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Insecticidal potentials of some selected plants

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ABSTRACT

The phytopesticidal effects of Piper guineense, Capsicum annum, Zingiber officinale and Lippia adoensis were tested for the mortality rates of the following insects: Rhaffella germanium, Aedes spp, Diphtheria spp and the brown plant hoppers. Percentage mortality rates of 89.5±2.2 for Rhaffella germanium; 55.3 ± 4.6 for Aedes spp; 92.4 ± 1.8 for Diphtheria spp and 61.7 ± 3.4 for the brown plant hopper was recorded by Piper guineense as compared to Capsicum annum which had mortality rates in percentage as 90.9 ± 3.2 for Diphtheria spp; and 50.5 ± 3.3 for the brown plant hopper.Lippia adoensis also had mortality rates in percentage of 56.3 ± 3.0 for Rhaffella germanium, 87.7 ± 2.7 for Aedes spp; 69.3 ± 5.9 for Diphtheria spp and 61.1 ± 2.2 for the brown plant hopper as compared to Zingiber officinale which showed percentage mortality rates of 31.1 ± 3.3 for Raffella germanium, 91.3 ± 2.8 for Aedes spp; 91.1 ± 2.5 for Diphtheria spp and 34.4 ± 3.8 for the brown plant hopper. The above result seem to suggest that Piper guineense and Capsicum annum exhibit greater insecticidal potency on the German cockroach (Rhaffella germanium) as compared to Lippia adoensis and Zingiber officinale which showed very high insecticidal efficacy on Diphtheria spp. Also, Piper guineense and Zingiber officinale proved to be highly pesticidal against the mosquito larva (Aedes spp) as compared to the adult mosquito (Anopheles spp) whose percentage mortality rates were not as high as in the case of the larva.

Keywords: Phytopesticidal, Mortality, Potency, Insecticidal, Efficacy.

INTRODUCTION

Insecticides are pesticides used against insects in all forms of development. They include: ovocides and larvcides used against the eggs and larva of insects respectively [19].The use of insecticides is one of the major factors behind the increase in agricultural productivity in the 20th century [32]. In view of the severity of damage caused and of problems associated with the use of synthetic insecticides, natural methods for control of insects pests was evaluated [2].Presently, over 50 families have been found to possess insecticidal properties. The plant species that have been investigated are frequently those used locally as culinary spices or in traditional medicine.[18]. Since insecticides have the potential to alter the ecosystem, it is necessary to balance agricultural needs with safety concerns when using them [32]. The natural insecticides like nicotine and pyrethrum are made from plants as defense against insects in contrast to the inorganic insecticides like arsenates, copper and fluorine compounds [2]. Published research on the use of plant materials, extracts and oils for the control of stored product pests shows that over the past twelve years, a large number of plant species from a wide range of families have been evaluated [11]. It has been suggested that the most promising botanicals were to be found in the families; *Rutaceae, Arteraceae, Labiatae and Annonaceae.*

The ancient use of ginger as flavoring predates historical records [6]. Its origin is uncertain. It has a long history of use in South Africa both in dried and fresh form. [9].It is a rhizome, an underground stem that is used as a spice [14].The ginger plant is a tropical perennial that is vegetatively propagated [9].The plant is usually about 60-90cm in height with stalkless leaves. [6].The flowers are pale green with yellow margins. They are clustered in spikes

sometimes having yellow or purple spots [13].The fleshy rhizome of ginger has a sweet, spicy, pungent flavor and is used mainly in flavoring wines, candies and as seasoning [16].It is a useful antidote for stomach ailments. It also aids digestion [1]. It is valued highly for its 'hot' and 'warming' qualities [44].It's used commonly in Asian medicine to treat reheumatoid arthritis, migraine, sore throats and to improve circulation and reduced fat deposits in the arteries [7]. Ayurvedic practitioners use ginger rhizomes as a cure for cholera, anorexia and inflamed liver. Many of these traditional medicinal properties are supported by recent scientific research. [50].

