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GCMS CHARACTERIZATION AND MOSQUITO REPELLING POTENTIAL EVALUATION OF COIL PRODUCED USING *OCIMUM BACILLICUM* OIL

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ABSTRACT
Mosquito a vector for many protozoa, bacterial and viral diseases facilitating their transmission to human, resulting to loss of millions of lives annually. Its vectors capacity is enhanced by development of its resistance to many insecticides. The present study aimed at characterizing using FTIR and GC-MS methods of essential oil from *Ocimum basilicum*, production of mosquito repellent coil from the oil and bio-efficacy evaluation of the coil on adult mosquito (*A. stephensis*). The FTIR Spectral revealed the presences of P-OH, N-O, C-O, NO_2, C=O, O-H, =C-H, O-H and C-X which correlate with the functional groups of the major phyto-chemical constituent compounds revealed by GC-MS spectral. 15 phyto-constituents were identified with 9, 12, 15-Octadecanoic acid as the major phyto-constituent with percentage of 35.61%. Bio-efficacy evaluation shows high potential of the coil at all concentration and with highest value at 300mg and 400mg compared to the result obtained for commercially made coil (Baygon) at laboratory condition. *Ocimum basilicum* can therefore be used as an alternative repellent ingredient to repel adult mosquito.

Keywords: Malaria, *Ocimum basilicum*, Mosquito replant, FTIR, GC-MS, and Bio-efficacy

INTRODUCTION

Mosquitos are among the most disturbing blood sucking insects affecting human. The behaviour of female mosquito feeding on human blood is responsible for the transmission of a number of the diseases. The most prevalent of these diseases include malaria, *bancrofti, filariasis*, yellow fever, dengue fever and some arbovirus infections (Curtis *et al*., 1991; White, 1996). It is established that the transmission of these infectious diseases to human is via competent mosquito vector; hence its control initiatives remain top most to the prevention and control of the diseases **(**White, 1973; Curtis *et al*., 1991; White, 1996).

In the recent the hopes in control of malaria was revitalized in seeking to reduce the mosquito bite by the introduction and use of Insecticide Treated Nets (ITNs), especially with pyrethroids as the active ingredient and the protective utility of the nets was improved **(**Curtis *et al*., 1991; Chavasse *et al*., 1999). The reduction in morbidity and mortality rate of malaria demonstrated the potency of ITNs method (Abdulla *et al*., 2001). However, despite the common knowledge of the excite-repellent activity by pyrethroid based insecticide nets against indoor mosquito (Malima, 2008), they still bite people before retiring to bed or when out of the net at night. So the most viable malaria control measures are the mosquito control and personal protection from mosquito bites. Henceforth an additional mosquito control tool is therefore, urgently needed to complement ITNs, to curtail human-mosquito contact when not under the net.

About two decades ago, the discovery of insecticide activity of phyto-toxins present in *Asteracea* species had stimulated the interest in botanicals as part of the search for new plant derived insecticides (Rawls, 1986). Some plant extracts includes, Basil (*Ocimum basilicum* L, *O. grassticium* L, *O. americanium*, O. *anviflorium* L). *Citronella grass* (*Cybopagan nardus randle*), *Alpinagalangl* L, *Polvos synzyanium aromaticum L*) and thyme *V. vlgaria*) were reported to have demonstrated good efficacy against some mosquito species (Bernard, 1999).

As such natural repellent of plant based, like rotenone and nicotine, among others have been extensively used for insects control (Balandrin, 1985). Also *Limanoids* such as *Azadirachtin* and *Gedunin* present in species from the *Leliaceae* and *Rutaceae*are are recognized for their toxicity effects against insects, and that properties is exploited in several insecticide formulations in many parts of the world (Dua et *al*., 1995; Nagpal *et al*., 1996; Nkunya, 2002).

However, bio-efficacy evaluation and chemical characterization of the repelling activity and ingredients of some of these extracts were not exhaustive on experimental models (WHO, 1996). Therefore there is the need for such scenario. This work therefore, was designed to characterize using FTIR, GC-MS and evaluate the bio-efficacy of mosquito repelling coil produce using (*O. bacillicum*) basil oil and Compare the repelling potential of the coil with commercial produced (Baygon) mosquito coil in a named species of mosquito under laboratory condition.

