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Assessment of *Boxus chinensis* oil and PrecoceneII for the Control of the Red Palm Weevil, *Rhynchophorus ferrugineus* (Oliv.) (Coleoptera-Curculionidae) and the Palm Beetle *Pseudophilus testaceous* (Gahan) (Coleoptera-Cerambycidae)

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Abstract: Seven doses of a natural insecticide, *Boxus chinensis* oil and the anti-juvenoide, precoceneII were topically applied onto larvae, prepupae and adult of the red palm weevil *Rhynchophorus ferrugineus* and larvae of the palm beetle, *Pseudophilus testsceous*. Larvae of *R. ferrugineus* were less tolerance to *B. chinensis* oil and more tolerant to precoceneII than *P. testaceous* larvae. LD50 of *R. ferrugineus* larvae were 0.11mg/insect and 0.66 mg/insect due to effect of *Boxus chinensis* and precoceneII, respectively. LD50 of *P. testaceous* larvae were 0.48 mg/insect and 0.42 mg/insect, using the same previous chemicals, respectively. On the other hand larval, pupal and adult duration was shortened when larvae of *R. ferrugineus* were treated with *B. chnensis* and precoceneII. Moreover, *B. chinensis* oil and precoceneII were clearly occurred a morphogenic abnormalities of the treated larvae and adult of *R. ferrugineus* and larvae of *P. testaceous*.

Key words: Natural insecticide, *Boxus chinensis* oil, anti-juvenoide PrecoceneII, Palm weevils, beetles *Rhynchophorus ferrugineus*, *Pseudophilus testaceous*, toxicity, duration, morphogenic abnormalities

INTRODUCTION

The red palm weevils, *Rhynchophorus ferrugineus* and their relatives red palm beetle *Pseudophilus testaceous* were first discovered in India 1906 as a major pest of coconut and oil palms[1]. The occurrence of this pest in the Middle East was first reported from united Arab Emirates in 1985, then from Saudi Arabia in 1986, Iran in 1992, Egypt in 1995 and most recently from Jordan in 1998[2]. *R. ferrugineus* is widely growing on date palm plantation in Gulf and Middle East regions. Within 6 years of its discovery in the United Arab Emirates 1985, it spread to all Persian Gulf states including, Bahrain, Oman, Saudi Arabia and Iran and crossed the red sea to Egypt[3]. The crown, trunk and the bole of date palm trees are the nature habitats of *R. ferrugineus* and *P. testaceous*, where females lay their eggs into softened tissues. Hatched larvae tunnel directly through the wood until trunks become completely hollowed and larvae consumed the tender soft tissues[4] and led to killing the palms in 6-8 months[5]. Because of the concealed nature of the larvae, infested palms do not show any obvious early symptoms.

Many authors in a range of preventative and curative procedures designed to limit and contain the spread of an infestation apply chemical control of red palm weevil's *R. ferrugineus*. Abraham *et al.*[6], tested seven insecticides against *R. ferrugineus* in the laboratory, where trichlorphon was the most effective one (92%) when applied in the field. Soenardi *et al.*[7] reported the sevin and carbaryl have seen regular effect in field application. Phostoxin tablets (aluminum phosphide) were direct injected in the palm trees by Rao *et al.*[8] and this study was developed by Muthuraman[9]. El-Ezaby[10], investigates the effect of carbosulfan, pirimphos-ethyle and rogodial. Field application of insecticides was investigated by Abraham[11], Butani[12] and Abraham *et al.*[13]. Further investigation demonstrated that soaking of trees in the insecticides (chlorpyriphos and endosulfan) was an effective preventative measure[14].

During recent years synthetic pesticides had been widely used to control phytophagous insects. Most of these pesticides are very harmful for human, animals and beneficial insects. The global insecticides market was estimated at 8 billion dollars in 1995[15]. Due to the introduction of new technologies, the growth of the natural pesticides market is not now expected to exceed 141 million dollars in the year 2000[16]. However, the recent progress made with natural pesticides development means that great commercial opportunity exists to make a significant penetration into that market. Many investigators spend large screening efforts to find a compound that could be safe to the environment. Such as plant extracts and insect growth regulators, which had insecticidal effects against red palm weevils' *R. ferrugineus* and many other insects[17-22].

