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STUDIES ON EFFECT OF COROMBIA CITRIDORA OIL AGAINST AGROTIS IPSILON (HUFUNAGEL) (INSECTA: LEPIDOPTERA:NOCTUIDAE)

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***Abstract*:**
The black cutworm *Agrotis ipsilon* is a small noctuid moth found worldwide. The larvae are serious agriculture pest and many important grains. Present study was undertaken to evaluate the bioassay test of *Corymbia citridora* oil against *A.ipsilon*. Larva were collected from chincona village of Nilgiris.The study was conducted in the laboratory to evaluate the *C. citridora* oil with different concentrations (0.25, 0.5, 1% and 2%). The biological activity was recorded of 24hrs under laboratory condition. The larval antifeedant was 95.35% in 4th instar larvae of *A.ipsilon* after the trearment of *C.citridora* oil at 2% concentration.Whereas 4thinstar larval mortality was 98.32% at 2% treatment. The pupal mortality was 94.15% at 2% oil treatment. Larval duration was greatly extended after the treatment of *C.citridora* oil. The larval duration of 4th instar larvae of *A.ipsilon* was 6.16 days and 8.52 days after the treatment *C.citridora* oil (1% and 2%) than other concentration. The Pupal duration also extrended after the treatment *C.citidora* oil than control. The fecundity also significantly reduced after the treatment of *C.citridora* oil greatly affected the nutritional parameters of *A.ipsilon*. Consumption index of 4th instar larvae of *A. ipsilon* was 5.62mg/day after the treatment of *C.citridora* oil at 2%. Approximate digestibility was increased after the treatment. Larval-pupal intermediate was very high after the treatment of *C.citridora* oil. High bioactivity was observed in the botanical oil doses against the greasy cutworm, *A.ipsilon* such result may offer an opportunity for developing alternatives to rather expensive and environmentally hazardous in organic insecticides.

Key words
Agrotis ipsilon, *Corymbia citridora*, antifeedant, larvicide, pupicide, adultcide, pupal duration, adult duration.

1. INTRODUCTION

The Noctuidae family is the most varied group within Lepidoptera and includes the highest number of species in the agricultural ecosystem. The black cutworm, *Agrotis ipsilon*, is a major, undesirable insect pest, which attacks different field crops. *A. ipsilon* attacks the seedlings of most crops. Crops attacked include beans, broccoli, cabbage, carrot, corn, egg plant, flowering white cabbage, green beans, head cabbage, lettuce, mustard cabbage, potato, spinach, sugarcane, sweet potato, tomato, turnip, as well as many other plants (Rings, 1975). They are commonly feed on sprouts at ground level, cutting off the stem and sometimes dragging the plants into their burrows. Since the larvae occur burrowed near the roots of the host, it sometimes feeds on roots and the below ground stem. Because of the nature of their feeding on young plants, this pest can do great damage in newly planted fields. The black cutworm *Agrotis ipsilon* has a wide host range, feeding on nearly all vegetables and many important grains. It annually reinvades temperate areas,overwintering in warmer or subtropical regions. Long distance dispersal of adults has long been suspected in Europe, China, and North America. The basic pattern is to move north in the spring, and south in the autumn.

The adult is fairly large in size, with a wingspan of 40 to 55 mm. The forewing, especially the proximal two-thirds, is uniformly dark brown. Moths select low-growing broadleaf plants preferentially for oviposition, but lacking these will deposit eggs on dead plant material. Soil is an unsuitable oviposition site. The hind wings are whitish to gray, and the veins marked with darker scales. The adult preoviposition period is about seven to 10 days. Moths select low-growing broadleaf plants preferentially for oviposition, but lacking these will deposit eggs on dead plant material. Soil is an unsuitable oviposition site. The egg is white in colour initially, but turns brown with age. spherical in shape, with a slightly flattenedbase. The eggs normally are deposited in clusters on foliage. Females may deposit 1200 to 1900 eggs. Duration of the egg stage is three to six days. Eggs hatch in 5-10 days depending on temperature.

