

## USE OF CHOPPED GARLIC BULB (*Allium sativum* Linn.) AS REPELLENT OF COMMON HOUSEHOLD PESTS

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**ABSTRACT.** The study was conducted to evaluate the response of cockroaches, houseflies and tiger mosquitoes on chopped garlic as insect pest repellent if placed in center or periphery and compared its effect to lanzones peel and commercially available repellent. Repellency effect of each commodity was observed for an hour. Data were analyzed using Analysis of Variance in Completely Randomized Design. The Duncan's Multiple Range Test (DMRT) was used to measure the differences between treatment. Results showed that chopped garlic exhibited the same effect with the other commercial repellent and is more effective against mosquitoes and least to cockroaches. Between the two methods of placements, the center placement method gave a more remarkable repellent effect on common household pests. Analysis of Variance (ANOVA) showed a significant difference in the percentage repelled insects among varying levels of chopped garlic and pure concentrations of lanzones, off-liquid and alcanphor. The study found out that chopped garlic can effectively repel cockroaches, houseflies and mosquitoes and its effectivity increases with its concentration.

**KEYWORDS:** *chopped garlic, household pests, cockroaches, mosquito, housefly, repellent, mass rearing, negative response*

### INTRODUCTION

#### Background

Since time immemorial, man has been pestered by three notorious groups of insects: cockroaches, houseflies and mosquitoes. Most probably, even during, his cave-dwelling periods, man have also been bothered no end by these pests. When nomadic activities have been abandoned and started to stay put in one place, the pests began to proliferate with humans as there was already a constant supply of food and breeding places are continuously available.

Insects are the most dominant group of animals on earth today being the principal vertebrates that can live in dry environments and the only ones which can fly. In terms of number, they are most numerous land animals that have lived the earth for about 350 million years. The insects are the most successful terrestrial animals. No single factor can be pointed to as the one responsible for this tremendous success, but certainly one of the unique attributes of insects among all invertebrates is their power of flight. This has undoubtedly contributed to their success in allowing access to more habitats, permitting maximum dispersal and making possible escape from potential predators (Storer, *et al.*, 1979). They can be classified

on such bases as the type of wings, the pattern of life cycle and metamorphosis, and the type of mouthparts (Russel-Hunter, 1979).

Cockroaches are common household pests and feed on a wide variety of household goods. The major indictment against them is that they are dirty, distasteful and odoriferous creatures and are attracted to such materials as garbage, feces and foodstuffs consumed by humans. The most common household-invading species is the *Periplaneta americana* Linn. (Bell & Adiyodi, 1981; Hagenbuch *et al.* 1988; Rust *et al.*, 1991).

*P. americana* adults are about 1 3/8 to 2 1/8 inches (34-35 mm) long. Their color is a reddish brown except for a submarginal pale brown to yellowish band around the edge of their pronotal shield, an expanded version of the top surface plate of the front segment of the thorax. Both sexes are fully winged. The wings of males extend beyond the tip of the abdomen, while female's do not. They are poor to moderately fliers (Cruse, 1990).

The most obnoxious and annoying of all household pests is the common housefly, *Musca domestica* Linn. The housefly is a well-known cosmopolitan pest of both farm and home. This species is always found in association with humans or

activities of humans. This is the most common species found on hog and poultry farms, horse stables and ranches (Britanica, 2019).

The mosquito is humanity's worst enemy carrying diseases that cause more deaths than any other single cause (Gillet, 1973). *Aedes aegypti* (L.) often called the "Yellow Fever mosquito" and "Tiger Mosquito" and is an important vector of arboviruses, which include yellow fever, dengue, chikungunya and Zika viruses (Cigarroa-Toledo et al., 2016; Farraudière et al., 2017; Ferreira-de-Brito et al., 2016; Thonnon et al., 1998). This is a medium-sized blackish mosquito can be easily recognized by its silvery-white lyre-shaped pattern of scales on its scutum, possessing of broad basal white rings segments 1 to 4 of the hind tarsi and segment 5 is white. The coloration of both sexes is similar. The eggs deposited on dump surfaces within artificial containers such as cans, jars or rainwater containers (Ndenga et al., 2017).

In tropical countries, females of *A. aegypti* is the known vector in transmitting any 4 serotypes of dengue virus which causes dengue, a highly endemic infectious disease (Khetarpal & Khanna, 2016).

These three types of insect's species are harmful to humans and its impact on health and economies are substantial. The greatest potential harm is an agent for disease transmission. Many processed repellents are available at the market today but sometimes bring harm to other animals and mankind (Maia & Moore, 2011). Using alternative biological insecticides, such as garlic is therefore a welcome addition to the known safe methods of eliminating or repelling obnoxious creature.

