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Effect of powdered leaves of *Lantana camara*, *Clerodendrum inerme* and *Citrus limon* on the rice moth, *Corcyra cephalonica*

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Abstract

Powdered leaves of *Lantana camara* (L.) (Lamiales Verbenaceae), *Clerodendrum inerme* (L.) (Lamiales Verbenaceae) and *Citrus limon* (L.) (Sapindales Rutaceae) were tested for their efficacy against the stored grain insect pest *Corcyra cephalonica* (Stainton) (Lepidoptera Pyralidae). Seven different doses ranging from 0.05 to 2.0 g (0.05, 0.1, 0.15, 0.5, 1.0, 1.5, and 2.0 g) per 20.0 g of rice were tested against this common insect pest of rice to evaluate their effect on its life cycle and mortality. Three higher doses were further tested for their effect on physiological parameters like Total Haemocyte Count (THC), total protein content and glycogen level along with starved insects. *L. camara* and *C. inerme* exhibited biopesticidal activity as evidenced by the high mortality rate in treated insects while *C. limon* was ineffective against *C. cephalonica* in the tested conditions. There was also a significant reduction in the THC (39-53%), protein (30-38%) and glycogen (40-61%) content in *L. camara* and *C. inerme* treated larvae with respect to their controls. This was however similar to the results observed in starved groups (52.0, 39.0 and 82.0% respectively for THC, protein and glycogen) which mimic a physiological condition similar to them.

Key words: *Lantana camara*, *Clerodendrum inerme*, *Citrus limon*, mortality, total haemocyte count, glycogen, protein, *Corcyra cephalonica*.

Introduction

The rice moth, *Corcyra cephalonica* (Stainton) (Lepidoptera Pyralidae) is one of the most destructive insect pests of the stored grains including paddy grains, rice, jowar and other cereals and is widely distributed in India and many parts of the world (Osmen, 1984). The damage is mainly caused by the larvae which feed on grains under silken webs and convert them to mere frass and useless for human consumption (Frenemore and Prakash, 1992). More than 10% of the post harvest damage in warehouse and granaries occurs due to pest and mites infestation (Tooba *et al*., 2005) and 5-10% of the stored grains in India are lost due to insect pests (Frenemore and Prakash, 1992). Controlling them with chemicals is a serious concern as it leads to environmental contamination and health hazards (Tillman and Mulrooney, 2000).

Many plants possess chemical substances with remarkable biological activities which provide protection and resistance against pests and herbivores (Dwivedi and Garg, 2003). More than forty different steroids have been isolated from higher plants which showed α and β ecdysone activity providing resistance to the plants from insect infestation while more than 500 substances with Juvenile Hormone (JH) like activity have been isolated from different plants which are effective in pest control programmes (Slama, 1969). Many other alkaloids and flavanoids have also been reported in different plants with insecticidal properties (Omar *et al*., 2007). Since they possess such chemicals, utilization of the plant materials in powder form, crude extracts or purified form should be welcomed ecologically as biopesticides. Many of the natural plant components are known to act as antifeedants, depressants and growth regulators or to impair the immune functions of insects (Dwivedi and Karsawara, 2003; Deka and Singh, 2005; Omar *et al*., 2007; Curzio *et al*., 2009; Sule and Ahmed, 2009). Hence they have potential to play an important role in the production and post harvest protection of food grains which are seriously damaged by insect pests (Boeke *et al*., 2004; Tooba *et al*., 2005).

In fact, lots of reports now show the use of locally available plants against various kinds of pest infestation. Many plants like *Annona squamosa* (L.), *Lantana camara* (L.), *Clerodendrum inerme* (L.), *Cassia fistula* (L.), *Azadirachta indica* (A. Juss) and *Calotropis procera* (Ait.) are proved to be lethal to various stored grain pests and delay the developmental stages by interfering with their apolysis and moulting processes (Tewari and Singh, 1978; Dwivedi and Garg, 2003; Deka and Singh, 2005). Leaves of *Ocimum sanctum* (L.), *Vitex negundo* (L.), *Aegle marmelos* (L.) and *Lippia geminata* (L.) have been used for the protection of stored rice forms in rural India (Prakash and Rao, 2006). Similarly, leaf powders of *A. squamosa* and *Balanites aegyptica* (L.) caused high mortality in *Tribolium castaneum* (Herbst) and provided protection against seed damage (Sule and Ahmed, 2009). Laboratory and field studies in the UK and Northern Ghana with powdered leaves and hot water extracts of *Cassia sophera* (L.) against *Callosobruchus maculatus* (F.) and *Sitophilus oryzae* (L.) were found to be effective (Kestenholz *et al*., 2007). These traditional methods world wide are useful in protecting the grains variably for 5-12 months (Osmen, 1984; Kestenholz *et al*., 2007; Kiruba *et al*., 2008; Paul *et al*., 2009).

