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Physicochemical Properties of Honey Samples in Some Selected Regions of Ogun State Nigeria

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ABSTRACT
Honey is a tasty and sweet food that honey bees produce from plant nectar and honeydew. The physicochemical properties of honey samples were investigated in Ogun State, Nigeria. Honey samples were collected from beekeepers in the four (4) markets in different regions in Ogun State (Remo, Ijebu, Yewa and Egba). The physicochemical parameters were investigated using standard procedures. The parameters investigated were: colour, pH, total acidity, free acidity, electrical conductivity, sugar content, mineral content, moisture and ash content. The results of the physicochemical analysis indicated that the pH total acidity, electrical conductivity of all the samples differs significantly ($P<0.05$). The sugar content of the honey samples from other regions differs significantly ($P<0.05$) with the Remo region exhibiting the highest mean value (85.829%) followed by honey sample of the Yewa region (84.63%) and the least was from Egba region (76.87%). From the present study, it can be concluded that honey sample from Egba region recorded the highest pH (6.36), highest electrical conductivity (0.85), honey sample from Ijebu region recorded the highest free acidity (21.99) while honey sample from Yewa region recorded highest total acidity (33.71). It was observed that the honey samples from the four regions agree with the requirements of international honey standards.

Keywords*:* Honey; Physical properties; Chemical composition; Samples

INTRODUCTION
Honey is a tasty and sweet food that honey bees produce from plant nectar and honeydew (Abselami *et al.*, 2018). People have used it as the most intriguing and dependable natural sweetener for a very long time (Abselami *et al.*, 2018). Approximately 181 different compounds make up the complex mixture known as honey, including sugars (the primary compound), enzymes, amino acids, organic acids, carotenoids, vitamins, minerals, and aromatic compounds (Da Silva *et al*., 2016). The plant species from which the nectar is obtained, the climatic circumstances, the geographic locations, the beekeeping techniques and processing, the storage conditions, and the honeybee species used in its production all affect the composition, flavour, aroma, and colour of the honey produced. Morocco produces a variety of monofloral honeys, some of which are valued more than others due to their flavour and scent or their medicinal properties (Chakir *et al.*, 2016). It is interesting that the first method to determine the botanical origin of honey was melissopalynology.

Bees gather pollen and nectar from flowers, other plants, and honeydew to make honey. A naturally occurring sweet food called honey is made by the *Apis mellifera* bees from nectar and pollen grains or from the excretion of living plant components (Oroian *et al.*, 2016).

When conditions are difficult and there are no blossoms, bees produce honey to act as a nutrient reservoir for the colony. According to Klç Altun *et al.* (2017), honey is a naturally sweet substance made by honeybees from plant nectar, plant secretions, or insect excretions on living plant parts. Bees collect these substances, combine them with other elements from their nest, dehydrate, store them, and then leave them in honeycombs to ripen and mature. The variations in the chemical components of honey samples are likely connected to geochemical and regional variables (Abselami *et al*., 2018).

In addition to being composed of sugars like glucose, sucrose, fructose, and maltose as well as various poly- and oligosaccharides, acids, flavonoids, vitamins, minerals, waxes, fragrance compounds, pollen grains, pigments, and enzymes, honey has a superior nutritional value. The makeup is determined by the nectar and honeydews' makeup (Haouam *et al*., 2016). According to Boussaid *et al*. (2018), fructose and glucose are the two main sugars found in honey, while sucrose is still extremely rare. According to Atanassova *et al.* (2016), honey has a high viscosity and a significant nutritional value. Additionally, it has bactericidal, fungicidal, and antioxidant effects.

Natural honey's physicochemical properties, including pH, moisture, sugar content, hydroxymethylfurfural (HMF) concentration, colour, acidity, and specific conductivity, define and symbolize the distinctive qualities of each honey type.

Aljohar *et al.* (2018) claim that traditional medical professionals and the general public are increasingly accepting honey as a reliable and efficient therapeutic agent. It has a wide range of biological functions and has been used successfully to treat a wide range of illnesses, including gastrointestinal disorders, skin conditions, cancer, heart conditions, and neurological degeneration. Honey, which mostly contains carbs and water but also contains trace amounts of organic acids, vitamins, minerals, flavonoids, and enzymes, is a fantastic source of energy.

