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POTENTIALS OF FLORA SPECIES ON THE YIELD OF HONEY IN DAKKA FOREST RESERVE, BALI LOCAL GOVERNMENT AREA OF TARABA STATE, NIGERIA

[1]Kwaga, B.T., [1]Akosim, C., [1] Dishan, E. E. and [2]Khobe, D.

[1]Dept. of Forestry and Wildlife Management, Modibbo Adama University of Technology, Yola.
[2] Department of Animal Production, Adamawa State University, Mubi.
Corresponding Author's Phone Nos./email: 08027995044, 08072547283,
07038549207/ divinetizhe @ yahoo. Com/ zifadi007@gmail.com

ABSTRACT

The study assessed the potentials of flora on the yield of honey in Bali Local Government Area of Taraba State. Floral resources that could accommodate possible apicultural industry have not been examined in the study area. Data on plant species (trees, shrubs and herbaceous plants) utilized by honeybees were obtained through ocular assessment and total count methods. Information on the micro-climatic factors was gathered from the Nigerian Meteorological Agency, Jalingo, Taraba State. Yield of honey was recorded from different bee hives for 2 years. Data on species of plants visited by honeybees were analyzed using descriptive statistic, while woody plant species diversity was analyzed using Simpson Diversity Index. Multiple regressions were used in measuring the effect of various factors affecting honey yield. A total of 20 trees belonging to 13 families, 20 shrubs belonging to 12 families and 7 herbaceous plant species belonging to 5 families were visited either occasionally, frequently and very frequently by honeybees in the study area. Results of woody and herbaceous plant species diversity indicated 0.85488400 and 0.915007 respectively. Woody plant species diversity (12.434**) and temperature (0.832*) contributed more than other factors {P<0.05}. R.Square (65.9%) indicated high coefficient of determination between the determinant factors. Total honey yield of 68.1kg and 73.4kg were obtained for first and second years respectively. Langstroth and clay pot hives had the highest (24.6kg) and lowest (6.8kg) yields in the first year, while Israeli top-bar (33.4kg) and Langstroth (9.8kg) in the second year respectively. Further research on plants visited by honeybees and their nutrients composition is recommended.

Key words: plant species diversity, beehives, honey yield.

INTRODUCTION

A variety of habitats have been exploited by the honeybees and the choice of these habitats play an important role in their survival. Honeybees exist everywhere as long as there is food for them. Each habitat has a particular influence on the apicultural activities and major differences in floral habitat could exist at different seasons. Honeybee seasons are generally similar with respect to habitats, but local variations are determined by proximity to the predominant plant species and its richness (Mutsaers, 1995).

Nectar flow in a given habitat is dependent upon the species of plants and available nectar affecting those plants. While certain plant species are less attracted by weather pattern and habitats, others are not (Crane, 1990). The colonies of honeybees are fond of forming clusters in low temperatures and maintain it at the edge of these clusters above 9^0C with low normal activities. However, temperatures at 30^0C or above with relative humidity of 50% to 75% encourage nectar flow and pollen flow (Marieke, 1992).

Plant species density and climatic factors (rainfall, temperatures and relative humidity) have significant roles towards the yield of honey. Although each factor could contribute towards the yield of honey, plant species density seems to have greater effect than any other factor (Akosim *et al*, 2007). Too low (8^0C) and too high (above 50^0C) temperatures as well as relative humidity below 50% can affect laying of eggs, cause destruction of the larvae and make honeybees in-active (Marieke, 1992). Precipitation is also an important factor that accounts for the survival of plant population/diversity, yet species of honeybees withstand desert climate having annual rainfall less than 500mm. Precipitation do not only affect the distribution patterns and abundance of honeybee species, but also play an important part in species richness (Wanda, 2003). The amount of rainfall and temperature of an area exert a great influence on the life and output of honeybees. The insect can perform energetically at relatively high temperatures up to 30^0C, but their activities fall as the temperature drops below 20^0C and will not move at temperature below 8^0C (such temperatures are rare in Africa).

