

**“EFFECTS OF THREE NATURAL REPELLENTS – GARLIC,
LEMON AND BAY LEAVES ON COCKROACH.”**

Dissertation submitted to Mahatma Gandhi University

In partial fulfillment of the requirements for the award of the degree of

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CERTIFICATE

This is to certify that the project entitled “**EFFECTS OF THREE NATURAL REPELLENTS – GARLIC, LEMON AND BAY LEAVES ON COCKROACHES**” is a bonafide work done by **ANAGHA T.N.** with Register No. **170021037705** during 2019-2020 in partial fulfillment of the requirement for the award of the Bachelor Degree of Science in Zoology of M G University, Kottayam.

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DECLARATION

I do hereby declare that the work embodied in the dissertation entitled “**EFFECTS OF THREE NATURAL REPELLENTS – GARLIC, LEMON AND BAY LEAVES ON COCKROACH**”, submitted to Mahatma Gandhi University, Kottayam in partial fulfillment for the award of Bachelor of Science in Zoology is record of bonafide dissertation done by me under the supervision of **Dr. Simi Joseph P.**, Assistant Professor of Zoology Department, Bharata Mata College, Thrikkakara, and that no part of this work has been submitted for the award of any other degree/diploma/associate ship/fellowship or any other similar title to any candidate of any university.

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SYNOPSIS

The present investigation was aimed to assess the impact of indigenous plant products for their insecticidal and repellent activity against *Periplanata americana*. An attempt was undertaken to evaluate the efficiency of three plant products- *Citrus limon* (lemon), *Allium sativum* (garlic) and *Laurus nobilis* (bay leaves), owing to their insecticidal properties. Each of the plant material (PM) was pulverized and then applied on *P.americana* in three different concentrations. Dosages administered were 10 ml, 20ml and 30ml respectively. The results have shown that lemon was the most effective among the three natural cockroach repellents tested and it would be an excellent alternative to synthetic insecticides. All the three experimented plant products showed maximum repellency in their highest concentration. But the study was not conducted further since 100 % mortality was shown in 30 ml Lemon spray. The results of the present study would provide more knowledge and information about lemon as natural repellent. Additionally, this study will produce significant and relevant information for future studies regarding to this potent insect repellent.

INTRODUCTION

Cockroaches are insects of the order Blattodea, which also includes termites. About 30 cockroach species out of 4,600 are associated with human habitats. Cockroaches occupy a wide range of habitats. Many live in leaf litter, among the stems of matted vegetation, in rotting wood, in holes, in stumps, in cavities under bark, under log piles and among debris.

Cockroaches are nocturnal creatures that love dark, warm, moist hiding places in cracks, crevices, or hard-to-reach corners. The first step to eradicating an infestation is removing food sources and hiding places, especially since cockroaches only return to habitable places. With a little detective work, a persistent strategy, and preventative measures, you can make your house an unattractive place for roaches, which will not only manage an infestation, but also prevent them in the future.

Cockroaches live in groups and are attracted to humidity, warmth, and darkness, and are common in bathrooms, kitchens, dining rooms, and sometimes bedrooms. Cockroaches secrete a pheromone (an attractant chemical) in their feces, which attracts other cockroaches.

Cockroaches are scavengers. While walking on spoiled food in garbage containers, they pick up various bacterial organisms on their legs that they can later deposit on uncovered food.

Cockroaches themselves are not implicated in the transmission of any diseases. However, many disease-causing organisms can grow and multiply in their guts and can then be deposited on silverware, plates etc. during defecation. For example, cockroaches can pick up disease-causing bacteria like Salmonella on their legs and later deposit them on foods and cause food poisoning.

People continuously exposed to dust containing cockroach feces and crushed body parts become sensitized and may show allergic reaction and asthma after repeated exposure to such dust.

While cockroaches are not inherently attracted to dirty or unclean environments, unsanitary conditions can aggravate the problem. These scavenging insects enter homes and buildings to look for food, moisture, and warmth. Restricting access to these basic necessities is the most effective way of preventing a cockroach infestation. Removing cockroach hiding places and entry points will drive cockroaches away and prevent future infestations.

