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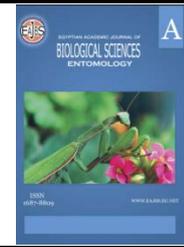
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Evaluation the efficiency of clove oil (*Syzygium aromaticum*) in controlling cowpea seed beetle, *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae)

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ABSTRACT

The present work aimed to studying the effect and evaluate the effectiveness of the clove oil as a natural product against the adults of the cowpea seed weevil, *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) under controlled laboratory conditions.

The study was carried out at the Biology Department, Faculty of Science, Princes Nora University, Al Riyadh, Saudi Arabia, using four concentrations of clove oil (5, 2.5, 1.25 and 0.12 mg/L).

Results obtained indicated that, the mortality percentage of the adult beetles increased with the increase of the oil concentration and the period after treatment. The percentage of mortality was 63.333% two days after treatment at the highest concentration (5mg/L), increased to reach 96.667% four days after treatment at the same concentration. At the lowest concentration (0.12 mg/L), the percentage of mortality was 73.333% four days after treatment and the LC₅₀ value was 2.188 mg/l and the LC₉₀ was 75.445 mg/l after two days from treatment.

INTRODUCTION

The grain and seed storage is a strategic global goal, and during storage periods in warehouses, they are being exposed to damage and loss as a result of warehouse pest infestation.

Dechte (1976) mentioned that, the annual loss rate of stored seeds in warehouses as a result of insect infestation reach 5% in developed countries, increased to 25 – 40% in developing countries.

The cowpea seed beetle, *Callosobruchus maculatus* (Fab.) is one of the most important store pests of worldwide distribution, infesting different legume seeds (Decell, 1981), causing great damage as weight loss in seeds, low percentage in germination and low commercial value (Singh and Benzet, 1974 and Sougthgate, 1979).

It is proved that, the use of pesticides in combating such pests in stores is of slight impact on the protection of these seeds from insect infestation, in addition to the high cost, hazards and bad side effects on humans, animals and the environment.

Therefore, many studies and investigations have been made to evaluate the effectiveness of several plant oils, extracts and natural products of plant origin as alternatives of insecticides and safe method against these pests, of those (Afifi *et al*, 1988 ; El Lakwah *et al*, 1992, 1993, 1995 and 2000 ; Chander and Ahmed, 1987; Su, 1983, 1984, 1985, 1988 and 1989; Ivbijaro, 1983 and 1990; Ivbijaro *et al*, 1985; Delobel and Malonga, 1987, Zewar, 1978; Chakrabortu and Chose, 1988; Saraswathi and Rao, 1987; Boating and Kusi, 2008 ; Zettler and Cuperus, 1990; Georghiou, 1990 ; White, 1995 and Al Bandari F 2014).

The present work was carried out in order to evaluate the effectiveness of clove oil as natural component against cowpea seed beetle and to contribute to the possibility of using natural oils and plant extracts as alternatives of pesticides in controlling such pests.

MATERIALS AND METHODS

The present study to evaluate the effectiveness of the clove oil, *Syzygium aromaticum* for the control cowpea seed beetle, *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) was carried out in the insect laboratory, Biology Department, Faculty of Science, Princes Nora University, Riyadh, Kingdom of Saudi Arabia.

Four concentrations of clove oil were prepared for the use in the experiment (5, 2.5, 1.25 and 0.12 mg/L). Cowpea seeds (*Vigna unguiculata*) were brought from the local market, impurities and damaged seeds were removed by hand. Healthy seeds were then washed, dried and maintained in suitable confined jars for at least three weeks to insure free of insect infestation (Adebayo and Gbofode, 1994 and Rajapakze *et al.*, 1998). Clean and not infested cowpea seeds were sterilized before the use at 60°C for 20 minutes. Equal quantities of seeds (1 Kg.) were put in plastic bags. Prepared concentrations of the oil were added to the bags using a pipette and then shaken well in order to encapsulate the seeds with the oil (three replicates for each concentration treatment were made).

All bags were left in a place away from any source of infestation for 15 days to the oil to get inside the seeds. Plastic boxes ca. 6 x 4 cm were used, in each box an equal quantity of treated seeds were put. Batches of 10 newly emerged adults of the cowpea seed beetles (*C. maculates*), reared in the laboratory were introduced into each box. The boxes were covered with plastic punctured cover and were incubated at 25°C and 70% R.H. suitable for grow and developing insects (Al-Jaberry and Abul Kareem, 1987) and left for new adult emergence from seeds.

Adult mortalities were recorded after 2 and 4 days from the treatment. Percentages of adult mortality were calculated and the Lc_{50} was determined. Comparisons were made on the basis of the slops of the LDP (Log. dose Probit, Finney, 1971).

