J. of Plant Protection and Pathology, Vol. 1 (2): 87 - 102, 2010

EFFICACY OF JOJOBA OIL AGAINST TWO STORED LEGUME SEED INSECT PESTS *Callosobruchus Maculatus* (F.) AND *C. Chinensis* (L.)

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ABSTRACT

Adults of *Callosobruchus maculatus* (F.) and *C. chinensis* (L.) were exposed to broad been seeds treated with four different concentrations of jojoba oil (70 % EC) 875, 1750, 3500, 7000 ppm and untreated control to evaluate the effectiveness of jojoba oil as a protectant. A negative correlations were observed between the jojoba oil concentration and all evaluated biological parameters, fecundity, egg viability, developmental period of the immature stages, adult emergence, broad bean seeds viability and seeds weight loss percentage for both tested insects *C. maculatus* and *C. chinensis*. The obtained results cleared that *C. chinensis* was more susceptible to jojoba oil than *C. maculatus* and there is a significant difference between the two tested insects in all tested biological aspects regardless to the concentration (for the fecundity 168.33 and 190 eggs/female, hatchability percentage 60.33 and 69.5 %, developmental period 26.3 and 28.3 days, and 36.33 and 45.33 F_1 emerged adults and weight loss percentage 6.02 and 7.56%, respectively. The highest concentration 7000 ppm gave a complete protection of seeds with zero weight loss percent for both tested insects. The mean percentage of weight loss in untreated seeds was ١٦.٠٤, ١٢.٩٦%, for *C. maculatus* and *C. chinensis* respectively, while, weight loss% reduced to more than the half averaged 7.56 and 6.02% for treated seeds. The residual effect of jojoba oil treatments was clearly effective in the first month of storage period which gave a 100% protection of treated bean seeds with 0.0 F_1 emerged adults in both tested insects (100% mortality of developmental stages). After six months of storage period, residual effect of jojoba oil reduced by the storage period prolongation, While, jojoba oil still could protect the broad bean seeds against *C. maculatus* and *C. chinensis* attacks although the efficacy of jojoba oil decreased with aging 79.92 and 61.86% reduction of F_1 adult emergence compared to untreated control. Slight harmful effect of jojoba oil application on the viability of broad bean seeds, so reduction of germination was most appeared at, the highest concentration7000 ppm particularly at the end of storage period averaged 28.22%.

INTRODUCTION

Family bruchidae consists of approximately 1300 species, grouped into 56 genera belonged to five subfamilies (Southgate 1979). Some of the bruchid species have showed high specificity to one or more species of host plant while others are capable to fed and breed on a wide range of hosts (Johnson 1981). Among storage bruchids, the cowpea beetle *Callosobruchus maculatus* (F.) and pulse beetle *C. chinensis* are considered as serious pests, causing immense damage every year to legume seeds and attacking legume seeds during the warm season, also they able to generate exceeding high levels of infestation even when they were passed only one or two generations on the host (Shomar 1963). The cowpea bruchid, *C. maculatus* (F.) is a cosmopolitan field –to- store pest and ranked as the principal post harvest pest of cowpea, *Vigna unguiculata* (L.) Walpers in the tropics (Jackai

and Daoust, 1986). It causes substantial quantitative and qualitative losses manifested by seed perforation, and reductions in weight market value and germinability of seeds (Seck *et al*. 1996; and Sekou *et al.* 2001). Under traditional storage conditions, 100% infestation of cowpea occurring within 3-5 months of storage is common (Booker 1967, Caswell 1981). Pulses are important sources of proteins, fats, carbohydrates, sugars, vitamin B and minerals, which considered as a poor men meat (Islam *et al.* 2006).

Jojoba oil is a vegetable oil obtained from the jojoba beans of slow growing jojoba plant (*Simmodsia chinensis*) widely grown in several countries. Jojoba oil presents no risks to humans or the environment, the oil has been used for decades in cosmetics, pharmaceuticals, and as an industrial lubricant (Ronhotra and Gelrouth 1989, Abo-El-Ghar *et al*., 1994; Sawires *et al*., 1995). The physical properties of jojoba oil are similar to those of other vegetable oils,wheares jojoba oil has a chemical structure that is somewhat different from that of most vegetable oils. Jojoba seed oil is not a fat but a liquid wax, the range value of jojoba oil in jojoba seed is 45 – 60% (Haumann 1988). Jojoba oil products are approved for controlling whiteflies and aphid-born virus in bean (Sepulveda and Navarrete, 1996), acts as a pesticide by forming a physical barrier between an insect pest and the leaf surface (Abo El-Ghar *et al.* 1994). Jojoba oil can also act as toxicant, antifeedant, growth and development and oviposition inhibitor Bream *et al.* 2001), (Shemias *et al.* 2002, and Osman 2003, and tested for protection of stored grains from insect attack, because they are considered a quite safe to man and his domestic animals (Yunytai and Burkhobler 1981), (Malik and Mujtaba 1984), (Taheya and Hammoud 1993). Oils of mustard, sunflower, safflower, castor and cotton acted as surface protectants against *C. maculates* population growth by reducing the seed damage rate. The cotton seed, sunflower, groundnut, soybean and mustard oils, when mixed with cowpea, completely suppressed adult emergence of *C. maculatus* (Ramzan 1994). On the other hand, the edible oils are potential control agents against *C. maculatus* and can play an important role in stored-grain protection (Shaaya *et al*. 1997). Ahmed *et al*. (1999) found that the neem and sesame oils completely inhibited adult emergence and appeared to be most promising as a seed protectant against *C. chinensis*. Yalamanchilli and Punukollu (2000) observed that the volatile oil from the leaves of *Curcuma domestica* could effectively protect the seeds, against *C. chinensis*, at a low concentration. Neem oil was the best protectant followed by the sesame oil.