PrecoceneII is known as anti-juvenile hormone. A number of chromene derivative precocenes were isolated from *Ageratum haustonium*. They are anti-allatotropic, i.e prevent juvenile hormone synthesis. This accelerates the development of insects, producing dwarf sterile animals, which are unable to survive. The open chain analogue of precocene, b-asarone oil showed anti-gonad activity in insects and exhibited complete inhibition of ovarian development when given to a number of stored-grain insects[23]. These oils may utilize as chemosterilants in plant products, which minimized the physiological development of the pests. This would be a noteworthy merit of the biorational chemicals over synthesis pesticides.

Boxus chinensis oil known as Jojoba or hohoba oil mixture of long chain, linear liquid wax esters extracted from the seed of the desert shrub *Simondsia chinensi*. The Jojoba plant is indigenous to the arid Sonorant region of northwest Mexico and the Southwest USA. Unlike all plant sourced oils which are based on tricylglycerols (triglycerides). Jojoba esters are formed mainly from C 22:1 (double bonde at the -2-9 position) monene fatty alcohols esterifies to C 20:1 (double bond at the n-9 position) fatty acids forming highly functional C 42 linear dine esters provide superior oxidative stability, excellent emolliency and effective[24].

The aim of this study was to assess the natural insecticides, of *Boxus chinensis* oil and precoceneII on different developmental stages of the red palm weevil *R. ferrugineus* and the larvae of the palm beetle, *P. testaceous*.

MATERIALS AND METHODS

Insects: Larvae, pupae and adults of the red palm weevil, *Rhynchophorus ferrugineus* and larvae of the palm beetles *Pseudophilus testaceous* were collected from infested date palm trees located in Al-Dawaser valley region in South West of Riyadh in Saudi Arabia. The collected adult and larvae were reared in laboratory and fed on sugar cane pieces. Females laid eggs separated between softened tissues of sugar cane. These eggs were kept until hatched in isolated cages under controlled temperature of 27±2°C and humidity 60: RH, according methods designed by Nassar and Abdullah[19].

Natural insecticide

***Boxus chinensis* oil:** This oil was obtained from a laboratory of pesticides, Agriculture Research Center (ARC), Dokki, Giza. Oils of *B. chinensis* known as Jojoba or hohoba oil which were extracted from the seeds of a slow growing plant, *Simmondsia chinensis* prepared as emulsifiable solution 96%.

Anti-juvenoid: PrecoceneII this compound in a powder form produced by Calbio-chemical, La-Jolla Company in California, USA).

Bioassay and statistical analysis: Obtained results were statistically analyzed using t test. The larvae of *Rhynchophorus ferrugineus* and *Pseudophilus testaceous* were topically treated with seven doses (4, 2, 1, 0.5, 0.25, 0.125 and 0.625 mg/L) of *Boxus chinensis* oil and precoceneII dissolved in acetone using Brand micropipette (5-50 μ). Also the adult and prepupae of *Rhynchophorus ferrugineus* received the same previous doses of the two compounds. Four replicates of each treated insect as well as control insects were kept at 27±2°C and 60% RH. Larval mortality of *R. ferrugineus* and *P. testaceous* were recorded also, prepupa and adult mortalities of *R. ferrugineus* estimated, as Bessel correction[25]. Larval, pupal and adult duration of *R. ferrugineus* were calculated as Dempstera equation[26]. Unfortunately the duration of *P. testaceous* was not recorded because the larval stage extended over one year without pupation. Morphogenic aberrations were recorded and expressed in percentage.

RESULTS AND DISCUSSION

Toxicity effect of *Boxus chinensis* and precoceneII on the different developmental stages of *R. ferrugineus* and larvae of *P. testaceous*: Represented data in Table 1 show that *Boxus chinensis* oil was less potent against larvae of *Pseudophilus testaceous* than *Rhynchophorus ferrugineus* larvae. Contrary preceoceneII was less potent against larvae of *R. ferrugineus* than larvae of *P. testaceous*. The higher mortality (98.5%) occurred when larvae of *R. ferrugenius* was treated with *B. chinensis* oil at dose of 4 mg/insect and the lower toxicity (11%) was obtained after the same larva was treated with the lower dose (0.0625 mg/insect) of precoceneII. In case of *P. testaceous* larva the higher dose (4 mg/insect) of *B. chinensis* produced 79.2% of larval mortality and the lower dose of precoceneII (0.0625 mg/insect) caused 22.1% mortality of the same larvae (Table 1). The prepupal stage of *R. ferrugineus*, was more affected by *B. chinensis* oil than precoceneII. The Prepupal mortalities were 75.6 and 60.4% after treatment of *R. ferrugineus* prepupae with the higher dose (4 mg/insect) of *B. chinensis* oil and precoceneII, respectively. On the other hand the adult mortality of *R. ferrugineus* had no certain trend by

