

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/360939561>

# Ethnobotanical survey of plant species used for mosquito control in Nigeria

Article in *Nigerian Journal of Parasitology* · May 2022

CITATIONS

0

READS

42

8 authors, including:



**Hilary Iwegbunem Okoh**

Federal University Oye-Ekiti

13 PUBLICATIONS 34 CITATIONS

[SEE PROFILE](#)



**Ugonna C. Morikwe**

Nnamdi Azikiwe University, Awka

10 PUBLICATIONS 12 CITATIONS

[SEE PROFILE](#)



**Aaron Nwana**

Federal University Oye-Ekiti

6 PUBLICATIONS 0 CITATIONS

[SEE PROFILE](#)



**Jamila Ahmed**

Ahmadu Bello University

8 PUBLICATIONS 0 CITATIONS

[SEE PROFILE](#)

Some of the authors of this publication are also working on these related projects:



VarATS Screening for sub-patent Malaria infection among women attending care in Lagos, Nigeria. [View project](#)



Insecticidal characterization of some spider toxins [View project](#)



## **Ethno - Botanical Survey Of Plant Species Used For Mosquito Control In Nigeria**

**Okoh\*, H.I.<sup>1</sup>, Mogaji, H.O.<sup>1</sup>, Adekoya, M.A.<sup>2</sup>, Morikwe U.C.<sup>3</sup>,  
Nwana, A.O.<sup>1</sup>, Ahmed, J.<sup>4</sup>, Makanjuola, W.A.<sup>5</sup>, Otubanjo, O.A.<sup>5</sup>**

<sup>1</sup>Department of Animal and Environmental Biology, Federal University, Oye - Ekiti, Ekiti State, Nigeria

<sup>2</sup>Department of Plant Science and Biotechnology, Federal University, Oye - Ekiti, Ekiti State, Nigeria

<sup>3</sup>Department of Pharmaceutical Microbiology, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria

<sup>4</sup>Department of Zoology, Ahmadu Bello University, Zaria

<sup>5</sup>Department of Zoology, University of Lagos, Nigeria

email:

### **Abstract**

In Nigeria, there is paucity of information on plants used to repel or kill mosquitoes despite the abundant plant species in the country's tropical rain forests. Majority of available data are on the traditional use of plants for curative purposes. This study documents some plant species used for insecticidal or repellent purposes against mosquitoes in Nigeria. An ethno-botanical survey was carried out in four geo-political zones in the country using structured questionnaires and focus group discussion. A total of six plant species belonging to five families were reported in Delta state with *Conyza Canadensis* (Compositae) being the most utilized (50%) and *Aspilia africana* (Compositae), the least mentioned (5.60%). In Enugu state, a total of nine plant species belonging to eight families were mentioned by respondents with *Aframomum melegueta* the most utilised (26.09%) while *Agava sisalana* and *Dracaena manii* belonging to the families Agavaceae and Dracaenaceae were the least mentioned (1.09% each). A total of six plant species belonging to five families were reported in Kaduna State with *Lantana camara* belonging to the family Verbenaceae accounting for 58.82% of the utilised plant species for mosquito control while *Ipomea asarifolia*, *Terminalia catappa* and *Citrullus vulgaris* belonging to the families Convolvulaceae, Combretaceae and Cucurbitaceae respectively were the least utilized (5.88% each). Lagos State recorded the highest number of plant species (twenty five) belonging to eighteen families. *Spondia mombin* belonging to the family Lilaceae was the most mentioned (7.33%) while the least mentioned (0.37% each) were *Magnifera indica*, *Baphia nitida* and *Pennisetum purpeum* belonging to the families Anacardiaceae, Fabaceae and Poaceae respectively. There is a need for further investigation on these plant species as they may constitute potential sources of cidal and repellent compounds against a wide range of insect pests.

**Keywords:** Ethno-botanical survey, insecticidal, repellence, mosquitoes, plant species

### **Introduction**

Mosquitoes remain the most significant insect vectors in the transmission of pathogens of both medical and veterinary importance [1, 2, 3, 4]. They are also known enemies of humans due to the noise nuisance and biting annoyance they create when

sourcing blood for the development of their eggs [5, 6, 7].