Garlic (*Allium sativum* Linn.) is a common staple found in countless kitchens and recipes worldwide. it belongs to the Family Amaryllidaceae (Majewski, 2014) and is commonly called "bawang" or "ajos in Spanish and Bisaya. Bawang is a low herb, with flat, long-pointed leaves, commercially grown in the Philippines. Many marvelous effects and healing powers have been ascribed to garlic. It is used as diaphoretic, diuretic, expectorant and stimulus. It possesses stimulant and stomachic properties. As an antiseptic, its use has long been recognized. In the latest war it was widely employed in the control of suppuration in wounds. The raw juice is expressed, diluted with water and put on swabs of sterilized sphagnum moss and then applied to the wound. It has been proved that there have been no septic results and

lives of thousands of men have been saved by its use. It is also good for ear ache, deafness and prevention of gray hair. The juice is also used for warts and corns, tinea, skin spots, etc. (Auer et al., 1990; Avicenna et al., 1988; Aviello et al., 2009; Bakhshi et al., 2012). Furthermore, in the well-known book of Avicenna (1988), *Al Qanoon Fil Tib* (The Canon of Medicine), garlic is recommended as a useful compound in treatment of arthritis, toothache, chronic cough, constipation, parasitic infestation, snake and insect bites and gynecologic diseases.

### Rationale

In the continuous struggle against insects' pests, man has learned to use chemical substances. Thus, we have pesticides and repellents that contain chemical with toxic properties enough to kill or drive out these insect pests (Maia et al., 2011).

Synthetic pesticides have been used extensively since World War II to reduce attack, damage or destruction to crops and livestock and prevent epidemics of insect-borne diseases. The loss of about one half of the world's food supply to pests has intensified the search for those insecticides that are effective and at the same time do not induce adverse side effects (Ross, et al., 1982). The use of toxic chemicals for pest control though, has led to many problems such as toxicity to non-target organisms and exposure to pesticides and residue in food. Furthermore, some insecticides are highly toxic to humans and many are potentially toxic especially to the personnel handling them who may get large amounts on their skin (Aktar et al., 2009). But in spite of all these concerns, many are still using these substances.

Plant-based repellents have been used for generations in traditional practice as a personal protection (Maia & Moore, 2011). Most plants contain compounds that they use in preventing attack from phytophagous (plant eating) insects (Pichersky & Gershenson, 2002). These chemical compounds provide a new source of natural pesticide and antifeedant (Hussein & El-Anssary, 2018).

Garlic has been useful as a spice for a very long time and known to be legion in its healthful properties which have been identified and validated by hard empirical science in over a thousand scientific reports this last decade (Womark, 1993) which makes it a great choice for the study.

### **Current State of Research in the Field**

Throughout the history, the potential use of garlic was recognized by many different cultures in a wide range of application. There is a good evidence that Garlic possess antibacterial, antiviral, antifungal, antiprotozoan and even insect-repellent properties.

During the surge of West Nile Virus spread by infected mosquitoes, it is interesting to explore the value of garlic as one method of avoiding mosquito bites. A number of studies of oil fraction of garlic destroy certain species of mosquito larvae (Amonkar & Reeves, 1970). Garlic sprays (made primarily with Garlic extracts are available on the market for use on plants as an alternative botanical pesticide. The sulfurs contained within the garlic extract have been shown to be effective against a wide range of insects, including mosquitoes and the lingering actor can deter mosquitoes from the area for weeks (HRDA, 2000). In the study of Dumay et al., (2019), where it uses the combination of citronella and garlic extracts, results revealed that the treated shirt specimen with citronella and garlic extracts repelled mosquitoes.

It is thought that garlic may be an alternative mosquito repellent for humans as well. In the field study conducted in India, a preparation made of one percent oil, petroleum jelly and beeswax that was rubbed on the arms and leg of study subjects was found to be effective in preventing mosquito bites for up to eight hours (Bhuyan, 1974).

In addition, there is some evidence that heavy consumption of garlic through supplements or well-flavored foods may help ward off mosquitoes. When garlic is eaten and its components are metabolized. Compounds are released from the body through the skin and breath. Although they may not be detectable to others (or may, in the case of garlic breath!), mosquitoes use smell to locate a host. For, example carbon dioxide and lactic acid released from the breath of humans are two known mosquito attractants that can be detected within 40 yards. While it has not been proven through clinical studies, it is through that the sulfur compounds present on the skin and in the breath after eating garlic may help ward off those pesky mosquitoes (Fradin, 1998; Gervais et al., 2010).

Carranza (2002), on her study showed that the garlic extract, has a high percentage of repellency for treatment T<sub>4</sub> with one hundred (100) %, 53.33% of

the female mosquitoes in T<sub>2</sub> repelled. 50% in T<sub>3</sub> and 26.66 in T<sub>0</sub>.

On the other hand, Maia & Moore (2011) found that garlic juice can be very toxic to mosquitoes in an increased concentration but does not harm a human. The odor it produces drives away mosquitoes as long as mosquitoes can detect it. Allicin plays a defense mechanism against the attacks of pest which has a powerful property, which repels mosquitoes. However, because these most essential extracts are volatile it evaporates quickly from the skin and once the scent is gone it has no more effect. Thus, Tawatsin et al. (2001) suggested that vanillin oil can be added to any extract slow down evaporation of scents.

### **Synthesis of the Art**

There are thousands of different kinds of pests that are harmful to humans. The three most common type of household pets are cockroaches, houseflies and mosquitoes. When this pest reaches a certain population density (e.g. 100 individuals per meter square) it becomes exceedingly annoying and may cause other problems such as many forms of diseases that make it desirable for us to reduce its numbers (Fernandez, 2020).

