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IJAZAH: Degree of Bachelor of Agriculture Science with Honors

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REPELLENT EFFECT OF *Chromolaena odorata* L. AGAINST *Periplaneta americana* L.

NOOR FATHIN BINTI AZMI @ ROSLI

DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF AGRICULTURE SCIENCE WITH HONOURS

HORTICULTURE AND LANDSCAPING PROGRAMME SCHOOL OF SUSTAINABLE AGRICULTURE UNIVERSITI MALAYSIA SABAH 2014

DECLARATION

I hereby declare that the dissertation is based on my original work except for citations and quotations which has been duly acknowledged. I also declare that no part of this dissertation has been previously or concurrently submitted for a degree at this or any university.

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ABSTRACT

Aqueos extract of *Chromolaena odorata* was evaluated for repellent activity against *Periplaneta americana* under laboratory conditions. *Periplaneta americana* were placed in polystyrene boxes applied with four (4) different concentration of *Chromolaena odorata* extract (10%, 25%, 50% and 100% and distilled water as control) and observed for 48 hours. The repellency value was obtained by using two way analysis of variance (ANOVA). The interaction between concentration and time was not significant. Yet, there were significance in difference concentration and also significance in difference time. The extraction showed excellent repellency in 100% concentration, followed by high degree of repellency in 50%, but other concentrations has lower repellent activity. *Chromolaena odorata* has good potential to use as cockroaches repellent. Therefore, it can be used as alternative natural product for controlling *Periplaneta americana.*

KESAN HALAUAN POKOK *Chromolaena odorata* L. TERHADAP *Periplaneta americana L.*

ABSTRAK

Pengekstrakan air *Chromolaena odorata* dinilai melalui kesan halauan terhadap *Periplaneta americana* di dalam kondisi makmal. *Periplaneta americana* telah diletakkan di dalam kotak polistirena yang telah dirawat dengan empat (4) jenis kepekatan *Chromolaena odorata* ekstrak (10%, 25%, 50% and 100% dan air suling sebagai control) diperhatikan selama 48 jam. Kesan halauan didapati melalui analisa dua hala analisa varians (ANOVA). Hubungan diantara konsentrasi dan masa tidak mempunyai kepentingan, tetapi, konsentrasi yang berbeza dan masa yang berbeza menunjukan hubungan yang baik diantara satu sama lain. Pengekstrakan menunjukan hasil yang sangat cemerlang di 100% konsentrasi dan diikuti dengan halauan yang tinggi di 50% konsentrasi akan tetapi kurang halauan terhadap konsentrasi yang lain. *Chromolaena odorata* didapati boleh menjadi potensi untuk digunakan sebagai halauan lipas. Oleh itu, ia boleh digunalan sebagai alternative produk semulajadi untuk mengawal *Periplaneta americana.*

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LIST OF SYMBOLS, UNITS AND ABBREVIATION

%	Percentage
ANOVA	Analysis of Variance
cm	Centimetre
g	Gram
kg	Kilogram
L	Litre
ml	Millilitre
^{o}C	Degree Celsius
RH	Relative Humidity
rpm	Revolution per minute
SPSS	Statistical Package for Social Science
SSA	School of Sustainable Agriculture
t	Treated area
u	Untreated area
UMS	Universiti Malaysia Sabah

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The American cockroach, *Periplaneta americana* (L.) (Dictyoptera: Blattellidae), is one of common significant pest throughout the world. Bell and Adiyodi (1981), stated that this *P. americana* was introduced to the United States from Africa as early as 1925. They are considered pest because of their uncleanly habits and bad smell. 'Peridomestic species' means that this cockroaches generally live in outdoor, however because they are so adaptable they can also move indoors and adjust to live in human structure. This cockroach can be found in a kitchen, bathroom, food storage area, floor drains, manholes sewer and all the places that are usually dark and have warm and moist area (Steven, 2002). Habits of feed things and harboring unsanitary places are the most importance aspect that they become a major pest to human. Spreading and eating variety of food supplies, dishes and utensil will give higher contamination than they able to eat. Cockroaches prefer starchy and sugary material like cheese, sugar and sweet chocolate to eat; they also feed on cardboard, books and even their own cast-off skins (Cornwell, 1968).