There are several honeybee products (beeswax, propolis, pollen, royal jelly, beebread, mead, organic honey, venom and honey) but honey seems to be the most favoured product. Honey is a mixture of fructose, glucose and water with small amount of other substances (minerals, vitamins, and proteins) (Jones and Yates, 2007). Beeswax has over 120 industrial uses, having ready market both at home and abroad. Propolis is used for filling cracks in the hives and gluing of top-bars by bees while pollen is used in feeding of brood at larval state. Royal jelly is specifically used by the queen bee during reproductive activities. In China, royal jelly is used in the manufacture of cosmetics (lotions and tonics) (Okonta, 2011). Bee venom is used in the treatment of arthritis and other related ailments (Stephen, 1990). Out of the estimated world honey consumption, 90% is eaten directly as food while the remaining 10% is utilized in various ways and other domestic products (Ikediobi and Obi, 1985). The value and importance of honey has been underestimated in the past due to lack of awareness and information on its antibiotic and medicinal properties (Ojeleye, 1999).

It is important to note that enough scientific information regarding the habitat potentials for beekeeping is necessary for the determination of viability of beekeeping industry in the study area. However, detailed survey that can yield data on floral resources (trees, shrubs and herbaceous plants) utilized by honeybees, their densities and diversities as well as ecological factors are yet to be ascertained in the study area (Kwaga *et al*, 2006), hence the need for this study which assessed the potentials of habitat for beekeeping in the study area.

METHODOLOGY.

Study Area T

Taraba State is located in the north-eastern part of Nigeria and lies between latitudes 7^0 30' and 8^0 30'N, Longitudes 10^0 30' and 12^0 00'E. It has a tropical climate marked by dry and rainy seasons. Annual rainfall varies from 1,200mm to 3,000mm in the central and south-eastern part of the State. The mean annual temperature ranges from 20^0C to 28^0C in both the mountainous parts of the southern region and along the border with Cameroon Republic, while maximum temperature ranges between 30^0C to 39.4^0C (Meteorological Inspectorate, Jalingo, 2013). The abundant woody plant species (trees and shrubs) include *Prosopis africana, Vitex doniana, Vitex simplifolia, Terminalia laxiflora, Combretum molle, Crossopteryx febrifuga, Danielia oliverii, Albezia species, Afzelia species, Triplochiton species, Gardenia aqualla, Ximenia americana, Parinari polyandra* and *Ceiba pentandra* among others. Herbaceous plant species consists of *Waltheria indica, Zornia latifolia, Cenchrus species, Pennisetum spcies, Tridax procumbens, Andropogon species, Panicum species and Sida acuta.* The state has twenty (20) forest reserves located within the sixteen (16) local government areas. The area occupied by natural forest is about 36.7% (Ministry of Environment and Urban Development, 2010).

Taraba State is blessed with the largest part of Gashaka-Gumti National Park which is an ecosystem of exceptionally high biodiversity and is rated as the largest National Park in the country (Nigeria National Park Service, 2007).

Its intricate vegetation supports over 1,000 species of mammals, 480 species of birds, 35 species of fish and over 300 species of butterflies (Gawaisa, 2002). Prominent species of mammals include *Pan troglodytes* (Chimpanzee), *Fellis acurata* (Golden cat), *Syncerus caffer* (African buffalo), *Panthera leo* (Lion) as well as *Panthera pardus* (Leopard), *Papio anubis* (Baboon), *Lycaon pictus* (Mud doff), *Kobus ellipsiprynus* (water buck), *Redunca redunca* (Red buck) and *Cephalophus monticola* (Blue duiker). Some reptile species include *Python sebae* (Python), *Crocodilus noliticus* (Nile crocodile). Among the birds' species are *Strunthio camelus* (Ostritch), *Tyto alba* (Owl), *Numida meleagris* (Guinea fowl) (Nigeria National Park Service, NNPS-2007) The major land-use in the study area is agriculture and fisheries. Forestry (e.g. Baissa Timber Corporation) also forms part of land-use.