Honey has always been a target for adulteration as a natural good with a fair amount of cost. The quality of honey is crucial from a business and health perspective (Aljohar *et al*, 2018). Additionally, honey contains a variety of macro and micro minerals, which make up 0.02-1.03 percent of its minor components. The ash content of honey is the principal source of trace elements. The body needs elements, which are inorganic substances, to carry out essential functions. While trace elements like Pb, Cd, and Al are regarded as toxic and should harm human metabolism, essential elements like Se, Cu, Mn, Fe, and Zn should be considered environmental pollutants if they exceed tolerance limits. These elements are necessary for normal metabolism (Altundag *et al*., 2015). Due to their cytotoxic and carcinogenic effects, Pb, Cd, Ni, and Cr levels are undesirable (Kováik *et al*., 2016). Honey comes in a variety of colours, tastes, and densities. However, a lot depends on the quality of the honey produced. Consumers can reject a product with just a minor colour, flavour, or scent variation from the standard quality associated with the brand. An International Honey Commission (IHC) was established so that honey would have a standardized standard. Its primary goal was to update the procedures and requirements for honey (Draiaia., 2015). To evaluate if honey is suitable for processing and to satisfy market demand, quality monitoring is crucial. High moisture levels may cause some varieties of honey to crystallize more quickly and raise the water activity to levels where some yeasts can flourish. Naturally, honey has long been regarded as a highly effective energy source. Additionally, it is known for having antimicrobial and antioxidant properties.

A complex mixture of additional carbohydrates, amino and organic acids, minerals, aromatic compounds, colours, waxes, and pollen grains are included in the concentrated water solution of inverted sugar. According to Boussaid *et al.*(2018), honey is a good source of natural antioxidants that can lower the risk of many inflammatory conditions as well as heart disease, cancer, immune system deficiencies, cataracts, and other diseases (including cancer).

In Ogun State, different types of honey are produced, and some of them are valued more than others because of their flavor and scent or their medicinal properties. Honey has various nutritional advantages, but its application has received little attention. Due to some limitations, scientists are now looking into physicochemical factors that might more accurately pinpoint the honey's botanical origin. The viruses can enter honey through pollen or by inappropriate handling and storage of the honey. This has a side effect on human health when consuming contaminated honey. Several studies have investigated the composition and physicochemical parameters but few studies have investigated the Physico-chemical parameters of honey gotten directly from beekeepers to the ones gotten from the market. It appears very interesting to examine different honey samples to determine the physicochemical composition. This study is therefore set to examine the physicochemical parameters of honey in Ogun State with the following objectives-: to assess the physicochemical properties of different honey samples produced in Ogun State, to compare the physicochemical properties of different honey samples and compare the physicochemical properties of honey from beekeepers and honey gotten from the market.

METHODOLOGY

Sampling site: Four(4) different sampling site from Ogun State were selected for collecting honey samples. These sites were Remo, Ijebu, Yewa and Egba.

Collection of samples: Sixteen (16) samples of honey produced in Ogun State were collected using the protocol described by Ujjwal *et al.* (2020) from sixteen beekeepers. Different kinds of honey samples were collected from the four zones in Ogun State (Remo, Ijebu, Yewa and Egba). Five (5) samples were collected in Remo, five (5) samples from Ijebu, three (3) samples from Yewa and three (3) samples from Egba. Two samples each were collected from the market in each zone. The samples collected were immediately kept in an air-tight container, kept in a cool environment and then taken to the laboratory for analysis.

Physicochemical analysis

Colour of honey

The procedure described by Olaitan *et al.* (2007) was used. L, a and b parameters were determined using a Croma Meter colorimeter. In detail, it assessed the following color traits: L (lightness) axis – 0 is black, while 100 is white; a (red–green) axis – positive values are red, while negative values are green and 0 is neutral; b (yellow–blue) axis – positive values are yellow, while negative values are blue and 0 is neutral. Multiple measurements (triplicate) of L, a and b parameters were determined using the colorimeter on the sample.

Moisture Content of honey

The Moisture content was determined by measuring the reactive index (R.I) using a refractometer (Abselami *et al*., 2018). The percentage (%) of water was determined using the Chataway table that relates the % of water with R.I. The experimental results were recorded in percentage.

Determination of Apparent Reducing Sugars and Total sugar of honey

Reducing sugar content was determined by titration of a modified Fehling's solution at its boiling point against a solution of honey (Abselami *et al*., 2018). The Lactose, sucrose content was calculated and recorded in percentage.

Determination of pH, Free Acidity, and Total Acidity of honey

The pH was measured using a pH-meter in a solution containing 10g of honey in 75ml of CO_2 free distilled water (Bogdanov *et al.*, 1997). The free acidity was obtained by plotting the neutralization curve with a sodium hydroxide solution and determining the pH of the equivalence point (pHe). The acidity of the lactones is obtained by adding excess sodium hydroxide to the honey solution and plotting the neutralization curve of the excess sodium hydroxide by back titration with sulphuric acid (Bogdanov *et al.*, 1997).

