

A Study of the Floristic and Nutritional Compositions of Bee Pollen from South Eastern Nigeria

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Abstract: The floristic and nutritional properties of bee pollen from *Apis mellifera adansonii* and *Melipona* species were examined using appropriate methods in the laboratory. The pollen pellets obtained randomly from the samples were weighed and recorded accordingly. Each of the pollen pellets contained approximately 6 and 10 plant pollen types with average weights of 0.10g and 0.21g for *Apis mellifera adansonii* and *Melipona* species respectively. The plant species identified in their pollen samples varied. This must have been as a result of differences in species preferences. The results of the proximate analysis revealed that *Melipona* species pollen had higher protein content (20.62%) than *Apis mellifera* pollen (19.29%). The value obtained from *Apis mellifera* pollen is lower than the amount required for optimum brood rearing (25% protein) and therefore might be a contributing factor to seasonal absconding of bees during the rains in southeastern Nigeria. However, bee pollen also contains other essential nutrients. The plant species contained in each of the pollen pellets should be inter planted in apiaries. Plants with high protein content that flower during the rains should also be studied. Bee pollen can serve as a protein supplement.

Keyword: Bee pollen, *Melipona* species and *Apis mellifera*

1. Introduction

Bees belong to the third largest insect order (Hymenoptera) which also includes wasps and ants. Deforestation resulting from our traditional farming practices, urbanization and modernization continued to reduce the natural habitats and food of the honey bees at a rate which gives little chance for re-establishment of the vegetation. This has led to reduction in honey bee population and colonies.

Apis mellifera adansonii provides various useful products. These include: honey, pollen, propolis, royal jelly, bees wax and bee venom. Honey is referred to as one of the most valuable products of the forest produced by honey bees. It can be used as food and also one of the ingredients in various other industries such as pharmaceutical and cosmetic industries [1]. Besides the importance of *Melipona* species as major pollinators of most wild plants and some cultivated species, honey and bee pollen of meliponins are also source of food and medicines and income to rural populations [2, 3]. Therefore the rearing of the species becomes important. Unlike honey and propolis, the scientific study and uses of bee pollen is not yet widely studied in developing countries [4]. Pollen grains are small male reproductive units formed in the anthers of the higher flowering plants [4]. Pollen is a natural source of protein, fat, minerals and vitamins, which are necessary elements for the natural development of a bee colony and likewise in human nutrition [5]. The research work aimed at analyzing the floristic and nutritional compositions of two types of bee pollen (*Apis mellifera adansonii* pollen and *Melipona* species pollen).

2. Materials and Methods

2.1 Sample Collection

Pollen samples harvested from colonies of *Apis mellifera adansonii* and *Melipona* species located within south eastern Nigeria were used.

2.2 Determination of the Floristic Composition

2.2.1 Determination Number of plants contained per pollen pellet

Ten (10) pollen pellets were randomly selected from each of the samples. The weight of each pollen pellet was taken using a sensitive weighing balance and recorded accordingly as shown in Table 1. Each pollen pellet was dissolved in a beaker with 35ml of warm (40-50⁰C) diluted sulphuric acid solution [6]. After a thorough shaking of the solution, it was centrifuged, decanted and the residue was acetolysed as described by [7, 8] and then suspended in 3ml glycerin alcohol in plastic vials for microscopic examination. Three drops of the thoroughly mixed suspension was mounted on the slide and examined under the microscope for pollen identification. The identification of pollen under the microscope was carried out with the aid of reference slides of plant pollen prepared directly from plants as well as photomicrographs of Nigerian plant pollen in books and journals by [8, 9, 10, 11]. The number of plant species found in each of the pollen pellets per sample was recorded in Tables 2 and 3.

2.2.2 Determination of the floristic compositions of *Apis mellifera* pollen and *Melipona* species pollen

1.0g of pollen was taken from each of the well blended pollen samples and prepared as described above and examined under the microscope at magnification 10 x 40 for pollen identification and counts (Table 4).

2.3 Determination of the Proximate Composition of Bee Pollen from South Eastern Nigeria

The proximate analysis was carried out as described by [12, 13, 14].

