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Control of *Spodoptera littoralis* (Boisd.) (Lepidoptera:Noctuidae) and *Tetranychus urticae* Koch (Acari:Tetranychidae) by Coriander Essential Oil

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ABSTRACT

This study aimed to evaluate essential oil bioactivity of *Corianderum sativum* L. on egg stage of *Spodoptera littoralis* (Boisd.) and *Tetranychus urticae* Koch in Egypt. Linalool and α-pinene were the basic constituents in the essential oil that recorded (64.103 and 11.964%). The ovicidal activity of obtained oil indicated that according to LC_{50} values, the younger one day-old eggs of both *S. littoralis* and *T. urticae* are more susceptible to coriander essential oil than older ones (three days-old) recording (0.055, 1.565%) and (1.489, 4.759%), respectively. Latent effect with LC_{50} of coriander oil on the successive stages of both pests resulted from treated eggs were detected. Larval mortality of *S. littoralis* recorded 20.00 and 16.00%, respectively, in return to zero% for controls. Furthermore, biological parameters were affected due to essential oil treatment that both larval and pupal duration as well as incubation period elongated compared to control while the reverse was true in case of pupation and pupal weight. Additionally, biological aspects of *T. urticae,* caused shortest incubation period of both tested egg-ages comparing to its control, treated 24 h old eggs caused elongation in longevity and life span of female compared to control, in both treated tested egg-ages. Finally results demonstrated that, highly significant reduction in the total number of eggs/female for 24 h old eggs was recorded 60.067 eggs, control gave 87.00±6.93 eggs. Insignificant reduction was detected as affected by treated 72 h old eggs laid 114 eggs, control laid 117 eggs.

Key words: Essential oil, coriander, *Spodoptera littoralis, Tetranychus urticae,* ovicides

INTRODUCTION

Serious problems of genetic resistance by insect species, pest resurgence, residual toxicity, phytotoxicity, vertebrate toxicity, wide spread environmental hazards and increasing costs of application of the presently used synthetic pesticides have directed the need for effective, biodegradable pesticides (Glenn *et al.*, 1994; Ewete *et al.*, 1996; Guedes *et al.*, 1997; Abd El-Aziz and Sharaby, 1997). These facts may help in the IPM programs and pest control strategies, including using plant derivatives against economic insect-pests. Plant derived essential oils are often environmentally safe with rapid biodegradation and are non-toxic to humans and other mammals (Isman, 2000). Various oil extracts have been proved to identify as effective pesticides (Colomaa *et al.*, 2006; Abdel Aziz *et al.*, 2007) and insect growth regulators (Kogan, 1986; Pavela, 2004; Mesbah *et al.*, 2006).

Coriander essential oil is obtained by steam distillation of the dried fully ripe fruits (seeds) of *Coriandrum sativum* L. (Apialis: Apiaceae). Coriander oil is approved for food uses by the Council of Europe (COE, 1970; FDA, 1996; FCC, 2003).

Polyphagous cotton leafworm, *S. littoralis* (Boisd.) (Lepidoptera: Noctuidae) and phytophagous mites such as *T. urticae* Koch (Acari: Tetranychidae) among the major pests in Egypt, attacking cotton, fruits, trees and vegetables. It usually feed on leaves whose epidermis is injured, consequently, reduction in both quantity and quality of the crops (Hosny and Isshak, 1967; Helle and Sabelis, 1985; Russell *et al*., 1993).

The objective of this work is to study the ovicidal and biological effects of coriander essential oil against both *S. littoralis* and *T. urticae*.

MATERIALS AND METHODS

Plant materials and isolation of essential oil: Essential oil was extracted from the seed of coriander, *Coriandrum sativum* L. of the family Apiaceae that obtained from Sharquia Governorate, Egypt. The essential oil was extracted by steam distillation for 4-6 h using a Clevenger-type apparatus where 250 g of seeds in 250 mL of water subjected to hydrodistillation (Marcus and Lichtenstein, 1979; Weaver *et al*., 1994). The oil was separated dried over anhydrous sodium sulfate and stored in dark glass bottles at 4°C in the refrigerator until used. The isolated oil is a colorless or pale yellow liquid with a characteristic odor and taste of coriander.

