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Feeding and Growth Inhibition Activities of *Tragia involucrata* Linn (Euphorbiaceae) on *Achaea janata* (Linn.) (Noctuidae: Lepidoptera) and *Pericallia ricini* (Fab.) (Lepidoptera: Arctidae)

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Abstract

To evaluate the growth and feeding inhibitory activities leaves extract of *Tragia involucrata* tested against third instar larvae of *Achaea janata* and *Pericallia ricini*. Feeding inhibition, larvicidal and growth inhibitory activities were tested with different solvent extracts of hexane, chloroform and ethyl acetate. Chloroform extracts showed promising feeding deterrent and larvicidal activities against *A. janata* and *P. ricini.* Percentage of deformed larvae, pupae and adults were maximum on ethyl acetate extract. Percentage of successful adult emergence was deteriorated by extract treated larvae. Ethyl acetate extracts of *T. involucrata*, showed higher percentage of feeding, larvicidal and growth inhibition activities. Hence, it may suggest it can use for controlling agricultural insect pests, *A. janata* and *P. ricini.*

Keywords

***Tragia involucrata*, *Achaea janata*, *Pericallia ricini*, Insecticidal, Feeding Inhibition**

Subject Areas: **Entomology**

1. Introduction

Applications of chemical pesticides minimize the threat from pest manifestation by rapid knock down effect,

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albeit with little consideration to the quality (nutritional contents) of the crop and agro-residues. Many workers reported that the indiscriminate use of chemical pesticide over a long period has not only proved to be a harmful to soil microflora, animals and human life, but also contributed to a number of side effects, *viz*. development of resistance by the insects/weeds/pests resurgence and outbreak of new pests, toxicity to non-target organism, presence of non permissible level of pesticide residues on seeds, vegetables, fruits, border alteration in dynamics of pest species population, cumulatively causing poor soil fertility and hazardous effects on environment endangering the sustainability of ecosystem [1]. Among current alternative strategies aiming at decreasing the use of classical insecticides, eco-chemical control based on plant-insect relationships is one of the most promising methods. Plant derived pesticides offer a more natural, "environmentally friendly" approach to pest control than synthetic insecticides [2].

The search for plant-derived chemicals that have potential use as crop protectants (insecticides, antifeedants, and growth inhibitors) often begins with the screening of plant extracts. Initially, the test insects are fed the extracts and effects on insect behaviour and development are monitored. Once a promising extract has been discovered, the next step is to find out how it is affecting the insect; *i.e*. what is its mode of action? This kind of information is needed to ensure safety to non-target organisms (humans, beneficial insects) [3].

Achaea janata Linn. (Noctuidae: Lepidoptera) is a serious pest of Castor in India. This caterpillar feeds on many different species of plants. Castor bean and croton are preferred hosts. Occasional hosts include banana, cabbage, Chinese cabbage, crown of thorns, macadamia, mustard, poinsettia, rose, sugarcane and tomato as well as some legumes, teas, and other Brassica species [4] [5]. *Pericallia ricini* (Lepidoptera: Arctiidae) commonly called as hairy caterpillar or wooly bear is the major pest of castor, gingerly, cotton, country bean, brinjal, drum stick, coccina, banana, calotropis, sunflower, oleander, tea, sweat potato, pumpkin [6] [7]. These pests status is well justified in its polyphagy on all economically important crops and the hurdles in its management. This necessitates the search for more potent insecticides which are safer to the user and consumer. The purpose of the present study was to quantitative the growth inhibitory and feeding deterrent effects of *Tragia involucrata* against oil crop insect pests.

2. Materials and Methods

2.1. Plant Collection and Extraction

The leaves of *Tragia involucrata* were collected from Thottiam, Tiruchirappalli District, Tamil Nadu, India. Plant was identified by Dr. S. John Britto, Director, The Rapinat Herbarium and Centre for Molecular Sytematics, St. Joseph's College, Tiruchirapalli, Tamil Nadu, India and The Voucher specimen (IPH 11) was deposited in Entomology lab, Arignar Anna Government Arts College, Musiri, Tamil Nadu, India.