MATERIALS AND METHODS

Collection and Identification of Plant Sample

Plant materials; fresh leave of *O. basilicum* (sweet basil) plant was collected in March from the premises of the main campus Kaduna Polytechnic and identified by botanist in the Department of Botany, Ahmadu Bello University Zaria.

Extraction of the Essential Oil from Basil using Steam Distillation Method

Fresh leaves of *O. basilicum* were shredded into pieces within 12 hours after collection and 100-200 g was weighed and transferred in to the Clevenger apparatus containing boiled 500 ml of distilled water for 5-6 hours until oil distillation ceased. The essential oil in the distillate were dried over anhydrous Na_2SO_4 and collected into a flask with air tight cover kept in the freezer for further testing. The percentage yield of the oil was calculated using the formula below.

$$\text{Percentage yield} = \frac{mass\ of\ extract}{total\ mass\ of\ sample\ extracted} \times 100\%$$

The extract obtained was stored to be used for characterization using FTIR and GC-MS and also for the production of mosquito repellent coil

GC-MS Analysis of the Oil

The dried solid extract was dissolved in methanol and analyzed using GC-MS model Qp2010 plus SHIMADZU equipped with detector and slit injection system the initial temperature was maintained at 60^0c for 3 minutes and was gradually increased to 250^0c. 1.6µl of solution was injected for analysis the sample injection temperature was maintained at 250^0c throughout the experimental period. The carrier gas (Helium) flow was 2ml per minute. The identification of components was based on comparison of their mass spectra with those present in the National Institute for Standard Technology computer data bank (NIST 2009 LIB).

FTIR Analysis of the Oil

FTIR analysis of the extract was carried out using infrared spectroscopy of the SHIMAZU FTIR-8400s. The extract was scanned in accordance with ASTM 125z-98. Small quantify of the extract was applied on the sodium chloride cell to obtain a thin layer pallet. The cell was mounted on the FTIR and scanned through the FTIR region.

Mosquito Coil Production

The mosquito repellent coil was produced using the following materials, activated carbon (adsorbent), sawdust (combusting agent), dye (colouring agent), starch (binding agent) and the essential oil (active ingredient). These materials were mixed in a proportion and coil into a spiral shape. It was allowed to dry at room temperature then stored for bio-efficacy testing.

Bio-efficacy testing of the Mosquito Repellent Coil Produced

Breeding of Mosquito

The mosquito's larva was obtained from breeding site at Congo Zaria and identified to be *Aides stephensi*. The Larvae were reared on a diet of floating catfish food. Adult Mosquitoes obtained from the larvae were reared and maintained at 27±3°C and 80±10 relative humidity (RH) under a 12:12 (L:D) photoperiod. The adults were maintained in screen cages on 10% sucrose solution but 24 h before experiments the sucrose solution was removed from cages. Repellency was tested against 3 to 5 days old, blood starved mosquitoes, and for each test 25 mosquitoes were used (Norashiqin, 2008; Barat, 2012)

Results

The Percentage Yield of the Extract

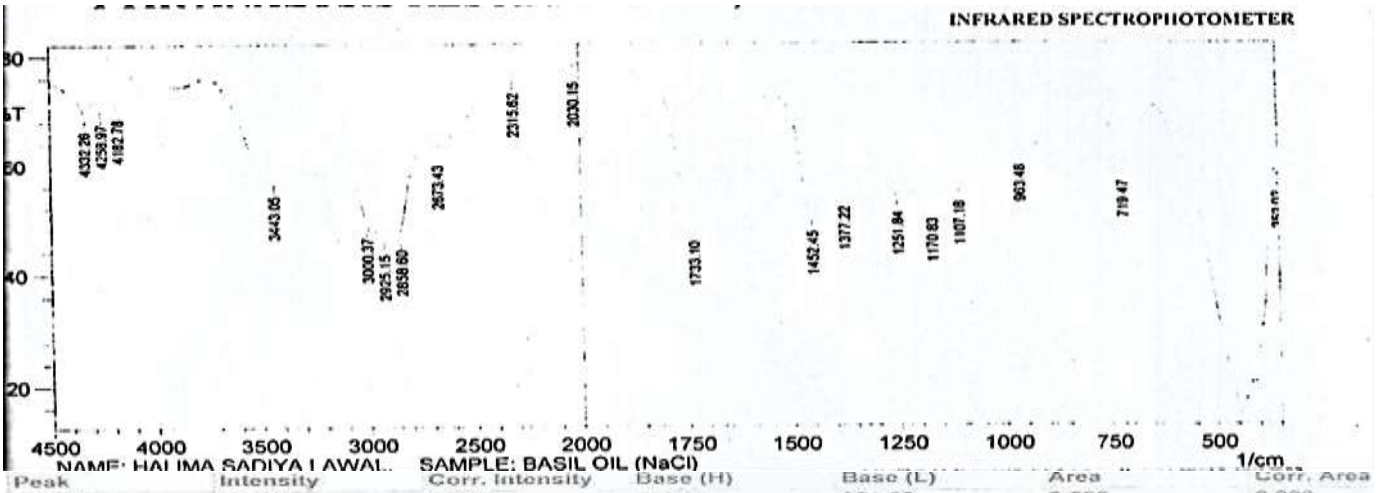
The percentage yield of the extract was 1.3%