Study Design and Data Collection

The study design followed the method described by Sutherland (1999) and adopted by Akosim *et al*, (2007). This involved the division of the entire area (Dakka Forest Reserve) into five plots. One hectare was randomly selected from each plot and 25 hives (comprising of Langstroth, Israeli top-bar, Kenya top-bar, Woven grass and Clay pot) i.e. 5 hives in each of the one hectare plots. Data on woody plant species list visited by honeybees and the intensity of visits were obtained through ocular/visual assessment of the plants as described by Kasina *et al* (2010). For assessment of density/diversity of woody plant species utilized by honeybees in the study area, total count of individuals as outlined by Ampitan and Okoro (2012) was done. For data on herbaceous plant species visited by honeybees, visual estimate as outlined by Sutherland (1999) was used. This involved the laying of one square meter ($1m^2$) quadrats at points randomly selected along a pre-determined transect and visual estimate were made of the cover during morning (7.00am) and evening (3.00pm-6.00pm) hours. The results were expressed in percentage classes <1%, 1-5%, 6-25%, 26-50%, 51-75% and 76-100% cover respectively.

Secondary data on rainfall, temperature and relative humidity for period of 3 years (2011-2013) were collected from Nigeria Meteorological Agency, Jalingo Taraba State following Kwaga *et al.* (2006). Data on the yield of honey in kg from various hives (clay pot, Israeli top-bar, Kenya top-bar, Langstroth and woven grass) were obtained for 2 years in the study area following Rahman and Lawal (2003) guide.

Statistical Analysis of Data

Descriptive statistics involving the use of tables, percentages and charts were used in presenting the list and intensity of visits to plant species by honeybees in the study area. Simpson Diversity Index as described by Akosim *et al* (2007) was used in determining the species diversity index in the study area. The mathematical formula is as follows

$D = \sum Pi^2$

$i = 1,$

Where, D = Simpson Diversity Index

P^2 = Proportion of the species, i.e. $\frac{ni}{N}$

ni= Individual of the species in a sample N.

D has a maximum value of 1 in a monoculture species and becomes smaller as the community becomes more diverse.

Multiple regression analysis was used to analyze the data on the effect of micro-climatic factors, woody and herbaceous plant species on the yield of honey in the study area. The formula is given as follows:

Y = bo b1x1 +b2x2 +b3x3 +b4x4 +b5x5 +Ut,

Where,

Y = Yield of honey in kg

X1 = Rainfall (mm)

X2 = Relative humidity (%)

X3 = Temperature (^0C)

X4 = Herbaceous plant species cover (%)

X5 = Woody plant species diversity.

b1 – b5 = Parameters ascertained, Ut = error term, bo = intercepts on Y axis

RESULTS AND DISCUSSION

The diversity of plant species list visited by honeybees and the intensity of visit in the study area (Table 1) indicated that a total of 20 trees belonging to 13 families were identified. Three (3) of the species *(Danielia oliveri, Terminalia*

glaucescens and *Terminalia laxiflora*) were frequently visited by bees, some of the species (*Detarium microcarpum, Combretum molle, Ficus ingens,Nauclea latifolia* and *Kigelia africana*) were occasionally visited.

The findings of this study revealed that a total of 20 shrub species belonging to 12 families were utilized by honeybees in the study area (Table 2). *Acacia tortilis* was visited very frequently, *Terminalia laxiflora, Ximenia americana* and *Combretum fragrans* among others were frequently visited as recently discovered species. *Vitex doniana, Vitellaria paradoxa* and *Detarium microcarpum* were occasionally visited by bees. This finding conforms to the report of Akosim et al (2007), who reported 4 shrub species visited by honeybees in certain parts of Adamawa State. The finding is also in strong agreement with Mwangi *et al* (2010), who reported that bee populations have been noted through foraging on plants, hedgerows bordering forests and related areas.

The finding equally indicated a high utilization of herbaceous plant species i.e. 7 species belonging to 5 families) (Table 3) that were rarely reported elsewhere. Typical herbaceous plant species that were utilized very frequently are *Hyptis suaveolens* and *Waltheria indica, Sida acuta* and *Urena lobata* were visited frequently while *Tephrosia pedicellata* was occasionally visited in the study area. The finding agrees with Akosim *et al* (2007), who reported 12 herbaceous plant species utilized by honeybees in a similar study.

