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Potential of Essential Oils to Control *Sitophilus oryzae* (L.) and *Tribolium castaneum* (Herbst) on Stored Wheat

Magdy I. E. Mohamed[1], Samir A. M. Abdelgaleil[2] and Mona A. Abdel Rasoul[3]

ABSTRACT

Some essential oils isolated from Egyptian plants viz, *Mentha microphylla* C. Koch., of *Artemisia judaica* L., *Eucalyptus camaldulensis* Dehnh. and *Majorana hortensis* Moench, were evaluated against the rice weevil, *Sitophilus oryzae* (L.) and the rust red flour beetle, *Tribolium castaneum* (Herbst) in stored wheat grains under laboratory conditions. The essential oils were applied on the wheat grains at rates of 0.5, 1 and 5 mg/g except for *M. microphylla* oil which was applied at lower rates of 0.01, 0.05 and 0.1 mg/g, because of its higher toxicity, to the two tested insect species. All tested essential oils had significant toxic effect to the two insects in sorted wheat. At all of the application rates, oils treatments showed significantly higher mortality of adults of both insects after one and two weeks compared with untreated wheat grains except for the treatments of the oil of *E. camaldulensis* at 0.5 mg/g and the oil *M. hortensis* at 0.5 and 1 mg/g with *S. oryzae*. The oil of *M. microphylla* was the most toxic one among the tested oils against both insects. The oil treatments also significantly reduced progeny production of *S. oryzae* compared with the untreated control. No progeny emerged after 6 and 12 weeks on treated wheat with *M. microphylla* oil at 0.5 mg/g and with *A. judaica* and *E. camaldulensis* oils at 5 mg/g. The treatments with tested essential oils significantly reduced grain weight loss, particularly at the higher application rates and all treatments with *M. microphylla* oil. These promising oils, *M. microphylla* and *A. judaica*, could be recommended for use as part of integrated pest management program of *S. oryzae* and *T. castaneum* in stored wheat.

***Keywords*: Egyptian plants; essential oils; insecticidal activity; *Sitophilus oryzae*; *Tribolium castaneum*; stored wheat.**

[1]Department of Stored Product Pests, Plant Protection Research Institute, Agricultural Research Center, Sabahia, Alexandria, Egypt
[2]Department of Pesticides Chemistry, Faculty of Agriculture, Alexandria University, 21545-El-Shatby, Alexandria, Egypt
Correspondence author. Fax: +20-3-592-0067; Tel.: +20-3-584-7175.
E-mail address: samir1969us@yahoo.com (S. Abdelgaleil)
[3]Department of Pest Control and Environmental Protection, Faculty of Agriculture (Damanhour), Alexandria University, Damanhour, Egypt
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INTRODUCTION

Contact insecticides and fumigants have been used for a long time to protect stored products from insect pests. Today, the use of these synthetic chemicals for the protection of stored crop products has declined significantly due mainly to high cost, a growing market demand for foodstuffs that are free of pesticide residues, and stored-product insects are developing resistance to the majority of these chemicals (Donahaye, 2000; Zettler and Arthur, 2000; Kljajic´ and Peric´, 2005; Collins, 2006). Current activities have therefore been directed towards introducing alternative methods of stored product protection, including the use of plant-derived insecticides and inert dusts. The use of plant-derived insecticides is one of the most promising alternatives to traditional residual insecticides, since they are of natural origin, have a wide range of insecticidal activity and have relatively low mammalian toxicity.

Essential oils extracted from plants represent very complex mixtures of compounds, mainly monoterpenes and sesquiterpenes. In some plant species one main constituent of the oil may predominate, while in many species no single compound predominates and instead, there is a balance of various components (Svoboda and Hampson, 1999). Essential oils and their components are gaining increasing interest because of their relatively safe status, their biodegradability, their wide acceptance by consumers, and their exploitation for potential multi-purpose functional use (Zygadlo and Grosso 1995; Sawamura, 2000; Ormancey et al., 2001). They possess a variety of biological properties (Maruzzella and Robbins, 1961), including pesticidal activity. It has been reported that essential oils have the potential of being ovicidal, fumigant, insect growth regulator and insecticidal against various insect species (Regnault-Roger et al., 1993; Tsao et al., 1995; Shaaya et al., 1997).

