Floral identification and the physico-chemical parameter of honey from Yelwa, Bauchi and Zaria, Kaduna State, Nigeria.

J.A. Ibegbulem , D.N. Iortsuun, E. Kogi, P. I. Bolorunduro, A. A. Yakubu, J. O. Omeke

Abstract— Floral identification of honey from Yelwa, Bauchi State and Zaria, Kaduna State, Nigeria were investigated and their physico-chemical parameters reported. Microscopic examination revealed that the honey from Yelwa, had the plant family Anacardiaceae and Zaria Rubiaceae as major pollen sources. The major sugar in both honey samples was fructose (38.89, 39.14%) followed closely by glucose (32.46, 31.28%) which exceeded the standard limit of 38.5 and 31% for fructose and glucose. The moisture, ash and sucrose contents for both samples were within standard limits. Zaria and Yelwa honey samples showed 12.17, 10.89 ppm; 1.92, 3.07 ppm for calcium and chromium content. This quantity is lower than the expected quantity to be consumed per day.

Index Terms— Honey, physico-chemical content, pollen, Yelwa, Zaria, Nigeria.

1 INTRODUCTION

Honey is 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 [1], [2]. Bees use a variety of plants to create honey, consequently compositional differences that can influence the value of a specific honey [3]. Melissopalynology also known as Melitopalynology is the branch of palynology which deals with the study of the botanical and geographical distribution of honey by subjecting honey sediments to microscopic analysis. It includes the study of pollen in the honey as well as the source of the pollen [4]. The concentration of the sugar in honey is frequently characteristic of the plant species but varies with environmental conditions [3]. Fructose (levulose) is the dominant sugar with about 38.5% in honey, glucose (dextrose) 31%, with at least twenty two other more complex sugars such as sucrose 1.5%, maltose, isomaltose, erlose, kijibiose, melezitose and all others with 4% per 100g [5], [6]. The mineral content of honey usually varies and is recognized as an environmental indicator at least since 1984. Honey contains all of the trace minerals that are essential to health; iron, copper, manganese, silicon, chlorine, calcium, potassium, sodium, phosphorus, aluminium and magnesium. The mineral content of honey is closely related to the floral type, mineral resources in the soil and environmental factors. Per 100g of honey 6mg calcium, 4mg phosphorus, 4mg sodium, 52mg potassium, 0.42mg iron, 0.22mg zinc, 2mg magnesium, 0.80mg selenium, 0.04mg copper and 0.08mg manganese is found [5], [6], [7]. Cadmium, lead and mercury are major contaminants of food supply and may be considered the most important problem to our environment while others like iron, zinc and copper are essential for biochemical

reactions in the body [8]. The limits prescribed by the European Directive concerning honey are as follows; water (g/100g) < 20, exception Calluna honey < 23, F+G (g/100g) >60 exception Honeydew >45, sucrose (g/100g) <5 exception *Eucalyptus* <10, Citrus <10 and Borago <15, electrical conductivity (mS/cm) < 0.8 and honeydew >0.8, exceptions *Eucalyptus* 0.4 -0.6, Tilia 0.3 -0.9. Free acidity <50, hydroxymethylfurfural (HMF) <40 exceptions; tropical honeys <80, Diastase (Schade units) >8 [9]. The result of the analysis of pure honey from a geographical location (Kaduna State) in Nigeria showed that it contains; levulose (41.0%), dextrose (35.0%), sucrose (1.9%), dextrin (1.5%), minerals (0.2%), and water (17.0%) [10]. The objective of this work was to evaluate the physico-chemical parameters of the honey sample from Yelwa Bauchi and Zaria Kaduna State Nigeria.

2 METHODOLOGIES

Sample collection

Honey samples were obtained from two locations from the northern guinea savanna in Nigeria; Zaria, Kaduna and Yelwa, Bauchi State. Choice of location was based on beekeepers acceptance to allow me partake in the harvesting of honey from the hive.

