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EXAMINATION OF THE INFLUENCE OF PLANT SPECIES AND BEEHIVE TYPES ON THE YIELD OF HONEY IN TOUNGO LOCAL GOVERNMENT AREA, ADAMAWA STATE, NIGERIA

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ABSTRACT

The study assessed the influence of plant species and beehives on the yield of honey in Mayo-Bakari Community Game Reserve in Toungo Local Government Area of Adamawa State. Data on list of woody and herbaceous plant species visited by honeybees were obtained through ocular assessment and total count method. Yield of honey was recorded from different bee hives for 2 years. Data on species list of plants visited by honeybees were subjected to descriptive statistics. Woody plant species diversity was analyzed using Simpson Diversity Index. Multiple regressions were used in the assessment of woody plant species diversity and herbaceous plant species cover on the yield of honey. Seventeen woody plant species belonging to 11 families and 10 herbaceous plant species belonging to 4 families were visited either occasionally, frequently and very frequently by honeybees in the study area. Results of woody and herbaceous plant species diversity were 0.9468 and 0.8305 respectively. Woody plant species diversity (111.416**) and temperature (0.627*) 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 110.47kg and 71.10kg were obtained for first and second years respectively. Langstronth and woven grass had the highest (39.19%) and lowest (8.10%) yields in the first year, while Langstronth (41.21%) and Kenya top-bar (7.31%) hives were noted in the second year. Further research on plants visited by honeybees and their nutrients composition is recommended.

Key words:woody plants, herbaceous plants, diversity, beehives, honey,

INTRODUCTION

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 composition 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, weather and available nectar affecting those plants.

These also affects the yield of honey in such areas. 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% encourages nectar flow and pollen flow (Marieke, 1992).

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. However, detailed survey 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 (Mohammed *et al*, 2006), hence the need for this study which assessed the potentials of habitat for beekeeping in the study area.

METHODOLOGY

Study Area

The study area is Mayo-Bakari community game reserve, located in Toungo local government area of Adamawa State and adjacent to Gashaka-gumti National Park. It lies between latitudes 8^0 00' north and longitudes 11^0 and 12^0 0' east of Green Witch Meridian (fig 1). Mean monthly temperatures ranged from 26.70^0C to 27.80^0C while relative humidity varies from 20% to 30% in January to March and reach its peak (above 70%) between August and September. Annual rainfall ranges from 1,100mm to 1,600mm and lasts for 6-7 months. (Minisry of Agriculture, Ganye Zonal Office, 2013). The dominant woody plant species include *Terminalia laxiflora, Guibourtia copallifera, Detarium microcarpum, Kigellia africana, Terminalia mantaly, Prosopis africana, Mitragyna inermis and Combretum nigricans.*Herbaceous plant species consists of *Waltheria indica, Sena obtusifolia, Sida acuta, Urena lobata* and *Hibiscus asper (*Akosim *et al*, 2007*).* The fauna resources include mammals like. *Pan troglodytes* (Chimpanzee), *Kobus ellipsiprynus* (water buck), *Redunca redunca* (Red buck), *Syncerus caffer* (African buffalo), *Cephalophus monticola* (Blue duiker), *Panthera leo* (Lion) as well as *Panthera pardus* (Leopard). Reptiles incude *Python sebae* (Python) and *Crocodilus noliticus.* Among the birds species are *Struthio camelus* (Ostritch), *Tyto alba* (Owl), *Numidea milleagris* (Guinea fowl) (Nigerian National Park Service, NNPS-2007) The major land-use in the study area is agriculture, fisheries and wildlife conservation (Akosim *et al.,* 2007)

