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BIO-EFFICACY OF FIVE DIFFERENT PLANT EXTRACTS AGAINST CALLOSOBRUCHUS MACULATUS (STORED PEST), SPODOPTERA LITUA (FIELD PEST) AND AEDES AEGYPTI (VECTOR)

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ABSTRACT

Objective: To investigate the larvicidal, ovicidal and pupicidal activity of methanol leaves extract of five different plants *Euphorbia hirta, Moringa oleifera, Cassia senna, Toddalia asiatica* and *Mallotus repandus* against the stored pest - *Callosobruchus maculatus*, field pest - *Spodoptera litua* and vector - *Aedes aegypti*. **Method:** The larvicidal, ovicidal and pupicidal activity was assayed in the methanol leaf extract of five different plants against *Callosobruchus maculatus*, *Aedes aegypti* and *Spodoptera litura* at different concentration ranging from 100 to 400 ppm under the laboratory conditions. Mortality of each was recorded after 24 hours exposure to extract. **Result:** Preliminary qualitative phytochemical analysis were studied. Then, it was observed that the bio-efficacy of the methanol extracts of *Euphorbia hirta, Moringa oleifera, Cassia senna* and *Mallotus repandus* showed insecticidal activity against the targeted pest. Whereas, *Toddalia asiatica* exhibited 100% insecticidal activity against the stored pest, field pest and vector. **Conclusion:** From, the results it can be concluded that the methanol extracts of *Toddalia asiatica* have an excellent potential and considered to be the promising plant to use against pest and vector control. Therefore, future studies on the bio-efficacy of the compounds will pave the way to know about the compounds toxicity against the targeted insects.

KEYWORDS: To investigate the larvicidal, ovicidal *Aedes aegypti*.

1.0 INTRODUCTION

India is basically an agro-based country and our economy is purely determined by agricultural productivity. Of the world's total agricultural production, 5-30% of it are being damaged by the insect. Since, the agricultural production and as well as the stored agricultural products are in serious threat (Alagarmalai Jeyasankar *et al.*, 2012), the management of insect pest has become a promising aspects to the researcher. Considering this into effect, my present investigation is to determine the insecticidal activities against the stored pest - *Callosobruchus maculatus*, field pest - *Spodoptera litua* and vector - *Aedes aegypti*.

The cowpea weevil, *Callosobrochus maculatus* is a notorious insect pest for stored products like leguminous grains such as cowpeas, green gram, lentils and black gram. It is a holometabolic insect. Initially, in the field this cowpea is being infested by the bruchid, before mature seeds are invested and causes 60% loses in a post harvest (Abd-El Razik and Zayed 2014).

The tobacco army worm, *Spodoptera litura* is an economically important polyphagous insect pest in India and causes great damage to vegetable and field crops. It is a serious pest to castor, cotton, tobacco, groundnut, sorghum, maize, soybean, banana, guava, brinjal, beetroot, cabbage, cauliflower, *Colocasia*, etc., and brings loss about 10% and 30% for major crops.

Aedes aegypti has a great economic impact because they are the vectors for transmitting a number of diseases such as yellow fever, dengue, chikungunya and Zika fever. Although *Aedes aegypti* mosquitoes most commonly feed at dusk and dawn, indoors, in shady areas, or when the weather is cloudy, "they can bite and spread infection all year long and at any time of day.

Initially, chemical insecticides were used to control the targeted insect and vector. But due to their non-selective nature it provoked undesirable effects which fostered environmental and health concerns (Kaliyamoorthy Krishnappa *et* al., 2012).

The concept of phyto-insecticidal activity instead of synthetic insecticides for the pest management is due to the disadvantage of synthetic insecticides which interferes with the nerve function and results in toxic nature to non-target organisms. The products or

formulations developed from plants are mostly non-cidal, but repel or dissuade feeding or disturb physiological functions of the target pest. The products may be dried and ground plant material, crude plant extract, or even fractionated active ingredients. Hence, the present study has been done to evaluate the insecticidal activity in the methanolic extracts of the leaves of five different plants namely ***Euphorbia hirta, Moringa oleifera, Cassia senna, Toddalia asiatica*** **and** ***Mallotus repandus*** against the targeted insect.

