Bioefficacy of a mangrove plant, *Sonneratia caseolaris* and a mangrove associate plant, *Hibiscus tiliaceus* against certain agricultural and stored product pests

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ABSTRACT

The insect antifeedant and toxic activity of two marine plants, *Hibiscus tiliaceus* and *Sonneratia caseolaris* on the herbivorous insects, *Spodoptera litura* F. were tested in the laboratory. The crude extracts were further purified in a column and their purified fractions were assessed for their antifeedant and insecticidal activity. The leaves extracted separately with acetone yielded crude extract which showed significant antifeedant activity to the 2nd as well as 3rd instar larvae of *S. litura*. The topical application of the plant crude extracts resulted in causing toxicity to the lepidopteran pest which was not more than 50 per cent with both the plant treatments. The extracts had considerable effect on the *S. litura* metamorphosis in the form of a delayed pupal formation and morphogenetic abnormalities in pupae due to the larval treatment, which affected the percentage adult eclosion. The crude leaf extract possesses moderate insecticidal activity to three of the major stored product pests, the flour beetle, *Tribolium castaneum* H., the rice weevil, *Sitophilus oryzae* L. and the lesser grain borer *Rhyzopertha dominica* (F.). All eluted fractions from *H. tiliaceus* and *S. caseolaris* have shown excellent antifeedant activity on *S. litura* than crude extracts. Particularly hexane eluted fraction of the crude extracts of both the marine plants showed potent growth inhibitory activity. We infer that the marine dwelling plants *H. tiliaceus* and *S. caseolaris* extracts has good feeding inhibitor activity to *S. litura* and a moderate toxicity to three of the major stored product pests.

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INTRODUCTION

Mangrove plants are a rich source of steroids, triterpenes, saponins, flavonoids, alkaloids, tannins (Nayak *et al*., 2014) that show different biological activities such as antifungal, antibacterial, antifeedant, molluscicidal, and pesticidal properties (Varahala Rao and Naidu, 2009). As several distinct chemicals are present in the extracts of various parts of the mangrove plants, they have been used for centuries as a popular method for treating several health disorders (Nayak *et al.,* 2014). Of late, research interest on mangrove plant exploration for medical usage and their utility in drugs for several ailments such as cancer, aids, etc has been increased (Batsa and Periyasamy, 2013). However, only a few number of reports are available on their agricultural use, particularly their utilization in pest management practices (Jeyasankar *et al*., 2014; Kabaru and Gichia, 2001).

Coringa mangrove forests situated in the estuary of river Godavari supports rich mangrove vegetation with species like Rhizophora, Avicennia, Sonneratia, and Aegiceros and is the largest surviving patch of Mangrove forests in the state of Andhra Pradesh with more than 65 Mangrove tree species (ICMAM) citations). Among these, mangrove associates, *Hibiscus* and *Sonneratia* are the two important genuses. *Hibiscus tiliaceus* Linn. (Malvaceae) is a mangrove associate; which is commonly known as sea hibiscus that occurs in the coastal environment and is also found within mangroves (Wong and Chan, 2010). Sea hibiscus is well adapted to grow in coastal environment in that it tolerates salt and water logging and can grow in quartz sand, coral sand and limestone. It is a fast-growing tree that reaches 15 m tall (Chan and Baba, 2009), and has several therapeutic uses such as cooling fever, soothing cough and removing phlegm, etc., whereas, flowers are used in treating ear infection and abscess and birth control in Asia and Africa (Rosa *et al*., 2006). Hibiscus genus are generally rich in a variety of bioactive molecules, such as lignanamides, phytosterols naphthalenes, tocopherols, polyphenols, carotenoids, flavonoids, anthocyanins, and long chain fatty esters (Holser *et al*., 2004). The plant is edible and almost all parts are consumed as vegetable in several regions of the world (Jariyah *et al.,* 2014).