Ash Content of honey

The ash content was determined by heating honey in a muffle furnace 600°C for 2 hours. After cooling, the ash content was determined (Tesfaye *et al.*, 2016).

Electrical Conductivity of honey

The electrical conductivity was determined using a conductometer as described by Bogdanov *et al.*, (1997). The measurements were carried out at 20°C in a 20% aqueous solution concerning the dry matter of the honey. The value of the conductivity was directly determined by the cell in the solution after immersion. The results were expressed in micro-Siemens per centimetre (μS/cm).

Mineral Content of honey

Emission measurements made by direct nebulization in an inductively coupled plasma optical emission spectrometer (Unico - S1100-RS), were used to analyse the elements Calcium (Ca), Magnesium (Mg), Phosphorus (p), Zinc (Zn) and Iron (Fe) (Boussaid *et al.*, 2018).

Data Analysis

The Microsoft Excel 2010 spreadsheet was used to input the physicochemical properties data. The Statistical Package for Social Sciences (SPSS v.23) was used for statistical analysis. Analysis of Variance (ANOVA) was used. The mean values were compared with each other

RESULTS

A total of twenty-four (24) honey samples were collected across the four (4) regions in Ogun State. The following physicochemical properties were tested for; colour, pH, total acidity, electrical conductivity, sugar content, mineral content, moisture and ash content.

The result in table 1 shows the mean of honey samples from the four regions in Ogun State. The pH of honey samples ranged from 6.245-6.31, with the lowest pH mean value of 6.245 in samples from Egba and the highest mean value of 6.31 in samples from Ijebu. The electrical conductivity of honey samples ranged from 0.791-0.813, with the lowest mean of 0.791 from Egba and the highest mean of 0.813 value from Ijebu. Free acidity ranged from 21.038-25.843, with the lowest mean of 21.038 from Remo and the highest mean of 25.843 from Egba. The total acidity of honey samples ranged from 33.403-33.657, with the lowest mean of 33.403 from Yewa and the highest mean of 33.657 from Egba. The colour of honey samples ranged from 11.317-11.482, with the lowest mean of 11.37 from Yewa and the highest mean of 11.482 from Egba. The moisture content of honey samples ranged from 1.67-3.077. The lowest evaluated mean value of 1.67 was recorded in samples collected from Egba and the highest moisture of 3.077 each from Yewa. The lowest ash content with the mean value of 0.33 was recorded in samples collected from Egba and the highest of 0.581 from Ijebu. The proximate makeup of the honey samples differs significantly ($p<0.05$) from one another.

Table 1: Proximate composition of honey samples from beekeepers mean±std. error

Proximate composition	Remo	Ijebu	Yewa	Egba
pH	6.262±0.001[b]	6.310±0.001[d]	6.287±0.001[c]	6.245±0.001[a]
Electrical conductivity	0.727±0.001[b]	0.813±0.001[c]	0.807±0.001[b]	0.791±0.001[a]
Free acidity	21.380±0.001[a]	21.268±0.001[b]	21.607±0.001[c]	25.848±0.001[d]
Total acidity	33.529±0.001[c]	33.465±0.001[b]	33.403±0.001[a]	33.657±0.001[d]
Colour	11.475±0.001[c]	11.317±0.001[a]	11.370±0.001[b]	11.482±0.001[d]
Moisture	2.807±0.001[c]	2..593±0.001[b]	3.077±0.001[d]	1.670±0.001[a]
Ash content	0.561±0.001[c]	0.581±0.001[d]	0.488±0.001[b]	0.330±0.001[a]

For each parameter, means with different superscript across column were significantly different ($p \leq 0.05$)

The means of the sugar content of honey samples gotten from beekeepers. The lactose means ranged from 1.779%-1.915%, with the lowest mean of 1.779% from Ijebu and the highest mean of 1.915% from Egba. The sucrose means ranged from 3.755%- 4.313%, with the lowest mean of 3.755% from Yewa and the highest mean of 4.313% from Egba. Reducing sugar content was highest in Egba samples with the mean value of 49.397%, followed by samples from Yewa with 47.955% while the lowest mean value of 47.069% was recorded in Remo samples. The lowest mean value of total sugar content was recorded in Egba samples with the mean value of 76.873 and the highest mean value of 85.829 was recorded from Remo.

