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Efficacy of Essential Oils for Eucalyptus Camaldulensis and Artemisia Herba Alba as Potential Natural Fumigant against Khapra Beetle Trogoderma Granarium E. (Coleoptera Dermestidae)

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Abstract-The present study examines the efficacy of essential oils of Eucalyptus camaldulensis and Artemisia herba alba. As fumigant toxicity against larvae of third instar and adults of Trogoderma granarium at 10, 20, 30, 40, 50, 60 µl/160cm³ for different exposure times 12, 24, 48h. The mortality rate for third larvae during the exposure period was 12h, 76.1% and 68.3%, in the second period of 24h, the mortality rate was 14.99% and 16.6%, while third exposure time was 0.55% and 1.1% for essential oils of Eucalyptus and Artemisia respectively. The percentage of killing increase as the concentration increased and decreased as the duration of exposure increased. Duration of the first exposure increased and the mortality rates were high compared with second and third periods with highest concentration killing rate of 50, 60 µl/160cm³ for essential oils of Eucalyptus. Adult of the insect during the exposure period 12h mortality reached 91.1% and 86.1%, while the second period of exposure 24h, the mortality rate was 6.6%, and third exposure time of 48h was the lowest reaching 2.2% and 7.2% for Eucalyptus and Artemisia respectively. Duration of the first exposure increased and the mortality rates were high compared with second and third periods with highest concentration mortality rate of 40, 50, 60 µl/160cm³ for essential oils of Eucalyptus and Artemisia. Generally, adult mortality rates were higher than larvae for the same duration of exposure. This indicates the possibility of using essential oil for both E. camaldulensis and A. herba alba in the applied field for the management of the pest population in the stores.

Keywords- *Khapra Beetle Trogoderma Granarium, Essential Oils*

I. INTRODUCTION

Cereals and processed foods are attacked by many insect species, causing both quantitative and qualitative losses, while losses of stored grains are estimated at between 5-30% for total global agricultural production (Shani 2000; Pugazhvendan 2009). The Trogodrma granarium (Everts) (Coleoptera: Dermestideae) is one of the most important major pests in grain stores, it affects the various stored foods, especially the starch grain, the most dangerous insect species in the world (Low et al. 2000; Burges 2008).

T. granarium is primary insect attacked grain directly T. granarium is most important species because it is a serious consumer of many stored foods. Its importance in reproductive capacity and high nutritional efficiency is a serious problem in grain stores, it is the most dominant insect pest in wheat and barley stores in Iraq (Champi and Dyte 1977; Al-Saffar 1979). The larval role is the most serious because it causes heavy economic losses for grain and stored food commodities. Leaving dust, skins and faces, which reduce the value of the crop as well as injuring the workers in the stores with inflammation of the mucous membranes. Seed germination as a seed for agriculture is preferred because it prefers the embryo of the grain to feed it (Aldryhim and Adam 1992; Muhammad et al. 2007).

The widespread use of chemical pesticides and their recurrence for long periods of time have led to the emergence of resistance to the pesticide action as well as adverse effects such as toxic waste on grain, pollution of the environment and its impact on non- target organisms, not to mention high costs (Porca et al. 3003). Including phosphine gas, despite its good quality as an insecticide has been found to be resistant to many insect pests of grain stores, including T. granarium. In line with the decisions of the Montreal Protocol, it is necessary to move away from the use of chemical evaporators, such as methyl bromide which is contaminated with the environment (Anonymous 1993; Rajendran and Sriranjini 2008).

Therefore, specialists in this field have restored to adopting alternative methods that seek to minimize the use of chemical pesticides and replace them with other methods that are highly efficient, safer for the biological environment such as plants and non-target organisms, with compatibility if needed for use with chemical pesticides in integrated pest management programs, which have a wide range of biological properties, such as the attraction or expulsion of insects, anti-feeding, egg laying and other vital effects of aromatic essential oil as special defence agents as natural agents for pest management (Koul et al. 2008).

II. Materials and Methods

A. Insect culture

A culture of T. granarium insects was reared in the lab in 800 ml glass jars covered with a piece of muslin and tightened with rubber bands to prevent the escape of insects and placed in an incubator in continuous darkness at 32±2 ℃. and 65±5% RH. Larvae were isolated using a sieve that allowed their separation from wheat grains. Adult and third instars larvae were used in the test.