The genus *Sonneratia* consists of nine species in the tropical and subtropical regions worldwide (Wang and Chen, 2002). It is reported that *Sonneratia caseolaris* L. (Lythraceae) is a mangrove plant among the *Sonneratia* family and is traditionally used as an astringent and antiseptic, sprain poultices, in treating piles and also in arresting hemorrhage (Bandaranayake, 1998). Since none of these plants were explored for their insect pest control activity, here we aimed at studying their bioefficicay against a major agricultural pest, *Spodoptera litura* F, and three major stored product pests, *Tribolium castaneum, Rhyzopertha dominica* (F.) and *Sitophilus oryzae* L.

Spodoptera litura (Fab.) (Lepidoptera: Noctuidae), is a notorious polyphagous pest distributed throughout the world. In India, *S. litura* severely damages several plants and the crop losses due to this pest vary between 10% and 30% in major crops (Ferry *et al*., 2004). The stored product pests, *Tribolium castaneum* (Herbst) (Flour beetle), *Sitophilus oryzae* L. (rice weevil) and *Rhyzopertha dominica* (F.) (Lesser grain borer) occur worldwide and cause serious problems to stored and processed grain products by reducing their dry weight and nutritional value. The present work reports the insect antifeedant activity as well as the larval and pupal toxicity of the leaf extracts of two marine plants *H. tiliaceus* and *S. caseolaris* to *S. litura* and also fumigation toxicity against stored grain pests *T. castaneum, R. dominica*, and *S. oryzae.*

MATERIALS AND METHODS

Insects and plant materials

Castor (*Ricinus communis* L.) plants of known variety (Kiran var.) were grown in the fields of the CSIR-IICT, Hyderabad, Telangana, India. The fresh castor leaves were collected daily and were used for rearing *S. litura* larvae and for the antifeedant bioassays. *Spodoptera litura* larvae used in this study were obtained from a laboratory culture maintained in the insectary at controlled laboratory conditions (28 ± 2ºC), 65 ± 5% RH and 16: 8 L: D photo period. Neonate larvae emerged from single egg mass on the same day was fed with fresh castor leaves. Healthy second and third instar larvae were used for the experiments. *Tribolium castaneum*, *S. oryzae* and *R. dominica* were grown in plastic containers separately in the insectary over 2 years without exposure to insecticide and in controlled conditions, 28±2ºC, and 65±5% RH. The diet consisted of semi crushed Jowar (*Sorghum bicolor*) mixed with yeast (10: 1, w/w). The adult beetles of 1-5 d old were used in laboratory bioassays.

Collection and extraction of Plant materials

Marine plant *Hibiscus tiliaceus* (Malvaceae) Linn and *Sonneratia caseolaris* (Lythraceae) were collected from Pedavalasa village, 10 km from coringa mangrove forest and near to Yanam, Kakinada, Andhra Pradesh, India. The leaves were separated and washed with water. The shade dried plant material (500 gms) was powdered mechanically using commercial electrical stainless steel blender and extracted with acetone in soxhlet apparatus (1000 mL) until exhaustion. The extract was concentrated in rotary evaporator under reduced pressure at 45^{o}C, and the residue obtained was termed as crude leaf extract which was stored at 4^{o}C till further use.

Fractionation by chromatography

The crude extracts *H. tiliaceus* and *S.caseolaris* were chromatographed on a silica gel column (50 cm length and 4 cm diameter), with Hexane [(100%) (Fraction 1)], chloroform [(100%) (Fraction 2)], ethyl acetate [(100%) (Fraction 3)]; methanol [(100%) (Fraction 4)] as eluents. Each eluted material was further concentrated using a rotary vacuum evaporator (Heidolph Laborota 4000) to remove excess solvent and kept at -20ºC till further use in bioassays.

Antifeedant Assay

Antifeedant activity of crude extracts of *H.* tiliaceus and *S. caseolaris* was assessed against the phytophagous pest, *S. litura*. The experiments were conducted in the laboratory using leaf-disc method (Devanand and Usha Rani, 2008). The method consists of exposing a known area of surface treated castor leaf disc to starved larvae which are in active feeding stage and measuring the quantity of leaf disc consumed. A small circular disc (21 cm^2) was cut from the fresh castor leaves. Crude extracts of *H. tiliaceus* and *S. caseolaris* at different concentrations (100 and 200 mg/ 21cm^2) and purified fractions (1 mg/ 21cm^2) were applied separately on the upper surface of the leaf disc with the aid of a micro pipette. After evaporating the solvent for about 30 sec at room temperature, leaf discs were kept in individual Petri plates (9 cm dia) lined with wet filter papers to prevent desiccation. In each petriplate single pre starved (for 3 hrs) 2^{nd} and 3^{rd} instar larvae of *S. litura* were introduced separately and the larvae were allowed to feed on treated discs for a period of 24 hrs. The leaf discs sprayed with acetone alone was the control.