The rice weevil, *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae), and the rust red flour beetle, *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae), are among the most widespread and destructive stored product pests throughout the world. They cause significant losses of stored products particularly in tropical and warm temperate regions (Hill, 1990).

Previous studies have shown that essential oils of eight Egyptian plants had a strong fumigant and contact toxicities against *S. oryzae* and *T. castaneum* (Mohamed and Abdelgaleil, 2008). Similarly, essential oils of some Myrtaceae plants growing in Australia and *Artemisia sieberi* growing in Iran possessed fumigant toxicity against *S. oryzae* and *T. castaneum* (Lee et al., 2004; Negahban et al., 2007). Essential oils and extracts of some aromatic plants from South Korean revealed contact and fumigant toxicities toward *S. oryzae* (Kim et al., 2003). Garcia et al. (2005) reported that essential oil of *Baccharis saliciflia* (Asteraceae) had toxic and repellent effects against *T. castaneum*. However, there were few reported studies on the effectiveness of the essential oils for control *S. oryzae* and *T. castaneum* in the stored products. Therefore, in this study we evaluated the efficiency of essential oils isolated from *Mentha microphylla*, *Eucalyptus camaldulensis*, *Majorana hortensis* and *Artemisia judaica* for controling of *S. oryzae* and *T. castaneum* in the stored wheat. The effect of these essential oils on adult mortality, progeny production and wheat loss was also considered examined.

MATERIALS AND METHODS

1. Plant materials

Leaves of *Mentha microphylla* C. Koch., *Eucalyptus camaldulensis* Dehnh. and *Majorana hortensis* Moench, and aerial parts of *Artemisia judaica* L. were collected from Faculty of Agriculture Farm, Alexandria and Sharm El-Sheikh, Sinai Peninsula**,** Egypt in April and August, 2007. The plant materials were identified with assistance of the Student's Flora of Egypt book (Tackholm, 1974) and confirmed by Prof. FathAllah Zaitoon of Faculty of Agriculture, Alexandria University. Voucher specimens have been deposited in Department of Pesticide Chemistry, Faculty of Agriculture, Alexandria University.

2. Insects

Two major stored-grain insect species were used in this study, *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae) and *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae). Both insects were laboratory-reared colonies, which have been maintained in our laboratory since 1999. *S. oryzae* adults were kept on whole hard wheat at 26±1°C and 65±5% R.H., while *T. castaneum* adults were kept on wheat flour mixed with yeast (10:1, w/w) under the same conditions. The adults used in the tests were 2 weeks post-emergence. Untreated, clean, sterilized and infestation-free Egyptian wheat with 13.6% moisture content was used in the tests for the two species.

3. Isolation and analysis of essential oils

The plants materials were dried at room temperature (26±1?C) for five days. Essential oils were extracted by hydrodistillation in a Clevenger-type apparatus for 2 h. The oils were dried over anhydrous sodium sulfate, and stored at 4°C. Essential oils were diluted in diethyl ether and 1 µl was injected into a gas chromatography (TRACE GC 2000, THERMO) /mass spectrometry (SSQ 7000, FINNIGAN) (GC/MS) set-up as previously described (Mohamed and Abdelgaleil, 2008).

