FUMIGANT TOXICITY OF ESSENTIAL OILS OF *LAVANDULA OFFICINALIS*, *ARTEMISIA DRACUNCULUS* AND *HERACLEUM PERSICUM* ON THE ADULTS OF *CALLOSOBRUCHUS MACULATUS* (COLEOPTERA: BRUCHIDAE)

Nazanin Manzoomi*, Gadir Nouri Ganbalani*, Hooshang Rafiee Dastjerdi* and Seyed Ali Asghar Fathi*

* Department of Plant Protection, Faculty of Agriculture, University of Mohaghegh Ardabili, Ardabil, 55181-83111, IRAN. E-mail addresses: nazanin_manzoomi@yahoo.com; nouri@uma.ac.ir; rafiee@uma.ac.ir; fathi@uma.ac.ir

[**Manzoomi, N., Ganbalani, G. N., Dastjerdi, H. R. & Fathi, S. A. A.** 2010. Fumigant toxicity of essential oils of *Lavandula officinalis*, *Artemisia dracunculus* and *Heracleum persicum* on the adults of *Callosobruchus maculatus* (Coleoptera: Bruchidae). Munis Entomology & Zoology 5 (1): 118-122]

ABSTRACT: *Callosobruchus maculatus* F. is a major insect pest of stored-grain legumes in many countries. In the present study, fumigant toxicity of essential oils from *Lavandula officinalis* L., *Artemisia dracunculus* L. and *Heracleum persicum* Desf. was assessed on the adults of *Callosobruchus maculates*. The results indicated that the mortality of adults increased with increased concentration and exposure time. LC_{50} values for oils from *Lavandula officinalis*, *Artemisia dracunculus* and *Heracleum persicum* were 41.52, 210.61 and 337.58 µlL^{-1}, respectively. Toxicity of *Lavandula officinalis* oil was more than other two plants (LC_{50} = 41.52 µlL^{-1}), but the essential oils from all three plants were effective against this pest. Therefore, these essential oils were suggested to be used for *Callosobruchus maculates* control in stores.

KEY WORDS: *Callosobruchus maculatus*, essential oils, fumigant toxicity, *Lavandula officinalis, Artemisia dracunculus, Heracleum persicum*

Chemical fumigants are commonly used to control stored product pests throughout the world, but these products adversely affect the environment and are hazardous to human health (Lee et al., 2004; Tapondjou et al., 2002). Therefore, considerable amount of investigations have been carried out in the last three decades to find alternative control methods of store product pests (Morimoto et al., 2002; Park et al., 2002; Koul et al., 2003). The *Callosobruchus maculatus* F. causes considerable damage to the legumes, especially to *Vigna ungiculata* (L.) in storages and it damages distinctively with feeding by larvae inside the seeds (Hu et al., 2008). Many researches are conducted for managing this pest by various essential oils. Kestenholz et al. (2007) reported that *Cassia sophera* L. extract is effective in reducing *C. maculatus* infestation. Ketoh et al. (2006) indicated that essential oils of *Cymbopogon schoenanthus* and piperitone had toxic effects on adults of *C. maculatus*.

In this study, the fumigant toxicity of *Lavandula officinalis* L., *Artemisia dracunculus* L. and *Heracleum persicum* Desf. oils were assayed on the adults of *Callosobruchus maculatus*.

MATERIALS AND METHODS

This research was conducted in the laboratory of the Department of Entomology at University of Mohaghegh-Ardabili, Iran, in 2008. One hundred pairs of two day old adults of *C. maculatus* were transfered on 150 g seeds of *Vigna ungiculata* (L.) in a plastic jar of 2000 ml volume. Experiments were carried out in an incubator that was set at 28 ± 1 ∘C, 60 ± 5% RH, in total darkness. Flowers of *Lavandula officinalis* L. were collected from Ferdowsi University of Mashhad, Iran and the leaves of *Artemisia dracunculus* L. and the fruits of *Heracleum persicum* Desf. were obtained from a drugstore in Mashhad, Iran. The plant materials were dried under suitable ventilation and shade conditions and were hydrodistilled with a Clevenger set to extract their essential oils. Concentrations of 24, 30, 36, 42, 51 and 61 µlL-1 of *Lavandula officinalis* L., and 91, 139, 206, 303 and 454 µlL-1 of *Artemisia dracunculus* L. and 152, 212, 333, 515 and 758 µlL-1 of *Heracleum persicum* Desf. were infused on the filter paper pieces of 2 cm in diameter. They were transferred to the caps of glass vials of 33 ml volume. Five pairs of two day old adults were transferred to each glass vial. In control containers no essential oil was used. The experiment was replicated eight times. Mortality was recorded after 3, 6, 9, 12 and 24 h exposure time. The relationship between data was examined by analysis of variance (ANOVA) and correlation analysis. The data were transformed into arcsin√x before statistical analysis as necessary. The means were separated by using the Tukey test, $\alpha = 0.01$. In order to determine LC_{50} values, mortality were recorded after 24 h. Data was analyzed using Probit analysis of SPSS 11.5.

