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Insecticidal Potential of Aquatic Alien Weed, *Eichhornia crassipes* (Mart) Solms on Tobacco Caterpillar, *Spodoptera litura* (F.)

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ABSTRACT

Insecticidal potential of aerial parts of E. crassipes against S. litura under laboratory was studied. Antifeedancy was recorded 57.8% in n-hexane extract and 35.9% in methanol extract against S. litura. Significant correlation was recorded between the antifeedant activities of treated leaves against S. litura. Phytochemicals present in E. crassipes through GCMS analysis showed secondary metabolites such as Docosane and Nonacosane reported to have synamonal activity; Camarolide and Erucylamide with promising insecticidal activity. Presence of fatty acids in n-hexane and methanol extracts of E. crassipes was found to be used to manage S. litura. Therefore, potential utilization of E. crassipes as a natural insecticide is an alternative for the management of E. crassipes.

Keywords: *Eichhornia crassipes*, Insecticide, Aquatic weed, *Spodoptera litura*

INTRODUCTION

Eichhornia crassipes (Mart) Solms (Pontideraceae) is a free floating invasive aquatic weed. It causes serious environmental problems to water ecosystems [1]. A large number of biologically active compounds have been extracted from this weed [2-4]. The devastating aquatic weed, *E. crassipes* found to have good antimicrobial, anticancerous and antioxidant activities [5,6]. GC-MS analysis of *E. crassipes* showed active compounds of pharmaceutical importance viz., Ambrosiol, Camarolide and Muricin B [7]. Different applications found for *E. crassipes* makes it suitable feed for many animals, source of protein for man, recommended in farming as fertilizer and compost for mushroom culture, to improve harvests of certain cereals and has been tested as source of pulp for the production of paper. Insecticides of plant origin have been exploited from time immemorial for the management of insect pests of crop plants [8]. However, there is paucity of information on insecticidal potential of *E. crassipes*. Hence, aerial parts of *E. crassipes* is analysed in the present study for its insecticidal potential.

MATERIALS AND METHODS

Collection of plant sample

Aerial parts of *E. crassipes* were collected from Coimbatore city, Tamil Nadu, India situated between 10°57'57.6" latitude and 76°57'48.96" longitude. The aerial parts of *E. crassipes* were chopped into small pieces and air dried at room temperature. The dried samples were ground into fine powder for further analysis.

Plant extraction

100 g of *E. crassipes* dried powder were subjected to hot extraction using soxhlet apparatus with methanol and n-hexane as solvents. After distillation, extracts were recovered from the solvent by subjecting to rotary evaporator (water bath: WB 2000, rotar: VV2000, cooler: superstat mini AB 1600). The same procedure was replicated thrice to get optimum extract.

Estimation of secondary compounds

Secondary metabolites were estimated from the extract with the following standard methods Phenols [9], free fatty acids [10], tannins -Vanillin hydrochloride method [11] and flavonoids - Aluminium chloride colorimetric assay method [12].

Evaluation of insecticidal activity

Synthetic insecticides are panacea for the management of insect pests. However, there are problems of pesticide resistance and negative effects on human beings and the environment. Therefore, search of alternative means of pest control is warranted to minimize the use of synthetic chemicals. Use of botanical pesticides is now emerging as a major means to protect crops from insect pests.

S. litura is an important insect pest of agricultural crops. It is a highly polyphagous defoliator on many cultivated plants (over 120 plants). Hence, larvae of *S. litura* were used in this study. They were collected from castor field, Annur, Coimbatore. The culture was maintained on *Ricinus communis* L. at room temperature (25 ± 2°C) and 16: 8 L: D photo period in the laboratory. 200 mg of the methanol and n-hexane extracts of *E. crassipes* was made upto 10 ml and these samples were used for the study. 3-4 h starved larvae were introduced into the container where pre-treated leaves with the extracts of *E. crassipes* were placed and the larvae were allowed to feed. Leaf area (cm^2) consumed by insect was assessed using Image analyzer (Leica Quantimet called QWin 500) (Figure 1). After treatment the leaves were spread in a platform and images were taken into the software called QWin using a CCD camera. The images were then calibrated to actual scale. The calibrated images were measured for the leaf area fed by the insect and the total leaf area using QWin. The 2D surface area was calculated as the area of a leaf occupied in the calibrated 2D image expressed. The antifeedant index (percent antifeedancy) was calculated using the following formula, Antifeedant index=[(C-T)\(C+T)] × 100. Where "C" is the area of leaf consumed in the control and "T" is the area of leaf consumed in the treatment [13].