GC-MS analysis of essential oil: The constituents and identification of oil constituent's analysis were performed using a Hewlett Packard gas chromatography coupled to mass spectrometry (GC-MS analysis) in National Research Center, Cairo, Egypt according to the method of (Likensm and Nickerson, 1966; Bernhard *et al.,* 1983).

Cotton leafworm, *Spodoptera littoralis* (Boisd.) rearing technique: A laboratory strain of cotton leafworm, *S. littoralis* (Lepidoptera: Noctuidae) (maintained on above 30 generations) were reared on castor bean leaves in laboratory under constant conditions of 27±2°C, photoperiod of 14 h light and 10 h dark and 65±5% R.H. The culture of the cotton leaf worm, *S. littoralis* was initiated from freshly collected egg-masses supplied from the division of cotton leafworm of Plant Protection Research Institute (PPRI) Sharquia Branch, Egypt. Larval stages were reared on castor bean leaves which were provided daily. The adult were kept separately and mated on the third day of emergence in clean jars (4 lb.) adults were fed on 10% honey solution, fresh green leaves of tafla, *Nerium oleander* (L.) were provided for egg laying.

Relative susceptibility of two developmental egg ages of *S. littoralis* to coriander essential oil: For studying the relative susceptibility of *S. littoralis* eggs at two developmental ages (one and three days old), seven serial concentrations of coriander essential oils were prepared using ethyl alcohol (95%) as solvent (5.0, 2.5, 1.25, 0.625, 0.312, 0.15 and 0.073%) (v/v). Egg-masses required were obtained from laboratory reared culture. As the female started to lay eggs, the mating cages should be completely cleared at limited known time and after 24 h, egg-masses were picked at the same limited time of cage clearance. The numbers of the collected egg-masses were divided into two groups, the first was the one-day old eggs, the second was left to the third day to represent the three days-old eggs. Using dipping technique, 5 egg-masses were dipped (for 20 sec) for each concentration in both groups. The treated egg-masses were left for air dryness, then transferred to Petri dishes (5 egg-masses/dish). The same number of egg-masses was dipped in ethyl alcohol 95% to be used as untreated check. Daily inspection for all treatments was made until 2 days after the untreated egg-masses were hatched. The incubation period was also calculated for each tested concentration.

Latent effect of coriander essential oil on the successive stages of *S. littoralis* resulted from treated eggs: The obtained LC_{50} of coriander essential oil on one and three old eggs of *S. littoralis* were applied in this experiment. Using dipping technique, the treated and untreated (one and three days old egg masses) were kept in Petri-dishes till hatching. Fifty of the newly hatched larvae resulted from each concentration and also from the check were picked randomly and separately and transferred into the glass rearing jars. The larvae were supplied daily with fresh castor bean leaves and kept under close observation until pupation. The rearing jars were kept under laboratory conditions mentioned before. Larval mortality percentage, larval duration, pupation percentage, pupal duration, pupal weight and moth emergence percentage. All these biological aspects represented the parameters of the long-term bioactivity of such concentration compared to the check on the different stages of *S. littoralis* previously treated.

Two-spotted spider mite, *Tetranychus urticae* rearing technique: The original colony of spider mite, *T. urti*cae Koch was supplied from heavily infesting eggplant leaves, *Solanum melongena* L. and reared on mulberry leaves, *Morus alba* L. at (PPRI). It maintained in laboratory conditions at 26±2°C, 70±5% R.H. and 16:8 L: D photoperiod.

