Pesticidal Prospectives of *Azadirachtin indica* as Home Pest Management

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Abstract

Neem oil or its scientific name *Azadirachta indica* oil was synthesized and mixed with lemongrass oil or benzene in order to determine the effect of the mixed neem oil with the respective materials used in different ratios towards house crickets, *Acheta domesticus*. The process of the induction of the mixture to the skin of the animal sampling and by well-mixed the mixture in the food consumption supplied to the *Acheta domesticus* was conducted in order to investigate the effectiveness of the mixed neem oil with lemongrass oil and benzene. The death was observed for three days and Fourier's Transform Infrared Spectroscopy (FTIR) was being carried out in order to determine the compound present in the lemongrass oil and neem oil that affected the animal sampling. Strong cyclopentanone, medium alkanes and aromatic compound have been found in the lemongrass and neem oil. These findings should be useful as the compounds present in the oils have been identified to have an adverse effects on *Acheta domesticus*. Out of all the sampling that have been tested, neem oil was the best sample to abolish *Acheta domesticus* and mixed the mixture in the food consumption that is supplied to animal sampling is better than inducing the mixture to the skin of the animal sampling.

Keywords: Benzene; Cricket; Lemongrass Oil; Neem Oil; Pesticide.

1. Introduction

The invention of pesticides is one of the greatest inventions of the human being as it has widely impacted their lifestyle in the terms of prevention from an airborne disease. Kumar et al. (2012), define pesticide as a substances used in agriculture field to increase the production of crops by the means of repelling, preventing and destroying pest. Pesticides mainly consist of several types which are insecticides, herbicides, nematocides and rodenticides in which each of these pesticides has its own goal to be achieved. It is believed that some of the pesticides derived from synthetic materials have the tendency to cause some adverse effects on human beings in various ways (Boadu et al., 2011). This type of pesticide which is mainly consists of synthetic chemicals such as N-diethyl-3-methylbenzamide and permethrin have been identified to have some adverse reaction such as irritation and headache and even led to the death of human being associated with its use although it has an excellent safety record.

Most of the existed agri-businesses also used a synthetic-derived based chemical of pesticides because they believed that it can protect a large number of crops and it also has a higher effectiveness compared to those pesticides derived from organic and natural material. But, this synthetic pesticides have more disadvantages than its advantages itself. On the other hand, most of the pesticides derived from synthetic chemical have the higher potency to contaminate the production of crop with harmful chemical residues, contaminate soils and groundwater and can cause a high health risk. The uses of artificial pesticide used in the production of crops has an excellence effect on insect pest and a crop fungal infestation pest and there are quite a few challenges faced by the synthetic pesticide which including residual toxicity, photo toxicity as well as the widespread of environmental hazard. Other than that, chlorinated chemical pesticide may remain in the environment for a long period of time and may have long-term negative effects to the environment and ecosystems. Besides, the environment is also impacted as well by the uses of pesticides known as *persistent organic pollutants* (POPs). POPs continuously poisoning the non-target organisms in the environment and it has the probability to increase the chances to disruption of human beings especially to the endocrine system and reproductive organs.

Recently, many researches have been conducted studies in order to procure an alternative for the replacement of synthetic-derived based chemicals which is known as biopesticides. The Environmental Protection Agency (EPA) defines biopesticides as a botanical pesticides derived from organic and natural material. This category includes a plant extract with insecticidal properties which have been widely used either in a crude form and to a lesser extend in a concentrated form as crop pest protectants (Moshi & Matoju, 2017). Biopesticides have been widely selected as the substitute for the synthetic-derived based chemicals as it is eco-friendly and it consists of low toxic chemical residues and thus environmental pollution could be reduced indirectly. Besides, biopesticides are much cheaper, has an easy access to its material and easy to be handle compared to synthetic-derived based chemicals of pesticide as it only affected the targeted group of insects. The study of biopesticide also has led to variety type of biopesticides such as microbial pesticide, biochemical pesticide and plant-incorporated-protectants (PIPs). These existences of various types of biopesticides have proven that they have become the major choices among the industries nowadays as the replacement for the current existing pesticides.

