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Susceptibility of Citrus Reticulate Blanco Fruit Peel Oil Against *Tribolium castaneum* (Coleoptera: Tenebrionidae) Infesting Stored Commodities

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ABSTRACT: The qualitative or quantitative harm and infection of saved commodities with the aid of using bugs, mites, rodents, and fungi can be averted with the aid of using control practices with minimum use of dangerous chemical substances and averting dangerous chemical residues. Certain compounds of vegetation inclusive of crucial oils, with insecticidal properties, had been taken into consideration as options to chemical insecticides for pest manage. This examine reviews the susceptibility & toxicity of Citrus reticulata Blanco (Rutaceae) peeling crucial oils in against to saved-product insect pest, red flour beetle, *Tribolium castaneum* Herbst (*Tenebrionidae*) adults. Experiment was carried out at $27 \pm 1^\circ \text{C}$ and $60 \pm 5\%$ relative humidity in darkness. Experimental concentrations were 15, 22, 31, 45, and 63 $\mu\text{l/l}$ air tested on adult (1-7 days old) insects after 24 and 48 h of exposure. The essential oils of Citrus reticulata fruit peels at the highest dose of 63 $\mu\text{l/l}$ air caused 76.6 % and 79 % mortality of insects after 24 and 48 hours of exposure, respectively. Mortality of *T. castaneum* increased with both increase in concentration of C. reticulata oils as well as exposure time of treated insects. These results suggest the potential of C. reticulata oil as a control agent against *T. castaneum*.

KEYWORDS: Citrus reticulata, essential oil, toxicity, *Tribolium castaneum*

I. INTRODUCTION

The red flour beetle *Tribolium castaneum* (Herbst) is a cosmopolitan (Weston and Rattlingourd 2000) pest that infests stored products such as flour and other milled cereal products or broken grains in food-processing facilities (Mills and Pedersen 1990) and flour mills, warehouses, and retail stores. It causes severe damage to the food commodities both quantitatively and qualitatively (Smith et al., 1971). This species can colonize small patches of meals and maintain itself with small quantities of meals. It has regularly been used as a version for ecological research due to its capacity to colonize a huge variety of saved products. *T. castaneum* can comfortably fly while the surroundings are heat and it's far able to dispersal in numerous foods, such as grains and flour saved in a garage area. The species can be a significant pest in anthropogenic structures used for processing and storage of grain-based products, such as flour, mills, warehouses, retail stores, etc. This species has a long association with food stored by humans and has been found associated with a wide range of products including cereal flour, peas, beans, nuts, and dried fruits. In addition, members of the genus *Tribolium* have been reported to secrete certain toxic quinones of carcinogenic nature in stored products that pose a serious risk to human health (ElMofty et al., 1989). *Castaneum* has been found to invariably attack peanut kernels and pods, causing significant losses during storage due to its high reproductive potential. Beetles can breed year-round in warm areas. Losses from this pest could be prevented through the use of pesticides or non-chemical methods. The use of synthetic pesticides to control these pests is strongly discouraged due to their adverse effects on human health and the environment. Plants are known to be good sources of anti-pimple agents.

Botanical products are environmentally friendly, less hazardous, inexpensive, and readily available. Farmers can grow them with minimal effort and extract those using native methods. Botanical materials can be used as an alternative to chemical pesticides. This is very helpful in minimizing the undesirable side effects of synthetic pesticides. The effectiveness of botanical insecticides has been proven in several studies. Plant dust is highly repellent and can play a role in protecting the storage of stored grain. Many of the plants used to preserve crops have been shown to be safe for

human consumption. Various plant products in various forms have been evaluated against the major stored grain pests and their effects concern pests in the secondary metabolism that acts as oviposition repellents, ingestion repellents, and growth retardants. Therefore, in the present study, various citrus peels were used as powdered bioinsecticides to control *T. castaneum*. Therefore, the research aims to determine the effectiveness of citrus peels for the management of *T. castaneum*.

II. MATERIAL AND METHODS

Study area

The experiments were conducted in the Department of Zoology & Environmental sciences, Lachoo Memorial College, Jodhpur under ambient conditions ($32 \pm 0.64^\circ\text{C}$ and $68 \pm 3\%$ R.H).

