

Bioactivity of *Tithonia diversifolia* (Hemsl), *Tagetes erecta* L. and *Lantana camara* L. against Grain Storage Pests *Tribolium castaneum* (Herbst)

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Introduction

According to the viewpoint of economists, farmers have an opportunity to take advantages of seasonal price rises, but the benefits can only be achieved if grain is held longer on the farm with no deterioration in quality. Then it appears the necessity of post harvest management. Post harvest deterioration of grains is principally caused by biological spoilage organisms including insects, fungi and small vertebrates (Golob *et al.*, 2002). Control of these insects relies heavily on the use of synthetic insecticides and fumigants. But their widespread use has led to some serious problems including development of insect strains resistant to insecticides, toxic residues on stored grain, toxicity to consumer and increasing costs of application (Jbilou *et al.*, 2006; Golob *et al.*, 1999). Thus, several of natural plant extracts had been tried in the control grain storage pest insects with the view of advantages such as local availability, little or no toxicity to humans and simple preparation procedures (Okigbo *et al.*, 2009).

The present study was undertaken to analyze the insecticidal activity of *Lantana camara* L., *Tagetes erecta* L. and *Tithonia diversifolia* (Hemsl) with the aim of development of plant base insecticidal fumigants to apply on grain storage pests. These are underutilized plants in Sri Lanka which are heavily used in conventional farming to eliminate insects. Also they have been shown to have repellent and insecticidal activities against certain insects (Adedire *et al.*, 2004; Nikkon *et al.*, 2009; Ogenido *et al.*, 2004). Insects, red flower beetle, *Tribolium castaneum* (Herbst) is considered as a major pest of stored grains (Jbilou *et al.*, 2006).

Materials and methodology

Fresh leaves of *T. diversifolia*, *T. erecta* and *L. camara* and flowers of *T. diversifolia* were collected from Badulla area and plants were confirmed for the identification by the Herbarium, National Botanic Garden, Peradeniya. Adult insects *Tribolium castaneum* were collected and introduced to a ventilated container containing wheat flour. After 24 hours, adult insects were removed and allowed to incubate. Insect culture was maintained in the ventilated container containing wheat flour.

Part of the collected plant materials were shade dried for seven days. Both fresh and dried leaves and flowers of *T. diversifolia* were extracted in to absolute methanol and fresh and dried leaves of *T. erecta* and *L. camara* extracted in to absolute ethanol by shaking the plant materials with solvent at room temperature for 72 h. Plant material: solvent ratio was maintained at 1 g : 5 mL. Each extract was evaporated, by rotary evaporator at or below 40 °C to obtain crude extracts.

Bioassay for mortality and repellency was conducted with two factor factorial design. 7.0, 10.5 and 14.0 mg of crude extracts were taken and dissolved in a 1 mL of extracting solvent. Solutions were introduced to 5 cm diameter Petri dish and air dried at room temperature to remove solvents leaving extracts on the plates in doses (weight of the extract/surface area) of 350, 525 and 700 µg/cm². Ten randomly selected adult insects of

age 90 days were added to the Petri dishes and air tied using Para films. Dishes with solvent but without extracts were maintained as the negative control. Observations for mortality and repellency were taken at 24, 48 and 72 hours (Nikken *et al.*, 2009). Motility percentages were reexamining at a randomly selected concentration series and using logit probit analysis median lethal doses (LD₅₀) values were calculated.

Statistical analyses were performed using Minitab Statistical Package and SAS Statistical Package.

Results and discussion

Mean mortality (M%) and repellency (R%) percentages with different type of plant crude extracts at 24 h exposure time (Table 1) indicates that there is a 100% repellency in most of the test samples. In control dishes there was no any mortality found even without food and air supplement. There is a gradual increment in the mortality percentage along with the concentration. ANOVA analysis on the results indicates there is a significant interaction effect of concentration and crude type to the mortality rate ($p < 0.05$). Further, the motility percentage is increased with time according to the observations at 48 and 72 h.

The highest mortality values were shown by crude extract of *T. diversifolia* dry leaves with the resulted mean mortality percentages of 90 %, 95 %, 95 % at 350, 525 and 700 $\mu\text{g} / \text{cm}^2$ doses, respectively. Also there is a considerable insecticidal activity of crude extract of *T. diversifolia* fresh flowers. Tukey mean comparison ($p < 0.05$) confirmed, these two crude extracts as the highest active among the studied crude extracts and Dunnett Test ($p < 0.05$) proved that there were no other effective extracts compared to best selected types. Thus, these two were selected for further analysis of LD₅₀ values.

Table 1: Mean mortality (M%) and repellency (R%) percentages with different type of plant crude extracts at different dose levels after 24 h exposure time.

Crude extract			Mortality (M%) and repellency (R%) at different doses					
			350 $\mu\text{g}/\text{cm}^2$		525 $\mu\text{g}/\text{cm}^2$		700 $\mu\text{g}/\text{cm}^2$	
Plant	Plant part	Fresh/ Dry	M (%)	R (%)	M (%)	R (%)	M (%)	R (%)
<i>T. diversifolia</i>	Leaves	Fresh	15	100	65	100	80	100
		Dry	90	100	95	100	95	100
	Flowers	Fresh	70	100	90	100	100	100
		Dry	30	65	75	100	85	100
<i>T. erecta</i>	Leaves	Fresh	0	100	25	100	40	100
		Dry	25	100	50	100	60	100
<i>L. camara</i>	Leaves	Fresh	0	100	20	100	95	100
		Dry	10	75	75	100	45	100
Negative control - Methanol			0	0	0	0	0	0
Negative control - Ethanol			0	0	0	0	0	0

Based on the mortality values at twenty randomly selected concentrations of crude extracts (between 100 and 350 $\mu\text{g} / \text{cm}^2$) Logit Probit analysis results the LD₅₀ of crude extracts of *T. diversifolia* dry leaves as 209.17 $\mu\text{g} / \text{cm}^2$ and fresh flower as 253.15 $\mu\text{g} / \text{cm}^2$.

These results indicate the high bioactivity of underutilized plant species, wild sunflower or tree marigold, *T. diversifolia* and the potential agricultural and industrial applications via the development value added products.

Conclusions

Lantana camara L., *Tagetes erecta* L. and *Tithonia diversifolia* (Hemsl) have good insecticidal activity. Both flowers and leaves of *T. diversifolia* have high insecticidal activity and can be used in the control of *T. castaneum* in pest management system. However, more studies should be carried out to isolation of bioactive compounds as well as for field trials, followed by the development of insecticidal fumigant.

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