



Bioactivity of marine brown algae *Padina gymnospora* (Kutzing) Sonder on *Spodoptera litura* (Fabricius)

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Abstract

Investigations were carried out to evaluate the insecticidal potential of abrown algal seaweed *Padina gymnospora* on the leaf eating caterpillar, *Spodoptera litura* (Fabricius). In the Department of Entomology, Faculty of Agriculture, Annamalai University, India during 2019 - 2020. The seaweed solvent extracts (methanol, acetone and hexane) were screened against homogenous population of *S. litura* (third instar larva) using contaminated food bio-assay technique with the following concentrations 0.1, 1, 3, 5, 7, 10 and 20 per cent. The highest larvicidal activity (100%) was observed after 72 hours of treatment at the maximum concentration (20%) and the least larval mortality were observed in 0.1 per cent concentration of acetone extract (13.33%). *Padina gymnospora* at higher concentration levels influenced cent per cent larval mortality wherein none of the treated larvae have not transformed into pupa whereas the larva treated with hexane extract demonstrated insect growth regulator activity viz., pupal malformations whereas the adult emergence rate was lower in acetone extract as compared to hexane extract in the meantime cent per cent adult emergence was noticed in respective solvent and untreated control treatments. The observed larval: adult conversion ratio demonstrated that the methanol extract was superior than the acetone and hexane extracts.

Keywords: *Padina gymnospora*, larval mortality, insect growth regulator-*Spodoptera litura*

Introduction

The tobacco caterpillar, *Spodoptera litura* (Fabricius) is an economically important and regular polyphagous pest attacking an array of field and horticultural crops and estimated to cause 26-100 per cent yield loss under field conditions in more than 180 crops worldwide. The development of resistance to existing conventional synthetic pesticides and the increasing public concern over environmental pollution and health hazards created by synthetic pesticides, generated a great need for new types of pest management agents advantageous with higher activity and lower impact on humans and environment (Kombiah and Sahayaraj, 2012) [11]. Marine algae have reported to possess many bioactive chemicals and active against bacteria, fungus, insects, nematodes etc (Smit *et al.*, 2004). Many red, brown and green algae viz., *Corralina mediterranea*, *Jania rubens*, *Pterocladia pinnata*, *Cladophoradalmatica*, *Enteromorpha intestinalis*, *Ulva lactuca* and *Ascophyllum nodosum* were widely used in agriculture due to their good biostimulant activity (Tuhy *et al.*, 2013) [19]. In this context, the anti-insect properties *Padina gymnospora* was investigated against *S. litura*.

Materials and Methods

Collection of seaweed

The seaweed (*Padina gymnospora*) was collected from Hare Island in Tuticorin. The fresh and healthy seaweed samples were collected from the free floated low-tide regions and from coral and small rocks based on their availability. The collected samples were washed with ample seawater to remove unwanted impurities prior to transferal to the laboratory and then washed thrice using tap water. The water was drained off and dried by spreading over the blotting paper followed by further drying under the shade for ten days under room temperature. The shade dried samples were stored in refrigerator at 4°C.

Preparation of seaweed extracts

The brown algal seaweed of *Padina gymnospora* were partially powdered, packed and loaded separately in Soxhlet apparatus (30g) and refluxed with 300ml of organic solvent (Methanol, Acetone, Hexane) for 12 hours continuously. The extracted solvent extracts were transferred into 500ml beaker and evaporated on a hot plate. The collected solvent extract residues were stored in air tight reagent bottles at 4°C under refrigerator condition until further use. The final extract as stock solution was used for the experiments. The extracts were stored at -20°C (Kannan and Dharanipriya, 2019) [9].

Preparation of stock solution

The seaweed solvent extracts were evaluated against the *Spodoptera litura*, for which 10 per cent stock solution was prepared by diluting 10gms of final extract in 100ml of respective solvent in standard flask and used for bio-assay experiments.

