Gashua Journal of Irrigation and Desertification Studies
Available online at www.gjidsfugashua.org.ng
Volume 2, Issue 2

EFFECTS OF MICRO-CLIMATIC FACTORS AND HIVE EFFICIENCY ON THE YIELD AND QUALITY OF HONEY IN HONG LOCAL GOVERNMENT AREA OF ADAMAWA STATE, NIGERIA

[1]Kwaga, B. T., [1]Ali, A., [2]Ringim, M. I.G.[3] and Dishi, K.
[1]Department of Forestry and Wildlife Management, Midibbo Adama University of Technology (MAUTECH), Yola, Adamawa State- Nigeria
[2]Biniyaminu Usman Polytechnic, Hadejia, Jigawa State
[3] Department of Crop Science, Adamawa State University, Mubi.
Correspondence: divinetizhe@ yahoo.com; zifadi00@gmail.Com:
07038549207; 08072547283; 08027995044

Abstract

The study examined the effects micro-climatic factors and beehive efficiency on the yield and quality of honey in Hong Local Government Area of Adamawa State. Habitat and hive potentials that could guarantee possible apicultural industry have not been examined in the study area. Data on the micro-climatic factors were gathered from the nearest meteorological station to the study site. Yield of honey was recorded from different bee hives for 2 years. Method of Association of Analytical Chemist (AOAC) was used to determine the chemical composition of honey. Multiple regressions were used in the assessment of effect of micro-climatic factors. Analysis of variance-ANOVA (RCBD) was used in assessing the efficiency of hive types on the yield and quality of honey. Temperature (0.527*) contributed more than other factors ($P<0.05$) to the yield of honey. R^{22} (65.9%) indicated high coefficient of determination between the determinant factors. A mean yield of 25.20kg and 6.95kg were obtained from Langstronth and clay pot respectively. Total honey yield of 36.20kg (38.39%) and 25.30kg (41.88%) were obtained for first and second years respectively. Yield varied significantly with hive types, but quality of honey did not vary significantly with hive types. Further studies should be conducted on other mineral elements of honey that were not covered by this research.

Keywords: Effects, Efficiency, beehives, honey yield, quality

INTRODUCTION

Apiculture is one of the branches of agriculture and a form of animal husbandry that includes the collection and care of bee swarms, pollination of field crops by the bees and breeding of bees for various products. The main aim is to obtain the desired hive products for various needs required at different periods of the season. It is a special agricultural enterprise that serves as foreign exchange earner for some countries within and outside Africa (Beetsma, *et al.*, 2001). Unfortunately, beekeeping as a commercial venture is still largely unexplored in Nigeria (Marieke, 1993).source?. This field is still at the crude stage with the exception of few farmers and individuals trying to keep pace with modern methodss. International Center for Tropical Agriculture –ICTA (2003), reported that honeybees play a vital role in plant productivity as well as horticultural production through cross-pollination. Through this process, yield pattern and productivity are said to be increased by 55%. Beekeeping for honey and nectar is becoming popular among the small-scale farmers but rare or absent among the large-scale farmers (Carol, 2003). Bee products (honey, wax, pollen) are highly demanded by the households, hospitals, pharmaceutical and cosmetic industries for the treatment of wounds, ulcers, and burns and as source of food (Balogun *et al.*, 2007).

Hives are used in housing the honeybees. They are categorized into traditional and modern bee hives. Honeybees that nest in the open produce far less honey than those confined in hives, reason being that colonies in the open are exposed to predators. Traditional bee hives have been in practice from time immemorial, especially in the Sahel regions (Ande *et al.*, 2008) source?. Woven grass and clay pot (from mud) play major roles in providing material for bee hive construction. Dry grasses are woven together in a basket or cylindrical form, usually with entry point at both ends and installed for baiting on trees or rocks to avoid termites. Such hives are usually used for short period (1-2 years). Log hives or tree hollows are also used in the African sub-regions that provide natural hollows for bees (Caro, 2003). source?. According to Kamatara (2009), traditional beekeeping utilizes cheap and plentiful local materials for hive construction, some of which would otherwise be wasted. Despite the fact that there is high rate of utilization of local materials for traditional bee hives (clay pot, woven grass) as well as hive products, the hives cannot easily be manipulated since bees fix their combs to the hive body. Combs cannot be inspected at all and detached combs cannot be easily replaced (Kamatara, 2009).