2.0 MATERIALS AND METHODS

2.1 Collection and preparation of plant extracts

The fresh leaves of ***Euphorbia hirta, Moringa oleifera, Cassia senna, Toddalia asiatica*** **and** ***Mallotus repandus*** **-** the plant material was collected from Javadhi hills, Vellore. The plant materials were brought to the laboratory and shade dried. The dried plant materials were powdered using electric blender and sieved through kitchen strainer and the fine powder was used for extraction using Soxhlet apparatus. The powders were extracted with methanol. The residues from the crude extract were dried well for complete evaporation of the solvent and the residue was collected in brown color vials and preserved at 4 ^{0}C. The diluted concentration was used for subsequent experiments.

2.1.1 Preliminary studies on phytochemical screening

The preliminary phytochemical screening was carried out for the quality of various organic compounds present in the effective crude extracts.

Steroid: Liebermann- Burchard test: A few mg of the substance in chloroform is treated with a few drops of acetic acid, acetic anhydride and two drops of concentrated H_2SO_4 the mixture was heated gently if necessary. Development of blue or green colour indicated the presence of steroid.

Triterpenoid: Noller's: A few mg of the substance in a dry test tube is treated with a bit of tin foil and 0.5 ml of thionyl chloride. Heated gently if required. Development of pink colour indicated the presence of triterpenoid.

Sugars/glycosides: A few mg of the substance is mixed with equal quantity of anthrone and treated with two drops of concentrated H_2SO_4. Heated gently on a water bath. Development of dark green colour indicated the presence of sugar/glycosides.

Acid: A few mg of the substance is treated with aqueous $NaHCO_3$. Effervescence shows the presence of acid, which is due to liberation of CO_2.

Quinone: A few mg of the substance in alcohol is treated with H_2SO_4 or aqueous NaOH. Coloration indicates the presence of quinoid compounds.

Coumarin: A few mg of substance in alcohol is treated with alcoholic NaOH. Development of yellow colour indicates the presence of coumarin.

Flavanoid: Shimoda test: A few mg of the substance in alcohol is treated with magnesium foils and a few drops of concentrated HCL. Development of red or pink colour indicates the presence of flavanoid.

Furanoid: Ehrlich test: A few mg of the substance in alcohol is treated with a pinch of paradimethyl amino benzaldehyde and a few drops of concentrated HCL. Development of red or pink colour indicates the presence of furanoid.

Tannin: A few mg of substance in alcohol is treated with a few drops of aqueous lead acetate. Precipitation indicates the presence of Tannin.

Alkaloid: Dragendorff'stest: A few mg of substance in acetic acid (filtered if necessary) is treated with two drops of dragendorff reagent (potassium mercuric iodide). Development of red or orange precipitation indicates the presence of alkaloid. Excess reagent should be avoided.

Phenol: A few mg of the substance in alcohol is treated with alcoholic ferric chloride. Any coloration indicates the presence of phenolic compounds.

2.2 Field collection and rearing of agricultural pests

2.2.1. Spodoptera litura: Moths, eggs and pupae of tobacco cutworm, *Spodoptera litura* (Fab.) (Noctuidae: Lepidoptera) were collected from nearby fields. The adult moths were collected during at night on white cloth placed under the white CFC bulb. The eggs and larvae were collected from the field were initially treated with sodium hypochlorite spraying to kill the pathogens within them. The insect culture was maintained on fresh castor leaves and maintained in the in the laboratory under standard conditions of temperature (27 ± 2°C) and relative humidity (75 ±5%) throughout the period of study. An insect culture was

continuously refreshed with wild moths, captured by a light trap in the vicinity of the agricultural fields. Generally, hale, healthy and uniform sized fourth instar larvae and freshly emerged moths were used for the experiments.