Toxic effects of *L. camara* and *C. inerme* have been reported against stored grain pests like *Rhyzopertha dominica* (F.) (Coleoptera Bostrichidae) and *Callosobruchus chinensis* (L.) (Coleoptera Bruchidae) (Dwivedi and Garg, 2003; Singh *et al*., 1996). They are also effective against field crop pests like *Dysdercus koenigii* (F.)

(Heteroptera Pyrrhocoridae) (Jaipal *et al*., 1983). Powdered leaves and oil extract from *Citrus limon* (L.) (Sapindales Rutaceae) have shown toxicity against larvae of *Culex pipiens* (L.) (Diptera Culicidae) by damaging the midgut epithelial cells (Zayed *et al*., 2009). It is also reported to show antifungal and antibacterial property (Bautista-Banos *et al*., 2000). However their effects on other parameters like total haemocyte count, total protein and glycogen level have not been reported so far. In insects, any physiological disturbances can alter the number of haemocytes, which is developmentally regulated (Pathak, 1983) and has got different functions including protection from pathogens in the body (Chapman, 1998). Similarly synthesis, storage and utilization of proteins and glycogen vary during different stages of development. Stored proteins are utilized during adverse conditions like starvation (Chapman, 1998). Hence, in the present study an attempt was made to evaluate the changes in Total Haemocyte Count (THC), total protein and glycogen level after treatment with leaf powders of *L. camara*, *C. inerme* and *C. limon* in addition to evaluating their toxicity. Since many of the plant components possess antifeedant and growth regulating effect, some of the larvae were also starved along with them to have a comparison to see whether these plant powders are producing similar physiological alterations as that of starved insects.

Materials and methods

Samples of rice grains

Local variety of rice grains, *Oryza sativa* (L.) cultivated in this region, were collected from market and dried properly. They were coarsely crushed in a mixer and mixed with 5% w/w powdered yeast and transferred in small quantities of 20 g each into plastic vials (250 ml volume) and covered with muslin clothes.

Preparation of leaf powders

Fresh leaves of *L. camara* and *C. inerme* were collected in the months of July-August from the Science faculty garden of the M. S. University of Baroda (22°18'39"N and 73°11'04"E). The leaves of *C. limon* were collected from the author's garden nearby. There was no history of pesticide application at both places. The collected leaves were washed and dried in the shade to avoid the loss of chemicals due to direct exposure to sunlight. After 3-4 days, the dried leaves were ground to a fine powder in a mixer and kept in air tight containers for further use. To evaluate their toxic effect, seven different concentrations ranging from 0.05 g to 2.0 g (0.05, 0.1, 0.15, 0.5, 1.0, 1.5, and 2.0 g) were added separately to the samples of 20.0 g rice already weighed and kept in small vials and mixed thoroughly with a glass rod. These vials were then labelled and used for experiments.

Selection of insect pest

Stock cultures of *C. cephalonica* were maintained in a culture room on coarsely crushed rice at 28 ± 1 °C, 60 ± 5% relative humidity and 14L:10D photoperiod for many generations in the laboratory. First and early fifth instars were separated from these stock cultures and used for different experiments.

Experimental design

Effect on developmental cycle

Fifteen insects (newly hatched first instars) per concentrations were separated from stock cultures and transferred to each labelled vials. Control cultures were maintained without any leaf powder treatment under identical conditions. At regular intervals of 24 h, the cultures were transferred on aluminium foil and gently examined for the effect of leaf powders. Dead larvae were identified by their black colour and removed after noting their number. Then the cultures were carefully poured back and the process continued till the remaining larvae completed one generation or up to a maximum period of 50 days. Experiments were repeated in triplicates in each group.

