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Comparative Study on the Compositional Analysis of Honeys Produced in South-South Region, Nigeria

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Abstract
This study investigate the compositional analysis of honey samples obtained from six states (Edo, Delta, Bayelsa, Rivers, Cross River and Akwa Ibom) in south-south region, Nigeria. The compositional parameters of the honey that were examined includes; moisture content, ash content, pH, refractive index, viscosity, potassium, magnesium, calcium, iron and glucose. The range of results for the six states are as follows; Moisture content (12.43% - 28.33%); Ash content (0.093– 0.86)g $100g^{-1}$; pH value (3.1 – 4.6); Refractive index @ 20^{o}C (1.4663 – 1.5064); Viscosity @ 20^{o}C (2.372 – 3.814) cP; Glucose (30.14 - 43.12%); Potassium (4.78 – 8.06) ppm; Magnesium (0.97 – 1.98) ppm; Calcium (0.43 – 0.51) ppm and Iron (2.49 – 7.16) ppm. The mean and standard deviation of the parameters for the six states are as follows: Moisture content (19.84 ± 5.79); Ash content (0.57 ± 0.31); pH value (3.91 ±0.63); Refractive index @ 20^{o}C (1.49 ±0.015); Viscosity @ 20^{o}C (3.142 ± 0.5254); Glucose (39.06 ± 5.00); Potassium (5.84 ± 1.16); Magnesium (1.43 ± 0.41); Calcium (0.47 ± 0.027) and Iron (5.76 ± 1.79). There is a significant difference in the properties of the honey with respect to locality at $p < 0.05$.The results of analysis shows that the studied parameters were within recommended limits with the exception of moisture and pH which recorded values beyond the maximum recommended limits for some of the studied samples.
Keywords: Analysis, Honey, mineral, carbohydrate and mean standard deviation
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INTRODUCTION

Honey is the natural sweet substance produced by honeybees. Honeybees depend wholly on plants for their food and both climate and soil determine what plants are able to grow and flower within the foraging range of bees from the colonies in a region. Honeybees collect nectar or honeydew and transform it by combining it with specific substances of their own, deposit, hydrate, store and leave in honeycombs to ripen and mature (Downey et al., 2005). Bees use a variety of plants to create honey, consequently compositional differences that can influence the value of a specific honey for medicinal or health promoting purposes arise (Flodhazi, 2004).

In Nigeria the demand for honey is ever increasing because of the nutritional and medicinal benefits. This is supported by the huge botanical endowment and the natural biodiversity, which makes the production very lucrative. However, a report of the Physico-chemical and sensory quality of available honey varies for different location. This is compounded by the preponderance of adulterated honeys, whose qualities are difficult to ascertain.

As food stuff used for healing purposes, honey must be free of objectionable contents. It should contain only small amounts of pollutants such as heavy metals (Przybylowski and Wilczynska, 2001). Heavy metal content is variable in honey and is a sign of environmental pollution.. Determination of heavy and transitional metals in honey is of interest for quality control when considering it as food.

High levels of metals are undesirable because of their known or supposed toxicity (Buldini *et al*., 2001). Each honey is unique on the basis of the number and combinations of the various components that give it a specific individualistic note. When honey is dried and burned, a small residue of ash invariably remains, which is the mineral content. Minerals affect honey colour, very light coloured honeys often contain little mineral matter and dark honeys may well contain much. Honey contains organic acids and mineral salts compounds which chemically are called ‘’ionizable’’ that is when in solution, they have the property to conduct electric current. Freshly extracted honey is a viscous liquid. Its viscosity depends on a large variety of substances and therefore varies with its composition and particularly with water content. Gathering viscosity data on a material gives manufacturers the ability to predict how the material will behave in the real world. Viscosity measurements are used in the food industry to maximize production efficiency and cost effectiveness. The strongly hygroscopic character of honey is important both in processing and for final use. For the design of honey processing plants, its thermal properties have to be taken into account .This paper therefore determine the compositional analysis of potential honeys from six (6) different states within the south-south region of Nigeria.

MATERIALS AND METHODS

Honey Samples Collection and Preparation

Honey samples were obtained from six (6) states in the south-south geographical region of Nigeria. Honey samples were collected from Edo State (Benin); Delta State (Effurun); Rivers State (Port Harcourt); Bayelsa State (Yenegoa); Akwa-Ibom State (Eket) and Cross-river State (Ogoja).

Fig. 1: South-south Map of Nigeria

Processed honey samples were collected and transported to the laboratory in labeled sealed containers. At the laboratory, the samples were homogenized by stirring thoroughly at least for three minutes with a glass rod (IHC, 2002).

