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Palynological characterization of honey samples from Kwara State, Nigeria

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Abstract

Palynological analysis of honey samples from different localities in Kwara State, Nigeria was carried out to isolate and identified pollen types in the honey samples. Out of forty two pollen types belonging to twenty two botanical families recovered, twenty five were identified to species level, eight to genus level and eight to family level. A total of 849,978 pollen grains were counted with 46,355 in Shao, 101,356 in Ganmo, 22,000 in Idofian, 28,337 in Omupo, 200,090 in Iludun Oro, 298,079 in Ijagbo, 22,100 in Offa I and 131,142 in Afon. The major pollen occurrences in the honey samples include those of *Sarcocephaluslatifolius, Parkiabiglobosa, Phyllantusdiscoideus, Tridaxprocubens, Combretaceae/Melastomataceae, Spondiasmombins and Hymenocardiaacida*. Other important honey plants identified are *Elaeisguineensis, Lanneasp, Parinarisp, Celtissp and Entadaabssynica*. All these are characteristic plant taxa of the Forest-Savanna ecotype of the studied area. The presence of relatively high quantity of pollen shows their richness in pollen composition and also a clear evidence that the honey are from botanical source and also multifloral.

Keywords: Palynological analysis; pollen types; honey samples; multifloral; Kwara State

Introduction

Honey which is a food substance produced by bees from nectar of plant has found its use in several aspects of our everyday life ranging from beauty purposes to being used as a sweetener in food substances and most importantly in health treatment. Honey bee produces dense and stable energy food from nectar which ripened to honey (Codex Alimentarius, 2001). Bee collect nectar containing dislodged plant pollen, transform and combine it with specific substance of their own, deposit into open comb of the hive, allow to ripe and mature inside the honey comb. In the hive, pollen is used as a protein source necessary during brood-rearing. The bees only select and collect those pollens which are rich in nutrition (Szczesna, 2006). Pollen is an essential tool in the analysis of honey. Pollen analysis is an indispensable method to authenticate honey botanical and geographical origin. Assessment of honey botanical source is of great important for quality control and helps to ascertain whether honey is adulterated or not (Terrab *et al*., 2003). From economical point of view, assessment of floral origin and other parameters usually add to quality and commercial value of honey (Kayode and Oyeyemi, 2014). Honey may be unifloral or bi-floral and heterofloral or multifloral. Unifloral honey is very rare to produce unless the bees were reared in apiaries and exposed to a particular species of bee pollinated plant.

Honey is not only useful as a food supplement; it is now increasingly been used in the treatment of various diseases (Molan, 2011). The use of honey, a non-forest product, by man in the treatment and prevention of various ailments since time immemorial, is as a result of the integration of pollen and nectar containing bio active ingredients from medicinal plants that the bees foraged on. Beside tropical applications of honey, the antiseptic and antibacterial properties of honey have been recently chemically explained (Jusbin, 1996; Abdulla and Abdul-Aziz, 1998; Wahdan, 1998). It is also known for its antioxidant, antibiotic and antiviral properties (Ferreira *et al*., 2009).

Beekeeping practice is an old as 1000 years in Africa particularly in the East where it is regarded as a profession for the aged. Africa is noted to have about 10% of the world's bee population with Nigeria as one the largest reservoirs (Hussein, 2000). Beekeeping industry should be encouraged as means of livelihood. Evaluation of botanicals for their utility as source of bee forage provides the necessary information to assess the potential for beekeeping in an area (Moses *et al*., 1987; Ramanujam and Khatija, 1991). Sustainable beekeeping can best be achieved through proper understanding and conservation of the most resourceful plants for the bees in terms of nectar, pollen and

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resin. Some authors have reported the important plants utilize by bees in honey production in some parts of Nigeria. Palynological study of honey from Anambra, Enugu and Kogi States of Nigeria were reported by Agwu and Abaeze, (1986). Similarly, Agwu and Akanbi (1992) conducted melissopalynological study of honey obtained from Abia and Imo State Nigeria. Pollen characterization of honey samples from North central Nigeria was reported by Ige and Modupe (2010). Likewise pollen contents of honey samples from Ekiti and Ondo State were investigated by Kayode and Oyeyemi (2012); Kayode and Oyeyemi (2014). Abdulrahaman *et al*., (2013). provided information on ,the two honey samples from Jatropha plantation and the Unilorin Apiary Farm at the University of Ilorin, Kwara State. However, much more information is needed in this field in Kwara State. Hence, the need for this present study which is a further contribution to the pollen analysis of honey samples in Nigeria.