In tropical and sub-tropical regions, infected female *Anopheles* mosquitoes are the primary host and major agent of transmission for the *Plasmodium* parasites that causes human malaria, a disease that is endemic in over 90 countries, with about 50% of the

worlds' population at risk [8, 9]. In addition, the disease accounts for over 200 million clinical cases in Africa, Asia and South-America, with about 400,000 deaths annually [10].

As part of efforts to control mosquitoes in the tropics, the World Health Organization recommends the use of insecticide treated nets, indoor residual spraying and environmental management approaches aimed at destroying larva-breeding sites [11, 12]. The over-reliance on synthetic insecticides for mosquito control, because they are fast acting and easy to apply, has led to a number of deleterious side effects which includes the development of strains of mosquitoes and other pest species resistant to insecticides and destruction of non-target organisms.

These observations have generated public health concerns and renewed interest in the search for more biodegradable, environmentally safer and low cost, easily available indigenous interventions for mosquito control [13, 14]. One of the most prominent of the aforementioned indigenous and environmentally friendly interventions is the use of natural products of plant origin, which are more target specific, relatively less toxic and less expensive [14]. They are also bio-degradable and easily available. The use of repellent plants against nuisance biting insects is common in the country (15, 16,17) and their potential for mosquito control requires evaluation of the different plant species available for the communities.

Ethno botany is the scientific study of interrelations between humans and plants. In modern times, it involves study of indigenous or traditional knowledge of plants, their classification, cultivation, and use as food, medicine and shelter (18). This field is an important step in the identification, selection and development of medicinal and insecticidal plants. Most of the ethno-botanical surveys that have been carried out in Nigeria focussed on documenting plant species used in herbal medicine for managing human diseases (19, 20, 21) with limited information on plant species used for mosquito control.

The mosquito repellent activity of ten plants popularly used by the indigenous people of Ibadan, south-western Nigeria against the malaria mosquito vector, *Anopheles stephensi* was investigated by [22]. Results showed that *Cymbopogon citratus* and *Lantana camara* exhibited appreciably high repellence against the mosquito vector. In addition,

[15] gathered information over a two-year period in randomly-selected villages across five states in south-east Nigeria, on plant species used as repellents against malaria vectors. Findings revealed twenty-four plant species across 16 families with mosquito repellent activity. This study therefore sought to add to the scanty body of knowledge on plant species used for mosquito control in Nigeria. Information obtained will serve as a guide for future ethnobotanical studies in the search for plant species with insecticidal and repellent properties as alternatives to synthetic insecticides.

## Materials and Methods

### *Study area and study design*

This study was carried out in Nigeria between 2008 and 2018. Nigeria is located in West Africa and borders Niger Republic in the north, Chad in the northeast, Cameroon in the east, and Benin Republic in the west (Figure 1). The country is the most populous in Africa, and the seventh most populous in the world with over 200 million inhabitants [23]. Administratively, the country has a total of 36 states and 1 Federal Capital Territory spread across six geopolitical zones. Study sites were selected using a two-stage approach, where all the states in the country were divided into geopolitical zones. Four of the six geopolitical zones (south-west, south-east, south-south and north-west) were selected for the study based on available funds. A random selection method was employed in the selection of a study site in the States and Lagos, Delta, Enugu and Kaduna representing south-west, south-south, south-east, and north-west geopolitical zone respectively were selected.

Lagos State is situated in the south-west geopolitical zone of the country, and is the smallest of the 36 states in terms of land area. The State however, is the most economically viable and contains the nation's largest urban area with over 9,019,534 inhabitants according to the 2006 Nigerian census. Enugu State is located in the south-east geopolitical zone, and has a population of 3,267,837. Delta State is situated in the south-south geopolitical zone with a population of 4,112,445 while Kaduna State is located in north-west geopolitical zone, and is a trade centre and a major transportation hub. The population of Kaduna was estimated to be at 6,113,503 according to the 2006 Nigerian census.

### *Sampling methods*

The study was cross-sectional in design and in each

of the selected study States, two popular herbal markets were purposively selected for the study; Mushin and Oyingbo markets in Lagos State, Main market, Warri, and Ogbogonogo market, Asaba in Delta State, Central Market, Kaduna and Sabongari Market, Zaria in Kaduna State, Ogbete market and Newhaven market in Enugu State). In each market, vendors who sell herbs were identified and approached with well-structured questionnaires to obtain information on the type of plants used to repel or kill mosquitoes following the method of [24,25,26].