2.4 Statistical Analysis

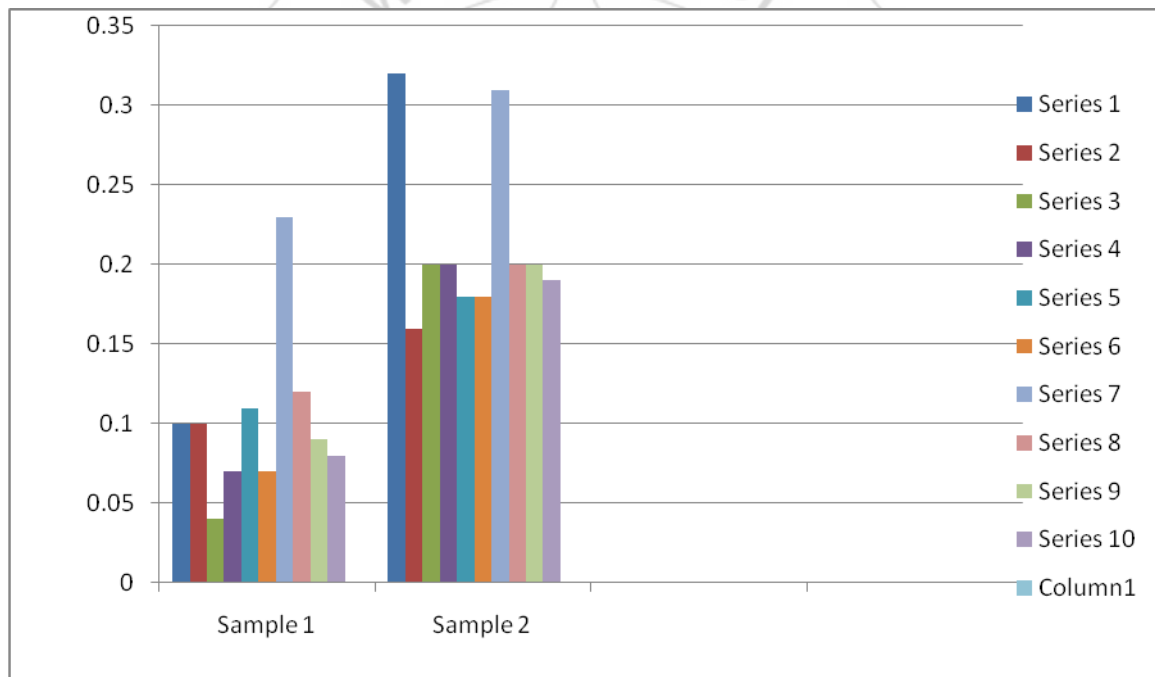
T-test was used to compare the means of the two pollen samples (*Apis mellifera adansonii* pollen and *Melipona* species pollen). Significance was tested at 0.05 probability level. Also tables, bar chats were used to analyze the data.

3. Results and Discussion

3.1Floristic Composition of Bee Pollen Samples from South Eastern Nigeria

Table 1: Weights of pollen pellets from the bee pollen samples collected from southeastern Nigeria. Samples

Pollen pellets numbers	<i>Apis Mellifera Adansonii</i> pollen (g)	<i>Melipona sp</i> pollen (g)
1	0.10	0.32
2	0.10	0.16
3	0.04	0.20
4	0.07	0.20
5	0.11	0.18
6	0.07	0.18
7	0.23	0.31
8	0.12	0.20
9	0.09	0.20
10	0.08	0.19
Mean	0.10	0.21



Pollen pellets from different cells of honey combs.

Where, Sample 1 = *Apis mellifera adansonii* pollen (g)

Sample 2 = *Melipona sp* pollen (g)

Figure (1): Weights of pollen pellets from the Bee pollen samples collected from South Eastern Nigeria

Apis mellifera pollen had an average weight of 0.1g and *Melipona* species 0.21g. The variation in weights of the

samples must have been as a result of the plant pollen types contained by the samples.

Table 2: Floristic compositions and frequencies of occurrence of pollen pellets extracted from sampled combs of *Apis mellifera adansonii* hives located within Southeastern Nigeria.

