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Ecological and Economic Potential of *Eucalyptus camaldulensis* and *Mangifera indica* Trees for Sustainable Apiculture in Kaduna Northern Guinea Savannah Ecozone, Nigeria

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ABSTRACT

Apiculture, which is the act of rearing, breeding and managing honeybee colonies in artificial hives for economic gains, leads to the production of valuable materials such as honey, bee wax, propolis, bee pollen, bee venom and royal jelly. Interest in bees started with the hunting of wild colonies in hollow cavities of trees or rocks. The ecological and economic potential of *E. camaldulensis* and *M. indica* trees for sustainable apiculture in the Kaduna Northern Guinea Savannah Ecozone, Nigeria, was studied. 10 Kenya top bar hives were randomly placed in each of the plantations with 95% dominance of each species (*Eucalyptus camaldulensis* and *Mangifera indica*). Honey and pollen produced from each plantation were collected at intervals for a period of 72 weeks, which were quantified and analysed. The highest quantity of honey was recorded in *the E. camaldulensis* plantation in both the dry and wet seasons, with 90.60 litres and 70.40 litres of honey, respectively. While in *the M. indica* plantation, 70.40 litres and 40.23 litres of honey were recorded in the dry and wet seasons, respectively. A total of 6.80kg and 4.00kg of pollens were collected in the 2 plots in both the dry and wet seasons. The quantity of honey and pollen collected in each plot was significantly different ($P<0.005$) in both seasons. The major species of bee found in the study area is *Apis mellifera*. However, the 2 tree species selected show a positive sustainable role in honey and pollen production in the Kaduna Northern Guinea Savannah. Measures to sustainably improve honey and pollen production in the ecozone were highlighted.

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1.0 Introduction

Honey and pollen are made from plant juice and other sources, such as saccharin exudation of plants, which supplied ferments to honey bees (Ayeni, 2002; Omonale, 2005). Honey products are regarded as evidence of nature's kindness, and their significance has always been overlooked as an important minor product from forests (Monar and SomeVille, 1998). Beekeeping, distinct from honey hunting, is not new in Nigeria. Interest in bees started with hunting wild colonies in hollow cavities of trees, shrubs, or rocks (Wageningen, 1991). The Centre for Bee Research and Development (CEBRAD) (1998) confirmed that African countries are blessed with abundant bee resources, but unfortunately, this part of the world has done little or nothing to tap the blessing. Honey collection has been a traditional activity throughout most parts of Africa because of its curative and nutritional properties (Jessen, 1987; Kall, 1991; Mutsaers, 1993; Komolafe, 1995; Akachukwu, 1995; Omonale, 2005). Apart from honey and other by-products derived from honey bees, estimates suggest that between 35 per cent and 73 per cent of the world's cultivated crops are pollinated by some varieties of bees, indicating that most of the plant species rely on bee insects for pollination (Klein *et al.,* 2007; Harshwardhan *et al.,* 2012; Oladimeji *et al.,* 2017b). Honeybees also provide numerous benefits to the natural environment and are capable of providing pollination services to a wide variety of crop species with an estimated annual contribution valued at $3.1 billion (Morse *et al.,* 2000; Oladimeji *et al.,* 2017b). The significance of beekeeping cannot be overemphasised.

Nigeria is blessed with rich vegetation suitable for honey production; honey production requires minimal capital and also supplements income for rural dwellers. Honeys found in the local market are usually from traditional beekeepers, which is usually lower in quality when compared with the honey produced by modern beekeeping methods, as well as the curative and nutritional qualities of it (Mutsaers, 1995). CEBRAB (1998) and Ayeni (2002) reported that in Nigeria many physicians have verified the healthful property of honey. Honey is a perfect drug for all wounds and ulcers, treatment of scrotal ulcers, duodenal ulcers, and diabetes mellitus; it improves weight gain, growth, haemoglobin formation, calcium retention, and relief from constipation and diarrhoea. Honey is a remarkable remedy for conjunctivitis and ear infections (otitis media), toothache, cough, sore throat, mouth disease, typhoid fever, hair loss and skin diseases. Beehive products such as beeswax, honey, propolis and pollen remain very important inputs in pharmaceuticals, food and beverages; furniture; soap; shoe polish and candle industries. Honey production is highly favoured among the Yorubas. It is used traditionally for ceremonies such as the completion of in-training apprenticeships, funerals, weddings, child naming and so on. Other products from the apiary include beeswax, which serves as raw material in the manufacture of cosmetics, foundation sheep for hives, medicine, polishes and so on. Pollen and propolis, which possess therapeutic and antibiotic characteristics. Pollen can contain up to 35 per cent protein; it can be eaten dry or added to other food. Pollen is sold to the perfume industry and nowadays also for consumption (Senegen, 1997).