Nutmeg belongs to the family 'myristicaceae, Naturally, nutmeg is limited to the Banda Islands in Eastern Indonesia [27].However, today nutmeg is obtainable here in Africa [37].It grows to a height of about 18m and produces fruits fifteen to twenty years after planting. The fruit splits when ripe revealing the brilliant red anvils encasing the brown nut [12]. The nut is also dried until the kernel inside rattles [31]. Nutmeg is used to cure insomnia, mouth sore, stomach disorders, muscle aches, whooping cough, cramping and as a digestive aid in Indonesia[20]. It is also believed to help stop arthritis and to heal sprains. Oil from nutmeg is applied to the forehead to stop headaches and help babies sleep. It also helps retain body heat when rubbed on the body. Malaysians also rub nutmeg oil on the abdomen to relieve stomach aches [7]. In India, nutmeg is used as treatment for fevers, diarrhea, Intestinal disorders and bad breath. It is also prescribed as a post-child birth tonic and an antidote to madness and malaria [3].It alleviates the common cold, kidney ailments and is used as an aphrodisiac and to decrease inflammation. It is also known to have hallucinogenic properties and relieves convulsions [39].

Black pepper belongs to the family *piperaceae*. It is native to the Western Ghats of Kerala sate, India, where it still occurs wild in the mountains [14]. It is a climber and grows to a height or length of 10m or more when its main stem is established. They are shaped like almonds and taper towards the tip. They are dark green and shinny above but paler green below [34]. Fruits are green at first but they turn red as they ripen. These fruits are picked when either green or red to produce black pepper [32].In Chinese folk medicine; black pepper is used to treat epilepsy. 'piperine' the active component of black pepper blocks convulsions induced by 'kainte' but not by glutamate, NMDA or guanidinosuccinate [42]. 'Trikatu' is an Ayurvedic preparation (black pepper, long pepper and ginger).prescribed routinely for a variety of diseases [24]. It is also used in Chinese medicine for the treatment of rheumatism, toothache and stomach ache. It is also crushed and eaten by pregnant women in Caspian Littoral of Iran where esophageal cancer rate is high. [46]

Black pepper has been prepared in the form of pills as a remedy for cholera and syphilis. It has also been used in tooth powder for toothache and for sore throat and hoarseness. It could be chewed to reduce throat inflammation [39].Other applications of black pepper include treatment of boils, hair loss and skin diseases. It also alleviates itching and paralysis. A mixture of black pepper and honey serves as a remedy for night blindness. Black pepper is also useful in hepatitis, urinary and reproductive disorders. Also alleviates colic indigestion and stomach acidity [27].

Chilli peppers are perhaps the first plants to be domesticated in Central America where there is evidence that they were consumed in 7500 BC [34]. Chilli pepper is obtained from a plant called *Schimus terebinthifolius*, otherwise known as the Brazilian pepper tree. Its fruits are pinkish-red. They are famous for their hot and pungent flavor [43]. Chilli pepper acts as counter-irritant when applied to the skin. It can also be used for some joint or muscle pains. It also helps to relieve some types of nerve pains such as post-herpetic neuralgia. They are also included in some cough preparations. Chilli pepper is also widely used as a condiment and vegetable all over the world. The fruits are consumed fresh, dried or processed as a spice [8].

EXPERIMENTAL SECTION

SAMPLE COLLECTION

Fresh rhizomes of *Zingiber officinale* and fresh fruits of *Capsicum annum* as well as dry seeds of *Lippia adoensis* and *Piper guineense* were all purchased from Umuahia main market, Abia state. The brown field hoppers were caught from the fields of Okwuta village, in Umuahia North L.G.A of Abia state, the adult cockroaches were caught from domestic sinks at Ehimmiri Housing Estate Umuahia Abia state, the *Diphtheria*(wall fly) were caught from damp walls in the female hostel of Michael Okpara University of Agriculture Umudike (MOUAU), all in Abia State.

SAMPLE PREPARATION

The fruit samples of *Capsicum annum*, *Piper guineense* and Nutmeg as well as the rhizome of Zingib*er officinale* were all examined for signs of disease, variegation and the presence of extevenous materials (insects, their eggs or larva). Though in Nigeria generally, black pepper, Nutmeg and Ginger are not known to be attacked by insect pests and by diseases and no reports exist on the use of chemical insecticides on these plants as far as I know. The four plants samples were ground to obtain the fine particle used for the insecticidal tests. Ginger and Chilli pepper were

ground fresh while nutmeg and black pepper were ground dry. The ground samples were tested for their ability to kill insects. For the phytochemical analysis, the four plants samples were properly ground and air dried to obtain the powder-like processed samples, used for the analysis.