American cockroaches can transmit a variety of bacterial diseases by feeding on contaminated material and the contacting people's food. Cockroaches also the fourth most common allergen. Fifty to sixty percent of all atopic and asthmatic people show intense reactions to cockroach extract. Sensitivity to cockroach allergens may be as high as 79% in asthmatic children and in severely infested homes. The species also has a psychological impact on humans, causing anxiety and stress due to embarrassment and physical invasion (Bioserv, 1998; Cochran, 1980). Cockroaches can be found in caves, mines, privies, latrines, cesspools, sewers, sewerage treatment plants and dumps (Bell and Adiyodi, 1981). Their presence in these habitats is of epidemiological significance. At least 22 species of pathogenic human bacteria, virus, fungi and protozoans, as well as five species of helminthic worms, have been isolated from field collected American cockroaches (Rust et al., 1991). Cockroaches are also aesthetically displeasing because they can soil items with their excrement and regurgitation (Barbara, 2021).

According to Sanchez-Arroyo (1998) and Issa (2019), more than 100 pathogens associated with

the common housefly may cause diseases in humans and animals including typhoid, cholera, bacillary, dysentery, tuberculosis, anthrax ophthalmia and infantile diarrhea as well as parasitic worms. Pathogenic organisms are picked up by flies from garbage, sewage and other sources of filth and then transferred via their mouthparts and other body parts, their vomitus, feces and contaminated external body parts to human and animal food (Barreiro et al., 2013).

*Aedes aegypti* (L.), is the primary carrier of viruses that cause yellow fever, dengue, chikungunya, and Zika fever (Womark, 1993). These mosquito-borne viruses (arboviruses) have been afflicting humans for millennia and continue to cause immeasurable suffering. *A. aegypti* has been the vector causing almost all major epidemics outside Africa (Powell, 2018). Furthermore, it is also a potential vector of dog heartworm, Murray Valley encephalitis and Ross River Viruses (Russell, 1996).

When this pest continuously increases the damage caused by their activity will be at risk. Most cases of pest control involve arbitrary decisions as to how much damage is tolerable. Current standards of blemish-free fruits and noncontaminated vegetables impose almost pest-free standards of production, a level very unnatural and costly to attain. Apart from chopped garlic with its marvelous effects and healing powers, dried lanzones fruit peel will also be used to compare the repellency effect against the three common household pests.

Lansones (*Lansium domesticum* Corr.), belong to Family Meliaceae is native to Thailand, Malaysia and Indonesia. Although it is planted sporadically throughout the tropics. It occurs in at least four cultivated forms, namely duku, langsat (lansones), duku langsat and dokong. Wood of langsat can be used for light construction (Klungsupya, 2015).

Langsat fruits are usually eaten fresh, but may be canned in syrup. Several parts of the plant have medicinal uses. The fruit peel is dried and burned to repel mosquitoes (Consuelo, 1971). It is also used to reduce fever, and the bark is used to treat malaria and scorpion stings (Bajaro, 2019).

### **Problems In the Field**

The increasing cost of insecticides and repellents in this time of economic crises and its negative effect on the environment would make the possibility of making garlic chopped as repellent a

welcome solution. If found effective, garlic as repellent to common housefly, mosquito and cockroach would significantly help business establishments and citizenry as a whole.

### **Gap Bridged by the Study**

A lot of studies were already conducted to test the efficacy of different plants when it comes to insect's repellency. Treatments using garlic extracts and other compounds were found to be effective in mosquitoes (Amonkar & Reeves, 1970; HRDA, 2000; Dumay et Al., 2019; Bhuyan, 1974; Fradin, 1998; Gervais et al., 2010; Carranza, 2002; Maia & Moore, 2011). However, in this study three test organisms were used.

### **Scope and Limitations**

In this study, the indices of behavioral change would be limited only on the directed response, alertness and attraction of the cockroaches, houseflies and mosquitoes to the stimuli. The directed responses are the negative response and positive response. Negative response includes insects that move away from the stimuli and positive response includes those that move toward the stimuli. The behavioral observations of the experimental units were limited to the defined duration of observation and any behavioral changes exhibited beyond the period were not considered. Furthermore, test organisms namely cockroaches, mosquitoes and houseflies were identified based on the characteristics in the available related literature.

### **Objectives of the study**

This study aimed to provide information on the response of cockroaches, houseflies and mosquitoes on the garlic chopped as insect repellent. Specifically, the study aimed to evaluate the effect of varying amounts of chopped garlic on the behavior of cockroaches, houseflies and mosquitoes after an hour; the paper further aimed to evaluate the effect of center and peripheral placement of garlic on the behavior of the insects; and to compare repelling activity of chopped garlic with those of lanzones peel and commercially available repellents.

## **METHODOLOGY**

### ***Collection and Mass Rearing of Household Insects***

Adult American cockroaches (*P. americana*) were gathered from the markets, storerooms, toilets, pipes, under the sink and other dark and moist places. They were placed in rearing cages are provided with corrugated cartons and left-over bread (Hornes, 2019). Females of the American cockroach laid eggs that are enclosed in hardened; purse shaped eggs called ootheca (Brenner, 2019). Ootheca were harvested every other day and were placed in a container (one batch per container) covered with nylon cloth. Once the eggs hatched, all emerging nymphs were transferred to another screen cage with food. The same procedure was repeated until enough adult is produced (Bonifacio, 1999; Rivera, 2002).