Pollen pellets number	No. of plants pollen type Per pellet	Floristic Compositions	Frequency of occurrence
1	7	<i>Lannea sp</i>	9
		<i>Dioscorea exculenta</i>	1300
		<i>Elaeis guinensis</i>	6
		<i>Mimosa pudica</i>	235
		<i>Citrus sp</i>	525
		<i>Pterocarpus sp</i>	75
		<i>Compositae</i>	18
2	5	<i>Elaeis guinensis</i>	1046
		<i>Citrus sp</i>	315
		<i>Dioscorea exculenta</i>	693
		<i>Mimosa pudica</i>	2400
		<i>Rauvolfia vomitoria</i>	33
3	4	<i>Dioscorea exculenta</i>	1820
		<i>Citrus sp</i>	128
		<i>Pterocarpus sp</i>	3
		<i>Lannea sp</i>	2
4	5	<i>Dioscorea sp</i>	2150
		<i>Citrus sp</i>	1800
		<i>Jatropha sp</i>	583
		<i>Elaeis guinensis</i>	562
		<i>Barteria nigritiana</i>	7
5	5	<i>Compositae</i>	1
		<i>Elaeis guinensis</i>	28
		<i>Citrus sp</i>	400
		<i>Mimosa pudica</i>	2225
		<i>Lannea sp</i>	556
6	4	<i>Irvingia gabonensis</i>	18
		<i>Pterocarpus sp</i>	5
		<i>Lannea sp</i>	21
		<i>Elaeis guinensis</i>	31
7	5	<i>Mimosa pudica</i>	1561
		<i>Ipomea batata</i>	437
		<i>Compositae</i>	1
		<i>Irvingia gabonensis</i>	9
		<i>Corchorus olitorus</i>	108
8	6	<i>Barteria nigritiana</i>	23
		<i>Pterocarpus sp</i>	1415
		<i>Nauclea latifolia</i>	14
		<i>Steculia sp</i>	28
		<i>Citrus sp</i>	143
		<i>Dioscorea exculenta</i>	863
9	7	<i>Citrus sp</i>	2
		<i>Mimosa pudica</i>	1681
10	8	<i>Elaeis guinensis</i>	4
		<i>Ipomea batata</i>	3
		<i>Lannea sp</i>	1115
		<i>Barteria nigritiana</i>	1
		<i>Khaya sp</i>	324
		<i>Hibiscus exculenta</i>	386
		<i>Barteria nigritiana</i>	9
		<i>Pterocarpus sp</i>	1826
		<i>Dioscorea sp</i>	2728
		<i>Elaeis guinensis</i>	325
<i>Lannea sp</i>	22		
<i>Citrus sp</i>	553		
<i>Nauclea latifolia</i>	14		
Mean	5.6		

Average plant pollen type per pellet = 5.6 plants per pollen pellet.

The results obtained as shown in Table 2 depicts that *Apis mellifera adansonii* stores approximately 6 plants per pellet. This must have been as a result of the wide variety of plants found in southeastern Nigeria. The plant pollens identified were as shown on the table above. The plant pollen types common in all the pollen pellets included *Dioscorea exculenta*, *Mimosa pudica*, *Citrus sp* and *Elaeis guinensis*. The frequencies of occurrence of these plants varied in each of the pellets. This must have been as a result of the flowering periods and preference by the bees. *Dioscorea exculenta* had the highest frequency (1300 pollens) in pollen pellet 1, *Mimosa pudica* (2400 pollens) was the highest in pollen pellet 2. The plant pollens with the highest frequencies in pollen pellets 3, 4, 8, 10, and 5, 6, 7, 9, were *Dioscorea exculenta* with frequencies of 1820, 2150, 863, 2728 and *Mimosa pudica* with frequencies of 2225, 1786 and 1681 respectively.

Table 3: Floristic compositions and frequencies of occurrence of sampled pollen pellets extracted from *Melipona Species* colony located within the Southeastern Nigeria.

