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Efficacy of *Melochia corchorifolia* L. (Sterculiaceae) on Feeding Behavior of Four Lepidopteran Pests

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ABSTRACT

Experiments were carried out to assess the pesticidal effects of solvent extracts of *Melochia corchorifolia* leaves, their fractions and new oil formulation consisting of neem and karanj oils against four lepidopteran pests viz., *Helicoverpa armigera* (Hub.), *Spodoptera litura* (Fab.), *Erias vittella* (Fab.) and *Leucinodes orbonalis* (G.) at 1% concentration. Antifeedant activity was determined by leaf disc no-choice method. Ethyl acetate extract of *M. corchorifolia* exhibited maximum antifeedant activity (54.24%). It was subjected to fractionation using column chromatography. Among thirteen fractions obtained, ninth fraction showed maximum antifeedant activity against all tested insects at 1000 ppm concentration. Phytochemical analysis of ninth fraction showed the presence of steroids and alkaloids. This active fraction was mixed with neem and karanj oils and evaluated against selected lepidopteran pests. Formulations 1 (F1) (neem+pongam oil+active fraction) showed good antifeedant activity of 63.75, 78.94, 84.69 and 78.96% against *H. armigera*, *S. litura*, *E. vittella*, *L. orbonalis*, respectively. This plant could be considered to prepare botanical pesticide.

Key words: Antifeedant activity, *Melochia corchorifolia*, lepidopterans, botanical formulation

INTRODUCTION

Chemical pesticides are a great threat to the health of the present and future generations. They also cause development of resistance in several pests. The plant-derived bioactive compounds are thought to be an important alternative source for pesticides. Biopesticides have gained importance in recent plant protection efforts. Natural pesticides of entomopathogenic fungus, *Beauveria bassiana* and bacteria, *Chromobacterium violaceum* have inhibited the larval population and growth of *Spodoptera litura* (Baskar and Ignacimuthu, 2012). Pure or mixture of compounds act as antifeedant, insecticidal and growth regulators against varieties of insects (Abd El-Aziz and El-Din, 2007; Khorram *et al*., 2011; Khatter, 2011). Tremendous achievements have been gained using neem tree, *Azadirachta indica* and some other plants have been used as a source of botanical pesticide (Sharma *et al*., 1992; Efil *et al*., 2005; Iloba and Ekrakene, 2006). However, deriving pure new biopesticidal substances from plants remains a complex task because it needs chemical screening complemented with biological effects. Plant products are mostly target specific and exhibit their anti-insect property in many ways. They act as repellants, insecticides, attractants, ovicides, oviposition deterrents, antifeedant and growth regulators. This multifaceted action of botanicals is advantageous for control of pest population. Products obtained from *A. indica* have been well

studied against many insects throughout the world (Rembold *et al*., 1982; Rahman *et al*., 2003) and the search for new compounds from many other plants for pest control is going on all over the world.

The *Helicoverpa armigera* is a polyphagous pest; it causes heavy losses throughout the world. In India, economic damage and control costs for *Helicoverpa* spp. are estimated at US$ 290-350 million per year (King, 1994) and in Australia insects cause economic damage amounting to $225 million annually (Matthews and Jago, 1993). The *Spodoptera litura* is a polyphagous pest it affects around 150 plant species (Rao *et al*., 1993). It is economically important pest in many countries including India, Japan, China and other countries of Southeast Asia and has been recorded as a cosmetic pest of sesame in Japan (Sintim *et al*., 2009). This pest may become serious during the seedling stage and cause extensive loss of agricultural production all over the world (Rathi and Gopalakrishnan, 2004). The spotted bollworm of cotton or okra fruit and shoot borer, *E. vittella* (Lepidoptera: Noctuidae) is a widely distributed insect pest. This pest has been reported to infest okra *Abelmoschus esculentus* L. (Malvaceae), cotton (G.spp.), hollyhock (*Alcea rosea*), safflower (*Carthamus* spp.), Indian mallow (*Abutilon* spp.), *Corchorus* spp., *Hibiscus* spp., *Malvas* spp., *Malvastrum* spp., *Sida* spp., *Theobroma* spp. and *Urena* spp. (Khan and Verma, 1946; Pearson, 1958; Butani and Verma, 1976). About 69% loss in marketable yield has been estimated due to attack of this insect on okra (Rawat and Sahu, 1973). Shoot and fruit borer *Leucinodes orbonalis* (Guenee) is one of the major insect pests of eggplant in Asia (Rahman, 2006). Larval stage of this pest causes serious damage to shoots and fruits of eggplant.