Plants could be eventually being used to extract a number of chemical compounds derived from primary metabolism and although most of the plants are essential for growth, physiologic development and reproduction, there are still a small fractions existed in the plants that can be allocated as a substrate for secondary compound pathways. Secondary compound pathways is the secondary mechanism metabolism in plant which is not involving in physiological processes but it is much more likely essential for the specialized compound in the plant to communicate with other organisms in mutualistic (eg: attraction of pollinators) or antagonistic interactions (eg: pathogens and herbivores). Next, a plant-derived product also has been proven to be eco-friendly, residue-free, biodegradable and cost effective. Other than that, it has been stated that the biodiversity of plant has provided as excellent sources of biologically active substances known as phytochemical which is produced by the plant for their defence. The most currently used of biopesticide stated by (Moshi & Matoju, 2017), there are actually several type of classes used in the synthesis of biopesticide which is from biomaterial, botanical, and microbial. The biomaterial used in biopesticide which is *Eucalyptus spp.* has been identified to have the higher effectiveness against the targeted insect pests which is *Sitophilus zeamais Motschlusky* as it exhibit a strong repellent effect while the botanical classes of material such as Marigold is used against root knot nematodes. Nowadays, people is not only rely on the uses of synthetic drug as for their health but now more than 50% of the worldwide population is depending on the uses of plant as the alternative for the healthcare. One of the medicinal plant is *Azadirachta indica* (Neem) (Chandra et al., 2017).

Neem tree or its scientific name which is known as *Azadirachta indica A. Juss* (*syn. Melia azadirachta*) is well known in India and in its neighboring countries for more than 2000 years as one of the most versatile medicinal plants having a wide spectrum of biological activity (Biswas et al., 2002). Neem extract is widely known as one of the sources of the plant that could be extracted and can be used as an ingredient substitution in pesticide. Several phytochemicals extracted from neem plants have been reported to have detrimental effects on insect and these compounds consists of alkaloids, steroids, saponin, tannin and flavonoids (Choudhury et al., 2017). Besides, some researchers have been working for almost 30 years on neem leaves and found out that these leaves has some adverse effect to insect like mosquitoes and rats. This is due to the strong anti-feedant, insect growth regulatory and reproductive effects to the target animal (Boadu et al., 2011). The highest potential and production of oil is also available in neem oil compared to the available wild oils (Singh & Sujana, 2013). Furthermore, Mustafa, (2016) says neem tree (*Azadirachta Indica*) have a wide range of application including in the medical fields such as the extracted neem oil could be used as an antibacterial, antifungal activities against different types of pathogens and anti-viral activity against diseases such as vaccinia, chikugunya, measles and coxsackie B viruses.

Azadirachtin is also categorized as the limonoid group as the complexity of its molecular structure added up a wide spectrum of actions which is responsible for biological activities against 550 species of insects such as *Coleoptera* (Beetles and Weevils); *Dictyoptera* (Mantids); *Diptera* (Flies); *Heteroptera* (Bugs); *Homoptera* (Aphids, Wasps and Ants); *Isoptera* (Termites); *Lepidoptera* (Moths and Butterflies); *Orthoptera* (Grasshoppers); *Siphonaptera* (Fleas); and *Thysanoptera* (Thrips) (Debashri & Tamal, 2012). Neem oil is usually derived from its fruit kernel or their leaves. It also has strong odor as it has a smells like garlic. Neem oil may have an adverse effect

on insects but it does not bring harm to any mammals and beneficial insects such as honeybee, butterfly and ladybird.

Although neem oil does not give a quick effect like other synthetic pesticides, but it helps to maintain the quality of the crops and the results at the end of the processes can be guaranteed. In some cases, the insect that has been contacted with or smell this oil will forget that they can eventually fly and it will block the insect's hormones from eating, mating and laying eggs. Apparently, if an insect forgets to breed or lay eggs, the cycle of their habitat will be destroy. And if the insects still lay eggs, the eggs will not hatch at all. This will cause extinction of the harmful insects. There are several ways to spread this oil to crops such as spray it on the leaves and apply it at the soil. It is best to apply this oil at the soil as the roots will absorb the oil directly to their systems. This will make the oil stays longer than other process suggested. The oil has a half-life of 3 to 22 days in soil, but it only last up to 45 minutes to 4 days in water and 1-2.5 days on leaves (Bonnie L. Grant, 2017). Thus, neem oil needs to be applying constantly. Recently, based on the study by (Moshi & Matoju, 2017), they have identify that neem oil is also effective against several types of targeted pests such as *Acanthoscelides obtecus Say, Zabrotes Subfasciatus Boheman* and *Cowpea weevil.*

