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Effect of Selected Plant Fumigants against Dengue fever Vector *Aedes aegypti* (Linn)

M. Mary Queen[1], P. Martin[1], K. Elumalai[1], C.Kandeepan[2], R.V.Kalaimathi[2] and P.Sivamani[3*]

[1]P.G & Research Department of Zoology, Government Arts College for Men (Autonomous), Nandanam, Chennai – 600 035. Taminadu, India
[2]Postgraduate & Research Department of Zoology, Arulmigu Palaniandavar College of Arts and Culture, Palani-624601 Tamilnadu, India
[3]Microlabs, Institute of Research and Technology, Arcot, Vellore, Tamilnadu, India-632 503
***Corresponding author**

KEYWORDS

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vector,
Bio pesticides

A B S T R A C T

Mosquitoes are the most important of insects in terms of public health importance which transmit a number of diseases such as dengue, chikungunya, Japanese encephalitis, yellow fever,filariasis and malaria, causing millions of deaths every year. Aedes aegypti (Ae. aegypti) is a major urban vector of dengue fever, dengue haemorrhagic fever, chikungunya and Yellow fever virus. Mosquito bites may also cause allergic responses including local skin reactions and systemic reactions such as urticarial. Personal protection is one approach to prevent mosquito bites. Most common mosquito repellents available contain N,N-diethyl-3-methylbenzamide or also called DEET that has shown strong protection from mosquitoes. However, it may exert toxic reaction under some circumstances and age groups and damage plastic, synthetic materials, thus the alternative new products need to be explored. Bio pesticides may be utilized to control the mosquito population in human ecosystem. Plant products may be used as bio control agent for mosquitoes to overcome the synthetic insecticides. The air dried powdered leaves of Pungamea glabra, Calotropis gigantea, Vinca rosea, Chrysanthimum indicum, Adhatoda vasica are used for the fumigant preparation. The fumigant was exposed once in three hours. The impact of smoke of plant product on the biting was analyzed every hour during the diel cycle. The highest biting rate (19 mosquitoes caught /day) was noticed in Calotropis gigantea fumigant exposure and lowest biting rate (7 mosquitoes caught/day) was in Pungamea glabra fumigant exposure. The fumigant of the entire plant product is found to be repellent against the dengue vector *Aedes aegypti*.

Introduction

Mosquitoes are the most important of insects in terms of public health importance which transmit a number of diseases such as dengue, chikungunya, Japanese encephalitis, filariasis and malaria, causing millions of deaths every year. *Aedes aegypti* (*Ae.*

aegypti) and *Culex quinquefasciatus* (*Cx. quinquefasciatus*) (Phasomkusolsil and Soonwera, 2011; Harrington et al., 2001) are major urban vectors of dengue fever, dengue haemorrhagic fever, chikungunya and Japanese encephalitis. Mosquito bites may also cause allergic responses including local skin reactions and systemic reactions such as urticarial. Personal protection is one approach to prevent mosquito bites (Senthilkumar and Venkatesalu, 2012; Pavela, 2009: Briassoulis et al., 1991). Most common mosquito repellents available contain N,N-diethyl-3-methylbenzamide or also called DEET (Roberts and Reigart, 2004)that has shown strong protection from mosquitoes. However, it may exert toxic reaction under some circumstances and age groups and damage plastic, synthetic materials, thus the alternative new products need to be explored(Tjahjani, 2008).

All over the world, people are at risk from mosquito-borne diseases such as malaria, dengue, yellow fever, West Nile virus, and several forms of encephalitis (Gubler 1989, Monath 1989). Personal protection from mosquito bites is currently the most important way to prevent transmission of these diseases (Fradin 1998).

Throughout the world, there are about 3,500 species of mosquitoes. The female mosquito bites people and animals because they need the protein found in blood to help develop their eggs. Mosquitoes are attracted to people by skin odors and the carbon dioxide from breath (Bowen 1991). The use of repellents makes a person unattractive for feeding and therefore repels the mosquito (Maibach et al. 1966).