Determination of Physico-Chemical Parameters

Moisture content, viscosity, pH, refractive index and ash content were determined using the method of International honey Commission (IHC) (2002).

Determination of Mineral Content

5 ml of 0.1 M HCl was added to each of the ashed samples and the mixture stirred on a hot plate to almost complete dryness. 10ml of HCl (0.1M) was added to the almost dry mixture and the solution brought up to 50ml with distilled water. For calcium and magnesium determination 1.5ml of Lanthanum (0.1% as chloride) was added in order to suppress other elements. Mineral content (mg/100g) for each sample was then determined using an Atomic Absorption Spectrophotometer (AOAC, 1990; IHC, 2002; Downey *et al.,* 2005).

Determination of Glucose by Benedict's Method

Two grams of anhydrous sodium trioxo-carbonate VI (Na_2CO_3), an anti bump was added to Benedict‟s reagent and boiled in a beaker. The honey sample in the burette was run into the beaker until the blue colour disappeared. The quantity at which the reagent colour became neutralized by the sample was noted and the glucose content calculated. Given that 100ml of glucose solution contains 0.5g glucose Then Z (quantity of honey sample used) contains Xg of glucose Substitute the value; this gives the amount of glucose in the 0.5% honey sample

Statistical Analysis

Analysis of Variance (ANOVA) was used to the level of significance. The significance was calculated for $P<0.05$

RESULTS AND DISCUSION

Table 1: Physico-Chemical Parameters of Honey

State	Moisture (%)	Ash (g $100g^{-1}$)	pH	Refractive Index @ 20^OC	Viscosity (cP) @ 20^OC
Edo (Benin)	17.01	0.093	4.25	1.4990	3.399
Delta (Warri)	12.43	0.86	3.9	1.5064	3.814
Bayelsa (Yenegoa)	25.00	0.81	3.2	1.4740	2.674
Rivers (Port-Harcourt)	28.33	0.81	3.1	1.4663	2.372
Cross-River (Ogoja)	17.720	0.319	4.40	1.4880	3.334
Akwa-Ibom (Eket)	18.540	0.518	4.60	1.4880	3.260
Mean	19.84	0.57	3.91	1.49	3.142
Standard Deviation	5.79	0.31	0.63	0.015	0.5254
International Standard	< 21	0 – 1.0	3.2-4.5	-	-

Table 2: Mineral Composition and Carbohydrate content of Honey Samples

Minerals Composition (ppm) and Carbohydrate Content (%)					
State	**Potassium**	**Magnesium**	**Calcium**	**Iron**	**Glucose (%)**
Edo (Benin)	4.78	1.74	0.46	5.49	43.12
Delta (Warri)	5.61	1.98	0.48	7.16	43.01
Bayelsa (Yenegoa)	6.02	1.21	0.43	5.39	39.22
Rivers (Port-Harcourt)	5.43	1.03	0.48	2.49	30.14
Cross-River (Ogoja)	5.16	0.97	0.48	6.95	36.90
Akwa-Ibom (Eket)	8.06	1.62	0.51	7.09	41.96
Mean	5.84	1.43	0.47	5.76	39.06
Standard Deviation	1.16	0.41	0.027	1.79	5.00
International Standard	-	-	-	-	No fixed limit

State	Moisture	Ash	pH	RI	Viscosity
Edo	17.01	0.093	4.25	1.499	3.399
Delta	12.43	0.86	3.9	1.5064	3.814
Bayelsa	25	0.81	3.2	1.474	2.674
Rivers	28.33	0.81	3.1	1.4663	2.372
Cross river	17.2	0.319	4.4	1.488	3.334
Akwa ibom	18.54	0.518	4.6	1.488	3.26

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	6	118.51	19.75167	34.0471
Column 2	6	3.41	0.568333	0.098503
Column 3	6	23.45	3.908333	0.398417
Column 4	6	8.9217	1.48695	0.000224
Column 5	6	18.853	3.142167	0.276069

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1507.561	4	376.8902	54.11931	5.95E-12	2.75871
Within Groups	174.1015	25	6.964062			
Total	1681.662	29				

State	K	Mg	Ca	Fe	Glucose
Edo	4.78	1.74	0.46	5.49	43.12
Delta	5.61	1.98	0.48	7.16	43.01
Bayelsa	6.02	1.21	0.43	5.39	39.22
Rivers	5.43	1.03	0.48	2.49	30.14
Cross river	5.16	0.97	0.48	6.95	36.9
Akwa ibom	8.06	1.62	0.51	7.09	41.96