4. Grain treatment and insect exposure

Exposure studies were carried out at 26±1°C and 65±5% R.H. A series of stock solutions of the test essential oils were prepared in acetone. Fifty grams of wheat were placed in 300 ml glass jars. The essential oils were tested at the application rates of 0.5, 1 and 5 mg/g of wheat grains for *E. camaldulensis*, *M. hortensis* and *A. judaica*, and 0.01, 0.05, 0.1 and 0.5 mg/g for *M. microphylla*. Wheat in glass jars were treated with 1 ml of the stock solution of the tested essential oils. Jars were treated with acetone served as control. All jars were shaken manually for approximately 5 min to achieve equal distribution of the essential oil through the entire grain mass. The jars were left for 30 minutes for complete evaporation of the solvent. Twenty adults of *S. oryzae* or *T. castaneum* were separately introduced into each jar. Three replicates were set up for each treatment and control. The jars were covered with cheese cloth fastened by rubber bands to prevent escape of insects and to ensure proper ventilation. Adult mortality was examined after one week and two weeks of treatment and cumulative mortality were counted and removed. Jars were kept under the same condition for another 6 and 12 weeks for adult emergence. In the assessment of adult mortality, insects were recorded as dead if they were unable to move after gentle prodding with a fine-haired brush or/and unable to move or walk during a 2-min observation period. After the last mortality count, all jars were retained under the same conditions as above. Then 6 and 12 weeks later, the number of emerged adults of *S. oryzae* were counted and expressed as progeny production. The following formula was used to determine the reduction percentage in the number of progeny after 12 weeks (Lkwah and El-Kashlan, 1999): $\% = (1 - x/y) \times 100$, where x = the number of adults emerging in the treatment; y = the number of adults emerging in the control. The grain was sieved and the powder was discarded. The weight of remaining grains in treatments and control was recorded. The weight loss percentage was calculated from the following formula: % weight loss = (Wu – Wi/Wu) × 100, where Wu = weight of uninfested grain; Wi = weight of infested grain of control and treatment. Then the efficiency (E) of the oils was calculated using this equation: E =(LC – LT/LC) ×100, where LC = loss of grain in control; LT = loss of grain in treatment.

Seed germination was tested using 100 randomly picked seeds from each jar treated with the highest concentrations of the most effective oils which were *E. camaldulensis*, *A. judaica* and *M. microphylla*. The seeds were placed on a moistened filter paper in glass Petri dishes and the number of germinated seeds was recorded after one week.

5. Data analysis

Statistical analyses were conducted using the statistical package SPSS version 12.0 (Statistical Package for Social Sciences, USA). The mortality, progeny, weight loss and efficiency data were submitted to a one-way analysis of variance (ANOVA). Mean separations were performed by Student-Newman-Keuls (SNK) test and differences at P = 0.05 were considered as significant.

RESULTS AND DISCUSSION

1. Effect of essential oils on mortality of *S. oryzae* and *T. castaneum*

The results of mortality test on *S. oryzae* showed that the essential oil of *M. microphylla* caused the highest mortality percentages followed by the essential oils of *A. judaica* and *E. camaldulensis*, while *M. hortensis* caused the lowest mortality percentages (Table 1). Comparing the mortality percentages of *S. oryzae* after one and two weeks of exposure revealed that there were slight increasing of mortality percentages with all of the tested oils and all of the tested application rates after two weeks than one week. In general, *M. microphylla* oil showed a strong toxicity towards *S. oryzae* with mortality pcentages of 93.3 and 100 at rates of 0.1 and 0.5 mg/g, respectively, after one week of exposure. In the case of *T. castaneum*, the oil of *M. microphylla* was also the most toxic among the four tested oils. This oil caused complete adult mortality at application rate of 0.5 mg/g after one week of exposure. The oils of *A. judaica*, *E. camaldulensis* and *M. hortensis* showed a relatively similar toxicity against *T. castaneum*. The toxicity of the essential oils on *T. castaneum* was enhanced with increasing the exposure time.