Liu *et al.* (2011) stated that cockroaches are major public health concern because they are able to carry a variety of bacteria and other pathogenic organisms. They disgorge portion of their partially digested food, drop feces everywhere, and discharge nauseous secretion from their mouth and gland opening on body then give offensive smell to that area (Cornwell, 1968). Some people are allergic to its feces and exuviate (Schal and Hamilton, 1990), and many people exhibit allergic response such as skin rashes, watery eyes, congestion sneezing and asthma. Indeed it has been found that cockroaches' antigen is most common in children of inner cities for asthma-inducing allergen (Aruda *et al.*, 2001; Busse and Mitchell, 2007). According to Kang (1976), asthma patients will develop asthmatic response when they inhale cockroach odours.

Pesticide is any chemical that kills, controls, drives away or modifies the behavior of a pest (Cunningham *et al.,* 2003). There are different type of pesticides and classified according to target organism such as insecticides, herbicides, fungicides and many more. Insecticides were designed to eliminate insect and can be applied to reduce the insect number around the house including cockroaches, primarily cockroaches are controlled with synthetic organic insecticide in the form of baits, foggers, aerosols, and crack treatment (Frishman, 1982; Rozendaal, 1997). However, the use of chemical control only give temporary relief, to control this cockroach it should be accompanied by environmental sanitation and house improvement (Schal, 1988). The uses of chemical product to control this pest sometimes is not a good idea, cockroaches can developed resistance toward several chemical when it is commonly used and in frequent number of treatment. Inappropriate use also can give potential short and long term risks towards the environment, for example the use of aerosol sprayer can deplete the ozone layer and contribute to global warming.

The increasing public concern over pesticide and insecticide safety and possible damage towards the environment, has resulted in increasing attention being given to natural product to control this pest (Rajendran and Sriranjini, 2008). In recent years, many researchers have focused to search for natural products those derived from plants as natural insecticide. Besides, the synthesis of repellent originated from plant may be easier and less expensive than synthesis of complex attractive semiochemicals (Shadia, 2011) thus the nonchemical insecticide contains lower residual and less effect to the environment. Essential oil is any volatile oil that contains many compounds including monoterpenoids which are responsible for aromatic criteria of the plant (Appel *et al.*, 2004).

Plant extracts has low toxicity to human and wildlife (Isman, 2006) and it can be used to replace traditional insecticide, as an excellent alternative. Plants offer alternative source of insect control agent, they contain range of bioactive chemicals and they have no harmful effect towards non targeted organisms (Shaaya *et al.,* 1997). It would be a good contact spray for insect that comes in reasonable price and also can be used as fragrance to user (Isman, 2006). The rapid action against some pest is indicative of a neurotoxic mode of action, and there are evidences for interference of neuromodulato octopamine (Kostyukovsky *et al.,* 2002) by some oils and GABA-gated chloride channels by others (Priestley *et al.,* 2003). In Malaysia, all pesticides must be registered under Agriculture Department of Malaysia on Malaysian

Pesticide Registration (PAN). Only those pesticides registered by Pesticide Board can be sold and marketed legally in Malaysia.

In this study, the focus is on one type of plant which is *C. odorata*, this plant can be classified as weed or beneficial plant. However, the family of this plant Asteraceae, is believed to contain several concentrations of pyrethrins. Pyrethrins are a group of six closely related monoterpenoid ester that natural occurring in plants important for insecticidal activity (Casida, 1980). They were originally isolated from *Chrysanthemum cinerariaefolium* (formerly known as Phyrethrum). According to Hogstad *et al.* (1984), pyrethrins is reported to present in another plants that also belong to this family such as *Chrysanthemum coccineum*, *Achillea ageratum* L., *Tagetes erecta* L., and *Tagestes minuta* L.

1.3 Justification

This study investigates the potential extraction of *C. odorata* repellent effect towards *P. americana* as alternative to replace synthetic chemical insecticide. Besides, can be controlling agent for *P. Americana,* but it also creates an economically viable and environmental friendly product to human. No study has been done previously to determine the repellent effect of *C. odorata* against *P. americana,* thus the available information about the potential repellent of this plant is limited.

1.4 Objective

The purpose of this study is (i) To determine the repellency effect of essential oil *C. odorata* towards *P. americana*. (ii) To determine the highest repellent value in the concentration extraction of *C. odorata*.