Materials and method.

Study Area

Kwara State is located in the West-central area of Nigeria. The State is situated between latitude 8° 5^1 - 10° 4^1 and longitude 4° 55^1 - 6° 5^1 E covering an estimated land area of 32,500km-^{2} with a population of about 1,548,412 people (NPC 1991; Olayinka 2003). The State share a common internal boundary with Niger, Oyo, Kogi, Ekiti and Osun State and international boundary with the Republic of Benin. The State is located in the forest savanna and enjoys a tropical climate with total amount of rainfall ranges between 800mm in the North parts to 1,500mm in the Southwest. The derived Guinea savanna grassland dominate the North parts of the State while some parts of the Southern Kwara fall within the rain forest agro-ecological zone of Nigeria.

Analysis of honey samples

Samples collection

Eight *Apismellifera* honey samples were collected randomly from different locations in Kwara State. The honey samples were obtained from beekeepers in different towns (Shao, Ghanmo, Idofian, Omupo, Iludun Oro, Ijagbo, Offa and Afon) in the State. The samples were then stored in glass bottles at room temperature not later than three weeks and taken to the Palynology Laboratory of the Department of Archeology, University of Ibadan, Oyo-State, Nigeria, for pollen analysis.

Approximate 10g of honey sample each were weighed in the 50ml clean dry centrifuge tubes and dissolved in 20ml of distilled water. The honey samples were mixed together by manual shaking until a uniform solution is obtained. The solutions were then centrifuged at 2500rpm for 5 minutes. After centrifuging, the supernatant fluid and the residue were separated by decanting. The recovered sediment was treated with 5ml of glacial acetic acid, stirred well and left for 5minutes before centrifuging and decanting. Freshly prepared acetolysis mixture (9ml of acetic anhydride mix together with 1ml of sulphuric acid) was the added to the residue in a fumed cupboard after which it was boiled and stirred a water bath at a temperature of 100°C for 5 minutes (Erdtman, 1969; Agwu and Akanbi, 1985). The acetolysis sample were then centrifuged and decanted. The residues from the decanted samples were further washed at a minimum of three times using distilled water, centrifuging at 3000rpm and decanting each time. The final residue was then centrifuged at 3500rpm and placed in liquid glycerine, which is used as a mounting agent for observation. One drop of glycerine jelly was deposited onto the cover slip and placed on the slide very slowly to avoid air bubbles. The mount was sealed off with transparent nail varnish to prevent drying up and then examined under Olympus microscope at ×400 magnification.

Determination of frequency class

The frequency of the pollen of the different representative plants or families in each sample was taken and recorded. The frequency classes were determined by classifying according to the percentage of the findings of the pollen grains as predominant pollen types (> 45%), secondary pollen types (16-44%), important minor pollen types (3-15%) and minor pollen type (<3%) (Jones and Bryant, 2004).

Identification of honey pollen grains

Identification of each of the pollen grains in the treated honey sample was facilitated with the aid of pollen atlases and also by comparison with the reference collection of pollen slides from Nigerian plants in the Palynology Laboratory of Department of Archeology, University of Ibadan, Oyo-State, Nigeria. Different bibliographic sources were consulted (Edrtman, 1969; Sowumi 1973, 1995; Moore and Webb, 1978; Faergi and Iversen, 1989).

Results and discussion

The pollen analysis results revealed the honey sediment to contain pollen grains of forty two plant tax belonging to twenty two botanical families (Table I). Pollen grains were collected from varying taxa of native herbs, shrubs, grass and trees. The result of the pollen spectra as shown in Table I revealed the occurrence of *Parkiabiglobosa* in all the eight honey samples investigated. Pollens of *Sarcocephaluslatifolius* and *Tridaxprocumbens* were found in 7 samples while Combretaceae/Melastomataceae,