B. Plant materials

The juvenile plant branches of Eucalyptus camaldulensis L. and Artemisia herba alba Asso were harvested at the flowering stage in April 2017, Baghdad-Iraq. Clean the leaves, free of injuries or any other damage, clean well and placed in a light layer at room temperature with ventilation for the purpose of drying with continuous flipping to prevent rot for seven days, collected dried plants in bags to keep them in conditions without moisture to be crushed and used in experiments (Supavarn et al. 1974).

C. Plant powders and extraction of essential oils.

After the samples were collected for the leaves of Eucalyptus camaldulensis and Artemisia herba alba, the drying process was then carried out to the powder. The oil samples were obtained by steam distillation for 3h, using a device called Clevenger (Clevenger 1928). Oil yields 2%, 0.95% w/w respectively (Tayoub et al. 2012b). Essential oils were stored at 4℃ until use.

D. Fumigation toxicity

The toxicity of E. camaldulensis and A. herba alba essential oil on T. granarium adults and third instars larvae were tested by filter paper dip method as described by (Negahban et al. 2007). AT laboratory conditions 32±2 ℃ and 65±5 % RH Whatman No.1 filter paper discs (2cm diameter) were impregnated with different concentrations (10, 20, 30, 40, 50 and 60) µL/L of essential oils separately and were attached to the under surface of the screw caps of glass vials (volume 160 ml) separately. The cap was screwed tightly on the vial after the release of 10 adult (2 days-old), third instars larvae for comparison a set of control, without essential oil, was maintained. Each treatment and control was replicated three times. Mortality was recorded after 12, 24 and 48 h from the commencement of exposure. When no leg or antennal movements were observed, insect were considered dead. Percentage insect mortality was calculated using the Abbotts correction formula (Abbott 1925).

E. Statistical analysis

Using the completely randomized design CRD, the differences between the mean of the transactions were compared to a value less significant difference of LSD in the probability level $P < 0.5$ to calculate the variance of the factors involved in the experiment, 2012 SAS program was used to analyze the global experiment (SAS, 2012).

III. Results

The results in table 1, 2 show that the mortality rates for third instar larvae and adult of T. granarium were subject to the effect of the variables in this study as they were observed and recorded mortality rates of some 100 %, depending on the type of essential oil, concentration and duration exposure the results showed in table (1) that there was difference in the treatment of evaporation of the percentage obtained for killing the larvae, and significant differences were recorded in the level of probability 0.5, and showed the evaporation results of essential oils of Eucalyptus and the effectiveness of high killing rates of larvae in the first exposure time got superiority of the concentrations 40, 50 and 60 µl/160cm³ with the highest kill rates of 93.33, 96.67 and 96.67 respectively for the oils of the Eucalyptus plant, while the concentration exceeded 40 µl/160cm³ for the oil of Artemisia herba alba and for the same period first mortality rates were 90 while lowest rates of killing in the first concentration for essential oils, which did not differ significantly from the first concentration of Eucalyptus reaching 46.67 and 49 respectively.

In the second exposure period, the third concentration of Eucalyptus oil showed superiority, with the killing values reaching 36.67 at 50.6 µl/160cm³ had the lowest mortality rates of 3.33, while the mortality rate was low for the third exposure for the oils of Eucalyptus and Artemisia herba alba because of highest mortality in the first exposure time.

Table(2) shows high mortality rates of adult insect reached 100% in the treatment fumigation with the essential oils of Eucalyptus plants and Artemisia herba alba at 40, 50 and 60 µl/160cm³ as well as concentration at 3060 µl/160cm³ for Eucalyptus with no significant difference in first exposure period, the lowest kill rates at 10 µl/160cm³ for Artemisia were 63.33 while the Eucalyptus at10 µl/160cm³ during the second exposure, the highest killing rate was 26.67 and lowest was 0 for both plants at 40,50 and 60 µl/160cm³. Achieved 10 µl/160cm³ in the third exposure period with the highest kill and significant improvement except for 20 µl/160cm³ for Artemisia. Moral superiority is observed for the duration of the first exposure in achieving highest kill. And for the complete killing of adults during three exposure period. Therefore, there was no significant effect of concentration for total three exposure period, although there was a significant difference between the type of volatile oils and concentration used and the exposure time when evaporation. More tightly sealed space is reflected in the reduction of exposure time and concentration of volatile oils used to increase efficiency.

IV. Discussion

E.camaldulensis and A.herba alba essential oils showed fumigant toxicity and repellent activity against T. granarium. Many investigators have reported fumigant toxicity and repellent activity of plant essential oils against stored product pests.

