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Insecticidal and repellant activities of plants oil against stored grain pest, *Tribolium castaneum* (Herbst) (Coleoptera:Tenebrionidae)

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ABSTRACT

Objective: The present investigation was aimed to assess the impact of five plants oil for their insecticidal and repellent activity against *Tribolium castaneum* (Herbst), a stored grain pest and they were tested in the laboratory. **Method:** Five plants oil *Citrus autantium*, *Cinnamomum zeylanicum*, *Gaultheria fragrantissima*, *Lavandula officinalis*, and *Ocimum sanctum* were evaluated for their insecticidal and repellent activities against *T. castaneum* by adapting the standard protocol *in vitro*. **Results:** In Tulsi oil showed powerful repellent against *T. castaneum* beetles at both the concentration and this property can be clearly seen from the values at 5 μ 1 (-0.60 and -0.73 in 1h and 6hr respectively) and 10 μ 1 (-0.56 and -0.81 in 1h and 6h respectively). Tulsi oil had more repelling property than other oil tested here against T. castaneum. Maximum percentage of mortality (76 and 92% at 48h and 72 hours after treatment respectively) in Tulsi oil. Wintergreen oil showed 86% mortality at 72 hours after treatment. **Conclusions:** The present work for botanical products to control the insect pest of stored grain *T. castaneum* .These results suggest the presence of actives principles in the plant oils. Further exploration of active principles and their structural elucidations are underway.

1. Introduction

Insects are a problem in stored grain throughout the world. Stored product insects cause serious losses in weight and quality of the stored products, Tribolium castaneum (Herbst) can be a major pest in storage of grain-based products cause severe damage to cereal grains throughout the world. This species has a long association with human stored food and has been found in association with a wide range of commodities including grain, flour, peas, beans, nuts, dried fruits and spices [1]. Control of stored product insects relies heavily on the use of synthetic insecticides and fumigants, which has led to problems such as environmental disturbances, increasing costs of application, pest resurgence, pest resistance to pesticides and lethal effects on non-target organisms, in addition to direct toxicity to users [2]. Biological control may be an effective strategy for stored-product pest management. Botanical pesticides have the advantage of providing novel modes of action against insects that can reduce the risk of cross-resistance as well as offering new leads for design of target-specific molecules [3]. Fumigation plays a very important role in insect pest elimination in stored products [4]. Plant essential oils and their components have been shown to possess potential for development as new fumigants and they may have advantages over conventional fumigants in terms of low mammalian toxicity, rapid degradation and local availability [5]. Essential oils derived from more than 75 plant species have been evaluated for fumigant toxicity against stored product insects so far [6]. The ethanol extracts of *E. fischeriana* roots were found to possess toxicity against Oncomelania snails and miracidiums of Schistosoma [7].

The insecticidal activity of a large number of essential oils and other plant extracts has been assessed against several major agricultural pests [8]. Many data indicated the essential oil possessed antimicrobial, antifungal, molluscidal, nematicidal, antioxidant and antiaflatoxigenic activities, as well as potential as a cancer preventing agent [9, 10]. The essential oil of *C. carvi* has been demonstrated to possess strong contact and fumigant toxicity as well as repellency against several insects and mites, (Reticulitermes

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speratus), rice weevil (*S. oryzae*) [11] [12]. Two synthetic volatile compounds (benzaldehyde and propionic acid) and two volatile oils (camphor and eucalyptus) were screened individually and in combinations against different life stages of *T. castaneum* [13]. This study specifically aimed to determine the insecticidal action, and repellency of plant oil of *Citrus autantium*, *Cinnamomum zeylanicum*, *Gaultheria fragrantissima*, *Lavandula officinalis*, and *Ocimum sanctum* against Tribolium castaneum.

2.Materials and methods

2.1. Collection of plant oil

Essential oils obtained from local market, India (Teeraj & Co, Chennai; commercial producers of plant essential oils and aromatic substances) were used in this study. The scientific name, common name of oils are *Citrus autantium* (Lime oil), *Cinnamomum zeylanicum* (Camphor oil), *Gaultheria fragrantissima* (Wintergreen oil), *Lavandula officinalis* (Lavender oil), and *Ocimum sanctum* (Tulsi oil).

2.2. Culture of Tribolium castaneum

The adult *Tribolium castaneum* was collected from infested grains purchased from local market and brought to the laboratory. The culture was established using rava in a plastic container of 25 X 10 cm and maintained at room temperature 30±2 ℃ and relative humidity of 70–75%. Sieving the culture separated the adult insects and the adults were used for subsequent experiment. The culture was continuously maintained in the containers throughout the study period.