Table I. Pollen spectra of *Apismellifera* honey derived from Kwara State

Pollen source	Locality/ pollen count (%)							
	1	2	3	4	5	6	7	8
RUBIACEAE								
Sarcocephaluslatifolius	22.20	34.19	5.45	3.16	0.27	9.20	1.40	-
Morindalucida	-	-	-	0.30	-	-	-	-
Ixoriasp	-	-	34.06	-	5.62	17.25	5.13	-
FABACEAE								
Acacia sp	-	-	-	3.16	-	0.12	-	3.71
Afzeliaafricana	0.02	0.03	-	-	0.03	-	-	-
Albiziazygia	0.08	0.08	-	-	0.09	-	-	-
Berlinasp	-	-	-	-	0.32	0.24	0.44	0.57
Danielliaoliveri	4.31	-	-	-	4.92	0.11	-	3.27
Entandaabyssinica	2.06	-	-	-	2.40	13.84	4.10	-
Parkiabiglobosa	0.61	0.52	2.27	28.87	0.38	13.80	40.99	1.47
Mimosapudica	-	-	0.99	-	0.16	-	0.20	-
EUPHORBIACEAE								
Brideliasp	-	-	-	-	-	-	-	1.69
Phyllathusdiscoideus	4.11	6.34	1.35	0.75	0.48	-	-	-
SAPINDACEAE								
Blighiasapida	-	-	-	-	-	15.12	4.49	-
ASTERACEAE								
Asteraceae	-	-	14.03	-	-	-	-	3.76
Tridaxprocumbens	1.83	1.39	-	32.63	2.14	0.14	15.55	3.73
Vernoniasp	2.75	-	-	-	3.21	-	-	-
CUCURBITACEAE								
Cucumismelo	0.67	0.32	-	-	0.78	-	-	-
Cucurbitaceae	0.68	-	-	-	0.82	1.08	032	1.88
BOMBACEAE								
Bombaxbuonopozense	-	-	0.46	-	-	-	-	-
Ceibapentandra	-	-	-	2.70	-	1.67	0.50	-
ARECACEAE								
Arecaceae	-	-	-	-	-	0.01	-	0.07
Elaeisguineensis	-	7.44	-	1.58	-	1.88	0.56	1.74
COMBRETACEAE/ MELASTOMATACEAE								
Combretaceae/Melastomataceae	17.39	26.79	1.08	9.88	20.31	-	-	9.39
ANACARDIACEAE								
Mangniferaindica	-	-	1.48	-	0.27	-	-	-
Lanneasp	10.75	0.87	0.67	1.18	0.06	-	-	-
Spondiasmombin	-	-	0.23	11.87	0.38	8.05	2.39	28.19
Lactucataraxacifolia	-	0.08	-	-	-	-	0.51	-
ULMACEAE								
Ulmaceae	0.09	0.11	-	-	0.12	-	-	-
Celtissp	9.38	14.45	-	-	36.13	-	-	-
ANNONACEAE								
Anonnasenegalensis	0.01	0.02	-	-	0.12	-	-	-
POACEAE								
Poaceae	-	-	-	2.76	-	0.80	0.24	-
CYPERACEAE								
Cyperaceae	-	-	13.77	-	-	-	-	0.19
PASSIFERACEAE								
Adeniacissampeloides	-	-	-	0.12	0.27	-	-	-
STERCULIACEAE								
Hildergadiabarteri	-	-	-	-	0.46	1.78	0.52	7.52
BIGNONIACEAE								
Newbouldialeavis	-	-	-	-	-	-	1.40	-
ROSACEAE								
Parinarisp	4.43	6.82	2.77	-	-	-	-	0.33
SAPOTACEAE								
Sapotaceae	-	-	18.87	-	-	-	1.04	-
Vitellariaparadoxa	-	-	-	-	-	-	-	5.64
MALPIGHIACEAE								
Malpighiaceae	-	-	-	-	-	1.49	0.44	-
HYMENOCARDIACEAE								
Hymenocardiaacida	15.79	-	1.81	-	18.43	11.64	3.46	9.49
NYCTAGINACEAE								
Boerhaviadiffusa	-	-	0.06	0.18	-	-	-	-

Table II. Pollen types found in *Apismellifera* honey samples collected from Kwara State