Nenaah and Ibrahim (2011) have reported the insecticidal activity of Pimpinella anisum, Cinnamomum camphora essential oils against T. granarium and T. castaneum.

Tayoub et al. (2012a) also reported essential oil vapours of the Juniperus foetidissima show variable toxicity to larvae of test insects, depending on concentration and exposure time. Mortalities of T. granarium larvae after exposure to the vapour of the essential oil at different concentrations and the highest effect was observed after 48h-exposure at 65µl/160cm³ air and results in about 98% mortality.

TABLE I. FUMIGANT MORTALITY OF ESSENTIAL OILS OF E.CAMALDULENSIS AND A.HERBA ALBA TO THE 3RD INSTAR LARVAE OF KHAPRA BEETLE T. GRANARIUM

Essential oil	Con. µL/160cm³	12h	24h	48h
E.camaldulensis	10	50.0	23.3	3.33
	20	63.3	16.6	0.00
	30	56.6	36.6	0.00
	40	93.3	6.6	0.00
	50	96.6	3.3	0.00
	60	96.6	3.3	0.00
Mean effect		76.1	14.99	0.55
A.herba alba	10	46.6	13.3	0.00
	20	60.0	13.33	0.00
	30	60.0	23.3	3.33
	40	90.0	6.6	3.33
	50	73.3	26.6	0.00
	60	80.0	16.6	0.00
Mean effect		68.33	16.66	1.11
LSD 0.05		8.88	9.72	4.86

TABLE II. FUMIGANT MORTALITY OF ESSENTIAL OILS E.CAMALDULENSIS AND A.HERBA ALBA TO ADULTS OF KHAPRA BEETLE T. GRANARIUM

Essential oil	Con. µL/160cm³	12h	24h	48h
E.camaldulensis	10	66.6	26.6	6.6
	20	83.3	10.0	6.6
	30	96.6	3.3	0.0
	40	100	0.0	0.0
	50	100	0.0	0.0
	60	100	0.0	0.0
Mean effect		91.1	6.66	2.22
A.herba alba	10	63.3	16.6	20.0
	20	70.0	13.3	16.6
	30	83.3	10.0	6.6
	40	100	0.0	0.0
	50	100	0.0	0.0
	60	100	0.0	0.0
Mean effect		86.11	6.66	7.22
LSD 0.05		7.94	5.61	5.61

Our results are in agreement also with Tayoub et al. (2012b) have reported the fumigants activity of essential oil vapours distilled from Eucalyptus globulus and Origanus syriacum were tested against larvae of T. granarium, the vapour dose needed to achieve near 100% death following 48h exposure time was 30 and 50µl/160cm³ air for Origanus syriacum and Eucalyptus globulus respectively. It was suggested that for fumigants, the active stage (adults and non-diapausing larvae) of insects are more susceptible than the sedentary stages (eggs and pupa) due to the difference in their respiratory rate (Rajendran and Sriranjini, 2008).

Fumigation is done for mortality insects or to avoid further damage in infected commodities, Kostyukovsky et al. (2002) show that rapid of essential oils or its constituents against insect pests is an indicative of neurotoxic actions. Therefore, treatments the insects with natural compounds such as essential oils or pure compounds may cause symptoms that indicate neurotoxic activity including hyperactivity, seizures, and tremors followed by knockdown (Ryan and Byrne, 1988).

Sendi and Ebadollahi (2014) have reported essential oils effects on the insect nervous system, either by inhibition of AChE or by antagonism of the octopamine receptors. As well as for good results to our study, A.herba alba and E.camaldulensis are medicinal plants used for different health problems. It has no toxicity to human beings. So the essential oils can be used as an eco-friendly alternate in stored product pest control programmes (Nattuduria et al. 2014).

REFERENCES

[1] Abbott, W.S., (1925). A method of computing the effectiveness of an insecticide. Journal of Economic Entomology 18: 265-267.

[2] Aldryhim, Y.N. and Adam, E. E. (1992). The biology of Trogoderma granarium (Everts) (Coleoptera: Dermestidae) in central province of Saudia Arabia. J. Kind. Sand. Univ. Agric. SCI. 4(1)79-85.

[3] Al-Saffar,Z.Y.(1979). Effectiveness of certain insecticides asstored grain protectants. M. Sc. Thesis, Mosul Univ., pp.130.