All the bioassays were repeated three times and there were ten replicates per each trial. The leaf area consumed and larval mortality due to feeding if any were measured after every 24 hrs using leaf area meter (Area meter AM 300, ADC Bioscientific Ltd). After 24 hrs, the left over leaf were retrieved and the percentage feeding calculated according to the following formula.

The antifeedant index (AI) was calculated as (C-T)/(C +T) x 100, where C is the consumption of control discs and T, the consumption of treated discs (Belles *et al*., 1985).

Contact Toxicity of the Mangrove Leaf Extracts

The experiments were conducted to evaluate the contact toxicity of the mangrove plant extracts. For this, the topical application method as described by Usha Rani and Rajasekarreddy (2009) was employed. Different concentrations (100 and 200mg) of crude extracts in acetone and purified fractions (2µL) were applied on to the dorsal thoracic region of second and third instar larvae of *S. litura* using a micro syringe. The larvae treated similarly with acetone as control. After the application the solvent was allowed to evaporate and the larvae transferred to plastic containers (500 mL capacity) having fresh castor leaves as food. The experiments were conducted in replicates. There were five replicates for each treatment and each treatment contained 10 larvae. The bioassays were conducted at laboratory temperature of 28±2ºC, and relative humidity of 65±5%. Per cent mortality was calculated according to Abbott (1925).

Fumigant toxicity of the extracts

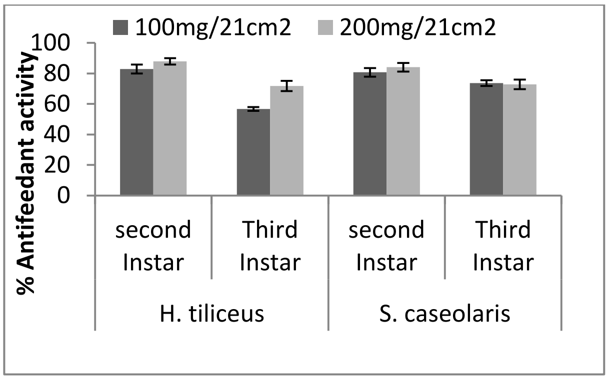
The fumigation toxicity of the leaf extracts of *H. tiliaceus* and *S. caseolaris* plants were evaluated against the three stored product pests according to a method described by Usha Rani and Rajasekharreddy (2010). Filter paper cut into small strips were treated separately with each test extract (50, 100, 150 and 200 mg /100µL) and purified fractions (50 µL) and were hung from the underside of the lid of a plastic container (100 mL capacity) having 20 gms diet of each pest insect. About 20 adults, 2 to 5-d old of each species of stored product pests, were released into the containers followed by closing the lid tightly. This prevented direct contact of the insects with the test compound. Solvent treatment was considered as controls. All tests were carried out at 28±2ºC temperature, and 65±5% relative humidity. After 24 hrs of treatment, the containers were opened and checked for the dead insects. Mortality was ensured by probing insect body with a slender paintbrush. Dead insects were counted every 24 hrs up to 72 hrs of treatment. There were five replicates per treatment while the tests were repeated 3 times on different dates to avoid any day-to-day variation if any.

RESULTS AND DISCUSSIONS

Insect antifeedant activity of the mangrove plants

Antifeedant property of *H. tiliaceus* and *S. caseolaris* leaf extracts was assessed by comparing the percentage leaf area consumed in the treated leaves with that of the control. Reduced food intake by *S. litura* was observed in both the plant extracts treated leaf discs. The highest per cent antifeedant activity was noted in the extract of *H. tiliaceus* (df, 4, 45; F=26.7, P=<0.001) treated castor leaves followed by *S. caseolaris* (df, 1,14; F=39.9, P=0.001) treated leaves with second instar larvae at 100mg/21cm^2 concentration (Fig 1).