The aim of this study is to evaluate the effect of jojoba oil on the fecundity, egg viability, developmental period of the immature stages, adult emergence and the viability of grains germination treated with the oil on the two stored legume seeds insect pests *C. maculatus* and *C. chinensis*.

MATERIALS AND METHODS

Insect rearing:

Cowpea beetles *Callosobruchus maculatus* and *C. chinensis* stock cultures maintained in 1- liter glass Jars containing a broad bean seeds *Vicia faba* and incubated in an environmental controlled conditions at 30 ± 2 ºC and 60 ± 5 % relative humidity (R.H.). Both insects of study were reared in

the research laboratory, Department of Plant Protection, Faculty of Agriculture Al- Azhar University, Cairo, Egypt for several generations. To distinguish between both tested insects*, C. maculatus* is a more elongate species with the posterior part of the abdomen not covered by the elytra and it more definitely spotted (Hill 1983). Differentiations of sexes were determined by examining the elytral pattern (Southgate *et al*., 1957; Halstead, 1963). The females are dark colored and possess four elytral spots. In contrast, males are pale brown and less distinguished by examination of the antennae, which are pectinate only in the male (Southgate, 1958,).

Broad bean seeds:

The seeds of broad bean were collected from local stores, sieved and cleaned from dusts and inert materials. Seeds were frozen at -20 ºC for 48 hrs to kill previous infestations then kept under room conditions for 3 weeks in order to reduce their moisture content to the normal rate (Huignard, 1985).

Botanical (jojoba) oil:

Jojoba oil: (plant part seeds)

English name: Goat nut Jojoba (pronounced hohoba)

Trade name: Jojoba oil 70% EC

Common name: *Simmondsia chinensis*

Chemical name: liquid wax esters

Formula:

Eicosenoic Acid	34	%
Docosenoic Acid	14	%
Oleic Acid	13	%

Treatment:

Serial concentrations of Jojoba oil were prepared in distilled water, 875, 1750, 3500 and 7000 ppm (w/v). Broad bean seeds were treated by each concentration by sub-merged 200 g of seeds for 30 seconds, subsequently, seeds aerated over night for assuring complete dryness. The untreated seed submerged in distilled water only as a control .Ten weighed broad bean seeds were taken out of the 200 g treated seed with each concentration. Treated seeds of each concentration exposed to five pairs of newly emerged adults of each tested insect pests *C. maculatus* and *C. chinensis* . They were placed in small transparent glass jars.Every trail was replicated three times for each tested concentration, and were kept in 30 ± 2 ºC and 60 ± 5 % RH covered with muslin for aeration and held with rubber band compared with untreated seeds.

Biological studies and measured criteria:

The fecundity was determined by calculating the number of deposited eggs by stereoscopic microscope seven days after removal of the adults from each jar, this time allowed the hatched larvae to penetrate and enter the seeds. Hatchability percentage was determined by counting the hatched larvae followed by daily check for the adult emergence, the emerged adults were counted from each jar and the developmental period was estimated from the time of eggs laid up to the appearance of first adult. The total number of emerged adults was counted and the mortality percentage of developmental stages (larvae and pupa) were calculated in relation to the number of hatched larvae. The developmental period of immature stages was

taken as criteria for determination the effect of Jojoba oil on immature stages. After adult's emergence, seeds were weighed after excluding the frass and dust, the weight loss was calculated using weight loss % equation (Khare and Johari 1984) As following:

$$\text{Weight loss \%} = \frac{(\text{Initial dry weight} - \text{Final dry weight})}{\text{Initial dry weight}} \times 100$$

The reduction percentage of fecundity, egg viability, developmental period of the immature stages, adult emergence of both tested insects and percent of weight loss of broad bean seeds and the viability of grains germination treated with the oil were calculated according to Abbott (1925) formula**.**

Residual effect of jojoba oil:

Samples (600 g) of broad bean seeds were treated with the effective chosen concentration of the oil (3500 ppm). The bioassay was carried out to verify the residual effect of Jojoba oil 1, 3 and 6 months storage period after treatment on the both tested insect pests. After exposing the tested insects to treated seeds in the three different storage periods (1,3 and 6 months), determination of fecundity, hatchability %, developmental period of immature stages and adult emergence have been calculated as mentioned previously.

Seeds germination:

The viability of the treated seeds was also examined; broad bean seeds previously treated with all tested concentrations of jojoba oil stored at room conditions were tested after initial treatment and six months intervals storage period by placing a 25 seeds (three replicates) on absorbing cotton pad soaked with water in petri dishes.