METHODOLOGY

Five empty tins were washed and dried using a neat piece of cloth material. The tins were perforated at the base center using a sharp knife and were all tightly covered with their lids. Three pairs of adult cockroaches were placed into the different containers through the perforated base and the ground plant materials were added to each of the different containers having the cockroach except the control. The perforated bases were then blocked with cotton lint to prevent the cockroaches from escaping and to allow adequate ventilation into the cans. The cans were allowed to stand undisturbed for 24 hours, after which the lids were removed for observation. The method used for the adult cockroach above was also used on Diphtheria specie (wall fly) and brown field hoppers one after the other. The insecticidal effect of the plant material was tested on mosquito larva as well. Water was collected in five big bowls and kept in a grass lawn for 9 days. At the end of the 9^{th} day, mosquito larva were seen thriving on the stagnant water in large numbers in different bowls. The different plant materials were crushed and poured into the mosquito larva habitat and allowed to stand for 24 hours, the control was not treated with any plant samples. After 24 hours, almost all the mosquito larva breeding in these bowls died and there was little or no movement in the water contained in the bowls. However mosquito continued to breed in the control.

QUALITATIVE AND QUANTITATIVE DETERMINATION OF PHYTOCHEMICALS

The plants were first screened for the phytochemicals before the quantitative determination of these chemicals were analysed. For the qualitative analysis; the Wagner dragendroff's test for Alkaloids, Ferric chloride test for Tannins, Ammonium test for Flavonoids, Liberman-Burchard test for steroids were employed [23].For Antocyanin, Saponin and Philobatannin the methods of [15] [5] were employed. Quantitative determination was carried out for Alkaloids, Antocyanin and Flavonoid [23], Saponin [17], Tannin and Steroid [10], Philobatannins [15]

STATISTICAL ANALYSIS

The results obtained were computed into means and ANOVA was used to separate the means according to the method of Ihekoronye and Ngoddy [21].The least significant difference (LSD) was used to determine level of differences among the varying samples.

RESULTS

The result of the phytochemical screening showed that black pepper contained all the phytochemicals tested for, Red pepper contained all but steroids, Nutmeg contain all except Tannins and Philobatannins, while Ginger contained all except steroids and philobatannins. The quantitative determination also showed that the phytochemicals were contained in different proportions by different plants as shown in the tables that follow. *Piper guineense* and *Capsicun annum* possessed the highest insecticidal abilities against *Rhaffella germanium* while *Lippia adoensis* and *Zingiber officinale* possessed high insecticidal effects against *Diphtheria*. *Piper guineense* and *Zingiber officinale* exhibited the highest insecticidal effects on mosquito larva. All the plants sampled showed poor insecticidal efficacy against the brown plant hoppers, even as the values for the tested were almost the same with that of the control.

TABLE 1.0 PHYTOCHEMICAL QUALITATIVE SCREENING TESTS OF THE PLANT SAMPLES

Sample	Alkaloids	Antocyanin	Flavonoids	Tannins	Saponins	Steroids	Philobatannins
Black pepper	+ve	+ve	+ve	+ve	+ve	+ve	+ve
Red pepper	+ve	+ve	+ve	+ve	+ve	-ve	+ve
Nutmeg	+ve	+ve	+ve	-ve	+ve	+ve	-ve
Ginger	+ve	+ve	+ve	+ve	+ve	-ve	-ve

+ve = Positive
-ve = Negative

TABLE 2.0 PHYTOCHEMICAL COMPOSITONS OF THE PLANT SAMPLES

Sample	Alkaloids (%)	Tannin (%)	Flavonoids (%)	Antocyanin (%)	Saponin (%)
Black pepper	9.27 ± 0.02	2.26 ± 0.01	12.25 ± 0.03	11.88 ± 0.01	9.13 ± 0.02
Red pepper	8.40 ± 0.01	5.37 ± 0.02	11.63 ± 0.02	11.38 ± 0.02	7.63 ± 0.01
Ginger	8.91 ± 0.03	8.53 ± 0.05	12.38 ± 0.02	11.25 ± 0.03	5.00 ± 0.02
Nutmeg	8.80 ± 0.02	-	11.50 ± 0.01	12.13 ± 0.02	0.38 ± 0.05

Values represent means ±SEM of triplicate determinations. Means with the same superscript along the same row are not significantly different at 95% confidence level (P<0.05)