The plant materials were thoroughly washed with tap water and shade dried under room temperature (27.0˚C ± 2˚C) at Entomology lab, PG & Research Department of Zoology, A. A. Government Arts College, Musiri. After complete drying the plant materials were powdered using electric blender and sieved through kitchen strainer. 1000 g of plant powder was extracted with hexane, diethyl ether and ethyl acetate, sequentially with increasing polarity of solvents and filtered through Whatman's No.1 filter paper. The solvents from the crude extract were evaporated to air dryness at room temperature. The crude extracts were collected in clean borosil vials and stored in the refrigerator at 4˚C for subsequent bioassay against *A. janata* and *P. ricini.*

2.2. Rearing of Test Insects

The larvae of *A. janata* and *P. ricini* were collected from vegetable field at Vadukapatti, Musiri taluk, Tamil Nadu, India. Larvae were reared in laboratory condition at the Department of Zoology, Government Arts College, Musiri, Tamil Nadu, India. These laboratory-reared larvae were used for bioassays and the cultures were maintained throughout the study period.

2.3. Feeding Inhibition Activity

Antifeedant activity of crude extracts was studied using leaf disc no choice method [8]. The stock concentration of crude extracts (5%) was prepared by dissolving in acetone and mixing with dechlorinated water. Polysorbate 20 (Tween 20) at 0.05% was used as emulsifier [9]. Fresh castor (*Ricinus communis*) leaf discs of 2 cm diameter were punched using cork borer and dipped with 0.625, 1.25, 2.50 and 5.0 mg/l concentrations of crude extracts,

individually. Leaf discs treated with acetone and without solvent (water) were considered as control. After air-drying, each leaf disc was placed in petridish (1.5 cm × 9 cm) containing wet filter paper to avoid early drying of the leaf disc and a single 2 hrs pre-starved third instar larvae of *A. janata* and *P. ricini* was introduced. For each concentration five replicates were maintained. Progressive consumption of leaf area by the larva after 24 hrs feeding was recorded in control and treated discs using Leaf Area Meter (Systronics 211). Leaf area consumed in plant extract treatment was corrected from the control. The percentage of antifeedant index was calculated using the formula of [10].

2.4. Larvicidal Activity

Fresh castor leaves were treated with different concentrations (as mentioned in antifeedant activity) of crude extracts. Castor leaves treated with acetone and without solvent were considered as control. Petioles of the tomato leaves were tied with wet cotton plug (to avoid early drying) and placed in round plastic trough (29 cm × 8 cm). In each concentration 10 pre-starved (2 hrs) third instar larvae of *A. janata* and *P. ricini* were introduced individually and covered with muslin cloth. Five replicates were maintained for all concentrations and the number of dead larvae was recorded after 24 hrs up to pupation. Percentage of larval mortality was calculated and corrected by Abbott's formula [11].

2.5. Growth Inhibition Activity

Growth inhibition activities of crude extracts were studied at four different concentrations against third instar larvae of *A. janata* and *P. ricini*. Ten larvae were introduced in a Petri-plate having tomato leaves treated with different concentrations of crude extracts. Water or acetone treated leaves were considered as control. After 24 hrs feeding, the larvae were transferred to normal leaves for studying the developmental period. For each concentration five replicates were maintained. During the developmental period, deformed larvae, pupae, adults and successful adults emerged were recorded. In addition, weight gain by the treated and control larvae were also recorded.

2.6. Data Analysis

Data analysis was carried out using Microsoft Excel 2007. Two-way ANOVA was performed for all the experimental data from that Least Significant Difference was calculated and the significant differences were marked with different alphabet.

3. Results

Leaves extracts of *T. involucrata* were prepared using solvents of hexane, chloroform and ethyl acetate and their bioactivities were tested at different concentrations against third instar larvae of *A. janata* and *P. ricini*. The bioactivity data were collected and subjected to one-way analysis of variance (ANOVA). Significant difference between the mean was separated using least significant difference (LSD) test.