Black cutworm larvae are gray to nearly black in colour with a light dorsal band and a ventral surface lighter in colour. The distinct head is dark brown. The larvae have three pairs of true legs and five sets of fleshy, abdominal prolegs. Overall, the larva has a greasy appearance; earning the common name “greasy cutworm” in some parts of the world. Under magnification, the skin of larger larvae has a granular appearance. Black cutworm larvae can be distinguished from the more common dingy cutworm and several other species. For example, they grow; cutworm larvae molt and pass through several larval stages or instars.There are 6 to 9 larval instars with 7 instars most common. Full grown larvae are about 2 inches long. Larval development from egg hatch to pupa takes approximately 28 to 35 days depending on temperature. Pupation occurs below ground at a depth of 3 to 12 cm. The pupa is 17 to 22 mm long and 5 to 6 mm wide, and dark brown. Duration of the pupal stage is normally 12 to 20 days. The entire life cycle from egg to adult takes 35–60 days. Multiple generations are produced until migration is triggered by weather conditions.

The larvae damages plant tissue by feeding with chewing mouthparts. The potential for feeding black cutworm larvae to kill plants, thereby reducing stand and potentially yield makes large infestations of black cutworm a serious threat to corn and other crops. Larvae are active mainly at night. Small larvae feed on leaves creating irregular holes and can cut small weed seedlings.While feeding near or below the soil surface, 4th instar and larger larvae can cut off corn plants sometimes dragging the cut plants below ground. Black cutworm larvae form silk lined burrows in the soil or thatch and emerge at night to feed on grass blades. Larvae are active for most of the night with the greatest activity between midnight and one hour before sunrise (Williamson and Potter, 1997a).

The black cutworm control is currently based on heavy use of many insecticides, which damage the environment and/or pose a threat to public health via food residues, ground water or accidental exposure. The problems caused by pesticides and their residues have amplified the need for effective and biodegradable pesticides with great selectivity (Hazaa and Alam EL-Din, 2011). Alternative strategies have included the investigation for new type of insecticides, and re-evaluation and use of traditional pest control agents. The adverse special effects of synthetic pesticides have enlarged the requisite for effective and bio-degradable pesticides. Because of the power of plant-insect interactions, the plant has well-developed defense mechanism against herbivores and are excel sources of new toxic substances for pests (Pickett *et al.*, 2006).

The black cutworm *Agrotis ipsilon* has a wide host range, feeding on nearly all vegetables and many important grains. Khadr *et al.* (1986) showed that the leaf extract of *Melia azadrach* had a significant antifeedant deterrent against the 3rd larval instar *A.ipsilon* and *S.littoralis*. Great losses occurred in yield due to *A. ipsilon* infestation especially at seedling stage (Ladhari *et al.*, 2013). In recent years, more attention was paid to essential oils as pest control agents. There are numerous researches on the pesticidal activity of essential oils from Lamiaceae family (Rajendran and Sriranjini, 2008; Isman *et al*., 2011). In this regard, the results of previous studies indicated that botanical extracts and their terpenes could be accepted as toxicants to control *A.ipsilon*. Jeyasankar (2012) showed that gaultheria oil was more effective than eucalyptus oil on insecticidal activities against *A.ipsilon* larvae.

Shukla *et al.* (2012) that the essential oils from flowers and leaves of Crofton weed, *Eupatorium adenophorum* and aerial part of Indian wormwood, *Artemisia nilagirica* showed significant antifidant activity at 96h against the red palm weevil adults at 1000ppmThe advantage of using plant essential oils is that they are easily available and they have been used extensively for medicinal purposes, implying that they have low or no toxicity to humans, (Upadhyay, 2013). Lambrano *et al.*(2014) reported the deleterious effects of plant products on insects can be manifested in several manners including toxicity, mortality, antifeedant growth inhibitor, suppression of reproductive behavior and reduction of fecundity and fertility, growth inhibition, perturbation of reproductive behavior (reduction of fecundity and fertility). Among various classes of natural substances that introduced as natural biopesticides are essential oils from aromatic plants (Isman and Grieneisen, 2014; Prakash *et al*., 2014). The deleterious effects of plant product on insects can be manifested in several manners including toxicity, mortality, antifeedant, growth inhibition, reduction of fecundity and fertility (Lambrano *et al*., 2014). Additionally Sharaby*et al.*(2015) reported that the essential oil of garlic, mint, cumin, caraway and parshely had antifeedant and starvation effects after treating the larvae of *A.ipsilon* with the LC_{50} value.