Houseflies (*M. domestica*) were gathered using a net from Daraga Public Market and placed in rearing cages. Milk, sugar, blood, feces, and decaying organic matter such as fruits and vegetables are the main food sources of houseflies (Hewitt, 1914; Kelling, et al., 2002; Marshall, 2006; Robinson, 2005; Swan and Papp, 1972). In this study, they were provided with cotton dipped in dissolved sugar. A similar amount of rice bran and broiler mash added with water and two (2) percent (%) milk were mixed in a container served as the breeding media. Adult houseflies were allowed to lay eggs. About twenty (20) groups of eggs were removed and transferred to a container whereby the eggs hatched and the larvae allowed to mature. Those that pupated were placed in separate screen cages for adult emergence (Carranza, 2002; Esguerra, 2002).

Adult tiger mosquitoes (*A. aegypti*) were gathered using a net from a moist area with a large-leaved herbaceous plant (e.g., banana) and placed in a rearing cage. A pan containing water, albino mice and cotton dipped in honey were provided for the mosquito cages. Pans with hay infusion were also placed in the cages in order for the female mosquito to lay eggs. The eggs were harvested by batch and were also placed in a pan containing a hay infusion where they hatched and mature in adults. Pupae were transferred in a rearing cage where they allowed to emerge into adults. The same procedure was repeated until enough adult cockroaches, houseflies and mosquitoes is produced (Bonito, 2003; Sanguin, 2001).

### **Experimental Design**

The experiment was laid out in a Complete Randomized Design (CRD). There were eight (8)

treatments used namely: (1) T<sub>0</sub> - untreated and was used as the negative control; T<sub>1</sub> to T<sub>4</sub> were the experimental treatments, (2) T<sub>1</sub> – 25 g, (3) T<sub>2</sub> – 50 g, (4) T<sub>3</sub> – 75 g, (5) T<sub>4</sub> – 100 g of chopped *A. sativum* Linn.; and for the positive controls, (6) T<sub>5</sub> – 100 g dried lansones peel, (7) T<sub>6</sub> – 100 ml Off-liquid, and (8) T<sub>7</sub> – 100 alcamphor. four (7) of them were experimental while the other one (1) was positive control. The number of releases (3) was also the number of replicates in each treatment. Each release involved ten (10) houseflies, ten (10) mosquitoes and five (5) cockroaches.

### **Repellency Test**

Only one (1) plastic box approximately sixteen inches (16”) in height by twenty inches (20”) in length and width was utilized for the test. The test employed four variables namely, (1) the commodities (native garlic, lansones and the commercially available repellent), (2) the placement of the chopped garlic relative to the release site (i.e. at the center and at the periphery), (3) the amount of material and (4) the test insect species (cockroaches, houseflies and mosquitoes). The repellent effects were observed immediately after the release and continued up to an hour.

### **Collection and Preparation of Garlic and Lansones Repellents**

One kilo each of native garlic and lansones were obtained at Daraga Public market. Collected samples were peeled off using a sharp household knife. Garlic cloves were sliced into small pieces approximately one-half cubic centimeters each. Only the air-dried lansones peels were used in the test.

### **Garlic Repellency Test**

Chopped *A. sativum* Linn. was placed at the center of the box according to the treatments. Released of the three household pests was also at the center. After an hour of observations, the test insects were removed and transferred to bottles covered with nylon cloth. The same method was used for the peripheral placement but the release of the test insects was still at the center. The procedure was repeated thrice which corresponds to the number of replicates.

### Lanzones Repellency Test

According to the Purdue University website and Asian Times, drying and burning of Lanzones (*Lansium domesticum*) peels can be used as natural mosquito repellents. And this were used to compare the repellency effect of chopped garlic bulb on common household pests.

Dried lanzones peels were put on a pot with a heated charcoal. The odor of heated lanzones peels was the repelling gas that was tested. Although the smoke was an ordinary method in repelling insects, the addition of lanzones peels odor may have made it more annoying for the three household pests (Ullita et. al., 2016). The same placement and release were made.

### Commercially Available Repellency Test

To balance the repellency effect of those biological materials (lanzones and chopped garlic), commercially available repellents were also tested, alcanphor or mothballs which was known to be cockroach and other insect's repellent and Off-liquid which provides protection against mosquitoes.

Alcanphor were pounded into small particles and weighed. In the treatment, Off-liquid was simply sprayed on cotton which is then placed in the same manner as above. The release of insects was also similar as above.

### Statistical Analysis

The data gathered were tabulated, analyzed and interpreted by means of Descriptive Statistics and Analysis of Variance (ANOVA). To measure the differences between treatment means Duncan's Multiple Range Test (DMRT) were used.

