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RESEARCH ARTICLE

Measurements and Analysis of the Physicochemical Properties of Honey Obtained from Different Sources

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Abstract

Honey is a sweet, viscous food material produced by honeybees using nectar from flowering plants. It is well-known as a natural sweetener and has long been recognized for its benefits in medicine. This study evaluated the physicochemical properties of honey samples from Gboko, Ukan (Ushongo LGA), and Jato Aka (Kwande LGA) in Benue State, Nigeria, to assess quality and suitability for consumption and medicinal purposes. Using standard laboratory procedures, parameters such as density, pH, conductivity, moisture content, viscosity, and total soluble solids (TSS) were analyzed. Results showed that the density of the honey samples ranged between 1.36 g/cm^3 to 1.38 g/cm^3, and the moisture content varied, with unrefined honey from Gboko showing higher moisture (22.88%) than refined samples. Conductivity values varied significantly, with the highest in Jato Aka honey, suggesting higher mineral content. Viscosity analysis revealed that honey from Ukan had the highest viscosity, indicating a thicker consistency, The TSS ranged from 0.30 mg/L to 8.18 mg/L, indicating differences in sugar concentrations, Overall, refined honey from Ukan met more quality standards, making it the most suitable for medicinal use, Meanwhile, honey from Gboko, with its high moisture content, was recommended mainly for dietary consumption, In conclusion, honey quality can vary greatly based on location and processing, affecting its potential health benefits. Further studies are recommended to explore factors impacting these properties, such as floral sources and seasonal changes, to optimize honey's quality for different applications.

Keywords: Honey, Physicochemical Properties, Natural Product, Honeybees, Medicinal Food Products.

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1. Introduction

Honey, a natural sweetener produced by bees from the nectar of flowers, has been cherished for its taste, nutritional value, and therapeutic properties for centuries. Its unique composition and diverse range of bioactive compounds make it not only a popular food product but also a subject of extensive scientific research [1, 2].

The study of honey's physicochemical properties provides valuable insights into its quality, authenticity, and potential health benefits, which are crucial for both consumers and producers. Honey, often referred to as "liquid gold," has been treasured by humans for thousands of years for its sweetness, nutritional value, and medicinal properties. This natural substance is produced by honeybees (Apis mellifera) through the enzymatic transformation of floral nectar. The complexity of honey's composition and its diverse range of bioactive compounds have made it a subject of significant scientific interest, particularly in the fields of food science, nutrition, and medicine [1, 3].

Historically, honey has been used not only as a food but also as a remedy for various ailments. Ancient civilizations, including the Egyptians, Greeks, and Romans, utilized honey for its healing properties, applying it to wounds and using it as a component of traditional medicines. The antibacterial and anti-inflammatory properties of honey have been recognized for centuries, long before the advent of modern antibiotics [3].

It is a supersaturated sugar solution, predominantly composed of fructose (about 38%) and glucose (about 31%), with minor amounts of other sugars such as sucrose, maltose, and isomaltose. Besides sugars, honey contains water (typically 17-20%), organic acids (such as gluconic acid), amino acids, vitamins, minerals, enzymes, phenolic compounds, and volatile compounds. The precise composition of honey varies significantly depending on the floral source, geographical origin, and environmental conditions [4].

Physicochemical properties refer to the physical and chemical characteristics of a substance. In the case of honey, these properties include moisture content, pH level, sugar composition, electrical conductivity, color, viscosity, acidity, hydroxymethylfurfural (HMF) content, total phenolic content. Each of these parameters plays a significant role in determining honey's quality, stability, and therapeutic efficacy [1, 2].

The primary problem is that consumers and healthcare providers face difficulties in identifying genuine, high-quality honey amidst widespread adulteration. This uncertainty necessitates a comprehensive understanding of the physicochemical properties of honey to establish reliable criteria for quality assessment. Determining these properties is essential to distinguish pure honey from adulterated products and to identify the types of honey that offer the best therapeutic benefits. The prevalence of honey adulteration, involving the addition of substances like sugar syrups, compromises honey's quality and therapeutic efficacy. Reliable criteria based on physicochemical properties—such as moisture content, pH level, sugar composition, electrical conductivity, and antibacterial activity—are needed to differentiate pure honey from adulterated products. Given the variability in honey due to floral source and geographical origin, this study aims to measure and analyze these properties to determine which types of honey are best suited for medical use. Addressing this issue will enhance the therapeutic application of honey and combat adulteration [1, 2]. The aim of the study is to measure and analyze the physicochemical properties of honey gotten from different sources.

2. Materials and Methods

2.1 Sample Collection

The study employs an experimental research design, where different honey samples from three different regions in Benue State; Ukan in Ushongo LGA, Jato Aka in Kwande LGA and Gboko Market in Gboko LGA, where the samples obtained in Ukan and Jato Aka are pure/unadulterated honey, and the sample obtained in Gboko is an adulterated honey sample. There are collected and subjected to a series of laboratory tests. The research is conducted in a controlled environment to ensure accuracy and reliability in measuring the physicochemical properties.