Currently, the growth and population of crickets in the world has increased every year. There are more than 900 species of crickets around the world. Cricket farming is emerging as a 'mini-livestock' production system. The environmental impact of farming crickets may be less than that of traditional livestock due to their poikilothermic nature, which allows more efficient feed conversion and therefore it could be a sustainable kind of animal-source food. (Halloran et al., 2017). The average life span of a cricket is usually around 3-5 months. They are usually found at tropical climate condition such as in Malaysia and more than 88 species of house cricket were found here. The habitat of crickets is normally found in the upper tree canopy, in bushes and among grasses and herbs. They could also eventually be found on the ground, caves and even some of them are hidden in a shallow burrow.

The lifecycle of cricket begins with the egg stage, larva or nymph stage and ended with adult stage. The chirping sound is normally produced only by male crickets as it is one of the mating rituals to attract the female cricket during the mating season. Throughout the mating season, a female cricket is capable to produce 5-10 eggs per day for a total of 100 eggs in the entire life of the female cricket under favorable conditions. The female crickets usually laid their eggs in sandy soil as the soil itself act as protective layer and barrier for the eggs as well as to provide a warm and favorable condition for the eggs to hatch. Crickets is also can be classified as a pest as they typically feed on the surface of clothing and carpets damaging and leaving the area of surface roughened from the effect of fibers lose. Crickets may also feed on a paper or a cloth products and any uncontained food.

In conclusion, neem oil has been selected to be the main component in the production of biopesticide which is one of the objectives of this study. The reason lies within is due to the unique characteristics of neem oil that compatible with the main subject which is cricket. Thus, the main objective of this study is to compare the effectiveness of the pesticide induce to the crickets in several different ways which is by contacting the pesticides with the animal's skin and well-mixed the pesticide in their food consumptions. This paper also represents the methods used for the synthesis of neem oil mix with aromatic compound such as benzene and natural ingredient such as lemongrass. The key parameters in this study such as the death of the animal sampling, the effectiveness between different methods induced, the analysis of component present in neem oil and lemongrass that contributes to the death of the animal sampling and the materials used to be mixed with neem oil is to be further study.

2. Methodology

2.1 House Cricket

The crickets were divided into four groups (I-IV) for the respective material used with 8 crickets in each group and Group I is set to be the control group in this experiment. The crickets were obtained from the nearest supplier of crickets in Pasir Gudang province. The crickets were housed in a laboratory at a temperature of (28.8°C±0.88°C) with relative humidity of (20-45%) and a light/dark cycle of 12 hours (Dziewiecka et al., 2016). Crickets were fed on with water spinach and supplied with sufficient amount of water throughout the period of the study. Group I for this experimental study is not being induced with any of the materials used while Group II-III were administered with the mixture of neem oil with benzene and the mixture of neem oil with lemongrass in the ratio of 30:70, 50:50 and 70:30 by volume respectively. Meanwhile, Group IV of the study is fed and induced with pure neem oil to study the toxicological effects of neem oil itself towards crickets.

Crickets will be introduced to the mixture of extracted neem with benzene and lemongrass in the way of spraying directly the mixture to the body of the cricket and mixed it with their food consumption as this is one of the ways to evaluate the death of cockroaches after 3 days of exposure. The number of dead crickets is then recorded. After exposure, the mixture of extracted neem (*Azadirachta indica*) may cause an immediate appetite suppression, as well as systemic poisoning and ecdysis inhibition. It may also causes defects in oviposition, infertility, and enzyme and chitin synthesis inhibition in the insects.

2.2 Materials

2.2.1 *Neem Oil*

Neem leaves were used to extract the oil out in this experiment. Neem tree were obtained in a nursery nearby which is in Pasir Gudang province. Neem leaves were then pluck from the tree and were grind in a blender by mixing them with 500ml of cooking oil and 3 tablespoons of cloves. Then, it is necessary to filter up the mixture to separate any residue presence in the oil. The mixture then is further undergoing a heating process by using hot plate at the temperature 100°C for 2 hours. The extracted oil obtained is then kept in a refrigerator to prevent the damage of enzyme present in the extracted oil. In this study, there are a total of 10 samples of neem oil that will be used. Sample I-III of the neem oil will be mixed with the benzene in the ratio of 30:70, 50:50 and 70:30, sample IV-VI of neem will not be used in this experimental study, sample VII-IX of neem oil will be mixed with lemongrass again with the same ratio as benzene and sample X of pure neem oil will be solely induced to the animal sampling.