Fig 1. Percent antifeedant activity of *H. tiliaceus* and *S. caseolaris* extracts on the second and third instar larvae of *S. litura.*



Values are mean of the five replicates of three trials ±standard error (ANOVA followed by TUKEY test performed, P< 0.001).

Interestingly both the mangrove plants caused almost similar present of antifeedant activity and there was not much difference (Fig 1) in the area fed by 2nd instar larvae in both the plant treatments. However, the efficiency of the mangrove plants decreased with the increase in age. At the dosage of 100mg/21cm^2 the third stadium larvae could consume a limited area (df, 9, 90; F=4.74, P=<0.001). Also the difference between the antifeedant efficiency of *S. caseolaris* and *H. tiliaceus* towards the larvae was not very significant (df, 3,16; F=36.8, P=<0.001 at 200 mg/21cm$^{2.}$ There was a drastic difference in consumption between 2nd and 3rd instar *S. litura* larvae on H. *tiliaceus* treated leaf at this dosage. The data also indicated clearly that antifeedant activity had increased to 87.8 and 84 percent with increase in concentration against second instar larvae. It appeared that the marine plants, *S. caseolaris* and *H. tiliaceus* had good feeding inhibitory activity towards the pest, *S. litura* (Fig 1). The hexane eluted fraction (79.3 percent) of the plant *H. tiliaceus* followed by methanol (76.5 percent) and ethyl acetate (60.7 percent) showed reduced feeding rate on *S. litura* at 1 mg/21cm^2 concentrations (Table 1). Antifeedant activity of hexane fraction of *S. caseolaris* showed maximum feeding deterrent activity (74.6 %) when compared to other fractions such as methanol (53.6 %) and ethyl acetate (42.3 %) (Table 1).

Table 1. Percent antifeedant activity of *H. tiliaceus* and *S. caseolaris* fractions on third instar larvae of *S. litura.*

Fractions	1 mg/21cm^2	
	H. tiliaceus	*S. caseolaris*
Hexane	79.3± 0.5	74.6±1.7
Ethyl acetate	60.7± 0.3	42.3± 0.2
Methanol	76.5±1.1	53.6 ± 0.9

Values are mean of the five replicates of three trials ± standard error (ANOVA followed by TUKEY test performed, P< 0.001).

Insect toxicity of the mangrove plant leaf extracts

The topical application of *S. caseolaris* and *H. tiliaceus* plant leaf extracts at 100 mg concentration caused larval mortality in different ranges (Table 2). The treated larvae were reduced in size (Fig-1) and lethargic in nature when compared to those in the control. However, majority of the treated 2nd instar larvae, about 70% in *H. tiliaceus* and 60% in *S. caseolaris,* metamorphosed into normal pupae, whereas 76% *H. tiliaceus* and 63% *S.*

caseolaris treated third stadium larvae at a concentration of 100 mg.

Table 2. A morphogenetic effect of *H. tiliaceus* and *S. caseolaris* extracts on the 2nd and 3rd instar larvae of *S. litura.*

Parameters	***H. tiliaceus***		***S. caseolaris***		***H. tiliaceus***		***S. caseolaris***	
	100 mg				200 mg			
	2nd	**3rd**	**2nd**	**3rd**	**2nd**	**3rd**	**2nd**	**3rd**
(%) mortality	29.6±0.3	23.0±0.4	40.2±0.2	36.0±0.4	43.0±0.4	42.0±0.3	50.0±0.4	42.6±0.3
(%) pupation	69.8±0.3	75.6±0.3	60.0±0.4	62.6±0.3	56.0±0.4	56.0±0.4	50.0±0.4	56.0±0.4
(%) No. of deformed pupae	5.0±0.4	6.0±0.2	4.4±0.3	4.4±0.3	8.0±0.2	5.4±0.3	8.6±0.3	4.6±0.3
(%)No. of emerged adults	16.0±0.2	17.0±0.2	14.0±0.2	4.4±0.3	8.8±0.2	12.0±0.4	6.0±0.4	12.6±0.4
(%)No. of adults deformed	1.6±0.1	1.6±0.2	1.8±0.2	1.4±0.1	2.0±0.2	1.8±0.2	1.6±0.1	1.4±0.1

Values are mean ± SE. ANOVA followed by TUKEY test performed; all the values are significantly different at P< 0.001.