1.5 Hypothesis

H_o= There was no repellent effect of *C. odorata* extraction towards *P. americana*

H_a= There was repellent effect of *C. odorata* extraction towards *P. americana*

CHAPTER 2

LITERATURE REVIEW

2.1 American Cockroach (*Periplaneta americana* L.)

American cockroaches among the largest cockroaches pest in homes (Susan, 2008), have approximately 1.3-2.1 inches long in adult stage, flattened oval in shape, have spiny legs, and filamentous antennae that are uniformly brown and equally as long as body size (Rachel, 2010). Adult with fully developed wings can cover the entire length of abdomen and will occasionally fly. However, when being disturbed they prefer run rather than fly because they are awkward fliers. Male and female American cockroaches have about same size and look very similar. But male cockroaches have an additional set of appendages being called styli, it is located on abdomens and between cerci (finger like appendages) but smaller and more delicate (Rachel, 2010). The presence of these styli is the easiest way to distinguish male from female cockroach. Under ideal conditions an adult female can live up to 15 months while males for somewhat reason have shorter period (Steven, 2002). They can continuously mate and reproduce when conditions are favorable.

Figure 2.1 *Periplaneta americana* body structure. Source: Copyright Ondrej, Z., 2013

2.1.1 Life Cycle

Cockroaches only have three stages of life cycle: egg, nymph, and adult. The life cycle from egg to adult averages about 600 days while adult life span may be another 400 days (Bell and Adiyodi, 1981). The egg cases (oothecae) are mahogany brown to blackish brown in color, and have about 3/8 inches long. The female will carry the egg case from the tip of abdomen for another two days and drop the egg capsule within a day after it is formed. Often drop it in suitable location near the food source and protected area. The deposited ootheca contains water sufficient for the egg to develop without receiving additional water from substrate (Bell and Adiyodi, 1981). Each of capsules contains average 14 to 16 eggs and arranged in two parallel rows. One capsule usually produced every week, and each of female adult can produce 15 to 90 eggs of capsules (Steven, 2002; Susan, 2008). The egg will hatch within 38 to 49 days depending on the temperature and surrounding humidity.

When the egg hatches, the nymph stage begins. This stage end when the nymph emerges to an adult. The number of offspring per year averages is about 800 of nymph (Steven, 2002). According to Bell and Adiyodi (1981), the number of times American cockroach molts varies from six to 14. They grow in stages by repeated shedding of the cuticle or skin (Cornwell, 1968). The first instars is white in color (immediately after hatching) and turns grayish brown in time, then after first few molts it may become reddish brown. This nymph stage varies in length from 160 to 971 days. They are wingless but wing pad become noticeable in the third or four instars (Kathryn, 2008), usually they were only few millimeters long. The nymphs actively looking for food and water as well as adults, so their body weight become approximately doubles between the molts.

2.2 Cockroach as Disease Transmitter

Many studies established that cockroach is one of the pest that can transmit bacteria organism through their legs, salivary secretions and droppings (Collin, 2010). It also may become independent risk factor for allergic asthma (Opender, 2008). An experiment has been tested on asthma patient whom are allergic to cockroaches, when extract of cockroach is applied in their skin, they developed asthmatic response after inhalation of extraction (Kang, 1976).

It can be reduced by managing cockroach infestation and exposure toward allergens. (O'connor and Gold, 1999). The amount of cockroach allergen can be measured in the house, allergen particle are large and settle rapidly on surface. It becomes airborne when the air is stirred by people moving around or children at play. Asthma is difficult to control; make an effort to keep home free from roaches and reduce the exposure although cannot change the allergic tendencies.

Cockroaches eat wide range of food including rotting garbage, it is believed that the cockroach may be reservoir for a range of bacteria including salmonella, staphylococcus and streptococcus. It also can harbor viruses such as polio virus (Rachel, 2010). Ingestion of bacteria from the food spill of cockroach can withstand and survive in digestive system in a very long period of time. The cockroach represents one of the most common sources of aeroallergens in Korea and around the world. Current evidence suggests that the exposure to cockroach allergens is important in causing sensitization to these allergens (Myung and Kim, 2012).

2.3 Cockroach Control

Most people widely used synthetic chemical insecticide and fumigants to control the cockroach. Dust such as boric acid, silica acrogel, and diatomaceous earth can be applied to avoid other harborages such as crack and crevices (Steven, 2002). While the use of spray or aerosol fogger within a structure has little value to control this roaches, this application may disperse cockroach and become difficult to control, this application only can be used for temporary controlled.