Kamaraj *et al.* (2018) showed reduction in growth and development of *H. armigera* and *S. litura* larvae when fed exclusively on Neem gum nano formulation (NGNF) treated castor leaves. Elbadawy *et al*. (2019) indicate that *jojoba* oil was most effective against the 4th instar larvae of *A.ipsilon*causing 60% mortality.Also, Elhosary *et al*. (2020) achieved a noticeable decrease in some growth indices after treatment 4th instar larvae of *A.ipsilon* with mango seed extracts and water fleabane leaves.

The deleterious effects of plant products on insects can be manifested in several manners including toxicity, mortality, antifeedant growth inhibitor, suppression of reproductive behavior and reduction of fecundity and fertility, growth inhibition, perturbation of reproductive behavior (reduction of fecundity and fertility) (Lambrano *et al.*, 2014). *A.ipsilon* has developed resistance in recent years to some of the conventional insecticides. Several attempts to combat the pest species on different crops using synthetic chemical pesticides culminated in problems like insecticide resistance, pest resurgence, outbreaks of secondary pests and environmental pollution. Keeping in view the economic importance of the insect pest and the hills crops in Nilgiris, laboratory studies were carried out to asses the effectiveness of the plant oils in controlling the black cutworm on cruciferous vegetables crops. Plant extracts including essential oils must have a great potential for pest management, which we shall review in light of recent literature. This work will complement previous reports on the biological and antimicrobial activities of essential oils as well as plant allelochemicals and their applications (Elumalai *et al.*, 2011).

The main goal of the present study was to evaluate the toxic activities of *C.citiridora* oil against the *A.ipsilon* larvae under controlled laboratory conditions for possible use as a safe biological method and alternative to chemical pesticides within the means of integrated pest control program.

2. MATERIAL AND METHODS

Collection of Plant oils

Corymbia citridora oil was purchased from MPDA (Medicinal plant development area), Chincona village, Doddabetta, The Nilgiris, Tamil Nadu, India and collected oil were used for bioassay against larvae of *Agrotis ipsilon.*

Rearing of Black cutworm, *A. ipsilon*

The larvae (***A. ipsilon***) were collected from cabbage field at Doddabetta, Chincona village, Udhagamandalam, Tamil Nadu, India. Larvae were reared in lab condition at the department of Zoology, Government Arts College, Udhagamandalam, Tamil Nadu, India. These laboratory-reared larvae were used for bioassays and the cultures were maintained throughout the study period. The culture was established using Cabbage leaves in a plastic container of 25×10 cm and maintained at room temperature and relative humidity of 70-75%. Sieving the culture separated the 4th instar larva and the larvae were used for subsequent experiment. The culture was continuously maintained in the containers throughout the study period.

Antifeedant Activity

Antifeedant activity of plant oil was studied using leaf disc no choice method (Isman *et al.,* 1997). The stock concentration of plant oil (2%) was prepared by mixing with dichlorinated water. Fresh cabbage leaf discs of 3cm diameter were punched using cork borer and dipped with 0.25, 0.5, 1.0 and 2.0 concentrations of plant oil individually. Leaf discs treated with water was considered as control. After air-drying, each leaf disc was placed in petri dish (1.5 cm X 9 cm) containing wet filter paper to avoid early drying of the leaf disc and single 2hr pre-starved fourth instar larva of *A.ipsilon* was introduced. For each concentration five replicates were maintained. Progressive consumption of leaf area by the larva after 24 hours feeding was recorded in control and treated leaf discs using graph sheet. Leaf area consumed in plant oils treatment was corrected from the control. The percentage of antifeedant index was calculated using the formula of (Ben Jannet*et al.*, 2000).

$$\text{Antifeedant Index} = \frac{C - T}{C + T} \times 100$$

Where C and T represent the amount of leaf eaten by the larva on control and treated discs respectively.