Locality	Honey type	Dominant pollen type (>45%)	Secondary pollen type (16-45%)	Important minor pollen type (3-15%)	Minor pollen type (<3%)
KW 1 Shao	Multifloral	-	Combretaceae/ Melastomataceae (17.39), *Sarcocephaluslatifolius*(22.20)	*Celtissp* (9.38), *Danielliaoliveri* (4.31), *Hymenocardiaacida* (15.79), *Lanneasp* (10.75), *Parinarisp*(4.43), *Phyllanthusdiscoideus*(4.11)	*Afzeliaafricana* (0.02), *Entadaabyssinica* (2.06), *Parkiabiglobosa* (0.61), *Tridaxprocumbens* (1.83), *Vernoniasp* (2.75).
KW 2 Ghanmo	Multifloral	-	Combretaceae/ Melastomataceae (26.79), *Sarcocephaluslatifolius* (34.19)	*Celtissp*(14.45), *Elaeisguineensis* (7.44), *Parinarisp*(6.82), *Phyllanthusdiscoideus* (6.34)	*Lanneasp* (0.87), *Parkiabiglobosa*(0.52), *Tridaxprocumbens*(1.39).
KW 3 Idofian	Multifloral	-	*Ixorasp* (34.06), Sapotaceae (18.87)	*Adeniacissampeloides* (13.77), Asteraceae (14.03), *Sarcocephaluslatifolius*(5.45)	*Bombaxbuonopozense* (0.46), Combretaceae/ Melastomataceae (1.08), *Hymenocardiaacida* (1.18), *Lanneasp* (0.67), *Mangniferaindica* (1.48), *Parinarisp* (2.77), *Phyllanthusdiscoideus* (1.35)
KW 4 Omupo	Multifloral	-	*Parkiabiglobosa* (28.87), *Tridaxprocumbens* (32.63)	*Acacia sp* (3.16), Combretaceae/ Melastomataceae (9.88), *Sarcocepholuslatifolius*(3.16), *Spodiasmombin*(11.87)	*Ceibapentadra*(2.70), Cyperaceae (1.58), *Elaeisguineensis* (1.58), *Lanneasp*(1.18), *Phyllanthusdiscoideus* (0.75)
KW 5 Iludun Oro	Multifloral	-	*Celtissp* (36.13), *Hymenocardiaacida*(18.43, Combretaceae/ Melastomataceae (20.31)	*Danielliaoliveri* (4.92), *Ixoriasp* (5.62), *Vernoniasp* (3.21)	*Adeniacissampeloides* (0.27), *Entadaabyssinica* (2.40), *Mangiferaindica* (0.27), *Parinarisp* (0.46), *Tridaxprocumbens*(2.14).
KW 6 Ijagbo	Multifloral	-	*Ixorasp* (17.25)	*Blighiasapinda* (15.12), *Entadaabyssinica* (13.84), *Hymenocardiaacida*(11.64), *Parkiabiglobosa* (13.80), *Sarcocephaluslatifolius* (9.20)	*Acacia sp* (0.12), *Berliniasp* (0.24), *Ceibapentandra* (1.67), Cucurbitaceae (1.08), *Elaeisguineensis* (1.88), *Hildergadiabarteri* (1.78), Malphigiacae (1.49)
KW 7 Offa	Multifloral	-	*Parkiabiglobosa* (40.99)	*Blighiasapinda* (4.49), *Entadaabyssinica* (4.10), Hymenocardiaacida (3.46), *Ixorasp* (5.13), *Tridaxprocumbens* (15.55)	*Berliniasp* (0.44), Ceibapentandra *(0.56),* *Hildergardiaacida* (0.52), *Lactucataraxifolia*(0.51), Malphigiaceae (0.44), *Sarcocephaluslatifolius* (2.73), *Parinarisp*(1.04), Poaceae (0.24), *Spondiasmombin* (2.39)
KW 8 Afon	Multifloral	-	*Spondiasmombin* (28.19), *Lophiralanceolata* (15.18)	*Acacia sp*(3.71), Asteraceae (3.76), Combretaceae/ Melastomataceae (9.39), *Danielliaoliveri*(3.27), *Hildergadiabarteri*(7.52), *Hymenocardiaacida* (11.27), *Tridaxprocumbens* (3.73), *Vitellariaparadoxa* (5.64)	*Berliniasp*(0.57), Arecaceae (0.07), *Brideliasp* (1.69), Cucurbitaceae (1.88), *Elaeisguineensis* (1.74), *Parinarisp* (0.33), *Parkiabiglobosa* (1.47), Poaceae (0.19)