A snowball sampling method was employed in selecting study participants. This involved identification and recruitment of other vendors in the same market from among the acquaintances of initial study participant until a maximum target of 50 vendors was met per market. However, in some instances, the number of vendors interviewed varied based on availability as at the time of visitation. Plants implicated in repelling/killing mosquitoes were purchased, dried and pressed in a suitable plant press. They were further identified and authenticated in the herbarium, Department of Botany, University of Lagos, and the Department of Plant Science and Biotechnology, Federal University Oye-Ekiti, Ekiti State, Nigeria.



Figure 1: Map of Nigeria showing the study states

### Data analysis

Data obtained from the completed questionnaires were extracted and inputted into Microsoft excel 2007 software. Descriptive statistics in form of percentages and frequencies were estimated. Chi-square statistics was used to investigate association between demographic variables and significant level was set at 95%.

### Results

#### Demographic characteristics of study participants

A total of 400 vendors who sell herbs were recruited across the four study locations. By age category, majority of the respondents, 57.2% were within 18 and 35 years and 42.8% were within the age group 36-65 years. There was no significant difference between the age of study participants across the study locations ( $p > 0.05$ ). Similarly, the vendors were more of males (60.8%) in respect to gender, those who were married (65.5%) and those with primary education (52.5%). However, there were significant differences between sex, marital and educational status of study participants across the study locations ( $p < 0.05$ ) (Table 1)

#### Knowledge about plants used to repel or kill mosquitoes

By location, 86%, 94%, 95% and 71% of vendors from Lagos, Enugu, Delta and Kaduna knows about plants that can repel mosquitoes (Table 1). A total number of 6 plants used to repel or kill mosquitoes were recorded in Delta with 18 mentions (Table 2). In Kaduna, 6 plants with 17 mentions (Table 3), 9 plants were recorded with 92 mentions in Enugu (Table 4), and 25 plants with 273 mentions in Lagos (Table 5) (Figure 1).

Figure 2: Frequency of mention of plants used to repel or kill mosquitoes across the study area

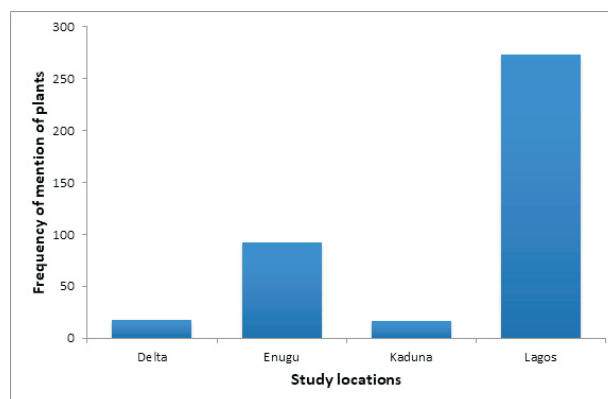


Table 1: Demographic characteristic of study participants

	Lagos N(%)	Enugu N(%)	Delta N(%)	Kaduna N(%)	Total N(%)
<b>Age (in years)</b>					
18-35	58 (58.0)	48 (48.0)	58 (58.0)	65 (65.0)	229 (57.2)
36-65	42(42.0)	52 (52.0)	42 (42.0)	35 (35.0)	171 (42.8)
Total	100 (100)	100 (100)	100 (100)	100 (100)	400 (100)
p-value					0.111
<b>Sex</b>					
Male	29 (29.0)	67 (67.0)	62 (62.0)	85 (85.0)	243 (60.8)
Female	71 (71.0)	33 (33.0)	38 (38.0)	15 (15.0)	157 (39.2)
Total	100 (100)	100 (100)	100 (100)	100 (100)	400 (100)
p-value					< 0.00001
<b>Marital status</b>					
Single	23 (23.0)	54 (54.0)	42 (42.0)	20 (20.0)	139 (34.5)
Married	77 (77.0)	46 (46.0)	58 (58.0)	80 (80.0)	261 (65.5)
Total	100 (100)	100 (100)	100 (100)	100 (100)	400 (100)
p-value					< 0.00001
<b>Educational status</b>					
No education	11 (11.0)	6 (6.0)	14 (14.0)	83 (83.0)	114 (28.5)
Primary education	61 (61.0)	78 (78.0)	55 (55.0)	16 (16.0)	210 (52.5)
Secondary education	28 (28.0)	16 (16.0)	31 (31.0)	1 (1.0)	76 (19.0)
Total	100 (100)	100 (100)	100 (100)	100 (100)	400 (100)
p-value					< 0.00001
<b>Knowledge about plants that repels mosquitoes</b>					
Yes	86 (86.0)	94 (94.0)	95 (95.0)	71 (71.0)	346 (86.5)
No	14 (14.0)	6 (6.0)	5 (5.0)	29 (29.0)	54 (13.5)
Total	100 (100)	100 (100)	100 (100)	100 (100)	400 (100)
p-value					<0.00001