Experiment was replicated three times for the treated and untreated broad been seeds to determine the germination percentage and percent of reduction of the treated and untreated broad bean seeds.

All the tested biological aspects were subjected to statistical analysis by Analysis of variance (ANOVA) test using a computer software SAS (SAS Institute 2000). Means were detected and compared by Duncan multiple range test at 0.05% probability level (Duncan, 1955).

RESULTS AND DISCUSSION

I- Effect of jojoba oil on the fecundity, hatchability, life cycle and adult emergence of insects:

a. Fecundity:

Results reflected that there is a negative correlation between the number of eggs laid and the concentration of jojoba oil (increasing the concentration reduces the number of eggs laid) of both tested insects *C. maculatus* and *C. chinensis* (R= - 0.8217, and - 0.7632), respectively (Table 1). The mean number of eggs laid/female by *C. chinensis* on broad bean seeds treated with jojoba oil in all tested concentrations was significantly lower than *C. maculatus* 69.66 and 85.55 eggs/female, respectively, (Figure 1a). The highest concentration (7000 ppm), significantly reduced the number of eggs laid to 0.0 egg/female with 100% of reduction of the eggs laid in both

tested insects, compared with the lowest concentration (875 ppm) which averaged 143.33 and 130 eggs/female laid by *C. maculatus* and *C. chinensis*, respectively, with 24.56 and 22.77% of reduction of eggs laid, respectively (Table 1 and 2). The number of eggs laid in the untreated seeds was 190 and 168.33 eggs/female, respectively (Table 1). Statistical analysis indicated that *C. chinensis* is more susceptible to jojoba oil than *C. maculatus* and there is a significant difference between the two tested insects regardless to the concentration (P=0.0083). Abo El-Ghar *et al.* (1994) found that a jojoba oil forming a physical barrier between an insect pest and the leaf surface which affect the oviposition and hatching rate. Jojoba oil reduced the fecundity but its highest dose considerably decreased the fertility of *Musca domestica* (Ghoneim *et al.* 2007). Some studies agreed with the present results Al-Jabr (2008) applied seven essential plant oils to storage pest *Rhyzopertha dominica*. They were effective as a repellent to *R. dominica* (F.) at higher concentrations. Mulatu and Gebremedhin (2000) showed that the oils of *Azadirachtia indica*, *Milletiaie ferruginea* and *Chrysanthemum cineraraefolium* were the most effective in partially or completely preventing egg laying, and pulse beetles emergence from the laid eggs. The highest rate 15 ml/kg of castor, corn and paraffin oils applied to cowpea seeds prevent egg laying completely in *C. chinensis* (Zewar 1986).

b- Egg viability:

Results in table (1) indicated a negative correlation between the percent of hatchability and the concentration of jojoba oil (increasing the concentration reduces the hatchability percentage of eggs) of both tested insects by *C. maculatus* and *C. chinensis* (R=-0.925, and R=-0.848,), respectively. High percentage of hatchability was recorded on the eggs laid by *C. maculatus* and *C. chinensis* females on the seeds treated with the lowest concentration (875 ppm) 69.5% and 60.33% with 24.15 and 31.62% reduction of hatchability, respectively. While, no eggs were hatched of the highest concentration (7000 ppm) for both tested insects. The mean hatchability percentage by *C. maculatus* and *C. chinensis* on broad bean seeds treated with jojoba oil in the two tested insects regardless to the concentrations was significantly different (P=0.080) averaged 58.79 and 50.75 %, respectively, (Figure 1b). These results are in agreement with Shemias *et al.* (2002) who reported that jojoba oil highly reduced the average number of eggs laid and hatchability percentage of *S. oryzae* and *S. granarius* at LC_{95} level. Also, Mahgoub *et al.* (1998) found that *Petroselinum sativum* oil gave a severe reduction in egg deposition, hatchability and percentage of progeny for *S. oryzae* and *C. maculatus* at LC_{95} level.

Results also agreed with Osman (2003), and Bream *et al.* (2001) they indicated that jojoba oil can act as toxicant, antifeedant, growth, development and oviposition inhibitor.

C- Developmental period:

The duration of *C. maculatus* and *C. chinensis* of life cycle, egg to adult, in Jojoba oil treatments showed a significant difference between the untreated and the treated concentrations (F=1215.00, P=0.0001) and (F=1072.5, P=0.0001), respectively. Results in table (1) revealed a significant difference in the duration period of developmental stages between the

treatments (increasing the jojoba oil concentration lengthened the duration of the immature stages). Consequently, the shortest duration period of the developmental stages was recorded in untreated treatment for both tested insects (26 and 25 days), respectively. They duration period of developmental stages of the two tested insects lengthened gradually as the concentration of jojoba oil increased (29 and 30 days) and (27 and 28 days), respectively for the concentrations (875 and 1750 ppm), respectively. While, duration period in the high concentrations (3500 and 7000 ppm) did not recorded because no adults were emerged (100% reduction of developmental stages) in both tested insects (table 1 and 2). Jojoba oil showed a great impact on the developmental stages of both tested insects in the highest concentration (7000 ppm) which significantly reduced the F_1 emerged adults to 0.0 adult (100% mortality). The mean duration period of *C. maculatus* on broad bean seeds treated with jojoba oil regardless to the concentrations was significantly longer than *C. chinensis* by 28.3 and 26.3 days, respectively, (Figure 1c).