Table 1: Toxicity effect of *Boxux chinensis* oil and precoceneII on the different developmental stages of red palm weevil *Rhynchophorus ferrugineus* and larvae of *Pseudophilus testaceous*

Doses mg/insect	% of larval mortality		% of prepupal mortality	% of adult mortality
B. chinensis	*R. ferrug.*	*Pseud. teste.*	*R. ferrug.*	*R. ferrug.*
0.0625	43.00	18.80	26.00	5.12
0.125	53.90	30.70	34.00	24.10
0.25	64.80	42.30	42.00	22.81
0.5	75.00	53.70	51.00	52.32
1	85.20	66.30	59.40	43.31
2	95.50	74.10	68.00	73.12
4	98.50	79.20	75.60	64.62
PrecoceneII				
0.0625	11.00	22.10	12.00	4.00
0.125	21.00	32.70	19.10	12.00
0.25	32.00	43.20	26.90	20.30
0.5	43.20	48.40	34.70	29.30
1	54.00	63.60	43.10	37.10
2	66.10	72.80	51.50	46.70
4	78.00	93.20	60.40	56.00
Control	1.17	1.00	0.34	0.25

applying the different doses of *B. chinensis* oil. The higher adult mortality (73.1%) produced at dose of 2mg/insect and the higher dose (4 mg/insect) caused 64.6% of adult mortality. This feature disappeared when adults were treated with different doses of precoceneII and the adult mortality was in dose-dependent course (Table 1).

B. chinensi oil was applied to crops as natural insecticide for control, white flies. Since the physical properties of *B. chinensis* oil are similar to other vegetable oils, although its chemical structure that is somewhat different from most vegetable[24]. Similar results were obtained against the red palm weevil, *R. ferrugineus* reported by many authors. Abdullah and Nassar[27] reported that *B. chinensis* oil, Abamectin, *N. oleander* and *A. viridis* extracts were effective and reduced the eggs fertility of *Spodoptera littoralis* larvae. Brean *et al.*[20] suggested that the lethal effect of *B. chinensis* oil was increased by increasing the age of pupae; Nassar and Abdullah[19], reported that Azadirachtin was very toxic against the different developmental stages of *R. ferrugineus*. Most of *B. chinensis* oil produced in USA used for treatment of skin disorders and hair care[28]. In addition, El-Defrawi *et al.*[29] suggested a possible action of the vegetable oils that penetrate the integument of the insect to affect presumably the nervous or respiratory system to exert the lethal effect. However, several authors using plant oils against insects had reported so many results[30-34]. Death of treated insects may be due to the inability of the molting bodies to swallow sufficient volumes of air. This led to split the old cuticle and expand the new one during ecdysis, or to a metamorphosis inhibiting effect of the plant extract, possibly based on the disturbance of the hormonal regulation[35]. On the other hand, prevention of ecdysis, and subsequently death, could attribute to the reduction in ecdysteroid peak or interference with the release of eclosion hormone[30,36].

The results showed that precoceneII affected insect behaviour within a few minutes after treatment. Treated adults were slightly less sensitive to insecticidal properties of precoceneII than treated larvae and prepupae of *R. ferrugineus*. The insecticidal activity of precoceneII may be due to the presence of terpenic compounds, mainly precocenes, with their anti-juvenile hormonal activity are probably responsible for the insecticidal effects[17]. Unithan *et al.*[37] Obtained similar results, against *Dysderus cingulatus* Farage and Varjas[38] on *Diploptera puncutata*; Santha and Nair[39] on *Spodopter mauritia,* found that toxicity of precoceneII was stage dependent. PrecoceneII is capable of causing death of insect upon penetrating the tissues in adequate amounts[18,40]; Bowers and Martinze-pardo[41], discovered that precoceneII destroy the corpora allata and they discussed that precoceneII is a chemical present in the common bedding plant, *Ageratum houstonianum*, would induce precocious metamorphosis and sterilize a variety of paurometabolous insects. Moreover, Fridman- coheen *et al.*[42] investigated that the lethal and anti-allatin effect of precocenII against *Schistocerca gregaria* was instar dependent and precoceneII increased the duration of the treated instar and the next instars. Unithan *et al.*[37] reported that precocenes are able to destroy corpus allatum following oxidation within the gland to reactive intermediates which alkylate crucial cellular elements. Ekundayo *et al.*[43] demonstrated the juvenilizing hormonal action of precocene I and II in insects, the most common effect being precocious metamorphosis, producing sterile or dying adults. Vayas and Nulchadani[44] reported the action of cromenes (precocene I and II), isolated from *Ageratum* plants, which accelerate larval metamorphosis, resulted in juvenile forms or weak and small adults. Gozales *et al.*[45] showed activity of *Ageratum* against *Musca domestica* larvae, using whole plant hexane extract; Dua *et al.*[34] investigated the repellent effect of *Lantan* extracts against *Aedes* mosquitoes.