RESULTS

Evaluation of the effectiveness of the clove oil against the adult cowpea seed beetle, *Callosobruchus maculatus* was carried out under laboratory conditions, using four different concentrations of the oil (5, 2.5, 1.25 and 0.12 mg/L).

General results indicate that, there are a positive relation between the mortality of adult insects and both of the concentration of the clove oil and the time after treatment, as shown in Table (1).

Table 1: The effect of clove oil *Syzygium aromatum* on adult *C. maculatus* after two and four days from treatment.

Concentration Mg/L	replicates	Total no. insects	After 2 days from treatment		After 4 days from treatment	
			dead	alive	dead	alive
5mg/L	1	10	5	5	10	0
	2	10	7	3	9	1
	3	10	7	3	10	0
2.5mg/L	1	10	5	5	9	1
	2	10	5	5	9	1
	3	10	7	3	10	0
1.25mg/L	1	10	3	7	9	1
	2	10	3	7	8	2
	3	10	4	6	8	2
o.12mg/L	1	10	3	7	8	2
	2	10	2	8	8	2
	3	10	0	10	6	4

Tables (2) and (3) show the percentage of adult mortality at the used different concentrations after two and four days from the treatment. From which, the percentage was found to be ranged between 16.667 and 63.333% at the lowest and highest concentrations (0.12 and 5 mg/L) after 2 days and was between 73.333 and 96.667% after 4 days from the treatment, respectively.

It is also clear from Table (2) and Fig., (1) that the value of LC₅₀ was 2.188 mg/L, and the value of LC₉₀ was 75.445 mg/L after 2 days from the treatment. Whereas the value of LC₅₀ was 0.013 mg/L and the value of LC₉₀ was 1.862 mg/L after 4 days from the treatment, Table (3) and Fig. (2). The slope was 0.834 and 0.599 after 2 and 4 days from the treatment, respectively.

Table 2: Response of *C. maculatus* adults to the tested clove oil concentrations after two days from treatment

No.	Treated	Concentration	Observed	Linear	Log	Linear
		10	Responded %	Responded %	Conc. 10	Probit
1	30	1.2	16.667	14.6676	0.079	3.949
2	30	12.5	3.333	41.9691	1.097	4.797
3	30	25	56.667	51.9251	1.389	5.048
4	30	50	63.333	61.7576	1.699	5.299

slope	0.834	+/- 0.217
X ²	1.32	Tabulated 6

LC	25	50	75	90	95	99
Mg/L	0.34	2.188	14.102	75.445	205.819	1351.991

Table 3: Response of *C. maculatus* adults to the tested clove oil concentrations after four days from treatment

No.	Treated	Concentration	Observed	Linear	Log	Linear
		10	Responded %	Responded %	Conc. 10	probit
1	30	1.2	73.333	71.5149	0.079	5.596
2	30	12.5	83.333	88.0581	1.97	6.178
3	30	25	93.333	91.2718	1.398	6.358
4	30	50	96.667	93.7943	1.699	6.539