2.2.2 Larvicidal assay

For the evaluation of larvicidal activity of the plant extract (*Toddalia asiatica*) against the selected pest, primarily, the plant extract was tested on wide range of concentration, from that a narrow range of concentration was derived. Thus, 100, 200 and 400mg/L concentrations were tested against the freshly moulted (0-6h) fourth instar larvae of *S. litura*. The fresh castor leaves were tied with wet cotton plug to avoid early drying and placed in plastic trough (29cm × 8cm). 25 pre-starved fourth instar larvae were introduced and covered with muslin cloth. Five replicates were maintained for each concentration, each replicate comprised of 25 numbers of larvae. Similarly, the control groups were maintained separately by treating with selected concentration of Acetone. After 24h of exposure period, the number of dead larvae were recorded from each replicate in all the concentrations and from the control. Then, the percentage of larval mortality was calculated using Abbott's formula Abbott., (1925). The larvae with no symptom of movement or shake while touched with soft camel brush were considered as dead.

$$\text{Mortality}(\%) = \frac{\%\text{MT} - \%\text{MC}}{100 - \%\text{MC}} \times 100$$

Where, % MT = % Larvae mortality in treatment and % MC = % Larvae mortality in control.

2.2.3 Ovicidal activity

For ovicidal activity, the freshly laid eggs (0-6hrs) of *S. litura* were carefully removed using fine camel brush. A total of 500 eggs were separated into five batch, each having 100 eggs and sprayed with 100-400mg/L concentration of solvent extracts of *Toddalia asiatica*. Control groups were maintained separately as stated in the previous experiments. After the exposure periods, the number of eggs hatched in control and treatments were recorded and the percentage of ovicidal activity was calculated using Abbotts formula Abbott *et*., (1925). For each experiment, five replicates and hatch rate was assessed 120h post treatment.

$$\%\text{OA} = \frac{\%\text{EHC} - \%\text{EHT}}{\%\text{EHC}} \times 100$$

Where, %OA = % ovicidal activity; % EHC = % of eggs hatched in control; % EHT = % of eggs hatched in treatment.

2.2.4. Pupicidal assay

Fresh pupae were selected for pupicidal assay. Five replicates were maintained for each concentration with 30 pupae in each replicates. After harvesting, the pupae were quickly soaked in 2% sodium hypochlorite solution to maintain disease free condition. Then they were transferred to Petri plates provided with cotton bed to avoid any physical damage at the time of pupal movement. Then the selected concentration (100, 200 and 400mg/L ppm) of *Toddalia asiatica* were sprayed individually on pupal and as well as on cotton bed uniformly. Similarly, the control groups were maintained separately by treating with selected concentration of Acetone. Then the Petri plates were kept undisturbed until the end of pupal period. After the exposure period the number of adults emerged from each concentration & control was noted for each replications. Pupicidal activity was calculated method prescribed by Abbott., (1925).

2.3. Callosobruchus maculatus: It was collected from the local varieties of cowpea field. The beetles were reared on cowpea in our laboratory for about a year (Approximately 10 generations) prior to the experiments. The insect culture was done in a climate chamber at 30 ±1ºC with 12h photo period at R.H (50-80%) For the experiment, newly emerged (1-1.5h) insects were used. In the experiments, the day of death of the adult beetles was determined as the day the antennae and legs did not move upon gentle disturbance with forceps.

2.3.1 Effect of plant extracts on weevil mortality: The toxic effect of *Toddalia asiatica* extract on adult *C. maculatus* was accomplished in Petri-dishes (9cm diameter) containing 25g of cowpea with concentrations of 100, 200 and 400mg/L ppm. The leaf extract were thoroughly mixed with the aid of a glass rod and agitated for 5-10min to ensure uniform coating. The dishes were left open for approximately 30 min so as to allow traces of solvent to dry off; after which 20 newly emerged adult *C. maculatus* were introduces into the dishes and mortality was observed daily for four days. Grains that were solvent treated served as the control experiment. Adults were considered dead where no response was observed after probing them with forceps.