The Blattodea include some thirty species of cockroaches associated with humans. These species are atypical of the thousands of species in the order. They feed on human and pet food and can leave an offensive odour. They can passively transport pathogenic microbes on their body surfaces, particularly in environments such as hospitals (Rivault, C.; Cloarec, A.; Guyader, A. Le (1993). Cockroaches are linked with allergic reactions in humans. One of the proteins that trigger allergic reactions is tropomyosin (Oliver, C.; Rizzo, M. C.; Naspitz, C. K.; et al. (1999). These allergens are also linked with asthma. About 60% of asthma patients in Chicago are also sensitive to cockroach allergens. Studies similar to this have been done globally and all the food, so just because no cockroaches are visible in a home does not mean they are not there. Approximately 20-48% of homes with no visible sign of cockroaches have detectable cockroach allergens in dust (Eggleston, P.A.; Arruda, L.K. (2001). Cockroaches can burrow into human ears, causing pain and hearing loss.

American cockroach, *P. americana* is a cosmopolitan species and is the largest of house-infesting cockroaches (Bell and Adiyodi, 1981; Jones, 2008). Cockroaches are considered a public health problem due to their association with human waste and diseases. Nearly, 22 species of pathogenic human micro-organisms and 5 species of helminthic worms have been isolated from field collected American cockroaches (Rust et. al., 1991). These insects are also responsible for contaminating food and surfaces with disease organisms that results in food-poisoning, dysentery or diarrhea (Barbara, 2008 and Jones, 2008). The control strategies involve chemical insecticides and spray that are detrimental to human and beneficial organisms and might cause ecological as well as resistance problems. Therefore, these chemical insecticides are to be replaced by biopesticides or low risk insecticides (e.g. Boric acid). Furthermore, the most recent technological advances in cockroach control consist of using bait formulations (Appel, 2004).

Many authors reported the toxicity and insecticidal profile of *Blattella germanica* (Kilani-Morakchi et al., 2005). Other findings demonstrated that ingested boric acid caused histopathological alterations in the mid-gut of *B. germanica*. Moreover, this compound exhibited a neurotoxic action as evidenced by symptoms of poisoning and a reduction in acetyl cholinesterase activity (Habes et al., 2006). Other harmful effects of boric acid on *B. germanica* was the reduction of number of oocytes per paired ovaries and the biochemical analyses revealed a significant reduction of ovarian contents of protein, lipids and carbohydrates.

Many remedies have been tried in the search for control of the major pest species of cockroaches, which are resilient and fast-breeding. Household chemicals like sodium bicarbonate (baking soda) have been suggested. Garden herbs including bay, catnip, mint, cucumber and garlic have been proposed as repellents. Poisoned bait containing hydrametylnon or fipronil, and boric acid powder is effective on adults. Baits with egg killers are also quite effective at reducing the cockroach population.(yaccob,1995)

Roaches can live underneath canned food labels, feeding on the label's glue, inside of paper bags, inside stacks of newspapers, kitchen cupboards, utensil drawers, and even children's toy box. Pesticides can be poisonous to humans as well. Some are very poisonous, or toxic, and may seriously injure or even kill humans. Others are relatively non-toxic. Pesticides can irritate the skin, eyes, nose, or mouth.

Natural pesticides are pesticides that are made by others organisms usually for their own defense or are derived from a natural source such as mineral. Natural pesticides are safer and more ecofriendly than man made pesticides.

So use of natural methods for killing cockroaches are preferred. Though natural products will not act as quickly as chemicals, they are much safer for pets and family. In this context a study was undertaken to assess the effects of three natural repellants on this household menace, *Periplaneta americana*.

AIM AND OBJECTIVES

AIM:

- The aim of the present study is to find out the effect of three natural repellents -lemon, garlic and bay leaves on Cockroach.

OBJECTIVES:

- To determine the effectiveness of garlic as natural repellent.
- To determine the effectiveness of lemon as natural repellent.
- To determine the effectiveness of bay leaves as natural repellent.