Table (1): Effect of jojoba oil on fecundity, egg viability, developmental period of the immature stages, adult emergence of both tested insects *Callosobruchus maculatus* and *C. chinensis.*

Conc. ppm	Mean No. of eggs laid		Hatchability %		Mean developmental period (days)		Mean no. of emerged adults	
	C. maculatus	*C. chinensis*	*C. maculatus*	*C. chinensis*	*C. maculatus*	*C. chinensis*	*C. maculatus*	*C. chinensis*
875	143.44	130	69.50	60.33	29	27	60	51.66
1750	86.66	70	47.91	36.66	30	28	28.66	20
3500	26.66	9.33	26.11	17.78	0	0	0	0
7000	0	0	0	0	0	0	0	0
Average	85.55	69.77	47.84	38.25	29.50	27.50	44.33	35.83
untreated	190	168.33	91.64	88.23	26	25	140	120
R-value	-0.8217	-0.7632	-0.925	-0.8484	0.9977	0.9973	0.5717	0.5822
F=value	59.921	41.984	150.581	72.746	1215	1072.5	17.355	18.117
P = 0.05	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0011	0.0009

Table (2): Reduction percentage of fecundity, egg viability, developmental period of the immature stages, adult emergence of *Callosobruchus maculatus* and *C. chinensis* treated with jojoba oil.

Conc. ppm	Reduction % of Number of eggs Laid		Reduction % of Hatchability %		Reduction % of Developmental period (days)		Reduction % of F1 emerged adults	
	C. macu	*C.chin*	*C. mac*	*C.chin*	*C. mac*	*C.chin*	*C. mac*	*C.chin*
875	24.56	22.77	24.15	31.62	57.14	56.95	11.00	08.00
1750	54.38	58.41	47.71	58.44	79.52	83.33	15.38	12.00
3500	85.96	94.45	71.50	79.84	100.00	100.00	100.00	100.00
٧٠٠٠	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Average	54.96	58.54	47.78	56.63	68.33	70.14	13.19	10.00

This results agreed with those reported by Shemias *et al.* (2002) that application of jojoba oil with high concentrations to wheat grains caused a high reduction in the percentages of emerged progeny (100%) of *Sitophilus oryzae* and *S. granarius*, no adults were emerged at LC_{95} level. Developmental period of *C. maculatus* elongated by application of black pepper powder by 35.2 days in comparison with the untreated 24.2 days, also developmental period prolonged as the concentration increased (El-Degwi and Rizk 2001).

d- Adult emergence:

Results showed a negative correlation between the number of F_1 emerged adults and the concentration of jojoba oil (increasing the concentration reduces the number of F_1 emerged adults) of both tested insects *C. maculatus* and *C. chinensis* (R= 0.5717) and (R= 0.5822,) respectively. The highest concentrations (7000 and 3500 ppm) significantly reduced the number of F_1 emerged adults to 0.0 in both tested insects, compared with 60 and 51.66 F_1 emerged adults of *C. maculatus* and *C. chinensis*, respectively, in lowest concentration (875 ppm). The number of F_1 emerged adults in the untreated seeds were 140 and 120 F_1 emerged adults, respectively (Table 1). The mean number of F_1 emerged adults of *C. maculatus* on broad bean seeds treated with jojoba oil in all tested concentrations was significantly higher than *C. chinensis* 45.33 and 36.33 adults, respectively, (Figure 1d). Jojoba oil showed a dramatic impact on the developmental stages of both tested insects in the high concentrations (3500 and 7000 ppm) significantly reduced the F_1 emerged adults to 0.0 adult (100% mortality and reduction). Results indicated that *C. chinensis* is more affected with jojoba oil in all concentrations than *C. maculatus* (more adults emerged) and there is a slight significant difference between the two tested insects (P=0.0224). The obtained results are in agreement with Shemias *et al.* (2002) findings who stated that the oil highly reduced the average numberof emerged adults of *S. oryzae* and *S. granarius* at LC_{95} level.

Ramzan (1994) reported that the oil of cotton seed, sunflower, groundnut, soybean and mustard oils, when mixed with cowpea, completely suppressed adult emergence of *C. maculatus*. Rahman and Talukder (2006) also reported that oils of mustard, sunflower, safflower, castor and cotton acted as surface protectants against *C. maculatus* population growth by reducing the number of F_1 emerged adults.

e- Effect on seeds weight loss:

Negative correlation between the percent of weight loss caused by larval feeding and the concentration of jojoba oil (increasing the concentration reduces the weight loss percentage) of both *C. maculatus* and *C. chinensis* insects (R=0.7521 and =0.5276), respectively (Table 3). High percentage of weight loss was recorded by *C. maculatus* and *C. chinensis* fed on the seeds treated with the lowest concentration (875 ppm) were 8.073, 6.726% (49.68 and 48.12% of weight loss reduction), respectively, while the lowest percentage of weight loss was recorded at the highest concentration (7000 ppm) was 0.0% (100% of weight loss reduction), compared with the highest weight loss percentage on the untreated seeds 16.0 and 12.96% (Table 3). The mean weight loss percentage by *C. maculatus* and *C. chinensis* on

treated broad bean seeds in both tested insects regardless to the concentrations were 7.56 and 6.02 % respectively, (Figure 2).