Table 2: Plant Species Used By Respondents In Delta State To Kill/repel Mosquitoes

Plant species	Family Name	English Name	Part of plant used	Number of mention	%
<i>Pterianthus macrocarpus</i>	Euphorbiaceae	Lady's slipper	Leaves	2	11.1
<i>Conyza Canadensis</i>	Compositae	Horse weed, fleabare	Leaves	9	50
<i>Newbouldia laevis</i>	Bignoniaceae	Boundary tree	Root	2	11.1
<i>Aspilia Africana</i>	Compositae	Wild sunflower	Leaves and Root	1	5.6
<i>Terminalia catappa</i>	Combretaceae	Tropical almond	Leaves	2	11.1
<i>Ipomea hederacea</i>	Convolvulaceae	Ivy leaf Morning glory	Leaves	2	11.1
				18	100

Table 3: Plant Species Used By Respondents In Kaduna State To Kill/repel Mosquitoes

Plant species	Family Name	English Name	Part of plant used	Number of mention	%
<i>Lantana camara</i>	Verbenaceae	Bush lantana	Leaves	10	58.82
<i>Ipomea asarifolia</i>	Convolvulaceae	Ginger leaf Morning glory	Leaves	1	5.88
<i>Newbouldia laevis</i>	Bignoniaceae	Boundary tree	Root	2	11.77
<i>Ipomea batatas</i>	Convolvulaceae	Sweet potatoes	Leaves	2	11.77
<i>Terminalia catappa</i>	Combretaceae	Tropical almond	Leaves	2	5.88
<i>Citrullus vulgaris</i>	Cucurbitaceae	Watermelon	Fruit	2	5.88
				17	100

Table 4: Plant Species Used By Respondents In Enugu State To Kill/repel Mosquitoes

Plant species	Family Name	English Name	Part of plant used	Number of mention	%
<i>Ocimum basilicum</i>	Labiatae	Scent leaf, Sweet and hairy basil	Leaves	8	8.70
<i>Aframomum melegueta</i>	Zingiberaceae	Alligator pepper, grains of paradise	Seeds	24	26.09
<i>Dennittia tripetala</i>	Annonaceae	Pepper fruit	Fruit	11	11.96
<i>Xylopia aethiopica</i>	Annonaceae	Ethiopian	Seeds	14	15.22
<i>Achyranthus aspera</i>	Amaranthaceae	Chaff flower/devil horsewhip	Stem and leaves	3	3.26
<i>Pergularia daemia</i>	Asclepiadaceae	Pergularia	Leaves	16	17.39
<i>Ageratum conyzoides</i>	Compositae	Goat weed	Leaves	14	15.22
<i>Agave sisalana</i>	Agavaceae	Sisal hemp	Sap	1	1.09
<i>Dracaena manii</i>	Dracaenaceae	Welw.ex baker	leaves	1	1.09
				92	100



Table 5: Plant Species Used By Respondents In Lagos State To Kill/repel Mosquitoes