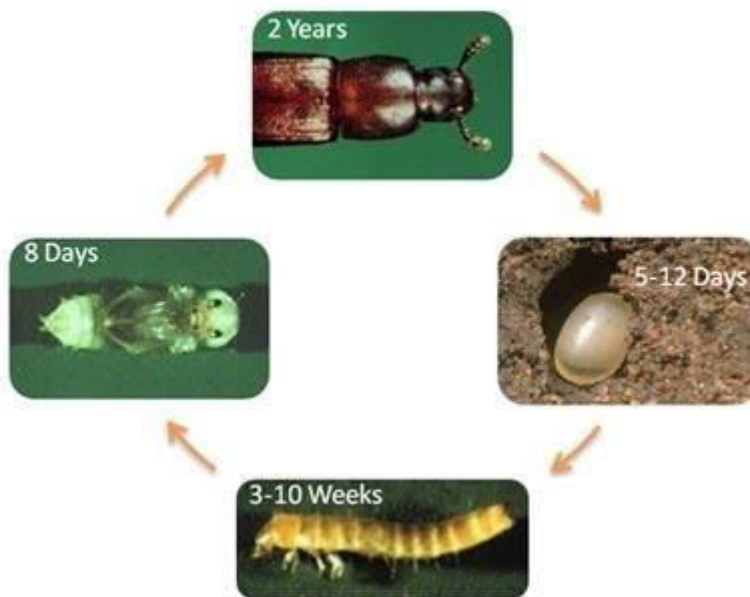
Plant Materials

Different fresh citrus fruits of sweet orange were bought from local market from Jodhpur city. The citrus fruits were peeled using a sharp clean knife and the peels were shade dried naturally outside the laboratory until they were crisp dry. Powder was prepared by grinding each of the citrus peels separately in a sterilized electric grinder, and then passed through a mesh size of 0.5 mm to obtain fine and uniform sample. The resulting plant powders were stored separately in white transparent container with label and kept at ambient laboratory temperature prior to use.



Collection and maintenance of the insect pests

Heterogenous samples of *Tribolium castaneum* were collected from various flour mills of Jodhpur region. *T. castaneum* was reared on wheat flour. Adult insects, 1-7 days old, were used for fumigant toxicity tests. The cultures were maintained in the dark in a growth chamber set at $27 \pm 1^\circ\text{C}$ and $60 \pm 5\%$ RH. All experiments were carried out under the same environmental conditions. The insects were left undisturbed for 7 days in the jars for mating and oviposition and then the adults were removed from the jars. Then the jars were placed in an incubator maintained at 30°C and 70% R.H. for completing the life cycle of insects after emergence from the eggs in the food. The population received from the jars after a month was considered of uniform age and were thus used for the experimentation. The insects were identified by their morphology (Bousquest, 1990, and Anonymous, 1986).



Extraction of the essential oils

Essential oils were extracted from fruit peels of *Citrus reticulata*. Peels were dried in absence of sun light at room temperature at $30 \pm 5^\circ\text{C}$ and ground by domestic mixer. Extracted oils were transferred to glass flasks and kept at 4°C in a refrigerator.

Fumigant toxicity of *Citrus reticulata* peel essential oil

The experimental concentrations of *Citrus reticulata* peel essential oils on *Tribolium castaneum* were determined by preliminary tests. Experimental concentrations were 15, 22, 31, 45, and $63 \mu\text{l/l}$ air for adult (1-7 days old) insects. For fumigant toxicity assays, filter papers (Whatman No. 1, cut into 4×5 cm paper strip) were impregnated with different concentrations using a microsampler. Thirty adult (1-7 days old) insects of *T. castaneum* were placed in small plastic tubes (3.5 cm diameter and 5 cm in height) with open ends covered with cloth mesh. Adult insects of *T. castaneum* were treated in three replicates per treatment. Two experiments were done separately with 24 and 48 h of insect exposures. Treated insects were incubated at $27 \pm 1^\circ\text{C}$. After this time, the number of dead adults was counted. Those insects that did not move when lightly probed or shaken in light and mild heat were considered dead. Mortality in the controls was not observed in any of the experiments.

