International Scholars Journals

International Journal of Pharmacy and Pharmacology ISSN: 2326-7267 Vol. 2 (8), pp. 001-004, August, 2011. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Contact toxicity of some fixed plant oils and stabilized natural pyrethrum extracts against adult maize weevils (*Sitophilus zeamais* Motschulsky)

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Accepted 21 March, 2011

The contact toxicity of some selected fixed plant oils and stabilized natural pyrethrum (*Chrysanthemum cinerariaefolium*) blends against adult maize weevils (*Sitophilus zeamais*) were investigated. Natural pyrethrum extract was stabilized against ultraviolet (UV) light by blending with fixed oils extracted from *Azadirachta indica* A. Juss (neem tree), *Thevetia peruviana* (yellow oleander) and *Gossypium hirsutum* L. (cotton) seeds. Cottonseed oil had the highest stabilization effect on the pyrethrum blend exposed to UV light of 366 nm. The results indicated that the natural pyrethrum extract blended with cottonseed oil was the most potent against maize weevils and that the potency was concentration-time dependent. Cottonseed and neem seed oils enhanced the stabilization of the natural pyrethrum insecticide.

Key words: Contact toxicity, maize weevils, ultraviolet light, natural pyrethrum, cottonseed oil.

INTRODUCTION

Pyrethrins are insecticides that are derived from the ex-tracts of chrysanthemum flowers (Klaassen et al., 1996). The active ingredients are a group of insecticidal esters called pyrethrins, namely pyrethrin I, pyrethrin II, cinerin I, cinerin II, jasmolin I and jasmolin II. Pyrethrin I, cinerin I and jasmolin I are esters of chrysanthemic acid which differ from one another only in the side chains attached to the cyclopenterolone ring. Pyrethrin II, cinerin II and jasmolin II are similarly related and are esters of pyrethric acid. Along with the pyrethrins, most insecticide products contain a synergist whose role is to amplify the chemical activity of the other compounds in the formulation. Syner-gists are used so that smaller quantities of the active ingredient can be used. It has also been suggested that vegetable oils act as synergists in bio- pesticide formulations(Tembo and Murfitt, 1995).

The maize weevil (*Sitophilus zeamais* Motschulsky) poses a serious threat to food security, particularly in developing countries. This has led to bioprospecting for effective pesticides. Extracts from *Lantana camara* L, *Tephrosia vogelii* Hook (Ogendo, 2000), *Aristolochia ringens* Vaal, *Allium sativum* L, *Ficus exasperata* L, *Garcinia kola* H (Avannilewa et al., 2006), essential oil from *Vernonia amygdalina* (Asawalam et al., 2006), and ashes of certain medicinal plants (Christopher and Francis, 2007), have been reported to be toxic against adult maize weevils. However, these plant-derived pesti-cides are not economically viable at present compared to the broad spectrum natural pyrethrum which is readily available in the world market (Robin, 1991). Furthermore, the pyrethrins have the advantages of low mammalian toxicity and low environmental hazard (Ray, 1991; Sithig et al., 1991) when compared to other pesticides. Despite their environmental safety record, selectivity, effectiveness

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and availability in the world market, natural pyre-thrins (and synthetic pyrethroids) are not photostable. A stabilized formulation can be developed by adding certain additives that protect the insecticides from artificial or solar radiation. Rappaport et al. (1982) reported stabilization effect of natural and synthetic pyrethrins when 1% of mixed diaryl-p-phenylenediamines in an aromatic solvent was added. Pyrethrins have also been stabilized by mixing with triglycerides derived from vegetable oils (Puritch et al., 1995) and natural plant compounds such as tannic acid and hydroquinone (Jovetic et al., 1994). It is reported that insecticide resistance to insects is less likely to occur when botanical insecticides are used (Isman, 1997). The objective of the present investigation was to study the bio-efficacy of stabilized natural pyrethrum extract with neem (*Azadirachta indica* A. Juss), cottonseed and yellow oleander (*Thevetia peruviana*) oils against maize weevils (*S. zeamais* Motschulsky). These plant oils have been reported to possess insecticidal properties (Mclaughlint et al., 1980; Jamie et al., 2002); cottonseed (*Gossypium hirsutum* L) oil has been reported to suppress *Cryptolestes pusillus* and *Rhyzopertha dominica* in maize and sorghum (Obeng-Ofori, 1995). Hence pyrethrum-botanical oil blends could be more effective insecticides compared to pure pyrethrum based insecticides.