Table 1. Mean mortality (%± SE) of *Sitophilus oryzae* exposed for 1 and 2 weeks on wheat grains treated with essential oils at different concentrations

Botanical o il	Application rate (mg/gm)	Mortality % ± SE after 1 week	2 weeks
Control	0.00	0.0 ^{a}± 0.0	3.3^{a} ± 1.6
Mentha microphylla	0.01	30.0^{b} ± 2.88	45.0^{b} ± 5.8
	0.05	51.7^{c} ± 6.64	63.3^{c} ± 9.29
	0.10	93.3^{d} ± 3.29	93.3^{d} ± 3.35
	0.50	100.0^{d} ± 0.0	100.0^{d} ± 0.0
$LSD_{0.05}$		**11.3**	**16.2**
Control	0.00	0.0^{a} ± 0.0	3.3^{a} ± 1.6
Artemisia judaica	0.50	20.0^{b} ± 0.0	30.0^{b} ± 7.62
	1.00	91.7^{d} ± 4.39	95.0^{d} ± 2.88
	5.00	98.3^{d} ± 1.67	100.0^{d} ± 0.0
Eucalyptus camaldulensis	0.50	8.3^{a} ± 1.67	15.0^{a} ± 2.88
	1.00	25.0^{b} ± 2.88	28.3^{b} ± 1.67
	5.00	100.0^{d} ± 0.0	100.0^{d} ± 0.0
Majorana hortensis	0.50	8.3 ^{a}± 3.35	11.7^{a} ± 1.67
	1.00	8.3^{a} ± 1.67	10.0^{a} ± 0.0
	5.00	36.7^{c} ± 3.35	63.3^{c} ± 6.0
$LSD_{0.05}$		**7.1**	**10.2**

The toxicity results of four essential oils are in a good agreement of our previous studies on the contact and fumigant toxicity of these oils against *S. oryza*e and *T. castaneum* in which the oil of *M. microphylla* was the most effective. The values of LC_{50} of *M. microphylla* oil were 0.01 mg/cm^2 on both insect in contact toxicity experiment, and 0.21 and 4.51 µl/L on *S. oryza*e and *T. castaneum*, respectively, in fumigant toxicity experiment (Mohamed and Abdelgaleil, 2008). Other studies have shown that the oil of *M. microphylla* exhibited toxic effects against the 4th instar larvae of *Culex pipiens* (Traboulsi et al., 2002) and the adults of *Acanthoscelids obtectus* (Papachristos and Stamopoulos, 2002). The toxic and repellent effects of *E. camaldulensis* oil against *Culex pipiens* had been described by Traboulsi et al. (2005) and Erler et al. (2006). It has been reported that the essential oil of *M. hortensis* possessed insecticidal activity against *Spodoptera littoralis* and *Aphis fabae* (Abbassy et al., 2009). The insecticidal and antifeedant activity of the essential oil of *A. judaica* has been described (Abdelgaleil et al., 2007).

Comparing the mortality percentages of four tested essential oils on the adults of *S. oryza*e and *T. castaneum* revealed that the oils of *M. microphylla* and *A. judaica* were more toxic towards *S. oryza*e than *T. castaneum*. In contrary, the oils of *E. camaldulensis* and *M. hortensis* were more toxic towards *T. castaneum* than *S. oryza*e. Deference response of the insect species to the essential oils has previously been reported on the stored products insects (Lee et al., 2003; Negahban et al., 2007).

The essential oil of *M. microphylla* showed promising toxicity against the adults of *S. oryzae* and *T. castaneum*. Since this oil caused complete mortality of *S. oryzae* and *T. castaneum* at the lowest application rate (0.5 mg/g) after one week of exposure in Table 2. The potent insecticidal activity of *M. microphylla* oil could be attributed to the major monoterpenoidal constituents (piperitenone oxide and piperitone oxide). The major constitute of this oil, piperitenone oxide, revealed strong toxic, repellent, and reproduction retardant effects on malarial vector *Anopheles stephensi* (Tripathi et al., 2004). In addition, the two major constituents, piperitenone oxide and piperitone oxide, possessed antibacterial and antifungal activity (Oumzil et al., 2002).