In addition, the present study may provide another factor and possibility to explain the lethal action of precoceneII or *B. chinensis* oil since water loss of pupae increased parallel to the increasing dose-level and increasing mortality percent. Such adverse process resulted in a degree of desiccation and subsequently impaired some vital physiological events leading to death of the treated insects.

Effect of *Boxus chinensis* oil and preceneII on the larva, pupa and adult durations of *Rhynchophorus ferrugineus*: Sex doses (2, 1, 0.5, 0.25, 0125, and 0.0625 mg/insect) of precoceneII and *Boxus chinensis* oil were applied for studying its effect on the insect duration, weight and morphogenic abnormalities. Because almost insects were died after treatment with the highest, dose, 4 mg/insect.

From the results recorded in Table 2, it shows that, duration was significantly ($p<0.05$) shortened by the effect of precoceneII and *B. chinensis* oil on larvae and adults of *Rhynchophorus ferrugineus*. The shortening was more in the case of precoceneII than *B. chinensis* oil. Also duration was dose dependent term, it decreased as increasing doses of preceoceneII and *B. chinensis* oil. Contrary the pupal duration was significant ($p<0.05$) increased by decreasing dose level of *B. chinensis* oil. The prepupal duration decreased, 9.4 days as affected by the high dose (2 mg/insect) of *B. chinensis* oil, while the lower dose (0.0625 mg/insect) caused increasing (27.2 days compared to 18.8 days of control) of the prepupal duration (Table 2).

With regard to the hastening of development which have been evidently conceived by the shortening effect of precoceneII and *B. chinensis* oil on duration of larvae, prepupae and adult stages of *R. ferrugineus* in the present study. Explicated by a specific physiological elasticity in the insect body enabling it to overcome the adverse condition by shortening the duration interval time into a period during which the insect would be more tolerant. Many authors obtained similar results by using precoceneII or some plant extracts. Shabana *et al.*[46] using aqueous extract of the whole plant, *Ageratum conyzoides* contained precoceneII, verified reduction of larvae emergence of *Meloidogyne incognita*. Plant extract of *A. conyzoides* in *Citrus orchards* sheltered predators of the spider *Panonychus citri*, suggested that its development in orchards is beneficial[17,47]. Treatment of insects, or their food with precoceneII causes growth inhibition and increasing doses of precoceneII in larval instars result in different forms of effect, one of them is extending the life period of larvae, which remain as 'over-aged" larvae of a wide variety of insects. The present study revealed that *B. chinensis* oil drastically decreased developmental duration of *R. ferrugineus*. Duration of the different developmental stages of the red palm weevil, *R. ferrugineus* was dose-dependent shortened after application of Azadirachtin[19,20].

Effect of *Boxus chinensis* oil and precoceneII on larval weight of *Rhynchophorus ferrugineus* and *Pseudophilus testaceous*: Table 3 shows that, larval weight of *Rhynchophorus ferrugineus* and *Pseudophilus testaceous* was more reduced after larval treatment with *Boxus chinensis* oil than precocene II. The larval weight of *R. ferrugineus* were 4.3, 4.1, 3.6, 3.8, 3.2 and 2.6 g when larvae were treated with doses of 0.0625, 0.125, 0.25, 0.5, 1 and 2 mg/insect of *B. chinensis* oil, respectively compared to 6.1g of control insect. The weight of *P. testaceous* larva was 7.5, 7.3, 6.8, 6.6, 5.4 and 4.2 g compared to 11.6 g of control insect after larval treatment with the same previous doses of *B. chinensis* oil, respectively. The high and lowest doses (2 and 0.0625 mg/insect) of PrecoceneII decreased larval weight of *R. ferrugineus* to 3.3 and 5.2 g, respectively compared to 6.1 g of control insect. The same previous doses of precoceneII decreased larval weight of *P. testaceous* to 4.7 and 9.1 g, respectively compared to 11.6 g of control larvae (Table 3).