TABLE 3.0 EFFECTS OF PLANT MATERIALS ON THE MORTALITY RATE OF *RHAFFELLA GERMANIUM*

Treatment	Mean Mortality Rate (%)			
	Ist trial	2nd trial	3rd trial	Mean
P.guineense	89.5 ± 2.1	87.1 ± 1.4	92.0 ± 3.2	89.5 ± 2.2
Casicum annum	92.0 ± 3.1	84.4 ± 4.0	94.0 ± 5.0	90.1 ± 4.0
Lippia adoensis	58.5 ± 2.4	60.0 ± 2.5	55.4 ± 4.1	56.3 ± 3.0
Zingiber officinale	30.0 ± 1.5	28.0 ± 4.3	35.2 ± 4.1	31.1 ± 3.3
Control	20.5 ± 5.2	25.4 ± 1.2	23.5 ± 3.4	23.1 ± 3.3

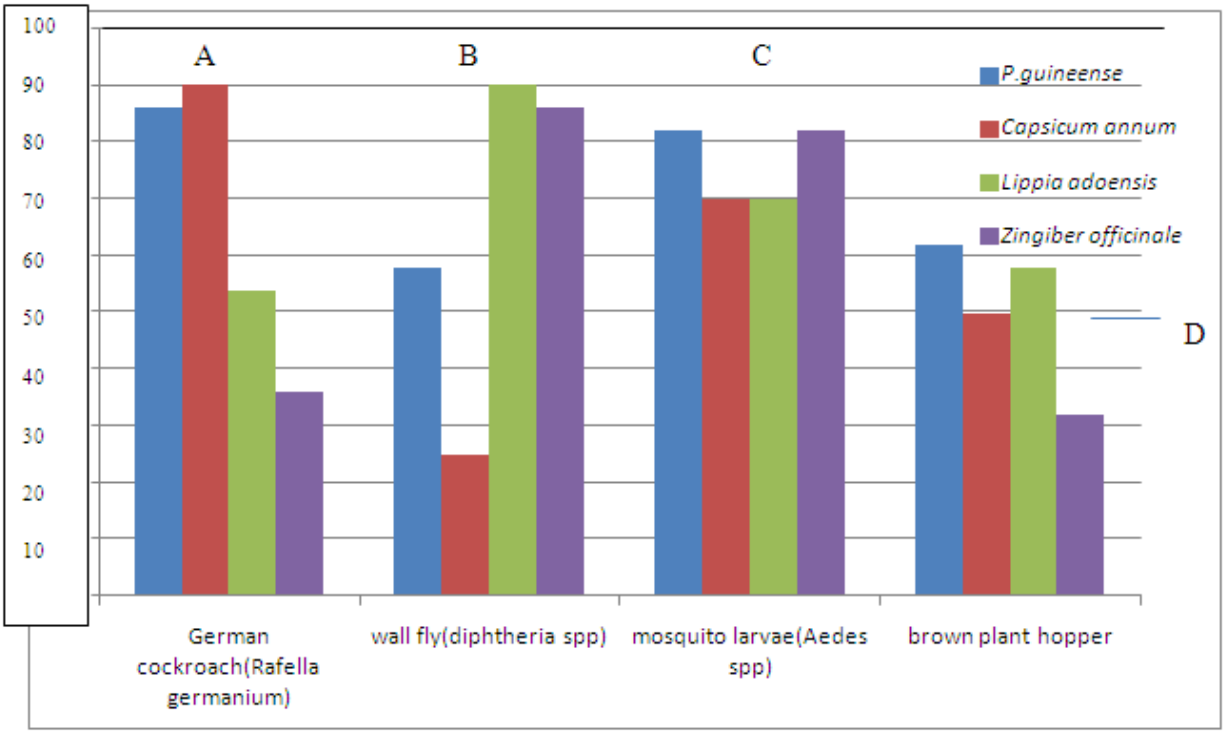
TABLE 4.0 EFFECTS OF PLANT MATERIALS ON THE MORTALITY RATE OF *DIPHTHERIA* (WALL FLY)