2.3. Bioassay

2.3.1. Repellent activity of Plant oils against Tribolium castaneum

To study the repellent activity of plant oils, 5μl and 10μl of the selected plant oils were put in to the filter paper strips (6X4 cm) and allowed to dry for 5minutes. Then the filter paper was placed in plastic jars and attached into the arm of olfactometer. For control filter paper without any treatment was used. After the attachment of all the plastic vials with the arms, fifty newly emerged adults of *T. castaneum* were introduced into the olfactometer and EPI values was calculated as using the formula of [14].

Where Nt= Number of insects in the treated sample side and Nc= Number of insects in the control sample side.

2.3.2. Insecticidal activity of Plant oils

Two week-old adults *T. castaneum* were collected from the laboratory colony. Three replications were carried out for each concentration and untreated control. To study the insecticidal activity of the oil 3mm circular filter paper was dipped with 5,10 and 15 μl of oil and placed in to a small glass jars containing healthy maize flour. And 20 insects were introduced in each jars and mortality was recorded every 24h for 3 days and the percentage of mortality was calculated by using Abbot's percent corrected formula[15].

3. Results

3.1. Repellent activity of Plant oils against Tribolium castaneum

Biological activity of different plant oils was tested against *T. castaneum* at 5μl and 10μl. The result indicates variation among the plant oils tested against the selected insect pest. The result pertaining the repellent activity was presented in Table 1. EPI values ranged from + 1 to -1. These terms simply express polarity of the directional choice. Positive and negative values indicated positive and negative approaches respectively. In the present study, Tulsi oil had more repelling property than other oil tested here. In general, repellency increased as the concentration increased in all treatments of the oils tested here. In Tulsi oil showed powerful repellent against *T. castaneum* beetles at both the concentration and this property can be clearly seen from the values at 5μl (-0.60 and -0.73 in 1h and 6hr respectively) and 10μl (-0.56 and -0.81 in 1h and 6h respectively). Next to Tulsi oil, Camphor oil showed higher repellent activity. At 5μl concentration it shows-0.13 and -0.52 EPI value and in 10μl concentration it shows -0.27 and-0.80 at 1h and 6 h respectively. Wintergreen oil showed moderate activity at both the concentration. The EPI value of the Wintergreen oil ranged between +0.11 to -0.63. The other two oils showed both the positive and negative values against the test insect. Both oils expressed attractant activity at 1 hr duration but the trend has been changed at 6 hr duration. EPI value of Lavender oil showed +0.38 and +0.62 at 5μl concentration and -0.60 and -0.71 at 10μl concentrations. Lime oil showed very less repellent activity against T. castaneum.

3.2. Insecticidal activity of Plant oils against Triboliurn castaneum

Insecticidal activity of Lavender oil, Lime oil, Tulsi oil, Camphor oil and Wintergreen oil were tested against *T. castaneum* at three different concentrations (5μl, 10μl and 15μl). Data pertaining to the insecticidal activity of the selected plant oils was presented in Table 2. The results indicating that variation among the plant oils tested against the selected insect pest. In general, the mean mortality of the insect was observed at higher concentration and higher duration. The order of the efficacy of the insect mortality was as follows; Tulsi oil> Wintergreen>Camphor oil>Lime oil>Lavender oil. Maximum percentage of mortality (76 and 92% at 48h and 72 hours after treatment respectively) in Tulsi oil. Wintergreen oil showed 86% mortality at 72 hours after treatment. Lime oil and Camphor oil showed moderate activity against *T. castaneum* whereas, lavender oil showed very less/nil activity.

Table 1

Impact of plant oils on the Excess Proportion Index (EPI) of Tribolium castaneum*

S. No	Plant oil Name	Concentrations tested			
		5 μ l		10 μ l	
		1 Hr	6 Hr	1 Hr	6 Hr
1	Lavender oil	+0.38	+0.62	−0.60	−0.71
2	Lime oil	+0.21	−0.08	−0.50	−0.36
3	Tulsi oil	−0.60	−0.73	−0.56	−0.81
4	Camphor oil	−0.13	−0.52	−0.27	−0.80
5	Wintergreen oil	−0.63	−0.52	+0.11	0.33