The chemical composition studies of the four tested essential oils revealed that the major constituents of these oils are monoterpenes (Mohamed and Abdelgaleil, 2008) It is well known that the insecticidal constituents of many plant essential oils are monoterpenoids (Ho et al. 1997; Huang and Ho, 1998; Huang et al., 1998; Garcia et al., 2005). Therefore, insecticidal activity of the essential oils investigated in the present study may be attributed to their major constitutes of monoterpenes. Since some of major constitutes of the test oils such as camphor, 1,8-cineole and γ- terpinene possessed insecticidal effects against the test insects (Lee et al., 2001, 2003; Garcia et al., 2005). Monoterpenes act as neurotoxicants against different insect species (Coats et al., 1991; Enan, 1998).

2. Effect of essential oils on progeny production of *S. oryzae*

The results of the progeny production of *S. oryzae* after 6 and 12 weeks and the reduction percentage after 12 weeks of treatment are presented in Table 3. In general, all of the tested essential oils at the tested application rates showed significant reduction in progeny after 6 and 12 weeks compared with control. The essential oil of *M. microphylla* was the most effective in reducing the progeny. At the application rate of 0.5 mg/g of this oil, no progeny emerged after 6 and 12 weeks and at 0.1 mg/g few adults were recorded (5.7 after 6 weeks and 17.3 adults after 12 weeks). The oils of *A. judaica* and *E. camaldulensis* caused complete reduction of progeny at application rate of 5 mg/g after 6 and 12 weeks of treatment, while the oil of *M. hortensis* caused a strong reduction at the same application rate. When the data converted to reduction percentage of the adult progeny, it was very obvious that the essential oils had a strong progeny reduction of *S. oryzae* even at the lowest application rates. It is well known that progeny reduction is more important than mortality of the parental adults introduced to the treated wheat. Since a grain protectant should protect the grain for a long storage period (Athanassiou et al., 2005). In the present study, a complete inhibition of the progeny was observed at the application rate of 0.5 mg/g of *M. microphylla* oil and at 5 mg/g of *A. judaica* and *E. camaldulensis* oils which indicated long-term protection for the stored wheat treated with these oils.

3. Effect of essential oils on weight loss of treated wheat

A high weight loss (34.1%) of wheat grain was observed in the control treatments indicating that *S. oryzae* is a distractive insect for the stored wheat. All of the tested oils significantly reduced the grain weight loss at the tested application rates except for the treated wheat with *A. judaica* and *E. camaldulensis* oils at the lowest rate (0.5 mg/g), and the treated wheat with *M. hortensis* oil at (0.5 and 1.0 mg/g (Table 4). Complete protection was observed at the application rate of 0.5

mg/g in wheat treated with *M. microphylla* oil and at 5 mg/g in wheat treated with *A. judaica* and

Table 2. Mean mortality (%± SE) of *Tribolium castaneum* exposed for 1 and 2 weeks on wheat grains treated with essential oils at different concentrations

Botanical oil	Application rate (mg/gm)	Mortality % ± SE after 1 week	2 weeks
Control	0.00	0.0a ± 0.0	0.0 ^{a}± 0.0
Mentha microphylla	0.01	31.7b ± 1.67	56.0^{b} ± 12.59
	0.05	33.3b ± 4.39	48.3^{b} ± 12.99
	0.10	63.7b ± 3.35	50.0^{b} ± 5.77
	0.50	100.0c ± 0.0	100.0^{c} ± 0.0
LSD$_{0.05}$		**8.1**	**26.8**
Control	0.00	0.0^{a} ± 0.0	0.0^{a} ± 0.0
Artemisia judaica	0.50	35.0^{cd} ± 5.02	55.0^{b} ± 5.02
	1.00	30.0^{bcd} ± 2.88	43.3^{b} ± 8.83
	5.00	91.7^{f} ± 1.67	96.7^{c} ± 1.67
Eucalyptus camaldulensis	0.50	20.0^{b} ± 2.88	45.0^{b} ± 5.77
	1.00	45.0^{d} ± 5.02	53.3^{b} ± 1.67
	5.00	75.0^{e} ± 0.0	90.0^{c} ± 0.0
Majorana hortensis	0.50	28.3^{c} ± 3.35	38.3^{b} ± 6.0
	1.00	38.3^{c} ± 6.0	46.7^{b} ± 7.27
	5.00	41.7^{cd} ± 4.39	48.3^{b} ± 4.39
LSD$_{0.05}$		**10.9**	**14.7**