Insecticidal Activity

Fresh leaves were treated with different concentrations (as mentioned in antifeedant activity) of plant oil. Petioles of the cabbage leaves were tied with wetcotton plug (to avoid early drying) and placed in round plastic trough (29 cm X 8 cm). In each concentration 10 pre-starved (2hours) IV instar larvae of *A.ipsilon* were introduced individually and covered with muslin cloth. Five replicates were maintained for all concentrations and the number of dead larvae was recorded after 24hours up to pupation. Percentage of larval mortality was calculated and corrected by Abbott's formula (Abbott, 1925).

$$\text{Abbott's percent correct mortality} = \frac{\text{\% mortality in treated} - \text{\%mortality control}}{100 - \text{\% mortality in control}} \times 100$$

Growth Regulation Activity of Plant Oil

Growth regulation activities of *C.citridora* oils were studied at four different concentrations against IV instar larvae of *A. ipsilon*. Ten larvae were introduced in a petricplate having potato leaves treated with different concentration of plant oil. Water treated leaves were considered as control. After 24hours feeding, the larvae were transferred to normal leaves for studying the developmental periods. For each concentration five replicates were maintained. During the developmental period deformed larvae, pupae, adults and successful adults emerged were recorded. In addition, weight gain by the treated and control larvae were also recorded.

Consumption of food

The larvae were taken out and were reared till they reached the third instar. From this culture, third instar larvae were collected and divided into 5 replicates (10 larvae in each replicate). Quantitative data of food consumption and utilization was recorded for third to fifth instar of the nineteen-butterfly species under study as per the details of Wald Bauer (1968). The larvae and the respective host leaves were weighed separately and then placed in petri dishes. The larvae were allowed to feed on the leaves for 24 h and then the weights of the larvae and the remaining leaf material, and faecal matter in the Petri dish were determined. Fresh food was supplied every 24 h and the related weights were also taken every 24h. From these fresh weight measurements, growth and food utilization were calculated.

Food utilization study

Consumption index (CI), Growth rate (GR), Approximate digestibility (AD), Efficiency of conversion of digested food (ECD), Efficiency of conversion of ingested food (ECI). The formulae of Waldbauer (1968) used in the calculation of these indices is as follows:

$$\text{CI (Consumption index)} = \frac{\text{Wt of food consumed}}{\text{Wt of instar x number of feeding days}}$$

$$\text{GR (Growth rate)} = \frac{\text{Wt gain of instar}}{\text{Mean wt of instar x Number of feeding days}}$$

$$\text{AD (Approximate digestibility)} = \frac{\text{Wt of food consumer - Wt of faeces}}{\text{Wt of food consumed}} \times 100$$

$$\text{ECD (Efficiency of conversion of digested food)} = \frac{\text{Wt gain of instar}}{\text{Wt of food consumed - Wt of faeces}} \times 100$$

$$\text{ECI (Efficiency of conversion of ingested food)} = \frac{\text{Wt gain of instar}}{\text{Wt of food consumed}} \times 100$$

The weights were expressed in milligrams (mg). The values are based on five observations for each parameter; standard deviations were also calculated.

Statistical analysis

All data was subject to analysis of variance and the treatment mean was separated by Duncan's Multiple Range Test (Duncan, 1995).

2. RESULTS

Table 1 provides the average food consumption of IV instar larvae of *A. ipsilon* after the treatment of *Corymbia citridora* oil. In control on IV instar larvae has no antifeedant activity after the treatment of *C.citridora* oil at 1% and 2% treatment, the antifeedant was 61.45% and 95.35%, respectively. Table 2 provides the larval weight gain after the treatment of *C. citridora* oil. The IV instar larval weight was 272 mg in control after the treatment of plant oil at 1% and 2%, it was 160 mg and 127 mg respectively.