REVIEW OF LITERATURE

American cockroach, *P. americana* is a cosmopolitan species and is the largest of house-infesting cockroaches (Bell and Adiyodi, 1981; Jones, 2008). Cockroaches are considered a public health problem due to their association with human waste and diseases. Nearly, 22 species of pathogenic human micro-organisms and 5 species of helminthic worms have been isolated from field collected American cockroaches (Rust et. al., 1991). These insects are also responsible for contaminating food and surfaces with disease organisms that results in food-poisoning, dysentery or diarrhea (Barbara, 2008 and Jones, 2008). The control strategies involve chemical insecticides and spray that are detrimental to human and beneficial organisms and might cause ecological as well as resistance problems. Therefore, these chemical insecticides are to be replaced by biopesticides or low risk insecticides (e.g. Boric acid). Furthermore, the most recent technological advances in cockroach control consist of using bait formulations (Appel, 2004).

Mutyala and Vadlamani, (2013) investigated the effects of fungal infection on the midgut ultrastructure of the adult of *P. americana* which was manifested in the form of damage to the microvilli, epithelial cell vacuolization, necrosis and disruption of the epithelial cell membrane which occurred with increase in the time interval post treatment with conidia from high virulent isolate (M20) at LC50 dosage. His study revealed that fungal infection instigated oxidative stress in the cockroach and that the villi of the midgut are also the target organs for the oxidative damage. Another such finding demonstrated the consequences of the infection of conidia from entomopathogenic fungal isolates of *Metarhizium anisopliae*, when subjected to injection into the haemolymph of *P. americana*, in terms of changes in the levels of antioxidants and free radicals as a measure of oxidative stress in the treated cockroaches (Babu and Padmaji, 2013).

Substantial amount of work throughout the world over the last 30 years has indicated that plant-based products for the control of insects have a great potential as biological insecticides. Paranagama et al. (2001) studied the effect of azadirachtin on the growth and development of *P. americana* together with its activity on the midgut enzyme in vivo and in vitro and the effects of neurohormones on the secretion of midgut enzymes. Moreover, Khan et al. (2011a) evaluated the histopathological effect of crude leaf extract of *Datura alba* on American cockroach, *P. americana*. The results revealed disruption of the cellular structures of the cockroach midgut fed

on different doses of leaf extract, most characteristic effects were disruption of columnar cells, peritrophic membrane, striated border, and longitudinal muscles.

Khan et al. (2011b) carried out the comparative study of chloroform leaf extract of *Cassia fistula* and commercial biopesticides, Neemarin (containing azadirachtin 0.15%EC) in terms of their toxicity on mortality and their effects on the midgut epithelium. Furthermore, Kesetyaningsih, (2012) evaluated the efficacy of *Annona squamosa* leaf extract against *P. americana* and found to be effective in causing mortality of the insect at higher concentrations. Achio et al. (2012) observed the same effects of neem preparations on some insects of agricultural and public health concern including *P. americana*.

Many authors studied the repellent activity of essential oils against cockroaches. Thavara et al. (2007) tested the repellency of seven commercial essential oils extracted from the plant species *Boesenbergia rotunda*, *Citrus hystrix*, *Curcuma longa*, *Litsea cubeba*, *Piper nigrum*, *Psidium guajava*, *Zingiber officinale* and naphthalene as a control against the three cockroach species *P. americana*, *B. germanica* and *Neostylopyga rhombifolia*. Much later, Liu et al. (2011) studied the repellent activity of eight essential oils obtained from hydrodistillation of Chinese herbs (*Angelica sinensis*, *Curuma aeruginosa*, *Cyperusrotundus*, *Eucalyptus robusta*, *Illicium verum*, *Lindera aggregate*, *Ocimum basilicum* and *Zanthoxylum bungeanum*) on German cockroach. On the other hand, the essential oils derived from *Cymbopogon citratus* (lemon grass), *Cymbopogon nardus* (citronella grass) and *Syzygium aromaticum* (clove) were evaluated for their repellent activity against the adult of *P. americana* and the result showed that the essential oil from *C. citratus* exhibited the highest repellency (100%) among the tested repellents and naphthalene (83% repellency) (Sittichok et al., 2013).

