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Common Medicinal Plants as Repellents against Stored Grain Insects- *Sitophilus oryzae* and *Tribolium castaneum*

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I. Introduction

Plant powders were traditionally used as grain protectants (Isman, 2000, rajasekhar et al, 2012). The mode of action of plant powders may vary but with low to moderate dosages, the effect is repellant or toxic (Rajapakse, 2006). Salvadores et al(2007) showed that powders of *P.nigrum*, *Cinnammomum annum* and *Cinnammommum zeylanicum* had a repellent effect on *Sitophilus zeamais*. In the study, at higher concentrations 100 percent mortality was achieved. Roots of *Inulara cemosa* showed high repellence to *Sitophilus oryzae* and also had strong insecticidal activities against the weevil (Liu et al, 2006). The use of plant powders is the simplest method of grain protection. However, extracting plant material with an appropriate solvent usually results in the concentration of the ingredients. These extracts are generally mixed with the grains in a liquid form, from which the solvent is evaporated completely before storing. Aqueous extract of *Lantana camara* was found to reduce infestation of tea leaves by the tea mosquito bug *Heopellis theivora* (Deka et al, 2001). Organic plant extracts are also reported to be effective against insects. In a study, among petroleum ether, acetone and ethanol extracts of turmeric used, acetone extracts was reported to act as the best repellent and growth inhibitor against *B.zonata* (Siddiqui et al, 2006).

Sitophilus oryzae L. and *Tribolium castaneum* H. are serious pests of stored grains having a worldwide distribution. Both larval and adult stages of the insects are destructive to stored products. The present study examines the repellency and toxicity of four common medicinal plants and a fern namely *Lantana camara, Hyptis sauveolens, Citrus medica, Aegle marmelos* and *Lygodium flexosum* against the two stored grain pests.

II. Materials And Methods

Sitophilus oryzae

Sitophilus oryzae is commonly known as rice weevil. It is a very serious major pest of stored rice and other cereals in the warmer parts of the world. The rice weevil is a small dark brown weevil with a long snout. The female weevil bores a tiny hole in the grain kernel and deposits an egg inside. The adult weevil emerges from the pupa and cuts an exit hole to emerge. Sometimes the adult lays eggs in the surface of the grains and the larvae can be seen outside the kernels. In rice the entire grain is usually destroyed by the time the adult emerges.

Tribolium castaneum

Tribolium castaneum is commonly known as red flour beetle. It is a worldwide stored product pest. Red flour beetles have chewing mouthparts, but do not bite or sting. Red flour beetles attack stored grain products causing serious damage. The beetle life cycle lasts about three years or more. The female flour beetle lies about 300-400 eggs during its life cycle. The beetles give off an unpleasant smell, and their presence encourages mould growth in flour.

Medicinal plants used for the study

L. camara, H. sauveolens, C. medica, A. marmelos, L.flexosum, plant leaves have collected and prepared the leaf powder and also aqueous and ethanol extracts were made from these powders using distilled water and ethanol as solvents.

Culture of insects

Adults from the stock culture were collected and deposited in separate culture bottles and kept for 2-3 days, so that the insect may lay eggs. After three days the adults were removed and the culture bottles were kept in the laboratory. The adults that emerged from the eggs in the culture from this bottle were considered as newly emerged. These newly emerged adults were used to study the repellent activity of plant powder and plant extracts.

Treatments with Improvised apparatus

An apparatus was designed with some modifications (Prakash and Rao, 2006) to study the adult deterrence. Materials used to make the apparatus were a plastic container; two plastic plates and seven glass beakers.The feed were taken in the glass beakers. In six beakers feed was mixed with the leaf powders and one beaker in the centre was kept vacant without adding either feed or leaf powder in it. The experiment was conducted in such a way that different concentrations of the leaf powders were tried at the same time or same concentration of the different plants was tried at the same time. 40 newly emerged adults were deposited in the middle beaker and the lid kept closed. The changes in the set up was analysed at particular intervals i.e. 1, 2, 3, 4, and 24 hours.

Calculation of percentage repellency:

Percentage repellency was calculated by the method described by Laudani et al. (1955):

Repellency = $[C - T] \div [C] \times 100$

Where T = mean number of msects on treated beaker; C = mean number of insects on control beaker Percentage repellency of the insects against different plant extracts at different concentrations has been observed. It was clear that both the insects, *S.oryzae* and *T.castaneum*, showed repellency against all the five plant powders. There was no significant difference in the percentage repellence among the insects i.e in the plant powders against *S.oryzae* and *T.castaneum*. At all the doses tried the repellency reached above 60%. It reached up to 95 % in certain doses.