Plant species	Family Name	English Name	Part of plant used	Number of mention	%
<i>Piper guineense</i>	Piperaceae	Bush pepper, African black pepper	Fruit	19	6.96
<i>Spondias mombin</i> Lin	Anacardiaceae	Hog plum, yellow mombin	Fruit	20	7.33
<i>Rhaphiostylis beninensis</i>	Icacinaceae	Rhaphiostylis	Leaves	13	4.76
<i>Lawsonia inermis</i> L.	Lythaceae	Henna plant	Leaves	14	5.13
<i>Carica papaya</i> Linn	Caricaceae	Pawpaw	Leaves	13	4.76
<i>Citrus sinensis</i>	Rutaceae	Sweet orange	Peels	13	4.76
<i>Allium sativum</i>	Liliaceae	Garlic	Bulb	16	5.86
<i>Ocimum gratissimum</i>	Labiatae	Scent leaf, balsam, basil	Leaves	8	2.93
<i>Nicotiana tabacum</i>	Solanaceae	Tobacco	Leaves	13	4.76
<i>Jatropha curcas</i>	Euphorbiaceae	Physic nut	Seeds	14	5.13
<i>Cymbopogon citratus</i>	Poaceae	Lemon grass	Leaves	12	4.40
<i>Erythrophleum suaveleus</i>	Leguminosae	Saaswood	Bark	10	3.66
<i>Zanthoxylum zanthoxyliodes</i>	Rutaceae	Fagara	Bark	13	4.76
<i>Cutcasia scandens</i>	Araceae	Climbing arum	Leaves	8	2.93
<i>Petiveria alliacea</i>	Phytolaccaceae	Anamu	Seeds	13	4.76
<i>Tetrapleural tetraaptera</i>	Leguminosae	Aridan	Seeds	11	4.03
<i>Hyptis suaveolens</i>	Labiatae	Hyptis	Leaves	9	3.30
<i>Zingiber officinale</i>	Zingiberaceae	Ginger	Rhizome	11	4.03
<i>Bucholzia coriacea</i>	Sterculiaceae	Wonder kola	fruit	9	3.30
<i>Capsicum frutescens</i>	Solanaceae	Chilli pepper	Seed	12	4.40
<i>Azadirachta indica</i>	Meliaceae	Neem tree	Leaves	17	6.23
<i>Anacardium occidentale</i>	Anacardiaceae	Cashew tree	Stem	2	0.73
<i>Magnifera indica</i>	Anacardiaceae	Mango tree	Leaves	1	0.37
<i>Baphia nitida</i>	Fabaceae	Camwood	Leaves	1	0.37
<i>Pennisetum purpureum</i>	Poaceae	Elephant grass	Leaves	1	0.37
				273	100

## Discussion

In this study, the demographic data showed that a high proportion of the respondents (86.5%) had good knowledge of plants with insecticidal and/or repellent ability. This observation is similar to findings in Tanzania, Southern Uganda, and Cameroon where respondents showed high knowledge of plants used for mosquito control [14, 27, 28]. Most of the respondents had little or no formal education with majority (52.5%) of the respondents with only primary school education and 28.5% with no formal education. Few of the respondents (19.0%) however had secondary school education while none of the respondents had tertiary education [29] observed a similar scenario in South-western Nigeria where most of the herbal medicine sellers had little or no formal education.

Most of the respondents (60.8%) were males while 39.2% were females. The only exception was in Lagos State where most of the herb sellers were females. This is in agreement with the pattern reported by [14, 30, 31, 32] who noted that males dominated the herb selling business. This could be attributed to the fact that most of the elderly population in Enugu, Delta and Kaduna States prefer to engage their male child in the family line of trade

instead of their female child who is likely to be married later in life.

Most of the respondents (57.2%) were youths between 18 and 35 years. However, the knowledge exhibited by this age group of youthful population in utilising plants for medicinal, insecticides/repellents purposes might have been gained from their elderly parents [33]. More so, the youths are more energetic compared to their older parents and hence they can be found in the market space carrying out one activity or the other.

From the ethno – botanical survey carried out in this study, a total of six plant species belonging to five families were reported in Delta State with *Conyza Canadensis* (Compositae) being the most utilized (50%) and *Aspilia Africana* (Compositae), the least mentioned (5.60%). The low occurrence of plant species used to kill and/or repel mosquitoes in this area may be as a result of environmental degradation occasioned by oil exploration.

In Enugu State, a total of nine plant species belonging to eight families were mentioned by respondents with *Aframomum melegueta*, the most utilised (26.09%) while *Agava sisalana* and *Dracaena manii* belonging to the families Agavaceae and Dracaenaceae were the least mentioned (1.09% each). The low number of plant species recorded in the State may be due to the fact that the State, like other south eastern parts of Nigeria, are commercial hubs, so most of the vegetation would have been cleared and replaced by buildings for commercial business purposes.

A total of six plant species belonging to five families were reported in Kaduna State with *Lantana camara* belonging to the family Verbenaceae accounting for 58.82% of the utilised plant species while *Ipomea asarifolia*, *Terminalia catappa* and *Citrullus vulgaris* belonging to the families Convolvulaceae, Combretaceae and Cucurbitaceae respectively were the least utilized (5.88% each). Kaduna State is located in North-western Nigeria which is characterized by sparse trees and grass land. This could be the reason behind the low number of plant species mentioned.