## RESULTS AND DISCUSSION

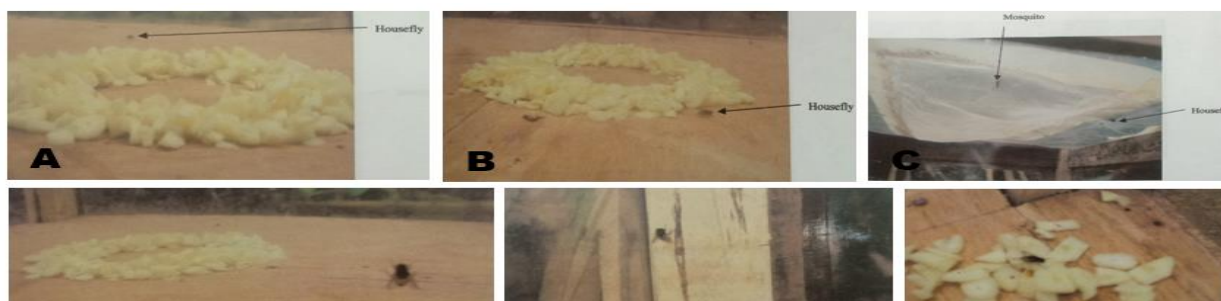
The experimental study was conducted to evaluate the repellency effect of varying amounts of chopped garlic either center or peripheral release on the negative response of cockroaches, houseflies and mosquitoes and compared to those of lanzones peel, alcanphor and off-liquid. Maia & Moore (2011) found that garlic juice can be very toxic to mosquitoes in an increased concentration but does not harm a human. The odor drives mosquitoes away for as long as mosquitoes can detect it because garlic contains Allicin as its defense mechanism against the attacks of pest. Allicin has a powerful property, which repels mosquitoes. However, these most essential extracts are volatile because it evaporates quickly from the skin and once the scent is gone it has no more effect. Tawatsin, Wratten, Scott, Avara, & Techadamrongsin (2001) suggested that vanillin oil can be added to any extract slow down evaporation of scents.



**Figure 1.** Images of the different responses of cockroaches, houseflies and mosquitoes to chopped *A. sativum* Linn. peripheral placement. **A** movement of cockroaches towards the center; **B** movement of cockroach toward the chopped garlic; **C** housefly stayed at the center of the box and a meter away from the chopped garlic

The repellency effect of each commodity in this study is expressed in terms of the number of insects that move away from the stimulus (commodity) that possessed certain degree of repellent property which was shown in Figure 1 and 2. With chopped garlic, repellency increased with the concentration of the

most effective treatment against all the test insects. Following was T<sub>3</sub> (75g chopped garlic) with 96.11% repellency that was almost the same effect as T<sub>5</sub> (100g lanzones peel), T<sub>6</sub> (100ml off-liquid) and T<sub>7</sub> (100g alcanphor). Though the concentration of the other commodities was varied, only the 100g lanzones and



(50g chopped garlic) was 85% repellency was attained and has similar effect with T<sub>0</sub> (control) which obtained 81.67% repelled insects.

Among the insects, the most sensitive to chopped garlic was the cockroaches. About 96.25%, of the insects were repelled but the percentage was not significantly different from the mosquitoes of 95.91%.

On the other hand, percent repellency was lowest in houseflies at 90.62% and this was significantly different from the obtained percentage of repelled cockroaches and mosquitoes (Table 2).

ANOVA shown in Table 3, found a significant difference in the percent repellency of varying levels of chopped garlic and other treatment in

cockroaches ( $p=0.000$ ). Also, placement ( $p=0.000$ ) of chopped garlic gave a significant effect on the percent cockroaches repelled.

**A. Placement of Repelled Test on Cockroaches**

In table 4, T<sub>4</sub> (100g chopped garlic), T<sub>5</sub> (100g lanzones) and T<sub>7</sub> (100g alcanphor) showed an equal 100% effectivity in repelling the cockroaches. In the T<sub>0</sub> (untreated), a 100% movement to the sides is not a repellency per se as there was no stimulus.

**Table 1.** Percent of Repelled Insects by Type at Varying Levels of Chopped Garlic and Concentrations of Dried Lanzones Peels, Alcamphor and Off-Liquid by Placement.

Treatment	Test Insects				MEAN*	
	Cockroaches		Houseflies			Mosquitoes
	Center	Periphery	Center	Periphery	Center	Periphery

T0 (untreated)	100.000	100.000	63.333	76.667	90.000	60.000	81.67 a
T1 (25g chopped garlic)	93.333	83.333	70.000	80.000	90.000	93.333	85.00 a
T2 (50g chopped garlic)	96.667	86.667	90.000	86.667	100.000	100.000	93.33 b
T3 (75g chopped garlic)	100.000	86.667	100.000	100.000	90.000	100.000	96.11 bc
T4 (100g chopped garlic)	100.000	100.000	100.000	100.000	100.000	100.000	100.00 c
T5 (100g lanzones peel)	100.000	100.000	100.000	96.667	100.000	100.000	99.44 bc
T6 (100ml off-liquid)	100.000	93.333	100.000	90.000	100.000	100.000	97.22 bc
T7 (100g alcanphor)	100.000	100.000	100.000	96.667	100.000	100.000	99.44 bc
Mean of placement	98.75 a	93.75 b	90.42	90.83	96.25	94.17	
<b>MEAN **</b>	<b>96.25<sup>b</sup></b>		<b>90.62<sup>a</sup></b>		<b>95.21<sup>b</sup></b>		

\*in a column, means labelled with the same letters are not significantly different at5% level by DMRT

\*\*in a row, means labelled with the same letters are not significantly different at5% level by DMRT

**Table 2.** Percent of Repelled Insects by Type at Varying Levels of Chopped Garlic and Concentrations of Dried Lanzones Peels, Alcanphor and Off-Liquid.