Melochia corchorifolia L. belongs to the family Sterculiaceae and is commonly known as Kattu Parai thuthi/Punnakku thalai. *M. corchorifolia* occurs throughout the hotter parts of India. A decoction of the plant has been reported in folk medicines as a cure for abdominal swelling, dysentery (Wealth of India, 1966) and water snake bites (Chopra *et al*., 1956). The cyclopeptide alkaloids franganine, frangufoline and adouetine-y (Tschesche and Reutel, 1968) and new cyclopeptide alkaloid and melofoline (Bhakuni *et al*., 1986) have been reported earlier from this plant. The present study was aimed at evaluating the bioefficacy of extracts, fractions and oil formulations of *M. corchorifolia* leaves against four lepidopteran pests.

MATERIALS AND METHODS

Plant collection and preparation of the crude extracts: The leaves of *Melochia corchorifolia* L. (Sterculiaceae) were collected during 2006 from surrounding areas of Chennai, Tamilnadu, India. Plant specimen was identified by Dr. D. Narasimhan, a plant taxonomist, Department of Botany, Madras Christian College, Chennai. Voucher specimen for this plant (LC/ERI/Her.No.558) has been deposited in the herbarium of Entomology Research Institute for further reference. The leaves were shade-dried at room temperature and coarsely powdered in a powdering machine. One kilogram powder of the plant was extracted sequentially with hexane, chloroform and ethyl acetate in the cold for 48 hours in an aspirator bottle. The extract was filtered through Whatman No.1 filter paper and distilled on water bath. The last traces of the solvent were removed using vacuum evaporator.

Establishment of insect culture: *Helicoverpa armigera* and *Erias vittella* larvae were collected from bhendi fields while *Spodotera litura* and *Leucinodes orbonalis* larvae were collected from groundnut and brinjal fields in Kancheepuram District, Tamilnadu, India. The field-collected insects were reared in the laboratory on their natural food except *H. armigera* which was

individually reared on artificial diet in plastic vials (20 mL) to avoid cannibalism. The pupae were transferred to separate petriplates and kept inside oviposition chambers. The adult moths that emerged form pupae were provided with a mixture of 10% honey solution and multivitamin liquid. Brinjal, bhendi fruits and groundnut seedlings grown in small paper cups were placed in the cages for oviposition of *H. armigera, S. litura, E. vittella* and *L. orbonalis*, respectively. The fresh fourth instar larvae were used for the laboratory experiments at 28±1°C, 11±1 h photoperiod and 65-70% Relative humidity.

Screening of crude extracts: The antifeedant activity of hexane, chloroform and ethyl acetate crude extracts of *M. corchorifolia* leaves was studied using leaf disc no-choice method (Isman *et al.*, 1990). The crude extracts (1%) were prepared by dissolving in acetone and mixed with Ploysorbate 20 (Tween 20) at 0.05% which was used as emulsifier (Saxena and Yadav, 1983). The crude extracts were tested against *H. armigera* and *S. litura*. The fresh castor and cotton leaf discs of 4 cm diameter were punched using cork borer and dipped in the crude extracts separately and air dried for 5 min. After 2 h pre-starvation, fourth instar larvae of *H. armigera* and *S. litura* were introduced into treated leaf discs. Leaf discs treated with acetone were considered as control. Five replicates were maintained for each treatment with 10 larvae per replicate (total, n = 50). Progressive consumption of leaf area by the larvae was recorded after 24 h in treatment and control using leaf area meter (Delta-T Devices, Serial No.15736 F 96 and UK). Leaf area consumed was calculated by deducting the treatments from control values. The percentage of antifeedant activity was calculated using the formula of Isman *et al.* (1990) which is given below:

