used in determining moisture content. The dietary fibers comprised of the total soluble and insoluble fibers of honey samples. 5g of honey sample was used to measure ash contents. Carbohydrate content of the samples was estimated as difference between 100% and the sum of percentages of moisture, fat, protein, ash and fibre as described by Onwuka, (2018). % Carbohydrate = 100 – (% moisture + % ash + % protein + % fat + % fibre).

**Analysis of Mineral Content of Honey Samples:** Determination of sodium and potassium content were done through the use of Jenway flame photometer at the wavelength of 589nm and 767nm for potassium and sodium respectively. Analysis of Ca, Mg, Zn, Cu, Mn, Fe, Pb, Co, Cr, N and I were carried out using a perking- Elmer model 3030 Atomic Absorption spectrophotometer (AAS) at their respective lamp and wavelength. (Ca 422.7nm, Mg 285.2nm, Zn 213nm, Cu 324nm, Mn 279nm, Fe 324nm, Pb 283.3nm, Co 240.7nm, Cr 357.9nm, I 365.0nm, N 149.3nm and C 1931.1nm). Analysis of phosphorus was done using UV – visible spectrophotometer.

Results: Zinc (Zn), Nickel (Ni), Manganese (Mn), Lead (Pb), Chromium (Cr) and Iron (Fe) concentrations were higher in honey samples collected from the farmland than in the forest (Table 1). Mercury (Hg) and Copper (Cu) were higher in forest honey samples than in farmland samples. However, the difference in heavy metal content in the honey samples was not statistically significant (Table 1). The macro-minerals; Sodium, Phosphorus, Calcium and Magnesium were higher in forest honey samples than in farmland (Table 2). Potassium, Iodine and Nitrogen were higher in the farmland honey samples than honey samples from forest (Table 2). The differences in the honey samples from the forest and farmland were not statistically significant, except for Iodine ($P$ = 0.0284). There was higher moisture ($P$ = 0.0286) and CF ($P$ = 0.0275) content in forest honey samples than in farmland honey samples (Table 3). Ash and fat contents were higher in forest honey samples than in farmland honey samples. However, the differences were not statistically significant ($P$ > 0.05). Farmland honey samples' dry matter, CHO and calorific values were significantly higher than forest honey samples. Though crude protein content was higher in farmland honey samples than in forest honey samples, the differences were not statistically significant (Table 3).Discussions: From the result obtained, forest honey samples had higher values of magnesium, sodium and calcium, and this is likely due to the presence of sodium, calcium and magnesium rich– plants such as trees and shrubs in the forest ecosystem (Kumar, Shrivastava, Lilawati, Prashant, Jayanti and Reena, 2023). Another possible reason may be the presence of *Chrysophyllum albidum* which have enormous nutritional values and need to be conserved since they are going into extinction, (Nnadi and Anyanwu, 2018) and they serve as a source of nectar for the Bees. These findings is in consistent with a study by Serra-bonvehi, Soliva and Enric (2001) which reported that forest honey tends to have higher levels of sodium, magnesium and calcium when compared to farmland honey. A study by Guler and Park (2011) found that forest honey from Turkey contained an average of 150mg/kg of magnesium, while agricultural honey contained an average of 100mg//kg. These minerals among the others are essential for humans and they play an important role on a number of biochemical processes (Garcia, Perez and Harrana, 2001), the variation of mineral elements in honey samples from one