Characterization of the Essential Oil of *O. basilicum*

The FTIR characterization of the extracted essential oil of *O. basilicum* as shown in the Table 1 and Figure 1 below indicates the presences of P-OH Stretching, N-O Stretching, C-H bending, NO_2 symmetric stretching, NO_2 Asymmetric, C=O stretching, O-H and N-H Stretching, C-H Stretching, O-H Stretching C-X stretching. This indicates the presences of Aldehydes, Amines, Alcohols, and Alkyl-halides as the functional groups present in the oil extracted (Table 1).

Table 1 The FTIR Characterization of the Essential Oil of *Ocimum basilicum.*

Molecular motion	Peak(cm^{-1})	Functional group
P-OH Stretching	353.02	Phosphorous compound
N-O Stretching	963.48	Nitrogen compound
C-H Bending	1107.18	Aromatic compound
NO_2 symmetric stretching	1377.22	Nitrogen compound
NO_2 Asymmetric	1452.45	Nitrogen compound
C=O stretching	1733.1	Aldehydes
O-H and N-H Stretching	2030.15	Amines
C-H Stretching	2858.6	Alkanes
=C-H Stretching	3000.37	Alkanes
O-H Stretching	3443.05	Alcohol
C-X stretching (X=F,Cl,Br,I)	1251.84	Alkyl halide



Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
352.02	57.556	0.392	353.95	351.06	0.686	0.003
446.54	15.68	0.123	447.5	433.03	11.352	0.014
719.47	59.641	12.075	784.09	639.42	26.185	5.189
963.48	62.636	0.057	964.44	786.98	30.363	0.037
1107.18	55.94	0.487	1116.82	964.44	34.495	-0.165
1170.83	52.842	2.333	1215.19	1116.82	26.275	0.922
1251.84	54.07	1.436	1329.96	1215.19	29.735	0.887
1377.22	55.135	0.792	1385.9	1340.57	11.346	0.151
1452.45	50.593	9.821	1508.38	1423.51	20.186	2.819
1733.1	48.702	0.348	1735.03	1723.45	3.566	0.007
2030.15	78.156	0.008	2032.08	2027.25	0.516	0
2315.62	76.33	0.058	2318.51	2196.03	13.445	-0.194
2673.43	63.047	1.114	2697.54	2351.3	55.125	0.274
2858.6	47.395	2.715	2882.71	2697.54	45.822	-1.986
2925.15	46.504	2.226	2991.69	2882.71	35.227	1.359
3000.37	49.615	0.185	3146.97	2997.48	38.483	-1.835
3443.05	57.428	0.012	3448.84	3442.09	1.625	0.001
4182.78	71.798	0.012	4183.74	3985.07	27.161	0.062
4258.97	70.914	0.999	4291.76	4220.39	10.447	0.227
4332.26	69.543	3.003	4487.54	4291.76	27.296	1.001