When an increased dose (200 mg) was applied topically to both the 2nd and 3rd instar larvae there was a slight increase in the mortality rate of the *S. litura* larvae and the rate of successful pupation was decreased by 15-20 % with both plants. *S. caseolaris* and *H. tiliaceus* plant leaf extracts at this dose interfered with the larval molting process leading to deformed pupae. Furthermore, adult moths which emerged from these pupae showed malformations in the wings (Table 2). The treatment of the stored grain pests with the test plant extracts resulted in moderate to excellent level of insecticidal properties (Table3).

Table 3: Fumigation toxicity of the *H. tiliaceus* and *S. caseolaris* leaf extracts against stored grain pests 24, 48 and 72 hours exposure.

Test plants	Dose(mg/ cm^2)	**Mortality (%) mean ± SE**								
		Days of the treatment								
		1			**2**			**3**		
		T. c	***R. d***	***S. o***	***T. c***	***R. d***	***S. o***	***T. c***	***R. d***	***S. o***
H. tiliaceus	50	12.5±0.9	10±0.2	12.8±0.9	14.6±0.4	10.3±0.3	15.2±0.3	12.6±0.4	12.3±0.3	18.1±0.3
	100	30.5±0.3	20.4±0.4	22.4±0.9	30.1±0.4	25.4±0.3	29.5±0.3	25.1±0.4	25.6±0.3	31±0.3
	150	60±0.9	70.3±0.8	29.8±0.6	60.3±0.3	69.3±0.4	29.9±0.3	71±0.3	1.3±0.4	34±0.3
	200	89±0.6	84.4±0.5	49.8±0.9	92.9±0.7	83.7±0.8	59±1.8	93.9±0.7	84 ±0.8	62±1.8
S. caseolaris	50	0.8±0.2	10.7±0.3	1.4±0.3	5.3±0.5	14.5±0.5	4.5±0.5	6.3±0.5	16.5±0.5	4.9±0.5
	100	1.7±0.9	10.6±0.3	1.5±0.3	7.1±0.4	17.9±0.4	5.4±0.34	7.4±0.4	20.9±0.4	7.5±0.34
	150	31.6±1.6	20.9±0.4	10.1±0.3	34.9±0.5	25.3±0.3	10.2±0.3	35.9±0.5	25.3±0.3	12.2±0.3
	200	50.4±0.6	29.9±0.3	11.3±0.3	59.6±0.8	30.1±0.3	15.2±0.5	60.5±0.8	32.2±0.3	18.2±0.5

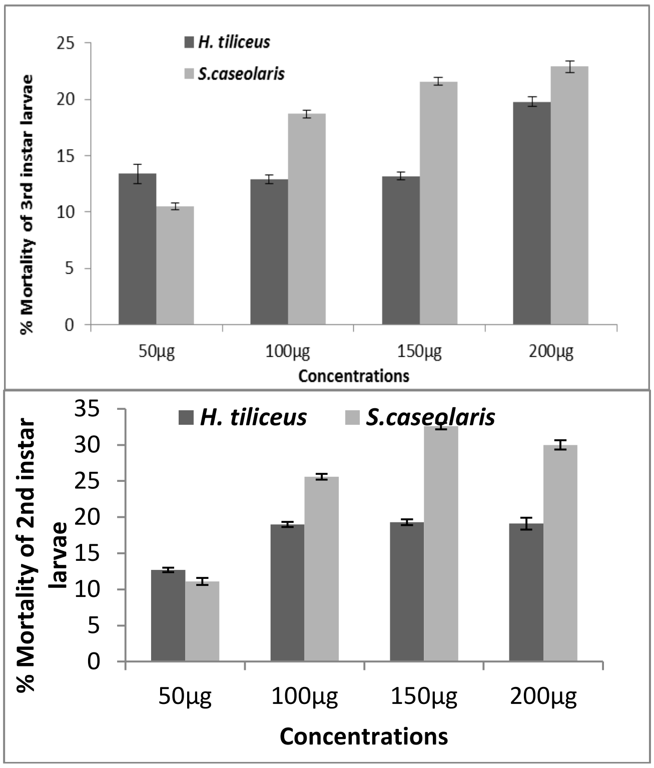
*(T.c = **T. castaneum, R. d =R. dominica, S. o= S. oryzae),*** Values are mean ± SE. mean values are significantly different at P< 0.001 (ANOVA, Tukeys test performed).