country to another is not controversial hence reports from many researchers have emphasized that minerals can be highly indicative of the geographical origin of honey and can be used as environmental indicators (Przybylowski and Wilczynska, 2001). The higher values of Zinc (Zn) Nickel (Ni) Manganese (Mn) and Iron (Fe) in farmland honey samples compared to forest honey samples could be the higher levels of micro-elements in the soil and plants. The higher values of lead (Pb) in farmland honey may be attributed to the use of pesticide, fertilizers, and other agricultural chemicals which can contaminate the nectar and pollen collected by bees. These findings have implications for the quality and safety of honey, as excessive levels of certain element can pose health risks to consumers. The results highlight the importance of considering the environmental origin and production practices when evaluating the quality and authenticity of honey. Further research is needed to explore the specific factors contributing to these differences and their impact on human health. From the result of proximate analysis in (Table 3) it was generally observed that farmland honey contained high percentage of dry matter followed by carbohydrates and moisture content fat was the least. Carbohydrates content (CHO) of the honey samples analysed was between 64% and 73 %.( Table 3). These values were similar to those obtained by (Famuyiwa, Anikwe, Adeoni-Pekun and Adebayo, 2020) who reported that carbohydrate content of some Nigeria honeys were in the range of 62 - 79.94 %. Carbohydrates are the main constituents of honey comprising about 95% of its dry weight (Bogdanov, *et al.*, 2008). Low percentage of crude protein content was recorded in honey samples from the both habitat. There is no fixed limit for permissible level of protein in honey, however, low levels of protein have been recorded by some authors (Buba, Gidado, Shugaba, 2013). The variability in protein content of different types of honey might refer to the plants visited by honeybees and the type of pollens. Honey is beneficial as protein contains amino acids utilized by the cells of the body to synthesize all the numerous protein required for the function of the cell and also to furnish energy (Sintayehu, Dereje and Jorge, 2022). The low fat content obtained in this study were in agreement with that reported by other authors (Azenedo, Azenedo, Desouza and Dautra, 2003; Alvarez-Suarez, Tulipani, Diaz, Estevez, Romandini, Giampieri, Damiani, Astolfi, Bompadre and Battino, 2010; Buba *et al.*, 2013; Anikwe, Akinwande, Adeonipekun and Makanjuola, 2016). High fat content makes foods susceptible to rancidity and subsequent spoilage during storage (Durrani, Srivastava and Verma, 2011; Anikwe *et al.*, 2016). Therefore, natural honey for human consumption should be low in fat. Moisture content is one the important parameters to be considered in the quality of honey. Honey is an excellent hydroscopic product and has tendency to absorb atmospheric moisture. Furthermore, the moisture levels may also largely depend on methods of harvesting and extraction of honey which may differ from location species and practices (Bogdanvov, Lullman, Martin, Wonder and Russman, 1999). From the current study the moisture content recorded were above within the internationally recognized level of 20% moisture content and honey that contained as high as 25% of moisture are unfit for market (Ishraga, Thoria, Amna, Hajer, Sayda and Safa, 2017)). High moisture content is not desirable because honey may begin to ferment and lose its fresh quality if the moisture in honey is greater than 20%. The high moisture content in farmland honey may be attributed to the proximity of farmland to water sources, such as irrigation canals or nearby water bodies, which can contribute to higher humidity levels during nectar collection. This, in turn, can influence the honey's water content. This agreed with the observation made by and Ishraga, *et al.*, (2017) and crane (1995) that, where the atmospheric humidity is very high, bees may be unable to reduce the water content of honey sufficiently. Akachuku (2002) also observed that in high humidity kind of weather open and sealed honey particularly in smaller colonies absorbed water from the air. Also different colonies might seal honey in cell at slightly different water contents. The Ash percentage found in honey expresses its richness in mineral content and constitute a quality parameter (Ishraga, *et al.*, 2017)). Honey sample from forest had higher ash content compared to honey sample from farmland habitat. In this study it could be noted that ashes percentage of the honeys from two habitats were within the allowable range of 0.1-1.0% (Adgada, 1999) and thus conform to the international regulatory standards for quality honey (Bogdanov, 1999). This result also agreed with findings of (Belie, 2009; Gebremedhin, 2013; Legese, 2014). Codex Alimentarius Commission Standards (2001) for honey, proposed Ash content not more than 0.6% for normal honey.

Conclusion: The study reveals that forest honey samples had higher values of magnesium, sodium and calcium which possess some nutritional and medicinal quality that can be used as supplement for the need of human. The moisture content was higher in farmland. The high moisture content in farmland honey sample may be attributed to the proximity of farmland to water sources, such as irrigation canals or nearby water bodies, which can contribute to higher humidity levels during nectar collection.