Eggs treatment: To investigate the ovicidal activity of coriander essential oil, ten adult females of *T. urticae* were placed on each mulberry leaf disc (3 cm diameter) which was put on wet cotton wool in a Petri dish (10 cm diameter) including 6 leaf discs for each concentration and incubated for 24 h to deposit eggs then adults were transferred form discs. The obtained eggs were divided into two groups, the first was one day-old eggs and the second was left to the third day to reach the three days-old eggs. Using glass atomizer, both egg-ages were sprayed with seven series concentrations of coriander oil were prepared using ethyl alcohol 95% as a solvent (5.0, 2.5, 1.25, 0.625, 0.312, 0.15 and 0.073%) while each concentration was represented by five replicates (40 eggs/replicate) for each egg age. Control was sprayed with only ethyl alcohol 95%. Mortality was recorded at day 6 post eggs laying for both tested ages.

Effect of essential oil of *C. sativum* on biological aspects of *T. urticae*: The obtained LC_{50} of coriander essential oil on one and three days-old eggs of *T. urticae* were sprayed in this experiment using glass atomizer, then twenty hatched eggs for each age were transferred singly to leaf discs (3 cm diameter) of mulberry leaves as rearing arenas. The discs were placed on cotton wool soaked with water in Petri-dishes. The life cycle, adult longevity, life span, pre-oviposition, oviposition, post-oviposition, number of deposited eggs per female, egg mortality and hatchability percentages were also recorded.

Statistical analysis: The percentages of untreated and treated eggs of both *S. littoralis* and *T. urticae* were recorded from which the average mortality percentage that calculated per each concentration and corrected using Abbott (1925). The LC_{50} and LC_{90} of tested oil were statistically analyzed according to (Finney, 1972). Toxicity Index calculated according to Sun (1950).

The significance of the main effects was determined by analysis of variance (ANOVA). The significance of various treatments was evaluated by Duncan's multiple range test ($p<0.05$) (Snedecor and Cochran, 1980). Data were subjected to statistical analyses using a software package (CoStat Statistical Software, 2005) a product of Cohort Software, Monterey, California.

RESULTS

Chemical constitution of coriander essential oil: Data in Table 1 and Fig. 1 indicated that the major constitutions of coriander oil was Linalool (64.103%) followed by α-Pinene (11.964%) which represented about (76.067%) of the oil composition. While the traces compound of coriander was found to be Terpinene-4-ol (0.0677%).

Effect on *S. littoralis*

Susceptibility of different egg ages of *S. littoralis* to *C. sativum* essential oil: Data in Table 2 showed that, *C. sativum* essential oil has an ovicidal effect on both developmental ages

Table 1: Chemical composition of coriander seed essential oil as analyzed by GC-MS

Essential oil components	Relative abundance (%)	Retention time (RT) (min)
α-Pinene	11.964	3.027
Sabinene	0.864	3.234
β-Myrcene	1.533	3.564
Camphene	3.358	4.174
β-Pinene	4.838	4.288
P-Cymene	3.428	4.573
Linalool	64.103	5.479
Citronellal	0.956	6.002
Geraniol	1.894	6.183
Terpinene-4-ol	0.067	7.146
Borneol	1.023	7.372
Linalyl acetate	1.103	7.527
Neral	1.349	7.813
Geranyl acetate	2.910	9.158

Table 2: Ovicidal activity of *C. sativum* essential oil on *S. littoralis* eggs

Tested eggs	LC_{50} (%) (lower-upper)	LC_{90} (%) (lower-upper)	Slope	Toxicity index
1 day-old eggs	0.055 (0.022-0.139)	5.939 (2.622-10.457)	0.629	100.000
3 days-old eggs	1.565 (1.326-1.848)	7.243 (5.233-13.027)	1.926	3.514