Lagos State recorded the highest number of plant species (twenty five) belonging to eighteen families. *Spondia mombin* belonging to the family Lilaceae was the most mentioned (7.33%) while the least mentioned (0.37% each) were *Magnifera indica*,

*Baphia nitida* and *Pennisetum purpureum* belonging to the families Anacardiaceae, Fabaceae, and Poaceae respectively. Lagos State is a cosmopolitan State, located in the rainforest zone of South-western Nigeria with abundant trees, shrubs and herbs. The high occurrence of respondents in the State could be as a result of influx of people from other parts of the country and beyond. The direct consequence of this is shown in the high number of plant species (twenty five) belonging to eighteen families mentioned. Majority of the respondents inherited the knowledge of their practices from their fore parents, relatives or friends.

In this study, Anacardaceae, Libiatae, Euphorbiaceae, Compositae and Convovulaceae were the most utilised families for pesticidal and repellence purposes in the surveyed geopolitical zones of Nigeria. In similar studies in southern Uganda, [28] reported that the family Euphorbiaceae, was one of the most useful for pesticidal purpose. Leaves (44.6%) were the most utilised plant part followed by seeds (22.0%), fruits (15.25%), bark (5.75%) bulbs (4.0%), peels (3.25%) and rhizomes (2.75%). Roots and stem/leaves (0.75%), stem (0.5%), sap and leaves/roots (0.25%) were the least mentioned. This is consistent with findings from various studies in which the leaves were identified as the most utilised plant parts for mosquito control [14, 34, 35].

Moreover, Leaves were the only plant part mentioned in all the four geopolitical zones. The fact that leaves are exposed and conspicuous makes them easy target for herbivores and other pathogens. Plants are therefore likely to deposit and store secondary metabolites in this area to serve as deterrent to predators. The high utilisation of leaves by the respondents for insecticidal and repellence purposes could also be because they are easily available and renewable [36].

There was no intersection in any of the plant species mentioned in any zone to that from another zone. This shows the high cultural and rich plant diversity in Nigeria as one moves from one geopolitical zone to another. It is imperative for developing nations like Nigeria to document its rich plant resources especially those with insecticidal/repellent properties in all communities before they become extinct due to urbanization and industrialization. The elderly population who are usually the custodians of such information are also fast disappearing.

Whole plants that have demonstrated appreciable

mosquito repellent activity can be mass produced and distributed among individuals within a community for mass-cultivation around dwellings. This way, they reduce the population of exophilic mosquitoes and also for beautification of the environment. These plants will be particularly promising in regions where mosquitoes bite early in the evening and in regions where they have exophagic (outdoor) feeding habits, and bed net use is unlikely to be very effective.

It is therefore very important that the diverse plant species in Nigeria especially those identified in this study are further investigated for mosquitocidal and repellent activities in order to provide justification for consideration as alternatives to synthetic insecticides.

## References

1. Goddard, J. (2008). Infectious Diseases and Arthropods. 2nd ed. Totowa, NJ: Humana Press.
2. Okorie, P.N., McKenzie, F.E., Ademowo, O.G., Bockarie, M. and Hope-Kelly, L. (2011). Nigeria Anopheles Vector Database: An Overview of 100 Years' Research. *PLoS One*, 6(12): e28347.
3. Massuod, W.A.M., Raqib, S.M., Budiharjo, A. and Mahajoena, E. (2014). Larvicidal Potentiality of the Bandotan (*Ageratum Conyzoides*) Leaves for Controlling the three important species of Mosquitoes (*Aedes Aegypti*, *Culex Quinquefasciatus* and *Anopheles Maculatus*). *International Journal of CBS*, 1(6).
4. WHO (2020). Vector – borne diseases. Fact sheets - <https://www.who.int/en/news-room/fact-sheets/detail/vector-borne-diseases>.
5. Wilson, J.J., Sevarkodiyone, S.P. and Karthikairaj, K. (2013). Prevalence of Mosquitoes in an Agro-Ecosystem (Athikulam, Virudhunagar District Tamil Nadu, India) *Academic Journal of Entomology*, 6(2):61-65.
6. Kumar, R.D., Chawla, P., Dhamodaram, and Balakrishnan, N. (2014). Larvicidal Activity of *Cassia occidentalis* (Linn.) against the Larvae of Bancroftian Filariasis Vector Mosquito *Culex quinquefasciatus*. *Journal of Parasitology Research*, 2014(1): e236838.