2.3.2 Ovicidal activity

The ovicidal activities for each developmental stage of the cowpea weevil, *C. maculatus* treated with the methanol extract of *Toddalia asiatica* was examined. Ovicidal activity was assessed 72 hrs later by dipping cowpea seeds with eggs to the concentrations of 100, 200 and 400 smg/L ppm of *Toddalia asiatica* leaf extract in a 200ml plastic cups (7cm dia x 9.5

cm ht) for 60 seconds followed by air-drying. Control groups were maintained separately as stated previously. The hatching rate was assessed by counting the number of hatched eggs.

$$\%\text{Ovicidal Activity} = \frac{\text{No. of eggs hatched}}{\text{Total no. of eggs treated}} \text{ X } 100$$

2.4 Rearing of mosquitoes in laboratory

Eggs and larvae of *Aedes aegypti* was collected within the college campus by placing water-filled plastic trays (23×15× 6.5 cm) with a lining of partially immersed filter paper. The eggs were placed in plastic trays (30×24×10 cm), each containing 2 l of tap water and kept at room temperature (27±2°C) with a photoperiod of 12:12 h (L:D) for larval hatching. The larvae (collected from the field) were maintained in separate containers under the same laboratory conditions and fed with yeast powder. Cotton soaked in 10% aqueous sucrose solution in a petri dish to feed adult mosquitoes was also placed in each mosquito cage. An immobilized young chick was placed for 3 h inside the cage in order to provide blood meal especially for female mosquitoes. A plastic tray (11× 10×4 cm) filled with tap water with a lining of partially immersed filter paper was then placed inside each cage to enable the female mosquitoes to lay their eggs. The eggs obtained from the laboratory-reared mosquitoes were immediately used for toxicity assays or allowed to hatch out under the controlled laboratory conditions. Only the newly hatched specific instars of larvae or the pupae of different mosquito species were used in all bioassays.

2.4.1 Larvicidal bioassay against *Aedes aegypti*

Larvicidal activity of the extract was determined by the standard procedure. The larvae (25 nos.) were introduced in 500-ml plastic cups containing 250 ml of aqueous medium (249 ml of dechlorinated water + 1ml of emulsifier) and the required concentration (100 ppm, 200 ppm and 400 ppm) of plant extract was added. Five replicates were kept for each test concentration as stated earlier. In each replicate, 25 larvae were used with five replicates of control. The experiment was performed under laboratory conditions at 27 ± 2^{o}C. The percentage of larvicidal activity was calculated by using probit analysis with Statistical Package for Social Sciences (SPSS) 23.0 Version in MS-Excel, 2007.

2.4.2 Ovicidal bioassay against *Aedes aegypti*

The ovicidal assay was performed by placing batches of 100 mosquito eggs in 100 ml of each test medium in a plastic bowl containing a specific concentration (100 ppm, 200 ppm and 400 ppm) of the methanol solvent extracts of *Toddalia asiatica*. In control, the same number of

eggs were maintained in 50 ml of dechlorinated tap water containing appropriate volume of 0.9% saline. All containers were maintained at room temperature (27±2°C) with naturally prevailing photoperiod (12:12 hrs L:D) in the laboratory. The experimental medium was changed after 48 hrs with fresh medium containing the same extract and test concentration. Water lost through evaporation was compensated by periodic addition of dechlorinated tap water. All the test media were carefully examined every 24 h up to 96 h for the number of intact (un hatched) eggs as well as the appearance of the number of first-instar larvae, and the latter indicated the successful egg hatchability. This maximum time point for egg hatchability was fixed since the embryogenesis in mosquitoes under normal condition has been reported to be completed within 96 h (Judson and Gojrati 1967). Besides, the unhatched eggs remaining in the test media after 96 h of exposure were transferred to tap water and maintained up to 24 h in order to ascertain the mortality of these eggs. The eggs that failed to hatch out even under this ideal condition were considered to be dead due to their previous exposure to a particular test medium. Percentage mortality of the eggs, representing the ovicidal effect of the test material, was calculated from the total number of eggs introduced into the medium and the number of unhatched or dead eggs.

