



Efficacy of various fruit peels as a source of novel insecticidal agent against *Tribolium castaneum*

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Abstract

Stored food products are subjected to infestation by a wide array of insect pests. These pests which enjoy a cosmopolitan distribution are a serious threat to food safety. Out of these pests, the red flour beetle, *Tribolium castaneum* pose severe risk as it infests almost all types of stored products. The damage is less due to feeding but more due to the secondary mold growth caused by their rapid proliferation in the food products. Management of this pest has been a matter of concern. The use of synthetic pesticides, though effective, is harmful to humans and environment. Hence people resort to the use of botanicals. In the present study, the potential of peels of *Citrus sinensis*, *Carica papaya* and *Punica granatum* in the control of the red flour beetle was studied. The different fruit peels extracted in various solvents at increasing concentrations were assessed for their toxicity against the pest. Among the three fruit peels, the peels of *Citrus sinensis* were proved to be effective. The *C. sinensis* peel extracted in Methanol and ethanol showed higher activity i.e. the percentage mortality of the insect was found to be $87.00 \pm 4.47\%$ and 80.00 ± 3.545 respectively at 15% concentration. The ethanolic extract of *C. papaya* and the methanolic extract of *P. granatum* also showed a greater percentage mortality.

Keywords: fruit peels, *Tribolium castaneum*, food security, botanical, IPM

Introduction

The upshots of the cost of unsafe food go far beyond human suffering. Contaminated and infested foodstuffs impede socioeconomic development, burdens healthcare systems and often would lead to compromises in economic growth and trade. Opportunities of an increasingly-globalized food market are lost to those developing countries that are unable to meet the proposed international food safety standards. Food safety threats cause an enormous load on economies from restraints in agri-food trade, to loss of food and allied income and squandered natural resources. The major threat to Food Safety & Security is the pest infestation in grain storage houses. Stored products pests, which revel in a cosmopolitan distribution, are the chief concern to food security. *Tribolium castaneum*, *T. confusum*, *Sitophilus oryzae*, *S. granaries*, *Rhyzopertha dominica*, *Plodia interpunctella*, *Oryzaeplilus surinamensis*, *Lasioderma serricornis* are the major pests causing hefty damage and pecuniary loss to a range of stored products in warehouses. Among these storage pests, *Tribolium castaneum* Herbst (Coleoptera: Tenebrionidae) is one of the most prevalent and damaging pest. *Tribolium castaneum* is a polyphagous pest commonly found in indoor food storage centres which feeds on different stored-grain and grain products, nuts and dried fruits ^[1, 2, 3]. The damage is less due to feeding, but more due to contamination of the stored product with large numbers of various life stages, dead bodies, cast skins and fecal pellets. They also produce many pungent substances during their activities that can seriously affect the quality of

grain and result in reduced marketability and consumption by humans. Growing concern over the injudicious use of synthetic pesticides and their impact on man and environment kindled a public awareness to seek effective alternatives to synthetic pesticide molecules ^[4]. In the present study efforts were made to study the effect of various fruit peels on the mortality of *Tribolium castaneum*, thus emphasizing on the development of value based products from cheap sources.

Materials and Methods

- Collection and maintenance of *Tribolium castaneum* (Herbst)

The pest, *T. castaneum* was procured from the nearby FCI warehouse from the infested wheat and has been continuously cultured on the same food source until the end of the experiments. The stock culture was maintained in the laboratory in dark atmosphere at $28 \pm 20^\circ\text{C}$ and 70 - 80% relative humidity.

- Solvent Extraction of the collected fruit peels

The fruit peels namely that of *Citrus sinensis*, *Carica papaya*, *Punica granatum* were taken and thoroughly washed to remove particles and shade dried at room temperature ($27 \pm 2^\circ\text{C}$; R.H. $75 \pm 5\%$). After shade drying, the peels were powdered by using mechanical grinder. 50 grams of the dry powder were extracted in 100 ml of methanol, ethanol, acetone and distilled water using Soxhlet apparatus. After 48 hrs the crude extracts were condensed in vacuum by using rotary vacuum evaporator. The condensed crude extract was stored in refrigerator at 4°C for further studies.

The extracts obtained were dissolved in the corresponding pure solvent for further experiments.

- Assessing the toxicity of the extracts against *Tribolium castaneum*

For investigating the effect of plant extract, different concentrations of the crude plant extracts (1%, 3%, 5%, 10% and 15%) each were treated with 20g feed kept in bottle. To these 10 newly emerged adults were added. Mortality was recorded upto 7 days. When no leg or antennal movements were observed, insects were considered dead. Each experiment was replicated five times. The mortality was calculated using the Abbott correction formula [5]. Statistical Analysis was performed in SPSS software (v25.0).