7. Taiwo Samson Awolola., Adedapo Adeogun., Abiodun K Olakiigbe., Tolulope Oyeniya., Hilary Okoh., Tolulope Arowolo., Joel Akilah., Adedayo Oduola., Chioma N Amajoh (2018). Pyrethroids resistance intensity and resistance mechanisms in *Anopheles gambiae* from malaria vector surveillance sites in Nigeria. 13 (12) : e0205230 . <https://doi.org/10.1371/journal.pone.0205230>
8. Huthmacher, C., Hoppe, A., Bulik, S. and Holzhütter, H. (2010). Antimalarial drug targets in *Plasmodium falciparum* predicted by stage-specific metabolic network analysis. *BMC Systems Biology*, 4:120.
9. Ashley, E.A., Phyto, A.P., Woodrow, C.J. (2018). Malaria. [www.thelancet.com http://dx.doi.org/10.1016/S0140-6736\(18\)30324-6](http://dx.doi.org/10.1016/S0140-6736(18)30324-6)
10. World Health Organization. (2018). Malaria fact sheets. WHO press, Geneva Switzerland.
11. World Health Organization (2017). Global Vector Control Response 2017–2030 Geneva: WHO, 2017.
12. Wilson AL, Courtenay O, Kelly-Hope LA, Scott TW, Takken W, Torr SJ, *et al.* (2020). The importance of vector control for the control and elimination of vector-borne diseases. *PLoS Negl Trop Dis* 14(1): e0000783 . <https://doi.org/10.1371/journal.pntd.0007831>
13. Kumar, D., Dhamodaran, P., Nilani, P. and Balakrishna, N. (2012). “Larvicidal activity of *Tephrosia purpuria* against *Culex quinquefasciatus*,” *Journal of Applied Pharmaceutical Science*, 2: 219–221.
14. Youmsi, R.D.F., Fokou, P.V.T., Menkem, E.Z., Bakarnga-Via, I., Keumoe, R., Nana, V. and Boyom, F.F. (2017). Ethnobotanical survey of medicinal plants used as insects repellents in six malaria endemic localities of Cameroon. *Journal of ethno-biology and ethno-medicine*, 13: 33-46.
15. Nsirim L. Edwin-Wosu, Samuel N. Okiwelu and M. Aline E. Noutcha (2013). Traditional sources of mosquito repellents in southeast Nigeria. *J. Bio Pest* 6(2): 104 - 107
16. Oparaoochaa, E.T., Iwub, I and Ahanakuc, J.E (2010). Preliminary study on mosquito repellent and mosquitocidal activities of *Ocimum gratissimum* (L.) grown in eastern Nigeria. *J Vector Borne Dis* 47. pp. 45–50
17. Usip, L.P.E., Opara, K.N., Ibanga, E.S and Atting, I.A. (2006). Longitudinal evaluation of repellent activity of *Ocimum gratissimum* (Labiatae) volatile oil against *Simulium damnosum*. *Mem Inst Oswaldo Cruz, Rio de Janeiro*, 101(2): 201-205,
18. Iwu, M.M (2002). Ethnobotanical approach to pharmaceutical drug discovery: strengths and limitations. *Advances in Phytomedicine*. Chapter 25. 1:309-320
19. Erinoso and Aworinde (2012). Ethnobotanical survey of some medicinal plants used in traditional health care in Abeokuta areas of Ogun State, Nigeria. *African Journal of Pharmacy and Pharmacology* Vol. 6(18), pp. 1352-1362,
20. Ogbole, O.O and Ajaiyeoba, E.O. (2010). Traditional management of tuberculosis in Ogun State of Nigeria: the practice and ethnobotanical survey. *Afr. J. Trad. Compl. Alter. Med.*, 7(1): 79-84.
21. Soladoye, M.O., Amusa, N.A., Raji-Esan, S.O., Chukwuma, E.C. and Taiwo, A.A (2010). Ethnobotanical survey of anti-cancer plants in Ogun State, Nigeria. *Ann. Biol. Res.*, 1(4): 261-273.
22. Egunyomi, A, Gbadamosi, I.T. and Osiname, K.O (2010). Comparative effectiveness of ethnobotanical mosquito repellents used in Ibadan, Nigeria. *Journal of Applied Biosciences* 36: 2383- 2388.
23. World Bank Group (2020). Nigeria Overview Retrieved 11 January. 2020.
24. Okoh, H.I., Adekoya, M.A., Makanjuola, W.A, Otubanjo, O.A., Awolola, S. (2016). Repellent activities of essential oils from ten Nigerian plant species against laboratory-bred and field-collected *Anopheles gambiae* and *Aedes aegypti* adults. *Nigerian Journal of Clinical and Biomedical Research*, 7 (6): 21 – 31. ISSN: 1596-0730
25. Okoh, H.I., Makanjuola, W.A., Otubanjo, O.A and Awolola (2017). Larvicidal activity of six Nigerian plant species against *Anopheles gambiae* and *Aedes aegypti* *Nigerian Journal of Parasitology*, 38 (1): 111 - 116. ISSN 11174145
26. Okoh, H.I., Adekoya, M.A., Makanjuola, W.A., Otubanjo, O.A., Awolola, S. (2018). Gas Chromatography - Mass