Although the uses of chemical insecticide have long lasting protection, it may give side effect. The uses of insecticide can contaminate unintended land and water. So, the control of cockroaches should be accomplished by IPM practice or by using non chemical product which is natural and more environmental friendly that is save to be consumed. IPM is a system approach that combines nonchemical strategies and target placement of pesticide with preference for product that are least harmful to human health and environment. It consist routine inspection and monitoring (Susan, 2008). Besides, it concern over health implication from the use of residual and broad insecticide treatments, which usually been used for alternative method. Repellent may play a very important role in some situation and place that insecticide are not able to be use (Nalyanya *et al.,* 2000).

2.4 Integrated Pest Management (IPM)

Cockroaches could not be controlled only by using insecticides; it must come along with a good practice management to inhibit the reproduction and growth of cockroach. First practice is prevention, eliminate any debris that can provide hiding place for cockroach, then install dehumidifier to inspect incoming items that could attract the cockroach. Make sure the building is in tight physical condition to reduce entry. Second is good sanitation, adopt cleaning standard that daily reduce the amount of available garbage, food and water that can start the infestation. Then, continuing the inspection and routine monitoring as often as possible.

2.5 Natural Insect repellent

Repellent is more desirable chemical because it gives protection with minimal impact on ecosystem, although the uses are not vigorously as chemical products, it is ensured safe to people and food intake. One of the natural products is essential oil that derived from plant. This repellency of plant material has been exploited for thousand years by man, simple example by hanging bruised plants in house to repel pest, this practice is still in wide use throughout the developing countries (Moore *et al.,* 2006).

For centuries plant is used based on form of crude fumigant, where that plant is burned away to drive nuisance of mosquito. First record oil formulation that applied to skin or cloth is on ancient Greek, Roman and Indian scholars writing (Herodotus, 1996; Owen T, 1805). Indeed, plant based repellent is still widely used traditionally through rural communities to protect from mosquito bites.

The discovery of new plant based repellent is heavily rely in ethno-botanical study. This target search for medicinal plant through interview with rural people and evaluation of experimental design for identification of potential use plants on repellent. Many commercial repellent on market contain a number of plant essential oils, it is used either for fragrance or using as repellents. The plant includes peppermint, lemongrass, geraniol, pine oil, pennyroyal, cedar oil, thyme oil and patchouli. Repellent that contained only essential oil in absence of an active ingredient such as DEET should not be recommended as repellent, high level of essential oils can cause skin irritation, especially when it is vaporized in sunlight. DEET may be unsafe for children because it has possible to cause encephalopathy to the kids (Abdel Rahman *et al.,* 2001).

Active chemical compound in plant that can repel insect varies according to insect species and plant secondary metabolites itself. Moreira *et al.* (2007) found that three insect pest species have repellent activity on present of coumarin compound in plant. Flavonoid also possesses a catercholic B-ring that seems to be responsible for the toxicant activity to insects (Onyilagha *et al.,* 2004). A slowly developing paralysis is major feature on insect poisoning by coumarin (Nicholson and Zhang, 1995). Besides, it closes parallels with botanical insecticide rotenone, antimycin, hydramethlnon which block the airflow in respiratory process if contact. Other than that, surangin B also is a potential inhibitor, they produce a significant reduction of energy and may disrupt a muscle function on insect. Surangin B also has a potential to release biotransmitter centrally in insect (Nicholson and Zhang, 1995).

This group of compound reported as anti-feedant and growth inhibitor to insect probably for their interference in hormone mechanisms (Onyilaga *et al.,* 2004). However, very little is known about the receptors responsible for the repellent response in cockroach, but oleic acid and linoleic acid have been indicated in death recognition and death aversion (repellency) in cockroach. EcoSMART technology has produced essential oil product based on cinnamon oil with cinnamaldehyde as active ingredient, and it has bring essential oil based pesticide in American market in short period of time. That product is aimed to control domestic pest such as cockroach, ants, flies and many more.