Sac method

Cloth sacs were made and they were soaked in liquid aqueous extracts of various concentrations (5%, 6%, 7%, 8%, 9% and 10%) and allowed to dry. Then the 20gm feed (raw rice and wheat flour) and 10 adult insects each were deposited in the sac and the mouths of the sacs were tied with thread. The experimental set up were kept for seven days and observed every day up to 7 days. Control was also prepared in the same way. Instead of soaking the sacs in aqueous extracts the sacs used for control set up was soaked in distilled water and allowed to dry. 5 replicates each were kept for control and experimental set up.

III. Observation And Results

Repellency in *S.oryzae* when treated with different leaf powders

The percentage repellency was 80% at the doses 5%, 6%, and 7% of *L.camara* leaf powder while it was 75%, 70% and 72% respectively at the doses 8%, 9% and 10%.

The percentage repellency was 75% at the dose 5% and it was 76% at the dose of 6% of *H.sauveolens* leaf powder. The repellency rate in *S.oryzae* reached 70% when treated with 7% dose leaf powder of *H.sauveolens*. The treatment of 9% and 10% dose of *H.sauveolens* resulted in the percentage repellency as 72% and 68% respectively.

The percentage repellency was 75% at the dose 5% of *C.medica* leaf powder while it was 80% when treated with 6% dose of *C.medica* leaf powder. The repellency rate was 70% when treated with 7%, 8%, 9% and 10%.

The repellency rate of *S.oryzae* when treated with the 5% dose of *A.marmelos* leaf powder was recorded as 73%. When the *S.oryzae* were treated with the 6% dose of *A.marmelos* leaf powder the repellency rate was 66%. The repellency rate was 70% when treated with the 7% and 9% dose leaf powder of *A.marmelos*. The repellency rate of *S.oryzae* when treated with 8% dose leaf powder of *A.marmelos* was observed as 72%. The repellency rate was observed as 68% when treated with the 10% dose leaf powder of *A.marmelos*.

The repellency rate in *S.oryzae* was 70% when treated with the 5% dose leaf powder of *L.flexosum*. When the *S.oryzae* adults were treated with 6% and 8% dose leaf powder of *L.flexosum* the repellency rate was 72%. The repellency rate was observed as 73% when treated with the 7% and 9% dose leaf powder of *L.flexosum*. The repellency rate was 70% when treated with the 10% dose leaf powder of *L.flexosum*.

Repellency in T.castaneum when treated with different leaf powders

The percentage repellency was 80% when treated with 5% dose of *L.camara* leaf powder, while it was 70% when treated with the 6% and 7% dose leaf powder. The percentage repellency was 68% when treated with 8%, 9% and 10% dose of *L.camara* leaf powder.

The repellency was 70% when treated with 5% dose of *H.sauveolens* leaf powder. The repellency rate was 73% when treated with 6% dose of *H. sauveolens*. The repellency rate was 66% when treated with 7% dose leaf powder. When treatment have done with the 8% dose of *H.sauveolens* the repellency was 65% when treated with 8% dose of *H.sauveolens* leaf powder. The percentage repellency was 72% and 73% when treated with 9% and 10% dose respectively.

The percentage repellency was recorded as 80% when treated with 5% dose leaf powder of *C.medica*. When 6% dose of Leaf powder of *C.medica* leaf powder was used for the treatment the repellency rate was 73%. The repellency rate was recorded as 75% and 72% respectively when the 7% and 8% dose leaf powder of *C.medica* was used for the treatment. The repellency rate was 68% when treated with 9% dose leaf powder. The repellency rate was 64% when *T.castaneum* treated with the 10% dose leaf powder of *C.medica*.

The repellency rate of *T.castaneum* when treated with the 5% dose of *A.marmelos* leaf powder was recorded as 60%. When the *T.castaneum* were treated with the 6% dose of *A.marmelos* leaf powder the repellency rate was 70%. The repellency rate was 95% when treated with the 7% dose leaf powder of *A.marmelos*. The repellency rate of *T.castaneum* when treated with 8%, 9% and 10% dose leaf powder of *A.marmelos* was observed as 73%.

The repellency rate in *T.castaneum* was 70% when treated with the 5% dose leaf powder of *L.flexosum*. When the *T.castaneum* adults were treated with 6% dose leaf powder of *L.flexosum* the repellency rate was 60%. The repellency rate was observed as 72% when treated with the 7%, 8% and 9% dose leaf powder of *L.flexosum*. The repellency rate was 68% when treated with the 10% dose leaf powder of *L.flexosum*.