Feeding inhibition activity of the leaves extracts of *T. involucrata* was studied at four different concentration and the results are presented in **Figure 1**. Antifeedant or feeding inhibition activity of solvent extracts was assessed based on antifeedant index. Higher antifeedant index normally indicates decreased rate of feeding. In the present study irrespective of concentration and solvents used for extraction the feeding inhibition activity varied significantly. Data pertaining to the above experiment clearly revealed that maximum feeding inhibition activity was recorded in chloroform extract 79.8% on *A. janata* and ethyl acetate extract 75.4% on *P. ricini* at 5 mg/l concentration compared to control. One-way analysis of variance (ANOVA) followed by least significant difference (LSD) test showed statistical significance ($p < 0.05$).

Larvicidal activity of leaves extracts of *T. involucrata* was studied at different concentrations and the results are presented in **Figure 2**. Larvicidal activity of solvent extracts was calculated based on larval mortality after treatment. High larval mortality normally indicates potential insecticidal activity of plant extracts. In the present study irrespective of concentration and solvents used for extraction the insecticidal activity varied significantly. Data pertaining to the insecticidal activity clearly revealed that maximum insecticidal activity was recorded in ethyl acetate extract in 60.4% on *A. janata* and followed by 65.3% on *P. ricini*. One-way analysis of variance (ANOVA) followed by least significant difference (LSD) test showed statistical significance ($p < 0.05$) compared

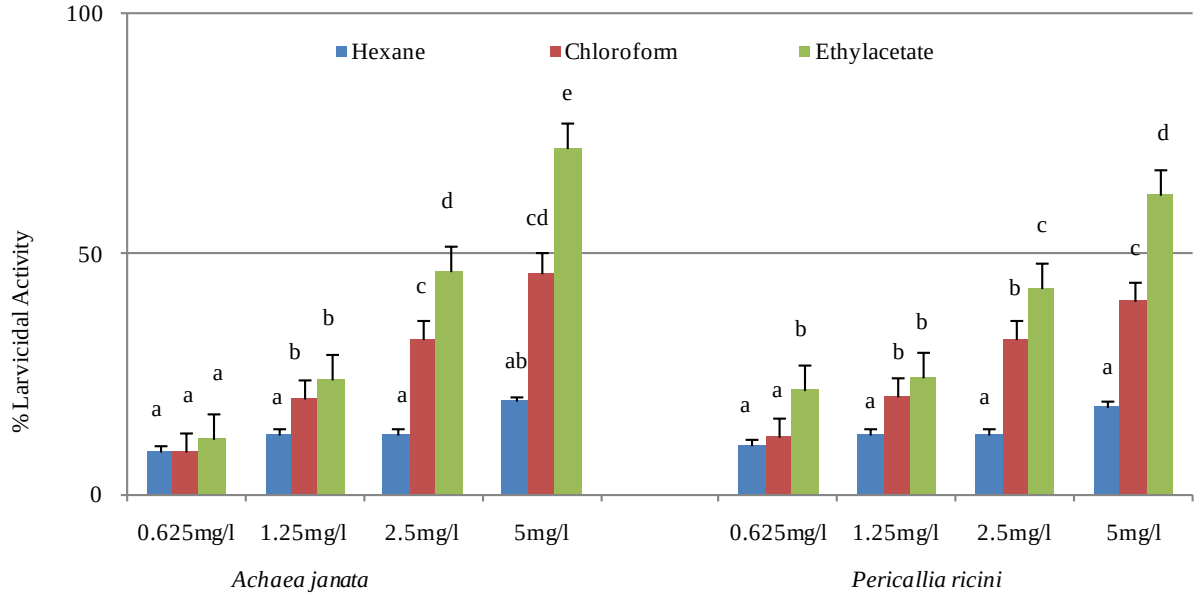

Figure 1. Feeding inhibition activity of crude extracts of *T. involucrata* against third instars larvae of *A. janata* and *P. ricini.* Values are mean of five replications. Within the column similar alphabets are statistically not significant ($p < 0.05$ by LSD).