Study Design and Data Collection

The study design followed the method described by Sutherland (1999) and adopted by Akosim *et al.,* (2007). This involves the division of the entire area (Mayo-Bakari community Game Reserve) into five plots of one hectare each. Three hectares were randomly selected and 15 hives (comprising of Langstronth, Israeli top-bar, Kenya top-bar, Woven grass and Clay pot) i.e. 5 hives in each of the one hectare plots) were located across the plots following Okonta (2011) and Kwaga *et al., (*2006) guides. Data on woody plant species visited by honeybees and the intensity of visit 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 involves 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 to 10.00am) and evening (3.00pm to 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 the nearest meteorological stations of the study area. Data on the yield of honey from various hives (clay pot, Israeli top-bar, Kenya top-bar, Langstronth 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 results. Simpson Diversity Index as described by Akosim *et al* (2007) was used in determining the species diversity index of what in the study area. The mathematical formula is as follows

$D = \sum Pi^2$

i = 1,

Where, D= Simpson Diversity index,

Pi=proportion of the species, i.e $\frac{ni}{N}$

n_i= individual of the species in a sample of 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 (^{0}C)

X4 = Herbaceous plant species cover (%)

X5 = Woody plant species diversity.

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

Regression Model

$Y = 28.363 + 0.038x_1 + 0.034x_2 + 0.627x3 + 111.416x_4 + 0.037x_5$

(54.410) ns (0.047) ns (-0.180) ns (1.623)* (104.440) ** (0.019) ns

RESULTS AND DISCUSSION

The diversity of woody plant species list visited by honeybees and the intensity of visit in the study area (Table 1) indicates that a total of 25 trees belonging to 14 families were identified. Two (2) of the woody plant species *(Acacia tortilis* and *Terminalia mantaly*) were very frequently visited by bees, 5 of the species (*terminalia albida, Detarium microcarpum, Danielia oliverii, Combretum nigricans* and *Pericopsis laxiflorus*) were frequently visited while 3 (*Sterculia setigera, Mitragyna inermis andFicus ingens*) were occasionally visited by bees morning and evening. The species of plants visited by honeybees were because of----which agrees with the statement of Reinhard (1997), who stated that many tree species were known for their apicultural values.

The finding of this study revealed that a total of 17 shrub species belonging to 11 families were utilized by honeybees in the study area (Table 2). *Terminalia albida,*

Terminalia mantaly, Acacia gerradii and *Acacia tortilis* were recently discovered species which. This conforms to the report of Akosim et al (2007), who reported 4 shrub species visited by honeybees in certain part 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. 10 species belonging to 4 families (Table 3). Typical herbaceous plant species that were utilized very frequently are *Hibiscus asper* and *Waltheria indica* while *Sida acuta* was visited frequently in the study area. The finding agrees with Akosim *et al.,* (2007), who reported 12 herbaceous plant species utilized by honeybees in Adamawa State .

Analysis of effects 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. Temperature positively and significantly {P<0.05} affected the yield of honey. Woody plant species diversity positively and 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.

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.

The Simpson diversity index of woody plant species in the study area indicated 0.9468 and 0.8305 for herbaceous plant species cover (Tables 5 and 6). The Simpson diversity principles 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 population 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 shown inTable 7 . A total yield of 103.47kg was recorded from all the hives during the first year (2012) with an average of 6.70kg per hive was obtained. Israeli top-bar hives had the highest total yield of 43.3kg (.14.43kg/hive) while the lowest yield of 9.0kg was recorded from woven grass (3.0kg/hive). In the second year (2013), a total yield of 61.10kg was obtained (average yield of 4.07kg/hive). Langstronth recorded the highest total yield of 39.77 (13.26kg/hive) and the lowest yield of 5.2kg was recorded from Kenya top-bar. 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 10.0kg per beekeeper per colony in Cameroon. Michael (2012) reported an average honey yield of 8.3kg per hive from Eucalyptus plantation in South Africa.

CONCLUSION

The study examined the effect of habitat potentials on the yield of honey in Toungo local Government area of Adamawa State, Nigeria. From the results obtained, it can be concluded that the study provided baseline information on the potentials of plant species and beehive types for beekeeping. It could be noted that there are adequate representations of plant species, which serve as ecological requirements for beekeeping in the study area. Studies on the nutrient composition of various forage resources for bees could be carried out in the study area.