Effect of aqueous extract on *S.oryzae*

At the doses 5%, 6%, 7%, 8%, 9% and 10% *L.camara* aqueous extract, the number of insects found dead were observed to be 1, 1, 2, 2, 3, and 3, respectively.

At the doses 5%, 6%, 7%, 8%, 9% and 10% *H.sauveolens* aqueous extract, the number of insects found dead were observed to be 1, 2, 2, 2, 3, and 4, respectively.

At the doses 5%, 6%, 7%, 8%, 9% and 10% *C.medica* aqueous extract, the number of insects found dead were observed to be 1, 1, 2, 3, 3, and 3, respectively.

At the doses 5%, 6%, 7%, 8%, 9% and 10% *A.marmelos* aqueous extract, the number of insects found dead were observed to be 1, 2, 2, 4, 4, and 4, respectively.

At the doses 5%, 6%, 7%, 8%, 9% and 10% *L.flexosum* aqueous extract, the number of insects found dead were observed to be 1, 2, 2, 3, 3, and 3, respectively.

Effect aqueous extract on *T. Castaneum*

At the doses 5%, 6% and 7% of *L.camara* aqueous extract, no mortality was observed in *T.castaneum* adults while at 8%, 9% and 10% the number of insects found dead were observed to be 1, 2 and 3 respectively.

At the doses 5% and 6% of *H.sauveolens* aqueous extract, no mortality was observed in *T.castaneum* adults while at 7%, 8%, 9% and 10% the number of insects found dead were observed to be 1, 1, 2 and 3 respectively.

At the doses 5%, 6% and 7% of *C.medica* aqueous extract, no mortality was observed in *T.castaneum* adults while at 8%, 9% and 10% the number of insects found dead were observed to be 1, 3 and 3 respectively.

At the doses 5%, 6% and 7% of *A.marmelos* aqueous extract, no mortality was observed in *T.castaneum* adults while at 8%, 9% and 10% the number of insects found dead were observed to be 2, 4 and 5 respectively.

At the doses 5%, 6% and 7% of *L.flexosum* aqueous extract, no mortality was observed in *T.castaneum* adults while at 8%, 9% and 10% the number of insects found dead were observed to be 2, 3 and 5 respectively.

Effect of ethanolic extract on *S.oryzae*

At the doses 5%, 6%, 7%, 8%, 9% and 10% *L.camara* aqueous extract, the number of insects found dead were observed to be 1, 2, 2, 3, 3, and 3, respectively.

At the doses 5%, 6%, 7%, 8%, 9% and 10% *H.sauveolens* aqueous extract, the number of insects found dead were observed to be 1, 2, 2, 3, 3, and 3, respectively.

At the doses 5%, 6%, 7%, 8%, 9% and 10% *C.medica* aqueous extract, the number of insects found dead were observed to be 1, 1, 2, 2, 4, and 4, respectively.

At the doses 5%, 6%, 7%, 8%, 9% and 10% *A.marmelos* aqueous extract, the number of insects found dead were observed to be 2, 2, 2, 3, 2, and 4, respectively.

At the doses 5%, 6%, 7%, 8%, 9% and 10% *L.flexosum* aqueous extract, the number of insects found dead were observed to be 1, 2, 2, 3, 3, and 4, respectively.

Effect ethanolic extract on *T.castaneum*

At the doses 5% and 6% of *L.camara* aqueous extract, there was no mortality in *T.castaneum* adults while at 7%, 8%, 9% and 10% the number of insects found dead were observed to be 1, 2, 2 and 4 respectively.

At the doses 5%, 6% and 7% of *H.sauveolens* aqueous extract, there was no mortality in *T.castaneum* adults while at 8%, 9% and 10% the number of insects found dead were observed to be 1, 2 and 2 respectively.

At the doses 5%, 6%, 7%, 8%, 9% and 10% *C.medica* aqueous extract, the number of insects found dead were observed to be 1, 1, 2, 3, 4, 5, respectively.

At the doses 5% and 6% of *H.sauveolens* aqueous extract, there was no mortality in *T.castaneum* adults while at 7%, 8%, 9% and 10% the number of insects found dead were observed to be 2, 3, 4 and 5 respectively.

At the doses 5%, 6% and 7% of *L.flexosum* aqueous extract, there was no mortality in *T.castaneum* adults while at 8%, 9% and 10% the number of insects found dead were observed to be 1, 3 and 4 respectively.