MATERIALS AND METHODS

Botanical oils and solvents

Isopropyl alcohol and acetone used for dilution were purchased from Merck, Germany. The natural pyrethrum extract (25% v/v pyrethrins) was purchased from the Pyrethrum Board of Kenya. The extract was refrigerated in dark plastic bottles. Dry neem seeds were bought from Neem Africa Ltd in Mombasa, while yellow oleander seeds were collected from JKUAT farm. Oils from neem and yellow oleander seeds were obtained by mechanically pressing the dry seeds. The oils were refrigerated in tightly sealed dark plastic containers till needed. Cottonseed oil was purchased from Juanco SPS Ltd, Nairobi.

Sitophilus zeamais Motschulsky

Adult maize weevils (*S. zeamais* Motschulsky) were obtained from the Zoology Department, Jomo Kenyatta University of Agriculture and Technology. They were bred, reared and kept under laboratory conditions, on a diet of maize seeds in a chamber maintained at 27 ± 2ºC.

Preparation of test solutions

Natural pyrethrum extract, neem and yellow oleander oils were diluted with acetone to make 2, 4 and 6% (v/v) solutions. Solutions of 1% pyrethrum extract were made containing 1, 2 and 3% cotton seed, neem and yellow oleander oils by using isopropyl alcohol as solvent for the botanicals. The pyrethrum extracts blended with botanical oils were each exposed to UV light at 366 nm for 4 h.

Insect bioassay: Direct toxicity by dipping method

The insect bioassay was carried out by the dipping method as described by Rahman et al., 2003. Five adult insect weevils were placed at the centre of a filter paper. The filter paper was twisted to enclose the weevils. The weevils were dipped into the test solution for 10 s. The insects were removed, air-dried and placed into a Petri dish containing 10 gm of maize grains. Mortality was observed at 24, 48 and 96 h for each experiment. Insects were examined daily and those that did not move or respond to gentle touch were considered dead. The experiment was done in triplicate for each test solution. Mortality of weevils was reported for the botanical oils and the natural pyrethrum blends exposed to UV light at 366 nm. Acetone solvent was used as a control. Data obtained was statistically analyzed using ANOVA (single factor).

RESULTS AND DISCUSSION

The toxicity of natural pyrethrum, botanical oils and pyrethrum blends was reported in Figures 1 and 2. There was a general increase in cumulative insect mortality with an increase in the concentration of the pyrethrum extract and the fixed oils from neem and yellow oleander bet-ween the first and the fourth day of the bioassay. The activity of neem oil was comparable to that of natural pyrethrins at concentrations of 4 and 6%. But yellow oleander oil exhibited the least contact activity against the maize weevils among the three botanical extracts (Figure 1).This was despite the reported potency of yellow oleander oil against the European corn borer, *Ostrinia nubilalis* (McLaughlin et al., 1980).

The highest insect mortality was observed on the third and fourth days, when 6% of the botanicals were used. This increase in activity could be attributed to the increasing concentration of the botanical oils. The cumulative weevil mortality was due to the residual effect of the botanical extracts on *S. zeamais* Motschulsky. A number of botanical oils and extracts have been found to be potent against adult weevils *S. zeamais* in a concentration dependent manner (Ogendo, 2000; Asawalam et al., 2006; Avannilewa et al., 2006). But residual toxicity has a capacity to affect the food chain. This necessitates further investigation of the plant biopesticides to ensure food safety.