Pollen characterization

The procedure recommended by [11] with modification was used. The modification included the option of acetolysis according to [12] and mounted on slides with glycerine jelly and viewed under the microscope. The pollen grains on slides for each sample were counted to determine the relative frequency of the different pollen types in the honey samples using an Olympus CH 30 light microscope at x40 objective lens. Identification of the pollen in the honey samples was done at the Palynology Laboratory, Department of Archaeology and Anthropology, University of Ibadan.

Physico-chemical parameters

Moisture content was determined using the method of [13], the ash content was determined using [13] and [14], mineral content [13], [14], pH and acidity [13], [14] and carbohydrate content [14].

3 RESULTS AND DISCUSSION

Floral identification

A total of forty one (40) different pollen types were identified in the honey samples from the northern guinea savanna (Table 1), 23 were identified to species level, 9 identified to generic level, 9 identified to family level and the last category, 5 different types, totalling six, could not be identified. Some identified pollen micrographs are shown on Plate 1.

The honey sample from Zaria contained numerous pollen grain varieties but most were minor pollens (<3%) (Table1). The sample from Yelwa was not rich in the pollen spectra but showed a high skewness towards *Lannea* sp. and an appreciable quantity of *Parkia biglobosa* pollen. Both honey samples from the northern guinea savanna (Table 1) were found to have a dominant plant. The Zaria honey contained *Pavetta* species from the family rubiaceae as the dominant pollen (>45%), *Combretum* sp. as a secondary pollen, *Berlinia* species as an important minor pollen and the rest as minor pollen while the honey from Yelwa contained *Lannea* sp. as the dominant pollen, *Combretum* sp. and *Parkia biglobosa* as an important minor pollen and the rest as minor pollen (Table 1). The sample from Yelwa was poor in the number of pollen counted while Zaria sample was normal (Table 1).

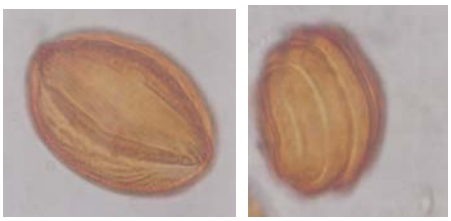

Plate 1: Some identified pollen micrograph

(A) (B)

Legend: (A) *Berlinia* cf. *Grandiflora* (B) *Thunbergia alata*. All grains are of x1000 magnification. Some identified micrographs.

Physico-chemical characteristics

The physico-chemical properties of honey samples from Yelwa and Zaria are shown in figure 1 and 2. The moisture content of the honey samples were 14.13% and 14.61%, pH 4.46 and 4.48, ash 0.13% and 0.51%.

Table 1: Pollen Analysis of Honey from the Northern Guinea Savanna zone

Plant taxa	Family	Frequency occurrence in honey from Zaria	Yelwa
Acacia dudgeoni	Fabaceae	MP	MP
Afzelia Africana	Fabaceae	MP	AB
Alchornea sp.	Euphorbiaceae	MP	AB
NIS	Anacardiaceae	MP	AB
Annonidium mannii	Annonaceae	MP	AB
Asteraceae	Asteraceae	MP	AB
Azadiractha indica	Meliaceae	MP	AB
Berlinia sp.	Fabaceae	IMP	AB
Bombax buonopozense	Bombaceae	MP	AB
Vitellaria paradoxa	Sapotaceae	MP	AB
NIS	Fabaceae	MP	AB
Celtis cf. *Brownie*	Ulmaceae	MP	AB
Combretum sp.	Combretaceae	SP	IMP
Daniellia oliverii	Fabaceae	MP	MP
Delonix regia	Fabaceae	MP	AB
Dichrostachys cinerea	Fabaceae	MP	MP
Diospyros sp.	Ebenaceae	AB	MP
Elaeis guineensis	Arecaceae	MP	AB
NIS	Ericaceae	MP	AB