Slope	0.834	+/- 0.201
X ²	1.32	Tabulated 6

LC	25	50	75	90	95	99
Mg/L	0.001	0.013	0.18	1.862	7.526	103.368

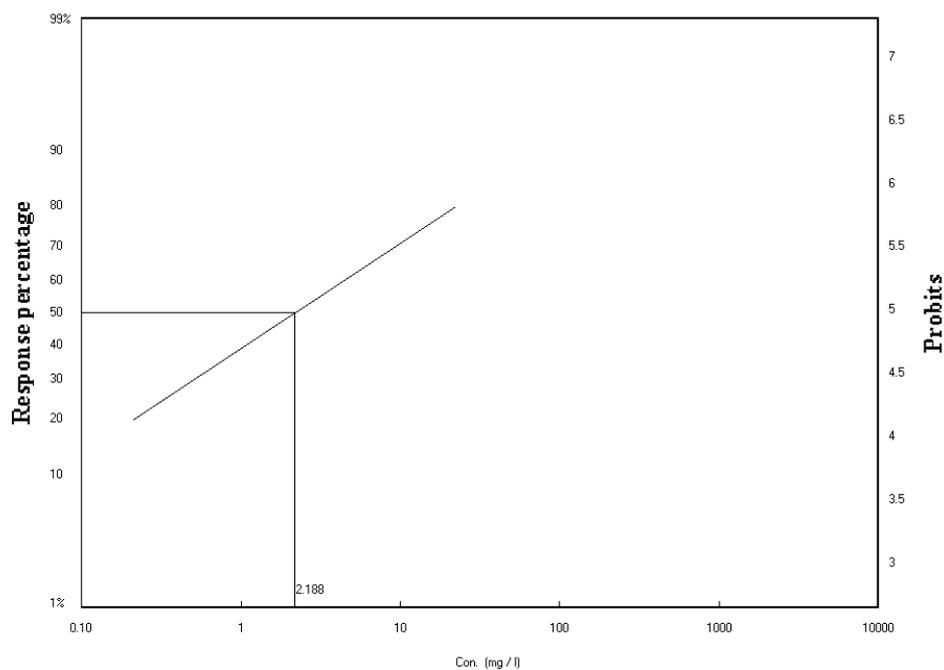


Fig. 1: Probit line showing response of *C. maculatus* adults to the different concentrations of clove oil after two days from treatment.

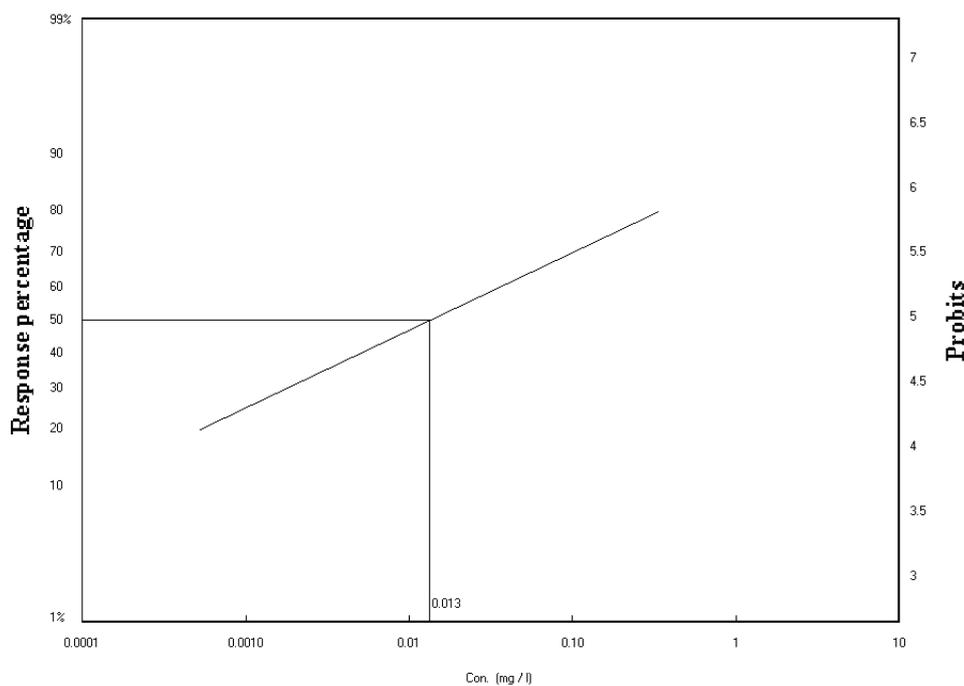


Fig. 2: Probit line showing response of *C. maculatus* adults to the different concentrations of clove oil after four days from treatment.

The χ^2 counted values were 1.32 and 0.77 after two and four days from the treatment, respectively. Whereas the tabulated value was 6 in both periods.

The resulted values of LC_{50} and LC_{90} represented in Tables (2 & 3) and illustrated in Figs. (1 & 2) showed the susceptibility of *Callosobruchus maculatus* under laboratory conditions to the tested oil after two and four days. Fig. (3) show a comparison between the two toxicity lines for the used oil after 2 and 4 days from the treatment and illustrated the values of LC_{50} .

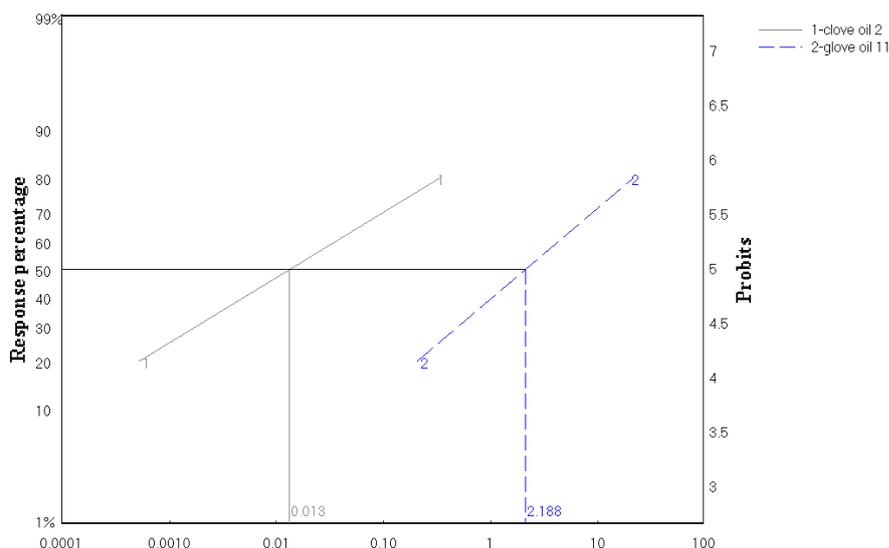


Fig. 3: Probit lines and LC₅₀ values of clove oil on *C. maculatus* adults after two and four days from treatment under laboratory conditions.