Treatment	Mean Mortality Rate (%)			
	1st trial	2nd trial	3rd trial	Mean
P.guineense	52.7 ± 3.1	55.2 ± 4.7	58.1 ± 6.0	55.3 ± 4.6
Capsicum annum	33.8 ± 4.5	28.5 ± 6.4	25.1 ± 5.4	29.1 ± 5.4
Lippia adoensis	83.2 ± 3.4	90.0 ± 2.2	90.0 ± 2.4	87.7 ± 2.7
Zingiber officinale	90.0 ± 2.5	95.3 ± 0.5	88.5 ± 5.3	91.3 ± 2.8
Control	20.7 ± 5.4	22.6 ± 4.2	28.7 ± 2.1	24.0 ± 3.9

TABLE 5.0: EFFECTS OF PLANT MATERIALS ON THE MORTALITY RATE OF *AEDES SPP* (MOSQUITO LARVA)

Treatment	Mean Mortality Rate (%)			
	1st trial	2nd trial	3rd trial	Mean
P.guineense	92.2 ± 2.1	94.3 ± 1.4	90.6 ± 2.0	92.4 ± 1.8
Capsicum annum	65.7 ± 3.4	71.4 ± 3.2	72.5 ± 2.9	69.9 ± 3.2
Lippia adoensis	73.5 ± 4.7	68.7 ± 5.7	65.9 ± 7.4	69.3 ± 5.9
Zingiber officinale	88.4 ± 3.2	91.4 ± 2.5	93.4 ± 1.8	91.1 ± 2.5
Control	19.5 ± 5.1	25.4 ± 3.4	21.7 ± 4.5	22.2 ± 4.3

REPRESENTATION OF RESULT IN A HISTOGRAM



A= Percentage mortality rates of the German cockroach (Rafella germanium) when treated with the plant materials.
B= Percentage mortality rates of diphtheria (wall fly) when exposed to the plant materials.
C= Percentage mortality rates of mosquito Larvae (Aedes spp) when treated with the plant materials.
D= Percentage mortality rates of the brown plant hoppers when treated with the plant materials.

TABLE 6.0 EFFECTS OF PLANT MATERIALS ON THE MORTALITY RATE OF THE BROWN PLANT HOPPERS

Treatment	Mean Mortality Rate (%)			
	1st trial	2nd trial	3rd trial	Mean
P.guineense	58.7 ± 4.8	64.0 ± 2.1	62.5 ± 3.2	61.7 ± 3.4
Capsicum annum	52.5 ± 2.7	48.7 ± 3.1	50.3 ± 4.1	50.5 ± 3.3
Lippia adoensis	58.7 ± 2.5	65.2 ± 1.4	59.5 ± 2.8	61.1 ± 2.2
Zingiber officinale	38.5 ± 3.4	30.2 ± 5.4	34.4 ± 2.6	34.4 ± 3.8
Control	51.4 ± 7.1	40.1 ± 2.4	25.4 ± 3.0	39.0 ± 4.2

Values represent means ±SEM of triplicate determinations. Means with the same superscript along the same row are not significantly different at 95% confidence level (P<0.05)

DISCUSSION

The phytochemical screening and quantitative estimation of percentage crude yields of chemical constituents of the plants studied, showed that the plants were rich in Alkaloids, Flavonoids, Antocyanin, Tannins, Saponinns, Philobatanins and Steroids. Ginger had the highest percentage composition of flavonoids (12.38 ± 0.02mg/kg). Ginger is valued highly for it's hot and warming qualities this could be responsible for their ability to suffocate the insects, its pungent flavor could also be an attribute that makes it insecticidal[48].Ginger has been discovered to have some insecticidal effects on American bollworms, aphids, plant hoppers, thrips, white fly, root knot nematode, brown leaf spot of rice, mango, anthracnose and yellow vein[38].The ginger rhizome is ground and made into paste it is then mixed with water, soap is added and the mixture is stirred and strained. The resulting mixture is sprayed on infected plants to obtain optimum results. [26]. Many of its actions are due to the presence of compounds in the rhizomes called'oleoresisns' especially those known as gingerols and shogoals (pungent principle) [51].Ginger contains approximately 1-4% volatile oils. The aromatic principles include: Zingiberene and bisabolene[36].Other components of their volatiles include: Zingiberene and arcurcumene, beta-bisabotene and arcucumene, D-camphor,Arylalkane[28]

Flavones have been reported to have the capacity of free radical scavenging and protective against hepatotoxicity [49], thus these plant materials could be medicinal. The plant samples are rich in saponin composition as well. Saponins are known to have anti-microbial activity [25] and thus could be insecticidal too. They also serve as emulsifying agents and detergents [41].Tannins and Alkaloids were also found present in all plant samples tested as shown in the result (Table 1.0).Tannins are known to possess astringent properties. Alkaloids are highly toxic, used as basic medicinal agents for their bacteriacidal effects.Alkaloids often have a powerful effect on animal philosophy [19] and may account for the use of the plants as insecticides. Antocyanin was also present in most of the plants and in moderate quantities.