$$\%\text{Ovicidal Activity} = \frac{\text{No. of eggs hatched}}{\text{Total no. of eggs treated}} \text{ X } 100$$

2.4.3. Pupicidal bioassay against *Aedes aegypti*

Pupicidal activities of crude extracts were evaluated as per the modified method of Krishnappa *et al.*, (2012). Batches of forty pupae were introduced into 100 ml of the test medium (tap water) in a 250ml plastic bowl containing particular concentration (as stated in the previous experiments) of the selected solvent extracts of the plant. In control, the same number of pupae was maintained in 250 ml of dechlorinated tap water. Any pupa was considered to be dead if its appendages did not move when prodded repeatedly with a soft brush. Mortality of pupae was recorded after 24 h of exposure to the extract. The percentage of pupicidal activity was calculated by using probit analysis with Statistical Package for Social Sciences (SPSS) 23.0 Version in MS-Excel, 2007.

3.0 RESULTS

3.1 Phytochemical analysis of methanol extracts for five different plant

The phytochemical screening of selected plant extracts was assessed and the results pertaining to the experiments are shown in table. From the results, it clearly indicates that the

Methanol extract of ***Toddalia asiatica*** showed the presence of all the phytochemicals except the acids. Whereas, for other plants it showed the absence of numerous phytochemicals.

Table. 3.1.1: Phytochemical analysis of methanol extracts for five different plant.

Phytochemicals	***Euphorbia hirta***	***Moringa oleifera***	***Cassia senna***	***Toddalia asiatica***	***Mallotus repandus***
Alkaloids Dragandroff's test	+	+	-	+	-
Flavonoids Shimoda test	+	-	-	+	+
Steroids Liebermann-Burchard test	-	+	-	+	+
Triterpenoid: Noller's test	+	+	+	+	-
Glycosides Legals test	+	-	+	+	+
Phenols: Ferric chloride test Lead acetate test	-	+	+	+	+
Acid	+	+	+	-	-
Tannins	+	+	+	+	+
Quinone	-		-	+	+
Coumarins: Alkaline test	-	-		+	-
Furanoid: Ehrlich test	-	-	-	+	-

3.2 Larvicidal activity of methanolic extracts of *Toddalia asiatica* tested against the freshly moulted (0-6h old) 4th instar larvae of *Aedes aegypti*, *Spodoptera litura* and adults of *Callosobruchus maculatus* (n=60).

Larvicidal activity of methanol extracts of ***Toddalia asiatica*** was tested against the fourth instar larvae of *S. litura*, *A. aegypti* and adults of *C. maculatus*.. The data pertaining to the experiments are shown in table 3.2.1. It was observed that methanol extract concentration at 400 ppm produced more than 95.0% larval mortality towards the targeted pest.

Table 3.2.1: Larvicidal activity of methanolic extracts of *Toddalia asiatica* tested against the freshly moulted (0-6h old) 4th instar larvae of *Aedes aegypti*, *Spodoptera litura* and adults of *Callosobruchus maculatus* (n=60).

Concentrations (ppm)	**Larvicidal activity (%),**		
	Aedes aegypti	***Spodoptera litura***	***Callosobruchus maculatus***
100	53.66 ± 2.55^{a}	60.88 ± 2.74^{a}	65.33 ± 5.33^{a}
200	73.88 ± 8.33^{b}	85.33 ± 6.66^{b}	79.20 ± 7.09^{b}
400	97.00 ± 6.55^{c}	100.00 ± 0.00^{c}	96.00 ± 8.33^{c}
Control	100 ± 0.00^{c}	95.00 ± 7.33^{c}	96.33 ± 6.66^{d}

3.3 Ovicidal activity of methanol extracts of *Toddalia asiatica* tested against the eggs of *Aedes aegypti*, *Spodoptera litura* and adults of *Callosobruchus maculatus*.