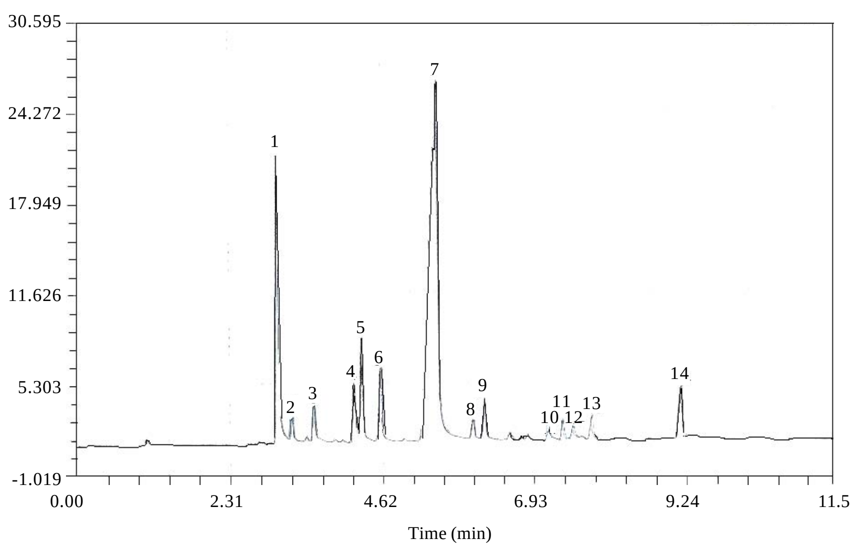

Fig. 1: GC-MS of coriander, *Coriandrum sativum*

of *S. littoralis* eggs where LC_{50} values are (0.055, 1.565%) at the two levels of development (1, 3 days-old eggs, respectively). At the level of LC_{90}, data showed the same trend (5.939, 7.243%, respectively).

Generally, the values of LC_{50} indicated that the younger eggs are more susceptible to coriander essential oil than older ones.

Incubation period: The incubation period of both one and three days-old eggs were increased as affected by all tested concentrations of coriander oil than control, with the exception of the two least concentrations (0.0787 and 0.15%) that gave the same incubation period of control (3 days). Using coriander oil at concentrations 5 and 2.5% against one day eggs, causing the significant elongation of incubation period (5±0.00 days) comparing to other tested concentrations, p = 0.0382, (Fig. 2). Whereas no statistical difference was observed against three days-old eggs, p = 0.233.

Latent effect of coriander essential oil on the successive stages of *S. littoralis* resulted from treated eggs: The previously LC_{50} values of coriander essential oil against both one and three days-old egg masses of *S. littoralis* (0.0550, 1.565%, respectively) were used to evaluate some biological parameters occurred in the successive stages resulted from the two tested developmental ages.

Effect on duration: Results indicated that, treated LC_{50} of coriander oil on treated 1 day-old eggs elongated the larval duration from 17±0.57 days of control to 18±0.577 days, without any significant differences, p = 0.287. While LC_{50} impacted to treated three days-old eggs exhibited identical larval duration like that obtained from its control (17.00 days), p = 1.00, Table 3.

As for the pupal duration, data in the same Table showed that the pupal duration lasted 12.50±0.620 and 12.25±0.405 days for treated one and 3 days-old eggs, respectively. Such increase was statistically insignificant when compared to its controls (11.05±0.533 and 11.23±0.693 days, respectively), p = 0.1507 and 0.273, respectively.