Apiculture is the art of rearing, breeding and managing honeybee colonies in artificial hives for economic gains (Shu'aib *et al.,* 2009), which leads to the production of valuable materials such as honey, bee wax, propolis, bee pollen, bee venom and royal jelly (Oladimeji *et al.,* 2017a). An apiary is a place where bees and bee hives are kept, while a hive is a hollow used to house bees. In spite of the favourable climatic and socio-economic environment, low cost and sufficient availability of flowering plants and manpower in tropical countries, most developing countries, including Nigeria, have not tapped the available apicultural potential optimally (Sodimu *et al.,* 2021). With the current growth in domestic consumption of honey in Nigeria and growing demand in the international market, the future of apicultural enterprise is very bright, as the demand for honey is bound to increase; it could provide food, nutritional, and livelihood security

to the rural workforce on an ecologically sustainable basis (Sodimu *et al.,* 2021). Ojo (2004) opined that apicultural practices need relatively small investment capital, and most of the equipment needed for apiculture can be sourced locally. In apiculture, the quality of land required is less important because hives are placed either on the trees or on the ground. It is also not competing with other enterprises for resources, as the bees use nectar and pollen grains of plants. The goal of honey bee colony management is to aid the colony to build up to its maximum during the main nectar flow and to survive the dearth. Well-managed colonies assure the greatest possible return for the beekeeper (Ayeni, 2003; Sodimu *et* al., 2010). It suffices to note that bees are renewable resources whose stock can be replenished. However, their renewability critically depends on the quality of management they are subjected to in order to maintain maximum sustainable yield (Oladimeji *et al.,* 2014a). Proper management of natural resources, particularly flora and water resources, is critical for bee sustainability, as they can be a driver for sufficient food and the achievement of global Sustainable Development Goals (SDGs) (Oladimeji *et al.,* 2014b). The objective of this study, therefore, is to determine the rate of honey and pollen production by the two (2) selected icon tree species (*E. camaldulensis and M. indica*) in the Kaduna Northern Guinea Savannah eco-zones of Nigeria and also to identify species of bees that dominate the zones.

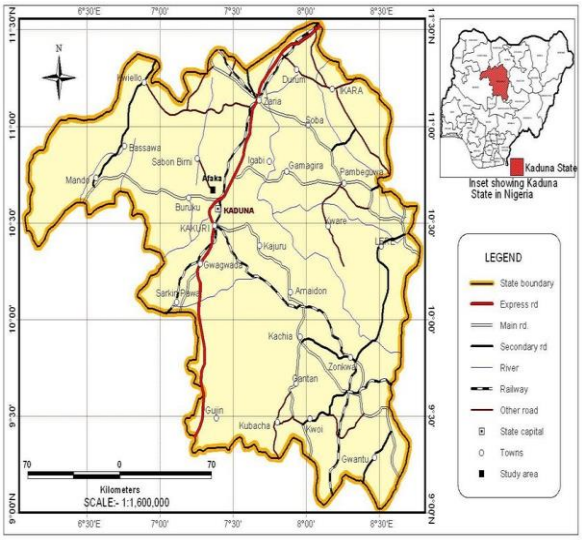
2.0 Materials and Methods

2.1 The study Area

The study was conducted at the Federal College of Forestry Mechanisation, Afaka, Kaduna State (Figure 1). The college is situated in the Kaduna Northern Guinea Savannah Ecological Zone of Kaduna State in the Igabi Local Government Area of the state. Latitude 10047'55'' and 10o46'41''N / longitude 7o31'29'' and 7o30'26''E (Otegbeye *et al.,* 2001; Sodimu *et al.,* 2022). Apart from the Gbagyi, who were initially non-Muslims or traditionalists before converting to Christianity, the majority of the indigenous population of Igabi is Muslim. Its area is 3,222 km², and its density is 180.5 km². With a projected estimated population of 581,500 residents, the region receives 1000–1500 mm of rainfall annually (KDBS, 2016). The vegetation is open woodland with tall grasses (1.3m high) in open areas and trees (up to 15m high), usually with short boles and broad leaves (FORMECU, 1998).

Figure1

The Study Area on a Map of Kaduna State



Source: Saka, 2021

2.2 Sampling Technique

Ten (10) Kenya top bar hives were randomly placed in each of the plantations with 95% dominance by *E. camaldulensis* and M*. indica.* Honey produced from each plantation was collected at intervals for a period of seventy-two (72) weeks in both the dry and wet seasons. Pollen traps were inserted in each of the Kenya top bar hives placed in each plot, and pollen grains were collected from each bee hive for a period of seventy-two (72) weeks. The honey and the pollen grain collected were quantified, and samples of species of bees which invaded the hives in each plantation were collected and identified. All data collected were subjected to analysis of variance (ANOVA) and Duncan's multiple range test (DMRT) contrast (P<0.05) as recommended by Ayeni (2002) and Alika (2006).