The efficacy of aqueous leaf extracts of *Nerium oleander*, *Nictiana tabacum* and *Eucalyptus camaldulen* against the nymphs of *P. americana* and *B. germanica* was investigated by Hassan and Abduljaleel (2014). In another study, methanolic extract of *Ocimum sanctum* with different concentrations ranging from 50 to 200 ppm were exposed to *P. americana* for 96 hrs and found an increase in the brain lipid content and cholesterol content, the author also suggested that bio-molecule of plant extract entering the brain become the site of action, because some major biochemical changes has been observed due to the leaf extract of *O. sanctum* (Hazarika and Boruah, 2014). Furthermore, insecticidal activity of *Jatropha curcas* seed oil phorbol esters were

tested against the nymphs, adult cockroaches (*P. americana*) and termites at different concentrations (Lateef et al., 2014).

To investigate the insecticidal efficacy of four different classes of insecticides: pyrethroids (deltamethrin), organophosphates (DDVP), phenyl-pyrazoles (fipronil) and neo-nicotenoids (imidacloprid) and discovered that fipronil 2.5% EC was highly effective at all concentrations applied, while DDVP 50% EC was least toxic amongst all (Syed et al., 2014). The repellent activity of the plant powders of Neem, Tulsi, Adathoda, Turmeric, Lantana etc. were also seen against *P. americana* (Mathew et al., 2014). Furthermore, Kariuki et al., (2014) tested the synergistic effects by combining pyrethrins and rotenoids extracts from *Chrysanthemum cinerariaefolium* and *Tephrosia vogelii* plants respectively at various ratio mixtures against adult of *P. americana*. More recently, study was conducted to test the comparative bioefficacy of commercial formulated biopesticides of plant-origin with the ethanolic crude extracts of *A. mexicana*, *N. oleander* and *P. hysterothorus* against *Periplaneta americana* (Khan and Qamar, 2015a). The efficacy of different parts of *P. hysterothorus* on the repellent and insecticidal activities of American cockroach was seen (Areaya et al., 2015).

The available literature mainly focused on the repellent and insecticidal activity of synthetic as well as natural products against cockroaches .

METHODOLOGY

Collection of cockroaches

In the present study, common cockroaches *Periplanata americana* was used . Cockroaches was collected and kept in a plastic container, which was perforated for aeration, These insect was starved for one day for experiment.

GARLIC SPRAY

Roaches hate the smell of **garlic** to such an extent that they will practically run away from it as quickly as possible. The best way to use this is to get **garlic** spray and sprinkle it quite freely around the areas where there is the most evidence of cockroach activity.

- 1garlic
 - 1 quart water
 - 4-5 drops dishwashing soap
 - Blender or food processor
 - Cloth
 - 1 Quart glass jar
-
- First, separate bulbs into cloves without peeling. Put all of the cloves into a high quality food processor or blender and add 1 cup of water. Mix them well.
 - After chopping, add in the remaining water and dishwashing soap. If, transfer to a blender and blend until the mixture is completely liquefied.
 - It's important to make sure it's completely liquid, using a spray nozzle to apply and even small chunks will get caught in the nozzle.

After a thorough blend, strain through cloth to catch any last chunks of garlic that would clog spray nozzle. Put the mixture into a glass jar for storage. mix 1 part of concentrated garlic mixture with 10 parts of water and add to a bottle with a spray nozzle top.

BAY LEAVES SPRAY

Cockroaches hate the pungent smell of bay leaves.

- 10 bay leaves
- Cloth
- Blender
- 1 quart water
- 1 quart glass jar
- 4 – 5 drops dishwashing soap

Take 10 bay leaves and crushed it using blender and then add a 1 cup of water mix them well . After chopping, add in the remaining water and dishwashing soap. Transfer to a blender and blend until the mixture is completely liquified. It's important to make sure it's completely liquid, using a spray nozzle to apply and even small chunks will get caught in the nozzle. Bay leaves to mix with the water and soap as possible. After thorough blend, strain through cloth to catch any last chunks of bay leaves that would clog spray nozzle. put the mixture into a glass jar for storage. Mix 1 part of concentrated bay leaves mixture with 10 parts of water and add to a bottle with a spray nozzle top.

LEMON SPRAY

The smell of lemons repels cockroaches to a great extent.

1. distilled white vinegar
2. citrus peels
3. large glass jar with lid
4. spray bottle

A large glass jar, fill it at least half way with citrus peels only (do not include seeds/juices etc.). Fill the rest of the jar with distilled white vinegar and cover for at least 1 week. Strain the vinegar/citrus mixture. Transfer into spray bottle.