$$\text{Antifeedant activity} = \frac{\text{Leaf area consumed in control-Leaf area consumed in treatment}}{\text{Leaf area consumed in control+Leaf area consumed in treatment}} \times 100$$

The antifeedant activity was assessed using bhendi fruit discs for *E. vittella* and brinjal fruit discs for *L. orbonalis*. Bhendi fruit discs (100 mm thick) with seeds were dipped in the crude extract (1%) which was prepared by dissolving in acetone and mixed with Polysorbate 20 (Tween 20) at 0.05% which was used as emulsifier. The fruit discs of both bhendi and brinjal (5 mm thickness) were air dried for 5 min, fruits were weighed and larvae of *E. vtitella* and *L. orbonalis* were introduced. A set containing 10 discs were placed separately in a Petri dish for each treatment and control for both the pests. Discs of bhendi and brinjal dipped in acetone and emulsifier mixture without larvae were also maintained to find out the weight loss in the discs due to desiccation at room temperature. After 24 h the discs were weighed and the difference between initial and final weights was calculated. Real consumption was calculated as follows:

$$\text{Weight loss due to desiccation (D)} = \text{Initial weight-Final weight}$$

$$\text{Real consumption} = \text{Initial weight-(Final weight+D)}$$

Isolation and screening of fractions: The ethyl acetate extract of *M. corchorifolia* was subjected to Column Chromatography over silica gel (Acme's silica gel 100-200 mesh) in hexane. The column was eluted with hexane and ethyl acetate mixture with increasing amount of ethyl acetate. Different solvent combinations of hexane and ethyl acetate ranging from 95: 5 to 0: 100 were used. A total of thirteen fractions were obtained. All the fractions were screened at 1000 ppm against

selected lepidopteran pests with the same methodology as followed for crude extracts. The highly effective fractions were further analyzed to ascertain whether they contained single compound or a mixture of compounds using TLC.

Preparation of formulations extract: When the ethyl acetate of *M. corchorifolia* leaves was subjected to column chromatography, thirteen fractions with different Rf values were obtained. From the screening experiments with all these fractions it was found that the 9th fraction eluted using (40:60) hexane and ethyl acetate (2:3) (Rf = 0.43) was very effective against four different pests. This active fraction was mixed with neem and karnj oils, emulsifier (DMA-NE) and stabilizer purchased from UNITOP chemicals to prepare the formulations. Stock solutions of 10 mL of the different treatments are given in Table 1. Only one concentration of formulation (500 ppm of active fraction) was prepared by mixing 0.7 mL of stock with 17 mL distilled water @ 3%. Totally six different formulations were prepared using the active fraction. One formulation without the oils was also prepared. The antifeedant bioassay experiments were tested against selected pests with the same methodology as followed for crude extracts and fractions. The antifeedant activity was calculated as mentioned earlier.

Preliminary phytochemical analysis: Phytochemical analysis of the isolated fractions from ethyl acetate crude extract of *M. corchorifolia* leaves for secondary metabolites such as steroids, triterpenods, phenols, flavanoids, tannins, coumarins, anthroquinones, quinones, catacines, alkaloids, saponins was done using standard methods as described by Harborne (1998).

Statistical analysis: The significance of treatments was found out by one way Analysis of Variance ANOVA and the effective treatment was separated by Tukey's multiple range test. Differences between means were considered significant at $p<0.05$.