- Spectrophotometry (GC-MS) analysis of essential oils from three Nigerian plant species with suspected insect repellent activities *Fuoye Journal of Pure and Applied Sciences*, 3(2): 87–98.
27. Kweka E. J., Mosha F., Lowassa A., Mahande A. M., Kitua J., Matowo J., Massenga C. P., Tenu F., Feston E., Lyatuu E. E., Mboya M. A., Mndeme R., Chuwa G., Temu E. A (2008). Ethnobotanical study of some mosquito repellent plants in north-eastern Tanzania *Malaria Journal*, 7:152
  28. Mwine J., Van Damme P., Kamoga G., Kudamba, Nasuuna M., and Jumba F. (2011). Ethnobotanical survey of pesticidal plants used in South Uganda: Case study of Masaka district. *Journal of Medicinal Plants Research*, 5(7):1155-1163.
  29. Dike, I.P., Obembe, O.O. and Adebisi, F.E. (2012). Ethnobotanical survey for potential anti-malarial plants in south-western Nigeria. *Journal of Ethnopharmacology*, <http://dx.doi.org/10.1016/j.jep.2012.10.002>
  30. Okello, J. and Ssegawa, P. (2007). Medicinal plants used by communities of Ngai Subcounty, Apac District, Centre Uganda. *African Journal of Ecology*, 45(1):76-83.
  31. Bekalo, T.H., Woodmatas, S.D. and Woldemariam, Z.A. (2009). An ethnobotanical study of medicinal plants used by local people in the low lands of Konta special Woreda, southern nations, nationalities and peoples regional state, Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, 5:26.
  32. Cheikhoussef, A., Shapi, M., Matengu, K. and Ashekele, H.M.U (2011). Ethnobotanical study of indigenous knowledge on medicinal plant used by traditional healers in Ohikoto region, Namibia. *Journal of Ethnobiology and Ethnomedicine*, 7:10.
  33. Igoli, J.O., Igwe, I.C. and Igoli, N.P.(2003). Traditional medicinal practices amongst the Igede people of Nigeria. *J. Herbs Spices Med Plants*, 11(3):82-87.
  34. Salako, E. A., Anjorin, T. S. and Ulelu A.J. (2015). Ethnobotanical survey of pesticidal plants used in Edo State, Nigeria. *African Journal of Agricultural Science and Technology*, 3(11): 448-460.
  35. Buwa-Komoren, L.V., Mayekiso, B., Mhinana, Z. and Adeniran, A.L. (2019). An ethno-botanical and ethno-medicinal survey of traditionally used medicinal plants in Seymour, South Africa: An attempt toward digitization and preservation of ethnic knowledge. *Publication of Pharmacognosy Magazine Network Worldwide*, 14:115-23.

**Citation**

Okoh, H.I., Mogaji, H.O., Adekoya, M.A., Morikwe U.C., Nwana, A.O., Ahmed, J., Makanjuola, W.A., Otubanjo, O.A.  
Ethno - botanical survey of plant species used for mosquito control in Nigeria pages 99 - 106  
<https://dx.doi.org/10.4314/njpar.v42i1.14>

*Nigerian Journal of Parasitology*  
ISSN 1117 4145 Volume 42[1] March, 2021