The repellent properties of plants to mosquitoes and other pest insects were well known before the use of synthetic chemicals. Traditionally, people used natural compounds to protect themselves against insect bites. Some plant species contain insecticidal and/or insect-repellent substances. A review by Sukumar (1991) highlighted the potential of plants for use in mosquito control, either as repellents, larvicides, or insecticides. Extracts of several plants—neem (*Azadirachta indica*), basil (*Ocimum basilicum*), (*Mentha piperata*), and lemon eucalyptus (*Corymbia citriodora*)—have been studied as possible mosquito repellents and have demonstrated good efficacy against some mosquito species (Sharma et al. 1993; Ansari et al. 2000; Trigg and Hill 1996).

The research is promising, but the number of plants that has been extensively studied is relatively small. Plants contain a wide range of chemical compounds. When extracted from the plant material, these compounds show useful biological activities such as repelling insects or altering insect feeding behavior, killing larvae, or disrupting growth (Duke 2000;Neal et al., 2012; Palson and Jaenson, 1999). My research investigated the possible potential of various botanicals: *Pungamea glabra, Calotropis gigantea, Vinca rosea, Chrysanthimum indicum and Adhathoda vasica.*

Collection of Herbal plant

Many plants which are found commonly in our place have mosquitocidal effects. The idea of using plants against mosquito has got biological significance. The following plants were chosen to find out the mosquitocidal effects on *Aedes aegypti*.They are*Pungamea glabra, Calotropis gigantea, Vinca rosea, Chrysanthimum indicum and Adhathoda vasica.* The plants have been identified, collected and their products were taken from them for the investigation on the effect of Bio pesticides on the larva and adult stages of *Aedes aegypti.*

Bio-extract preparation

The leaves of *Pungamea glabra, Calotropis gigantea, Vinca rosea, Chrysanthimum indicum and Adhathoda vasica* were shade dried then ground in mechanical grinder and finally passed through a 30 mesh sieve to get them in to a fine powdered form. 50 gm of above leaf powder and the solvents namely Petroleum ether, Benzene, choloroform, Acetone, Methanol were taken into soxhlet apparatus and the temperature is fixed according to the solvents. The extracts are collected into a conical flask and stored in a dark bottle covered by a filter paper to evaporate excess solvents.

Method of application

The leaves of *Pungamea glabra, Calotropis gigantea, Vinca rosea, Chrysanthimum indicum and Adhathoda vasica* were shade dried then ground in mechanical grinder and finally passed through a 30 mesh sieve to get them in a fine powdered form, this powder were fumigated for every 3 hours intervals to find out the biting rate of *Aedes aegypti*

Results and Discussion

The smoke of the leaves of *Pungamea glabra, Calotropis gigantea, Vinca rosea, Chrysanthimum indicum, Adhatoda vasica,* result are shown in table 1-6 and in figures 1-6.The treatment of the smoke was made at an interval of 3 hours on different days to find out the biting periodicity.It was noticed thatthe highest biting rate (19 mosquitoes caught /day) in *Calotropis gigantea* fumigant exposure and lowest biting rate (7 mosquitoes caught/day) was in *Pungamea glabra* fumigant exposure. The fumigant of the entire plant product is found to be repellent against the dengue vector *Aedes aegypti*.

The purpose of this research was to evaluate the potential of plant extracts as natural repellents. Fumigation and repellants are playing a major role in protecting the humans from the bites of insects pests and an effective repellant will be useful in reducing man-vector contact and in the interruption of disease transmission and therefore repellant compounds should be non-toxic, non- irritating and confirmed that their broad spectrum of chemicals were effective as repellents against *A. aegypti* mosquitoes.

Plant essential oils in general have been recognized as important natural resources of insecticides because some are selective, biodegrade to non-toxic products and have few effects on non-target organisms and environment (Pavela, 2009). Many research insect repellents derived from plant extract, such as *Eucalyptus citriodara* (*E. citriodara*), *Syzygium aromaticum, Cymbopogon nardus, Cymbopogon citratus* (*C.citratus*), *Curcuma longa, Zingiber officinale* (*Z. officinale*), *Azadirachta indica, Ageratum houstonianum, Pogostemon cablin, Albizzia amara, Ocimum basilicum, Zanthoxylum piperitum, Anethum graveolens, Kaempferia galangal, Aristolochia bracteata, Cardiospermum halicacabum, Clausena anisata and Vetiveria zizanioides*, have been studied as possible mosquito repellents and have demonstrated good efficacy against *Aedes* spp., *Culex* spp. and *Anopheles*spp(Tjahjani, 2008; Sophia and, Pandian, 2009).