2.2 Materials and Equipment

The following materials and equipment were used in this study:

Figure 1. *Hydrometer, for measuring the density of honey samples*

Figure 2. *pH meter, to determine the acidity or alkalinity of the honey.*

Figure 3. *Conductivity meter: For measuring the electrical conductivity of the honey samples*

Figure 4. *Viscometer, to measure viscosity at ambient and elevated temperatures.*

Figure 5. *Refractometer, for measuring moisture content and total soluble solids.*

2.3 Procedures

2.3.1 Density Measurement

The density of each honey sample was measured using a hydrometer. The procedure involved filling the hydrometer with the honey sample, weighing it, and then calculating the density by dividing the mass by the volume of the honey.

2.3 2 pH Measurement

A pH meter was calibrated using standard buffer solutions (pH 4 and pH 7) before use. Approximately 10 grams of honey was dissolved in 75 mL of distilled water, and the pH was measured directly from the solution.

2.3.3 Electrical Conductivity

To measure the electrical conductivity, 20 grams of honey was dissolved in 100 mL of deionized water, and the conductivity was measured using a conductivity meter. This measurement helps in determining the mineral content and purity of the honey.

2.3.4 Viscosity Measurement

Viscosity was measured using a viscometer. Honey samples were first tested at ambient temperature (25°C) and then heated to 40°C to observe changes in viscosity. This analysis is critical in understanding the flow behavior of honey under different conditions.

2.3.5 Moisture Content Determination

A refractometer was used to determine the moisture content of honey. A small drop of honey was placed on the refractometer's glass surface, and the reading was taken directly. This parameter is essential for assessing the honey's shelf life and susceptibility to fermentation.

2.3.6 Total Soluble Solids

A refractometer was used to determine the total soluble solids of honey. drops of honey are placed on the prism to measure TSS in °Brix, a direct sugar concentration reading. the sugar concentration in honey, indicating its sweetness and quality.

3. Results

Table 1. *Physicochemical Properties of Honey Obtained from Three Different Sources.*

Sample ID / Parameters	Unrefined Honey in Gboko (Grocery Hotspot Honey) (UHG)	Refined/natural honey in Ukan, Ushongo LGA (RHU)	Refined/natural honey in Jato Aka, Kwande LGA (RHJ)	F ratio	P value
Density (g/cm^3)	1.36±0.00	1.38±0.00	1.37±0.00	---------	---------
pH	5.64± 0.14	5.16± 0.35	4.94± 0.12	10.89	0.002*
Conductivity(µ/g)	0.67±0.01	3.12±0.01	6.83±0.60	1031.74	<0.001*
Moisture content (%/g)	22.88±0.00	16.37±0.00	19.69±0.00	----------	---------
Viscosity (mPa.s)	509.8±207.58	513.3±213.95	513.03±25.45	0.21	0.815
Total Soluble Solids (TSS) (mg/L)	0.30±0.02	1.58±0.01	8.18±0.30	1,867.60	<0.0001*

4. Discussion

The density of the honey samples obtained from UHG was 1.36 g/cm³ while RHG had a density of 1.38 g/cm³ and 1.37 g/cm³ for RHJ. This give a range of 1.36 g/cm³ to 1.38 g/cm³. Honey has a density of 1.36 to 1.45 g/cm³, as per standard rules and popular knowledge. This range may vary slightly depending on factors such as moisture content and temperature. For example, honey with a lower moisture content is denser [5]. All samples fall within the acceptable range, suggesting they are of good quality.

The pH levels of the honey samples obtained from UHG was 5.64 and 5.16 for RHU while RHJ had a pH of 4.94 which gave a range of pH from 4.94 to 5.64. While the World Health Organization (WHO) does not specify a pH range for honey, it is widely understood that the usual pH range is 3.2–4.5 [6]. This acidic pH range is a natural property of honey, caused mostly by the presence of different acids, and adds to its antibacterial effects. This indicates that while the samples are generally safe for consumption, the honey sample obtained from Jato Aka is best for human consumption and medicinal use due to its close pH value to the recommended honey pH for human consumption. The slight acidity is crucial for honey's preservative qualities and its antibacterial properties.

The electrical conductivity levels of the honey samples obtained from UHG was 0.67(µ/g), while RHU had an electrical conductivity of 3.12(µ/g), and 6.83(µ/g) for RHJ which gives a range from 0.68 to 6.83 µS/cm. While WHO does not set strict standards for EC, high conductivity values can indicate a higher mineral content and floral source diversity. The variation suggests that local honeys have distinct floral origins [7].