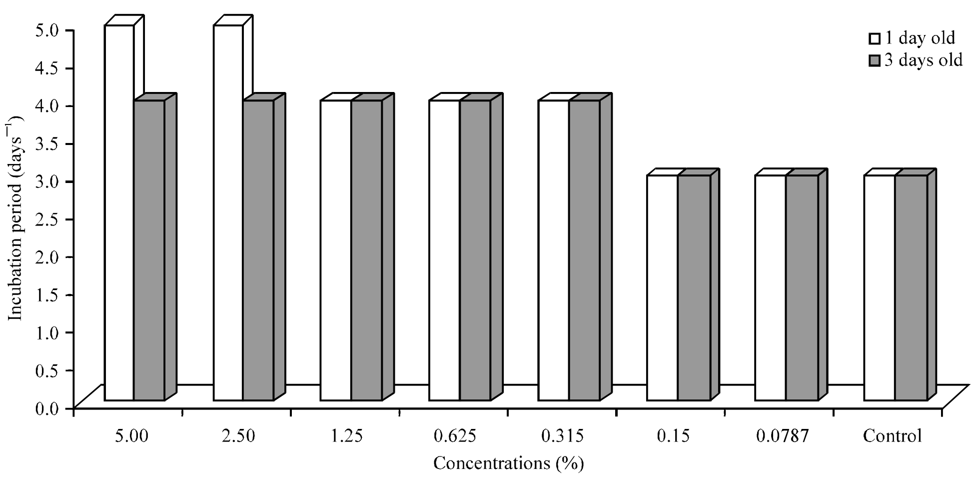

Fig. 2: Incubation period of the two tested *S. littoralis* egg ages subjected to coriander essential oil

Table 3: Biological aspects of *S. littoralis* resulted from treated eggs with *C. sativum* essential oil

Tested age	Treatments	Larval duration (days)	Larval mortality (%)	Pupation (%) Normal	Pupation (%) Deformed
1 day-old eggs	Treated	18.000±0.577[a]	20.00±2.00[a]	88.20±4.394[b]	11.8±1.141[a]
	Control	17.000±0.571[a]	0.00±0.00[b]	100.00±0.00[a]	0.00±0.00[b]
	$LSD_{0.05}$	2.2669[ns]	5.5528***	7.8997***	3.3434***
	p	0.2879	0.0006	0.0143	0.0006
3 days-old eggs	Treated	17.00±1.527[a]	16.00±1.154[a]	92.48±2.479[b]	7.52±0.774[a]
	Control	17.00±0.00[a]	0.00±0.00[b]	100.00±0.00[a]	0.00±0.00[b]
	$LSD_{0.05}$	4.2410[ns]	3.2059***	6.8829***	2.0110***
	p	1.00	0.0002	0.0387	0.0005

Tested age	Treatments	Weight of pupae (g)	Pupal duration (days)	Emergence (%) Normal	Emergence (%) Deformed
1 day-old eggs	Treated	0.3450±0.0216[a]	12.50±0.62[a]	94.59±2.226[a]	5.41±0.871[a]
	Control	0.3604±0.0291[a]	11.05±0.532[a]	100.00±0.00[a]	0.00±0.00[b]
	$LSD_{0.05}$	0.0962[ns]	2.2692[ns]	6.1820[ns]	2.4205***
	p	0.6798	0.1507	0.0720	0.0034
3 days-old eggs	Treated	0.3163±0.0281[a]	12.25±0.4052[a]	97.30±2.019[a]	2.70±0.3335[a]
	Control	0.3538±0.0266[a]	11.23±0.6929[a]	100.00±0.00[a]	0.00±0.00[b]
	$LSD_{0.05}$	0.1075[ns]	2.2287[ns]	5.6083[ns]	0.8983***
	p	0.3078	0.2727	0.2523	0.0010

Treated eggs at level of LC_{50} of coriander essential oil, Data expressed as Mean±SE, *** = p≤0.01, ns = Non significant, Mean under each variety having different letters in the same column denote a significant different (p≤0.05)

Larval mortality: It is important to point out that the mortality during larval stage were higher as affected by both tested concentrations of coriander oil than untreated egg masses (Table 3). The larval mortality recorded 20.00±2.00 and 16.00±1.15%, respectively in return to zero% for controls, p = 0.0006 and 0.0002, respectively.

Pupal weight: Concerning the pupal weight, data in Table 3 indicated that, pupae resulted from treated one and three days-old eggs with LC_{50} of coriander oil weighed less than control, with more pronounced reduction in old eggs (0.3163±0.0281 g) than in young one (0.3450±0.0216 g), Table 3. No significant differences were obtained among means, p = 0.679 and 0.308, respectively.