Figure 1: The FTIR Spectra of the Essential Oil of *Ocimum basilicum*

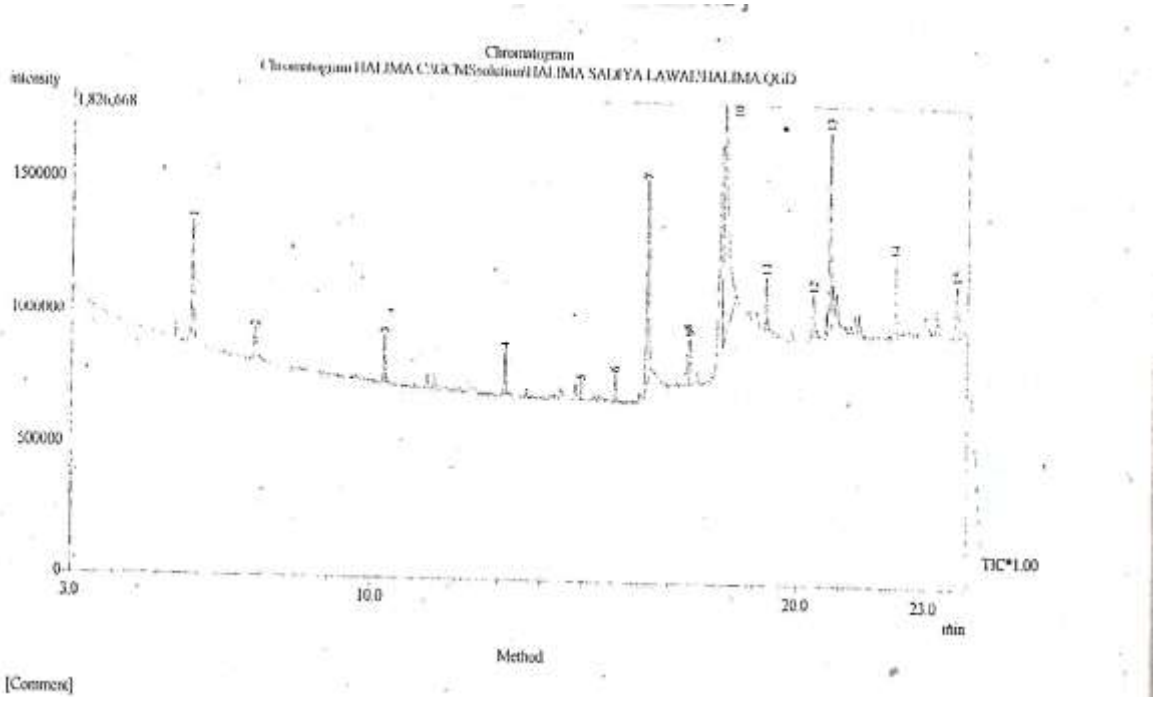
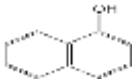
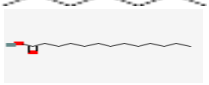


Figure 2: The GCMS Spectra of the Essential Oil of *Ocimum basilicum*

Table 2: The GC-MS analysis, showing, the Retention Time, Base Peak, Structure, Molecular Weight and Formular and the Percentage Composition of the Photo-constituents of the Essential Oil of Ocimum *basilicum*

Retention time	Base peak value	Pyto-consituent	Structure of phyto-constituent	Molecular weight	Molecular formular	% composition
5.825	42.95	1,6-Octadien-3-ol		154	$C_{10}H_{18}O_2$	7.76
7.292	43.00	Butanoic Acid		170	$C_{10}H_{18}0_2$	2.66
10.292	41.00	1,3,6,10-Dodecatetraene		204	$C_{15}H_{24}$	2.33
13.117	42.95	1-Naphthalenol		222	$C_{15}H_{26}O$	2.70
14.925	43.00	2-heptanone		128	$C_8H_{16}0$	0.81
15.727	74.00	Tridecanoic acid		228	$C_{14}H28O2$	1.33
16.475	43.00	Noanadecanoic Acid		29	C19H3802	15.37
17.433	55.00	1-Octadecenoic		298	C19H3602	4.07
17.5	79.05	9,12,15-Octadecatri-1-ol		264	C18H32O	2.23
18.275	79.05	9,12,15-Octadecatrinoic acid		278	C18H32O2	35.61
19.258	43.00	Octadecane		296	C20H40O	2.92
20.367	43.00	9-Tetradecenal		210	C14H26O	2.20
20.742	55.00	9-Octadecenal		266	C18H34O	12.15
22.292	57.05	2-Bromo-d0decane		245	C12H25br	4.31
23.742	69.05	Squalene		410	C30H50	3.53

The Bio-efficacy Test of the Mosquito Coil Produced at Different Concentrations.