Analysis of effects of micro-climatic factors, woody plant species diversity and herbaceous plant species on the yield of honey in the study area (Table 4) indicated that woody plant species diversity and temperature contributed significantly more than other factors. It could be assessed that woody plant species do not only provide forage for the honeybees, they also serve as homes or shelter for teaming bee populations. Hence, woody plant species diversity is an important ecological requirement of honeybees in the study area. Temperature in the study area ranges from 27^0C to 28^0C in cold season and rarely exceeds 45^0C to 50^0C in the hot season. Relative humidity ranges between 16% to 87%. Mutsaers (1992), observed that too low (8^0C) and too high (above 50^0C) temperatures as well as relative humidity below 50% can affect egg laying, destroy the larvae and abstract other activities in honeybees. The micro-climatic condition in the area is said to be suitable for beekeeping. Wilson (2006), observed that amount of rainfall and temperature of an area exert a great influence on the life and output of honeybees.

The Simpson diversity index of woody plant species in the study area indicated 0.85488400 and 0.915007 for herbaceous plant species cover (Tables 5 and 6). The Simpson diversity principle stipulates that diversity of species grow higher as the index approaches 1 and becomes lower as it approaches 0. The Simpson diversity index values for both woody and herbaceous plant species are indications of high diversity of forage species for honeybees. Maguran (2004), suggested that a variety of objective measures have been created to obtain the qualitative estimate of habitat for effective development. Both woody and herbaceous plant species in the study area have been found to be good forage resources for honeybees. Mwangi et al (2010), reported that bee populations have been noted through foraging on hedgerows on plants bordering forest reserves in Kenya. Albert (2012), reported that diversity is a quantitative measure that reflects many different species in existence, which also quantify the biodiversity of a habitat.

The yield of honey in relation to habitats and hive types in the study area is reported in Table 7. A total yield of 68.1kg was recorded from all the hives during the first year (2012) while an average of 13.62kg per hive was obtained. Langstroth hives had the highest total yield of 24.46kg while the lowest yield of 6.8kg was recorded from clay pot. In the second year (2013), a total yield of 73.4kg was obtained (i.e. average yield of 14.68kg/hive). Israeli top-bar recorded the highest total yield of 33.4 while the lowest yield of 9.8kg was recorded from Langstroth and none (0.00kg) from woven grass. However, when compared to the yield of honey from other studies elsewhere, the yield seemed to be encouraging. Beetsma *et al* (2001), reported an average honey yield of

1.5kg to maximum of 10.0kg per beekeeper per colony in Cameroon. Michael (2012), reported an average honey yield of 8.3kg per hive from Eucalyptus plantation.

CONCLUSION

The study examined the potentials of floral species on the yield of honey in Dakka Forest Reserve of Bali local Government area, Taraba State, Nigeria. From the results obtained, it could be noted that there are adequate representations of plant species in the study area. About 40% of the plants were frequently visited by the honeybees indicating high utilization, high nectar and pollen flow in the area, which serve as ecological requirements for beekeeping in the study area. Multiple linear regression carried out further confirmed the significant role of the floral species and micro-climate (temperature, rainfall and relative humidity) towards the yield of honey in the study area. It could therefore be concluded that given proper planning and management, beekeeping in the study area would be a worthwhile business.