Terpenoid is also an active chemical compound that can get rid of pests, the main component is monoterpenoids and sesquiterpenoids that contribute to distinct scent of plant. Sterol is complex terpenoid which has become precursor to essential hormone in plant. Some saponin is toxic to cold blooded organism like insect in specific concentration. Glycoside also will stimulate the heart and causes gastric disease. Alkaloidis also used to interfere insects' nerve impulses in insecticide, the present of alkaloid in essential oil can use to repel the pest, but if in high concentration it has limited use because of high toxicity in human.

Because of many essential oil product will not last longer when vaporized, many researchers have demonstrated improved repellency of plant-derived topical repellency product after formulating with a base or fixative materials, such as vanillin, salicyclic acid, and mustard and coconut oils (Stuart *et al.,* 2000; Tawatsin *et al,* 2001; Das *et al,* 2003).

2.6 *Chromolaena odorata L.*

Plant species *Chromolaena odorata* (L.) King & Robinson that belongs to family (Asteraceae, Eupatorieae) also formerly known as *Eupatorium odoratum* L. These plants grow wild in different geographic locations. It is also known as Siam Weeds and locally called as aeroplane plant in Malaysia. *C. odorata* is a major weed in Africa, India, Sri-Lanka, South East Asia, Australia and its native land (Oriebee, 2012). *C. odorata* has two noticeable growth habits; the first is bushy habit and second is creeping habit which mostly observed in South Africa. Perennial shrub that has 1.5-2.0 m in height and has dense tangled bushes which reached 2cm diameter of stem, it may have 20 or more stems of varying size and often bent under the weight of their branch, it can shade 3.5m^2 of ground area (Howard, 1989). While creeping habit often reach the top of canopy while climb nearby vegetation, it can up to 25m in height if have higher light intensity there (Sandberg, 2000).

This plant is maintained by system abundant, yellowish, fine lateral roots, multiple sprouts arise from the root crowns and lower stems. Foliage occurs only on recent growth and the leaves are aromatic when crushed, it has brownish gray to black seeds with 4 mm length (Howard, 1989). Sexual reproduction is first initiated when the plant is one year old, white or pale bluish-lilac is the colors of their flower. Flowering initiation appears to be mainly related to the onset of the main dry season (Binggeli, 1997). The small fruit weight is about 0.2mg can mature within a month, it is typically wind dispersed as dry and windy weather for fruit release. When flowering is over, most of the leaves will fall then new shoot grow from old leaf axils (McFadyen, 1988). The maximum lifespan of *C.odorata* plant cannot be identified (McFadyen, 1988).

Figure 2.2 Leaves of *C. odorata* plant. Source: Oriebe, 2012.

2.6.1 *Chromolaena odorata* as a Weed

In most invaded countries, this aggressive pioneer shrub give very serious threat to agriculture and environment. It is been classified as alien invasive weed because it has higher rate of survival from the origin of its country and it is successfully naturalized in new environment. The high productivity of light seed allows this species to invade and disturb any site in a short period of time (Swaine *et al.,* 1997). The height gained by clambering habit may also facilitate more efficient wind dispersal of the seed. Many characteristic such as quick germination, form dense woven canopy and have a fast growth rate have caused those researchers to recognize and decide that *C. odorata* is a serious weed in countries where it grows. It is also considered as a considerable threat to conservation and ecotourism as it has invaded natural area and reducing biodiversity of grasslands, savannah and forest (MacDonald, 1983).

C. odorata possesses an underground organ at the base of the stem and considerable starch reserves in the crown which might ensure the plants survivability through fire, drought, or mechanical damage such as coppicing (McFadyen 1988; Binggeli, 1997). Oriebe (2012), stated that this plant have the ability to grow successfully in any type of soil because it is a perfect competitor hence suppress the growth of any other plant, in other hand, Crutwell (1972) overstated that *C. odorata* prefer well-drained soils and tend to die under waterlogged conditions, but it grow best in sunny, open area such as roadside, abandoned fields, pasture and disturbed forest. Because of the perfect environment in other country, this plant can become invasive weed and invade a new area.

Besides, breeding habitat of *Crocodylus niloticus* which is Nile crocodile in South Africa has been found treated by *C. odorata*, this plant claim to decrease the temperature of nesting by shading and crowding the sites. It also can induce female biased sex ratios or may even prevent embryotic development altogether (Leslie and Spolita, 2001). According to Susan (2008) this plant also gives problem to commercial tree plantation when it suppresses the growth of young pine and eucalypt tree and allows fire to penetrate deeper into plantations. Prashanti and Kulkani (2005), reported that there is urgent need to manage weed growth and its spread, to maintain ecological integrity habitats. It was found that the introduction of natural enemies could control this plant.