In the present study, topical application of *B. chinensis* oil onto the larvae of *R. ferrugineus* and *P. testaceous* led to pronounced suppression in the maximal body weights at the different dose-levels. In addition, *B. chinensis* oil enhanced the development because the larval duration was significantly shortened

Table 2: Effect of *Boxus chinensis* and precoceneII on larval, pupal and adult durations of *Rhynchophorus ferrugineus*

Doses mg/insect	Larval duration in days±SD	Prepupal duration in days±SD	Adult longevity in days±SD
Boxus chinensis			
2	16.4±0.6*	9.4±0.3*	8.8±0.52*
1	18.31±1.1*	13.1±0.1*	10.6±0.71*
0.5	21.3±1.4*	16.4±0.7*	12.3±0.82*
0.25	26.4±1.6*	19.2±0.9*	15.4±0.66*
0.125	28.3±0.8NS	24.3±0.4*	19.2±0.67*
0.0625	32.6±0.11NS	27.2±0.11*	34.5±1.11*
PrecoceneII			
2	12.3±0.3*	3.1±0.6*	6.2±0.33*
1	13.1±0.6*	3.2±0.2*	8.1±0.42*
0.5	16.4±0.4*	7.3±0.4*	11.2±0.31*
0.25	20.2±0.8*	10.6±0.3*	13.3±0.22*
0.125	23.6±0.3NS	12.2±0.8*	16.5±1.2*
0.0625	25.1±1.2NS	15.5±0.5NS	27.1±0.8*
Control	33.5±3.24	18.8±2.4	55.3±4.31

Table 3: Larval weight of *Rhynchophorus ferrugineus* and *Pseudophilus testaceous* as affected by *Boxus chinensis* oil and precoceneII

Doses mg/insect	Larval weight/g±SD of *R. ferrugineus*	Larval weight/g±SD of *P. testaceous*
Boxus chinensis		
2	2.6±0.62*	4.2±0.24*
1	3.2±0.62*	5.4±0.73*
0.5	3.8±0.11*	6.6±0.45*
0.25	3.6±0.21*	6.8±0.31*
0.125	4.1±0.45*	7.3±0.36*
0.0625	4.3±0.38*	7.5±0.61*
PrecoceneII		
2	3.3±0.23*	4.7±0.37*
1	3.5±0.56*	6.8±0.57*
0.5	4.3±0.44*	7.4±0.56*
0.25	4.6±0.13*	7.7±0.23*
0.125	4.9±0.28NS	8.2±0.72*
0.0625	5.2±0.73NS	9.1±0.54*
Control	6.1±0.64	11.6±0.83

*: Significant at $p<0.05$, NS: Non significance $p>0.05$

especially at the higher two dose-levels. To large extent, similar results on growth and development of larvae were obtained by the effect of precoceneII. The present data distinctly show a reducing effect of *B. chinenesis* and precoceneII, generally, on the larval body weight and stimulating action of both compounds upon the development of *R. ferrugineus* and *P. testaceous* because the larval duration was significantly shortened. Anyhow, the suppressing action of precocene or *B. chinenesis*, in the present study, was reflected in drastically reduced larval weights in both treated insects. This may be attributed to the increased energy expenditure in order to detoxify the extracts within the insect body[20,21]. On the other hand, growth inhibitions in insects, by the action of precoceneII, thought to result from a blocked release of morphogenic peptides, causing alterations in ecdysteroid and juvenoid titers[17,44,48]. Also, some possible direct effects of precoceneII on tissues and cells undergoing mitosis may have occurred[18].

Moreover the decreasing of larval weight by using precoceneII *and B. chinensis* oil, may occurs due to physiological elasticity in the insect body enabling it to overcome the adverse condition by shortening the time interval into a period during which the insect would be more tolerant.