Ovicidal activity of methanol extracts of ***Toddalia asiatica*** was tested against the eggs of *S. litura*, *A. aegypti* and adults of *C. maculatus*. The data pertaining to the experiments are shown in table 3.3.1. It was observed that methanol extract concentration at 400 ppm produced 99.3±0.0**%,** 94.00±0.00**%** and 100.00± 0.00**% ovicidal activity against *A. aegypti, S. litura* and *C. maculatus***.**

Table 3.3.1: Ovicidal activity of methanol extracts of *Toddalia asiatica* tested against the eggs of *Aedes aegypti*, *Spodoptera litura* and adults of *Callosobruchus maculatus*.

Concentrations (ppm)	Ovicidal activity (%)		
	Aedes aegypti	***Spodoptera litura***	***Callosobruchus maculatus***
100	60.0±5.55[a]	64.0±10.09[a]	77.66± 6.30[a]
200	86.66±4.83[b]	90.0 ± 7.00[b]	100.00 ± 0.00[b]
400	99.3±0.0[c]	94.00±0.00[c]	100.00± 0.00[b]
Control	100.00±0.00[d]	100.00±0.00[d]	100.00±0.00[c]

3.4 Pupicidal activity of methanol extracts of *Toddalia asiatica* tested against the pupae of *Spodoptera litura*.

Pupicidal activity of methanol extracts of ***Toddalia asiatica*** was tested against the pupae of *S. litura*. The data pertaining to the experiments are shown in table 3.4.1. It was observed that methanol extract concentration at 400 ppm produced 94% **pupicidal activity against *S. litura.***

Table 3.4.1: Pupicidal activity of methanol extracts of *Toddalia asiatica* tested against the pupae of *Spodoptera litura*.

Concentrations (ppm)	Pupicidal activity (%)	
	Spodoptera litura	***Aedes aegyptis***
100	77.33 ± 1.9c	63.33 ± 2.22[a]
200	85.75 ± 3.71[b]	78.88 ± 3.30[a]
400	94.77 ± 6.60[c]	94.75 ± 5.33[a]
Control	100.00±0.00[d]	100.00±0.00[a]

4. DISCUSSION

There is a great interest shown by scientist to analyze the bio-efficacy of the plant extracts against stored pest, field pest and vector (Dubey *et al.*, 2008). The monoterpenoids are the insecticidal constituents of the plants extract (Abdurrahman Ayvaz *et al*., 2010). In our study, fresh leaves of five different plants *Euphorbia hirta, Moringa oleifera, Cassia senna, Toddalia asiatica* and *Mallotus repandus* were analyzed in the methanolic extracts. Among,

these five plants, the methanolic extracts of *Toddalia asiatica* exhibited the presence of the major insecticidal phytochemicals in it. Many researchers have reported the insecticidal activities of the plant - *Toddalia asiatica.* The plant has important secondary metabolites like flavonoids, Saponins, Coumarins, Steroids, Alkaloids etc., (Praveena A and Suriyavathana M. 2013). These secondary metabolites exhibit antimicrobial activity (Bonjean et al., 1998), also acts as a natural biological modifiers (Robards et al., 1999), antifungal and anticancer activity (Wattenberg et al., 1983). Also, these important secondary metabolites of *Toddalia asiatica* have contributed to the fumigant and repellent activity against three coleopteran pests of stored pest (Gopal Nattudurai *et al*., 2014).