The design of modern bee hives is based on the discovery of Lorenzo Lorraine Langstronth, who invented a hive with frames separated by bee space in which the bees could build their combs. Frames of Langstronth are so arranged that they can be carefully removed and inspected without disturbing other combs and or crushing the bees. Almost all commercial hives in use today operate on the Langstronth pattern (Ande *et al.*, 2008a). The combs of the frame hives (Langstronth) are attached firmly to the four sides, thus facilitating easy harvesting with little or no damage to the comb. The frame hive affords easy inspection as well as control of a colony of bees without fear of breakage before arrival at the new destination. Queen and brood are confined to the lower chamber. Although all the hive types could be stolen, that of clay pot and woven grasses are more prone to theft (Kamatara, 2009).

Natural bee hives typically referred to as ‘’nests” are naturally-occurring structures occupied by honeybee colonies while domesticated honey bees live in man-made beehives often in an apiary. Only species of the sub-genus Apis live in hives, but only the Africanized honey bee Apis *mellifera* and the eastern honey bee *Apis* *cerana* are domesticated by humans (Ande *et al.*, 2008a). The beehive's internal structure is a densely packed matrix of hexagonal cell made up of bee wax, called a honey comb. The bees use the cell to store food (honey and pollen) and to house the brood (eggs, larvae, pupae). Production and yield of honey is influenced by the type of hive, environmental factors (pesticides, fire and disease), ecological factors (rainfall, relative humidity, temperature) as well as the experience of the beekeepers (Ayodele and Onyekuru, 1999; Stilling, 2002).Micro-climatic factors (temperature, precipitation, and relative humidity) and plant species density have significant role on the yield of honey. Although each of these factors could affect the yield of honey immensely, plant species density seemed to have greater effect than climatic factors (Akosim *et al.*, 2007).

METHODOLOGY

Study Area

The study area is Hong local government area of Adamawa State. It lies between latitudes 10^0 00' N and longitudes 13^0 00'E of Greenwich Meridian. Mean monthly temperatures ranged from 20.03^0C to 30.8^0C while relative humidity varies from 18% to 21% in January and March and reach its peak (above 64.9%) between August and September. Annual rainfall ranges from 67mm to 223mm and lasts for 5-6 months. (Ministry of Agriculture, Mubi Zonal Office, 2013). Among the dominant woody plant species in the study area are : *Acacia senegal, Acacia nilotica, Acacia tortilis, Ficus species, Ziziphus mauritiana, Danielia oliverii, Adansonia digitata, Khaya senegalensis, Nauclea latifolia, Diospyros mespiliformis, Parkia biglobosa Balanites aegyptica, Sterculia setigera, Terminalia albida, Ziziphus spina-christi, Sena siamea, Annona senegalensis, Terminalia glaucescens, Guiera senegalensis, Tamarindus indica* and *Grewia venusta* while the abundant grass species are: *Cenchrus species, Sena obtusifolia, Sida acuta, Hibiscus asper, Tridax procumbens, Croton lobatus* and *Portulaca quadrifida* among other species. Some of the shrub, grass and tree species of the southern and northern guinea vegetation/zones are also found in this zone (Ikusemoran *et al.*, 2013)

DATA COLLECTION TECHNIQUES

Data on rainfall, temperature and relative humidity

Secondary data on rainfall, temperature and relative humidity for the period of three years (2010, 2011 and 2012) were collected from the nearest meteorological stations (Ministry of Agriculture, Mubi Zonal Office, Adamawa State) following Kwaga *et al.*, (2006) method. The mean monthly rainfall, temperature and relative humidity for a period of three (3) years were also obtained.

Data on honey yield in the study area

The yield of honey from the various hive types (clay pots, Israeli top-bar, Kenya top-bar, Langstronth and Woven grass) were obtained for a period of two years in the study area. Total and mean yield of honey from each hive type were obtained for two (2) years (2012 and 2013). This followed the method described by Rahman and Lawal (2003).

Chemical properties of honey

The honey samples were subjected to laboratory analysis following Association of Official Analytical Chemist (AOAC-1990) methods. The following chemical properties (Amino acids, Fatty acids, Sugars, minerals and vitamins) were determined.

Statistical Analysis of Data

Effect of micro-climatic factors on the yield of honey

Linear multiple regression analysis was used to analyze the data on the effect of micro-climatic factors (Temperature, Rainfall and Relative Humidity) on the yield of honey in the study area. The formula as outlined by Adesoye (2004) is given as follows.

$Y=bo +b_1x_1 +b_2x_2 +b_3x_3 +Ut$. Where;

Y= Total Yield of honey in Kg,

x_1= Mean Rainfall in mm (for 3 years),

x_2= Mean Relative humidity in percentage (%) (for 3 years)

x_3= Mean Temperature in ^{0}C (for 3 years)

b_1—b_3=parameters to be determined, Ut= error term, b0=intercept on Y axis.