In the present, most insecticides are non-selective and can be harmful to other organisms and environment. There is a need to develop new formulations for controlling mosquitoes in an environmentally safer way, using biodegradable and target-specific insecticides against them(Pavela, 2007: Jawale et al., 2010).

Table.1 The biting periodicity of the biting periodicity of *Aedes aegypti* in the diel cycle

TIME OF THE DAY	RATE OF BITES
4 -5	4
5 - 6	3
6 - 7	2
7 - 8	2
8 -9	2
9 - 10	1
10 - 11	1
11 - 12	3
12 - 13	2
13 - 14	1
14 -15	3
15 - 16	2
16 - 17	3
17 - 18	5
18 - 19	7
19 – 20	8
TOTAL NO. OF BITES	**49**

Table.2 The Biting Periodicity of *Aedes aegypti* during fumigation of *Pungamea glabra*

TIME OF THE DAY	RATE OF BITES
4 -5	2
5 - 6	2
6 - 7	3
7 - 8	FUMIGATE
8 - 9	0
9 - 10	0
10 - 11	0
11 - 12	FUMIGATE
12 - 13	0
13 - 14	0
14 -15	0
15 - 16	FUMIGATE
16 - 17	0
17 - 18	0
18 - 19	0
19 – 20	0
TOTAL NO. OF BITES	**7**

Table.3 The biting periodicity of *Aedes aegypti*

TIME OF THE DAY	RATE OF BITES
4 -5	1
5 - 6	2
6 - 7	3
7 - 8	FUMIGATE
8 - 9	1
9 - 10	1
10 - 11	1
11 - 12	FUMIGATE
12 - 13	0
13 - 14	0
14 -15	0
15 - 16	FUMIGATE
16 - 17	0
17 - 18	0
18 - 19	1
19 – 20	1
TOTAL NO. OF BITES	**11**

Table.4 The Biting Periodicity of *Aedes aegypti* During Fumigation of *Vinca rosea*,

TIME OF THE DAY	RATE OF BITES
4 -5	2
5 – 6	3
6 – 7	3
7 – 8	FUMIGATE
8 – 9	1
9 – 10	1
10 – 11	1
11 – 12	FUMIGATE
12 – 13	0
13 – 14	0
14 -15	0
15 – 16	FUMIGATE
16 – 17	1
17 – 18	0
18 – 19	0
19 – 20	0
TOTAL NO. OF BITES	**12**

Table.5 The Biting Periodicity of *Aedes aegypi* during fumigation of *Calotropis gigantea*

TIME OF THE DAY	RATE OF BITES
4 -5	3
5 – 6	3
6 – 7	3
7 – 8	FUMIGATE
8 – 9	1
9 – 10	1
10 – 11	1
11 – 12	FUMIGATE
12 – 13	2
13 – 14	2
14 -15	2
15 – 16	FUMIGATE
16 – 17	0
17 – 18	0
18 – 19	0
19 – 20	0
TOTAL NO. OF BITES	**18**

Table.6 The Biting Periodicity of *Aedes aegypti* during fumigation of, *Chrysanthimum indicum*

TIME OF THE DAY	RATE OF BITES
4 -5	3
5 – 6	4
6 – 7	3
7 – 8	FUMIGATE
8 – 9	2
9 – 10	2
10 – 11	2
11 – 12	FUMIGATE
12 – 13	1
13 – 14	1
14 -15	1
15 – 16	FUMIGATE
16 – 17	1
17 – 18	0
18 – 19	0
19 – 20	0
TOTAL NO. OF BITES	**19**

From the results, it showed that the herbal essential oils have a protection time less than Kor Yor 15® insect repellent lotion (containing DEET 25.63%). Therefore, it may be improved by developing a formulation that would prolong the time of constituents of the oil on the skin. Many researchers have demonstrated improved repellency of repellent products after formulation with a base or fixative materials such as report from Songkro et al., who also reported that effect of glucam P-20, vanillin and fixolide on the mosquito repellent property of citronella oil lotions and found that the lotion containing emulwax and 5% vanillin was the most effective repellent (Songkro et al., 2012).