RESULTS

The results illustrated that LC_{50} value for *A. dracunculus* oil (210.61 µlL^{-1}) was about 8 times higher than for *L. officinalis* oil (41.52 µlL^{-1}). *L. officinalis* oil was the most toxic one. *H. persicum* oil had the highest LC_{50} value (337.58 µlL^{-1}) and had less toxic effect on the pest (Table 1). It was found that mortality depended on concentration and exposure time in addition to essential oil type (Table 2). There was no mortality in concentrations 24 µlL^{-1} of *L. officinalis* oil and 91 µlL^{-1} of *A. dracunculus* at 3, 6 and 9 h exposure time. Also no mortality was observed at the concentrations of 30, 36 and 42 µl$L^{-1}$of *L. officinalis* oil, 139, 206 and 303 µlL^{-1} of *A. dracunculus* oil and 152, 212 µlL^{-1} of *H. persicum* oil at 3 and 6 h exposure time. The highest mortality at 3 h exposure time was 6.25% at the concentration of 758 µlL^{-1} of *H. persicum*. The mortality rate increased in all essential oils by increased concentrations at 12 and 24 h exposure time. Regression analysis of data indicated significant correlation between percentage mortality and period of exposure in all treatments ($P<0.05$). The highest coefficient of determination (96%) was attributed to *L. officinalis* oil (Table 3).

DISCUSSION

Among the three essential oils that were assayed in this research, *L. officinalis* oil was more toxic and *H. persicum* oil was less toxic than the others. Papachristos & Stamopoulos, 2001 indicated that essential oils from various plant species had very different toxicities on *Acanthoscelides obtectus* (Say). According to Park et al. (2002) some constituents of many plants such as linalool, terpineol, carvacrol and myrcene have insecticidal effects on some stored products pests.

The results showed that insect mortality varied with the essential oils type, concentration and the exposure time. The mortality of adult *C. maculatus* has increased with increasing of concentrations of *Ocimum basilicum, O. gratissimum*, *A. scoparia* and *A. sieberi* oils (Keita et al., 2001; Sanon et al., 2002. Negahban et al., 2006). The slope value of probit mortality regression of *L.*

officinalis oil was higher than the other two oils which indicated that there was a large increase in the mortality of insects with relatively small increase in the concentration of the toxicant. Similar results were reported by Tiwari and Singh, 2004. According to LC_{50} values, *L. officinalis* oil was the most toxic (LC_{50} =41.52 µlL^{-1}) and *H. persicum* oil was the least toxic (LC_{50} = 337.58 µlL^{-1}) in our studies. Keita et al. (2001) has reported that fumigant LC_{50} value of *Ocimum basilicum* on *C. maculatus* was 440 µlL^{-1}. It was higher than LC_{50} values of essential oils tested in our study means *Ocimum basilicum* was less toxic to *C. maculatus*.

ACKNOWLEDGEMENT

We would like to acknowledge the financial support provided to this research by the University of Mohaghegh Ardabili in Iran.

LITERATURE CITED

Hu. F., Zhang, G. N. & Wang, J. J. 2008. Scanning electron microscopy studies of antennal sensilla of bruchid beetles, *Callosobruchus chinensis* (L.) and *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae). Micron, 40 (3): 320-326.

Keita, S. M., Vincent, C., Schmidt, J., Arnason, J. & Belanger, A. 2001. Efficacy of essential oils of *Ocimum basilicum* L. and *O. gratissimum* L. applied as an insecticidal fumigant and powder to control *Callosobruchus maculatus* (Fab.) (Coleoptera: Bruchidae). Journal of Stored Products Research, 37 (4): 339-349.

Kestenholz, C., Stevenson, P. C. & Belmain, S. R. 2007. Comparative study of field and laboratory evaluations of the ethnobotanical *Cassia sophera* L. (Leguminosae) for bioactivity against the storage pests *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) and *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae). Journal of Stored Products Research, 43 (1):79-86.