[4] Anonymous (1993). Regulatory action under the clean air act on Methyl bromide. United States Environmental Protection agency. Office of Air Radiation Stratospheric Protection Division. Washington , DC.

[5] Burges, H. D. (2008). Development of the khapra beetle, Trogodera granarium, in the lower part of its temperature range. J. Stored Prod. Res., 44: 32-35.

[6] Champi, B. R. and Dyte E. C. (1977). FAO global survey of pesticide susceptibility of stored - grain pests, FAO Pl. Prot. Bull. 25(1):47-67.

[7] Clevenger , J.F. (1928).Apparatus for the determination of volatile oil. Journal of the American Pharmacists Association ,17 : 345-349.

[8] Kostyukovsky, M.; Rafaeli, A.; Gileadi, C.; Demchenko, N. and Shaaya, E. (2002) Activation of octopaminergic receptors by essential oil constituents isolated from aromatic plants : Possible mode of action against insect pests. Pest Manag. Sci., 58:1101-1106.

[9] Koul, O., Walia, S. and Dhaliwal, G.S.(2008).Essential oils as green pesticides: Potential and constraints. Biopesticides International, 4:63-84.

[10] Low, S.;Browne,M.; Boudjelas, S. and DePoorter, M.(2000).100 of the World's Worst Invasive Alien Species: A Selection from the Global Invasive Species Database. Invasive Species Specialist Group, World Conservation Union (IUCN). http://www.issg.org/booklet.pdf.

[11] Muhammad, S.A.;Abdul, K.; Muhammad, T.;Muhammad, A. and Shagufta, Z.(2007). Khapra Beetle (Trogoderma granarium Everts):a serious threat to food security and safety.Pak. J. Agri. Sci., Vol. 44(3).

[12] Nattudurai, G.; Paularj, M.G. and Ignacimuthu, S.(2014).Toddalia asiatica(L.) Lam.Essential oil: A potential natural fumigant and repellent against three Coleoptera pests of stored products. Int. J. of Pure and Applied Zoology.Vol.2(3)pp.246-255.

[13] Negahban, M.; Moharramipour, S.; Sefidkon, F.(2007).Fumigant toxicity of essential oil from Artemisia sieberi Besser against three stored product insects. J. Stored prod. Res. Vol. 43:123-128.

[14] Nenaah, G.E. and Ibrahim, S.I.A.(2011).Chemical composition and the insecticidal activity of certain plants applied as powders and essential oils against two stored products coleoptera beetle. J. Pest. Sci. 84:393-402.

[15] Pugazhvendan, S.R.; Elumalai, K.; RonaldRoss, P. and Soundararajan,M. (2009). Repellent Activity of Chosen Plant Species Against Tribolium castaneum. World Journal of Zoology ,4 (3): 188-190.

[16] Porca, M., Ghizdavu, I., and Bunsecu, H. (2003). Control of the Coleopteres in stored agricultural products by non- chemical methods. Journal of Central European Agriculture (online), 4 (3): PP.217-220.

[17] Rajendran, S., and Sriranjini, V. (2008). Plant products as fumigants for stored-product insect control. J Stored Prod Res. 44:126–135.

[18] Ryan, M.F. and Byrne, O.(1988).Plant insect coevolution and inhibition of acetyl cholinesterase. J. Chem. Ecol. , 14: 1965-1975.

[19] SAS.(2012).Statistical analysis system, users guide. Statistical. Version 9.1thed. SAS. Inst. Inc. Cary. N.C. USA.

[20] Sendi, J. J.; Ebadollahi, A (2013) Biological activities of essential oils on insects. Uni. of Mohaghegh Ardabili. https://WWW.researchgate. Net / publication / 270273498.

[21] Shani,A.(2000).Chemical communication agents(pheromones) in integrated pest management. Drug Develop. Res., 50: 400–405.

[22] Supavarn , P.F,W. Knapp, and R. Sigafus.(1974).Biological active plant extracts for control of mosquite larva Mosq. New. Vol. 34 , PP: 398-402.

[23] Tayoub, G.; Abu-Alnaser, A. and Ghanem, I.(2012a).Fumigant activity of leaf essential oil from Myrtus communis against the khapra beetle. Int. J. Med. Arom plants. 2(1) pp.207-213.

[24] Tayoub, G., A.A. Alnaser and I. Ghanem,(2012b). Toxicity of two essential oils from Eucalyptus globulus Labail and Origanum syriacum L. on Larvae of Khapra beetle. Int. J. Med. Arom. Plants, 2: 240-245.