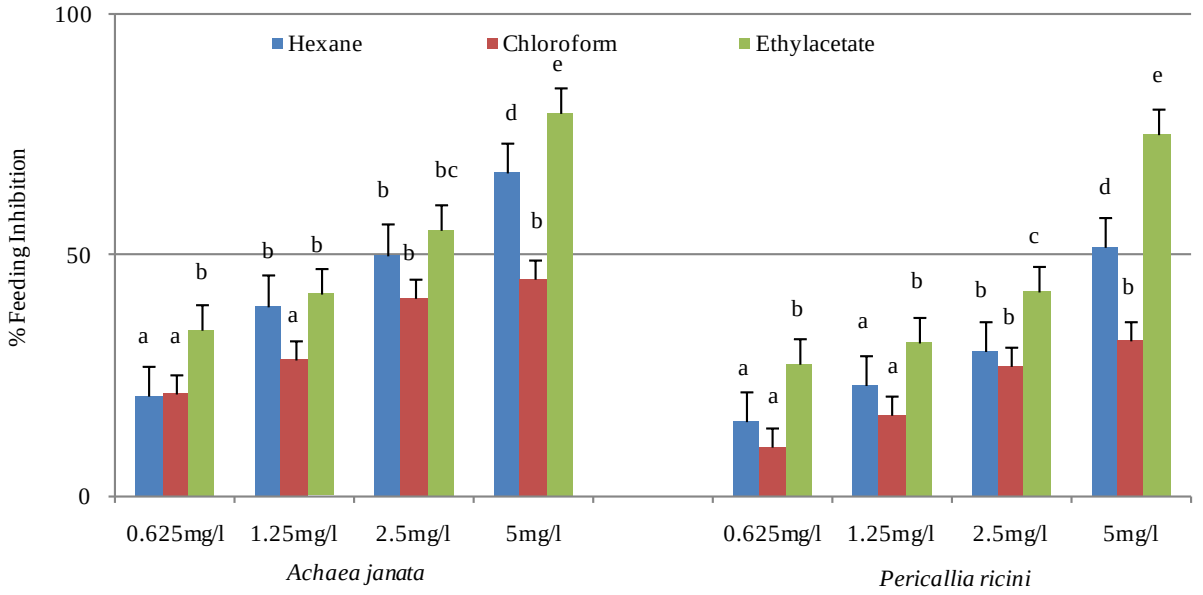

Figure 2. Larvicidal activity of *T. involucrata* against third instar larvae of *A. janata* and *P. ricini.* Values are mean of five replications. Within the column similar alphabets are statistically not significant ($p < 0.05$ by LSD).

to control. Percentage of deformities due to the treatment of crude extracts from *T. involucrata* at 5 mg/l concentration is presented in **Figure 3**. Maximum larval, pupal and adult deformities were observed in ethyl acetate extract on both insects. Percentage of successful adult emergence was minimum found to be in ethyl acetate extract in 13.8% and 15.4% on *A. janata* and *P. ricini* respectively.

4. Discussion

Plant damage caused by insect feeding is initiated by release of plant volatiles (attractants and phagostimulants), which help herbivores to locate their hosts. Some previously reported findings indicate that secondary plant metabolites exhibiting insecticidal and especially repellent (antifeedant) activities are the most acceptable and