Table 1: Details of different formulations

Formulation 1.	Formulation 2.	Formulation 3.
Active fraction-12.25 mg	Active fraction-12.25 mg	Active fraction-12.25 mg
Neem oil-4.45 mL	Neem oil-8.9 mL	Karanj oil-8.9 mL
Karaj-4.45 mL	Emulsifier-1.00 mL	Emulsifier-1.00 mL
Emulsifier-1.00 mL	Stablizer-0.10	Stablizer-0.10
Stabilizer-0.10 mL	Total = 10 mL	Total =10 mL
Total = 10 mL		
Formulation 4.	Formulation 5.	Formulation 6.
Active fraction-12.25 mg	Neem oil-4.45 mL	Active fraction-12.5 mg
Emulsifier-1.00 mL	karanj oil-4.45 mL	Acetone-10 mL
Stabilizer-0.10	Emulsifier-1.00 mL	Total = 10 mL
Distilled water-8.90 mL	Stabilizer-0.10 mL	
Total = 10 mL	Total = 10 mL	
	Control	
	Emulsifier-1.00 mL	
	Stabilizer-0.10 mL	
	Distilled water-8.90 mL	
	Total = 10 mL	

RESULTS

The results of the antifeedant activities of different crude extracts of *M. corchorifolia* screened at 1% against *H. armigera*, *S. litura*, *E. vittella* and *L. orbonalis* are presented in Table 2. In the present study, significant antifeedant activity was noticed in ethyl acetate extract against *H. armigera* (27.04%), *S. litura* (29.96%), *E. vittella* (53.71%) and *L. orbonalis* (54.24%) followed by chloroform and hexane extracts of *M. corchorifolia*.

The results of the antifeedant activity of thirteen fractions, isolated from ethyl acetate extract of *M.corchorifolia* and screened at 1000 ppm against selected lepidopteran pests are presented in Table 3. Among the tested 13 fractions, the highest antifeedant activity was recorded in fraction 9 against all tested insects viz., *H. armigera* (15.28%), *S. litura* (26.98%), *E. vittella* (31.84%) and *L. orbonalis* (42.53%) followed by fraction 10, fraction 1 and fraction 8 against *H. armigera*, S. *litura*, *E. vetella* and L. *orbonalis*, respectively. The effective fraction 9 was eluted with hexane: ethyl acetate (3:2).

The results of the antifeedant activity of different oil formulations against the lepidopteran pests are given in Table 4. Maximum antifeedant activities of 63.75, 78.94, 84.69 and 78.96% were observed in formulation 1 against *H. armigera*, *S. litura*, *E. vittella* and *L. orbonalis*, respectively. Formulation 2 exhibited antifeedant activity of 55.60% against *H. armigera*, F3 (63.51%) and T2

Table 2: Percent antifeedant activity of different crude extracts of *M. corchorifolia* against four lepidopteran pests

	Insects			
Treatments	*H. armigera*	*S. litura*	*E. vitella*	*L. orbonalis*
Hexane	15.45±1.87^{b}	10.85±1.37^{b}	23.83±1.51^{b}	32.97±2.19^{b}
Chloroform	21.30±0.87^{c}	17.10±1.69^{c}	26.66±2.16^{b}	36.55±2.17^{c}
Ethyl acetate	27.04±1.80^{d}	29.96±1.69^{d}	53.71±1.98^{c}	54.24±1.78^{d}
Control	02.54±0.29^{a}	02.46±0.25^{a}	01.27±0.31^{a}	03.81±0.34^{a}

Within the column, mean±SD followed by the same letter do not differ significantly (Tukey's test, p≤0.05)

Table 3: Percent antifeedant activity of different fractions isolated from the ethyl acetate crude extract of *M. corchorifolia* leaves against *H. armigera* and *S. litura* at 1000 ppm