Results and Discussion

The problems caused by pesticides and their residues have augmented the need for effective use of botanicals with greater choosiness and efficacy. Realizing the adverse effects of chemical insecticides, attention has been focused

in favour of non-chemical methods of pest management. Botanicals are the utmost promising alternatives to the current insect control agents for they constitute a rich source of bioactive chemicals. In the current study, peels and rinds of three different fruit were used for the pest control study. The different fruit peels extracted in various solvents at increasing concentrations were assessed for their toxicity against the pest. Among the three fruit peels, the peels of *Citrus sinensis* were proved to be effective. The *C. sinensis* peel extracted in Methanol and ethanol showed higher activity i.e. the percentage mortality of the insect was found to be 87.00±4.47% and 80.00±3.55 respectively at 15% concentration. The acetone and aqueous extract of the *C. sinensis* peels showed a percentage mortality of 14.00±2.24 and 14.00±2.74 respectively (Table 1). The ethanolic extract of *C. papaya* showed a greater percentage mortality followed by its acetone extract, methanolic extract and aqueous extract (Table.2). The peels of *P. granatum* extracted in methanol was effective against the pest followed by that extracted in ethanol, acetone and distilled water (Table 3).

Table 1: Effect of *Citrus sinensis* fruit peels on the mortality of *T. castaneum*

Fruit Peel	Extract	%Mortality when treated with different concentrations				
		1%	3%	5%	10%	15%
<i>Citrus sinensis</i>	Methanolic Extract	15.00±3.53 ^a	18.00±2.74 ^a	35.00±7.90 ^b	66.00±6.52 ^c	87.00±4.47 ^d
	Ethanolic Extract	17.00±2.74 ^a	20.00±3.53 ^a	46.00±4.19 ^b	56.00±4.19 ^c	80.00±3.54 ^d
	Acetone extract	10.00±6.12 ^a	13.00±2.74 ^a	16.00±4.18 ^b	13.00±2.73 ^c	14.00±2.24 ^d
	Aqueous Extract	0.00±0.00 ^a	5.00± 3.54 ^a	6.00±2.24 ^b	10.00±0.00 ^c	14.00±2.74 ^d

*All values are mean ±S.D of five replicates and significant at p≤0.05 level of significance

Table 2: Effect of *Carica papaya* fruit peels on the mortality of *T. castaneum*

Fruit Peel	Extract	%Mortality when treated with different concentrations				
		1%	3%	5%	10%	15%
<i>Carica papaya</i>	Methanolic Extract	7.00±4.47 ^a	10.00±0.00 ^b	14.00±4.18 ^c	17.00±4.47 ^d	28.00±4.47 ^e
	Ethanolic Extract	18.00±5.70 ^a	32.00±5.70 ^b	46.00±5.48 ^c	57.00±2.74 ^d	73.00±4.47 ^e
	Acetone extract	5.00±3.54 ^a	7.00± 2.74 ^b	22.00±5.70 ^c	31.00±10.25 ^d	32.00±2.74 ^e
	Aqueous Extract	0.00±0.00 ^a	1.00±2.24 ^b	3.00±2.74 ^c	5.00±5.00 ^d	7.00±4.47 ^e

*All values are mean ±S.D of five replicates and significant at p≤0.05 level of significance

Table 3: Effect of *Punica granatum* fruit peels on the mortality of *T. castaneum*

Fruit Peel	Extract	%Mortality when treated with different concentrations				
		1%	3%	5%	10%	15%
<i>Punica granatum</i>	Methanolic Extract	3.98±3.66 ^a	6.00±4.35 ^a	9.98±6.25 ^b	23.32±2.37 ^c	61.34±2.99 ^d
	Ethanolic Extract	7.98±4.48 ^a	10.00±5.28 ^a	22.00±3.79 ^b	38.00±5.60 ^c	46.66±6.22 ^d
	Acetone extract	2.00±2.99 ^a	7.32±4.34 ^a	14.64±5.04 ^b	23.32±4.70 ^c	29.34±2.76 ^d
	Aqueous Extract	0.66±1.48 ^a	2.64±1.48 ^a	2.66±2.79 ^b	5.34±1.86 ^c	10.66±1.48 ^d

*All values are mean ±S.D of five replicates and significant at p≤0.05 level of significance

The results thus reveal the potential of waste products such as fruit peels to be used as an insecticidal agent.

Conclusion

Botanicals are the most promising alternatives to the commonly used synthetic insect control agents as they are reservoirs of numerous bioactive chemicals. Plant secondary metabolites, in the earlier times, were considered to have no specific function with showcasing only its of biodiversity richness [6]. But, in the modern times, studies have shown that mostly all of these compounds play an important role in plant-insect relations either independently or synergistically setting up a vigorous chemical defense barrier against certain pests and diseases [7]. Plant based pesticides are commercially feasible and ecologically safer than their

synthetic equivalents. Unlike chemical pesticides, most of the plants have more than one chemical compound which exerts diverse biological activity on the target and thus the chances of developing swift resistance to different chemicals are improbable. Poor and economically fringe farmers are grieving from the growing costs and perils of the synthetic pesticides. The use of plant based insecticides could enable farmers to grow their own pesticide yielding plants which could be also utilized as a source of income by small scale industrialists [8]. The present study thus introduces the use of fruit peels as a novel insecticide. Further studies could be done in the near future to standardize and validate the formulation of such insecticides.

References

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