Pupation percentage: Over 88% of larvae resulted from treated one and three days-old eggs exhibited normal pupae (Table 3) which was significantly less than 100% normal pupae found in controls, p = 0.0143 and 0.0387, respectively. Coriander essential oil caused significantly higher percentage of deformed pupae (11.80±1.141 and 7.25±0.727%, respectively) compared to its controls which did not cause any pupal deformations, p = 0.0006 and 0.0005, respectively.

Adult emergence: The percentage of normal adults that emerged from both one and 3 days-old treated eggs caused insignificant reduction than controls, p = 0.720 and 0.252, respectively. The adult emergence were recorded 94.59±2.226 and 97.30±2.019% for treated eggs, respectively. Control gave 100% emergence, Table 3. Significant differences were observed in the rates of deformed adults emerging of both tested egg ages treated with LC_{50} of coriander oil (5.41±0.871 and 2.70±0.323%, respectively) than the control ones (did not cause any deformations) p = 0.0034 and 0.0011, respectively.

Effect on *T. urticae*

Susceptibility of different egg ages of *T. urticae* to *C. sativum* essential oil: Results obtained in Table 4 revealed that, the coriander essential oil has ovicidal activity on both tested egg ages (1, 3 days-old) with special references to the first age that recorded (1.489, 12.798%) at LC_{50} and LC_{90}, respectively. while three days-old eggs age gave (4.759, 185.061%, respectively). The same trend obtained in *S. littoralis* eggs was also recorded in *T. urticae* eggs that the younger eggs are more susceptible than older ones to coriander essential oil.

Activity of *T. urticae* eggs treated with coriander essential oil on some biological parameters: Both one and three days-old eggs of *T. urticae* that developed successfully to the adult stage after treated with LC_{50} of coriander essential oil and its controls were tabulated in Table 5.

The shortest incubation period of both treated egg-ages were noted (3.42±0.07, 4.13±0.12 days) comparing to its control (3.50±0.08, 4.20±0.17 days), respectively without any significant differences, p = 0.4959, 0.6185, respectively.

Generally, treated one day old egg caused highly significant shortness in life cycle (8.52±0.06 days) than control (10.00±0.42 days) while the reverse was true in the case of three days-old eggs (Table 5).

Female longevity that includes three parameters, pre-oviposition, oviposition and post-oviposition periods were shown in Table 5. Treated one day-old egg caused elongation in the three tested parameters compared to control. The p = 0.3738, 0.4766 and 0.4093. Conversely, the

Table 4: Ovicidal activity of *C. sativum* essential oil on *T. urticae* eggs

Tested eggs	LC_{50} (%) (lower-upper)	LC_{90} (%) (lower-upper)	Slope	Toxicity index
1 day-old eggs	1.489 (0.546-4.326)	12.798 (8.163-16.079)	0.754	100.000
3 days-old eggs	4.759 (2.579-7.182)	185.061 (102.560-300.219)	0.919	31.288

Table 5: Biology aspects of *T. urticae* eggs treated with coriander essential oil