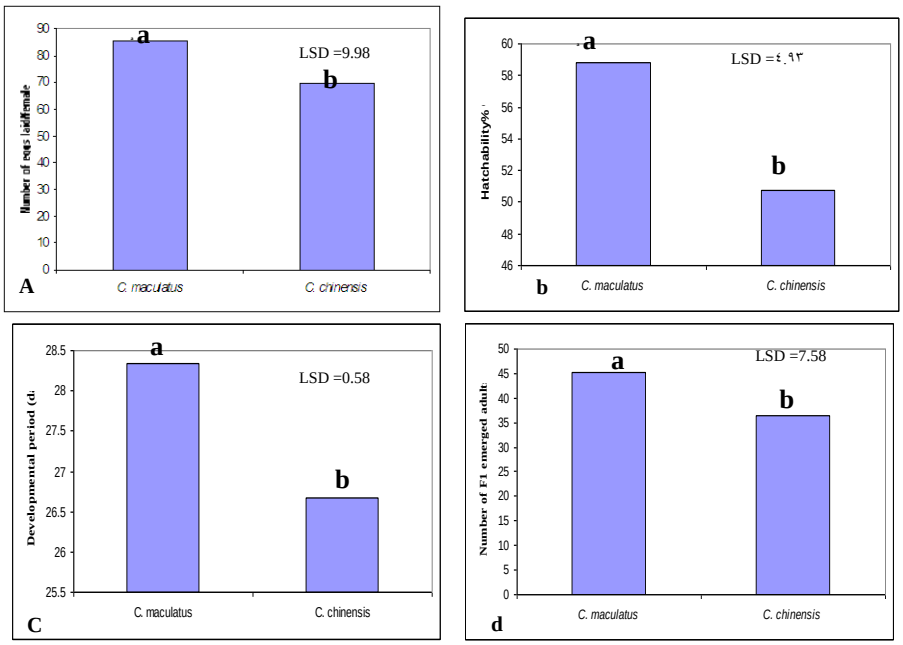

Figure (1): Mean number of eggs laid (a), percent of hatchability (b), F_1 and developmental period (C) and number of emerged adults (d) by *C. maculatus* and *C. chinensis* on broad bean seeds treated with jojoba oil.

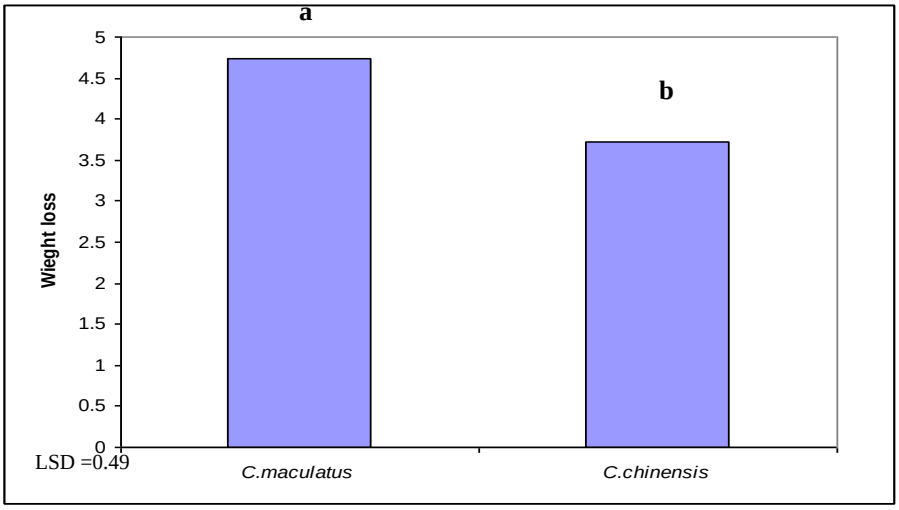

Figure (2): Percent of weight loss of broad bean seeds treated with jojoba oil exposed to *C. maculatus* and *C. chinensis*.

These results indicated that the impact of jojoba oil on the weight loss percentage is significantly different between the two tested insects which may be due to that *C. maculatus* was less susceptible than *C. chinensis* (P=0.0001). Rahman and Talukder (2006) reported that oils of mustard, sunflower, safflower, castor and cotton acted as surface protectants against *C. maculatus* population growth by reducing the seed damage rate. Results agreed with Abd El-Kaway (1991) who reported that weight loss was gradually reduced with the increase of oil concentration. Similar results indicated that treated wheat with 1000 ppm azadiractin gave a good protection from *Sitophilus oryzae* attacks with 4.66% weight loss compared with 22% for untreated (El-Shabrawy, 2007). Low seeds loss caused by *C. chinensis* was noted with castor, mustard and groundnut at 1% level up to 100 days after treatment with the high concentration (1%v/w).

Table (3): Weight loss percentage of broad bean seeds treated with jojoba oil as a result of feeding by *Callosobruchus maculatus and C. chinensis*.