IV. Discussion

Strong insect repellent activity noted in all the plants used in the study, indicate the presence of active compounds in the plant components and hence indicate promising sources of plant based insecticides. There are several reports of such phytochemicals influencing the life and behaviour of insects. Larvae are suggested to be more susceptible than adult insects (Koul and Isman, 1991; Jagannath and Nair, 1992). Plant species have been reported to be effective against insects either by direct effects on the growth and development or reduced feeding by acting on receptors. Fresh and dry leaves of *C.aequalis* were reported to emit strong persistant aromatic odours repellant to weevils (Parhetel, 1998; Ntonifer and Monah, 2001). Entire or powdered fruits of Piper spp. have insecticidal and repulsive effect against many pests (Ntonifer and Monah, 2001). Biologically active flavonoids identified in hydro ethanolic extracts of *Inula racemosa* (Pachew – Sanchz et al, 2013) were believed to be responsible for the high repellence and strong insecticidal activities of the plant against *S.oryzae* (Liu et al, 2006). Contact toxicity of many plant powders to insect pests and repellency effects have been demonstrated (Boeks et al, 2004). It is indicated that plant powders may act as repellent, fumigant, stomach poison and physical barrier, blocking the spiracles and insairing respiration (Law – Ogbomo and Enobakhare, 2007; Mulungu et al, 2007).

About 2000 plants are reported to possess some type of antifeedant, repellent or insecticidal compounds (Bouda et al, 2001). Since the plants used in this study are medicinal, they are quite safe for human consumption and thus can be included in any pest control strategy. However, further work aimed at isolation of the specific compounds acting against the insects and nature of the effects of the compounds at the cellular level would be interesting.

Fig 1: *Sitophilus oryzae*

Fig 2: *Tribolium castaneum*

Fig 3: *Lantana camara*

Fig 4: *Hyptis sauveolens*

Fig 5: *Citrus medica*

Fig 6: Aegle marmelos

Fig 7: Lygodium flexosum

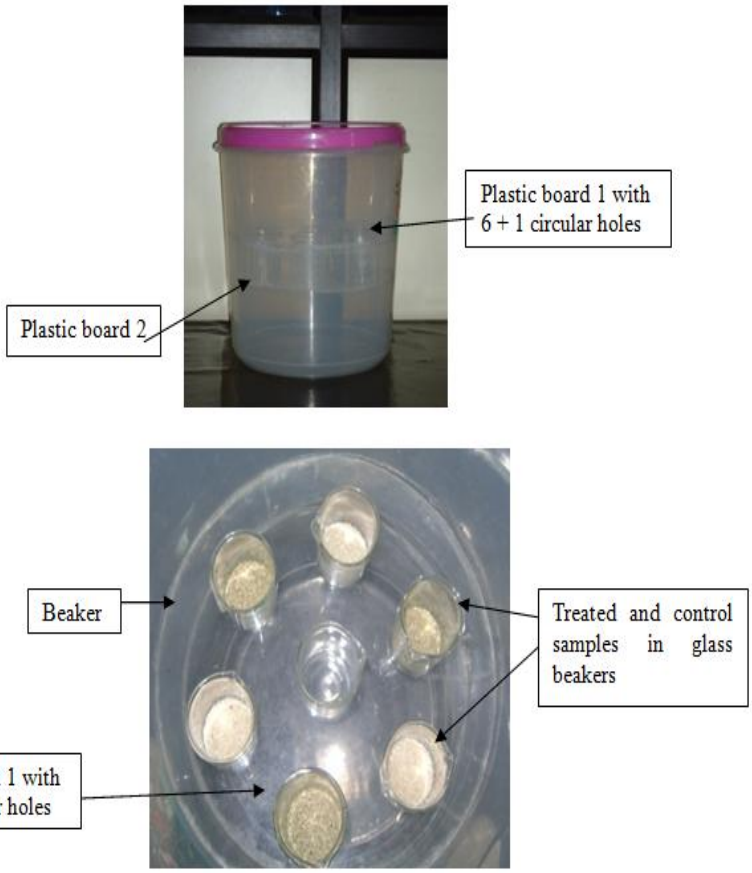
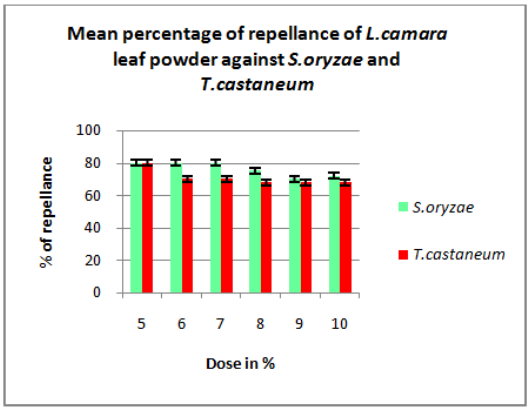
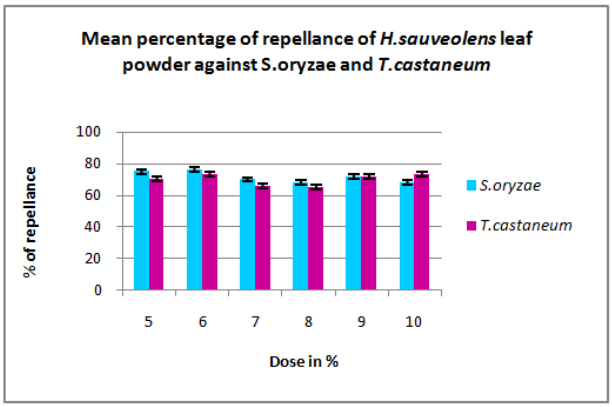