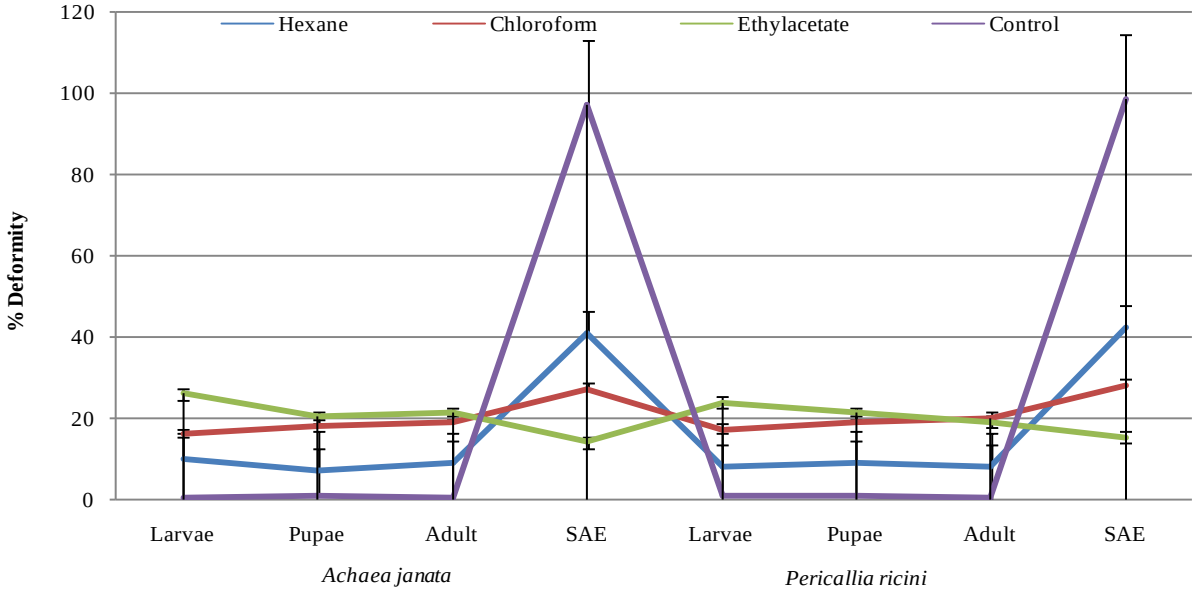

Figure 3. Insect growth activity of *T. involucrata* against third instar larvae of of *A. janata* and *P. ricini*. Values are mean of five replications. SAE: successful adult emergence.

without side effects [12]-[14].

The present study, chloroform and ethyl acetate extracts of *T. involucrata* was promising in reducing feeding rate of *A. janata* and *P. ricini*. The rate of feeding significantly varied depending on the concentration of the plant extracts. This indicates that the active principles present in the plants inhibit larval feeding behaviour or make the food unpalatable or the substances directly act on the chemosensilla of the larva resulting in feeding deterrence. The present results suggest that leaves extracts sufficiently inhibited the responses of larvae to these specific stimuli. The physical properties of the tested extract probably were not significant in the sense of feeding inhibition, since there were not visible differences between treated and untreated leaves. Therefore, prevention of leaf damage achieved by the application of tested extract could be mainly attributed to their active compounds. These findings are in agreement with the earlier reports of Jeyasankar *et al*., [15]-[17].

Screening plant extracts for deleterious effects on insects is one of the approaches used in the searching for novel botanical insecticides [18]. Secondary plant compounds act as insecticides by poisoning per se or by production of toxic molecules after ingestion. These compounds also deter or possibly repel an insect from feeding [19]. In the present study ethyl acetate extract of *T. involucrata* exhibited significant larvicidal activity at higher concentration (**Figure 2**). It is possible that the insecticidal property present in the selected plant compound may arrest the various metabolic activities of the larvae during the development and ultimately the larvae failed to moult and finally died. Insect growth regulation properties of plant extracts are very interesting and unique in nature, since insect growth regulator works on juvenile hormone. The enzyme ecdysone plays a major role in shedding of old skin and the phenomenon is called ecdysis or moulting. When the active plant compounds enter into the body of the larvae, the activity of ecdysone is suppressed and the larva fails to moult, remaining in the larval stage and ultimately dying [20]. In the present study, deformed development of larvae, pupae and adults were noted. Among the solvents extract tested, percentage of deformed larvae, pupae and adults were observed maximum on ethyl acetate extract of *T. involucrata*.

The morphological deformities at larval, pupal and adult stages are due to toxic effects of subfractions on growth and development processes. Since morphogenetic hormones regulate these processes, it can be suggested that these solvent crude extracts interfere with these hormones of the insects. These results are consistent with the earlier reports on various lepidopteran species [21]-[23].

5. Conclusion

Ethyl acetate extract of *T. involucrata* showed higher antifeedant, insecticidal and growth inhibition activities against agriculture important pests of *A. janata* and *P. ricini*. Hence, it may be suggested that the extract of *T.*

involucrata can be used for controlling the economically important oil crop insect pests.

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Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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