Plants are chemical factories of natural surroundings. Human have used plant parts, products and metabolites in pest control since early historical times. Plant metabolites have strong medicinal and insecticidal property. There is a urgent need to protect stored food grains from attack by insects because the large quantities of food grains are being destroyed by the stored pest which were stored for long-term resulting in the contamination of grain with their excreta, cast skins and dead bodies (Pimentel *et al,* 1991). Plant extracts exhibited the insecticidal activity on *Callosobruchus maculatus.* (Obembe and Kayode 2013). The similar activity was also exhibited against the Coleoptera pest (Marcio Dionizio Moreira et al., 2007).

Alagarmalai Jeyasankar et al., 2012 suggested that the Solanum pseudocapsicum showed insecticidal, antifeedant and growth inhibition activities on field pest – *Helicoverpa armigera* and *Spodoptera litura*. Similar activity was exhibited against the field pest when exposed to the medicinal plant *Tinospora cardifolia* (Selvam and Ramakrishnan 2014). Priyanka Bhatt *et al.,* 2014 reported that the medicinal plants are toxic to *Spodoptera litura*. Similarly, *Rivinia humilis* also showed pesticidal activity against *S. litura* (Elumalai Arumugam *et al*., 2014).

The crude methanolic plant extracts of *An. reticulata* showed remarkable larvicidal activity on *Aedes aegypti* and *Anopheles stephensi* (Thirumalapura Krishnaiah *et al.,* 2016). Likewise, the leaf extracts of *Spondias mombin* showed mosquito adulticidal activity on *Aedes aegypti* (Elijah Eze Ajaegbu et al., 2016) and *Clerodendrum phlomidis* showed larvicidal activity on *C. quinquefasciatus* and *A. aegypti* (Chellaiah Muthu *et al*., 2012).

So, in recent times by using plant extracts and oils man has been able to control certain pests and vectors (Wood A. Compendium of Pesticide Common Names: Insecticides). Similarly,

insecticidal activities were also noticed in essential oils of the plant. Previously, Elumalai *et al*., (2010a) reported that the plant essential oils are currently studied more and more because of the possibility of their use in plant protection. Biological activities of 10 essential oils were studied against the fourth instar larvae of armyworm, *S. litura*. Krishnappa *et al*., (2010a) identified that the *Tagetes patula* volatile oil contain 10 compounds and they were tested against the fourth instar larvae of *S. litura* for their antifeedant activity by using the leaf disc bioassay. Krishnappa *et al*, (2010b) reported that the *Clausena dentate* leaves essential oil against armyworm, *S. litura* exhibited significant larvicidal activity. Senthilkumar *et al*., 2008 have also reported that the larvicidal and adulticidal activities of ethanolic and water mixture of seven plant extracts were tested against *An. stephensi* and the most effective between 80% and 100% was observed in all extracts.

Kumar and Sevarkodiyone 2009 also reported that *Annona squamosa* and *Lepidium sativum* reduced the hatching efficiency of *Spodoptera litura* eggs. Ovicidal activity was also noticed in neem azal T/S, neem azal and ten medicinal plant oils against *Spodoptera litura*. Elumalai *et al.*, 2010 noticed ovicidal activity in plant oils of *Zingiber officinale*, *Ocimum bassilicum*, *Cyperus scariosus*, *Pimpinella anisum*, *Nigella sativa*, *Rosmarious officinalis* and *Curcuma longa* against *Spodoptera litura*. Baskar *et al* also reported that crude and fractions from *Atalantia monophylla* leaves showed ovicidal activity against *Spodoptera litura*. Conclusively, with these findings a study has been carried out with the most promising plant - *Toddalia asiatica* for their larvicidal, ovicidal and pupicidal activity against the targeted pest and the significant results were recorded for future studies.

CONCLUSION

From the findings of present investigation, it has been concluded that of the selected five plants: *Toddalia asiatica* exhibited remarkable larvicidal, ovicidal and pupicidal activity against the *Callosobruchus maculatus, Spodoptera litura* and *Aedes aegypti.*

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