Total haemocyte count (THC)

The THC was carried out from starved and leaf powder treated early fifth instars after a period of 7 days exposure. Haemolymph was collected from heat fixed larvae (Clark and Jones, 1980) in chilled Eppendorf tubes, pre-rinsed with 0.25 % Phenyl thiourea and stored at 4 °C. One part of the haemolymph was then diluted with 2-6 parts of 2% acetic acid which served both as a fixative and an anticoagulant. The diluted samples were used for THC using a haemocytometer, calculated (Jones, 1962) and expressed as the number of cells per mm^3 of haemolymph. Insects without starvation and leaf powder treatment served as controls. All experiments were repeated in triplicates of six larvae per set.

Estimation of total protein and glycogen

Whole body homogenate was prepared separately using glass-glass homogenizer from early fifth instars, exposed to different concentrations of leaf powders (1.0, 1.5 and 2.0 g) and controls separately and kept in cold condition. An aliquot of this was further processed for protein estimation (Lowry *et al.*, 1951) using bovine serum albumin (BSA, Merck, Denmark and Germany) as standard. Six larvae per set were maintained and the experiment was repeated in triplicates.

For estimation of glycogen content, the larvae were digested with 30% KOH in boiling water bath. These tubes were cooled and then added Ethyl alcohol under cold condition. The supernatant was removed by centrifugation. The process was repeated 2-3 times and the precipitate was further used for estimating the glycogen against standard glucose (Seifter *et al*., 1950). Six larvae were used per set and the experiment was repeated in triplicates. Control insects without any treatment were maintained under similar conditions.

Starvation

Effect of starvation on THC and on the levels of protein and glycogen was assessed after depriving the larvae from food source for a period of seven days. This was done along with the above set of experiments to have an insight into the probable mechanism of action of the leaf

components. Proper controls were maintained under identical conditions. For each set of experiment six larvae were used and the experiment was repeated in triplicates.

Statistical analysis

Abbott's formula (1925) was used for calculating the percentage mortality over controls.

The data obtained from three replicates were tabulated as mean ± SE. Further statistical analysis for all data were performed using one way analysis of variance (ANOVA) followed by Bonferroni (compare all pairs of column) test using the software prism 3 and significant values are represented at respective places. The percentage difference in values over control is also provided in tables 3 and 4.

Results

The effect of powdered leaves of *L. camara*, *C. inerme* and *C. limon* on the life cycle of *C. cephalonica* is depicted in table 1. In control insects, the time taken for completing the life cycle was about 44 ± 3 days, whereas in *L. camara* and *C. inerme* treated groups it varied from 40 ± 1 to 44 ± 3 days. In case of *L. camara*, only 0.05, 0.1, and 0.15 g treated insects could complete the life cycle, whereas with the remaining concentrations, larval to pupal conversion is delayed or they were dead after certain period of exposure. With the higher concentrations of 1.5 and 2.0 g, larvae could survive only for 15-17 days (table 1). From 0.1 to 1.0 g concentration, they showed slight delay in larval period. When larvae were treated with *C. inerme* leaf powder, they could complete the life cycle in 40 ± 1 to 44 ± 2 days. However 1.5 and 2.0 g treated larvae died after a period of 20-21 days. The larval period varied from 28 ± 2 to 33 ± 2 days (table 1). *C. limon* was comparatively ineffective and the treated larvae took a similar time to complete their life cycles as those in the controls with similar durations of larval, pupal and adult stages (table 1).

There was a dose dependent increase in mortality after treatment with *L. camara*, and *C. inerme*. Larval stage was found to be more sensitive to the toxic effect than pupae and adults (table 2). The higher concentrations of 1.5 and 2.0 g were highly effective as they produced 100% mortality in the larval stage itself. The percentage mortality over controls in all stages showed significant variations ($P < 0.01$) with almost all the concentrations of *L. camara* and *C. inerme*. In case of *C. limon* treated groups, the mortality rate was negligible and insignificant in comparison to controls (table 2).

There was a delay in the pupal-adult moult after treatment with *L. camara* and *C. inerme* (table 1). It was also observed that their silken cocoons produced for pupation were comparatively loose and in some cases the pupal case was not formed at all. The adults emerged from these abnormal pupae were unable to survive and reproduce as they lived only for a very short duration and died immediately.

Table1. Effect of powdered leaves of *L. camara*, *C. inerme* and *C. limon* on the life cycle of *C. cephalonica* (The values are mean ± SE of three replicates. In each replicate 15 larvae were used. *Abnormal silken cocoon **more than 50% were deformed adults).