2.2.2 Lemongrass

Lemongrass or its scientific name known as *Cymbopogon spp.* has a lot of uses in the daily life of human being. There are 55 species of lemongrass that has been recorded around the world (Madivoli, Gitu, & Gumba, 2012). Lemongrass are widely use in medicine, culinary and natural repellent as it has strong scents. This plant has a lot of nutrients that is good for human bodies. It helps to regulates high blood pressure, heals cold or flu and it also has anti-cancer properties. As for natural repellent, it helps to repel cockroaches, mosquitos, ants and other type of insects. . The uses of lemongrass is favorable in this experimental study as the extracted essential oil from *Cymbopogan spp.* consists of the mixture of some active compound such as geraniol, geranyl acetate and monoterpene olefins such as limonene (Mohamed Hanaa et al., 2012). This plant also produces essential oils known as citral and citronella.

The lemongrass was extracted first by chopping off the stalk of the lemongrass finely and crushed it in the mortar and pestle to extract out the oil. Then, fine-crushed lemongrass is added in cooking oil after the oil has been heated up for further enhancement of extraction and the mixture is welly stirred. The mixture is simmering for one hour for the oil to be extracted. The mixture is then filtered out and the extracted oil were refrigerated to ensure it is kept at the

best quality. There are two different ways that can be applied for lemongrass oil to be extracted. The oil in the lemongrass could be extracted with the aid of water. But, in this experimental study, the extraction of lemongrass oil by using other solvent such as the cooking oil is much more favorable. In this experimental study, there will be 6 sample of lemongrass oil that will be used. Sample I-III of the lemongrass will be mixed with sample IV-VI of the extracted neem oil but this sample will not be involved in this study. However, sample IV-VI of the lemongrass oil will be mixed with sample VII-IX of the neem oil in the ratio of 30:70, 50:50 and 70:30 respectively.

2.2.3 Benzene

Aromatic compounds are substances that consist of one or more rings that contain alternating single and double bonds in its chemical structure. Many aromatic compounds have an odor, however there are some of them are chemically aromatic but do not have a distinct smell. Aromatic molecules are very stable and do not break easily to react with other substances. Benzene is one of the common aromatic compounds used in this study. Benzene evaporates quickly in air as it is a volatile component. In this study, benzene is mixed with neem oil and the mixture was stirred for 15 minutes to allow the mixture to well-mix. The mixture is then introduced to the cricket by mixing the mixture in their food supply as the main way that benzene could be exposed off is by breathing in air and can be absorbed through the skin. Benzene was chosen in this study after factors such as auto-ignition and flash point of the benzene which is 497.78°C and -11.1°C respectively has been taken into consideration. This is to ensure the safety of the working environment during the experimental study is conducted.

2.3 Testing and Analysis

2.3.1 Fourier's Transform Infrared Spectroscopy Analysis

Fourier's Transform Infrared Spectroscopy (FTIR) Analysis is the analysis of infrared spectroscopy analysis that being carried out in this experimental study in order to determine the organic, polymeric and in some cases an inorganic material. The FTIR analysis uses an infrared light to test the samples and observe the chemical properties. In this experimental study, FTIR analysis is necessary as it helps to determine type of compounds present in the neem and lemongrass oil itself which can greatly affected the animal sampling which is the house cricket.

2.3.2 Effectiveness of Induction Methods to Animal Sampling

The effectiveness is recorded based on how the materials were induced on the animals sampling which are cricket and the different ratios used between the mixture of neem oil with lemongrass and benzene. This experiment used two ways of inducing the mixtures on the cricket. The first method used was by spraying the mixture of neem oil with benzene and lemongrass oil directly to the cricket and the second method used was by well-mixed the mixture of the materials in their food consumption. The mixture of the neem oil with lemongrass oil and benzene in different ratio was to be study in order to identify which ratio between the mixtures has the higher effectiveness against cricket.