Data analysis

Mortality data were analyzed with SPSS software (SPSS Inc, 1993). Probit analysis was used to determine LC_{50} and LC_{95} values. The values significance of χ^2 was estimated according to Robertson and Preisler (1992). Data were analyzed using one-way analysis of variance (ANOVA) followed by Tukey's honestly significant difference (HSD) test to estimate statistical differences between means at $\alpha = 0.05$.

Results

The result of fumigation toxicity of *Citrus reticulata* fruit peel essential oil is shown in Table 1. Analysis of variance showed that insect mortality fully correlated with essential oil concentrations after 24 and 48 h of exposure. Differences (HSD) indicated that all treatments were statistically different in their lethality to insects. Comparing mean mortality values, it was observed that as the concentration of *Citrus reticulata* peel essential oil increased, the mortality rate of adult *Tribolium castaneum* increased accordingly (Table 1). The insecticidal activity varied with the plant-derived material, the different concentrations of the oils and the exposure time. *Citrus reticulata* peel essential oil at the highest dose of $63 \mu\text{l/l}$ air resulted in mortality of 77.6% and 79% after 24 and 48 hours of exposure, respectively (Table 1). No dead insects were observed in the control treatments. The highest dose of essential oil showed a significantly higher mortality ($P < 0.05$). Table 2 shows the results of the analysis and the corresponding LC_{50} and LC_{95} values.

(Table-1) Mean percent mortality \pm SE of *T. castaneum* treated with citrus reticulata peel essential oils after 24 h and 48 h exposure.

Exposure times (h)	Concentrations (μ l/l air)					
	Control	15	22	31	45	63
24	0.0* \pm 0.0 ^E	18.8 \pm 0.3 ^D	25.5 \pm 0.3 ^C	46.6 \pm 0.5 ^B	64.4 \pm 0.8 ^A	77.6 \pm 0.0 ^A
48	0.0 \pm 0.0 ^D	19.9 \pm 0.6 ^C	26.6 \pm 0.6 ^C	45.5 \pm 0.58 ^B	68 \pm 0.0 ^B	79 \pm 1 ^A

(Table-2) Analysis of the mortality of *T. castaneum* treated with different concentrations of citrus reticulata peel essential oil, 24 and 48 hours after exposure.

Intercept \pm SE ^c	Slope \pm SE ^b	χ^2 [df = 5, 12]	LC ₉₅ * (μ l/l air)	LC ₅₀ * (μ l/l air)	Exposure times (h)
-0.43 \pm 0.5	5.6 \pm 0.22	2.9	136.7 (107.2 – 169)	38.2 (23 – 49.9)	24
-0.4 \pm 0.22	6.7 \pm 0.3	2.4	114.8 (87.22 – 130)	35.6 (21.1 – 45.8)	48

III. DISCUSSION

Essential oils and components from more than 75 plant species belonging to different families have been shown to possess high fumigation activity against insect pests of stored produce. Rutaceae is a large family of 130 genera in seven subfamilies with many important fruits and essential oil products. The bark has the highest value of all essential oils and is often used as a flavoring agent in bakeries, as a fragrance in perfumery and also for pharmaceutical applications. In this study, the results showed a significant insecticidal effect of citrus peel essential oils on *Tribolium castaneum* after 24 and 48 h exposure. The essential oil obtained from orange peel is known to have toxic, anti-feeding and developmental effects on the grain weevil *Rhyzopertha dominica* (F.), rice weevil, *Sitophilus oryzae* (L.) and the flour beetle *Tribolium castaneum*. Citrus reticulata fruit peel essential oil has also been reported to have fumigant toxicity against cowpea, *Callosobruchus maculatus* (F.), to have fumigant activity against *Xenopsylla cheopis* (R.) (Weinzierl and Henn, 1992), domestic insects, *Blattella germanica* (L.) and *Musca domestica* (L.), and stock product *Sitophilous oryzae* (L.). Volatile vegetable essential oils from the peel of some citrus species have been reported to have insecticidal properties against insect pests of stored grain. The essential oils extracted from the genus Citrus have monocyclic monoterpenoids and their main component is dlimonene and has insecticidal activities against insect pests. Similarly, in the present study, C. reticulata essential oil was found to exhibit remarkable fumigation toxicity upon 24- and 48-hour exposure to adult *T. castaneum*. The results of this experiment showed that all essential oil components of the peel of the C. reticulata fruit were relatively toxic to *Tribolium castaneum*.

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