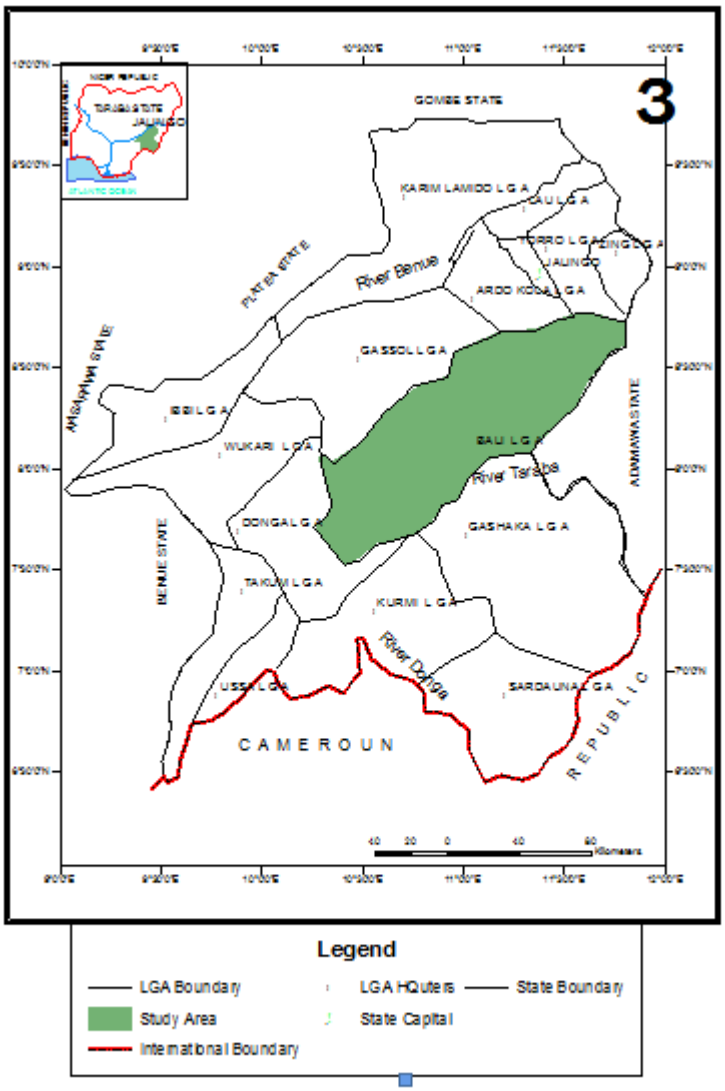

Figure 1: Map of Taraba State showing the study Area (Bali L.G.A.).
Source: Lazarus (2015).

Table 1: Tree Species visited by honeybees in Dakka Forest Reserve, Bali Local Government Artea of Taraba State, Nigeria.

S/No	Family	Scientific name	Common/local name	Flowering period	Intensity of visit Morning	evening
1.	Anacardiaceae	*Annona senegalensis*	Wild custard apple	March-May	*	*
2	Annonaceae	*Anogeissus leiocarpus*	African birch	All year round	*	*
3.	Boraginaceae	*Bridelia macrantha*		March-May	*	*
4.	Combretaceae	*Combretum molle*		March-May	*	*
5.	Convolvulaceae	*Crossopteryx febrifuga*		August-Oct	**	**
		Danielia oliveri	African copaiba	Jan-March	**	**
		Detarium microcarpum	Tallow tree	July-Sept	*	*
6.	Fabaceae	*Ficus sycomorus*		March-May	*	*
		Ficus platyphylla	Flake rubber tree	March-May	*	*
		Ficus ingens		March-May	*	
7.	Flacourtiaceae	*Guibourtia copallifera*	West African copal	Jan-March/ Oct-Dec	*	*
8.	Hymenocardiaceae	*Kigelia africana*	Sausage tree	March-May	*	*
9.	Loganiaceae	*Lophira lanceolata*	Red oak/ Red ironwood	Feb- April	*	*
10	Myrtacaceae	*Nauclea latifolia*	African peach	July-Sept	*	*
11	Opiliaceae	*Piliostigma thonningii*	Camel' foot	June-August	*	*
12	Tamaricaceae	*Terminalia laxiflora*		March-May	**	**
		Terminalia glaucesens		March-May	**	**
13	Vitaceae	*Vitellaria paradoxa*	Shea-butter tree	Jan-March	*	*
		Vitex doniana	Black plum	March-May	*	*
		Vitex simplicifolia		March-May	*	*

Key: * Occasionally visited ** frequently visited **Source:** Field Survey, 2012, 2013

Table 2: Species of shrubs visited by honeybees in Dakka Forest Reserve, Bali Local Government Artea of Taraba State, Nigeria.