3.0 Results and Discussion

Table 1

Rate of Honey and Pollen Production in the Two (2) Selected Tree Species in Dry Season

Plot	No of Hives	Honey(litres)	%	Pollen(kg)	%
A	10	90.60[a]	60.00	4.20[ab]	61.77
B	10	60.40[b]	40.00	2.60[a]	38.23
Total	20	151.00	100.00	6.80	100.00

Plot A-*Eucalyptus camaldulensis* Plot B-*Mangifera indica*.
DMRT (Figures with different letters are significantly different (P<0.05)

The highest quantity of honey, 90.60 litres, was collected in the dry season in Plot A (*E. camaldulensis),* while a total of 60.40 litres was collected in Plot B (*M. indica*). A total of 6.80kg of pollen was collected in the dry season in the two (2) plots; the highest quantity of pollen, 4.20 kg, representing 61.77%, was collected in Plot A, and 2.60kg was collected from Plot B, representing 38.23% of the total pollen.

Table 2

Rate of Honey and Pollen Production in the Two (2) Selected Tree Species in Wet Season

Plot	No of Hives	Honey (litres)	%	Pollen (kg)	%
A	10	70.40[a]	63.64	2.05[a]	51.25
B	10	40.23[b]	36.36	1.95[b]	48.75
Total	20	110.63	100.00	4.00	100.00

Plot A-*Eucalyptus camaldulensis;* Plot B- *Mangifera indica*.
DMRT (Figures with different letters are significantly different) (P<0.05).

The highest quantity of honey, 70.40 litres, was collected in the wet season in plot A (*E. camaldulensis*), while a total of 40.23 litres was collected in plot B (*M. indica*). A total of 4.00kg of pollen was collected in the wet season in the two (2) plots. The highest quantity of pollen, 2.05 kg, representing 51.25%, was collected in plot A, and 1.95kg was collected from plot B, representing 48.47% of the total pollen.

E. camaldulensis and *M. indica* trees produce distinctly different honey and pollen. *E. camaldulensis* honey is known for its rich, fruity, and butterscotchy flavour, often with a fine crystallised texture and orangish to golden yellow hue, while *M. indica* honey is characterised by its deep sweetness, with a slight salty aftertaste. Pollen from both trees contributes to the unique properties of the honey, with eucalypt pollen imparting an herbal, slightly medicinal flavour and mango pollen likely adding to the overall flavour profile. In Tables 1 and 2, the highest quantity of honey and pollen was recorded in Plot A in both dry and wet seasons; this may be connected with the dry annual period of flowering of *E. camaldulensis,* which was between 6 and 8 weeks (between February and March), while *M. indica's* annual flowering period was between 4 and 6 weeks, respectively. This is in line with the findings of Mutsaers (1983); Agwu and Okeke (1997); and Sodimu *et al.* (2021). There was a significant difference in the quantity of honey and pollen produced in each plot in both the dry and wet seasons (P<0.05).

3.1 Identification of Species of Bees Collected

Samples of bees collected from the two (2) plots were identified at the Department of Forestry Technology, Federal College of Forestry Mechanisation, Afaka, Kaduna, as:

Apis mellifera
Family-Apidae
Order-Hymenoptera
Class-Insecta
Genus-Apis
Species-mellifera

Distinctive characteristics of the body structures are a hairy skin, a light brown-yellowish abdomen, an extended proboscis, a pollen basket at the rear legs, a soft-looking head with a strong labial palm holding out sideways, and also maxillae lying close to the proboscis. This species identified is in line with the findings of Omonale (2005), Ayansola (2003) and Ajao *et al.* (2014a).

4.0 Conclusion and Recommendation

Eucalyptus camaldulensis and *Mangifera indica* are very good apicultural tree species due to their long annual flowering period and high nectar content. The differences in honey and pollen characteristics between *E. camaldulensis* and *M. indica* trees highlight the diverse flavours and benefits that can be found in different honey varieties, depending on the plant source. These species are relatively abundant in Northern Guinea Savannah ecological zones of Nigeria. It is recommended that more plantations of these species should be established for apicultural purposes. Modern beekeeping techniques should also be taught in rural areas to increase beehive products, which can also serve as a source of income, foreign exchange and livelihood. Furthermore, bee farmers should form a genuine association and influence such an association as an avenue to access finance, inputs, and technical information and markets and also organise capacity building on the technical know-how of beekeeping so that they can improve their apiary and apiary products.

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