DISCUSSION

The present toxicity experiments indicated that the clove oil was highly effective against the cowpea seed beetle *Callosobruchus maculatus* when using high concentrations of the oil and there was a positive relation between the rate of the adult mortality and the concentration of the oil.

Moderate rates of mortality were obtained after two days of treatment and high rates were after 4 days at the highest concentration of the oil (5 mg/L). Other concentrations gave less mortality rates in the two periods.

The current results could be in harmony with that obtained by Ali *et al.* (1983) who tested a number of plant oils (Neem oil, *Melia azadirach*; Coconut oil, *Cocos nucifera*; Turnip oil, *Brassica sp.*; Sesame oil, *Sesamum indicum* and Palm oil, *Elaeis guineensis*) on adults of the cowpea seed beetles breeding on chickpea plant, which were used at concentrations of 0.05 and 1ml/100 gm seeds. They found that, neem, coconut, mahua, sesame and palm oils caused high rates of mortality, could reach 100% after three days from the treatment at 1m/L.

The results also agree with Zewar (1987) who stated that, some plant oils (castor, olive, paraffin and maize oils) are efficient against adults of cowpea seed beetle *Callosobruchus maculatus*. And that when exposing adult insects of higher concentration 12ml/kg seeds caused death reached 100% after two days of exposure to grains treated with castor and paraffin oils, whereas in the case of maize oil caused 90% death at the same concentration.

The results also agreed with the findings of many authors, such as Su (1983, 1984, 1985 and 1988), Don-Pedro (1985), Boating and Kusi (2008), Rajapakse and Ratnasekera (2008), Srinivasan, (2008) who tested many natural compounds against some pests of stored seeds of which the beetle *Callosobruchus maculatus* is one of them. They all determined and evaluated the efficacy of each compound.

The present study revealed and recommended the effectiveness of clove oil against the cowpea seed beetle, *Callosobruchus maculatus*, especially when using at high concentration (5 mg/L.).

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ARABIC SUMMERY

تقييم فعالية زيت القرنفل *Syzygium aromaticum* في مكافحة حشرة خنفساء اللوبيا
(رتبة غمدية الاجنحة : فصيلة خنافس البقول) *Callosobruchus maculatus* (F.)

البندري فهد اليوسف

قسم الأحياء، كلية العلوم، جامعة الأميرة نوره بنت عبدالرحمن
المملكة العربية السعودية

ستهدفت الدراسة الحالية دراسة تأثير وتقييم فعالية زيت القرنفل كأحد المستخلصات الطبيعية على خنفساء بذور اللوبيا تحت الظروف المعملية.
اجريت هذه الدراسة بقسم الاحياء بكلية العلوم جامعة الاميرة نورا بنت عبد الرحمن بالرياض، المملكة العربية السعودية باستخدام اربع تركيزات من زيت القرنفل (٥ ، ٢.٥ ، ١.٢٥ و ٠.١٢ مللجرام / لتر) لمكافحة حشرة خنفساء بذور اللوبيا تحت الظروف المعملية.
اظهرت نتائج الدراسة ان نسبة الموت للحشرات الكاملة قد زادت بزيادة تركيز الزيت والفترة بعد المعاملة حيث بلغت نسبة الموت بعد يومين من المعاملة الى ٦٣.٣٣٣ % عند اعلى تركيز للزيت (٥ مللجرام/ لتر). ارتفعت هذه النسبة لتصل الى ٩٦.٦٦٧ % بعد اربعة ايام من المعاملة عند نفس التركيز. بينما بلغت نسبة الموت ٧٣.٣٣٣ % عند اقل التركيزات المستخدمة (٠.١٢ مللجرام / لتر) وذلك بعد المعاملة بأربعة أيام، وان قيمة التركيز القاتل ل ٥٠% من الافراد يساوي ٢.١٨٨ مللجرام / لتر، والتركيز القاتل ل ٩٠ % من الافراد كان ٧٥.٤٤٥ وذلك بعد يومين من المعاملة.