	Insects			
Treatments	*H. armigera*	*S. litura*	*E. vitella*	*L. orbonalis*
Fraction-1	12.45±1.38^{cdef}	23.66±2.38^{fg}	26.37±2.90^{ef}	30.03±1.65^{f}
Fraction-2	08.36±1.08^{b}	13.54±2.07^{b}	16.84±1.29^{cd}	16.12±1.86^{bc}
Fraction-3	09.02±1.49^{bc}	13.52±2.25^{b}	10.83±2.18^{b}	17.67±2.54^{bcd}
Fraction-4	10.55±1.45^{bcd}	14.78±1.59^{bc}	14.98±1.55^{bcd}	18.99±2.14^{cde}
Fraction-5	13.20±2.18^{def}	15.22±2.81^{bc}	17.85±1.81^{d}	20.43±1.52^{de}
Fraction-6	12.09±1.22^{cdef}	16.87±2.72^{bcde}	14.84±1.75^{bcd}	17.97±1.86^{bcd}
Fraction-7	10.65±2.03^{bcd}	14.75±1.71^{bc}	17.37±2.21^{d}	21.69±1.57^{e}
Fraction-8	11.42±2.28^{bcde}	21.01±2.77^{def}	23.54±2.72^{e}	37.67±1.54^{g}
Fraction-9	15.28±2.15^{f}	26.98±3.37^{g}	31.82±1.56^{g}	42.52±1.52^{h}
Fraction-10	14.95±1.36^{ef}	18.45±2.15^{cde}	30.42±1.99^{fg}	19.02±1.27^{cde}
Fraction-11	08.24±1.18^{b}	21.47±1.63^{ef}	12.67±1.25^{bc}	14.44±0.89^{b}
Fraction-12	08.36±1.56^{b}	13.46±1.22^{b}	16.98±1.92^{d}	16.54±1.09^{bc}
Fraction-13	13.44±1.46^{def}	16.27±1.69^{bcd}	22.62±1.99^{e}	22.38±1.59^{e}
Control	04.36±1.25^{a}	03.53±0.32^{a}	02.12±0.13^{a}	03.47±0.63^{a}

Within the column, mean±SD followed by the same letter do not differ significantly (Tukey's test, p≤0.05)

Table 4: Percent antifeedant activity of different oil formulation prepared with bioactive fraction isolated from ethyl acetate extract of *M. corchorifolia* against four lepidopteran pests

	Insects			
Treatment	*H. armigera*	*S. litura*	*E. vitella*	*L. orbonalis*
Formulation-1	63.75±2.03^{f}	78.94±2.18^{e}	84.69±1.71^{f}	78.96±2.68^{e}
Formulation-2	55.60±3.32^{e}	60.20±2.45^{d}	51.65±2.75^{e}	47.38±2.64^{d}
Formulation-3	47.25±2.55^{d}	63.51±3.12^{d}	26.92±1.91^{d}	22.95±1.68^{c}
Formulation-4	35.77±1.81^{b}	33.41±2.35^{b}	19.58±3.98^{b}	11.62±1.99^{b}
Formulation-5	42.55±2.40^{cd}	51.48±2.39^{c}	25.54±1.59^{cd}	12.46±1.63^{b}
Formulation-6	38.85±2.89^{bc}	53.47±2.58^{c}	22.12±1.98^{bc}	19.66±1.25^{c}
Control	04.36±1.21^{a}	03.55±0.56^{a}	02.12±0.19^{a}	03.45±0.77^{a}

Within the column, mean±SD followed by the same letter do not differ significantly (Turkey's test, $p \leq 0.05$)

Table 5: Preliminary phytochemical analyses of different fractions isolated from ethyl acetate extract of *M. corchorifolia* leaves