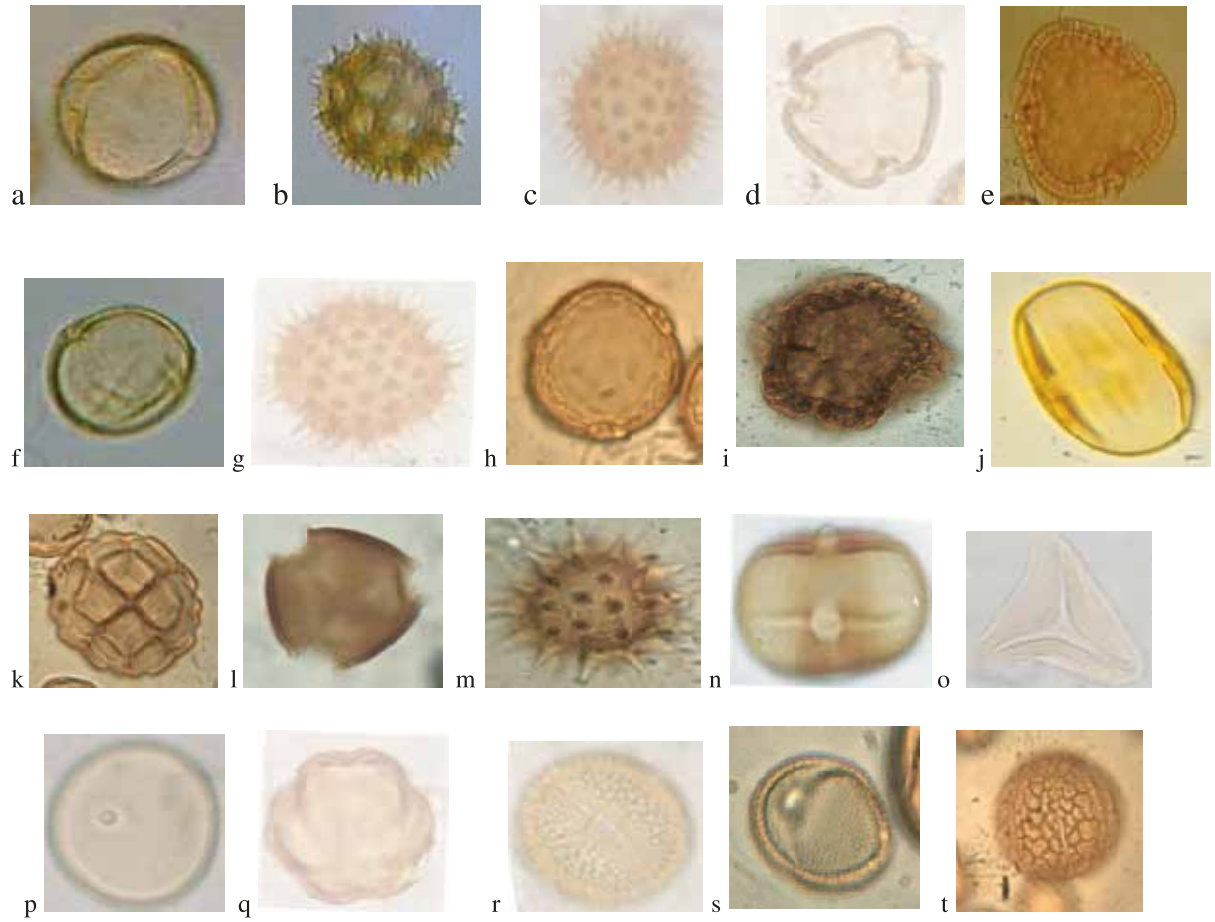
Table III. The percentage pollen frequency class of honey samples from Kwara State.