Mass culturing of *Spodoptera litura*

Field collected egg masses of Tobacco caterpillar *S. litura* were used to initiate the culture. The emerging neonates were maintained in 0.05 per cent sodium hypochlorite sterilized castor leaves kept inside a plastic basin (30 cm dia.) covered with muslin cloth. Fresh castor leaves provide to the larvae until they reached to pupation. The pupating larvae were transferred to plastic tray containing sterilized soil. After pupation, they transferred to a oviposition cage (45×25×25). The emerged adults (five pairs) are supplied with honey solution as food and allowed to mating. After which they start to lay eggs on nerium twigs (in conical flask with water) which is kept inside the adult cage. After the eggs are hatched up, the neonates were fed up with fresh castor leaves until they reached third instars. Now the uniformed size third instars larvae were used to conduct the bio assay experiments.

Leaf disc method (free choice)

Padina gymnospora seaweed extracts were evaluated against the test insect using leaf disc bioassay utilizing different solvents (methanol, acetone and hexane) and different concentrations viz., 0.1, 1.00, 3.00, 5.00, 7.00, 10.00 and 20.00 per cent and compared with solvent control and untreated control with three replications under completely randomized block design. Fresh castor leaf disc (5 cm²) was dipped in various concentrations for two minutes and allowed to evaporate at room temperature. They were then kept in individual petriplates (9 cm dia) containing five pre starved newly molten 3rd instar larvae of *S. litura*. The larvae were allowed to feed on treated discs for 24 hours and the observations were recorded on larval mortality, pre-pupal mortality, pupation percentage, pupal malformation, pupal mortality and adult emergence, and the data was statistically analyzed. (Kannan and Bharathkumar, 2016) [8].

Results and Discussions

Studies on different solvent extracts (Methanol, Acetone and Hexane) of brown algal seaweed *Padina gymnospora* for their efficacy against growth and development of *Spodoptera litura* exhibited various out comes at different levels of concentration. The algal extracts of respective solvents at different concentration viz., 0.1, 1.0, 3.0, 5.0, 7.0, 10.0 and 20.0 per cent registered larval mortality at 72 hours of treatment, wherein the mortality level ranged between 0.00 and 100 per cent. Cent per cent mortality was observed in the 3.0, 5.0, 7.0, 10.0 and 20.0 per cent concentration of methanol extract treatments at 72 hours of exposure and the concentrations like 0.1 and 1.0 per cent concentrations have scored 93.33 per cent larval mortality. Acetone extract at 20.00 per cent recorded 66.66 per cent larval mortality after 72 hours of treatment, whereas at the same concentration hexane extract have registered 46.66 per cent mortality with no larval mortality in both the solvent and untreated controls of all the solvent extract experiments (Fig. 1).