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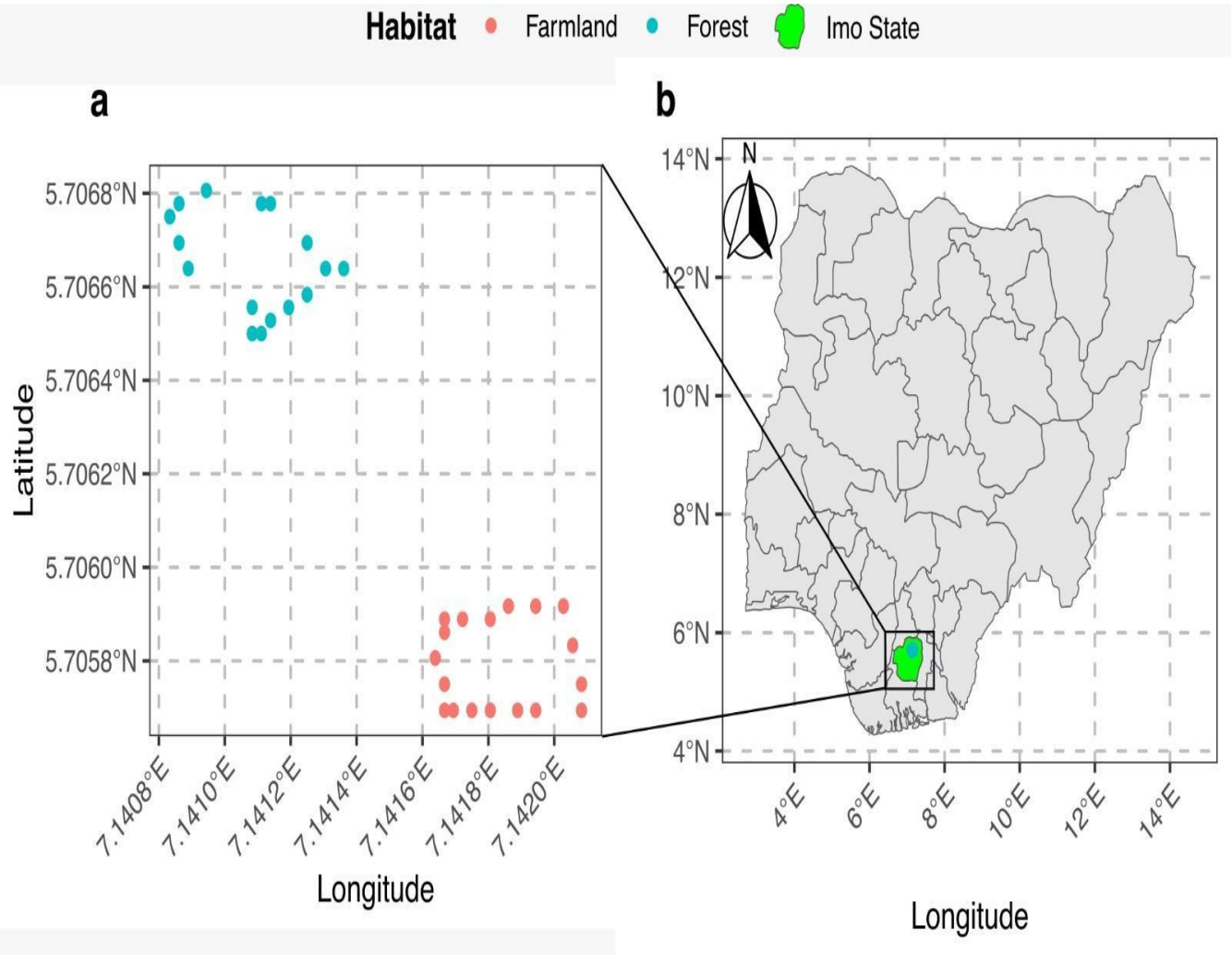
Habitat
Farmland
Forest
Imo State
a
b
5.7068°N
5.7066°N
5.7064°N
5.7062°N
5.7060°N
5.7058°N
Latitude
7.1408°E
7.1410°E
7.1412°E
7.1414°E
7.1416°E
7.1418°E
7.1420°E
Longitude
N
14°N
12°N
10°N
8°N
6°N
4°N
4°E
6°E
8°E
10°E
12°E
14°E
Longitude

**Table .1. Comparison of heavy metals content between honey samples collected from farmland and forest**

| | Zn | Ni | Hg | Mn | Pb | Cu | Cr | Fe |
|---|---|---|---|---|---|---|---|---|
| **Farmland** | 0.396±0.149 | 3.144±2.023 | 0.044±0.039 | 3.292±1.88 | 0.006±0.003 | 1.339±1.54 | 0.191±0.108 | 1.701±1.44 |
| **Forest** | 0.345±0.087 | 2.646±0.276 | 0.082±0.046 | 2.045±0.318 | 0.005±0.002 | 1.682±0.297 | 0.16±0.015 | 0.964±0.145 |
| **p value** | 0.7715 | 1 | 0.3429 | 1 | 1 | 1 | 1 | 1 |

**Table 2. Comparison of macro minerals content between honey samples collected from farmland and forest**

| Sample | Ca | Mg | K | Na | P | I | N |
|---|---|---|---|---|---|---|---|
| **Forest** | 162.825±5.01 | 44.085±5.816 | 4.609±0.44 | 9.957±4.845 | 4.4±2.316 | 0.40±1.282 | 0.159±0.011 |
| **Farmland** | 160.335±23.146 | 41.01±9.119 | 4.729±1.51 | 9.65±0.135 | 4.245±0.533 | 1.884±0.256 | 0.174±0.013 |
| **p value** | 1 | 1 | 1 | 1 | 1 | 0.0284 | 0.3035 |

**Table 3 Comparison of Proximate content between honey samples collected from farmland and forest habitats**

| Sample | Moisture | DM | Ash | CF | Fat | CP | CHO | Calorific value |
|---|---|---|---|---|---|---|---|---|
| **Forest** | 25.532±1.614 | 65.91±1.605 | 0.269±0.155 | 0.03±0.016 | 0.019±0.009 | 0.998±0.067 | 64.518±1.608 | 262.227±6.273 |
| **Farmland** | 34.0723±1.043 | 74.477±1.043 | 0.268±0.015 | 0.005±0.006 | 0.013±0.001 | 1.08±0.071 | 73.11±0.973 | 298.128±3.51 |
| **p value** | 0.0286 | 0.0284 | 0.3429 | 0.0275 | 1 | 0.3065 | 0.0286 | 0.0286 |