Natural pyrethrum extract blended with cottonseed oil exhibited the highest mean mortality against the adult maize weevils. This implied that cottonseed oil had the highest stabilization effect on natural pyrethrum among the botanical oils used (Figure 2a). On the other hand the stabilization effect of neem oil generally increased with concentration in the insecticide blend (Figure 2b), however, oleander oil had moderate stabilization effect, which decreased with the amount of oil added to the insecticide.

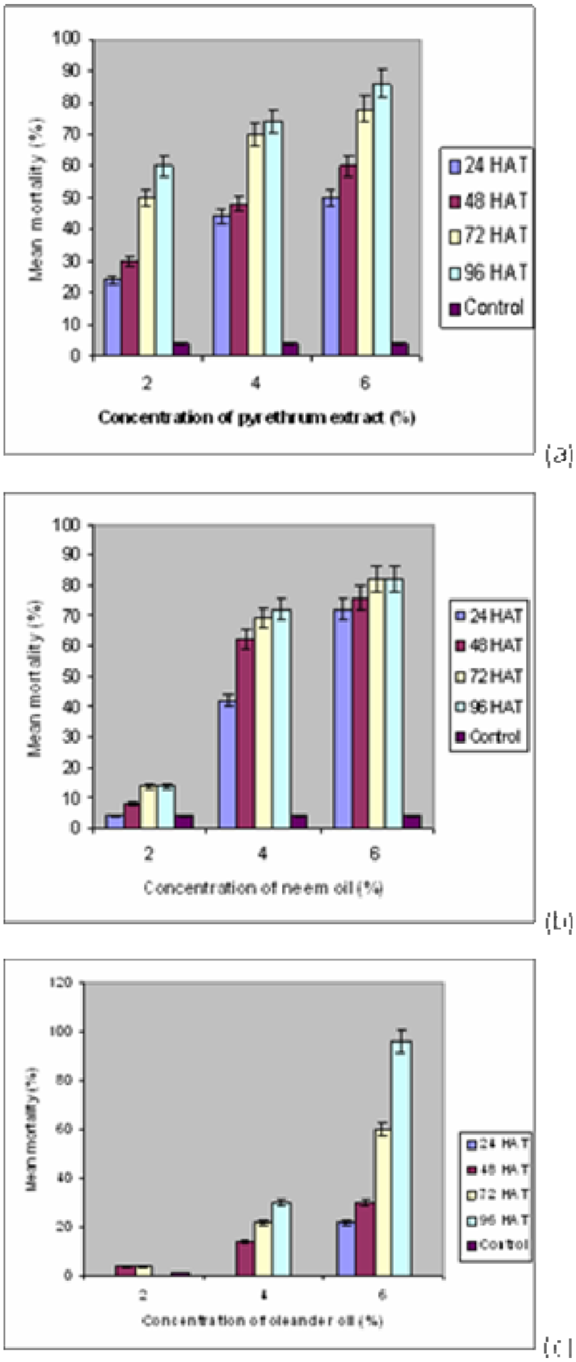
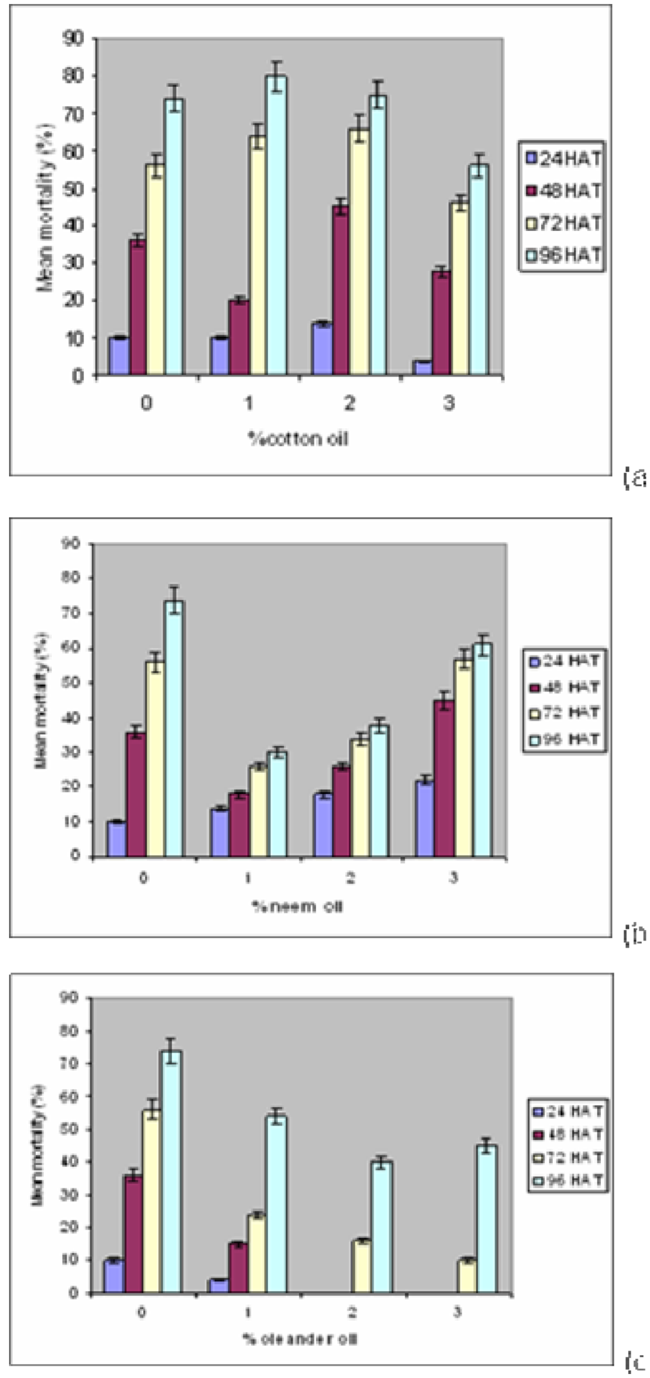