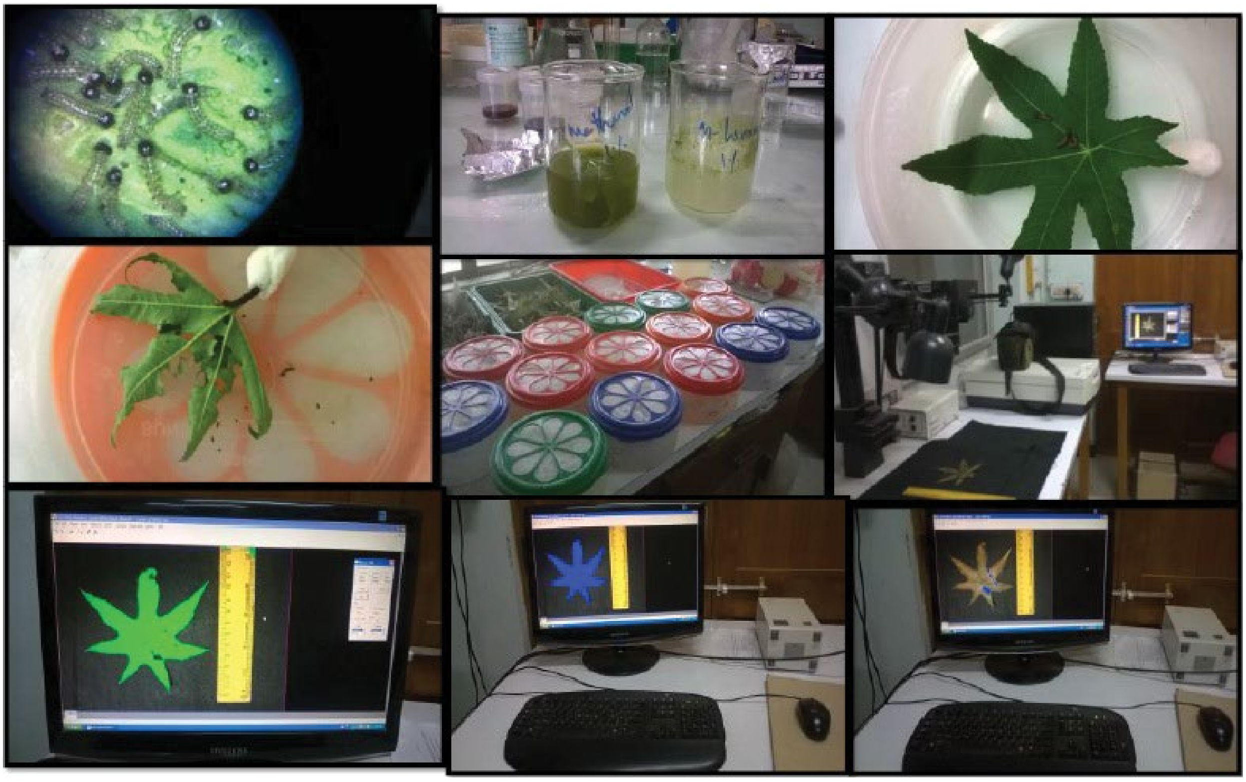

Figure 1: Test procedure of anti-feedant activity of methanol and n-hexane extracts of *E. crassipes* against *Spodoptera litura*

STATISTICAL ANALYSIS

The data obtained on anti-insect pests assay were analyzed statistically tested through ANOVA, and the mean values compared by using LSD and DMRT with the level of significance set at $p<0.05$ using SPSS (version 16.0) software for ascertaining treatment differences. Correlation coefficient to compare the correlation among treatments and cluster analysis to identify the relationship among treatments were analysed in terms of insecticidal properties using statistical software STATISTICA (version 6.0).