Table 2: Sugar content of honey samples from beekeepers, from different region of Ogun State

Sugar content (%)	Remo	Ijebu	Yewa	Egba
Lactose	1.796±0.001[a]	1.779±0.001[a]	1.798±0.001[a]	1.915±0.120[b]
Sucrose	3.983±0.001[b]	4.159±0.001[c]	3.755±0.001[a]	4.313±0.001[d]
Reducing sugar	47.069±0.001[a]	47.274±0.001[b]	47.955±0.001[c]	49.397±0.001[d]
Total sugar	85.829±0.001[d]	85.024±0.001[c]	84.630±0.001[b]	76.873±0.001[a]

Means with different superscript across column were significantly different ($p \leq 0.05$)

The result in table 3 shows the mean value of calcium (Ca) ranged from 22.705-25.383, honey samples from Egba had the highest mean value of 25.383 and the lowest mean value of 22.705 was recorded from Yewa. Magnesium (Mg) mean value ranged from 39.237-42.68, with the lowest mean of 39.237 from Ijebu and the highest mean value of 42.68 from Egba. Phosphorus (p) had the lowest mean value of 134.99 from Yewa and the highest mean value of 136.572 from Egba. Zinc (Zn) had the lowest mean value of 3.655 recorded from Ijebu and the highest mean value of 3.807 recorded from Egba. Iron (Fe) had the lowest mean of 3.142 from Remo and the highest mean of 3.613 recorded from Ijebu.

Table 3: Mineral content of honey samples from beekeepers of different region of Ogun State

Mineral content	Remo	Ijebu	Yewa	Egba
Ca	24.542±0.001^{c}	23.427±0.001^{b}	22.705±0.001^{a}	25.383±0.001^{d}
Mg	41.335±0.001^{c}	39.237±0.001^{a}	40.135±0.001^{b}	42.680±0.001^{d}
P	135.757±0.001^{c}	135.082±0.001^{b}	134.990±0.001^{a}	136.572±0.001^{d}
Zn	3.753±0.001^{c}	3.655±0.001^{a}	3.663±0.001^{b}	3.806±0.001^{d}
Fe	3.142±0.001^{a}	3.613±0.001^{d}	3.245±0.001^{b}	3.585±0.001^{c}

Means with different superscript across column were significantly different ($p \leq 0.05$)

The result in table 4 shows that pH of honey samples ranged from 6.305-6.363, with the lowest pH mean value of 6.305 in samples from Remo and the highest mean value of 6.363 in samples from Egba. The electrical conductivity of honey samples ranged from 0.801-0.854, with the lowest mean of 0.801 from Remo and the highest mean value of 0.854 from Egba. Free acidity ranged from 21.04-21.99, with the lowest mean of 21.04 from Yewa and the highest mean of 21.99 from Ijebu. The total acidity of honey samples ranged from 33.34-33.71, with the lowest mean of 33.34 from Egba and the highest mean of 33.71 from Yewa. The colour of honey samples ranged from 11.168-11.658, with the lowest mean of 11.168 from Remo and the highest mean of 11.658 from Ijebu. The moisture content of honey samples ranged from 2.428-2.848. The lowest evaluated mean value of 2.428 was recorded in samples collected from Egba and the highest moisture of 2.848 each from Yewa. The lowest ash content with the mean value of 0.595 was recorded in samples collected from Ijebu and the highest of 1.005 from Yewa.

Table 4: Proximate composition of honey samples from the market mean ± std. error

Proximate composition	Remo	Ijebu	Yewa	Egba
pH	6.305±0.001^{a}	6.340±0.001^{c}	6.330±0.001^{b}	6.363±0.001^{d}
Electrical conductivity	0.801±0.001^{a}	0.816±0.001^{b}	0.825±0.001^{c}	0.854±0.001^{d}
Free acidity	21.560±0.001^{b}	21.998±0.001^{d}	21.038±0.001^{a}	21.870±0.001^{c}
Total acidity	33.650±0.001^{c}	33.510±0.001^{b}	33.713±0.001^{d}	33.340±0.001^{a}
Colour	11.168±0.001^{a}	11.658±0.001^{d}	11.433±0.001^{b}	11.461±0.001^{c}
Moisture	2.423±0.001^{a}	2.743±0.001^{c}	2.848±0.001^{d}	2.428±0.001^{b}
Ash content	0.650±0.001^{b}	0.633±0.001^{a}	1.075±0.001^{d}	0.765±0.001^{c}

Means with different superscript across column were significantly different ($p \leq 0.05$)

The lactose means ranged from 1.663%-1.858%, with the lowest mean of 1.663% from Egba and the highest mean of 1.858% from Ijebu. The sucrose means ranged from 3.725%- 4.205%, with the lowest mean of 3.725% from Yewa and the highest mean of 4.205% from Remo. Reducing sugar content was highest in Egba samples with the mean value of 51.678%, followed by samples from Ijebu with 50.358% while the lowest mean value of 47.62% was recorded in Yewa samples. The lowest mean value of total sugar content was recorded in Yewa samples with the mean value of 78.408 and the highest mean value of 89.65 was recorded from Egba and presented in Table 5.