Effects of hive and habitat types on the yield of honey

Analysis of Variance ANOVA (RCBD) was used in assessing the effect of hive types on the yield of honey in the study area. Habitat/vegetation constitutes the blocks while beehives constitute the treatments. This followed Akindele (1996) and Swarmy (2002) methods. The model is as stated below;

$Yij = \mu + \beta_i + T_j + \epsilon_{ij}$

Where,

Yij = individual observation in the jth treatment in ith block (Hives and Habitats).

μ = general mean of honey yield per habitat and hive types

β_i = effect of the ith block (habitats)

T_j = effect of the jth treatment (hives)

Cij= experimental error

Effects of habitat and hive types on the quality of honey

The variations in the quality of honey from different hives and habitats were determined using Analysis of Variance ANOVA (RCBD). Habitat/vegetation constitutes the blocks while beehives constitute the treatments. This followed Akindele (1996) and Okwu and Ndu (2006) methods.

The method is as illustrated below;

$Yij = \mu + \beta_i + T_j + \epsilon_{ij}$

Where,

Yij = individual observation in the jth treatment in ith block (Hives and Habitats).

μ = general mean of chemical elements of honey per hive and habitat types

β_i = effect of the ith block (habitats)

T_j = effect of the jth treatment (hives)

Cij= experimental error

RESULTS AND DISCUSSION

Effect of Micro-Climatic Factors on the Yield of Honey in the Study Area

Table 1 shows the effect of micro-climatic factors on the yield of honey in the study area. The result indicated that woody plant species diversity was highly significant

(1121.434**). 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.

Effects of hive types on the yield of honey in the study area

Table 2 showed the mean results of hive types on the yield of honey in the study area. The results indicated that Israeli top-bar had the highest mean yield (25.20kg) while clay pot had the lowest mean yield (6.95kg). Results of total yield of honey in the study area is presented in Table 3. Langstronth recorded the highest yield (38.39%) while the lowest mean yield (9.01%) was recorded from clay pot. The yield varied significantly (P<0.05) between hives while there was no significant variation (P>0.05) within the habitats. The results of honey yield for the second year (2013) indicated that Israeli top-bar hive had the highest (41.88%) honey yield with clay pot having the lowest yield (7.48%) in the study area.

Effects of hive types on the quality of honey in the study area

Results of effects of hive types on the quality of amino acids, fatty acids, sugar, vitamin and mineral element composition of honey in the study area are presented in Table 4. The results indicated that hive 5 had the highest mean value of amino acids (0.0122mg) while hive2 had the lowest mean value (0.0102mg). For fatty acids, hive 5 had the highest mean value (8.614µg) while hive1 had the lowest (8.530µg). For sugar composition, hive 2 had the highest mean value (16.592%) while hive 5 had the lowest mean value (16.460%). Hive 3 had the highest mean value of vitamins (0.6322µg) while hive 1 had the lowest mean value (0.5494µg). The results also shows the mineral elements composition with hive 5 having the highest mean value (1.9600mg) while hive1 recorded the lowest mean value (1.6937mg).There was no significant difference (P>0.05) between hive types on the quality of honey in the study area.

Effects of Micro-climatic Factors on the Yield of Honey in the Study Area.

The yield of honey has been shown to be affected by rainfall, relative humidity and temperature (Wilson, 2006). While rainfall negatively (-0.038) but did not significantly affect yield of honey in the study area; relative humidity (0.034) and temperature (0.627*) positively affected the yield of honey. The result of the effect of rainfall showed that increase in rainfall results in decrease in yield of honey. This is in consonance with the report of Wilson (2006), who observed that at high rainfall, comb building ceases, bees remain indoors and consume stored honey. The result of relative humidity indicated that yield increases and decreases with relative humidity, an observation that agrees with Marieke (1992) report that a too low and too high relative humidity affects the yield of honey. Because relative humidity of below 50% affects laying of eggs, destruction of larvae and causes the bees to be inactive.

Temperature is also an important factor that influences the yield of honey. In this study, temperature positively and significantly ($P<0.05$) affected the yield of honey, indicating that lower temperature will lead to a decrease in yield while relatively higher temperature will cause increase in yield. The result is therefore not at variance with the reports of Marieke (1992) and Wilson (2006) that bees perform energetically at relatively high temperature, up to 35^0C but falls in their activity as the temperature drops below 20^0C. At a very high temperature (37^0C to 40^0C), bees spend all their time fetching water to cool their hive, consequently nectar collection ceases. The implication of this is reduction in honey production.