Table 1. Antifeedant activities of *Corymbia citridora* oil against fourth instar larvae of *A. ipsilon*

Treatment (%)	Antifeedent (%)
Control	00[e]
0.25	24.13[d]
0.5	31.34[c]
1.0	61.45[b]
2.0	95.35[a]

Within a column means followed by the same letters are not significantly different at 5% level by DMRT

Table 2: Effect of *Corymbia citridora* oil on weight gain of fourth instar larvae of *A.ipsilon*

Treatment (%)	Average larval weight (mg)
Control	272[a]
0.25	176[b]
0.5	160[c]
1.0	127[d]
2.0	108[e]

Within a column means followed by the same letters are not significantly different at 5% level by DMRT

Table 3 provides the larval and pupal mortality of *A. ipsilon* after the treatment of *C. citridora* oil. The larval mortality values of IV instar of *A. ipsilon* was 68.42% and 98.32% respectively after the treatment of *C. citridora* oil at 1% and 2%. The pupal mortality of *A. ipsilon* was 61.36% and 94.15% respectively after the treatment of *C. citridora* oil at 1% and 2%.Table 4 provides the larval duration of *A. ipsilon* after the treatment of *C. citridora* oil. The larval duratin was greatly extended after the treatment of *C. citridora* oil. The larval duration of 4th instar larvae of *A. ipsilon* was 6.16 days and 8.52 days respectively after the treatment of *C. citridora* oil at 1% and 2%. Table 5 gives the pupal, adult duration and fecundity of *A.ipsilon* after the treatment of *C.citridora* oil. The pupal duration was extended by treatment than control. The pupal duration was significantly increase after the treatment of *C. citridora* oil. Adult longevity was greatly reduced by the treatment of *C. citridora* oil at 2%. The fecundity also significantly reduced after the treatment of *C. citridora* oil.

Table 3. Larval and pupal mortality of *A. ipsilon* after the treatment of *C.citridora* oil

Treatment (%)	Larval mortality (%)	Pupal mortality (%)
Control	0^{e}	0^{e}
0.25	23.34^{d}	22.32^{d}
0.5	39.51^{c}	34.52^{c}
1.0	68.42^{b}	61.36^{b}
2.0	98.32^{a}	94.15^{a}

Within a column means followed by the same letters are not significantly different at 5% level by DMRT

Table 4. Larval duration of *A. ipsilon* after the treatment of *C.citridora oil*

Treatment (%)	1st instar (days)	2nd instar (days)	3rd instar (days)	4th instar (days)	5th instar (days)
Control	2.15^{d}	2.36^{d}	2.75^{d}	2.92^{d}	3.68^{d}
0.25	3.05^{d}	3.25^{d}	3.43^{d}	3.62^{d}	4.15^{d}
0.5	4.38^{c}	4.56^{c}	4.85^{c}	4.96^{c}	5.30^{c}
1.0	5.89^{b}	6.01^{b}	6.16^{b}	6.22^{b}	6.82^{b}
2.0	7.18^{a}	8.34^{a}	8.52^{a}	8.73^{a}	9.02^{a}

Within a column means followed by the same letters are not significantly different at 5% level by DMRT

Table 5. Pupal, adult duration and fecundity of *A .ipsilon* after the treatment of *C.citridora* oil

Treatment (%)	Pupal duration (days)	Adult longevity (days)		Fecundity (Nos of eggs)
		Male	Female	
Control	8.15^{e}	7.50^{a}	8.90^{a}	1820^{a}
0.25	9.25^{d}	6.32^{b}	7.62^{b}	1325^{b}
0.5	11.14^{c}	5.15^{c}	6.31^{c}	840^{c}
1.0	13.56^{b}	4.02^{d}	4.15^{d}	580^{d}
2.0	15.74^{a}	2.85^{e}	2.98^{e}	416^{e}

Within a column means followed by the same letters are not significantly different at 5% level by DMRT

Table 6. Nutritional indices of IV instar larvae of *A. ipsilon* after the treatment of *C.citridora* oil

Treatment (%)	GR (mg/ day)	CI (mg/day)	AD (%)	ECD (%)	ECI (%)
Control	0.60[e]	3.71[c]	95[a]	18.4[a]	16.2[a]
0.25	0.72[d]	4.25[b]	96[a]	16.51[b]	15.40[ab]
0.5	0.85[c]	4.83[b]	97[a]	15.23[bc]	14.20[b]
1.0	0.93[b]	5.67[a]	98[a]	14.34[c]	13.10[bc]
2.0	0.98[a]	5.62[a]	99[a]	13.56[c]	12.20[c]