S/No	Family	Scienctific name	Common/ local name	Flowering period	Intensity of visit	
					Morning	Evening
1.	Apocynaceae	*Parinari polyandra*		August-Oct	*	*
2.	Anacardiaceae	*Annona senegalensis*	Wild custard apple	March-May	*	*
3.	Combretaceae	*Combretum fragrans*		March-May	**	**
		Combretum molle		March-May	*	*
4.	Convolvulaceae	*Detarium microcarpum*	Tallow tree	July-Sept	*	*
5.	Fabaceae	*Ficus sycomorus*		Feb-April	*	
6.	Flacourtiaceae	*Gardenia aqualla*		Feb-April	*	
		Grewia barterii		April-June	*	
		Guibourtia copallifera		All year round	*	*
7.	Loganiaceae	*Lophira lanceolata*	Iron wood	Feb-April	*	
8.	Mimosoidea	*Acacia tortilis*		July-Sept	***	***
		Acacia sieberiana	White thorn	April-June	*	*
9.	Myrtaceae	*Nauclea latifolia*	African peach	March-May	*	*
10.	Opiliaceae	*Piliostigma thonningii*	Camel's foot	June-August	*	*
11.	Tamacaceae	*Terminalia laxifolia*		March-May	**	**
		Terminalia glaucescens		March-May	**	**
12.	Vitaceae	*Vitellaria paradoxa*	Shea-butter tree	Feb-April	*	*
		Ziziphus abyssinica	Catch thorn	August-Oct	**	**
		Ximenia Americana	Wild olive	March-May	**	**
		Vitex doniana	Black plum	March-May	*	*

Key: * Occasionally visited ** frequently visited *** Very frequently visited

Table 3: Species of herbaceous plants visited by honeybees in Dakka Forest Reserve, Bali Local Government Area of Taraba State, Nigeria .

S/N	FAMILY	SCIENCTIFIC NAME	COMMON/ LOCAL NAME	FLOWERING PERIOD	INTENSITY OF VISIT	
					Morning	Evening
1.	Euphorbiaceae	*Croton hirtus*		August-Oct	*	*
2.	Lamiaceae	*Hyptis suaveolens*	Bush tea	August-Oct	***	***
3.	Leguminosae	*Tephrosia pedicellata*		August-Oct	*	*
		Zornia latifolia		August-Oct	**	**
4.	Malvaceae	*Sida acuta*	Broom weed	August-Oct	**	**
		Urena lobata	Hibiscus bur	August-Oct	**	**
5.	Sterculiaceae	*Waltheria indica*		August-Oct	***	***

Key : *Occasionally visited, ** frequently visited, *** Very frequently visited

Table 4: Linear Regression of Micro-climatic Factors, Woody plant species Diversity and Herbaceous plant species Cover on the Yield of Honey in Dakka Forest Reserve, Bali Local Government Artea of Taraba State, Nigeria.

Variables	Parameter Estimate (Coefficients)	Standard error	T-ratio
Intercepts	28.363	54.410	0.521
Rainfall	-0.038	0.047	- 0.813
Relative Humidity	0.034	-0.180	0.192
Temperature	0.832*	1.623	- 0.386
Woody plant Species	12.434**	1059.441	1.059
Herbaceous Plant Spe	-0.037	0.019	- 1.924

* = Significant at 5% {P<0.05} ** = Significant at 1% {P<0.01} R^2 = 65.9%

Regression Model

$Y = 28.363 + 0.038x_1 + 0.034x_2 + 0.627x_3 + 1121.434x_4 + 0.037x_5$

Rainfall negatively but did not significantly affect yield of honey in the study area. Relative humidity had a positive effect but did not significantly affect yield of honey in the study area.

Temperature positively and significantly {P<0.05} affected the yield of honey. Woody plant species Diversity positively and highly significantly {P<0.01} affected yield of honey. Herbaceous plant Species Cover negatively but did not significantly affect yield of honey in the study area.

Table 5: Woody Plant Species Diversity in Dakka Forest Reserve, Bali Local Government Area of Taraba State,Nigeria.