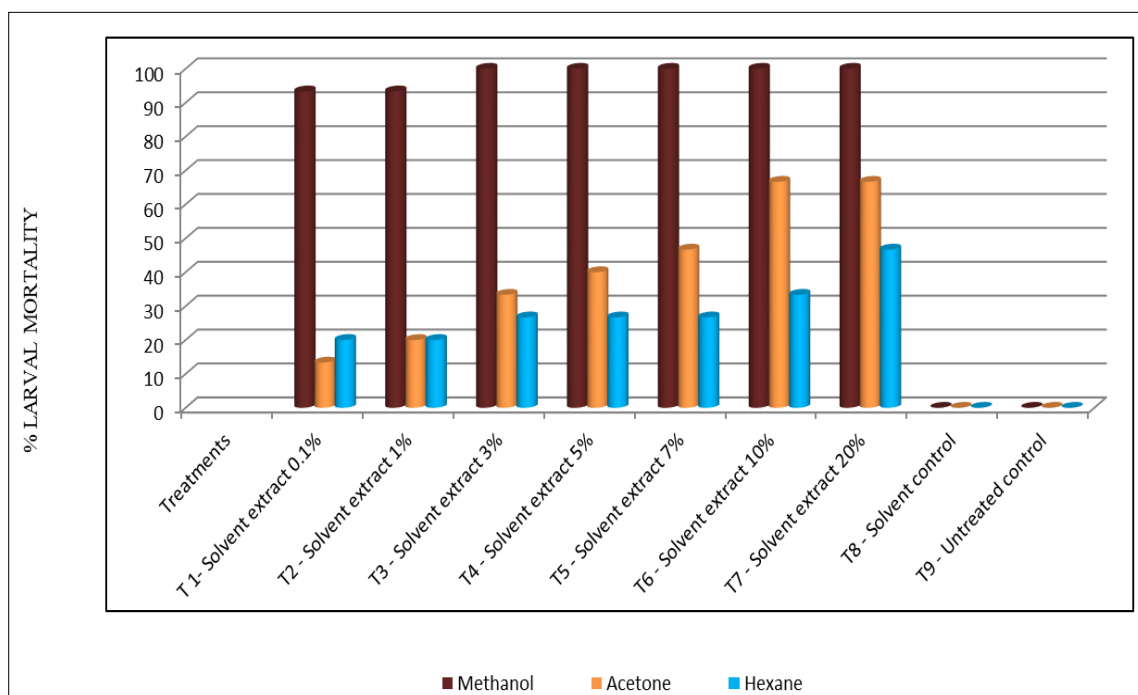


Fig 1: Larval mortality of methanol, acetone and hexane solvent extracts of brown algal seaweed *Padina gymnospora* on *Spodoptera litura*

Data recorded to assess the IGR activity of the insect treated with the solvent extracts of the brown algal seaweed *Padina gymnospora* on *Spodoptera litura* displayed the following results. The pre-pupal mortality of 0.1 and 1.0 per cent concentrations of methanol extract was 6.66 per cent and all the acetone extract treatment exhibited 13.33 per cent pre-pupal mortality (Fig. 2). The highest pupation percentage (80.00%) was recorded in 0.1 and 1.0 per cent concentration of hexane extracts and least in 20.0 per cent concentration (53.33%) (Fig. 3). Pupal malformation was observed in insects received with which ranged between 6.66 to 13.33 per cent on hexane extract (Fig. 4). The highest adult emergence was observed in 0.1 and 1.0 per cent concentration of hexane extract and minimum emergence was recorded by 10.00 and 20.00 per cent concentration of Acetone extracts (13.33%) whereas similar pupation (100%) and adult emergence (100%) was observed in solvent and untreated control of all the solvents (Fig. 5).

Table 1: Larval to adult conversion ratio of *S. litura* as influenced by solvent extracts of *Padina gymnospora*

IGR Activity	Solvents	Treatments									
		T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	Solvent control	Untreated control	
L to A conversion ratio	Methanol	1:0	1:0	1:0	1:0	1:0	1:0	1:0	1:0	1:0	1:0
	Acetone	1:0.73	1:0.66	1:0.53	1:0.46	1:0.40	1:0.13	1:0.13	1:1	1:1	
	Hexane	1:0.80	1:0.80	1:0.66	1:0.66	1:0.66	1:0.60	1:0.40	1:1	1:1	

L to A - Larval to Adult Conversion Ratio

The survived larvae were transformed into pupal stage and it was observed that all of them have metamorphosed to adults with different conversion ratio Between 1:0 to 1: 0.80 larval to adult conversion ratio with the lowest L: A conversion ratio was exhibited by hexane at 20% 1:0.40 followed by acetone 1:0.13 (Table1).

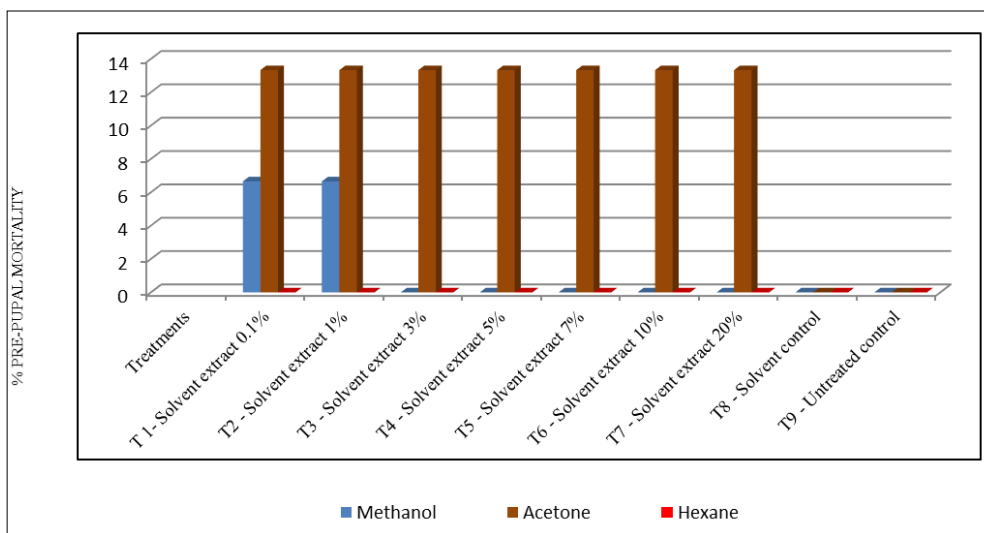


Fig 2: Pre-pupal mortality of methanol, acetone and hexane solvent extracts of brown algal seaweed *Padina gymnospora* on *Spodoptera litura*