It provided the longest protection time of 4.8 h, while the lotion containing emulwax and 2.5% glucam P-20 had the shortest protection time of 1 h. Kongkaew et al. have reported that the combination of citronella oil and vanillin provided complete repellency at least 3 h in Anopheles and Culex mosquitoes, a combination of citronella oil and vanillin product demonstrated a comparable protection time against DEET(Kongkaew et al., 2011). Kim et al. (2012) ; Bell. J . et al., (2002) Briassoulis et al., (2001) have reported that the combination of lemongrass oil, xanthoxylum oil and vanillin (1:3:1, v:vo:w) provided 270 min of complete protection time compared with 15% N,N-diethyl-3-methylbenzamide (247.5 min of complete protection time).

Conclusion

Plants may serve as a source for managing the control of mosquitoes. However, no one should think that success is at hand and that botanical insecticides will replace all synthetic products.

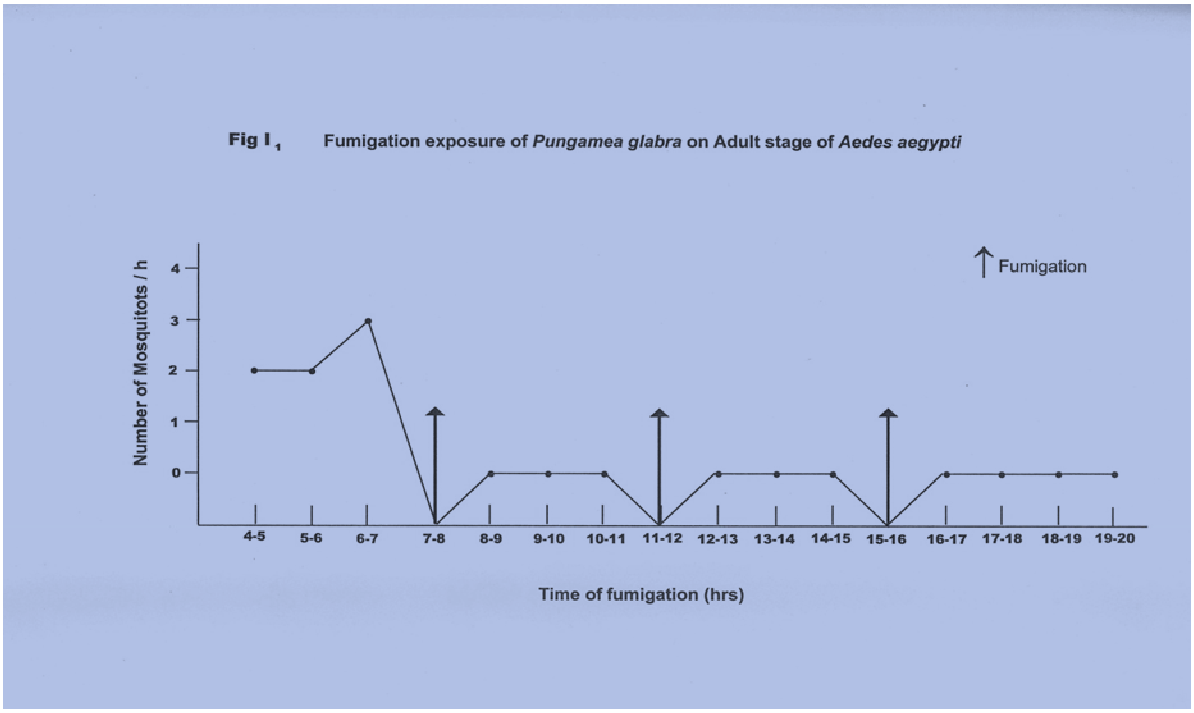


Fig I 1 Fumigation exposure of Pungamea glabra on Adult stage of Aedes aegypti
Number of Mosquitots / h
0
1
2
3
4
Fumigation
4-5
5-6
6-7
7-8
8-9
9-10
10-11
11-12
12-13
13-14
14-15
15-16
16-17
17-18
18-19
19-20
Time of fumigation (hrs)