The cockroaches collected was tested for the repellent activity of three plant extracts of lemon , garlic ,bay leaves . First we took 9 containers and each container contained 5 cockroaches .Then we allowed 1 hour for adaptation to the environment for the experiment we used 3 different concentration ie,10,20,30 ML of each extracts for bioessay on cockroach .we applied 10 ML lemon extract on the first container and garlic, bay leaves extracts to second and third containers respectively. After applying the spray we waited for result .We confirmed the result by triplicating.

Then we added 20 ML concentration of garlic ,lemon ,bay leaves extracts to the second set of container (4 th ,5 th ,6 th) as we did in the previous trial. It was also exposed to hours for the result.

Then we tested for 30 ML concentration to the last set of container (7 th ,8 th ,9 th) death occurred at the maximum concentration. Lemon showed best results when compared to garlic and bay leaves.

RESULT

The results obtained on the mortality of *Periplanata americana* treated with different concentrations of plant extract of garlic (*Allium sativum*), Lemon (*Citrus limon*), bay leaves (*Laurus nobilis*) are presented below.

Table1 shows repellent activity of garlic (*Allium sativum*) against *P.americana* at different concentration.

Concentration (ml)	Number of Cockroach taken	Number of cockroaches died
10	5	1
20	5	2
30	5	3

Table2 shows repellent activity of lemon (*Citrus limon*) against *P.americana* at different concentration.

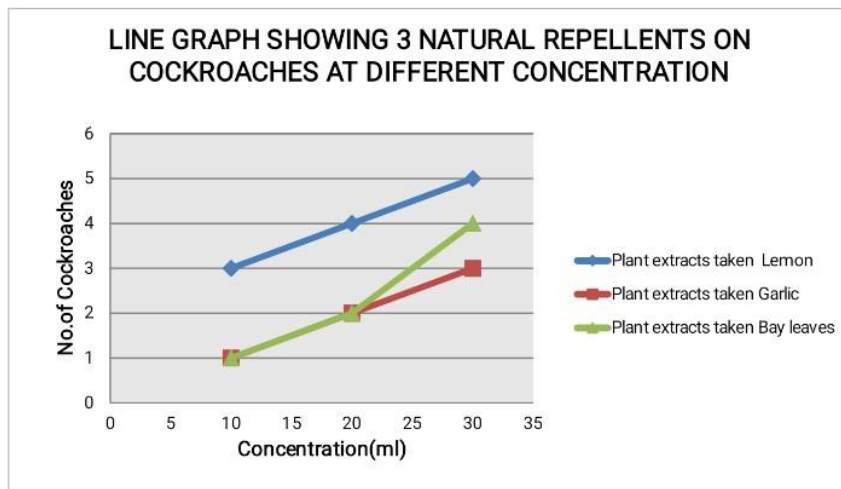
Concentration (ml)	Number of Cockroach taken	Number of cockroaches died
10	5	3
20	5	4
30	5	5

Table3 shows repellent activity of bay leaves (*Laurus nobilis*) against *P.americana* at ,different concentration.

Concentration (ml)	Number of Cockroach taken	Number of cockroaches died
10	5	1
20	5	2
30	5	4

As compared to garlic (*Allium sativum*) and bay leaves (*Laurus nobilis*), Lemon (*Citrus limon*) shows more repellent property. Takes 10, 20, 30 ml of solutions for making repellent sprays. Three individual trials has done against cockroaches with each sprays.

Table 1, shows that 30 ml of garlic solution killed three cockroaches out of five; Table 2 shows 30 ml of lemon solution killed five cockroaches out of five and Table 3 shows that 30 ml bay leaves solution killed four cockroaches out of five.



Repellent activity of lemon extract, garlic extract, bay leaves extract is plotted.

With increase in concentration of all the three extracts, the number of cockroach deaths also increased. Maximum mortality was recorded at highest concentration of lemon extract i.e 30 ml solution followed by . By which lemon solution cockroaches died fastly in 6 hours as compared bay leaves (8hours) and garlic (10 hours).The order of repellency can be shown as lemon > bay leaves > garlic .From all these observation it was finally concluded that lemon (*Citrus lemon*) has greater repellent property to cockroaches than bay leaves and garlic. As 100 % mortality was noticed with lemon extract, further studies were not conducted with increasing concentrations of these repellants.