	Name of the compounds										
No. of fractions	St	Tp	Ph	Fl	Ta	Co	Aq	Qu	Ca	Ak	Sa
1	-	-	+	-	-	+	-	-	-	-	-
2	-	+	-	-	-	-	-	-	-	+	+
3	+	-	-	+	-	-	-	-	-	-	-
4	+	-	-	+	-	-	-	-	-	-	-
5	-	-	+	+	-	-	-	-	-	-	+
6	-	-	+	+	-	-	-	-	-	-	+
7	-	-	+	-	+	-	-	-	+	-	-
8	-	-	+	-	+	-	-	-	+	-	-
9	+	-	-	-	-	-	-	-	-	+	-
10	-	+	-	-	+	-	-	-	-	+	-
11	-	+	-	-	+	-	-	-	-	+	-
12	+	-	-	-	-	-	-	-	-	-	+
13	-	-	+	-	-	+	-	-	-	-	-

St: Steroids, Tp: Triterpenods, Ph: Phenol, Fl: Flavanoids, Ta: tannin, Co: Coumarins, Aq: Anthroquinones, Qu: Quinones, Ca: Catacines, Ak: Alkaloids, Sa: Saponins, +: Indicates positive result, -: Indicates negative result

(61.20%) against *S. litura*, F2 (51.65%) and (46.98%) against *E. vittella* and *L. orbonalis*, respectively. Least antifeedant activity was noticed in formulation 4 against all the tested insects. Oil formulations exhibited various kinds of abnormalities in larva, pupa and adults of all the tested pests.

Different factions isolated from the ethyl acetate crude extract of *M. corchorifolia* were subjected to preliminary phytochemical analysis to confirm the major group of compounds present. The results are presented in Table 5. Fraction 1 showed the presence of phenol and coumarins; fraction 2 showed the presence of triterpenoids, alkaloids and saponins; fractions 3 and 4 showed the presence of steroids and flavanoids, fractions 5 and 6 showed the presence of phenols, flavanoids and saponins; fractions 7 and 8 showed the presence of phenols, tannins and catechins; fraction 9 showed the presence of steroids and alkaloids; fractions 10 and 11 showed the presence of triterpenoids, tannins and alkaloids; fraction 12 showed the presence of steroids and saponins; fraction 13 showed the presence of alkaloids, phenols and coumarins.

DISCUSSION

The utilization of crude plant products and isolated phytochemicals in pest management is increasing day by day due to increasing public awareness on safe environment and deleterious effects of chemicals on human beings. There is plenty of literature available on insecticidal, antifeedant, oviposition deterrent, ovicidal, repellent and growth inhibiting properties of botanical pesticides (Koul *et al*., 2000), *Cestrum parqui* exhibited different type of malformation against *S. littoralis* (Ikbal *et al*., 2007). Antifeedant activity of botanicals against insects has been studied in many countries. Quantification of antifeedant effect of botanicals is of great importance in the field of insect pest management. From an ecological point of view, antifeedants are very important since they never kill the target insects directly and allow them to be available to their natural enemies and thus help in the maintenance of natural balance. The monophagous or oligophagous insects die due to the application of antifeedants on their food plants, due to starvation.

In the present study, ethyl acetate extract of *M. corchorifolia* showed maximum antifeedant activity against all the tested pests. This result corroborates with earlier findings where ethyl acetate extract of *Aristolochia tagala, Blumea mollis* and *Hygrophila auriculata* (Baskar *et al*., 2011a; Baskar *et al*., 2011b) showed antifeedant activity of 33, 20 and 46%, respectively against *S. litura*. Similarly ethyl acetate extracts of *Couroupita guianensis* (Baskar *et al*., 2010) and *Atalantia monophylla* (Baskar *et al*., 2009) showed antifeedant activity of 39 and 36% against *H. armigera* respectively at 1% concentration. Muthu *et al*. (2010) demonstrated that ethyl extract of *Atalantia monophylla* showed antifeedant activity against *Earias vittella*. Many workers have highlighted that ethyl acetate extracts from plants showed antifeedant activity against a variety of insects: Raja *et al*. (2005), Duraipandiyan *et al*. (2011) and Pavunraj *et al*. (2011) on *H. armigera* and *S. litura*; Jeyasankar *et al*. (2010) and Baskar *et al*. (2008) on *S. litura* and Lingathurai *et al*. (2011) on *Plutella xylostella*. Methanolic extract of *Chrysanthemum* showed antifeedant activity against *Tribolium confusum* (Haouas *et al*., 2008).