Locality/Sample	Pollen type	% Frequency	Frequency class
KW 1 Shao	*Celtissp*	9.38	Rare
	Combretaceae/Melastomataceae	17.39	Frequent
	Danielliaoliveri	4.31	Rare
	Entadaabyssinica	2.06	Sporadic
	Hymenocardiaacida	15.79	Sporadic
	Lanneasp	10.75	Sporadic
	Sarcocephaluslatifolius	22.20	Frequent
	Parinarisp	4.43	Rare
	Phyllanthusdiscoideus	4.11	Rare
	Tridaxprocumbens	1.83	Sporadic
	Vernoniasp	2.73	Sporadic
KW 2 Ganmo	*Celtissp*	14.45	Rare
	Combretaceae/Melastomataceae	26.79	Frequent
	Elaeisguineensis	7.44	Rare
	Sarcocephaluslatifolius	34.19	Frequent
	Parinarisp	6.82	Rare
	Phyllanthusdiscoideus	6.34	Rare
	Tridaxprocumbens	1.39	Sporadic
KW 3 Idofian	*Adeniacissampeloides*	13.77	Rare
	Asteraceae	14.03	Rare
	Combretaceae/Melastomataceae	1.08	Sporadic
	Hymenocardiaacida	1.81	Sporadic
	Sarcocephaluslatifoliius	5.45	Rare
	Parinarisp	2.77	Sporadic
	Parkiabiglobosa	2.27	Sporadic
	Sapotaceae	18.87	Frequent
KW 4 Omupo	*Acacia sp*	3.16	Rare
	Ceibapentandra	2.70	Sporadic
	Cyperaceae	2.76	Sporadic
	Sarcocephaluslatifolius	3.16	Rare
	Parkiabiglobosa	28.87	Frequent
	Spondiasmombin	11.87	Rare
	Tridaxprocumbens	32.63	Frequent
KW 5 Iludun Oro	*Celtissp*	36.13	Frequent
	Combretaceae/Melastomataceae	20.31	Frequent
	Danielliaoliveri	4.92	Rare
	Entadaabyssinica	2.40	Sporadic
	Hymenocardiaacida	18.43	Frequent
	Ixorasp	5.62	Rare
	Tridaxprocumbens	2.14	Sporadic
	Vernoniasp	3.21	Rare
KW 6 Ijagbo	*Blighiasapida*	15.12	Rare
	Ceibapentandra	1.67	Sporadic
	Entadaabyssinica	13.84	Rare
	Hymenocardiaacida	11.64	Rare
	Ixorasp	17.25	Frequent
	Sarcocephaluslatifolius	9.20	Rare
	Spondiasmombin	8.05	Rare
	Parkiabiglobosa	13.80	Rare
KW 7 Offa	*Blighiasapida*	4.49	Rare
	Entadaabyssinica	4.10	Rare
	Hymenocardiaacida	3.46	Rare
	Ixorasp	5.13	Rare
	Sarcocephaluslatifolius	1.40	Sporadic
	Parkiabiglobosa	40.99	Frequent
	Spondiasmombin	2.39	Sporadic
	Tridaxprocumbens	15.55	Frequent

Table III. The percentage pollen frequency class of honey samples from Kwara State (Continued).

Locality/Sample	Pollen type	% Frequency	Frequency class
KW 8 Afon	*Acacia sp*	3.71	Rare
	Asteraceae	3.76	Rare
	Combretaceae/Melastomataceae	9.39	Rare
	Danielliaoliveri	3.27	Rare
	Hildergadiabarteri	7.52	Rare
	Hymenocardiaacida	11.27	Rare
	Lophiralanceolata	15.18	Rare
	Spondiasmombin	28.19	Frequent
	Tridaxprocumbens	3.73	Rare
	Vitellariaparadoxa	5.64	Rare

Spondiasmombins and Hymenocardiaacidaoccurred in 6 samples and *Phyllanthusdiscoideus, Lanneasp, Elaeisguineensis* and Cucurbitaceae were noted in 5 samples. Pollen grains of the anemophilous plants of Poaceae andCyperaceae are very few in the honey samples (Table I). Melisopalynological evaluation of the honey samples showed no dominant pollen types (>45%) while pollens of Combretaceae/Melastomataceae (17.39%,



a-Danielliaoliveri, b- Venoniasp, c- Trudaxprocumbens, d- Blighiasapida,e- Bombaxbuonopozenses, f-Hidergerdiabarteri, g-Tridaxprocumbens, h-Hymenocardiaacida, i- Afzeliaafricana, j- Sapotaceae, k- Acacia sp, l- Cucumismelo, m- Asteraceae, n-Vitellaria+paradoxa, o- Elaeisguineensis, p- Poaceae, q- Combretaceae/Melastomataceae, r- Adeniacissampeloides, r- Ixorasp, t- Cucurbitaceae.