Pollen Pellet Nos.	No. of Plant pollen type per pellet	Floristic compositions	Frequency of occurrence
1	10	<i>Andropogon sp</i>	118
		<i>Hibiscus exculenta</i>	60
		<i>Tapinanthus sp</i>	12
		<i>Citrus sp</i>	222
		<i>Nauclea latifolia</i>	5387
		<i>Lannea sp</i>	6
		<i>Irvingia gabonensis</i>	24
		<i>Blighia sapida</i>	306
		<i>Asteraceae</i>	6
		<i>Pterocarpus sp</i>	30
2	16	<i>Rauvolfia vomitoria</i>	13
		<i>Funtia elastica</i>	1
		<i>Bombax sp</i>	272
		<i>Pentaclethra macrophylla</i>	420
		<i>Lea guinensis</i>	121
		<i>Lannea sp</i>	9
		<i>Nauclea latifolia</i>	318
		<i>Irvingia gabonensis</i>	3
		<i>Compositae</i>	11
		<i>Tapinanthus sp</i>	68
3	10	<i>Citrus sp</i>	3
		<i>Combretum sp</i>	1
		<i>Newbouldia laevis</i>	639
		<i>Pterocarpus sp</i>	13
		<i>Hildegardia barteri</i>	63
		<i>Dialium guinensis</i>	5
		<i>Tapinanthus sp</i>	1347
		<i>Compositae</i>	1
		<i>Newbouldia laevis</i>	3
		<i>Cardiospermum sp</i>	1746
4	9	<i>Allophylus sp</i>	7
		<i>Pterocarpus sp</i>	731
		<i>Occimum gratissimum</i>	345
		<i>Blighia sapida</i>	78
		<i>Lannea sp</i>	11
		<i>Citrus sp</i>	2
		<i>Pentaclethra macrophylla</i>	24
		<i>Andropogon</i>	189
		<i>Compositae</i>	1
<i>Irvingia gabonensis</i>	7		
5	8	<i>Citrus sp</i>	13
		<i>Spondias mombin</i>	1
		<i>Blighia sapida</i>	5
		<i>Khaya sp</i>	11
		<i>Nauclea latifolia</i>	945
		<i>Ipomea batata</i>	1557
		<i>Khaya sp</i>	19
		<i>Citrus sp</i>	722
		<i>Trichilia sp</i>	12
		<i>Combretum sp</i>	1
<i>Bombax boumopouzensis</i>	18		
<i>Spondias mombin</i>	927		
<i>Hymenocardia acida</i>	102		
6	7	<i>Nauclea latifolia</i>	3315
		<i>Andropogon sp</i>	17
		<i>Lannea sp</i>	25
		<i>Jatropha sp</i>	4
		<i>Steculia sp</i>	5
		<i>Khaya sp</i>	2
		<i>Trichilia sp</i>	1
		<i>Nauclea latifolia</i>	6624
		<i>Hibiscus exculenta</i>	1
		<i>Lannea sp</i>	14
<i>Pterocarpus sp</i>	10		
<i>Barteria nigriflora</i>	1		
<i>Allophylus sp</i>	6		
<i>Bombax boumopouzensis</i>	5		
7	7	<i>Andropogon sp</i>	604
		<i>Pentaclethra macrophylla</i>	47
		<i>Irvingia gabonensis</i>	48
		<i>Ceiba pentandra</i>	12
		<i>Hildegardia barteria</i>	2957
		<i>Triplochiton sclerezylon</i>	1852
		<i>Hibiscus sp</i>	25
		<i>Blighia sapida</i>	1
		<i>Compositae</i>	1
		<i>Citrus sp</i>	30
<i>Terminalia sp</i>	8		
<i>Crossopteryx febrifuga</i>	19		
<i>Terminalia sp</i>	8		
8	9	<i>Steculia sp</i>	3
		<i>Andropogon sp</i>	513
		<i>Hildegardia barteri</i>	225
		<i>Uapaca sp</i>	233
		<i>Rauvolfia vomitoria</i>	18
		<i>Triplochiton sclerezylon</i>	5038
		<i>Blighia sapida</i>	39
		<i>Hildegardia barteri</i>	27
		<i>Hibiscus exculenta</i>	14
		<i>Lannea sp</i>	9
<i>Jatropha sp</i>	9		
<i>Pterocarpus sp</i>	4		
<i>Pentaclethra macrophylla</i>	11		
<i>Funtia elastic</i>	2		
<i>Lannea sp</i>	18		
<i>Uapaca species</i>	5176		
9	9	<i>Andropogon sp</i>	11
		<i>Hildegardia barteri</i>	225
10	11	<i>Uapaca sp</i>	233
		<i>Rauvolfia vomitoria</i>	18
Total	9.6	<i>Andropogon sp</i>	513
		<i>Hildegardia barteri</i>	225