Ketoh, G. K., Koumaglo, H. K., Glitho I. A. & Huignard, J. 2006. Comparative effects of *Cymbopogon schoenanthus* essential oil and piperitone on *Callosobruchus maculatus* development. Fitotera, 77 (7-8): 506-510.

Koul, O., Daniewski, W. M., Multani, J. S., Gumulka, M. & Singh, G. 2003. Antifeedants effects of the Limonoids from *Entondrrophragma candolei* (Meliaceae) on the gram pod borer, *Helicoverpa armigera* (Lep: Noctuidae). Journal of Agriculture and Food Chemistry, 51 (25): 7271-7275.

Lee, B. H., Annis, P. C., Tumaalii, F. & Choi, W. S. 2004. Fumigant toxicity of essential oils from the Myrtaceae family and 1,8-cineol against 3 major stored-grain insects. Journal of Stored Products Research, 40 (5): 553-564.

Morimoto, M., Tanimoto, K., Sakatani, A. & Komai, K. 2002. Antifeedant activity of an anthraquinone oldehyde in *Galium aparine* L. against *Spodoptera litura* F. Phytochem, 60 (2): 163-166.

Negahban, M., Moharramipour, S. & Sefidkon, F. 2006. Fumigant toxicity of essential oil from *Artemisia sieberi* Besser against three stored-product insects. Journal of Stored Products Research, 43 (2): 123-128.

Papachristos, D. P. & Stamopoulus, D. C. 2001. Toxicity of vapors of three essential oils to the immature stage of *Acanthoscelides obtectus* (say) (Coleoptera: Bruchidae). Journal of Stored Products Research, 38 (4): 365-373.

Park, I. K. Lee, S. G., Choi, W. S., Jeong, C. Y., Song, Ch. & Cho, K. Y. 2002. Insecticidal and acaricidal activity of piperonaline and piperoctadecalidine derived from dried fruits of *Piper longum* L. Crop Protection, 21 (3):249-251.

Sanon, A., Garba, M., Auger, J. & Huuignard, J. 2002. Analysis of the insecticidal activity of methylisothiocyanate on *Callosobruchus maculatus* F. (Coleoptera: Bruchidae) and its parasitoid *Dinarmus basalis* Rondani (Hymenoptera: Pteromalidae). Journal of Stored Products Research, 38 (2): 129-138.

Tapondjou, A. L., Alder, C., Bouda, H. & Fontem, D. A. 2002. Efficacy of powder and essential oil from *Chenopodium ambrosioides* leaves as post-harvest grain protectants against six-stored product beetles. Journal of Stored Products Research, 38 (4):395-402.

Tiwari, S. & singh, A. 2004. Pesticidal and anti-acetyl cholinesterase activity of *Euphorbia royleana* stem bark extracts against freshwater common predatory fish *Channa punctatus*. Environmental Toxicology and Pharmacolgy, 18 (1): 47-53.

Table 1. Fumigant toxicity of essential oils of *Lavandula officinalis* L., *Artemisia dracunculus* L. and *Heracleum persicum* Desf. on *Callosobruchus maculatus* F. after 24 h exposure time§

Source of essential oil	LC50 values ($\mu L L^{-1}$)	LC90 values ($\mu L L^{-1}$)	Slop ± SE	Chi-square$_{(df)}$	P-value
L.officinalis	41.52 (39.70 - 43.03)	61.52 (57.27 - 67.27)	7.50 ± 0.60	$5.8_{(4)}$	0.29
A.dracunculus	210.61 (190.91 - 232.72)	520.30 (438.18 - 661.21)	3.26 ± 0.31	$2.9_{(3)}$	0.51
H.persicum	337.58 (305.45 - 373.64)	848.97 (713.93 - 1073.03)	3.21 ± 0.30	$7.9_{(3)}$	0.69

§ Oil applied to 2 cm filter papers held in 33 mL vials.