Fig. 1. Light microscopic photographs of some pollen grains found in Kwara State honey.

26.79%) and *Sarcocephaluslatifolius*(22.20%, 34.19%) occurred as secondary pollen in KW1 and KW2 honey samples respectively (Table II). Pollen grains of *Ixorasp* and Sapotaceae accounted for 34.06% and 18.87% respectively in KW3 honey sample. *Parkiabiglobosa* (28.87%) and *Tridaxprocumbens* (32.63%) were identified and categorized as secondary pollen types in KW4 honey. Other pollen types whose pollen percentage were above 16% but less than 45% include *Celtissp* (36.13%) and *Hymenocardiaacida*(18.43%) in KW5, *Ixorasp* (17.25%) in KW6, *Parkiabiglobosa*(40.99%) in KW7, *Spondiasmombin* (28.19%) and *Lophiralanceolata* (15.18%) in KW8 honey. The important pollen types in the honey as shown in Table II were *Lanneasp, Phyllanthusdiscoideus, Elaeisguineensis, Acacia sp, Danielliaoliveri, Vernoniasp and Hidergadiabarteri*. All samples analyzed were of multifloral honey(Table II).The result of the percentage frequency class showed that Combretaceae/Melastomataceae, *Sarcocephaluslatifolius, Sapotaceae, Parkiabiglobosa, Tridaxprocumbens and Hymenocardiaacida* occurred as "frequent" while 15 taxa occurred as "rare" (3-16%) and the remaining taxa identified were "sporadic" (<3%) (Table III). The photomicrograph of some pollen grains in the honey samples is presented in Fig. 1.

Forty two pollen taxa of necteriferous and non-nectariferous which contribute both pollen load and nectar source were recorded in the honey samples. The pollen spectra result further revealed the abundant and diversified pollen compositions which are characteristics of the forest savanna vegetation of the area studied. This agrees with the report of Herbert (1992) who stated that the contribution of anemophilous and entomophilous taxa found in honey samples would often produced a pollen spectrum that is unique for the specific geographical area where it was produced. The frequently occurred plant taxa in the honey were savanna plants followed by forest plants. This finding corroborates the earlier works of Njokocha and Ekweozor (2007) who examined the pollen content of commercial honey from Opi, Nssuka, Nigeria. The findings in this study further established that forest savanna ecotypes usually have abundant and diverse plant species dominated by entomophilous and nectariferous plant species. The pollen types in the honey samples are those of characteristics species of this localities such as *Danielliaoliveri, Parkiabiglobosa, Blighiasapida, Bombaxbuonopozenses, Ceibapentandra, Parinarisp* and *Hymenocardiaacida*.The high numbers of pollen grains in each of the honey sample analyzed in Kwara State indicates their richness in pollen concentration and also suggest that the honey samples are pure. Pollen grains of *Sarcocephaluslatifolius, Parkiabiglobosa, Tridaxprocumbens, Elaeisguineensis, Lanneasp, Spondiasmombin*, Combretaceae/ Melastomataceae and Hymenocardiaacida are very important and preferred source of nectar for the bees whenever and wherever they are available. This result agrees with the report of Kayode and Oyeyemi(2012).

Conclusion

The data obtained from the pollen analysis revealed that the honey samples were rich in pollen composition and were actually produced from beehives around the catchment area. The areas randomly selected for this study have good potential for sustaining beekeeping ventures when considering the diversity and abundance of nectar and pollen taxa. *Parkiabiglobosa* and Combretaceae/ Melastomataceae, which are the main pollen types constitute valuable source of nectar and pollen for honey bees. Concerted efforts should be made by the rural dwellers and concern authorities in preserving *Parkiabiglobosa*, an economic tree and other indigenous species that provide forage for honeybees in the area studied.

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References

Abdulrahman AA, Solomon OR, Adeyemi SR, Liadi MT, Ahmed RN, Belewu MA and Oladele FA (2013), Melisopalynological Analysis of Honey Samples from Jatropha Plantation and UnilorinApiary Farm, *International Journal of Phytofuels and Allied Sciences* **2**(1): 81-92.