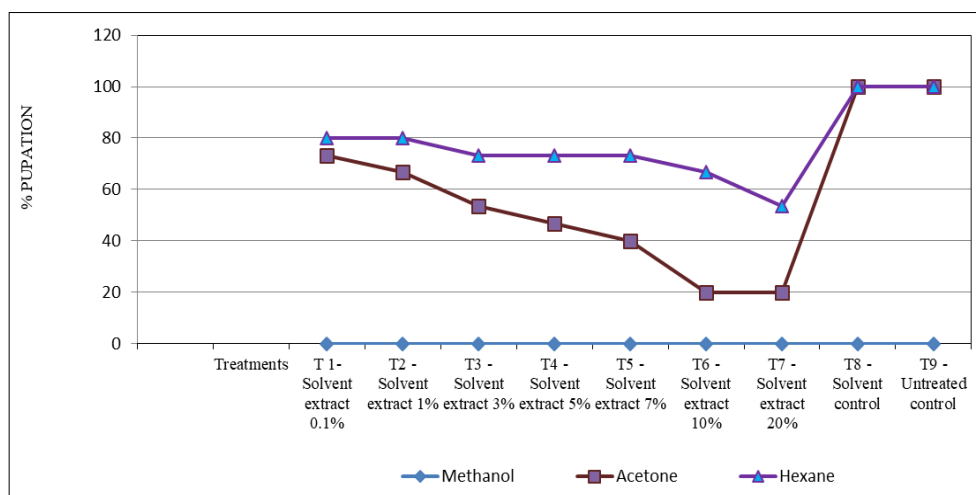


Fig 3: Pupation percentage of methanol, acetone and hexane solvent extracts of brown algal seaweed *Padina gymnospora* on *Spodoptera litura*

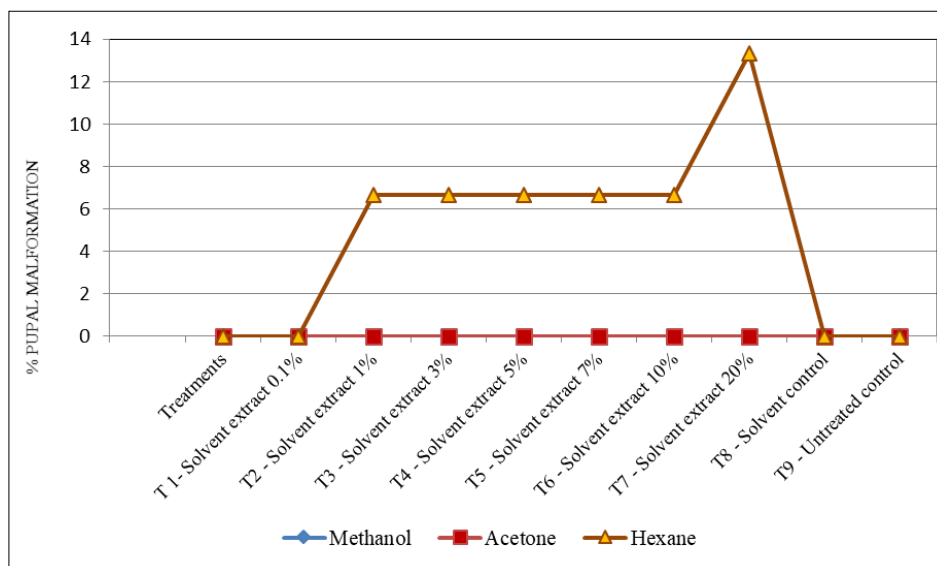


Fig 4: Pupal malformation of methanol, acetone and hexane solvent extracts of brown algal seaweed *Padina gymnospora* on *Spodoptera litura*