RESULTS AND DISCUSSION

It is well known that the threats posed by *E. crassipes* on water bodies. Hence, various management measures have been taken to eradicate this weed. Though various uses of this weed have been identified, insecticidal property of *E. crassipes* is not yet attempted. Thus the effective utilization of water hyacinth with respect to insecticidal values is made in this study.

Quantitative analysis of secondary metabolites

The methanol and n-hexane extracts of aerial parts of *E. crassipes* were screened for different classes of phytoconstituents such as alkaloids, steroids, terpenoids, glycosides, flavonoids, tannins, phenolic compounds, saponin and carbohydrates using standard methods [13,14]. It was found that the free fatty acid content in both the extracts is high compared to other phytochemicals (Figure 2). The maximum amount of free fatty acids is present in oils of Coriander (59.25 mg/gm) and Neem (23.98 mg/gm) [10]. Because of the higher ranged value, neem and coriander oil cannot apply edibly while using for medicinal purpose. From the study it is evident that the fatty acids present in methanol extract (56.10 mg/gm) and n-hexane extract (84.15 mg/gm) which are found to be higher and can be employed therapeutically. Tannins, water-soluble polyphenols have been reported to reduce feed intake, growth rate, feed efficiency, and protein digestibility in many experimental animals. The total tannin is determined by Vanillin hydrochloride method [11]. Methanol extract was found to be more tannin content than n-hexane extracts of *E. crassipes*. The maximum phenolic content was found in the methanol extract (2.21 mg/g) of *E. crassipes*. Trace amount of flavonoid was also observed in methanol extract of *E. crassipes*.