Treatment	Life cycle in days			
	Larval period	Pupal period	Adult period	Total period
Control	27 ± 3	11 ± 2	6 ±2	44 ± 3
L. camara (in g)				
0.05	28 ± 1	11 ± 3	6 ±1	45 ± 2
0.1	28 ± 2	11 ± 2	7 ±1	46 ± 2
0.15	29 ± 1	12 ± 1	3** (all dead)	41 ± 1
0.5	31 ± 3	16 ± 3* (all dead)	-	-
1	33 ± 2	-	-	-
1.5	All dead after 17 days	-	-	-
2	All dead after 15 days	-	-	-
C. inerme (in g)				
0.05	28 ± 2	11 ± 1	5 ± 1	44 ± 2
0.1	28 ± 1	10 ± 1	6 ± 1	44 ± 1
0.15	26 ± 1	13 ± 2	2 ± 1** (all dead)	41 ± 2
0.5	25 ± 1	15 ± 1*	3 ± 1** (all dead)	43 ± 1
1	23 ± 2	16 ± 1*	1 ± 1** (all dead)	40 ± 1
1.5	21 ± 1 (all dead)	-	-	-
2	20 ± 1 (all dead)	-	-	-
C. limon (in g)				
0.05	28 ± 2	10 ± 1	5 ± 1	43 ± 1
0.1	28 ± 1	11 ± 1	6 ± 2	45 ± 2
0.15	27 ± 2	10 ± 2	5 ± 3	42 ± 2
0.5	26 ± 1	9 ± 3	6 ± 1	41 ± 2
1	26 ± 2	10 ± 1	7 ± 1	43 ± 1
1.5	25 ± 3	10 ± 2	6 ± 2	41 ± 2
2	25 ± 1	9 ± 1	7 ± 1	41 ± 1

Table 2. Percentage mortality in *C. cephalonica* after exposure to powdered leaves of *L. camara*, *C. inerme* and *C. limon* (The values are mean ± SE of three replicates. In each replicate 15 larvae were used, ns = not significant, P > 0.05).

Treatment	Percentage corrected mortality over control ± SE	
	Larval mortality	Pupal + adult morality
Control	-	-
L. camara (in g)		
0.05	24.09 ± 0.5	15.53 ± 0.2
0.1	31.02 ± 0.8	14.8 ± 0.3 ns
0.15	51.7 ± 0.1	43.29 ± 0.1
0.5	65.4 ± 0.2	33.4 ± 0.2
1	79.3 ± 0.5	29.14 ± 0.2
1.5	100 ± 0	-
2	100 ± 0	-
C. inerme (in g)		
0.05	20.88 ± 0.2	14.8 ± 0.1
0.1	30.19 ± 0.3	14.8 ± 0.2
0.15	41.7 ± 0.5	7.76 ± 0.3 ns
0.5	44.77 ± 0.6	22.05 ± 0.1
1	51.7 ± 0.7	43.32 ± 1.2
1.5	100 ± 0	-
2	100 ± 0	-
C. limon (in g)		
0.05	3.15 ± 0.1 ns	2.1 ± 0.1 ns
0.1	2.5 ± 0.2 ns	2.2 ± 0.2 ns
0.15	3.1 ± 0.3 ns	3.4 ± 0.1 ns
0.5	3.3 ± 0.2 ns	3.6 ± 0.3 ns
1	3.6 ± 0.2 ns	4.3 ± 0.2 ns
1.5	4.03 ± 0.1 ns	4.6 ± 0.2 ns
2	4.13 ± 0.3 ns	5.0 ± 0.4 ns

Table3. Effect of starvation on THC, protein and glycogen levels of *C. cephalonica* (The values are mean ± SE of three replicates. In each replicate six larvae were used, ** P < 0.01, *** P < 0.001).

Groups	THC (cells/mm^3 of haemolymph)	Protein (mg/g tissue)	Glycogen (mg/100 mg tissue)
Control	1387 ± 7.79	106.3 ± 2.78	0.9065 ± 0.003
Starved	666.7 ± 4.38***	65.4 ± 1.152***	0.1643 ± 0.001**
% difference over control	51.93	38.48	81.88

Table4. Effect of powdered leaves of *L. camara*, *C. inerme* and *C. limon* on THC, Protein and Glycogen levels of *C. cephalonica* (The values are mean ± SE of three replicates. In each replicate six larvae were used. ** P < 0.01, *** P < 0.001).