Morphogenesis abnormalities: From the results obtained in Table 4, it observed that many deformities appeared due to the effect of *Boxus chinensis* oil and precoceneII on the different developmental stages of *R. ferrugineus and* larvae of *P. testaceous.* The percentage of deformation was dose-dependent term by using both compounds. The greatest larval deformation (31%) occurred due to effect of 2 mg/insect of *B. chinensis* oil on *R. ferrugineus* larva while the lower deformation (1%) produced due to the effect of 0.5 mg/insect of precoceneII oil on the larvae of *P. testaceous.* On the other hand neither *B. chinensis* oil nor precoceneII produced deformations of *P. testaceous* after larval treatment with the three lower doses (0.25, 0.125 and 0.0625 mg/insect). Least morphogenic abnormality occurred to adult of *R. ferrugineus* due to the effect of both compounds. Also a dose of 2 mg/insect of both compounds caused higher deformations of the prepupae and adult stages of *R. ferrugineus.* Different categories of deformations were observed among larvae, prepupae and adult stages of *R. ferrugineus* as affected by *B. chinensis* oil and precoceneII. These deformed forms varied between darkening of the cuticle particularly, collapsed antenna, protrusion of mouthparts and crumpled wings in the case of the adult stage. The skin of *R. ferrugineus* and *P. testaceous* larvae was crawled with black-brown colour. While almost of abnormal pupae died inside the cocoon and failed to emerge or change to adults (Table 4).

Boxus chinensis oil and precoceneII affected the pupation rate of *R. ferrugineus* in the present study, because various larval prepupal and adult malformations observed increasingly as the level doses increased. Preupal deformities varied between dorso-ventrally-compressed body and collapsed appendages and failure to metamorphose into adult weevils. The emerged adult weevils, were blocked in different percentages, in the case of *B. chinensis* oil and reversal correlated with the dose values. In the case of precoceneII, adult deformities varied between permanently expanded membranous wings, failure to form elytra, collapsed external appendages and appearance of pits on elytra. Molting inhibition had been reported for precocenes exhibiting several morphogenic effects in a number of insect species due to delayed or suppressed ecdysteroid titers. Raja *et al.*[48] using *Ageratum conyzoides* ethanolic extract (contains precoceneII) from fresh leaves (250 and 500 ppm) in the fourth instar of *Chilo partellus*, on a sorghum pests. It observed the presence of a dark stain in the insects cuticle and immature pupae formation both symptoms of deficiency of juvenile hormone. Shabana *et al.*[46] using aqueous extract of the whole plant (*A. conyzoides*), verified reduction of larvae emergence of *Meloidogyne incognita.* Further deformations obtained due to effect of precoceneII against many insects[17,49-52].

Whereas the present study reported number of larval-pupal or pupal-adult intermediates, various pupal and adult deformities had been observed as previously mentioned. To a great extent, similar results had been obtained in *R. ferrugineus* by the effect of Azadirachtin[19,20,45]. Such deranged or halted program of

Table 4: Morphogenic abnormalities of the different developmental stages of red palm weevil *Rhynchophorus ferrugineus* and larvae of *Pseudophilus testaceous* treated with *Boxux chinensis* oil and precoceneII

Doses mg/insect	%Deformed larvae		%Deformed prepupa	%Deformed adults
	R. ferr.	*P. testac.*		
Boxus chinensis				
2	31.0	12.0	19.0	13.0
1	27.0	8.0	15.0	11.0
0.5	18.0	5.0	10.0	7.0
0.25	14.0	-	6.0	5.0
0.125	12.0	-	6.0	3.0
0.0625	8.0	-	4.0	2.0
PrecoceneII				
2	28.0	19.0	16.0	11.0
1	26.0	7.0	13.0	9.0
0.5	22.0	1.0	10.0	6.0
0.25	16.0	-	8.0	4.0
0.125	11.0	-	6.0	4.0
0.0625	6.0	-	4.0	2.0
Control	00.0	00.0	00.0	00.0

deformation in the present study may be attributed to the absence of necessary titer of ecdysteroids needed for achieving the larval-pupal transformation normally[53,54] on spruce budworm *Choristoneur fumiferna* and Abdullah[55], on *Eutetranychus orientalis*.

The appearance of deformed larval pupae and adult by the action of precoceneII or *B. chinensi* may be, also, due to the alterations in ecdysteroid and juvenoid titers[19], on *R. ferrugenieus* and Josef *et al.*[56], on *Phanerotoma ocularis*. Another conceivable suggestion is that precoceneII or *B. chinensis* oil may indirectly affect of release insect ecdysteroid, by interfering with the neuroendocrine sites of release of tropic hormones, especially the prothoracicotropic hormone[20]. The effect of precoceneII or *B. chinensis* oil on the adult morphogenesis of *R. ferrugineus* in the present study suggested by mostly similar findings in different insect species by various plant extracts as will[19,34,57-60]. The impaired pupal-adult transformation resulting in adult deformities may suggest persistent metamorphic and morphogenic actions of *B. chinensis* oil extract (or precoceneII) vise its effect on the hormonal events[60-65].

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