Within a column means followed by the same letters are not significantly different at 5% level by DMRT

C.citridora oil greatly affected the nutritional parameters of *A. ipsilon* (Table 6). Consumption and relative growth rate were reduced by *C. citridora* oil treatment. Consumption index of 4th instar larvae of *A. ipsilon* was 5.62mg/day after the treatment of *C.citridora* oil at 2%. Approximate digestibility was increased after the treatment of *C.citridora* oil.

3. DISSCUSION

The results of the present study may have a great importance as today the environmental safety of an insecticide is considered to be a paramount importance.This has created a worldwide interest in the development of alternative strategies, including the search for new types of insecticides and the reevaluation and use of botanical pest control agents (Heyde *et al*., 1984). Chander and Ahmed (1986) recoded that percent of deposited eggs by *Callosobrocus chinenses* on Cowpea seeds significantly decreased after seeds treatment with *Carum carvi* oil.

Sharaby *et al*. (1994) mentioned that essential oil of *Dodonea viscose* plant leaves caused antifeedant and starvation effects on *S. littoralis* larvae. Gurusubramanian and Krishna (1996) found that severe reduction in egg hatchability occurred in *Earias vitalla* (Fabricius) and *Dysdercus koenigii* (F.) when their eggs were exposed to the vapour of *Alluim sativum*. They attributed that to some chemical ingredients present in the volatiles of *A. sativum* (bulbs) which probably diffused into eggs and affected the vital physiological and biochemical processes associated with embryonic development. The embryonic development in these eggs was not relatively complete; and the egg colour did not change from crystal - transparent to dark colour as in the control eggs.

Mahgoub *et al*. (1998) mentioned that Parsley oil decreased the reproductive potential of *C. maculates*, at 95% concentration of oil the adults was prevented for laid eggs on the treated wheat seeds. Sabbour and Abd El- Aziz (2002) reported that Eucalyptus oil was effective as an antifeeding deterrent against the 3rd larval instar of *A. ipsilon* and *S. littoralis*. Essential oil constituents are primarily lipophilic compounds that act as toxins, feeding detterents and oviposition deterrents to a wide variety of insect pests, it was also effective as a fumigant (Koul *et al.*, 2008). Eziah *et al.* (2011) found that application of neem oil at 5ML/L were effective dosage in preventing the development of *Ephestia cautella* larvae, mortality ranged from 32.5 – 55 % after 96 hours of exposure period, the observed mortality can be attributed to the inherent properties of neem, mortality was dosage and time dependent. Shadia *et al*. (2007) reported the larvicidal effect of Basil essential oil tested against *A.ipsilon* was more effective than its active component (eugenol). The effect was more pronounced at the higher tested concentration. Basil oil at 3% (conc.), only 35 % of the larvae reached the pupal stage with 67.16 % reduction than control and 13 % of the pupae were deformed. Eugenol caused 40 % larval mortality. The reduction in percentage of adult emergence at 3 % and 2 % of basil reached 76.84 and 54.74 %, respectively. The deformities among adult reached 11% and 7 % at 3 and 2 % basil, respectively.

Botanical insecticides have broad spectrum in pest control and may are safe to apply, unique in action and can be processed and used easily. The botanical oil doses used in the present study are not toxic to vertebrates as well as they are cheap, the present study showed high bioactivity of the botanical oils doses against the greasy cutworm, *Argotis ipsilon*, such results may offer an opportunity for developing alternatives to rather expensive and environmentally hazardous organic insecticides. Sharaby *et al*. (2012) reported that there were statistical variable numbers of increased the nymphal periods of *Heteracris littoralis*, life cycle, adult longevity and life span comparing with the control test. Garlic oil inhibited egg lying by the resulting female offspring of the treated 1st instar nymphs. High reduction in the deposited eggs and egg fertility caused by Eucalyptus or Mint oil and marked malformation were observed.