Treatment	Test Insects			MEAN*
	Cockroaches*	Houseflies*	Mosquitoes*	
T0 (untreated)	100.00 c	70.00 a	75.00 a	81.67 a
T1 (25g chopped garlic)	88.33 a	75.00 ab	91.67 b	85.00 a
T2 (50g chopped garlic)	91.67 ab	88.33 bc	100.00 b	93.33 b
T3 (75g chopped garlic)	93.33 ab	100.00 c	100.00 b	96.11 bc
T4 (100g chopped garlic)	100.00 c	100.00 c	100.00 b	100.00 c
T5 (100g lanzones peel)	100.00 c	98.33 c	100.00 b	99.44 bc
T6 (100ml off-liquid)	96.67 bc	95.00 c	100.00 b	97.22 bc
T7 (100g alcanphor)	100.00 c	98.33 c	100.00 b	99.44 bc
<b>MEAN **</b>	<b>96.25<sup>b</sup></b>	<b>90.62<sup>a</sup></b>	<b>95.21<sup>b</sup></b>	

\*in a column, means labelled with the same letters are not significantly different at5% level by DMRT

\*\*in a row, means labelled with the same letters are not significantly different at5% level by DMRT

**Table 3.** ANOVA on Percent Repelled Cockroaches by Treatments and Placement

Dependent Variable: REPELLED

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
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Model	446200.000 (a)	16	27887.500	1115.500	.000
TRTMENTS	891.667	7	127.381	1115.500	.001*
PLACEMNT	300.000	1	300.000	5.095	.002*
TRTMENTS * PLACEMNT	333.333	7	47.619	12.000	.101 ns
Error	800.000	32	25.000	1.905	
Total	447000.000	48			

a R Squared = .998 (Adjusted R Squared = .997)

Instead, it can be considered as the insects' natural tendency to move toward sides on the upper parts of boxes with loss light that disturbs them so much. It must be remembered that these pests are dwellers of dark parts of houses hence they are sensitive to light. Treatment 6 (100ml off-liquid) at 96.67% repellency showed the same effect on T<sub>2</sub> (50g chopped garlic) at 91.82%, T<sub>3</sub> (75g chopped garlic) at 93.34%, but not

significantly to T<sub>4</sub>, T<sub>5</sub> and T<sub>7</sub>. T<sub>1</sub> (25g chopped garlic) which gave the lowest percent of repellency at 88.33%.

Repelling materials as shown in Figure 3, when placed at the center gave higher percentage of repelled cockroaches at 98.75% than when positioned at the periphery with 93.75%.

**Table 4.** Percent of Repelled Cockroaches at Varying Levels of Chopped Garlic and Concentrations of Dried Lanzones Peels, Alcamphor and Off-Liquid by Placement.

TREATMENT	PLACEMENT		MEAN*
	CENTER	PERIPHERY	
T0 (untreated)	100.00	100.00	100.00 c
T1 (25g chopped garlic)	93.33	83.33	88.33 a
T2 (50g chopped garlic)	96.67	86.67	91.67 ab
T3 (75g chopped garlic)	100.00	89.67	100.00 ab
T4 (100g chopped garlic)	100.00	100.00	100.00 c
T5 (100g lanzones peel)	100.00	100.00	100.00 c
T6 (100ml off-liquid)	100.00	93.33	96.67 bc
T7 (100g alcamphor)	100.00	100.00	100.00 c
<b>MEAN **</b>	<b>98.75<sup>b</sup></b>	<b>93.75<sup>a</sup></b>	

\*in a column, means labelled with the same letters are not significantly different at 5% level by DMRT

\*\*in a row, means labelled with the same letters are not significantly different at 5% level by DMRT

### B. Placement of Repelled Test on Houseflies

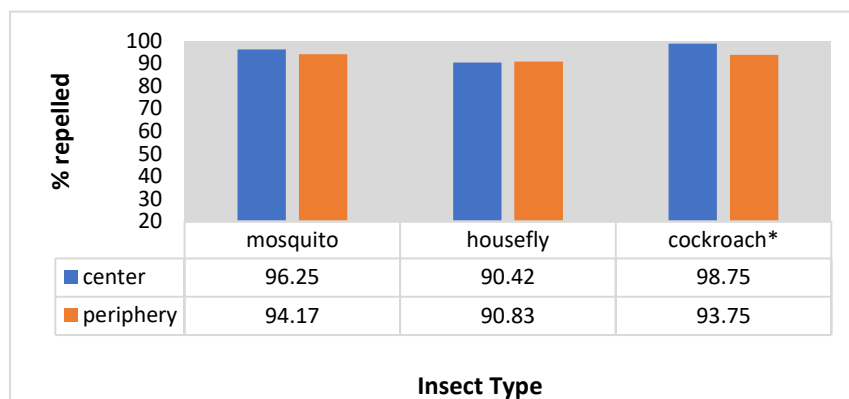
Results of this test shows that T<sub>3</sub> and T<sub>4</sub> exhibited the highest repellency effect at 100% regardless of the placement followed by T<sub>5</sub> and T<sub>7</sub>

both with 98.34% repellency on houseflies. When placed at the center, 90.42% and 90.83% repellency was observed when at the periphery (figure 3).

ANOVA in table 6, showed a significant difference in the percent repellency of varying levels

of chopped garlic and other treatment in houseflies (p=0.000). Also, placement (p=0.000) of the chopped

garlic gave a significant effect on the percent of houseflies repelled.