Concentration ppm	*C.maculatus*		*C.chinensis*	
	Weight loss %	**Reduction %**	**Weight loss %**	**Reduction %**
٨٧٥	٨.٠٧٣	49.68	٦.٧٢٦	48.12
١٧٥٠	٥.٧٤٤	64.19	٤.٤٠٢	66.04
٣٥٠٠	٠.٤٢٣	97.36	٠.٠٣٥	99.73
٧٠٠٠	٠	100	٠	100
Average	4.74	70.41	3.72	71.29
Untreated	١٦.٠٤		١٢.٩٦	
R value	0.7521		0.5276	
F value	39.445		14.517	
P = 0.05	0.0001		0.0022	

II- Residual effect of jojoba oil on *C. maculatus and C. chinensis* after different storage periods:

a- Effect of the oil on the fecundity:

The residual effect of jojoba oil treatment on the fecundity of both tested insects *C. maculatus and C. chinensis* after three different storage periods (1, 3 and 6 months) is summarized in table (4). The impact of jojoba oil on the fecundity was clearly observed and significantly differed (P=0.0001) on the treated broad bean seeds 46.99 and 49.98 eggs/female, respectively, compared with untreated seeds 175.55 and 156.11 eggs/female,respectively. Results presented in Table (5) revealed that 3500 ppm concentration has persistent effect as seed protectant against bruchid fecundity until three months from the initial treatments with 59.81% and 60.15 reduction of eggs laid for both tested insects, respectively, (table 4). Generally, jojoba oil could protect the broad bean against *C. maculatus* and *C. chinensis* attacks by reducing the oviposition rate, although the efficacy of jojoba oil decreased markedly with aging which gave seeds protection for general average of storage period by 62.55% and 67.40% reduction of eggs laid, respectively. Results in agreement with Babu *et al*.(1989) finding that treatment of mungbean (table 4) seeds with castor oil effectively reduced oviposition of C*. chinensis*. Results also agreed with Pereira (1983) who indicated that neem

oil reduced oviposition of *C. maculatus* and has ovicidal effect at a treatment of 8 ml oil/kg seed castor, sesame and paraffin oils applied to cowpea seeds caused a significant reduction in egg ovipostion, hatchability percentage and F_1 emerged adults of *C. chinensis* (Zewar 1986).

Table (4): Residual effect of jojoba oil on *C. maculatus and C. chinensis* after different storage periods of treated and untreated broad bean seeds.

Treatment	Storage period	Number of eggs Laid		Hatchability %		F_1 emerged adults		Developmental period (days)	
		C. macu	*C.chin*	*C. mac*	*C.chin*	*C. mac*	*C.chin*	*C. mac*	*C.chin*
Treated	1 months	٢٦.66	8.33	26.11	17.78	٠.٠	٠.٠	٠.٠	٠.٠
	3 months	61.66	53.33	56.02	59.05	8.33	١٣.٣٣	32	٣١.٣٣
	6 months	106.67	٨٨.٣٣	62.74	٧٤.٨١	33.33	٤٥	30.33	٢٨.٣٣
	Average	46.99	49.98	48.29	50.54	20.83	29.16	31.16	29.83
Untreated	1 months	190	١٦٨.٣٣	٩٠.٤٨	٨٧.٠٩	١٤٠	١١٠	٢٦	٢٥
	3 months	١٥٣.٣٣	١٣٣.٣٣	٨٩.٨٧	٨٦.٠٧	١٠٣	٨٣.٣٣	٢٨	٢٥
	6 months	١٨٣.٣٣	١٦٦.٦٧	٩٠.٨٦	٨٧.١٩	١٢٣	١١٨	٢٧	٢٤.٦٧
	Average	175.55	156.11	90.40	86.78	122	103.77	27	24.89
F-value		٢٢.٩٢	٣٦.١٧	٢٨.٦٨	١١.٢٤	٣٢.٧٧	٤٤.٨٤	٦.٤٧	٥.٠٨
P-value		٠.00٠١	٠.٠٠٠١	٠.٠٠٠١	٠.٠٠٠٥	٠.٠٠٠١	٠.٠٠٠١	٠.٠٠٥٧	٠.٠١٣٨

b- Effect on Hatchability (%):

The hatchability percentage of both tested insects *C. maculatus and C. chinensis* decreased significantly respectively in the treated broad bean seeds ٤٨.٢٩ and 50.54% compared to the untreated 90.40 and 86.78% in all different storage period table (4). On the other hand, jojoba oil application has clear effect at the first month of the storage period 71.14% and 79.58% reduction of hatchability, then the other two storage periods (3 and 6 month) resulted less than 50% reduction (table 5). Generally, the potential effect of jojoba oil reduced the hatchability with an average mean of reduction percentage of hatchability 46.66 and 41.72% for both tested insects, respectively. The highest rate 15 ml/kg of castor, corn and paraffin oils applied to cowpea seeds almost prevents egg hatchability of *C. chinensis* (Zewar 1986).