Table 5: Sugar content of honey samples from the market

Sugar content	Remo	Ijebu	Yewa	Egba
Lactose (%)	1.838±0.001^{c}	1.858±0.001^{d}	1.685±0.001^{b}	1.663±0.001^{a}
Sucrose (%)	4.205±0.001^{d}	4.178±0.001^{c}	3.725±0.001^{a}	3.783±0.001^{b}
Reducing sugar (%)	48.498±0.001^{b}	50.358±0.001^{c}	47.620±0.001^{a}	51.675±0.001^{d}
Total sugar (%)	80.055±0.001^{b}	87.720±0.001^{c}	78.408±0.001^{a}	89.650±0.001^{d}

Mean±Std. error; Means with different superscript across column were significantly different ($p \leq 0.05$)

The mean value of calcium (Ca) ranged from 20.353-25.08, honey samples from Remo had the highest mean value of 25.08 and the lowest mean value of 20.353 was recorded from Yewa. Magnesium (Mg) mean value ranged from 37.735-41.93, with the lowest mean of 37.735 from Ijebu and the highest mean value of 41.93 from Egba. Phosphorus (p) had the lowest mean value of 134.345 from Yewa and the highest mean value of 137.408 from Remo. Zinc (Zn) had the lowest mean value of 3.403 recorded from Yewa and the highest mean value of 3.82 recorded from Remo. Iron (Fe) had the lowest mean of 3.095 from Ijebu and the highest mean of 3.653 recorded from Egba.

Table 6: Mineral content of honey samples from the market mean±std. error

Mineral content	Remo	Ijebu	Yewa	Egba
Ca	25.080±0.001^{d}	24.015±0.001^{c}	20.353±0.001^{a}	23.385±0.001^{b}
Mg	40.805±0.001^{c}	37.735±0.001^{a}	38.823±0.001^{b}	41.930±0.001^{d}
P	137.408±0.001^{d}	135.773±0.001^{b}	134.345±0.001^{a}	135.873±0.001^{c}
Zn	3.820±0.001^{a}	3.573±0.001^{d}	3.403±0.001^{c}	3.428±0.001^{b}
Fe	3.405±0.001^{c}	3.095±0.001^{a}	3.263±0.001^{b}	3.653±0.001^{d}

Means with different superscript across column were significantly different ($p \leq 0.05$)

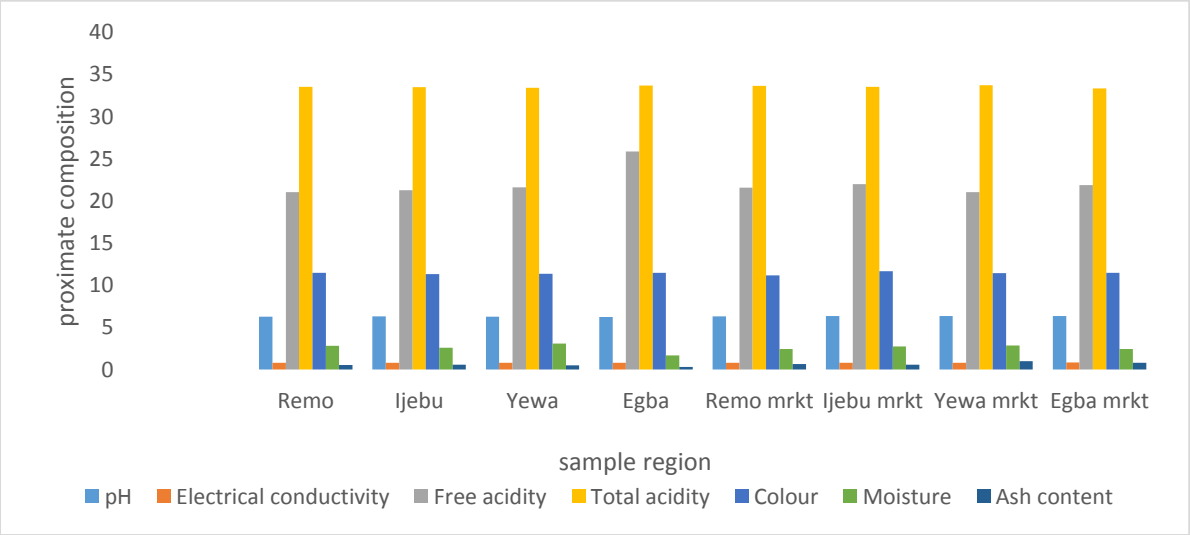

Figure 1: Proximate composition of honey samples from beekeepers and from the market