**Table 5.** Percent of Repelled Houseflies at Varying Levels of Chopped Garlic and Concentrations of Dried Lanzones Peels, Alcamphor and Off-Liquid by Placement.

TREATMENT	PLACEMENT		MEAN*
	CENTER	PERIPHERY	
T0 (untreated)	63.33	76.67	70.00 a
T1 (25g chopped garlic)	70.00	80.00	75.00 ab
T2 (50g chopped garlic)	90.00	86.67	88.33 b
T3 (75g chopped garlic)	100.00	100.00	100.00 c
T4 (100g chopped garlic)	100.00	100.00	100.00 c
T5 (100g lanzones peel)	100.00	96.67	98.34 c
T6 (100ml off-liquid)	100.00	90.00	95.00 c
T7 (100g alcamphor)	100.00	96.67	98.34 c
<b>MEAN **</b>	<b>90.41<sup>ab</sup></b>	<b>90.83<sup>a</sup></b>	

\*in a column, means labelled with the same letters are not significantly different at5% level by DMRT

\*\*in a row, means labelled with the same letters are not significantly different at5% level by DMRT

**C. Placement of Repelled Test on Mosquitoes**

Effect of commodity on mosquitoes differed significantly among varying levels with no difference in the placement of treatment (Table 8). The chopped

garlic gave a higher percentage of repelled mosquitoes when placed at the center than in periphery with means of 96.25% and 94.17% respectively.

**Table 6.** ANOVA on Percent Repelled Houseflies by Treatments and Placement

Dependent Variable: REPELLED

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
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Model	400766.667	16	25047.917	156.143	.000
TRTMENTS	5931.250	7	847.321	5.282	.000*
PLACEMNT	2.083	1	2.083	.013	.910 ns
TRTMENTS * PLACEMNT	614.583	7	87.798	.547	.792
Error	5133.333	32	160.417		
Total	405900.000	48			

a R Squared = .987 (Adjusted R Squared = .981)

**Table 7.** ANOVA on Percent Repelled Mosquitoes by Treatments and Placement

Dependent Variable: REPELLED

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Model	439833.333	16	27489.583	527.800	.000
TRTMENTS	3214.583	7	459.226	8.817	.000*
PLACEMNT	52.083	1	52.083	1.000	.325 ns
TRTMENTS * PLACEMNT	1464.583	7	209.226	4.017	.003
Error	1666.667	32	52.083		
Total	441500.000	48			

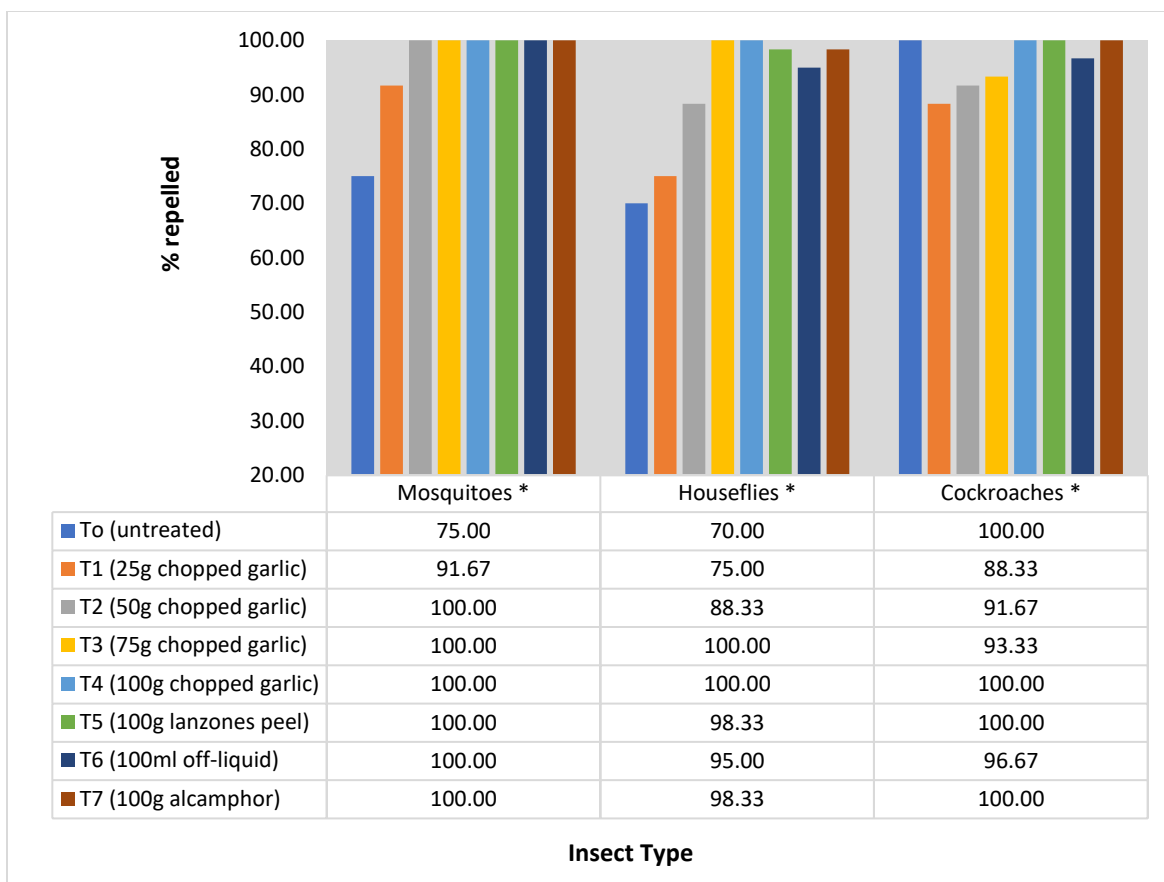
a R Squared = .998 (Adjusted R Squared = .997)