C- Effect on developmental period:

The duration of *C. maculatus* and *C. chinensis* life cycle (egg to adult), in Jojoba oil treatments increased significantly (P=0.0057) and (P=0.0138), in the treated broad bean seeds 31.16 and 29.83 days, compared to the untreated 27.00 and 24.89 days, (table 4). Results indicated that the duration of the developmental stages decreased as storage period prolonged due to the effect of jojoba oil which reduced by aging (32.0 and 30.33 days) for *C. maculatus*, while were (31.33 and 28.33) for *C. chinensis* for 3 and 6 month storage periods, respectively. While at the first month of the storage period 100% of reduction was recorded due to the potential effect of jojoba oil on the developmental stages with zero emerged adults for both tested insects (table 5).

Pereira (1983) found that neem oil showed larvicidal properties on *C. maculatus* even after 90 days of storage period at treatment of 8 ml oil/kg seed. Life cycle of spider mite (*Tetranychus urticae*). was prolonged as concentration of jojoba oil increased from 1.5% to 5.5% (v/v) and the

percentage of individual which succeeded to reach adulthood was affected (El-Duweini and Sedrak 1997).

Table (5): Impact of jojoba oil on treated broad bean seeds on two insects after different storage periods.

Storage period	Reduction % of Number of eggs Laid		Reduction % of Hatchability %		Reduction % of F1 emerged adults		Reduction % of Developmental period (days)	
	C. macu	*C.chin*	*C. mac*	*C.chin*	*C. mac*	*C.chin*	*C. mac*	*C.chin*
1 months	86.00	95.06	71.14	79.58	100.00	100.00	100.00	100.00
3 months	59.81	60.15	37.66	31.39	91.91	98.43	14.28	25.20
6 months	41.84	46.99	30.94	14.19	79.92	61.86	12.22	14.71
Average	62.55	67.40	46.66	41.72	90.61	86.76	42.16	46.63

d- Effect on adult emergence:

The F_1 emerged adults of both tested insects *C. maculatus and C. chinensis* decreased significantly in both tested insects (P=0.0001), in the treated broad bean seeds 20.83 and 29.16 compared with the untreated 122.0 and 103.77 in all different storage periods in table (4). The first month of storage period gave a 100 percent protection of treated bean seeds in 0.0 F_1 emerged adults in both tested insects. Results revealed that a positive relationship between the storage period and number of F_1 emerged adults due to decreasing the residual effect of jojoba oil by aging from 3 to 6 months)with reduction percentage of F_1 emerged adults by 91.91 and 79.92% for *C. maculatus* and 98.43 and 61.86 for *C. chinensis* (Table 5). Pereira (1983) reported that neem oil gave a good protection of *C. maculatus* attacks for cowpea seeds up to 3 months. Cowpea seeds treated with castor, sesame and paraffin oils at the highest rate 15ml/kg gave a complete protection (no emergence of adults was recorded) against *C. chinensis* up to 6 months (Zewar 1986).

III- Seed viability:

The effect of jojoba oil treatment on broad bean seeds germination was presented in table (6). Germination of broad bean seeds treated with jojoba oil at 875, 1750, 3500, 7000 ppm and untreated (control) was observed over the six months storage period. Generally, broad bean seeds viability slightly affected by jojoba oil application. Results showed slight differences between untreated and treated seeds in the germination percentage at all tested concentrations. Germination decreased in the untreated seeds from 92 for the initial time to 82.66% after six months of storage period. Germination percentage decreased as the concentration of the oil increased in both initial time and after six month storage period (Table 6). Consequently, the reduction in germination was increased markedly with aging from 3.63% to 11.59% at the lowest and highest concentrations 875 and 7000 ppm, respectively, at the initial time of treatment. Similar trend was recorded after six months of the storage period, the reduction percentage of germination increased form 3.2 to 28.22%, respectively. The reduction of germination was most appeared at the highest concentration (7000 ppm) particularly at the

end of storage period 28.22%. The present results are in agreement with the findings of Schoonhoven (1978), and Pacheco *et al.* (1995). The percentage of germination was higher than 67 % with oil at 3500 concentration. Also, results agreed with those of Shemais *et al.* (2002) who stated that the reduction of germination of wheat treated with jojoba oil was most appeared at high concentrations and also at the end of storage period (24 weeks). Similar trend of the oil influences on the reduction of germentation affected markedly with aging was against *C. maculatus* at a rate of 8 ml / kg and of *C. chinensis* for 18 months at rate of 10 ml/kg (Babu *et al*. (1989) and Singh *et al*. 1978).

Table (6): Effect of jojoba oil on germination of treated broad bean seeds at two different storage periods.

Conc. ppm	Initial time		After six months	
	Germination %	Reduction %	Germination %	Reduction %
875	88.66	03.63	80	03.2
1750	87.33	05.07	76.66	07.25
3500	85.33	07.25	67.33	18.62
7000	81.33	11.59	59.33	28.22
untreated	92.00		82.66	

CONCLUSION

A negative correlations were observed between the jojoba oil concentration and the all tested biological parameters (number of eggs laid, hatchability percentage, developmental period, F_1 adult emergence, and broad bean seeds weight loss percentage for both tested insects *C. maculatus* and *C. chinensis*. Results revealed that *C. chinensis* is more susceptible to jojoba oil than *C. maculatus* and there is a significant difference between the two tested insects in all tested biological aspects regardless to the concentration (for the fecundity 168.33 and 190 eggs/female, hatchability percentage 60.33 and 69.5 %, developmental period 26.3 and 28.3 days, and 45.33 and 36.33, F_1 emerged adults and weight loss percentage 6.02 and 7.56%, respectively.