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	6	35.06	5.843333	1.353547
Column 2	6	8.55	1.425	0.17091
Column 3	6	2.84	0.473333	0.000707
Column 4	6	34.57	5.761667	3.209537
Column 5	6	234.35	39.05833	24.95074

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	6255.622	4	1563.905	263.4129	4.83E-20	2.75871
Within Groups	148.4272	25	5.937087			
Total	6404.049	29				

RESULTS AND DISCUSSION

Honey samples obtained from south-south vegetation zone of Nigeria are summarized in Tables 1 – 2 above. The moisture content of the honey samples in the south-south region was within the international standard except for honey samples from Bayelsa and Rivers state which are slightly elevated. This agrees with Oddo and Piro (2004). This means that the honey samples are capable of remaining stable and can resist spoilage by yeast fermentation upon storage. There was a significant deference in the moisture content of the honey samples from the different States. Variations in the moisture content of honey have been attributed to the composition and floral origin of honey . Moisture contents of honey samples from different parts of the south-south vegetation zone ranged from 12.43 – 28.33 %. The moisture content of honey samples in this study was in agreement with that of Adebiyi *et al.* (2004) (16.38-30.82%) for some Nigerian honeys. Given that honey is hygroscopic in nature and takes up moisture from the environment , during processing, alteration`s and moderations that affect honey quality through exposure to the environment had been excluded.

This study recorded an ash content of the range (0.093 – 0.86) (g $100g^{-1}$) and standard deviation of ±0.31. Honey sample from Delta States had the higher ash content; the reason might be because of the large number of pollen spectra and grain. The range obtained in this study is similar to the range (0.19 – 0.36%) obtained by Omafuvbe and Akanbi (2009). There were significant differences in the values of ash content of the honey samples. The highest (0.86g 100 g^{-1}) ash content was obtained from Delta State honey sample, while the lowest (0.093g 100 g^{-1}) was obtained from Edo State honey sample . Ash represents the direct measure of inorganic residues after honey carbonization.

All honey are acidic with pH value lying between 3.5 and 5.5. The range (4.6 – 3.1). The reason might be that the honey samples are from different geographic regions, also, the major botanical origin of the honey was different.

The highest refractive index was recorded for the sample from Delta state with a value of 1.5064. Refractive index is the measure of ratio of velocity of light in free space to that of medium (honey). Similar results were reported by other workers in Venezuelan honeys where the refractive index was 1.50. There was a significant difference of refractive index between Delta, Bayelsa and Rivers State with values of 1.5064, 1.4740 and 1.4663 respectively @ 20^{o}C.

Viscosity is an important technical parameter during honey processing because it reduces honey flow drying extraction, pumping, settling, ,mixing and bottling. The viscosity of each of the honey samples from various locations revealed that samples from Delta State had the highest viscosity of 3.814 (cP) and samples from Rivers State had the least value 2.372 (cP). Viscosity of the honey samples is a measure of the quality of the honey samples. Pure honey has high viscosity. A low viscosity indicates a high moisture content or dilution. The viscosity values of the Nigerian honey samples therefore shows that all the samples were still in their natural state of production and had not undergone any form of adulteration in terms of dilution with other products.

The glucose value obtained from the south-south vegetation zone of Nigeria showed a range of 30.14 – 43.12 % indicating that after fructose, glucose sugar is the main constituent of honey. of sugars in honey are the simple sugars, fructose and glucose, which represent 85 – 95 % of total sugar found in honey.

The mineral elements detected in honey samples collected from the south-south vegetation zone showed that minerals are in trace quantities. Potassium, magnesium, calcium and iron were the mineral elements detected in trace quantities, except K and Fe, which were found to occur in significant quantities. K regulates acid-alkaline balance in the blood and is involved in the transmission of nerve impulses, activates the functions of several enzymes and the muscular function of the heart. It also has a positive effect on the function of skin and kidneys. It is the most abundant trace elements followed by Fe and Mg found in the honey samples produced in the mangrove agro-ecological zone of Nigeria.

There is a significant difference in the properties of the honey with respect to locality at $p < 0.05$. This is shown in the ANOVA summary, with $F > F_{crit}$. This could be attributed to handling and/or techniques involved in the harvesting of the honey from the comb.

CONCLUSION

The study of compositional analysis of honey samples produced in the south-south region of Nigeria showed that the honey in this region met the required international market standards. There was significant difference in moisture content, pH, ash content, viscosity and index of the honey samples from different states of the vegetation region under study.

There was also significant difference between the average mineral compositions of the honey samples amongst the six (6) different states under study. The study also showed that honey could maintain its stability without significant physicochemical change for at least two years if properly harvested, extracted and preserved hygienically at room temperature without undue interference during processing and storage.

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