Table 1 Continues

Plant taxa	Family	Frequency occurrence in honey from Zaria	Yelwa
Flabellaria paniculata	Malpighiaceae	MP	AB
Gardenia ternifolia	Rubiaceae	MP	AB
Gossypium sp.	Malvaceae	MP	AB
Hildergardia barteri	Sterculiaceae	MP	AB
Hymenocardia acida	Hymenocardiaceae	MP	AB
Hypheaene sp.	Arecaceae	MP	AB
Lannea sp.	Anacardiaceae	AB	**D**
NIS	Meliaceae	MP	AB
Mimusops	Sapotaceae	MP	MP
NIS	Moraceae	MP	AB

NIS	Myrtaceae	MP	AB
Oldenlandia corymbosa	Rubiaceae	MP	AB
Parinari kerstingii	Rosaceae	MP	AB
Parkia biglobosa	Fabaceae	MP	IMP
Paulinnia pinnata	Sapindaceae	MP	AB
Pavetta sp.	Rubiaceae	**D**	AB
Prunus type	Rosaceae	MP	AB
Thunbergia alata	Acanthaceae	MP	AB

Table 1

Continues

Plant taxa	**Family**	**Frequency occurrence in honey from**	
		Zaria	**Yelwa**
Vernonia amygdalina	Asteraceae	MP	MP
Zea mays	Poaceae	MP	AB
Unidentified (5)		MP	AB
TOTAL		**82,768**	**13,594**

Cf: looks like, predominant pollen D>45%, secondary pollen SP 16-45%, important minor pollen IMP 3-15%, minor pollen MP <3% and AB- absent, NIS Not Identified to Species level.

The honey samples recorded a free acidity (FA) value of 23.76 and 83.60Meq/Kg, lactonic acidity (LA) 12.40 and 19.76Meq/Kg, total acidity (TA) 36.24 and 103.26Meq/Kg for Yelwa and Zaria honey samples respectively. The moisture content recorded in this study (14.13 and 14.61%) was generally low. There was no significant difference in the physico- chemical properties of both honey samples p>0.05 and there was a very positive correlation coefficient value of 0.78.

The glucose, fructose and protein content of both honey samples (Figure 1 and 2) were above the accepted limit of 31.00%, 38.5% and 0.20%, but both samples sucrose content was within the standard limit of <5%. Cadmium content of both honey samples was very negligible Table 2. There was no significant difference in the mineral composition of both honey samples p>0.05, though there was a very high positive correlation coefficient value of 0.99.

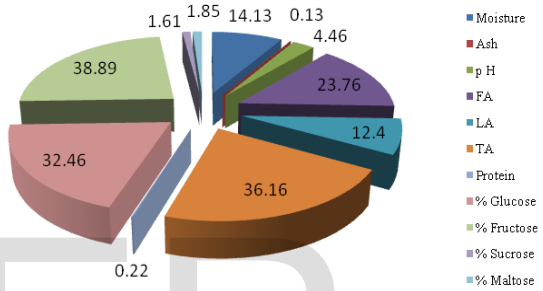

Figure 1: Physico-chemical properties of honey sample from Yelwa

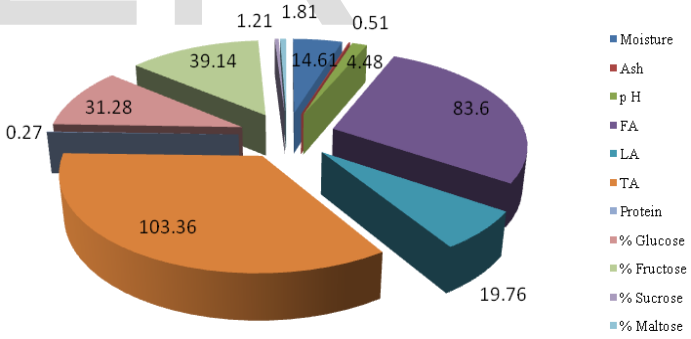

Figure 2: Physico-chemical properties of honey sample from Zaria

The dominant pollen types in this study were: *Lannea* sp. and *Pavetta* sp., this is an indication that these plants are very useful bee forage. The study revealed that the pollen spectra (Table 1) of the honey samples were majorly from Anacardiaceae, Combretaceae, Fabaceae and Rubiaceae. *Lannea* sp. is a plant that has been observed in honey samples over time and is still a dominant plant for bees'

food as at the time of this study. The pollen grains observed from this study are consistent with that observed by Ige and Modupe [15], Agwu and Okeke [16] who studied honey samples from similar regions.