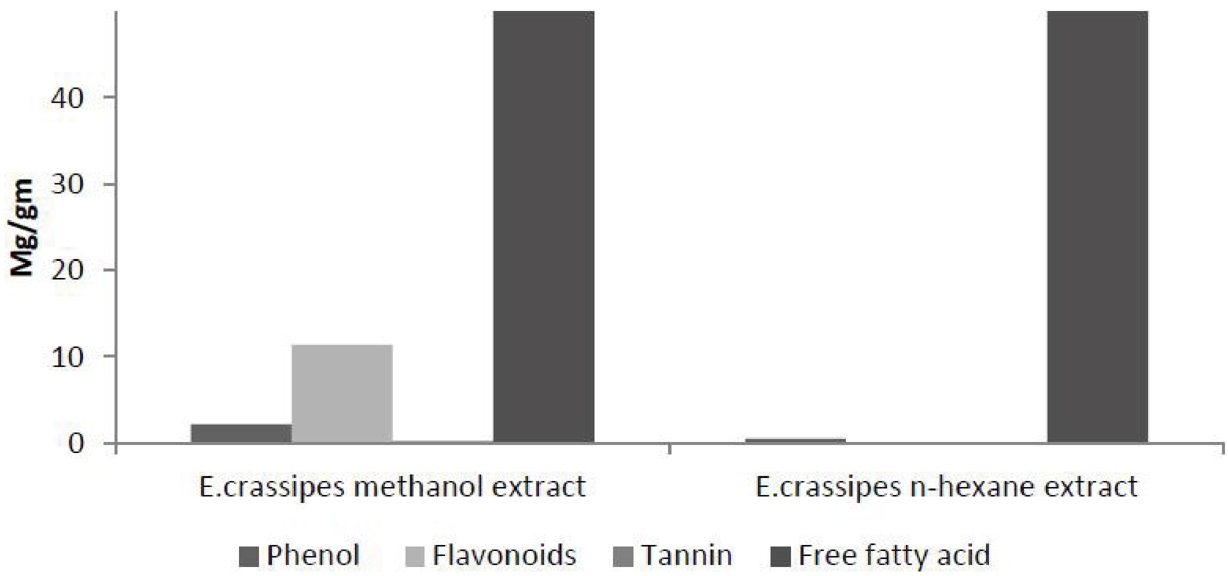

Figure 2: Quantitative analysis of secondary metabolites

Antifeedant activity of E. crassipes aerial extracts against *S. litura*

S. litura is one of the polyphagous insect pests of many economically important crops. Biologically active substances derived from plants and microbes affect the growth and development of insects and provide protection against herbivores [15-17]. Botanical and microbial pesticides are highly effective, safe, and ecologically acceptable, since use of insecticides to control insects has resulted in resurgence and pesticide resistance [18]. Hence, the present study aimed to evaluate antifeedant efficacy of methanol and n-hexane extracts of *E. crassipes* (20,000 ppm) against *S. litura*. The antifeedant activity varied significantly among the two different extracts of *E. crassipes* when compared to control. Antifeedant effects of methanol and n-hexane extracts were evaluated based on leaf area consumed by *S. litura* (Table 1). The antifeedant activity was recorded high in n-hexane extract (57.83%) than methanol extract

(35.99%), indicated that n-hexane extract was maximum in reducing feeding rate of *S. litura* (Figure 3). It was reported that essential oils [19] of some medicinal plants possessing antifeeedant property against *S. litura* which includes *Syzygium lineare*, *C. fistula* [20], *Pedalium murex* [21], *Tectona grandis*, *Tamarindus indica*, *Madhuca indica*, *Momordica charantia*, *Jatropha curcas* [22], *Pergularia daemia* [23] and *Synedrella nodiflora* [24].

Table 1: Antifeedant activity of methanol and n-hexane extracts of *E. crassipes* against *Spodoptera litura*

S. No.	Test	Area of the leaf (cm^2)	Total area fed (cm2)	Leaf area fed by insect (%)	Antifeedant activity (%)
1	Control	32.44	2.75	1.59	0
2	Methanol extract	30.94	1.29	1.11	35.99
3	n-hexane extract	44.65	0.73	0.38	57.83