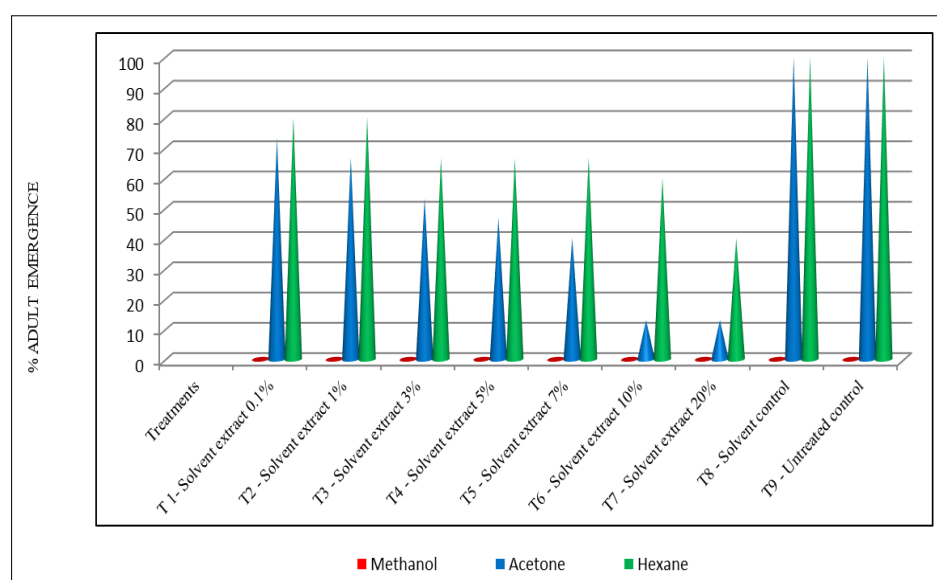


Fig 5: Adult emergence of methanol, acetone and hexane solvent extracts of brown algal seaweed *Padina gymnospora* on *Spodoptera litura*

The present findings revealed that the methanol extract of *Padina gymnospora* was most promising solvent extract at different concentrations have influenced higher larval mortality as compared to solvent and untreated controls. The IGR activity prominent by the brown algae on the test insect as confirmed in this study has been connected positively with a published scientific statement of Ahmad *et al.* (2016) [1] in which the pupal transformation and adult emergence rate of *A. aegypti* and *A. albopictus* have inhibited by *Sargassum siliquosum*. Similar reports by many authors revealed that the highest death rate was exerted by *Dictyopa crenubtu* against *Tuta absoluta* (Soto and Martin, 2002) [17]; sterility was caused by *S. tenerrimum*, also reduced nymphal growth, adult longevity and egg laying capacity of *D. cingulatus* (Sahayaraj and Jeeva, 2011) [14]; *P. pavonica* evident nymphicidal and ovicidal activity against *D. cingulatus* (Sahayaraj and Kalidas, 2011) [15]; the midgut physiology of *Anopheles sundaicus* was interfered by *S. wightii* (Kumar *et al.*, 2012) [12]; *S. wightii* and *P. pavonica* exerted nymphicidal and ovicidal activity against *D. cingulatus* (Asaraja and Sahayaraj, 2013) [2]; *A. nodosum* reduced the pest population by altering growth and development of immatures of Thrips and Persian mite (Holden and Ross, 2014) [7] and *Sargassum binderi* reduced the adult emergence rate of *A. aegypti* (Yu *et al.*, 2015) [20].

Similarly, the brown seaweed algae *P. pavonica* has been well studied since the beginning of the last century and is, environmentally and medically, an important algae, and extensively used as a feedstock for the production of biodiesel (El Maghraby *et al.*, 2014) [4], in heavy-metal biosorption, as a pollution bioindicator (Geraldino *et al.*, 2005) [6], a trace metal biomonitor (Campanella *et al.*, 2004), an antioxidant (Khaled *et al.*, 2012) [10], an anticancer drug (by inducing apoptosis of cancer cells) (Stanojkovic *et al.*, 2013) [18], an antibacterial agent (Sahayaraj *et al.*, 2012) [11, 13] and a bioinsecticide (Elbanna and Hegazi, 2011) [5].

Conclusion

Based on the observed results it was concluded that the methanol extract of brown algal seaweed *Padina gymnospora* at the highest concentration have caused the maximum larval mortality as compared to acetone and hexane extracts.

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