The larval mortality percent was found to be concentration dependent i.e. increased the concentration of the botanical oil used, increased the toxicity values of the tested botanical oil. In agreement with the present results, Bhargava and Meena (2002) tested 6 vegetable oils, i.e. castor, mustard, groundnut, sesame, coconut and sunflower against *Callasobruchus chinensis* in cowpea. Pavela (2005) tested 34 essential oils for insecticidal activity against larvae of *spodopetra littoralis* and concluded that they were toxic or highly toxic. In similar findings by Tripathy and Singh (2005) in India reported that larval mortality in *Helicoverpa armigera* as induced by some vegetable oils (mustard oil, sesame oil, linseed oil, castor oil, cotton seed oil and groundnut oil). Rao *et al.*(1999) cleared that botanical oils has a great effect on the digestive enzymes and decrease the concentration of the haemolymph protein, also block the ionic neuronal channels (Shafeek *et al*., 2003). Klingauf *et al*. (1982) and Huang *et al*. (2002) attributed decreasing of fecundity and fertility to decreasing in periods and time of adults mating which leading to decreasing in ovulation.

Duraipandiyan *et al.* (2011) has been reported that antifeedant and larvicidal activities of rhein isolated from *Cassia fistula* flower against lepidopteron pests *S. litura* and *H. armigera*. Significant antifeedant activity was observed against *H. armigera* (76.13%) at 1000 ppm concentration. Rhein exhibited larvicidal activity against *H. armigera* (67.5), *S. litura* (36.25%) and the LC_{50} values was 606.50 ppm for *H. armigera* and 1192.55 ppm for *S. litura*. Popovic *et al*. (2013) reported that the essential oils from three plants against laravacidal activity and repellent effect was observed by *Calamintha galandulosa* with concentration of 1.14% showed higher mortality rate after 24 hr (56.67%). Bairwa *et al.*(2015) reported that Neem seed Kernel extract and Nimbecide were effective against thrips on mothbean, *Vigna aconitifolia.*

Sharaby *et al.* (2016) reported that the mixture of some essential oils and terpenes improved their toxicity toward *A. ipsilon* larvae, resulting in larval deformation and growth inhibition. Hamada *et al.*(2018) reported the insecticidal activites of oils from garlic cloves (*Allium sativum*) and ginger rhizomes (*Zingiber officinale*) were evaluated on *S.littoralis* by means of sublethal concentration (LC_{50}). Nadia *et al*. (2019) reported in toxicity of neem and peppermint oils nanoformulation against blackcut worm larvae. They are recorded in toxicity of loaded peppermint oil had the 81.36% insecticidal activity as expressed. Yildirim *et al*. (2019) studied the antifeedant effects of essential oil of (*Mentha longifolia*) and also have recorded most valuable chemical constituents in Piperitone and Menthon components. *M. longifolia* oil against on *Subcoccinella vigintiduapunctata* L. (Coleoptera: Coccinellidae).

Moatoz *et al*. (2021) reported the insecticidal activity of lemongrass oil as an ecofriendly agent againt the blackcut worm, after 96hrs post treatment the LC_{15} and LC_{50} value were recorded of *C.citraus* on 2nd instar larvae of *A.ipsilon.* Among various classes of natural substances that introduced as natural biopesticides are essential oils from aromatic plants (Isman and Grieneisen, 2014; Prakash *et al*., 2014). There are numerous researches on the pesticidal activity of essential oils from Lamiaceae family (Rajendran and Sriranjini, 2008; Isman *et al*., 2011; Ebadollahi, 2011). The advantage of using plant essential oils is that are easily available and have been used extensively for medicinal purposes, implying that have low or no toxicity to humans (Upadhyay, 2013).