2.6.2 Usage and Advantage

C. odorata is a type of plant that can be classified as weed or beneficial plant. Their uses towards medicinal purpose could not be doubted since ancient time the uses for healing activity is excellent, until many research has been done to test the chemical content in this plant. It has been used traditionally for medicinal properties especially external uses in wound, skin infection, inflammation (Binggeli, 2013) it also could be used as local antiseptic agent (Adjanohoun and Ake, 1979).

Leaf extract with salt is used to gargle for sore throat and colds. It is also used to scent aromatic baths (Liogier, 1990). Caceres *et al.* (1995) found that the extract of *C. odorata* can inhibit or kill *Neisseria gonorrhoeae* bacteria that cause gonorrhea on in vitro, besides this extraction also can accelerate blood clotting. Other than that, the fresh extract has been used as treatment of malaria in Ghana and Benin (Ayensu *et al.,* 1978).

In cultivation of plant, the uses of organic matter that contain aeroplane plant can reduce the nematodes' population in soil (M'Boob, 1991). It is also useful as mulch for row crops (Swennen and Wilson, 1984). Farmers in the Niary valley claims that *C. odorata* can improve soil fertility, as seen it increased peanut productivity in their farm. This observation was confirmed by Madembo and Ekonamine (1993) which these plants inhibit the development of *Imperata cylindrica* and shorten the period of fallow land in Kombe and Niori valley from 6-7 year to 3-4 years only.

2.6.3 Secondary Metabolites

The phytochemical screening revealed that *C. odorata* is highly rich in saponins, moderately rich in phytates and tannins, with little content of alkaloids, flavonoids (aurine, chalcone, flavones, and flavonol) and cyanogenic glycosides (Igboh *et al.,* 2009). Steroid, terpenoids also present in extraction of this plant.

C. odorata essential oil has enhanced insecticidal insect repellent (Cui *et al.,* 2009) and antibacterial activities. Although no research has been done to find the repellency of cockroaches toward this plant, certain chemical in this plant is believed useful to repel the cockroach such as alkaloid, flavonoids steroid, saponin and glycoside. The family of this weed also has certain chemical compound name pyrethrin that being used for repel pest in long time ago, however the present pyrethrin in *C. odorata* cannot be identified yet.

2.7 Pyrethin

Pyrethrins contain in *Chrysanthemum cinerariaefolium* from family Asteraceae. Commonly called asphyrethum because the presence of chemical compound named pyrethins that belongs to group Pyrethroids. This active compound is very important to become insecticide active ingredient that included Cinerin 1 (5.1%), Cinerin 2 (2.5%), Jasmoline 1 (2.5%), Jasmolin 2 (2.4%), pyrethrin 1 (19.9%), pyrethrin 2 (15.3%) (Essig and Zhao, 2001).

About 200,000 kg of pyrethrins are used as an insecticide each year (Crosby, 1995). Pyrethrins are generally effective insecticide that displays low toxicity to mammals and breakdown quickly under environment condition such as sunlight (Chen and Casida, 1969). However, the uses of synthetic pyrethroids are not approved in organic productions. Pyrethrins work in affecting the nervous system of insect by causing multiple action of delaying the closing of an ion channel (Costa, 1997).

Pesticide products containing pyrethrin usually contain synergist (piperonyl butoxide). Insecticide that contains pyrethrin is the least poisonous to mammal (Ray, 1991). It is proven by experiment with rat that feeds with high dosage of pyrethrin and resulted only liver damage. The exposed rat to pyretrin showed difficulty in breathing and become more exhaustion (Hayes, 1982). From the experiment, it conclude that pyrethrin compound is low toxicity to human and other mammal such as cat and can be used as bio-insecticide which may replace chemical insecticide in future.

Recently, many pyrethrum products become widely important in the market. The fast acting contact poison can knock down susceptible insect and lead to paralysation (Casida, 1973). It is commonly used to control household pests like mosquitoes and flies. However, according to Moreira *et al.* (2007), it only has little residue effect so it is effective in flushing cockroaches out of hiding area when used as contact sprayer. Unlike resmethin (synthetic pyrethrins) it has more and good residual effect so that it gives effective flushing out from hiding area.

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