Average floristic composition for pollen pellet = 9.6 pollen types per pellet

Each of the pollen pellets for *Melipona* species varied in their floristic composition with few of the pollen types found in more than one pellet sampled. The results presented in Table. 3 above showed that *Melipona* species pollen stored approximately 10 pollen types per stored pollen pellet. Some of the species identified and their frequencies of occurrence were *Nauclea latifolia* (5387), *Newbouldia laevis* (639), *Cardiospermum sp* (1746) *Uapaca sp* (5176), *Nauclea latifolia*(945), *Ipomea batata* (1557), *Nauclea latifolia* (6624) *Hildegardia barteri* (2951), *Andropogon sp* (604), *Uapaca sp* (5176) and were the predominant plant species found in pollen pellets 1 to10 respectively. These predominant plant species must have been collected by the bees as a result of their preferences to the bees as well as their availability due to their flowering periods. The *Melipona sp* pollen grain showed a higher average number of pollen types (10) per pollen pellet than *Apis mellifera adansonii* pollen (6) per pollen pellet. This might have resulted as a result of differences in species preferences for pollen. Therefore the analysis indicates that the *Melipona sp* collects more plant pollen types than the *Apis mellifera adansonii*. Some of the pollen types collected by the *Melipona species* were also found in the *Apis mellifera* pollen. These plant pollens were *Citrus sp*, *Nauclea latifolia*, *Compositae*, *Lansea sp* and *Ipomea batata*. The combination of these plant species in each of the pellets by the bees may not be a coincidence but can be as a result of the chemical compositions of each of these plants which are necessary to the bees.

Table 4: Floristic Compositions of the Bee Pollen Samples from Southern Nigeria

Floristic composition	<i>Apis Mellifera</i> pollen Frequency	<i>Melipona species</i> pollen Frequency
AMPELIDAE		
<i>Leea guinensis</i>	12	-
ANARCARDIACEA		
<i>Lansea sp</i>	591	72
<i>Spondias mombin</i>	821	1
APOCYNACEAE		
<i>Astonia boonei</i>	-	-
<i>Rauwolfia vomitoria</i>	-	31
<i>Funtia elastica</i>	-	1
BIGNONACEAE		
<i>Newbouldia laevis</i>	-	642
BOMBACACEAE		
<i>Bombax bounopozense</i>	-	295
<i>Ceiba pentandra</i>	-	13
CAESALPINACEAE		
<i>Dialium guinensis</i>	-	5
COMBRÉTACEAE		
<i>Combretum sp</i>	-	2
COMPOSITAE	231	2
CONVOLVULACEAE		
<i>Ipomea batata</i>	440	1557
DIOSCOREACEAE		
<i>Dioscorea exculenta</i>	5978	-
EUPHORBIACEAE		
<i>Jatropha sp</i>	583	13
<i>Uapaca sp</i>	-	5411
<i>Hymenocardia acida</i>	-	102
<i>Irvingia gabonensis</i>	27	-
LORANTHACEAE		
<i>Tapinanthus sp</i>	-	1427

MALVACEAE		
<i>Hibiscus sp</i>	386	100
MELIACEAE		
<i>Khaya sp</i>	11	32
<i>Trichilia sp</i>	-	13
MIMOSACEAE		
<i>Mimosa pudica</i>	6663	-
<i>Pentaclethra macropylla</i>	-	502
PALMÆE		
<i>Elaeis guinensis</i>	1479	-
<i>Raphia sp</i>	-	-
PAPILONACEAE		
<i>Pterocarpus sp</i>	1909	775
PASSIFLORACEAE		
<i>Barteria nigriflora</i>	34	-
RUBIACEAE		
<i>Nauclea latifolia</i>	1143	311
RUTACEAE		
<i>Citrus sp</i>	4352	1077
SAPINDACEAE		
<i>Blighia sapida</i>	-	429
<i>Allophylus sp</i>	-	13
<i>Cardiospermum sp</i>	-	1746
<i>Barteria nigriflora</i>	34	-
RUBIACEAE		
<i>Nauclea latifolia</i>	1143	311
RUTACEAE		
<i>Citrus sp</i>	4352	1077
SAPINDACEAE		
<i>Blighia sapida</i>	-	429
<i>Allophylus sp</i>	-	13
<i>Cardiospermum sp</i>	-	1746
STECULIACEAE		
<i>Steculia sp</i>	21	1746
<i>Tryplochiton scleroxylon</i>	-	2890
<i>Hildegardia barteri</i>	-	3266
TILIACEAE		
<i>Corchorus olitorus</i>	108	3266
Grand Total:	24,796	20,736
No. of pollen Types	18	28

A total number of eighteen (18) pollen types were identified in *Apis mellifera* pollen sample and twenty eight (28) pollen types were found in *Melipona species* pollen (Table 4). The plant species collected by the bees for pollen collection included *Citrus sp*, *Nauclea latifolia*, *Mimosa pudica*, *Pterocarpus sp*, *Dioscorea sp*, *Uapaca sp*, *Ipomea batata*, *Elaeis guinensis*. These plants had the highest frequencies as indicated in table 4 and have also been identified by Agwu and Agbaeze (1998), Akachuku (2002) as honeybees' plant species.