The moisture content levels of the honey samples obtained from UHG was 22.88(%/g) while RHU had a moisture content of 16.37(%/g), and 19.69(%/g) for RHJ. Moisture content was highest in the Gboko sample at 22.88%, while Ukan and Jato Aka samples had lower moisture contents of 16.37% and 19.69%, respectively. The WHO standard for moisture content in honey is less than 20%[8]. The Gboko honey exceeded this limit, indicating potential issues with fermentation.

The viscosity levels of the honey samples obtained from UHG was 509.80(mPa.s), while RHU had a viscosity of 513.30(mPa.s), and 513.07(mPa.s) for RHJ. This result showed that all honey samples demonstrated high viscosity, typical of honey. While no specific WHO standards exist for viscosity, honey sample from RHG 513.30 has higher viscosity [5]. Viscosity often correlates with higher sugar concentrations and lower moisture content.

The total soluble solids levels of the honey samples obtained from UHG was 0.30 (mg/L), while RHU had a TSS of 1.58(mg/L), and 8.18(mg/L) RHJ. TSS readings varied significantly among the samples, with the highest being in Jato Aka honey at 8.18 mg/L, while Gboko honey showed much lower TSS levels at 0.30 mg/L which is best for human consumption because they indicate lower risk of contamination. TSS is a crucial indicator of honey's sweetness and quality, with WHO standards indicating an ideal range that supports flavor profiles and sugar content [9-11].

The results indicate significant differences across the various quality parameters, shedding light on the impacts of geographic and processing influences on honey composition.

The density values obtained in the various honey samples show that values recorded were within the expected range for honey, varying from low at 1.36 g/cm³ to high at1.38 g/cm³. This consistency suggests that the samples possess comparable levels of sugar concentration, which is a hallmark of good-quality honey. The pH levels ranged from lower at 4.94 to highest at 5.64. The lower pH values of the refined honeys indicate better preservation techniques, which are critical for enhancing shelf life and maintaining flavor stability. All samples fell within the generally acceptable pH range, which suggests good quality honey.

The Conductivity measurements revealed a significant disparity between the samples, particularly with refined honey displaying higher values (6.83 μS/g). This suggests a greater presence of minerals and soluble substances in the refined honeys, which is often associated with better nutritional quality. The moisture content ranged from lower at 16.37% to highest at 22.88%. Higher moisture content in unrefined honey may indicate less rigorous processing and could lead to fermentation if not managed correctly. All samples were within the acceptable limits; however, lower moisture content is preferable to extend the honey's shelf life.

The Viscosity measurements demonstrated the flow characteristics of honey. Consistent viscosity across different rotational speeds indicates that the honey maintains desirable thickness and spread ability, essential for both culinary and medicinal applications. The TSS values varied significantly, with unrefined honey registering 0.30 mg/L and refined honey from Jato Aka measuring 8.18 mg/L. The higher TSS values correlate with a sweeter taste and better flavor profile, critical for consumer acceptance.

Statistical analysis of the results confirmed the reliability and consistency of the measurements, with low standard deviations observed for most parameters, indicating stable readings across the three samples. The physicochemical properties of honey samples from Benue State generally align with WHO standards, with minor deviations noted in pH and moisture content. The differences observed in the properties of the honey reflect the diversity of the floral sources and the environmental conditions in which the bees operated. This implies that honey gotten from Benue state are of good quality and can be medicinal.

5. Conclusion

In conclusion, this research successfully evaluated the quality of honey samples from different regions of Benue State, revealing critical insights into the influence of source and processing methods on honey composition. The study highlighted the importance of maintaining high quality in honey production, which directly impacts consumer safety and health. The variation in parameters such as pH, moisture content, and TSS underscores the need for continuous monitoring and improvement in production practices. By adhering to quality standards, producers can enhance the reputation of Nigerian honey, ensuring that it meets both local and international consumer demands.

Ultimately, this study advocates for a collaborative approach involving producers, consumers, and regulatory authorities to promote the quality and safety of honey, thereby fostering a thriving honey industry that benefits all stakeholders involved.

Author Contributions

A.M.S.: Investigation, Resources, Supervision, Funding acquisition, Writing—review & editing. A.M.S.: Methodology, Data curation, Visualization, Formal analysis, Writing—origina, draft. C.V.O.: Writing—review & editing, Sample collection. A.M.S.: Sample collection. A.M.S.: Supervision. A.M.S., T.S.T., N.J.T., A.P.A., O.M.C., U.N.O., N.K.O., R.O.N., F.O.I., N.U.M., D.K.N., A.M.N., B.O.N., C.H.C., W.E.U., I.O.M., C.C.O, O.P.C, I.K.U. Resources. A.M.S.: Funding acquisition, Writing—review & editing. The published version of the manuscript has been read and approved by all authors.

Availability of Data and Materials

The corresponding author is accessible upon request to provide the data supporting the findings of this study.

Consent for Publication

Permission to publish the work is granted by the authors to the publisher.

Conflicts of Interest

The authors of this manuscript declare that they have no conflicts of interest.

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