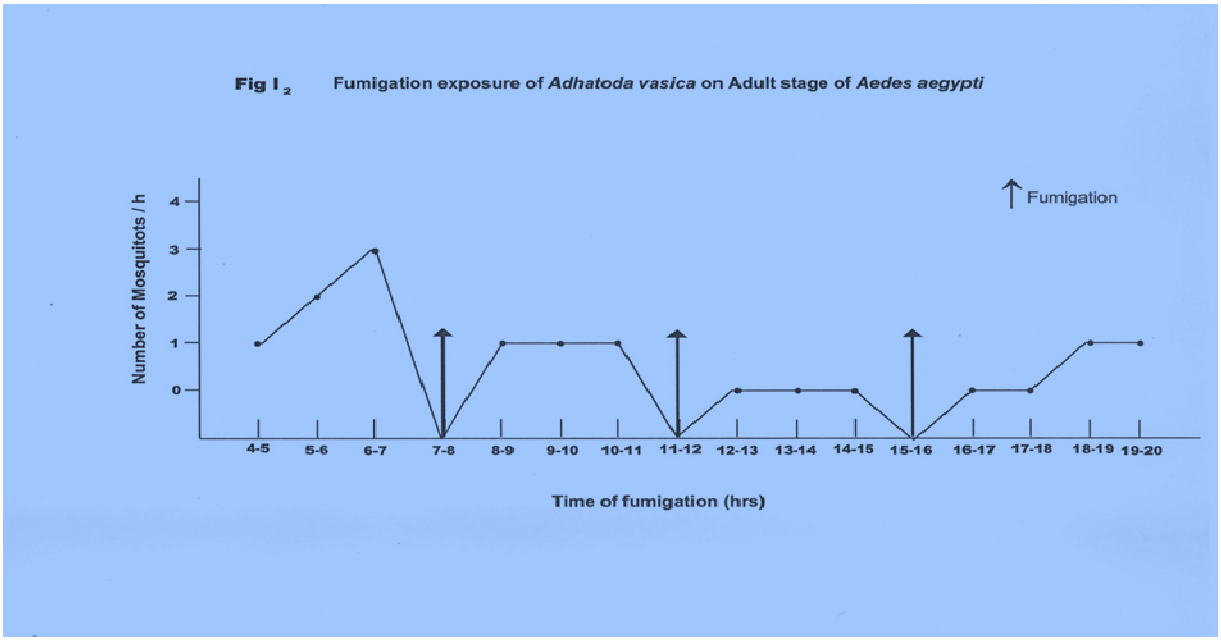


Fig I 2 Fumigation exposure of Adhatoda vasica on Adult stage of Aedes aegypti
Number of Mosquitots / h
0
1
2
3
4
Fumigation
4-5
5-6
6-7
7-8
8-9
9-10
10-11
11-12
12-13
13-14
14-15
15-16
16-17
17-18
18-19
19-20
Time of fumigation (hrs)

Fig I 3 Fumigation exposure of *Vinca rosea* on Adult stage of *Aedes aegypti*

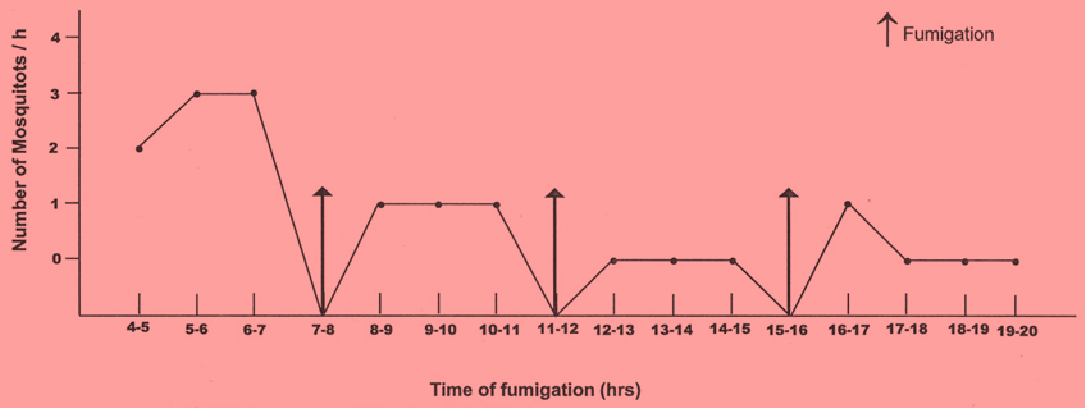


Fig I 4 Fumigation exposure of *Chrysanthimum indicum* on Adult stage of *Aedes aegypti*