The data presented in (Table 3) shows that both plants were significantly (*H. tiliaceus,* df, 2,51; *F*= 5.56; *P*=<0.001) (*S. caseolaris* df,2,51; *F*=7.65, *P*=<0.001) more toxic to all tested stored grain pests at a dosage of 200mg/cm^2 after 24, 48, 72 hrs times of exposure. *Tribolium castaneum* was the most sensitive insect (df, 11,108; *F*=2.72, *P*=<0.001) followed by *S. oryzae* (df, 11, 108; *F*=2.40, *P*=<0.001) and *R. dominica* (df,11,108; *F*=2.40, *P*=<0.001 value should be included) with *H. tiliaceus* after 24 hrs treatment. The treatments of both the plant extracts at a dosage of 50 (*H. tiliaceus,* df, 2,51; *F*=39.7; *P*=<0.001) (*S. caseolaris* df,2,51; *F*=122.8, *P*=<0.001)and 100 mg (*H. tiliaceus,* df, *2,51; F=10.5; P=<0.001)* (*S. caseolaris* df,2,51; *F*=69.3, *P*=<0.001) failed to show significant toxic effects on the test insects, while a dosage of 200mg was considerably good. Among both the marine plants *H. tiliaceus* produced more than 85 percent toxicity to almost all the three pests and this toxicity had increased 3-days after the pests exposure to the compounds. However, the mangrove plant, *S. caseolaris* though a good antifeedant to *S. litura*, failed to show any toxicity to stored pests even after 72hrs post treatment.

Mangroves have received much attention in recent years for their possession of potentially useful natural chemicals. Mangroves and a few of mangrove associated plants due to their unique property of salt tolerance also consist of a unique range of biochemicals having immense medicinal potential (Patra and Mohanta, 2014).

This phenomenon instigated us to explore a mangrove plant, *S. caseolaris* and a mangrove associate plant, *H. tiliaceus* for insect control activity which can lead to environmentally safer pest control measures. Both the test plants possess insect antifeedant properties against the major agricultural pest, *S. litura*. Antifeedant is defined as a chemical that inhibits feeding without killing the insect directly, while the insect remains near the treated foliage and dies through starvation. Since both the plants prevented pest feeding at higher doses tested, we presume that the plant leaves possess chemicals that can act upon *S. litura* larval gustatory receptors which leads to the feeding inhibition on the surface treated castor plant leaf. It also appears that in both the cases 2nd instar larvae are more susceptible than the 3rd instars. The feeding inhibition was more in second instar larvae. The third instars appeared to overcome the treatment effects and could consume a slightly more quantity of leaf than the 2nd instars. Screening botanical extracts for deleterious effects on insects is one of the approaches used in the search for novel insecticides (Isman *et al.,* 2001). The results obtained with the test plant extracts indicate a positive role that these plants can play in the management of the notorious pest in the world. Santhanam *et al.* (2014) also studied the effect of pentacyclic triterpenoids and a linear alkane from the milky mangrove tree, *Excoecaria agallocha* L. on the larva of *Helicoverpa armigera* Hubner. Extract of *E. agallocha* showed growth inhibition of late 2nd and early 3rd instars larvae of *H. armigera* and caused 50% mortality of early third stadium instars larvae. Previously a few investigators had screened the plant extracts for their antifeedant activity against the third instar larvae of *S. litura* (Arivoli and Samuel, 2013; Jaipal Singh choudhary *et al.,* 2014; Tukiran, 2013). None of the compounds acted as post-ingestive toxins which is evident during the antifeedant assays. At the lower doses employed leaf consumption had occurred, but even after the ingestion larvae remained the same without any toxic symptoms. Only the cuticular penetration of the extracts into the insect body through topical application caused larval mortality.