ANOVA in table 7, revealed a significant difference in the percent repellency of varying levels of chopped garlic and other treatments in tiger mosquitoes ( $p=0.000$ ). Also, placement ( $p=0.000$ ) of the chopped garlic gave a significant effect on the percent of mosquitoes repelled.

All treatments excluding the control manifested similar repellency effect and gave significantly higher percentage than the control where

75% disturbed to insects was noted compared to the 100% recorded by the treatment.

In figure 4, the treatment using pure chopped garlic yielded the highest repelled cockroaches (100%) which had the same percentage to lanzones peel and alcanphor. On houseflies, using an only minimum of 75% chopped garlic already gave comparable effect to pure garlic, off-liquid and alcanphor. Treatment 2 containing 25g



**Figure 4.** Percent repelled insects by type at varying levels of treatments.

chopped garlic was as effective as the other treatments which differed significantly from the control.

The results obtained in this study are very consistent with the results obtained by Bhuyan (1974), Fradin (1998), HRDA (2000), Carranza (2002), Mayor (2002) and Osea (2004). Garlic, especially when chopped, is very effective in repelling the three household pests. Consistent use of this material in homes may therefore ward off these pesky insects and help prevent the spread of disease.

Bulbs of garlic contain amino acid that converts to a substance called allicin (Savatree, 2002). When the clove is crushed, blended or chopped, an enzyme, alliinase, is released. Alliin and alliinase interact to form allicin, an organosulphur which is considered the major biologically active component of garlic and during the process the odor was released

which makes it a powerful natural insect repellent (Sangha, 2017; Wong, 2020). This was in agreement with the reports of Graigne et al. (1985) and Osipitan & Mohammed (2008) that indicated the insecticidal, repellence, antifeedant, and fumigative effects of garlic. Rahman and Motoyama (2000) also reported the repellency effects of garlic clove, grated garlic and its volatile extract was applied on, maize weevil (*Sitophilus zeamais* Motschulsky), brown rice (*Nilaparvata lugens* Stål) and red flour beetle (*Tribolium* sp.), and suggested that the active volatile compounds are likely to be sulfide compounds produced by the rapid degradation of allicin. In addition, allicin was a principal segment of garlic extract and had repellency effects on pests showed using GC-MS analysis (Rahman & Schmidt, 1999)

**Table 8.** Percent of Repelled Mosquitoes at Varying Levels of Chopped Garlic and Concentrations of Dried Lanzones Peels, Alcamphor and Off-Liquid by Placement.

TREATMENT	PLACEMENT		MEAN*
	CENTER	PERIPHERY	
T0 (untreated)	90.00	60.00	75.00 a
T1 (25g chopped garlic)	90.00	93.33	91.67 b
T2 (50g chopped garlic)	100.00	100.00	100.00 b
T3 (75g chopped garlic)	90.00	100.00	95.00 b
T4 (100g chopped garlic)	100.00	100.00	100.00 b
T5 (100g lanzones peel)	100.00	100.00	100.00 b
T6 (100ml off-liquid)	100.00	100.00	100.00 b
T7 (100g alcanphor)	100.00	100.00	100.00 b
<b>MEAN **</b>	<b>96.25<sup>ab</sup></b>	<b>94.17<sup>a</sup></b>	

\*in a column, means labelled with the same letters are not significantly different at5% level by DMRT

\*\*in a row, means labelled with the same letters are not significantly different at5% level by DMRT

Furthermore, in the study of Sangha et al., (2017) allacin reported to possessed ovicidal, larvicidal, and adulticidal activity against *Musca domestica* Linnaeus (Diptera: Muscidae) but partially ovicidal and larvicidal activity observed against *P. xylostella* (Diamondback moth). Garlic according to Roobakkumar et al. 2010 has larvicidal, fumigant, or repellent activity against a wide range of insect pests.

### CONCLUSION

Chopped native garlic was evaluated for its effectivity to common household pests at different concentrations and was found out to possess repellent properties. It can be therefore concluded in this study that chopped garlic possesses a remarkable repellency effect in common household pests and its effectivity increases with concentration; repellency of chopped garlic yielded on cockroaches is comparable to lanzones peels and alcanphor; center placement was more effective than peripheral placement; for cast application, 50g chopped garlic can be used as it is as effective as the other treatments; and garlic exhibited the same effectivity as the other commercial repellents and had the strongest effect against mosquitoes and least to cockroaches.

### RECOMMENDATION

Pure or 100g chopped garlic is recommended for use against cockroaches, 75g should be utilized for

houseflies and 25g chopped garlic to mosquitoes. Further studies may be conducted to further evaluate the efficiency of chopped garlic in terms of insecticidal property. The use of other varieties of garlic, the Taiwan was also recommended since only the native type of garlic was used in the study.

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