Species	**Frequency**	**Pi**	**$(pi)^2$**
Pterocarpus erinaceus	77	0.0481551	0.002318913
Ficus ingens	72	0.0450281	0.002027534
Ficus platyphylla	8	0.0050031	2.50313e-05
Ficus thonningii	15	0.0093809	8.80006e-05
Ficus sycomorus	13	0.0081301	6.60982e-05
Parkia biglobosa	14	0.0087555	7.66583e-05
Pilliostigma thonningii	96	0.0600375	0.003604504
Pericopsis laxiflora	13	0.0081301	6.60982e-05
Terminalia laxiflora	6	0.0037523	1.40801e-05
Terminalia mantaly	19	0.0118824	0.000141192
Terminalia albida	122	0.0762977	0.005821337
Guibourtia copallifera	126	0.0787992	0.006209322
Gardenia aqualla	156	0.097561	0.009518144
Kigellia africana	85	0.0531582	0.002825797
Terminalia glaucesens	25	0.0156348	0.000244446
Entada africana	102	0.0637899	0.004069147
Euphorbia kamerunica	21	0.0131332	0.000172481
Prosopia africana	53	0.0331457	0.001098638
Danelia oliveri	64	0.040025	0.001602002
Detarium microcarpum	137	0.0856785	0.007340814
Santaloides afzelii	14	0.0087555	7.66583e-05
Crossopteryx febrifuga	2	0.0012508	1.56445e-06
Parinari curafellifolia	5	0.003127	9.77784e-06
Naudea latifolia	10	0.0062539	3.91114e-05
Ochna schvein furthiana	3	0.0018762	3.52002e-06
Sterculia setigera	20	0.0125078	0.000156445
Haematostaphis barteri	8	0.0050031	2.50313e-05
Mitragyna inermis	25	0.0156348	0.000244446
Acacia nilotica	2	0.0012508	1.56445e-06
Acacia tortilis	7	0.0043777	1.91646e-05
Acacia sieberiana	2	0.0012508	1.56445e-06
Acacia genardii	3	0.0018762	3.52002e-06
Blighia sapida	78	0.0487805	0.002379536
Vitex doniana	53	0.0331457	0.001098638
Vitex simplifolia	4	0.0025016	6.25782e-06
Vitellaria paradoxa	1	0.0006254	3.91114e-07
Ximenia americana	34	0.0212633	0.000452127
Boswellia dalzielii	2	0.0012508	1.56445e-06
Boswwllia papyrifera	2	0.0012508	1.56445e-06
Spondias monbin	4	0.0025016	6.25782e-06
Spondias lutea	3	0.0018762	3.52002e-06
Annona senegalensis	54	0.0337711	0.001140488
Combretum fragrans	5	0.003127	9.77784e-06
Combetum nigricans	17	0.0106316	0.000113032
Anogeissus leiocarpus	14	0.0087555	7.66583e-05
Manilkara multinervia	3	0.0018762	3.52002e-06
	1599	1	0.05320594
Simpson's diversity index			**0.94679406**

Table 6: Herbaceous plant species Simpson Diversity Index in Dakka Forest Reserve, Bali Local Government Artea of Taraba State, Nigeria.

Species	**Frequency**	**Pi**	**$(Pi)^2$**
Sena obtusifolia	66	0.2142857	0.045918367
Sida acuta	71	0.2305195	0.053139231
Urena lobata	58	0.1883117	0.035461292
Sida garckeana	5	0.0162338	0.000263535
Waltheria indica	5	0.0162338	0.000263535
Tephrosia pedicellata	44	0.1428571	0.020408163
Hibiscus asper	17	0.0551948	0.003046467
Sida cordifolia	30	0.0974026	0.009487266
Tephosia linearis	12	0.038961	0.001517963
	308	1	0.169505819
Simpson's diversity index			**0.830494181**

Source: Field Survey (2012, 2013)

Table 7: Yield of Honey (in kg) for 2 years (2012 and 2013) in Dakka Forest Reserve, Bali Local Government Artea of Taraba State, Nigeria.

Period/Year	**Hive Types**	**Hive no.**	**Total Yield in kg**	**Percentage (%)**
2012	Clay pot H1	3	11.15	10.78
	Israeli top-bar (H2)	3	12.20	11.71
	Kenya top-bar (H3)	3	27.97	26.96
	Langstroth (H4)	3	43.30	41.85
	Woven grass (H5	3	9.0	8.70
Total			**103.47**	**100.00**
Mean			**6.70**	
2013	Clay pot H1	3	5.90	9.65
	Israeli top-bar (H2)	3	20.10	32.90
	Kenya top-bar (H3)	3	5.2	8.51
	Langstroth (H4)	3	24.30	39.77
	Woven grass (H5	3	5.6	9.17
Total			**61.10**	**100**
Mean			**4.07**	

Source: Field Survey, 2012, 2013

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