Fig 3. Contact toxicity of the mangrove leaf extracts of *H. tiliaceus* and *S. caseolaris* on the second and third instar larvae of *S. litura.*



Bars indicate the means (±SE) are different significantly at P<0.0001 (ANOVA, Tukey's test), N=30.

The crude acetone extracts of *S. caseolaris* and *H. tiliaceus* plants were also evaluated for their toxic property against an agricultural as well as three stored grain pests. The crude leaf extract possesses moderate level of toxicity to *S. litura* larvae. Even at a high dose tested i:e 200mg, only less than 50 percent larval mortality was obtained. Among the plants, *S. caseolaris* caused higher larval mortality rate than *H. tiliaceus* against both the second and third instar larvae of *S. litura*. This larval mortality with crude extract of *H. tiliaceus* and *S. caseolaris* may be due the presence of active toxic group in the leaves of mangrove plants. Similar results with both topical and leaf applications of crude aqueous extract of *Lantana camara* leaves were observed to be highly effective in controlling the lepidopteran pest *S. litura* by causing heavy mortality (Deshmukhe *et al*., 2008). Similarly insecticidal activities of many plants and their compounds against different groups of insect pests have been reported previously (Rajam, 1991; Supratman *et al*., 2001; Leatemia, and Isman 2004; Jeyasankar, 2012). The reason for the activity is due to the fact that the insecticidal property present in the selected plants have compounds that may arrest the various metabolic activities.

The present investigation revealed that column eluted fractions of *H. tiliaceus* and *S. caseolaris* exhibited maximum activity on 3rd instar of *S. litura* larvae at lower concentrations compared to crude. In both the fractions of *H. tiliaceus* and *S. caseolaris*, we found that hexane eluted fraction is the most potent growth inhibitor. This indicated that the active principles present in the plants inhibit larval feeding behavior or make the food unpalatable or the substances directly act on the chemosensilla of the larva resulting in feeding deterrence (Jeyasankar *et al*., 2010)

Fumigation is one of the major chemical methods to control stored-product insect infestations and currently, phosphine and methyl bromide are being used worldwide (Duangsamorn Suthisut *et al*., 2011). Bioactivity of phytochemicals against stored product pests depends upon several factors such as the chemical composition of the crude extracts and varied susceptibility of target species (Usha Rani *et al*., 2011). No reports are available previously on the insecticidal activity of the mangrove and mangrove associated plant *S. caseolaris* and *H. tiliaceus* against the stored grain pests. However, results of some of the previous research work may be comparable with the present findings. In our study we found that *H. tiliaceus* and *S. caseolaris* leaf extracts produced high volatility, which is a desirable characteristic for insecticidal preparations that can act as fumigants for the control of stored product pests *T. castaneum, R. dominica* and *S. oryzae.* The observed mortality percentage was increased with increase in time intervals after treatment and also with increase in dose. Similarly, Adeniyi *et al*. (2010) also reported the insecticidal activity of *Bryophyllum pinnatum* and *Eucalptus globules* against rice weevil. They have found that toxic effects of the extracts were proportional to the concentration and that higher concentrations had stronger effects. Ethanolic extract of melgota, *Macaranga postulata* was tested for repellency, insecticidal activity against rice weevil, *S. oryzae* (Rahman *et al*., 2006). Since both the test plants consist no mammalian toxicity, it is ideal to utilize these plants for the control of the major stored products in fumigation method.

This is the first report on mangrove plants, *H. tiliaceus* and *S. caseolaris* which can be consider as crop protectants and for pest management. The results obtained suggest that potential use of marine plant extracts as both fumigant agents against *T. castaneum, R. dominica*, and *S. oryzae* adults. Hence, plant-derived insect control agents play a very important role in Integrated Pest Management strategy. By considering the overall performance, and identifying the components from both crude and purified fractions of leaf extracts of *H. tiliaceus* and *S. caseolaris*, they may be utilized in the management of lepidopteran pests in future.

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