Eggs age/ parameters	1 day-old eggs				3 days-old eggs			
	Treated	Control	$LSD_{0.05}$	P	Treated	Control	$LSD_{0.05}$	P
Incubation period	3.42±0.07	3.50±0.08	0.2968^{ns}	0.4959	4.13±0.12	4.20±0.17	0.3605^{ns}	0.6185
Larva	1.70±0.03^{b}	2.11±0.19^{a}	0.3049*	0.0203	1.33±0.08	1.40±0.03	0.2457^{ns}	0.4733
Protonymph	1.55±0.01^{b}	2.08±0.45^{a}	0.2624**	0.0005	2.97±0.22^{a}	1.99±0.03^{b}	0.5976*	0.0104
Deutonymph	1.85±0.09	2.31±0.45	0.3853*	0.0295	2.66±0.25	2.56±0.06	0.4668^{ns}	0.5840
Life cycle	8.52±0.06^{b}	10.00±0.42^{a}	0.8593**	0.0060	11.09±0.42^{a}	10.15±0.29^{b}	0.4425**	0.0040
Pre-oviposition	2.25±0.01	2.00±0.29	0.3738^{ns}	0.1370	0.72±0.11	0.75±0.12	0.1312^{ns}	0.5600
Oviposition	8.75±1.59	8.33±0.93	0.4766^{ns}	0.7070	16.06±1.57^{b}	21.66±3.73^{a}	2.1813**	0.0020
Post-oviposition	1.85±0.09	1.83±0.17	0.4093^{ns}	0.8986	2.33±0.33	2.07±0.12	0.2990^{ns}	0.0732
Adult longevity	12.85±1.79^{a}	12.16±0.83^{b}	0.6029*	0.0308	19.11±1.22^{b}	24.48±3.79^{a}	0.8139***	0.0001
Life span	21.37±1.81	22.16±1.07	1.3853^{ns}	0.1841	30.20±1.54	34.63±3.71	5.3509^{ns}	0.0840
No. of eggs/♀	60.67±10.87^{b}	87.00±6.93^{a}	12.6278**	0.0072	114.00±9.07	117.00±14.18	9.7505^{ns}	0.4411

Treated eggs at level of LC_{50} of coriander essential oil, Data expressed as Mean±SE, * = p≤0.05, **-*** = p≤0.01 ns = Non significant, Mean under each variety having different letters in the same raw denote a significant different (p≤0.05) treated three days-old eggs reduced both pre-oviposition and oviposition periods whereas prolonged post-oviposition period as compared to control. Such reduction or prolongation were statistically insignificant with the exception of oviposition period, $p = 0.0020$.

Data in Table 5 indicated that, the three days-old eggs treated with LC_{50} was highly significant remarkable shortness female longevity from 24.48±3.79 days for control to 19.11±1.22 days, $p = 0.0001$. On the other hand, treated one-day old eggs was significantly increased the female longevity from 12.16±0.83 days (control) to 12.85±1.79 days, $p = 0.0308$.

Life span that contains sum of life cycle and longevity was recorded. Both treated eggs decreased the life span than its control. The life span lasted (21.37±1.81, 22.16±1.07 days) for one and (30.20±1.54, 34.63±3.71 days) for three days-old, respectively. However, such decrease in the life span was statistically insignificant, $p = 0.1841$ and 0.0840, respectively (Table 5).

Results demonstrated that, highly significant reduction in the total number of eggs laid per female (fecundity) for one-day old eggs treated with LC_{50} of coriander essential oil was recorded 60.67±10.87 eggs/female, control gave 87.00±6.93 eggs. Insignificant reduction was detected as affected by treated three days-old eggs (114.00±9.07 eggs), control recorded 117.00±14.18 eggs.

DISCUSSION

The primary chemicals identified from coriander oil were the major compound (Linalool, 64.10%), α-pinene, (11.96%) and β-pinene, (4.84%). More than 80% of coriander oil consisted of various terpenes and lacked any identifiable esters. The results of our analysis are in agreement with the literature that reported Linalool as a major constituents in the essential oil of coriander (Lopez *et al*., 2008; Bleeker *et al*., 2009; Badawy *et al*., 2010). However, (Mann *et al*., 2012) found that the major compound was α-pinene (37.45%) followed by Linalool (15.09%).

The variations of chemical composition of coriander essential oil may be attributed mainly to the plant part, the season, temperature, photoperiod, hygrometry, the method of harvesting or used to isolates the plant product (Smallfield *et al*., 2001; Misharina, 2001).