The biological activity (larval and pupal mortality, larval and pupal duration, pupal weight, GR, ECI, ECD, AD and CI effects) of the tested oil the all tested oil has great effect on growth and development of *A. ipsilon.* Oil has the greatest effect where all larvae died after 4-8 day from feeding on the treated as a result of starvation and toxic effect of the *C. citridora* oil. The oil gave highly significant variation comparing with the control untreated test. The results obtained indicated that the tested *C.citridora* oil caused significant larval and pupal mortality as compared with control. In addition, the of botanical oils prolonged significantly the larval and pupal duration as compared to the control. Also significantly reduced the percentage of adult emergence and significantly decreased the weight of the resulted pupae as compared with the untreated control. Moreover, the tested oil caused malformation percentages among the resulted pupae and adults. However, the abnormal emerged adults were all died within few days. Similar findings, were also obtained by many authors using different botanical oils (Das,1986) on *Callosobruchus chinesis*; Trivedi (1986) on *Rhyzopertha dominica* and *Tribolium castaneum*; Baskran and Janarthanan (2000) on *Sitotroga cerealella* and *C.chinensis*; Pavela (2005) on larvae of *Spodoptera littoralis*; Abdel El-Aziz *et al.* (2007) on *A. ipsilon* and Moawad and Ebadah (2007) on *Phthorimaea operculelle*).

This results coincide with the earlier findings of Jeyasankar (2012) reported that antifeedant, insecticidal and growth inhibitory activities of selected plant oils on black cutworm, *A.ipsilon*. Maximum percentage of insecticidal activity (86.92%) and deformities in treated larvae was recorded in gaultheria oil. Several attempts to combat the pest species on different crops using synthetic chemical pesticides culminated in problems like insecticide resistance, pest resurgence, outbreaks of secondary pests and environmental pollution. Keeping in view the economic importance of the insect pest and the hills crops in Nilgiris. Laboratory studies were carried out to asses the effectiveness of the plant oils in controlling the black cutworm on cruciferous vegetables crops. Plant extracts including essential oils must have a great potential for pest management, which we shall review in light of recent literature.

4. CONCLUSION

Using plant derivatives (botanicals) is one of the alternatives to persistent, non-target, very toxic synthesis. Essential oils are compound extracted from plants. Essential oils are usually safe to humans and the environment. Insecticides of plant origin are expected to be target selective and biodegradable leading to fewer harmful effects on human and other animals and are environmentally safe as compared to synthetic mixtures.The evaluation of the efficacy of tested, dealt with the biological activity (Antifeedant activity, larval and pupal mortality, larval and pupal duration, fecundity and nutritional indices) against the larvae.

Moreover, the efficacy of these *C.citridora* oil and on food consumption and utilization, total instar larvae was studied. The results obtained are summarized as follows:The data obtained indicated that the highest larval mortality percent was caused by the highest concentration (100%) of *C.citridora* oil tested.The percentage of larval and pupal mortality increased significantly with the increase of doses used.The mean larval duration was significantly prolonged and pupal duration prolonged. The percentage of adult emergence reduced.

The larval duration and pupal duration was significantly prolonged by plant oil as compared with that of untreated control. *C.citridora* oil tested induced malformation percentages among the resulted pupae and adults. Plant oil induced the highest percent. In addition, the treatment of larval instar with the oils significantly decreased the weight of the resulted pupae.

Moreover, the results indicated a significant decreased in fecundity level as induced the of tested *C. citridora* oil .The results showed a significant decrease in fresh body weight of *A.ipsilon* fed on leaves treated with *C.citridora* oil. In addition, the results recorded reduced percentages in food ingested by the larval instar as a result of feeding on leaves treated with *C. citridora* oil. Moreover, the *C. citridora* oil tested caused significant reduction in food consumption index (F.C.I.), growth rate (G.R.), approximate digestibility (A.D.), efficiency of conversion of ingested food (E.C.I) and efficiency of digested food to body substance (E.C.D.).

Citriodora oil (Lemon eucalyptus) showed greater performance of Antifeedant activity, larvicidal and repellent activities against *A.ipsilon* .These findings demonstrated the potential of the essential oil for further development into a botanical pesticide in the control of the black cutworm *A.ipsilon* may be in the field as toxic bait traps or as spraying emulsion on plants through integrated pest management program, Hence, it may be suggested that the citriodora oil, can be used for controlling the insect pest, *A.ipsilon* which will replace the chemical pesticide

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