Effects of Hive Types on the Yield and Quality of Honey in the Study Area.

The results of honey yield according to hive types showed that Langstronth had a significantly ($P<0.05$) higher yield followed by Israeli top-bar and thirdly by Kenya top-bar. The clay pot and woven grass both of which are traditional hives had the lowest output of honey. The result agrees with the report of Nicola (2009) that the modern beehives particularly the Langstronth has the highest efficiency in terms of its usage for honey production by honeybees; and further observed that the traditional beehives are prone to pests and diseases a situation that results in poor yield. Michael (2012) recorded a honey yield of 35kg per hive with Langstronth in South Africa, while Jemaiyo (2009) reported a yield of 15.00kg per hive per harvest in South Africa. Therefore, the yield of 25.20kg and 20.50kg from Langstronth and Israeli top-bar respectively in the study area can be said to be a reasonable output, which strongly suggests that the practice of apiary in the study area will be more profitable with the modern beehives particularly with Langstronth.

RECOMMENDATIONS AND CONCLUSION

The study examined the effects of some micro-climatic factors and beehive efficiency on the yield and quality of honey in Hong Local Government of Adamawa State, Nigeria. The results of the study indicated that no significant ($P>0.05$) difference occurred between hive types in the quality of honey produced. However, there were variations in amounts of nutrients between the hives. Nutrient levels were relatively higher than those reported by Efem (1998) and Bidemi (1999). Overall, the results suggested that with the use of appropriate beehives (Langstronth, Israeli top-bar and Kenya top-bar) in the study area and proper management, a profitable beekeeping venture is likely to be obtained. Further study on other chemical composition of honey and plants used by the bees in the study area is highly recommended.

REFERENCES

Adesoye, P.O (2004). *Practical Guide to Statistical Analysis for Scientists.* Premier Edition, Ibadan –Nigeria pp 1-189.

Akindele, S.O (1996) *Basic Experimental Designs in Agricultural Research.* Monterm Paperbook, Akure-Nigeria pp 1-122

Ande, A.T., Oyerinde, A.A. and Jibril, M.N. (2008. Comparative Study of Influence of Hive Types on Bee Colony Establishment. *International Journal of Agriculture and Biology (Online).http.//Fspublishers.org/ijab/pastissues/IJAB Vol. 10, No.5/9.pdf.*

Association of Official Analytical Chemists (AOAC-1990)

Ayodele, I.A. and Onyekuru, K.E. (1999). *Essentials of Beekeeping.* 1st ed.Sam Bookman Ibadan, Nigeria Pp1-45.

Balogun,O,S., Akinyeni,O., Simoyan, J.B. and Babasanya,M.B.(2007). Economics of Honey and Bee Wax Production Using Traditional Beehive in Kagarko Local Government Area of Kaduna State. *International Journal of Food and Agricultural Research.* Development Universal Consortia, Ikat Ekpene-Nigeria. Pp154-160.

Beetsma,J., Kaal,T., Mulde, V. and Summeijer,R.(2001), *Beekeeping in the Tropics.* Centre for Tropical Agriculture (CTA). Wageinager, Netherlands pp1-89.

Carol, K.M. (2003). Annual Workshop for Beginning Beekeeping. Spring Sting Bee Flying. Texas-U.S.A pp 1-4, 18-25.

Efem,S.E.E.(1998). Clinical Observation on Wound Healing Properties of Honey. *British Journal of Surgery.* 75: 679-681.

Ikusemoran, M.Anthony, D. and Maryah, U.M. (2013). Assessment of Flood Risk and Vulnerability of Communities in Benue Floodplains, Adamawa State, Nigeria. *Journal of Geography and Geology 5 (4): 148-160 International Centre for Tropical Agriculture (ICTA-2003). Paper delivered at Training for Trainers , Federal College of Forestry Mechanisation, Awake. Kaduna State, Nigeria. 11th-14th March, 2003. Pp 1-4*

Jemaiyo,C. (2009). No sting in the tail. *Spore Magazine.* Centre for Tropical Agriculture (CTA), Netherlands, February,2009. No 139. p7.

Kamatara, K.B. (2009). *Beekeeping Practice and Theory.* Days to colonization and absconding of different hives in Central Uganda. Fountain Publishers Ltd, Kampala, Uganda .Pp1-106).