The bio-efficacy test result shows that Baygon a commercial coil had percentage mortality of 43.35% which is lower than the 63.50% of the coil produced with 100 mg concentration from basil oil. While that of 200, 300 and 400 mg give the percentage mortality of 85.00, 91.50 and 96.50% respectively. This showed the coil from basil has higher efficacy when compared with Baygon and the LC_{50} and LC_{95} are 1.225 and 3.136 respectively (Table 3).

Table 3: The Bio-efficacy Test of the Mosquito Coil Produced at Different Concentrations.

Concentration (mg)	Total number of mosquito	Response after 30 min (number of mortal mosquito)	% mortality after 30 min	LC_{50}	LC_{95}
Baygon	20	16	43.35	$y = 2.9719x + 0.1333$	
	20	0		$R^2 = 0.865$	
	20	10			
	60	**8.67**			
100 mg	20	20	63.50	1.225	3.136
	20	5			
	20	13			
	60	**12.7**			
200 mg					
	20	20	85.00		
	20	18			
	20	13			
	60	**17**			
300 mg	20	20	91.50		
	20	20			
	20	15			
	60	**18.3**			
400 mg	20	20	96.50		
	20	20			
	20	18			
	60	**19.3**			

DISCUSSION

Mosquitoes are among the most blood sucking insects which characteristic is responsible for the transmission of a number of diseases. Malaria been the most prevalent (Curtis *et al.,* 1991; White, 1996) and most devastating menace, a re-awaken searches for control of both causative agent and the host using the natural heal was necessitated. This work therefore characterized the oil of *O. basillicum,* used in mosquito repellant coil production, by FTIR and GC-MS methods. It further comparatively evaluates the bio-efficacy of the produced coil from *O. bacillicum* on the adult *A. stephensi* with mosquito repelling coil (Baygon) commercial product. The 1.3% percentage yield of the oil was within the range obtained by Özcan and Chalchat (2002) that had the percentage yield of 1.28 and 1.73 even though the method and location of the research differs.

The identified functional groups corresponding to Aldehydes, carboxylic acid, Amines, Alcohols and Alkylhalides on the FTIR characterization of the essential oil of *O. basilicum* (Table 1) correlate with the chemical composition identified by the GC-MS analysis (Table 2). The chemical composition of the essential oils representing a total number of fifteen volatile compounds making 98% of the total composition identified to be fatty acids and aldehydes hydrocarbons to be the major group of compounds, Octadecatrinoic acid (35.61%) being the most prominent phyto-constituent followed by - Noanadecanoic Acid (15.37%) Octadecenal (12.15%). The most abundant components found in the oil was Octadecatrinoic acid also called linolenic fatty acid (Table 2). The essential oil chemical composition in this work however, differs with those identified by Özcan and Chalchat, (2002) whose compositions include Methyl eugenol (78.02%), α-cubebene (6.17%), nerol (0.83%), α-muurolene (0.74%), 3,7-dimethyloct-1,5-dien-3,7-diol (0.33%) and β-cubebene (0.30%). The variation could largely be influenced by the geography location and ecological factors that could possible determined the type of secondary metabolite that plant produce at particular point in time. The mosquito coil bio-efficacy increases with increase in concentration (Table 3)

as compared to commercially produced repellent (Baygon). The produced coil was observed to be more effective than the commercially produced coil (Baygon) which could be associated to the chemical composition and possible resistance of the mosquito to the commercial product.

CONCLUSION

This study revealed the major composition of the oil to be Octadecatrinoic acid having the highest percentage composition which is perfectly correlated with FTIR findings. While the result indicated high efficacy of the coil produced using basil, which repelling action against the adult mosquito is attributed to the chemical composition. It is pertinent to conclude that the coil of basil can competitively be a better product when employed for mosquito repelling activity.

REFERENCES

Abdullah, S. I., Schellenberg, J. A., Nethan, R., Mukasa, O., Marchent, T., Smith, T., Tanner, M. and Lengerler, C. (2001). Impact on malaria morbidity of a programme supplying insecticides treated nets in children aged under 2years in Tanzania community cross sectional study. *Medical Journal.* Pg. 270-273

Balandrin, M. F. (1985). Natural plant chemicals sources of industrial and medicinal materials. Science 228:1154-1160.

Barnard, D. R. (1999). Repellence of essential oils to mosquitoes (*Diptera culicidae*) *Journal of Medicine Enotomol*. Pg 625 - 629.