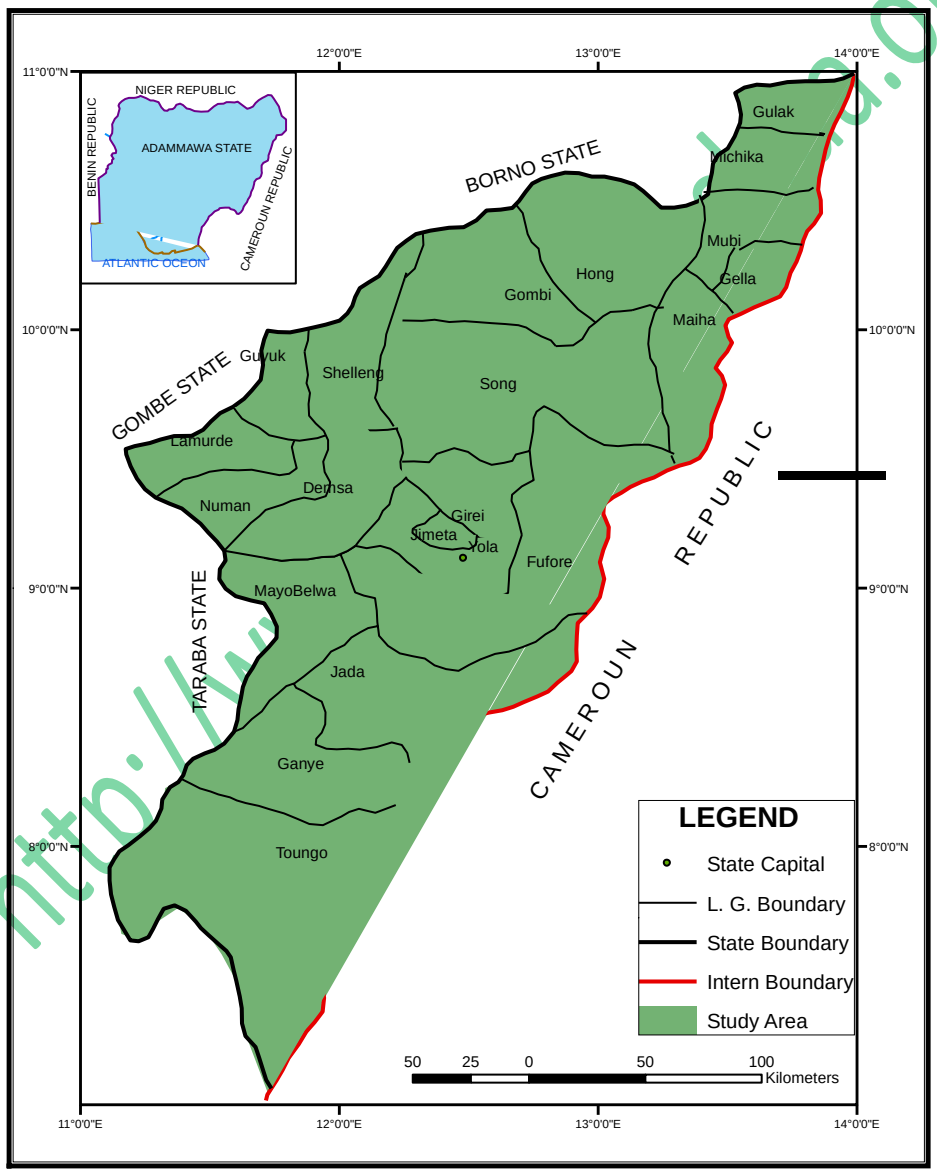

FIGURE 1: MAP OF ADAMAWA STATE SHOWING THE STUDY SITES (Toungo L G A and Hong L G A)

Fig.1: Map Adamawa State Showing the Study Area
Source; Ministry of Agriculture, Ganye Zonal Office, Adamawa State (2013).