According to the findings, honey obtained from the Egba market had a mean pH of 6.363, whereas honey obtained from beekeepers in the Egba region had a mean pH of 6.245. The greatest mean value of electrical conductivity in honey samples from Egba market was 0.854, while the lowest mean value came from the same location at 0.791. Egba region had the greatest mean value of free acidity in honey at 25.843, while Remo Region had the lowest mean value at 21.038. The average total acidity of honey from Yewa market was 33.71, while the average for honey from Egba market was 33.34. The honey obtained from Remo market had the lowest mean (11.168) and the honey obtained from Ijebu market had the highest mean (11.658), indicating a little variation in the honey's colour. The moisture content of honey obtained from beekeepers in the Yewa region had the highest mean value of 3.077 and the lowest mean value of 1.620 for honey from the Egba region. The mean value of the ash content of honey obtained from Yewa market was 1.005, whereas the mean value of honey obtained from Egba region was 0.330.

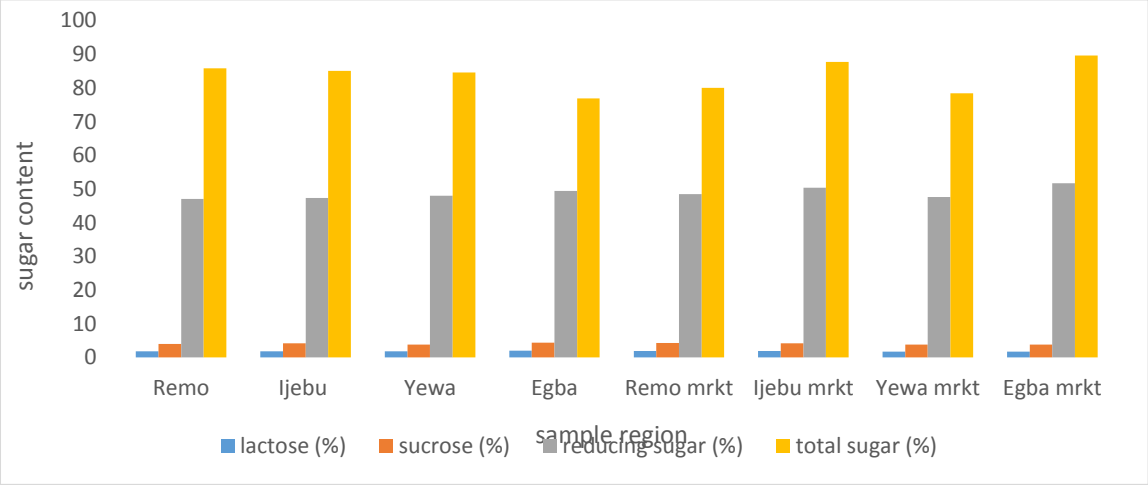

Figure 2: Sugar content of honey samples from beekeepers

The lactose content of honey obtained from beekeepers in the Egba region had the highest mean value of 1.915 and the lowest mean value of 1.663 from Egba market. The mean value of sucrose in honey obtained from beekeepers in the Egba region was greatest, coming in at 4.313, while the lowest, coming from Yewa market, was 3.725. Honey from Egba market had the highest average reducing sugar value (51.678), while honey from Remo region had the lowest average reducing sugar value (47.069). Honey produced by beekeepers in the Egba region had the lowest mean of 76.873 while honey from the Egba market had the highest mean of 89.650 for total sugar.