Table 3. Mean progeny production (± SE) and mean reduction (% ± SE) of *Sitophilus oryzae* on wheat grains treated with essential oils at different concentrations

Botanical oil	Application rate (mg/gm)	Progeny production ± SE after 6 week	1 2 weeks	Reduction % after 12 weeks
Control	0.00	165^{d} ± 13.63	561^{d} ± 23.44	
Mentha microphylla	0.01	86.3^{c} ± 6.75	276.3^{c} ± 24.54	50.4^{a} ±5.95
	0.05	53.3^{b} ± 5.02	218.3^{b} ± 16.92	61.2^{b} ± 1.73
	0.10	5.7^{a} ± 1.21	17.3^{a} ± 2.42	96.3^{c} ± 0.26
	0.50	0.0^{a} ± 0.0	0.0^{a} ± 0.0	100.0^{c} ± 0.0
LSD$_{0.05}$		**22.7**	**53.5**	**10.1**
Control	0.00	165^{d} ± 13.63	561^{d} ± 23.44	
Artemisia judaica	0.50	125^{c} ± 12.12	409.3^{c} ± 28.06	28.3^{a} ± 16.34
	1.00	9.7^{a} ± 2.3	45.7^{a} ± 8.31	91.8^{c} ± 1.56
	5.00	0.0^{a} ± 0.0	0.0^{a} ± 0.0	100.0^{c} ± 0.0
Eucalyptus camaldulensis	0.50	57.3^{b} ± 6.06	293.3^{b} ± 37.0	47.8^{b} ± 6.41
	1.00	54.7^{b} ± 4.27	239.3^{b} ± 24.88	57.2^{b} ± 4.79
	5.00	0.0^{a} ± 0.0	0.0^{a} ± 0.0	100.0^{c} ± 0.0
Majorana hortensis	0.50	125^{c} ± 10.39	322^{b} ± 14.15	4 2.5^{b} ± 2.6
	1.00	129.3^{c} ± 14.43	313b ± 41.61	44.3^{b} ± 6.47
	5.00	19.7^{a} ± 0.87	46^{a} ± 13.0	91.6^{c} ± 2.5

$LSD_{0.05}$		**25.1**	**75.7**	**11.1**

Table 4. Mean weight loss (%± SE) of treated wheat and efficiency of essential oils at different concentrations

Botanical oil	Application rate (mg/gm)	Weight loss % ± SE	Effeciency % ± SE
Control	0.00	$34.1^{c} \pm 1.21$	
Mentha microphylla	0.01	$18.7^{b} \pm 1.73$	$45.2^{a} \pm 6.23$
	0.05	$15.7^{b} \pm 1.67$	$53.9^{a} \pm 3.87$
	0.10	$3.6^{a} \pm 0.87$	$89.4^{b} \pm 2.3$
	0.50	$0.0^{a} \pm 0.0$	$100.0^{b} \pm 0.0$
$LSD_{0.05}$		**3.99**	**12.6**
Control	0.00	$34.1^{e} \pm 1.21$	
Artemisia judaica	0.50	$27.4^{d} \pm 1.85$	$19.6^{a} \pm 2.83$
	1.00	$6.4^{b} \pm 1.73$	$81.2^{c} \pm 5.66$
	5.00	$0.0^{a} \pm 0.0$	$100.0^{d} \pm 0.0$
Eucalyptus camaldulensis	0.50	$24.7^{d} \pm 1.7$	$27.6^{a} \pm 5.66$
	1.00	$19.5^{c} \pm 1.73$	$42.8^{b} \pm 7.0$
	5.00	$0.0^{a} \pm 0.0$	$100.0^{d} \pm 0.0$
Majorana hortensis	0.50	$25.8^{d} \pm 1.39$	$24.3^{a} \pm 5.43$
	1.00	$25.6^{d} \pm 1.79$	$24.9^{a} \pm 3.23$
	5.00	$5.6^{b} \pm 0.57$	$83.5^{c} \pm 2.25$
$LSD_{0.05}$		**4.1**	**12.8**

E. camaldulensis. When the wheat loss percentages were converted to efficiency, it was very clear that the oil of *M. microphylla* was the most effective followed by *A. judaica* and *E. camaldulensis*, while the oil of *M. hortensis* was the less effective as grain protectant.