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Table 1: Species list of woody plants visited by honeybees in the Savannah woodland.

S/N	FAMILY	SCIENTIFIC NAME	COMMON/LOCAL NAME	FLOWERING PERIOD	INTENSITY OF VISIT Mor.	Evng
1.	Annonaceae	*Annona senegalensis*	Wild custard apple	March-May	*	*
2.	Bignoniaceae	*Blighia sapida*	Akee	March-May, Nov-Jan	*	*
3.	Convolvulaceae	*Detarium microcarpum*		July-Sept	**	**
4.	Fabaceae	*Ficus ingens*		March-May	*	*
5.	Flacourtiaceae	*Gardenia aqualla*		Feb- April	*	
6.	Mimosoideae	*Mitragyna inermis*	False abura	July-Sept	*	*
		Acacia tortilis		July-Sept	***	***
		Acacia gerardii		March-May	***	***
7.	Myrtaceae	*Nauclea latifolia*	African peach	July-Sept	*	*
8.	Opiliaceae	*Piliostigma thonningii*	Camel's foot	June-August	*	*
9.	Proteacea	*Pterocarpus erinaceus*	Sensgal Rosewood	Feb-April	*	*
10.	Tamaricaceae	*Terminalia mantaly*		March-May	***	***
		Terminalia albida		March-May	***	***
		Terminalia glaucescens		March-May	**	**
11.	Vitaceae	*Vitex doniana*	Black plum	March-May	*	*
		Ximenia Americana	Wild olive	March-May	*	*

	Vitex simplifolia	March-May	*	*

Key * occasionally visited ** frequently visited *** Very frequently visited
Source: Field Survey, 2012, 2013

Table 3: Species list of herbaceous plants visited by honeybees in the Savannah woodland.

S/N	FAMILY	SCIENCTIFIC NAME	COMMON/LOCAL NAME	FLOWERING PERIOD	INTENSIT OF VISIT	
					Morning	Evening
1.	.Leguminosea	*Sena obtusifolia*		August- October	*	*
		Tephrosia pedicellata		August-October	*	*
		Tephrosia linearis		August-October	*	*
2.	Malvaceae	*Sida acuta*	Broom weed	August-October	**	**
		Urena lobata	Hibiscus bur	August-October	**	**
		Sida garckeana		August-October	*	*
		Hibiscus asper		August-October	***	***
		Sida cordifolia		August-October	**	**
3.	Portulacaceae	*Portulaca quadrifida*	Ten'o'clock plant	August-October	*	*
4.	Sterculiaceae	*Waltheria indica*		August-October	***	***

Key * Occasionally visited ** frequently visited *** Very frequently visite

Table 4: Linear Regression of Micro-climatic Factors, Woody plant species Diversity and Herbaceous plant species Cover on the Yield of Honey in the Study Area.

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	0.627*	1.623	- 0.386
Woody plant Species Diversity	111.416**	104.440	1.066
Herbaceous Plant Species Cover	-0.037	0.019	- 1.924

* = Significant at 5% {P<0.05} ** = Significant at 1% {P<0.01}

Key: Figures in parenthesis are corresponding standard errors

* = Significant at 5% {P<0.05} ** = Significant at 1% {P<0.01} ns = Not significant, R^2 = 65.9%

Table 5: Woody plant species Diversity in the Study Area.