Chavasse, D. C., Shier, R. P., Murphy, O. A., Huttly S. R., Cousens S. N., and Akhatar, T. (1999). Impact of fly control on Childhood Diarrhoea in Pakistan Community-randomised trial. Lancet 353:22-25

Colemen, R. E., Robert, L. L., Roberts, L. W., Glass, J. A., Seeley D. C., Laughinghouse, A., Perkins, P. V. and Wirtz, R. A. (1993). Laboratory evaluation of repellents against four mosquitoes (*Diptera culicidae*) and two *Pulebotamine* sand fillies (*Dipter* p*sychodidae*) *Journal of Medicine Enotomol*. Pg. 499-502.

Curtis, C., Line, J., Lu, B., and Renz, A. (1991). Natural and synthetic repellent in Curtis C. F (ed). Appropratiate Technology in vector contol CRC Pres Florida Chapter 4.

Debboun, M., Strickme, D., Solberg, V. B., Wikerson, R. C., Mcherson, K. R., Golenda, C., Wirtz, R. A., Burge, R.and Kelvin, T. A. (2000). Field evaluation of DEET and Piperdine repellent against *Aedes communis* (*Dipetera sculadae*) and (*Diptera simulidae*) in the Adiondack mountains of new York. *Journal of Medicine Entomol* Page 919-923.

Dua, U. K., Nagpal, B. N. M. and Sharma, U.P. (1995). Repellent action of Neem cream against mosquitoes. *India Journal of Malariology*. 32: 47 – 53.

Fradin, M. and Day, J. F. (2002). Comparative efficacy of insect repellents against mosquito bites. *New England Journal of medicine.*347 Pg 13-17.

Malima, R. C., Magesa, S. M., Tungu, P. K., Mwigia, V., Magog, F. S. and Rowland. (2008). An Experimental nut Evaluation of *Olyse*t. (R) Nut against anopheles mosquito after seven years of use in Tanzania village. *Malaria Journal*. Page 38-71

Nadjm, M. (2012). Malaria: An update on the epidemiology of Malaria Parasites. *Society of Tropical Medicine and Hygiene.* Pg. 74.

Nagpal, B. N., Srcivastava, A. and Sharma, V. P. (1996). Control of mosquito breeding using scrapings treated with Neem oil, *India Journal of Malaria*. 32: 64-59

Namedo, A. G. (2007). Plant elicitation for production of secondary metabolites a review. *Pharmacognosy Review* 1.69-79.

Nkunya, M. H. (2002). Natural chemicals, for disease and insect management. Professorial Inaugural lecture series 42, University of Dares Salaum, Tanzania.

Ntonifor, N. N., Ngufor, C. A., Kimbi, H. K. and Oben, B. (2006). Traditional use of indigenous mosquito-repellents to protect humans against mosquitoes and other insect bites in a rural community of Cameroon. *East Africa Medicinal Journal.* Pg. 553-558.

Ogendo, J, O., Kostyukovsky, M., Ravid, U., Matasyoh, J. C. Deng A. L. Omolo E. O., Kariuki, S. T. and Shaaya, E. (2008). Bioactive of *Ocimum grasstisum L*. oil and two of its constituents against five insects' pest attacking stored food products. *Journal of stored products*. Res 44(3): Pg. 328 – 334.

Peterson, C. and Coats, J. (2001). Insect repellent, past, present and future pesticide outlook. Pg 154 – 158

Özcan, M. and Chalchat J.-C. (2002): Essential oil composition of *Ocimum basilicum* L. and *Ocimum minimum* L. in Turkey. Czech J. Food Sci., 20: 223–228.

Qui, H., Jun, H. W. and McCall, J. M. (1998). Pharmacokinetics, Formulation and Safety of Insect Repellent N, N-dimetyl-3-meythylbenzamide (DEET): *A review. Journal of American mosquito control association* 14: Pg 12-27.

Schreck, C. E. and McGovern,T. P. (1989).Repellents and other personal protection strategies against aedasalbopictus. *American Journal of Mosquitoes.* Control Assoc. Pg 247-252

USAID (2011). Saving lives: A global leader in fighting malaria USAID from the American people Infection Disease. Retrieved 15 October 2011.

White, G. B. (1996). The insect repellent volume of *Ocimum* (spp).Traditional mosquito repellent. *East Africa Medical Journal*. Page 248.

World Health Organization. (1996). Report of the informal consultation on the evaluation and testing of insecticides. *Geneva World Health Organization.*