Table 5: T-test of the Proximate Compositions of Bee Pollens of *Apis-mellifera adansonii* and *Melipona Species*

Sample	Moisture	Crude fibre	Ash	Fat	Protein	Carbohydrate
<i>Apis mellifera</i>	20.05	2.51	12.80	1.96	19.10	43.54
<i>Melipona sp</i>	39.19	3.02	12.06	2.86	20.61	22.24
T-cal	-35.057	-23.49	4.61	-58.92	-5.97	32.70
Sig (2-tailed)	.000	.000	.010	.000	.004	.000

❖ Values are the means of three replicates

The comparative analysis of the two pollens showed highly significant differences as shown in Table 5. The *Melipona species* was higher in Moisture (39.19%), Fiber (3.02%), Fat (2.86), and Protein (20.61) than 20.05%, 2.15%, 1.96%, and 19.10% respectively found in the *Apis mellifera adansonii* pollen. A higher percentage ash (12.80%) and carbohydrate (43.54%) were found in *Apis mellifera* pollen while 12.07% (ash) and 22.24% carbohydrate respectively was contained by the *Melipona sp* pollen. The lower moisture content found in *Apis mellifera* pollen indicated that it has a longer shelf life than the *Melipona species* pollen. Water content of a product determines its shelf life [15, 16, 17]. The crude protein levels were 19.22% and 20.60% for *Apis mellifera adansonii* and *Melipona species* respectively. The results obtained are within the range (7.5 to 35%) reported by [4] as the typical range of protein content of bee pollen. The bee pollen is rich in protein and thus can be taken as protein supplement. The nutritional benefits of protein from various floral sources can be divided into three general categories. Pollens with >25% crude protein were classified as excellent quality, 20-25% crude protein as average quality and <20% crude protein as poor quality [18]. The results were lower than 25% considered as excellent quality of pollen required for optimum brood rearing and colony performance. This must have been as a result of the floral sources of the pollen samples which may not be excellent sources of protein. Relating the most frequent plant species in *Apis mellifera* pollen to their flowering periods, this sample must have been produced during the rainy season, and therefore since the protein content of that sample was not up to the 25% needed for optimum brood rearing might be a contributing factor to the reduction of brood rearing during the rains and also seasonal absconding of bees in southeastern Nigeria. Ample protein promotes a high birth rate and long-lived bees whereas low protein intake minimizes the number of brood reared and the longevity of adult bees [18, 19]. The results obtained from the analysis 19.22% and 20.62% protein were close to the percentage contained by some other good sources of protein such as fish (19%), meat (18%) soybean (34%) common dry bean (22%) as reported by [20]. Therefore pollen can serve as a good source of protein.

4. Conclusion \ Recommendations

The study showed that the good floral sources of bee pollen required by the bee species in southeastern Nigeria included: *Mimosa pudica*, *Citrus species*, *Pterocarpus sp*, *Dioscorea sp*, *Ipomea batata*, *Nauclea latifolia* and *Uapaca sp*.

The *Melipona species* collected a wider variety of plants than the *Apis mellifera adansonii*. However, *Apis mellifera adansonii* frequencies of visits to the different plants are

higher. *Apis mellifera* stores approximately six (6) plants per pellet while the *Melipona species* stores approximately eleven (10) plant species per pellet. It has also been found from this analysis that bee pollen contains all the essential nutrients. The percentage protein contained in the sample are lower than the adequate amount needed for optimum brood rearing and colony production and might be a contributing factor to seasonal absconding of bees during the rain. However, the following recommendations are made: the identified floral sources of bee pollen should serve as a guide to beekeepers in establishing farms (apiaries). The plant species found in each of the pollen pellets should be inter-planted in apiaries as the availability of these plant species will enhance pollen quality and quantity. Also, the identified plants should be conserved. Research, should be carried out on individual plant pollen to determine the nutrient composition of each plant species especially for these plants that are frequently visited by the bees to determine their contributions to colony growth.

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