DISCUSSION

To control the cockroaches, many studies have been conducted in various forms. In the present study, to evaluate the efficiency of three plant Products – *Citrus limon* (lemon) ,*Allium sativum* (garlic) and *Laurus nobilis* (bay leaves).Owing to their insecticidal properties. Each of the plant material was pulverized and then applied on *Periplanata americana* in three different concentrations. Dosages administered were 10 ML, 20 ML ,30 ML respectively.The results have shown that lemon was the most effective among the three natural cockroach repellent tested and it would be an excellent alternative to synthetic insecticides. All the three experimented plant products showed maximum repellency their highest concentration. The result of the present study would provide more knowledge and information about lemon as natural repellent.

The results were classified and discussed in getting cockroaches from sewers into bulidings and their elimination, insecticide susceptibility, application of dust, bait and Inestfly paint insecticide formulations, biocontrol, and futuristic action categories. Cockroaches cause harmful diseases like typhoid and salmonella. A recommending manner to achieve a successful *P. americana* cockroach control in sewers is using a combination of Integrated Pest Management (IPM) strategies which resulted in significant reductions of cockroach infestations and asthma health outcomes. Use of *P. americana* breeding thelytoky, push-pull strategies and an automated sewer robot, and integrating health into the future buildings may be new approaches of *P. americana* control strategies.

Natural repellents are usually safe to humans and the environment (Yang et al., 2005). Insecticides of plant origin are expected to be target selective and biodegradable leading to fewer harmful effects on human and other animals and are environmentally safe as compared to synthetic compounds (Jeyabalan et al., 2003; Prabhakar and Jebanesan, 2004). Natural repellents have been shown to be relatively nontoxic to fish, birds and mammals and easily biodegrade in the environment (Stroh et al., 1998; Kumar et al., 2012b). Some natural extracts or their volatile constituents have been used to prevent and treat illness due to perceived antibacterial, antiviral, antioxidant and antidiabetic properties (Edris, 2007). It is used in sensitive areas, such as homes, schools, restaurants, and hospitals (Batish et al., 2008; Palacios et al., 2009b). Isman (2000) studied the effect of natural extracts from herbal plants generally known to have fumigant insecticidal properties, to control of various insects. He concluded that the mode of action involved elements of acetylcholinesterase inhibition and octopaminergic effects. Additional effects could be seen in

behavior modification (attraction/repellency) and contact toxicity for different life stages (Koul et al., 2008).

In the present study, the repellent activity of lemon (*Citrus limon*), garlic (*Allium sativum*), bay leaves (*Laurus nobilis*) against cockroaches was tested. The activity was highest in *Citrus limon* followed by *Laurus nobilis*, *Allium sativum*. Among the three plant extracts the highest repellency was seen in the case of citrus limon and the least repellency was shown by *Allium sativum*. The order of repellency can be shown as lemon > bay leaves > garlic.

The repellency of garlic, bay leaves and lemon solutions were tested on cockroaches at three different concentrations. The trials were conducted in triplicates. Maximum mortality was recorded at the highest concentrations of the three plant extracts. This study showed that lemon was more effective against cockroaches. In the case of lemon spray, cockroaches died immediately because of the citrus Power and smell (Blackwell et al., 2003) . Garlic and bay leaves spray killed the cockroaches because of their pungent smell (Choochote et al,2007).

CONCLUSION

The present study indicated that the extracts of selected plant species were highly effective and could be introduced as repellants against cockroaches. It could also be used widely in many industrial and commercial purposes, so future prospect of the study lies in the fact that more plant species should be identified and utilized for such pest repellent activities so that an eco-friendly approach can be followed for sustainable development of the nature and its dependents. Human beings suffer from diseases that are acquired from the pests like cockroaches that lives in their home. Aiming to find an alternative way in eliminating these kind of insects in an effective, safe and affordable way wherein consumers can afford to produce their own homemade pesticide. Based upon the experimentation, it is concluded that *Citrus limon* spray is effective enough in killing cockroaches .

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