Table 2. Mortality percent (±SE) in the adults *Callosobruchus maculatus* exposed for various periods to *Lavandula officinalis* and *Artemisia dracunculus* essential oils at different concentrations (replicates =8)§

Source of essential oil	Concentration ($\mu L L^{-1}$)	Exposure period (h) 3	6	9	12	24	Effects of exposure period F(4,35)	p
L.officinalis	24	0.00	0.00	0.00	1.25±1.25^{A}	3.75±2.63^{A}	1.57	0.20
	30	0.00	0.00	7.50±2.50^{ABab}	7.50±2.50^{Aab}	16.25±4.60^{ABb}	6.72	0.001
	36	0.00	0.00	12.50±3.70^{ABa}	15.00±5.34^{Aa}	36.25±4.98^{BCb}	16.53	0.001
	42	0.00	0.00	23.75±4.20^{BCb}	38.75±5.15^{Bbc}	46.25±4.98^{Cc}	33.34	0.001
	51	1.25±1.25^{a}	3.75±2.63^{a}	37.50±4.53^{CDb}	56.25±5.96^{Bbc}	71.25±5.15^{Dc}	53.29	0.001
	61	0.00	5.00±2.67^{a}	50.00±4.22^{Db}	81.25±3.98^{Cc}	95.00±1.89^{Ec}	209.82	0.001
Results of concentration effect	F(5,42)	1	2.24	28.73	51.28	64.75		
	P	0.43	0.07	0.001	0.001	0.001		
A.dracunculus	91	0.00	0.00	0.00	3.75±1.83^{Aab}	11.25±2.95^{Ab}	9.92	0.001
	139	0.00	0.00	1.25±1.25^{Aab}	15.00±4.22^{ABb}	36.25±5.96^{Bc}	23.19	0.001
	206	0.00	0.00	5.00±2.67^{Aa}	32.50±6.20^{BCb}	43.75±5.32^{Bb}	30.40	0.001
	303	0.00	0.00	12.5±3.66^{ABa}	46.25±4.98^{CDb}	67.50±4.53^{Cc}	92.82	0.001
	454	0.00	2.50±1.64^{a}	18.75±3.98^{Bb}	58.75±5.15^{Dc}	88.75±2.26^{Dd}	152.95	0.001
Results of concentration effect	F(4,35)	-	2.33	11.15	24.11	52.50		
	P		0.08	0.001	0.001	0.001		
H.persicum	152	0.00	0.00	1.25±1.25^{Aa}	5.00±2.67^{Aab}	12.5±3.66^{Ab}	6.36	0.001
	212	0.00	0.00	6.25±2.63^{Aa}	13.75±3.75^{ABab}	26.25±5.96^{Ab}	10.83	0.001
	333	0.00	1.25±1.25^{a}	23.75±4.60^{ABb}	36.25±7.06^{BCb}	52.50±4.53^{Bc}	36.89	0.001
	515	2.50±1.64^{a}	5.00±2.67^{a}	35.00±6.27^{BCb}	41.25±4.41^{Cb}	67.50±5.90^{BCc}	35.51	0.001
	758	6.25±2.63^{a}	8.75±3.98^{a}	52.50±5.90^{Cb}	63.75±4.60^{Db}	88.75±3.98^{Cc}	67.79	0.001
Results of concentration effect	F(4,35)	3.91	2.96	21.26	32.29	39.38		
	P	0.01	0.03	0.001	0.001	0.001		

§ Mortality data at each exposure period was a mean of eight replicates, concentrations applied to 2 cm filter papers held in 33 mL vials. Exposure periods were 3, 6, 9, 12 and 24 h. The means with similar words have no significant difference in each row (small words) and columns (large words). (Tukey test, α = 0.01).

Table 3. Linear regression analysis of *Callosobruchus macuclatus* mortality data on exposure periods in various concentrations of the three essential oils§

Source of essential oil	Concentration (μlL^{-1})	Total number of insects	$F_{(1,3)}$	P-value	R^2	Slop ± SE
L.officinalis	24	560	36.82	0.009	90	0.26 ± 0.04
	30		37.45	0.009	90.1	0.79 ± 0.13
	36		93.03	0.002	95.8	1.80 ± 0.19
	42		10.67	0.047	70.7	2.34 ± 0.72
	51		12.86	0.037	74.8	3.49 ± 0.97
	61		10.44	0.048	70.2	4.74 ± 1.47
A.dracunculus	91	480	40.80	0.008	90.9	0.58 ± 0.09
	139		41.18	0.008	90.9	1.69 ± 0.26
	206		14.65	0.031	77.3	2.32 ± 0.60
	303		28.81	0.013	87.4	3.50 ± 0.65
	454		30.73	0.012	88.1	4.54 ± 0.82
H.parsicum	152	480	78.49	0.003	95.1	0.64 ± 0.07
	212		76.07	0.003	94.9	1.34 ± 0.15
	333		35.26	0.010	89.5	2.59 ± 0.44
	515		25.60	0.015	86	3.18 ± 0.63
	758		15.44	0.029	78.3	4.40 ± 1.03

§ Concentrations applied to 2 cm filter papers held in 33 mL vials.