Species	Frequency	Pi	$(Pi)^2$
Pterocarpus erinaceus	77	0.0481	0.0023
Ficus ingens	72	0.0450	0.00203
Ficus platyphylla	8	0.0050	2.5031E-05
Ficus thonningii	15	0.0094	8.8001E-05
Ficus sycomorus	13	0.0081	6.6098E-05
Parkia biglobosa	14	0.0088	7.6658E-05
Pilliostigma thonningii	96	0.0600	0.0036
Pericopsis laxiflora	13	0.0081	6.6098E-05
Terminalia laxiflora	6	0.0037	1.4080E-05
Terminalia mantaly	19	0.01188	0.0001
Terminalia albida	122	0.0763	0.0058
Guibourtia copallifera	126	0.0788	0.0062
Gardenia aqualla	156	0.0976	0.0095
Kigellia Africana	85	0.0532	0.0028
Terminalia glaucesens	25	0.0156	0.0002
Entada Africana	102	0.0638	0.0041
Euphorbia kamerunica	21	0.0131	0.0002
Prosopia africana	53	0.0331	0.0011
Danelia oliverii	64	0.0400	0.0016
Detarium microcarpum	137	0.0857	0.0073
Santaloides afzelii	14	0.0088	7.6658E-05
Crossopteryx febrifuga	2	0.0013	1.5644E-06
Parinari curafellifolia	5	0.0031	9.7778E-06
Naudea latifolia	10	0.0063	3.9111E-05
Ochna schvein furthiana	3	0.0019	3.5200E-06
Sterculia setigera	20	0.0125	0.0002
Haematostaphis barteri	8	0.0050	2.5031E-05
Mitragyna inermis	25	0.0156	0.0002
Acacia nilotica	2	0.0012	1.5644E-06
Acacia tortilis	7	0.0044	1.9165E-05
Acacia sieberiana	2	0.0013	1.5644E-06
Acacia genardii	3	0.0019	3.5200E-06
Blighia sapida	78	0.0488	0.0024
Vitex doniana	53	0.0331	0.0011
Vitex simplifolia	4	0.0025	6.2578E-06
Vitellaria paradoxa	1	0.0006	3.9111E-07
Ximenia Americana	34	0.0212	0.0005
Boswellia dalzielii	2	0.0013	1.5645E-06
Boswwllia papyrifera	2	0.0013	1.5645E-06
Spondias monbin	4	0.0025	6.2578E-06

Spondias lutea	3	0.0019	3.5200E-06
Annona senegalensis	54	0.03378	0.0011
Combretum fragrans	5	0.0031	9.7778E-06
Combetum nigricans	17	0.0106	0.0001
Anogeissus leiocarpus	14	0.0088	7.6658E-05
Manilkara multinervia	3	0.0019	3.5200E-06
	1599	1	0.0532
		SIMPSON'S	**0.9468**

Table 6: Herbaceous plant species Simpson Diversity Index in the Study Area.

Species	Frequency	Pi	$(Pi)^2$
Sena obtusifolia	66	0.2143	0.0459
Sida acuta	71	0.2305	0.0532
Urena lobata	58	0.1883	0.0355
Sida garckeana	5	0.0162	0.0003
Waltheria indica	5	0.0162	0.0003
Tephrosia pedicellata	44	0.1429	0.0204
Hibiscus asper	17	0.0552	0.0030
Sida cordifolia	30	0.0974	0.0095
Tephosia linearis	12	0.03896	0.0015
	308	1	0.1695
		SIMPSON'S	**0.8305**

Table 7: Yield of Honey in kg for 2 years (2014 and 2015) in the study Area.

Period/Year	Hive Types	Hive no.	Total Yield in kg	Percentage (%)
2014	Clay pot H1	3	11.15	10.09
	Israeli top-bar (H2)	3	19.20	17.38
	Kenya top-bar (H3)	3	27.90	25.25
	Langstronth (H4)	3	43.30	39.19
	Woven grass (H5)	3	9.0	8.10
Total			**110.47**	**100.00**
Mean			**7.36**	
2015	Clay pot (H1)	3	5.90	8.30
	Israeli top-bar (H2)	3	25.10	35.30
	Kenya top-bar (H3)	3	5.2	7.31
	Langstronth (H4)	3	29.30	41.21
	Woven grass (H5)	3	5.6	7.88
Total			**71.10**	**100.00**
Mean			**4.74**	

Source: Field Survey, 2012, 2013