Treatment	T H C		P r o t e i n		G l y c o g e n	
	cells/mm^3 of haemolymph	% difference over control	mg/g tissue	% difference over control	mg/100mg tissue	% difference over control
Control	1387 ± 7.788	-	106.3 ± 2.779	-	0.9065 ± 0.003	-
L. camara (in g)						
1	761.2 ± 8.034***	45.12	69.38 ± 3.038**	34.73	0.5433 ± 0.008**	40.07
1.5	762.4 ± 7.521***	45.03	65.06 ±1.307**	38.79	0.438 ± 0.009**	51.68
2	742.2 ± 4.283***	53.41	68.08 ± 1.98**	35.28	0.3848 ± 0.007**	61.61
C. inerme (in g)						
1	836.8 ± 5.722***	39.67	74.11 ± 1.325**	30.28	0.4546 ± 0.01**	49.85
1.5	782.6 ± 2.088***	43.58	68.65 ± 1.262**	35.42	0.4345 ± 0.004**	52.07
2	730.2 ± 3.942***	47.35	67.55 ± 2**	36.45	0.4152 ± 0.007**	54.20
C. limon (in g)						
1	1366 ± 3.28	1.5	100.9 ± 1.472	5.08	0.8778 ± 0.009	9.35
1.5	1361 ± 3.84	1.87	101.8 ± 1.548	4.23	0.8837 ± 0.007	2.5
2	1363 ± 1.2	1.73	96.92 ± 2.428	8.82	0.8595 ± 0.003	5.18

After seeing the results of toxicity, three higher concentrations (1.0, 1.5, and 2.0 g) were selected for further studies as they were more effective than lower concentrations. To evaluate the effect of starvation, early fifth instars were starved for seven days and the total protein and glycogen content were estimated from them. It is observed that seven days of starvation has produced significant decline in THC as the number showed a drastic decline from 1387 ± 7.79 in control to 667 ± 4.38 in starved insects ($P < 0.001$). This was about 51.93% less than that of normal controls. Similarly there was a significant reduction in the levels of total protein (38.48%, $P < 0.001$) and glycogen content (81.88%, $P < 0.01$) of the larvae (table 3) when compared to those of controls.

The effect of powdered leaves of *L. camara*, *C. inerme* and *C. limon* on THC, total protein and glycogen content after treatment with leaf powders are shown in table 4. Exposure to *L. camara*, and *C. inerme* produced a significant reduction in THC. The number of haemocytes showed a reduction of 45-53% in case of *L. camara*, while it was 39-47% in case of *C. inerme* ($P < 0.001$). Total protein content showed a decline of 35-38.79% in case of *L. camara* whereas it was 30.0 to 36.45% in case of *C. inerme* ($P < 0.01$). Reduction in glycogen content was still higher with a value of 40-62% for *L. camara* treated insects and 50-54% with *C. inerme* treated ones ($P < 0.01$). There were not many variations in THC or in the levels of protein and glycogen after treatment with *C. limon* in comparison to the controls (table 4).

Discussion

In the present study, analysis of percentage mortality and developmental cycle of *C. cephalonica* reveals high mortality in larval, pupal and adult stages with the effect being highest at larval stages. There was a delay in the pupal-adult moult after treatment with *L. camara*, and *C. inerme.* Interestingly, the silken cocoon produced for pupation by the treated larvae were less rigid and were absent in some. More than 50% of such pupae produced abnormal adults with distorted wings. However, the adults formed were unable to survive and reproduce. This is in conformity with the results reported earlier (Dwivedi and Garg, 2003), where ovicidal, larvicidal, and moult inhibiting properties of *L. camara* extract on *C. cephalonica* were reported. These researchers reported that the moult inhibiting properties of the active ingredient, especially alkaloids were due to their adverse effect on the apolysis process. Singh *et al.* (1996) also found a lower fecundity, reduced adult emergence, developmental delay and seed protection effect of *L. camara* against *R. dominica*. Jaipal *et al.* (1983) reported a juvenile hormone like activity of *L. camara* on *D. koenigii* when they observed morphological aberrations in the insect body followed by developmental delay and infertility. Rharrabe *et al.* (2007) have also reported similar results with harmeline, a plant secondary metabolic compound against *Plodia interpunctella* (Hubner) where it showed high mortality, prevention of larva to pupal or adult stage and weight loss. Similarly *Peganum harmala* (L.) seed extracts when mixed with food at 2.5, 5.0, and 10.0% concentrations, reduced food intake, increased larval period and prevention of larva to pupal or adult stage thereby preventing F1 progeny production in *T. castaneum* (Jbilou and Sayah, 2008).