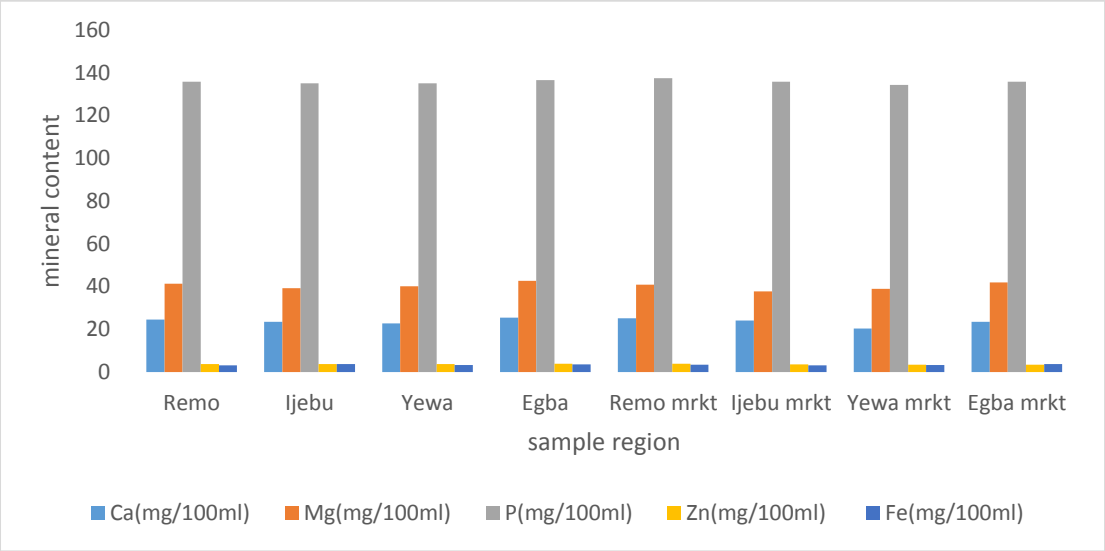

Figure 3: Mineral content of honey samples from beekeepers and from the market.

The greatest mean value of 25.383 was found in the honey samples from beekeepers in the Egba region, and the lowest mean value of 20.353 was found in the Yewa market. Magnesium (Mg) average value ranged from 37.735 in honey from Ijebu market to 42.680 in honey from beekeepers in the Egba region. Phosphorus (p) had the lowest mean value from Yewa market at 134.345 and the highest mean value from Remo market at 137.408. The lowest mean value for zinc (Zn) was reported from the Yewa market at 3.403, and the highest mean value was recorded from the Remo market at 3.820. Ijebu market had the lowest mean for iron (Fe) at 3.095 while Egba market had the highest mean at 3.653.

DISCUSSION

The present study focused on the comprehensive examination of honey samples collected from four distinct regions in Ogun State. Various physicochemical properties were investigated, including color, pH, free acidity, total acidity, electrical conductivity, sugar content, mineral content, moisture, and ash content. The findings demonstrated significant variations in these properties among the different regions. The pH values, which ranged from 6.245 to 6.310 and indicated somewhat acidic conditions, were highest in Ijebu and lowest in Egba. In contrary, earlier studies by Guerzou *et al.* (2021) on samples of Algerian honey revealed that its pH ranged from 3.50 to 4.50 and that it had a very acidic character. Similar to this, Akharaiyi & Lawal (2016) discovered that the average pH value in their study was 3.34, which may have been tampered with. It's important to note that honey naturally contains organic compounds, which help to preserve it against microbiological deterioration and give it a unique flavor. Furthermore, pH has a significant impact on the quality, stability, and life span of honey during the extraction procedure.

Mineral composition and pureness were evaluated using electrical conductivity, a crucial sign of honey purity. Ijebu had the greatest mean electrical conductivity value, and Egba had the lowest.

The observed electrical conductivity values varied from 0.791 to 0.813. In comparison, Guerzou *et al*. (2021) recorded greater electrical conductivity values for their samples collected, varying from 0.83 101 to 6.41 101 mS/cm. Saka *et al*. (2018) discovered smaller value for samples of acacia honey, varying from 0.25 to 0.03 mS/cm, in contrast.

Free acidity levels varied from 21.038 to 25.843, with Egba having the highest mean and Remo having the lowest. In the investigation by Guerzou *et al*. (2021), the variation of free acidity in the samples collected evaluated was greater, ranging from 11.0 to 47.0 meq/kg. The total acidity of honey samples ranged from 33.403-33.657, with the lowest mean of 33.403 from Yewa and the highest mean of 33.657 from Egba. There was significant difference ($p<0.05$) in the total acidity of the samples

The beekeeper's operations and diverse honeycomb management techniques, including reusing used honeycombs, coming into connection with metallic elements, being exposed to extreme heat, as well as the color of honey changing with long retention times, could all result in honey changing color. Undiluted honey's color, though, is influenced by its plant origin (Tesfaye *et al*. 2016). The color of the honey samples ranged from 11.317 to 11.482, with Yewa having the lowest mean and Egba having the highest mean. There is discernible difference between the honey color results ($p<0.05$).