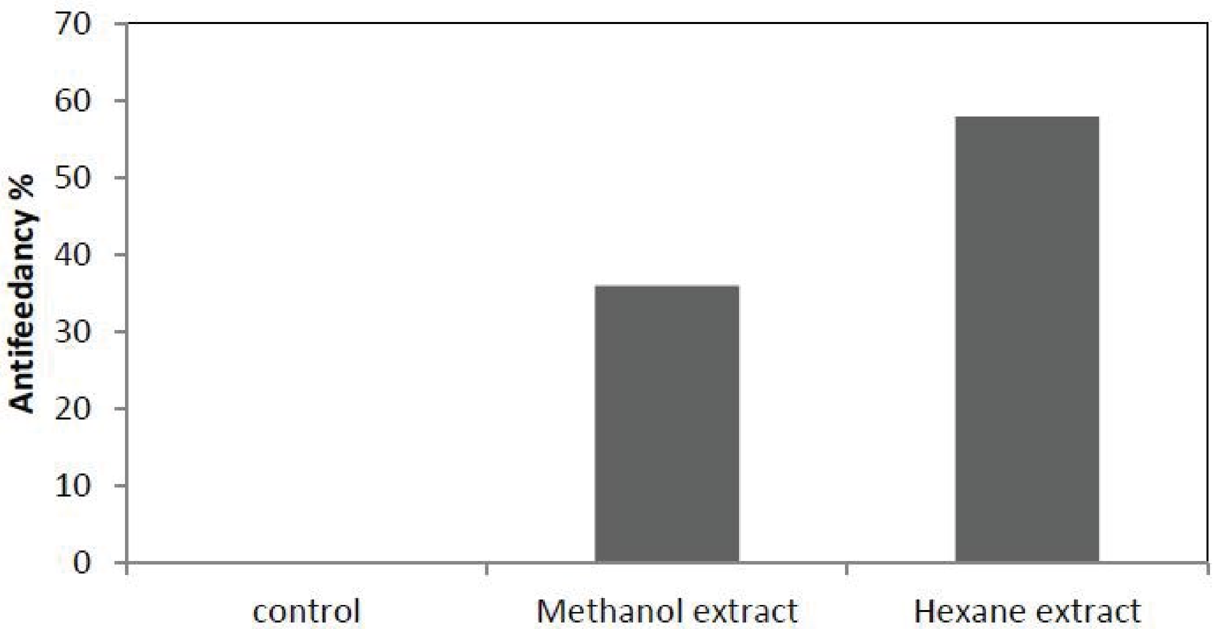

Figure 3: Antifeedancy of *E. crassipes* against *Spodoptera litura*

Table 2: Correlation matrix of antifeedant activity of *S. litura* against solvent extracts of *E. crassipes* aerial part (Marked correlations are significant at p<0.05; N=3)

	Control	Methanol extract	n-hexane extract
Control	1	-0.974	-0.9782
	p= ---	p=0.145	p=0.133
Methanol extract	-0.974	1	0.9998
	p=0.145	p= ---	p=0.012
n-hexane extract	-0.9782	0.9998	1
	p=0.133	p=0.012	p= ---

Antifeedant is a chemical that inhibits insect feeding without killing the insect pests directly, while insect dies through starvation [25]. Antifeedant activity of *S. litura* was found to be negatively correlated with methanol (-0.974) and n-hexane extracts (-0.9782) (Table 2). Significant correlation was recorded (p=0.012) between the antifeedant activity of treated leaves against *S. litura*.

Plants have a range of secondary metabolites like alkaloids, terpenoids, flavonoids, phenols, glycosides, sitosterols and tannins which are known to protect the plants from insect-pests and pathogens [26]. Cluster analysis of *E. crassipes* solvent extracts with reference to antifeedant activity of *S. litura* revealed that the methanol extract was grouped with control and the n-hexane extract stands independent due to its high antifeedant activity. The present study revealed that the n-hexane extract of *E. crassipes* was promising in reducing feeding rate of *S. litura*. The active principles present in *E. crassipes* inhibit feeding behaviour of *S. litura* resulting in feeding deterrence. Phytochemicals present in *E. crassipes* through GCMS analysis showed secondary metabolites such as Docosane and Nonacosane with synamonal activity; Camarolide and Erucylamide with promising insecticidal activity [7]. Quantification of antifeedant effect of botanicals in the field of insect pest management is very important [27]. Several plants have been reported to have antifeedant activity against *S. litura* at varied frequencies. Plant derived insecticidal compounds alter behaviour and physiology of insects. Quinoline, indole alkaloids, sesquiterpene lactones, diterpinoids and triter-pinoids are reported as most potent insect antifeedants [28]. Alkaloid and quinines were observed to be the maximum insecticidal activity in the ethyl acetate extract leaves extract of *A. aspera* against *Henosepilachna vigintioctopunctata* [29]. Many reports are available on insecticidal activity of many plants and their compounds against different groups of insects [30]. Erucylamide was found to have insecticidal property [31]. GCMS analysis of *E. crassipes* found to have Erucylamide [7].

CONCLUSION

E. crassipes is an alien invasive aquatic weed causing a serious threat to aquatic ecosystem throughout the world. Various management measures have been taken to control this aquatic weed throughout the globe, but nothing is found effective. *E. crassipes* is found to possess phytochemicals with many biological properties. The present study has proved that methanol and n-hexane extracts of aerial parts of *E. crassipes* significantly reduce the feeding rate of polyphagous insect pest, *S. litura*, hence, found to have antifeedant potential (35-57%) due to presence of various phytochemicals of insecticidal potential found through GCMS analysis. Hence, *E. crassipes* may be considered as a potential biopesticide for the management of *S. litura*.

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