The active ethyl acetate extract derived fractions showed antifeedant activity against all the tested pests. Among the fractions, ninth fraction showed maximum antifeedant activity against all the four pests. The present results coincide with the findings of Vendan *et al*. (2009) who reported that fractions from ethyl acetate extract of *Hydnocarpus alpina* showed antifeedant activity against *H. armigera*. Ethyl acetate derived fraction of *Hyptis suaveolens* exhibited antifeedant activity against *H. armigera* and *S. litura* (Raja *et al*., 2005). Different fractions isolated from diethyl ether extract of *H. suaveolens* exhibited maximum antifeedant activity against *H. armigera* (Elumalai *et al*., 2004). Nine fractions derived from ethyl acetate extract of *Momordica charantia* showed antifeedant activity against *P. xylostella* (Ling *et al*., 2008). Ethyl acetate extract derived fractions of *Fagara macrophylla* showed antifeedant activity against *S. littoralis* and *S. frugiperda* (Tringali *et al*., 2001).

In the present study the formulation with neem+karanj oils+fraction 9 showed maximum antifeedant activity against all the tested pests. Similarly *Azdirachta indica* formulations had shown antifeedant activity against *Henosepilachna vigintioctopunctata* (Rao *et al*., 1992). Sadeghian and Mortazaienezhad (2007) have reported neem leaves extract used for pesticides. Neem oil exhibited antifeedant activity against *Epilachna indica* (Abdullah and Subramanian, 2008) Neem with Endosulfan formulation exhibited antifeedant activity against *S. litura* (War *et al*., 2011).

The promising formulation 1 also caused different malformation, deformities and mortality in larval, pupal and adult stages. This finding is in accordance with Anumol (2004) who found that

tested botanical formulations prepared with the combination of neem oil (70%), karnj oil (30%) and azadirachtin (12.25 mg) showed antifeedant activity against *S. litura* and *H. armigera*. Ayyasamy *et al.* (1999) evaluated neem, karanj and maduca seed kernel extracts (NSKE, PSKE and MSKE) at 5% and found biological effects on red-hairy caterpillar, *Amsacta albistriga* and leaf worm, *Spodoptera litura*. Rao *et al.* (2003) found that neem extract *Azadirachta indica* (N) with extract of sweet-flag (*Acorus calamus*) (S) and *Pongamia glabra* (P) at 1:1:1 (NSP 1), 2:1:1 (NSP 2) 3:1:1 (NSP 3) ratios the controlled of *Erias vittella*. Neem based insecticides exhibited different degrees of malformation against *Dystercus cingulaus* (Pandey and Tiwari, 2011). Preliminary phytochemical analysis of the active fraction of *M. corchorifolia* showed high amounts of triterpenods and steroids which coincide with the findings of Tschesche and Reutel (1968). According to Schoonhoven (1982) most insect antifeedants are flavonoids, alkaloids, sesquiterpene lactones, steroids, diterpenoids and triterpenoids. Varitimidis *et al.* (2006) also reported that sitosterol glycopyranoside lipids 2-5 isolated from *Anemone pavonina* showed significant levels of insecticidal activity against *Pheidole pallidula* ant. Celestraceae family derived β-dihydroagarofuran sesquiterpene polyesters and pyridine alkaloids exhibited insect anifeedant activity (Deepa and Narmatha Bai, 2010).

CONCLUSION

The commercially available neem based pesticides are prepared with azadirachtin. The cost of neem oil and karanj oil is cheaper than that of azadirachtin and these oils are easily available and can be used at low cost. The synergistic activity of these oils with the active fraction isolated from *M. corchorifolia* tested in the present investigation has given encouraging results and these new formulations can be used for sustainable management of the pests in future.

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