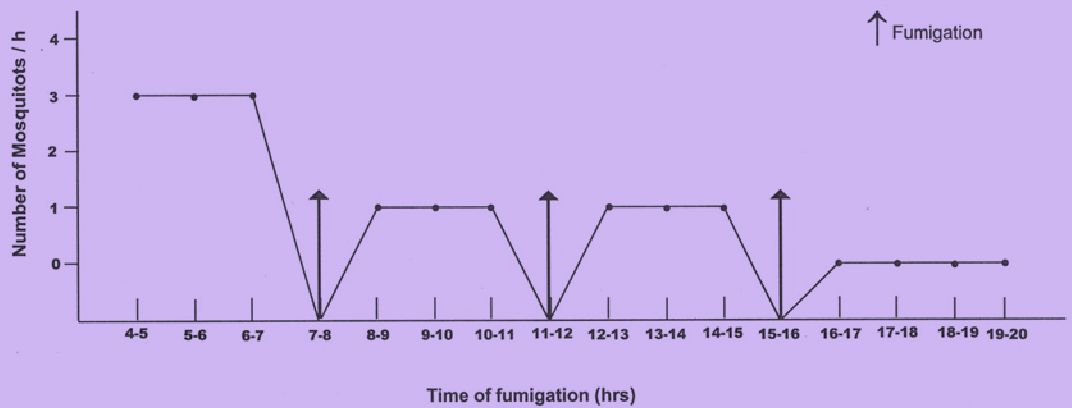


Fig I $_5$ Fumigation exposure of *Calotropis gigantea* on Adult stage of *Aedes aegypti*

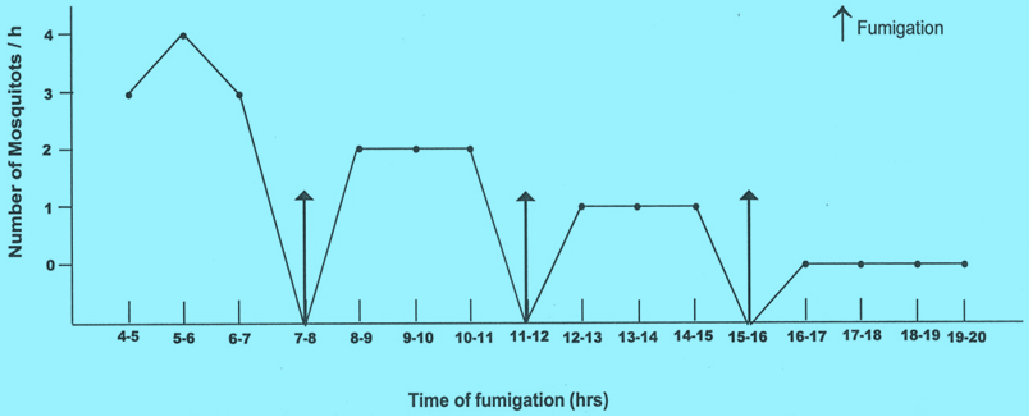
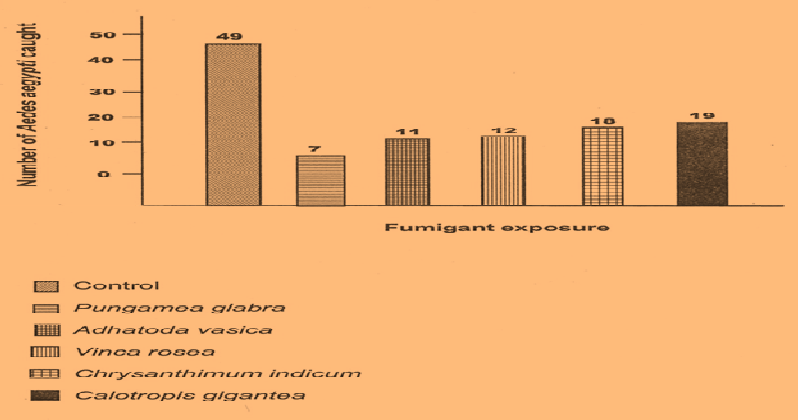


Fig III Number of *Aedes aegypti* caught during Control and different Fumigant exposure



They are only alternatives to be used in integrated pest-management programs, and they should be used together with other available control measures. The results of this study clearly demonstrated that clove oil, citronella oil and lemongrass oil had high potency to control two species of vector mosquitoes. Hence, the results may contribute to a reduction in the application of chemical in mosquito repellents, which in turn increases the opportunity for natural product for control of vector-borne disease. Further studies on identification of active compounds, toxicity and field trials are needed to recommend the active fraction of these plant extracts for development of eco-friendly to control insect vectors.

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