Based on LC_{50} and LC_{90} of the essential oil of coriander proved to possess highly pronounced ovicidal action on both tested pests, *T. urticae* and *S. littoralis* than its controls. The marked decline in egg hatchability resulting from diffuse of oil vapors into eggs and affected the physiological and biochemical process associated with embryonic development (Raja *et al*., 2001). The results indicated that the important role played by age of eggs that determined the ovicidal activity of coriander against both pests, the younger eggs of both *S. littoralis* and *T. urticae* are more susceptibility to coriander oil than the old ones that due to occurrence of acetylcholine esterase enzyme in eggs which had an important role on ovicidal action in insect eggs such as rice stem borer, *Chilo simplex* (Butt.), cabbage army worm, *Baratha brassicae* (L.) and silkworm, *Bombyx mori* (L.) (Chino and Yushima, 1953, 1954), Also, Mehrotra (1960) indicated that this enzyme was not present in early stages of eggs and also that the orders of appearance of components of cholinergic system in insect eggs, being cholinacetylase, cholin esterase and acetylcholine.

Additionally, major of tested concentrations of coriander oil elongated the incubation period of both tested pests than control. The present results revealed that the coriander essential oil has acaricidal and insecticidal activities against *T. urticae* and *S. littoralis*, respectively. Essential oil may affect the cuticle of soft-bodied insects such as aphids, white flies, thrips and psyllida more than that of hard-bodied insects due to lesser sclerotization (Isman, 1999; Chiasson *et al*., 2004). Generally, insecticides can cause deformation in the shell of *S. exigua* (Lepidoptera: Noctuidae) eggs and interfere in reproduction and population growth of this insect (Adamski *et al.*, 2009). Abd El-Aziz and El-Din (2007) reported that extract of *Anabasis setifera* had the superior ovicidal activity on the viability of *S. littoralis* egg masses. Furthermore, the essential oil of *Mentha longifolia*, *Salvia officinalis* and *Dracocephalum moldaviacea* showed toxic and biological effects against eggs of *T. urticae* (Amer *et al.*, 2011). The highest activity against *T. urticae* and *S. littoralis* could be due to the higher concentrations of terpens compound such as Linalool and α-pinene. Each compound has a chemical structure allows the compound to penetrate and go directly to active site to make its action. Moreover, the essential oils are known to reduce growth and fecundity of insects and act as antifeedants and moulting inhibitors (Arnason *et al.*, 1989).

Several authors demonstrated Linalool, active constituent compound in the coriander oil responsible for the toxicity against tested pests (Lopez *et al.*, 2008; Burdock and Carabin, 2009; Badawy *et al.*, 2010). Linalool and α-pinene have been reported to repel or kill several herbivore insect species including hemipterans (Ukeh *et al.*, 2007; Sfara *et al.*, 2009). Similarly, other constituents of coriander oil such as α-terpenoil, terpinolene, p-cymene and eucalyplol, previously reported to repel or kill arthropods (Bleeker *et al.*, 2009; Kaufman *et al.*, 2010; Mann *et al.*, 2010). Our results are in agreement with that of Ibrahim and Amer (1992) who demonstrated that essential oil from *Callistemon lanceolatus* DC. had a strong effect on some biological aspects of *T. urticae* females since the female longevity and oviposition period were shortened while, the pre-oviposition was prolonged. Moreover, oils from *T. vulgaris*, *M. viridis*, *M. piperita*, *R. officinalis*, *M. hortensis*, *L. officinalis* and *M. spicata* caused a reduction in the total number of eggs laid by females of *T. urticae* (El-Gengaihi *et al.*, 1996; Amer *et al.*, 2001; Momen *et al.*, 2001; Refaat *et al.*, 2002; Omar *et al.*, 2009).

The forgoing results indicate that the essential oil of coriander have properties which cause larval mortality, retardation in the development stages, reduction in the pupal weight and increased both pupal and adult morphogenesis and this maybe correlated to the chemical constituents of this plant. These findings are in harmony with those of Abd El-Aziz and El-Din (2007) and Marei *et al.* (2009) when treated different essential oils against *S. littoralis*.

CONCLUSION

It can be concluded that, the essential oil of coriander, *Coriandrum sativum* was effective in suppressing the population of both *S. littoralis* and *T. uricae* either directly through its acute toxicity on egg stages or indirectly through their delayed effects on immature stages and adults.

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