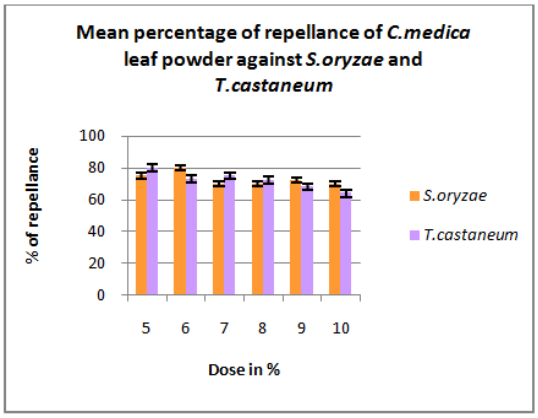
Fig 8: An apparatus was designed for treating insects with plant extract

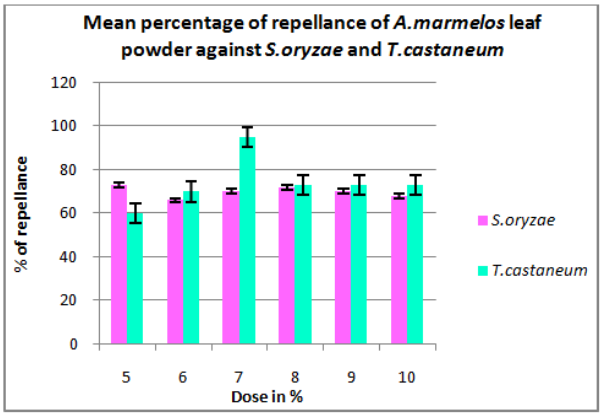
Table 4.1.1: Percentage repellency of *L.camara* leaf Powder against *S.oryzae* and *T.castaneum*

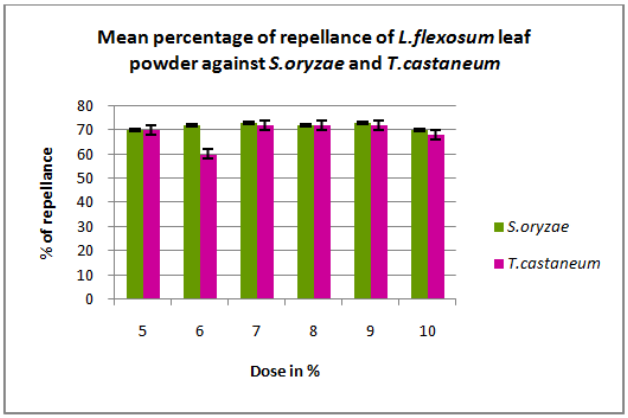
% Repellancy Dose	*L.camara*		*H.sauveolens*		*C.medica*		*A.marmaelos*		*L.flexosum*	
	S. oryzae	***T. castaneum***	***S. oryzae***	***T. castaneum***	***S. oryzae***	***T. castaneum***	***S. oryzae***	***T. castaneum***	***S. oryzae***	***T. castaneum***
5%	80	80	75	70	75	80	73	60	70	70
6%	80	70	76	73	80	73	66	70	72	60
7%	80	70	70	66	70	75	70	95	73	72
8%	75	68	68	65	70	72	72	73	72	72
9%	70	68	72	72	72	68	70	73	73	72
10%	72	68	68	73	70	64	68	73	70	68











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