Figure 1. Toxicity of natural pyrethrum and botanical oils against maize weevils (*S. zeamais* Motschulsky). *HAT – hours after treatment.



toxicity of the latter blend was highest at a concentration of 1% in the second and third day of treatment (Figure 2c). The botanical oils stabilization effects were statistically different at 24 ($p = 0.006$) and 72 ($p = 0.015$) h of UV exposure, but statistically not different at 48 ($p = 0.64$) and 96 h ($p = 0.071$).

There was a possibility that botanical oil extracts not only stabilized pyrethrins but also worked in synergy with natural pyrethrum to increase its potency. This was particularly observed with the potency of cottonseed and neem oils when blended with natural pyrethrum extracts

(Figures 2a and 2b). Cottonseed (*G. hirsutum* L) oil has been reported to suppress *Cryptolestes pusillus* and *Rhyzopertha dominica* in maize and sorghum (Obeng-Ofori, 1995). Furthermore, synergism contributed by vegetable oils in bio-pesticide formulations (Tembo and Murfitt, 1995) may contribute to the enhanced activity of some pyrethrum blends investigated.

Conclusions

Pyrethrum extracts stabilized with cotton and neem oils showed a marked increase in bio-efficacy against the maize weevils while the yellow oleander seed oil had a moderate stabilizing effect on the pyrethrum insecticide.
Cotton seed oil, however, had the highest stabilizing effect on the pyrethrum extract compared to the other botanical oils.

ACKNOWLEDGEMENT

The authors acknowledge the funding of their research by Juanco SPS Ltd. Special thanks goes to Paul Karanja, Food biochemistry laboratory, JKUAT for his technical assistance. Thanks to Dr. Peter Njenga for providing adult maize weevils used in this experiment.

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