* Mean of five replications

Table 2

Insecticidal activity of volatile oils against *Tribolium castaneum* *

S. No	Oil Name	Concentrations tested								
		5 μ l			10 μ l			15 μ l		
		Exposure time								
		24hr	48hr	72hr	24hr	48hr	72hr	24hr	48hr	72hr
1	Lime oil	2.0± 0.50	2.0±0.44	2.0± 0.64	6.0± 0.55	20.0± 1.22	22.0± 0.84	14.0± 0.71	22.0± 1.36	32.0± 1.30
2	Wintergreen oil	2.0± 0.44	4.0±0.55	14.0± 2.07	24.0± 0.55	54.0± 0.54	74.0± 1.34	32.0± 1.30	40.0± 0.70	86.0± 0.55
3	Lavender oil	0 ± 0.00	0 ± 0.00	2.0± 0.44	0 ± 0.55	4.0± 0.55	6.0± 0.54	2.0± 0.64	4.0± 0.55	10.0± 0.84
4	Tulsi oil	8.0± 1.10	8.0±0.84	22.0± 0.84	14.0± 0.55	44.0± 0.89	88.0± 0.44	42.0± 1.43	76.0± 1.14	92.0± 0.84
5	Camphor oil	0± 0.00	2.0±0.44	6.0± 0.55	12.0± 0.84	16.0± 0.55	20.0± 0.71	18.0± 0.84	34.0± 0.89	40.0± 1.00

* Values are mean percentage of five observations of 20 insects and ± SD

4. Discussion

Plant products having considerable potential as insecticidal compounds are gaining tremendous importance in recent years. Controlling adults is also another important biological parameter to protect post harvest production. If the plant extracts and oils have the insecticidal compounds that kill the adult insects, the egg-laying and progeny development are consequently reduced. The chemical composition of the essential oil of *C. carvi* collected from various countries has been widely studied [16, 17].]. Many data indicated the essential oil possessed antimicrobial, antifungal, molluscidal, nematicidal, antioxidant and antiaflatoxigenic activities, as well as potential as a cancer preventing agent [18]. In the present study, the oils showed insecticidal activity at varying degree. The plant oils at 24 hour exposure period, showed no mortality in *T. castaneum*. Thereafter minimum mortality was recorded at 72h after treatment. Notably Tulsi oil and Wintergreen oil showed higher insecticidal activity against the target insect pest. In the olfactometer study maximum repellent activity was observed in the plant powders of *T. purpurea* showed higher EPI values against *T. castaneum* [1].

The two compounds were demonstrated to be a potent inhibitor of acetylcholinesterase (AChE) activity from larvae of several stored product insects [19]. several stored product insects, rice weevil (*S. oryzae)*, lesser grain borer (*R. dominica*), red flour beetle *(T. castaneum*) and flat grain beetle (*Cryptolestes pusillus*) [20], The fumigant activity of the essential oil and the pure compounds against *S. zeamais* and *T.castaneum* adults was tested as described by Liu and Ho [21]. The contact toxicity of the essential oil/pure compounds against S. zeamais and *T. castaneum* adults was measured as described by Liu and Ho [21]. [22]The activity of essential oils mainly depends upon the major volatile components they possess. In eucalyptus oil the major component is 1,8-cineole and this compound is responsible for the oil's biological activity. [23] showed similar results by evaluating essential oil compounds from *Cymbopogon citratus* (DC) Stapf. and *Eucalyptus citriodora* (Hook) and identified the monoterpenes, linalool, 1,8- cineole, neral and geranial among compounds with repellent activity against. However, the essential oil exhibited the same fumigant toxicity to *T. castaneum* adults as MeBr. Compared with the other essential oils in the lieterature, Perovskia abrotanoides (LC_{50} = 11.39 μL/L) [24] and *Drimys winteri* (LC_{50} = 9.0-10.5 μL/L) [25], but lesser toxic than the essential oil of *Laurelia sempervirens* (LC_{50} = 1.6-1.7 μL/L) [41]. However, compared with the other essential oils in the previous studies, the essential oil of *C. carvi* exhibited stronger fumigant toxicity against the maize weevils, e.g. essential oils of, *Artemisia lavandulaefolia* and *Artemisia sieversiana* [26], *A. vestita* (LC_{50} = 13.42 mg/L) [27], The suggest that the essential oil of Tulsi oil show potential for development as a novel natural fumigant for stored products.

Conculsion

Repellent activity of five plant oils was tested against Tribolium castaneum. Maximum repellency was recorded in Tulsi oil, Wintergreen oil and Lavender oil at higher concentration. Insecticidal activities of plant essential oils and extracts were tested against T. castaneum. The percentage of mortality was maximum in Tulsi oil and Wintergreen oil.

Conflict of interests

The authors declare that there is no conflict of interests.

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