The moisture level of the honey that was being studied ranged from 1.67 to 3.077 percent. The different honey sample harvests were complete considering the low moisture that were found (Tchoumboue *et al*., 2007) The findings are consistent with those that are reported for Algerian (Yaiche and Khali, 2014) and Northern Ethiopian honey types (Gebreegziabher, Gebrehiwot and Etsay, 2013). Azowande *et al*. (2018) attributed the variation in moisture levels to many natural conditions, including weather, the botanical source of honey, honey moisture content, processing techniques, and storage time. In the light of this, moisture content is a complicated function of several factors, including extracting and processes, humidity, and this in turn varies depending on climate, the season, and other factors.

The mean water contents of the samples collected used in Akharaiyi *et al*. (2016) analysis was 16.4%. Healthy honey ought to have a low water content to avoid fermenting by microbial species and enzymatic activities. Since the worldwide standard for acceptable honey is (20 percent) and the findings of this study are within this range, the honey samples were assessed to have low moisture contents that would not support the growth of bacteria for honey sample deterioration.

Honey samples collected from Egba had the lowest mean ash level at 0.330 while samples taken from Ijebu had the highest mean ash content at 0.581. Ash content, a quality indicator for honey, reflects the number of elements the honey contains. Tesfaye *et al*. (2016) study found that all of the regions under investigation's honey had an average ash content that was 0.21 just below legal level and complied with international standards for high-quality honey. There were no appreciable differences in the ash content of the samples collected from any of the regions, which ranged from 0.14 to 0.30 ($P>0.05$).

The lactose content ranged from 1.779% to 1.915%, with Egba having the highest mean and Ijebu having the lowest. The sucrose content varied from 3.755% to 4.313%, with Egba having the highest mean and Yewa having the lowest. The reducing sugar content was highest in Egba samples, while Remo had the lowest mean value. The total sugar content ranged from 76.873% to 85.829%, with Remo having the highest mean and Egba having the lowest.

Additionally, these findings are in accordance with those from Iran (74.0-81.8%), Algeria (69.1-82.1%), Burkina Faso (73.9-85.5%) and Cameroon (77.9-83.1%) reported by Mehryar, Esmaiili, and Hassanzadeh, (2013), Koula, Nacera, and Hayat (2014) as well as Dongock and Tchoumboue (2015). However, earlier studies by Azowande (2018) on floral honey and honeydew revealed low result, varying from 60 to 70 percent of total sugars.

From the honey samples collected from the study areas, the calcium content ranged from 22.705 to 25.383, with Egba having the highest mean and Yewa having the lowest. The magnesium content varied from 39.237 to 42.68, with Ijebu having the lowest mean and Egba having the highest. Phosphorus exhibited slight variations across the regions, while zinc and iron content also varied.

The results show that honey's physicochemical properties and composition from the market are comparable to those obtained from beekeepers, with slight variations observed in certain parameters. The study's findings showed that the average pH of the Egba market was 6.363, whereas the average pH of honey produced by beekeepers in the Egba region was 6.245 (average of 6.304). The findings of Buba *et al*. (2013), in contrast, had an average mean of 4.2, which represents a lower value than the findings of this study. The pH of the honey can be used to predict honey degradation during storage and provide a reliable indicator of the honey's botanical origin (Buba *et al*. 2013). The greatest mean value of electrical conductivity in honey samples from Egba market was 0.854, while the lowest mean value came from the same location at 0.791. No significant difference was observed. The results shown in Figure 1 proximate composition reveal no significant difference ($p>0.05$).

The variations in the contents of lactose and sucrose did not differ significantly. There was a significant difference ($p < 0.05$) between the honey produced by beekeepers in the Egba region with the lowest mean of 76.873 and the honey from the Egba market with the highest mean of 89.650 for total sugar. The honey sample collected from Egba was a crystalized honey which could be the reason for the increase in the sugar content moreover, the crystallization of honey can be attributed to the shelf life of the honey. These findings support the notion that honey's primary ingredients are sugars.

The amount of minerals varied slightly. Minerals like Zn and Cu, as well as Fe and Mn, are naturally occurring components of soil minerals and are widely known as potential air or soil pollutants of anthropogenic origin (Akharaiyi *et al*. 2016). The variations observed in pH, electrical conductivity, acidity, colour, sugar content, and mineral content can be attributed to several factors, including floral sources, environmental conditions, and beekeeping practices.

Consuming honey is linked to a number of nutritional advantages and therapeutic potential as a nutraceutical agent. The varied and essential parts of honey have an impact on its biological activity. Both natural and man-made elements, which differ according to the botanical and geographic origins of the ingredients, have a significant impact on the composition of honey. Despite being minimal components of honey, minerals and heavy metals are essential in identifying the honey's quality. The amounts of chemical components in honey samples from around the world vary, and environmental contamination also has an impact.

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