The results from the insecticidal tests revealed that each of the materials tested have distinct effects on the survival of the different insects. It was also observed in the course of the study, that treatment with higher concentration of extracts resulted in higher mortality rates. Crude aqueous extracts of black pepper significantly reduced egg viability in *M vitrata and C tomentosicollis* at all concentrations [4].I ts crude extracts have also been reported to be highly toxic to rice weevil,*(Sitophilus oryzae,)* L Cowpea weevil, *(Anthonomus grandis)* and European corn borer*(Ostrinia nubilalis)* [29]. The striking effects of *P guineense* powder could be attributed to its *guinensine 1* component, and to its irritating smell, which prevents physical contact and caused suffocation among the various insects. *P guineense* also contain *Piperine* and *Chavicine* which are known to possess insecticidal properties [33].

In recent study, twenty-six different plant species were found useful as grain storage protectants, the most common being *chomoleana odorata* (Siam weed), *Azadirachta indica* (neem) and *capsicum annum*(chilli pepper)[30] This agrees with the high level of insecticidal efficacy shown by *capsicum annum* against the German cockroach and the mosquito larva.

Lippia adoensis, which also showed high insecticidal potency against the *diphtheria spp* as well as the mosquito larva, have been reported to be effective against some crop pest species. *Lippia adoensis* contains about 10% essential oil, which is mostly composed of terpene hydrocarbons (pinenes, camphene, Pcynene, Sabinene, Phellandroe, Terpinene, Limonene, Myrcene, together 60-90%,terpene derivatives ,Linalool, geraniol, terpineol, together 5 to 15%) and phenylpropanes (myristicine, elemicine, satrol together 2 to 20%) [4].

For the brown plant hoppers, varying degrees of mortality were noticed in both the treated and untreated insects. The insecticidal properties of the plant materials were not pronounced as when they were used on the other insects. This indicates that, the brown field hoppers may possess some degree of resistance to these plant materials. It was also noticed that the mortality rate in the control was fairly high, this seem to suggest that the mortality rates observed for

the brown plant hoppers may not strictly be as a result of the treatment .This opens a door for further research in this direction.

The result from this study therefore suggest that *Zingiber officinale, piper guineense, capsicum annum* and *lippia adoensis* actually possess insecticidal properties against the tested insects and may exhibit a wide range of insecticidal abilities on other insects not tested in this work. In Nigeria, the present harsh economic realities caused by low productivity and high exchange rates against the local currency and the removal of government subsidies on agricultural goods including importation of pesticides have created the urgent need to explore and develop new sources of chemical compounds from plants which are non-toxic, safe, biodegradable and of broad activity spectrum. Fortunately, Nigeria has a wide range of herbal landraces spread across the various ecological zones, which are largely unexploited. Cashew, Clove and African nutmeg extracts have also shown insecticidal properties against some flowering pests of cowpea.

Since *Piper guineense, Lippia adoensis, Capsicum annum and Zingiber officinale* are readily available to local farmers for use in protecting their crops against harmful insects here in Nigeria, these materials could be crushed on farms and the freshly prepared extracts then applied by local farmers. They are safe to the workers and can be produced easily by the small-scale limited resource farmers. The biodegradable nature of such materials also minimizes the hazard to the environment. Repeated use of a single synthetic pesticidal ingredient can result in resistance amongst the target populations where as natural products in plants defense mechanism often consist of a variety of toxins which make adaptation of the predator unfavorable.

Proper identification should be carried out by a botanist or a herbalist to avoid application of the wrong plant extract, which could be harmful to the crop. The use of these plant materials should be maximized in the control of the malaria-causing mosquito (*Anopheles spp*) at its larval and adult stages of development, this could go a long way to minimize malaria crisis in the nation. On-farm or stimulated field trials should be facilitated and resourced as a priority, A suitable infrastructure for the introduction of plant materials to be used as protectants at the rural areas should be provided. Training of extension personnel in the understanding and use of such materials is also necessary.

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