Table 2: Mineral composition of honey samples

Site/Element (ppm)	Ca	Pb	Cr	Ni	Cd	Mg	Fe	Cu
Yelwa	10.89	0.18	3.07	0.15	0.01	0.38	0.30	0.06
Zaria	12.47	0.16	1.92	0.20	0.01	0.39	0.58	0.08

The moisture content recorded in this study (14.13 and 14.61%) was generally low; this might be accounted for by the direct assessment of the ripe honey from the hives, therefore no adulteration during processing, also the major origin of the nectar source, the maturity of the honey sample and/or the weather condition at the collection site (Northern guinea savanna) might have affected the low water content observed. The range gotten agrees with the work of Omafuvbe and Akanbi [17] (11.47-19.62%) but was much lower than that recorded by Adebiyi *et al.,* [18] 16.38-30.82% for honey from south western and eastern Nigeria and Odeyemi *et al.,* [19] (16.81-21.52%) for Ado- Ekiti Nigerian honey. The pH range 4.46-4.48 observed in this study was within the limit 3.5-5.5 [20] of the optimum range for honey pH. The reason for the observed pH might be as a result of the plant source(s) from which the bees produced the honey. Also, the soil type might have affected the pH. A similar value of 4.31-6.02 was recorded by Adebiyi *et al.,* [18] for some south west and eastern Nigerian honeys. The value of the ash content of the honey sample from Yelwa was much lower than that from Zaria; this might be accounted for by the presence of a higher total number of pollen grains recorded by the Zaria honey sample. The reason for the low FA observed for Yelwa honey 23.76Meq/Kg might be as a result of the predominant plant the bees visited to make this honey and/or the low total pollen number. The FA value obtained was within the range recorded by Omafuvbe and Akanbi [17] (24.00-31.00Meq/Kg) for Ewu - Esan (Edo State), Enugu - Ezike (Enugu State), Ile-Ife (Osun State), Osogbo (Osun State) and Saki (Oyo State) honey samples, while the honey from Zaria showed a FA value of 83.60Meq/Kg and therefore failed to attain the European Union standard of ≤40Meq/Kg for pure honey and ≤80Meq/Kg for Baker's honey. High FA may make the honey to sour quickly, it is therefore undesirable. The large number of pollen grains observed in this honey might account for the honey's high FA. The LA and TA of Yelwa honey was within the standard limit, where as Zaria honey sample had a LA within the standard limit and a TA above the accepted range. The TA was affected by the high FA value of the honey sample. Both the physico-chemical parameters and the mineral composition of both honey samples showed a positive correlation coefficient, this might be due to the fact that both honey samples are from the same region and have therefore recorded values in the same direction.

Though the sample from Zaria had more pollen types and numbers compared to Yelwa, they both exceeded the standard range for glucose and fructose. It might be that honey from Nigeria generally has a higher glucose and fructose content than the European honeys. The attainment of the sucrose limit with low values of 1.61 and 1.21% seems to further confirm that the bees were not sugar fed.

4CONCLUSION

Pollen spectrum was consistent with the flora of the Nigerian northern guinea savanna zone. Honey from Yelwa and Zaria attained most E.U. standard for honey, what this

implies is that there is hope for farmers who want to go into honey exporting. More samples have to be analyzed to enable Nigeria form her own standard limit(s) especially for fructose and glucose content. It is the high glucose content in honey that makes honey crystallize sometimes right from the hives.

5 ACKNOWLEDGMENT

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