Abdulla F and Abdulaziz MA (1998), The prophylactic and curative effect of cedar honey induced ulcers in rabbits, *The Second International Arab Apicultural Conference- Amman* **1**: 26-31.

Agwu COC and Akanbi TO (1986), A Palynological study of honey from four vegetation zones of Nigeria, *Pollen et Spores* **27**: 335-348.

Agwu COC and Abaeze CC (1991), Palynological study of honey from Anambra, Enugu and Kogi States of Nigeria, *Journal of Agriculture, Science and Technology* **1**(2): 126-131.

Bryant VM (2004), Pollen content of honey, CAP Newsletter **24**(1): 10-24.

Codex Allimentation (2001), Draft revised standard for standard for honey (at step 10 of the Codex procedure), Alinorm, 01/25: 19-26.

Erdtman G (1969), Handbook of Palynology.An Introduction to the study of pollen grains and Spores. Hafnar Publishing Company, New York pp 486.

Faergi K and Iversen J (1989), Textbook of pollen analysis, John Wiley and Sons, pp 295.

Ferreira ICFR, Aires E, Barreira JMC and Eastervinho KM (2009), Antioxidant activity of Portuguese honey samples: Difference contributions of the entire honey and phenolic extract, *Food Chemistry* **114**: 1438-1443.

Herbert EW (1992), Honey bee, Dadant and Sons, Hamilton, Illionius, pp 197-234.

Hussein MH (2000), Beekeeping in Africa, *Journal of Apiacta* **1**: 32-48.

Ige OE and Modupe TO (2010), Pollen characterization of Honey samples from North Central Nigeria, *Journal of Biological Sciences* **10**(1): 43-47.

Jusbin OS (1996), Chemical Composition and Application. ***In:*** Bee Products Ed. Schmidt, Plenum Press, New York, pp 25-26.

Kayode J and Oyeyemi SD (2012), Pollen analysis of honey derived from Ekiti State, Nigeria. *Bulletin of Applied Sciences*, **31B**(1): 39-47.

Kayode J and Oyeyemi SD (2014), Pollen analysis of *Apismellifera* honey collected from Nigeria, *American Journal of Agriculture and Forestry* **2**(5): 226-231.

Molan PC (2001), Why honey is effective as a medicine: The scientific explanation of its effects, *Bee World* **82**(1): 22-40.

Moore D and Webb JA (1978), An illustrated Guide to Pollen Analysis, 1st Ed. Holdder and Stoughtonnm, London, p 133.

Moses TS, Singh Joshi, Madhakanta A and Suryanarayana MC (1987), Evaluation of source of pollen to honey bees at Vijayarai, A.P, Proc. 5th Ind. Synp.Palynol.Dept. Bot. Inst. Sc., Nagpur India, 65-71.

Njokuocha RC and Ekweozor CC (2007), Pollen Contents of Commercial Honeys of Opi, Nsukka, Enugu State, Nigeria, *Plant Product Research Journal* **2**: 5-11.

NPC (1991), Population of Nigeria, National Population Commission, Census Report p 29.

Olayinka YB (2003), Senior Secondary Atlas, 2nd Ed, Longman, Nigeria plc. pp 5-11.

Ramanujam CGK and Khatija F (1991), Melittopalynology of the Agriculture tracts in Guntur District, Andra, Pradesh, *Journal of the Indian Institute of Science* **71**: 25-34.

Sowumi MA (1973), Pollen grains of Nigerian plants I. woody species, Grana, **13**: 145-186.

Sowumi MA (1995), Pollen Grains of Nigeria Plants. Grana, **34**: 120-141.

SzczesnaI (2006), Pollen content and amino acid composition of bee collected pollen from selected botanical origin, *Journal of Apicultural Sciences* **50**: 81-90.

Terrab A, Diez MJ and Heredia FJ (2003), Palynological characterization of Moroccan Honeys. I. River Red Gum *(Eucalyptus camaldulensis* Dehnl.) Honey, *International Journal of Food Science and Technology* **38**: 378-386.

Wahdan H (1998), Causes of the antimicrobial activity of honey, *Infection* **26**(1): 25-26.

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