The effect of the highest application rate (0.5 mg/g in the case of *M. microphylla* oil and 5 mg/g in the case of *A. judaica* and *E. camaldulensis*) on seed germination was studied. The seed germination percentages were 95, 98 and 95 for *M. microphylla*, *A. judaica* and *E. camaldulensis* oils, respectively compared with 100% in control after seven days from treatments.

In summary, the activities of the four tested plant essential oils on adult mortality of *S. oryzae* and *T. castaneum*, progeny reduction and weight loss of stored wheat reported in this paper are valuable. These activities suggest that these oils, particularly the oil of *M. microphylla*, have the potential to be candidate as an effective and alternative natural method for managing of *S. oryzae* and *T. castaneum* after confirmation of its toxicity to mammals.

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الملخص العربي

كفاءة الزيوت النباتية فى مكافحة حشرتى سوسة الأرز وخنفساء الدقيق الصدئية فى القمح المخزون

مجدى إبراهيم الدسوقى محمد، سمير عبد العظيم عبد الجليل، منى عبد النبى عبد الرسول

تم تقييم بعض الزيوت النباتية المعزولة من النباتات المصرية التالية *Mentha microphylla* و *Artemisia judaica* و *Eucalyptus camaldulensis* و *Majorana hortensis* على سوسة الأرز وخنفساء الدقيق الصدئية فى حبوب القمح المخزون تحت الظروف المعملية. تم تطبيق الزيوت على الحبوب بمعدلات ٠,٥ و ١ و ٥ مجم/جم حبوب قمح عدا زيت *Mentha microphylla* الذى تم تطبيقة بمعدلات ٠,٠١ و ٠,٠٥ و ٠,١ و ٠,٥ مجم/جم وذلك لسميته العالية لهاتين الحشرتين. كل الزيوت المستخدمة كان لها تاثير سام معنوى ضد الحشرتين موضع الدراسة. كل المعدلات المطبقة أظهرت نسب موت عالية ومعنوية ضد الحشرتين مقارنةً بالحبوب غير المعاملة عدا فى حالة زيت *Eucalyptus camaldulensis* عند معدل ٠,٥ مجم/جم وزيت *Majorana hortensis* عند تركيزى ٠,٥ و ١ مجم/ جم ضد حشرة سوسة الأرز. زيت *Mentha microphylla* كان أعلى الزيوت فاعلية فى التاثير السام ضد الحشرتين. معاملات الزيوت سببت أيضاً خفض معنوى فى أعداد حشرات سوسة الأرز الناتجة بعد ٦ و١٢ أسبوع من المعاملة مقارنة بالكنترول. لم تظهر أى حشرات جديدة بعد ٦ و١٢ أسبوع من المعاملة فى القمح المعامل بزيت *Mentha microphylla* على معدل ٠,٥ مجم/جم و كذلك المعامل بزيتى *Artemisia judaica* و*Eucalyptus camaldulensis* على معدل ٥ مجم/جم. وقد خفضت المعاملة بالزيوت الفقد فى حبوب القمح معنوياً خاصة عند المعدلات العالية وكذلك كل معدلات زيت *Mentha microphylla* المستخدمة. نتائج هذه الدراسة أوضحت أن الزيوت الواعدة مثل *Mentha microphylla* و *Artemisia judaica* يمكن أن يوصى بها كأحد مكونات نظام المكافحة المتكاملة لحشرتى سوسة الأرز وخنفساء الدقيق الصدئية فى القمح المخزون.