The residual effect of jojoba oil treatments was clearly effective in the first month of storage period which gave a 100 percent protection of treated bean seeds with 0.0 F_1 emerged adults in both tested insects (100% mortality of developmental stages). Thus, residual effect of jojoba oil reduced as the storage period prolonged, still jojoba oil could protect the broad bean seeds against *C. maculatus* and *C. chinensis* attacks although the efficacy of jojoba oil decreased with aging.

Treated broad bean variability was slightly affected by jojoba oil application, reduction of jojoba oil residues due to aging. The reduction of germination was most appeared at 7000 ppm (the highest concentration) averaged particularly at the end of storage period 28.22%.

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فاعلية زيت الچوچوبا ضد اثنتان من الآفات الحشرية لبذور البقوليات المخزونة خنفساء اللوبيا (F.) *Callosobruchus maculatus* و خنفساء البقول *C. chinensis* (L.)

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تم تعريض الحشرات البالغة لكل من خنفساء اللوبيا وخنفساء البقول لبذور الفول المعامله بأربعة تركيزات مختلفه من زيت الچوچوبا (مركز مستحلب ٧٠ %) وهى ٨٧٥ ، ١٧٥٠ ، ٣٥٠٠ ، ٧٠٠٠ جزء فى المليون وكذلك البذور الغير معامله (الكنترول) لتقبيم فاعلية زيت الچوچوبا في الوقاية من الحشرتين محل الدراسة.

اثبتت الدراسة ان هناك علاقه عكسيه بين تركيز زيت الچوچوبا وبين القياسات البيولوجيه التى تم تقييمها وهى وضع البيض ، نسبة الفقس للبيض ، فترة النمو للأطوار الغير كاملة (يرقات و عذراى) ، خروج الحشرات البالغة من الجيل الأول ، حيوية البذور (نسبة الإنبات) وأخيراً النسبه المئويه للفقد فى وزن البذور لكل من الحشرتين خنفساء اللوبيا وخنفساء البقول .دلت النتائج على أن خنفساء البقول كانت أكثر حساسيه لزيت الجوجوبا عن خنفساء اللوبيا حيث وجد ان هناك فرق معنوى بين الحشرتين المختبرتين فى جميع القياسات البيولوجيه التى تم إختبارها بغض النظر عن التركيز فكان متوسط عدد البيض ١٦٨.٣٣ ، ١٩٠ بيضه / أنثى ونسبة الفقس كانت ٦٠.٣٣ ، ٦٩.٥ % وكان متوسط فترة النمو للأطوار الغير كاملة ٢٦.٣ ، ٢٨.٣ يوم و كان عدد الخلفه (الجيل الأول) ٣٦.٣٣ ، ٤٥.٣٣ حشره وايضاً كانت نسبة الفقد فى وزن البذور ٦.٠٢ ، ٧.٥٦% على التوالى .أعطى التركيز العالى ٧٠٠٠ جزء فى المليون حمايه كامله للبذور مع عدم فقدان فى وزن البذور لكل من الحشرتين المختبرتين . كان متوسط النسبه المئويه للفقد فى البذور الغير معامله ١٦.٠٤، ١٢.٩٦ % لخنفساء اللوبيا وخنفساء البقول على التوالى بينما إنخفضت النسبه المئويه للفقد فى الوزن إلى أكثر من النصف بمتوسط ٧.٥٦ ، ٦.٠٢% لكل من البذور المعامله بزيت الچوچوبا. وفى دراسة التأثير المتبقى لزيت الچوچوبا على الحشرات محل الدراسة دلت النتائج ان هناك تأثير واضح فى الشهر الأول من فترة التخزين والذى أعطى حمايه ١٠٠% للبذور المعامله مع عدم ظهور خلفه (الجيل الأول) لكلا الحشرتين (١٠٠% موت أثناء مراحل النمو) . إنخفض التأثير المتبقى لزيت الچوچوبا بعد ستة أشهر من فترة التخزين أى ان إطالة فترة التخزين اثرت نسبياً على كفاءة وفاعلية الزيت. بينما كان زيت الچوچوبا مازال قادراً على حماية بذور الفول من الإصابه بخنفساء اللوبيا وخنفساء البقول بالرغم من نقص فعالية زيت الچوچوبا بسبب طول فترة التخزين بعد المعاملة (٧٩.٩٢ ، ٦١.٨٦% إنخفاض فى الجيل الأول مقارنةً بالكنترول) . و اثبتت النتائج ايضاً ان تأثير زيت الچوچوبا على حيوية البذور (نسبة الإنبات) كان ضعيفاً جداً ولم يظهر هذا التأثير إلا فى التركيز العالى ٧٠٠٠ جزء فى المليون خاصةً فى نهاية فترة التخزين و كان متوسط الخفض ٢٨.٢٢% .

قام بتحكيم البحث

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