A high level of JH and decreased level of JH esterase activity are reported in many Lepidoptera during starvation (Cymborowsky *et al.*, 1982; Memmel *et al.*, 1988; Venketesh and Roe, 1988), which delay the post embryonic development and metamorphosis (Reddy and Kumaran, 1973). In insects, many of the physiological changes like variations in THC, synthesis of storage proteins, storage and utilisation of carbohydrates are hormonally regulated (Chapman, 1998). A high level of JH titre is known to suppress ecdysteroid production in the larval forms of Lepidoptera (Senhal *et al*., 1981).

Since the powdered leaves of *L. camara* and *C. inerme* have produced delay in developmental cycle and abnormal adult formation, some of the larvae were starved along with them to have a comparison of the physiological attributes like variations in THC and the levels of protein and glycogen. These parameters reflect the changes associated with hormonal imbalances produced by starvation (Sujatha and Duttagupta, 1991). A precise developmental pattern can be observed in total haemocyte count during different developmental stages and metamorphosis of insects. Physiological conditions also influence the mitotic index and size of haemocyte population (Pathak, 1983; Rao *et al*., 1984). Starvation is one such condition which cause extra larval ecdysis in penultimate instars and delay in pupation of last instars (Cymborowsky *et al*., 1982; Reddy and Kumaran, 1973). When the larvae were starved for seven days, they showed a significant decline in THC which conforms to the results reported earlier (Sujatha and Duttagupta, 1991). A similar trend was seen after treatment with powdered leaves of *L. camara* and *C. inerme*. However, *C. limon* failed to cause any significant variation in THC when compared to controls. In general, there is an increased level of JH titre in the starved Lepidoptera due to low JH esterase activity (Cymborowsky *et al*., 1982; Memmel *et al*., 1988; Venkatesh and Roe, 1988). The role of starvation, refeeding and application of brain homogenate, JH and ecdysone exogeneously on THC was reported earlier in *C. cephalonica* (Sujatha and Duttagupta, 1991; 1993). The current experiments with starvation and powdered leaves of *L. camara* and *C. inerme* have produced almost similar results for THC which indicated a probable role of JH like activity of the plant components (Jaipal *et al*., 1983).

In insects, the synthesis, storage and utilization of proteins vary during different stages of development and also during different physiological conditions under the influence of different hormones. Stored proteins are utilized during adverse conditions like starvation.

Moreover, it is reported that high level of JH during starvation inhibits the synthesis of storage proteins (Dortland, 1978) and diapause protein (Tojo *et al*., 1981). In general, trehalose is the readily mobilizable carbohydrate which gets converted to glucose by the

action of trehalase. However, during flight or starvation, the stored glycogen is converted to trehalose by the action of hyperglycemic or hypertrehalosemic hormone from corpora cardiaca (Chapman, 1998) and utilised. The results reported here show that *L. camara* and *C. inerme* have produced a significant decline in protein and glycogen levels similar to those of starved insects. Similar results were reported with harmeline against *P. interpunctella* (Rharrabe *et al*., 2007) and *P. harmala* seed extracts against *T. castaneum* (Jbilou and Sayah, 2008). The decreased level of protein and glycogen in treated and starved insects might induce the release of hyperglycaemic hormone to utilize the stored glycogen (Gies *et al*., 1988). It is also possible that further synthesis of protein and glycogen were prevented by the increased level of JH like activity in treated insects as in starved insects (Cymborowsky *et al*., 1982).

In the present study, *L. camara* and *C. inerme* have shown biopesticidal property and interference with normal metabolic activities. *C. limon* turned out to be ineffective in producing such effect in *C. cephalonica* under the tested conditions. With the tested parameters *L. camara* and *C. inerme* have shown results which are strikingly similar to those of starvation. Morphological abnormalities observed during development also suggest the JH like activity of the plant components. It is not surprising to see such activity since many plants are reported to possess JH like activity which helps and protect them from insect infestation (Slama, 1969). However, the JH like activity of these plant components has to be experimentally proved before making any final conclusion and for this purpose the work is in progress in such direction.

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