Kwaga,B.T., Amadi,D.C.A., Akosim,C. and Stephen,J.(2006). Economic Potentials of Beekeeping in Adamawa State, Nigeria. *Nigerian Journal of Tropical Agriculture,* School of Agriculture and Agricultural Technology, Federal University of Technology, Yola.Vol:8, pp279-289.

Marieke, M. (1993). Honey bee Husbandry in Nigeria, Traditional and Modern Practice. *International Field Study Journal of West Africa.* The Nigerian Field. .No 58 pp 1- 18.

Michael, M. (2012). Honey Survey. South African Apicultural Federation, South Africa. Pp 23-28.

Ministry of Agriculture, Mubi Zonal Office, Adamawa State- Nigeria (2013)

Nicola, B. (2009). *Non-Wood Forest Products.* Bees and their Roles in Forest Livelihoods. A Guide to Series Provided by Bees and the Sustainable Harvesting, Processing and Marketing of their Products. Viale delle, Rome, Italy.

Okwu, C. and Ndu B.D. (2006). *Physiochemical and vitamin content of indigenous species of south eastern Nigeria.* Department of Chemical Sciences, Michael Opara University of Agriculture Umudeke, Bland Ford Press Poble Dorset. P 5.

Rahman, S.A. and Lawal, A. B. (2003). Economic Analysis of Maize-based Cropping System in Giwa Local Government Area of Kaduna State. *An International Journal of Agricultural Science, Sciences, Environment and Technology (ASSET).* Series A. University of Agriculture, Abeokuta, Nigeria. Vol. 3, No. 2. pp 139-148.

Stilling, P. (2002). *Ecology: Theories and Application 4th ed.* Parantice Hall, India. p 1-403.

Swamy, R.R. (2002). *Agricultural Statistics 2nd ed.* New age international, New Dell. pp1- 497.

Wilson, R.T.(2006). Current Status and Possibilities for Improvement of Traditional Apiculture in Sub Saharan Africa. Livestock *Research for Rural Development,* Vol.18,ArticleNo.111.Retrived 20/3/2010 .http/www./rrd.org/Irrd 18/8/wils181111 .htm.

Table 1: 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

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

Table 2: Effects of Hive Types on the Yield of Honey in Study Area.

Hive types	Mean yield values in kg
Hive 1	6.95^{d}
Hive 2	20.50^{b}
Hive 3	13.10^{c}
Hive 4	25.20^{a}
Hive 5	6.98^{d}
SEM	3.81

Means with different superscripts differ significantly at {$P<0.05$}.
Key: Hive1 = Clay pot, Hive 2 = Israeli top-bar, Hive 3 = Kenya top-bar, Hive 4 = Langstronth
Hive 5 = Woven grass
SEM = Standard error of the mean
Field Survey, 2012, 2013.

Table 3: Yield of Honey in kg for 2 years (2012 and 2013) in the study Area.

Period/Year	Hive Types	Hive no.	Total Yield in kg	Percentage (%)
2012	Clay pot H1	3	8.50	9.01
	Israeli top-bar (H2)	3	12.20	12.95
	Kenya top-bar (H3)	3	28.40	30.12
	Langstronth (H4)	3	36.20	38.39
	Woven grass (H5)	3	9.00	9.53
Total			94.30	100.00
Mean			18.86	
2013	Clay pot (H1)	3	4.50	7.45
	Israeli top-bar (H2)	3	25.30	41.88
	Kenya top-bar (H3)	3	7.70	12.76
	Langstronth (H4)	3	13.80	22.85
	Woven grass (H5)	3	9.10	15.06
Total			60.40	100.00
Mean			12.08	

Source: Field Survey, 2012, 2013

Table 4: Effects of Hive Types on the Quality of Honey in Study Area.

Nutrient composition	Hive types					
	Hive 1	Hive 1	Hive 1	Hive 1	Hive 1	SEM
Amino acids (mg)	0.0110	0.0102	0.0112	0.010	0.0122	0.103
Fatty acids (µg)	8.530	8.566	8.562	8.534	8.614	2.925
Sugar (%)	16.488	16.592	16.468	16.522	16.460	4.062
Vitamins (µg)	0.549	0.564	0.632	0.559	0.558	0.756
Mineral elements (Mg)	1.693	1.848	1.953	1.881	1.960	1.366

Means without superscripts are not significantly different at {P>0.05}

Key: Hive1 = Clay pot, Hive2 = Israeli top-bar, Hive3 = Kenya top-bar, Hive4 = Langstronth, Hive5 = Woven grass

SEM = Standard error of the mean

Source: Field Survey, 2012, 2013.