NTU Journal of Agricultural and Veterinary Science - (NTU-JAVS)
(P-ISSN: 2788-9890 e-ISSN: 2788-9904)

Bio Effect of Seven Aqueous Plant Extracts Against larvae Khapra Beetle Trogoderma granarium Everts (Coleoptera: Dermestidae)

1st Shelan H. Younus [1] 2nd Batol A. Karso[2]
Email: shelanhasan91@gmail.com
1 , 2. College of agricultural engineering Science-University of Duhok
Received: 2-2-2022, **Accepted:** 20-3-2022, **Published online:** 17-5-2022

Abstract. The study showed the effectiveness of the aqueous extracts of seven plant species for Clove buds (*Syzygium aromaticum*), Garlic seed (*Allium sativum*), Thyme leaves (*Thymus vulgaris*), Eucalyptus leaves (*Eucalyptus oleosa*), Sage (*Salvia officinalis*), Black Arum leaves (*Eminium spiculatum*), and Red hot pepper fruits (*Capsicum annuum*) with five different concentrations (1.5, 3, 5, 7.5 and 10) % in some aspects of biological performance of the Khapra beetle larvae *Trogoderma granarium* Everts. The aqueous extract of sagebrush showed the highest lethal effect, as the mortality rate was 100% at a concentration of 5%, and toxicity index and toxicity efficiency amounted to 100, 28, and 23, respectively, compared to the rest of the studied plants. It was noted that the aqueous extracts of plants sagebrush and sagebrush tested showed the characteristic of repelling insects and that the sagebrush plant gave the highest repelling rate of 63.33%, while the plants of garlic, hot pepper, cloves, thyme, and eucalyptus showed attract effect and clove extract gave highest attraction rate by 73.33%.

Keywords: Khapra beetle, aqueous plant extracts (Clove buds, Garlic seed, Thyme leaves, Eucalyptus leaves, Sagebrush, Black Arum leaves and Red hot pepper), Botanical insecticides.

Introduction

The Khapra beetle *Trogoderma granarium* Everts (Coleoptera: Dermestidae) is one of the most destructive stored grain product pests (Dwivedi and Shekhawat., 2004; Omar et. al. 2012; Asiry and Zaitoun, 2020). To control store insects, synthetic chemical insecticides, for instance fumigant through phosphine, methyl bromide, or dust compounds are used (Tsumura et al., 1994, Yadav and Srivastava, 2021). The widespread use of chemical synthetic insecticides against stored grain insects has resulted in insecticide resistance (White, 1995) as well as increased insecticide residues on grains which pose danger to human health. Therefore, it has become necessary to search for safe methods for health and the environment to control stored insects (Mohammed et al., 2019, Asiry and Zaitoun, 2020). by using natural plant products Similar in effect to chemical pesticides (Mahmoud et al., 2015; Khalique et al., 2018). Many plants contain toxic, repellent, or attractive substances for arthropods, where 1005 plant species have a toxic effect on insects, 384 species that have an inhibitory effect on nutrition, 279 species that have an insect repellent effect, 31 species that inhibit growth, and 5 species that cause sterility in insects (tang, et al 2013). Attention has been drawn to the use of plant-based materials in pest control because insecticides of plant origin are effective on insects and are of low toxicity to animals and humans (Bowers, 1992). As an influence on reproduction (Raju *et al.*,1990; Ali, 2017, and Demis and Yenewa, 2022). The horizons have expanded today to include the testing of many plants to see their effect on insects and the possibility of their use as alternatives to pesticides, where many researchers have tested many powders and plant extracts against some insects of stored materials (Khader, 2002; Al-Iraqi, 2003; Al-Ghadban, 2019 ; Boukouvala Kavallieratos, 2020, and Domingue et al., 2022). Therefore, the study aimed to test the effect of the effect of seven plant aqueous extract of [Clove buds (*Syzygium aromaticum*), Garlic seed (*Allium sativum*), Thyme leaves (*Thymus vulgaris*), Eucalyptus, sagebrush (*Salvia officinalis*), Black Arum (*Eminium spiculatum*), and Red hot pepper (*Capsicum annuum*)] against larvae of Khapra beetle (*Trogoderma granarium* E.).

Materials and Methods

he source and rearing of the insect;

The grain beetle (Khapra) (*Trogoderma granarium* E.) was obtained from infected wheat grains taken from the insect laboratory of the Plant Protection Department/ College of Agriculture Engineering Sciences, University of Duhok. It was placed inside plastic containers with a capacity of 1 kg, placed in

the incubator at 30 ± 1 ° C, and relative humidity of 65 - 70± 5% for several generations. (Al-Jubouri 1997; Ali, 2017).

Preparation of Aqueous solutions:
500 g of fresh study plants [Clove buds (*Syzygium aromaticum*), Garlic seed (*Allium sativum*), Thyme leaves (*Thymus vulgaris*), Eucalyptus (*Eucalyptus oleosa*), Sagebrush (*Salvia officinalis*), Black Arum (*Eminium spiculatum*), and Red hot pepper (*Capsicum annuum*)] collected from Duhok mountain and local market. washed, and dried at the room condition for 14 days, then grind, crushed them well, then pulverized product (Hiakal, and Omer, 1993), to make dry powders for making aqueous extracts.

The aqueous extracts of the plants were prepared according to the method of Riose, et.al. (1987) by adding 100 ml of distilled water to 25 g powder of each plant, the mixture was placed in a grinder for good mixing and stirring by the magnetic stirrer for 60 minutes, then leave the mixture for 24 hours at a temperature of 4 C for soaking, then filter it by using filter paper. The extracts were filtered again by using Whatman filter No 1 papers by a Buchner funnel, to get the crude extract, samples were kept in dark glass bottles until the dilutions were made.

preparation of aqueous extracts concentrations:
Five different concentrations (1.5, 3,5,7.5,10) %, were prepared for each aqueous extract. With 3 replicates\concentration, each replicate contains 20 larvae of third instar Khapra beetles, control treatment use distilled water only, under 28 C° ± 2 and 65-70 % humidity. the percentage of mortality, LC_{50}, and LC25 values, confidence recorded according to Finney, D. J. (1977) mentioned in Al-Mallah, and Aljubuory (2011). Also calculated the toxicity index and relative efficiency (relative toxicity) Sun, and Johnson (1960).

Depending on the formulas:
Toxicity index % = LC_{50} value is the most efficient tested extracts/LC_{50} value of the less extracts x 100

Relative efficacy% =LC_{50} value is the most efficient tested extracts /LC_{50} value of the other extracts

Calculation of the repellent and attractive effect of the extracts

The study was done depend on the sub-lethal concentration of aqueous extraction using a Chemo-tropometer consisting of the Wooden box dimension (96 × 20 × 20 cm) with a removable cover and a glass tube (3 cm diameter and 100 cm length). The tube had three holes (one in the center and two on both ends). The tube measured to centimeters, both ends of the tube were closed with pieces of cotton, on the right side treated with plant extract (used LC25 for each extract), and on the left side treated with water only. 20 larvae of third instar were introduced to the center of a tube for 20 min. with three replications for each extract treatment. (Al Mallah, and Al Jubur, 2011)

% Attraction= [No. of insects attracted to the extraction /total No.] X100

% Repellency= [No. of insects repelled from the extraction/total No.] X100

Data Analysis: the experimental was designed as a Completely Randomized Design (CRD). The comparison between means carried out according to Duncan's multiple range test (P< 0.05) by using a computer program of SAS (Dey, 2022).

Results and discussion

The lethal effect of aqueous plant extracts against Khapra beetle larvae:
Table (1) shows significant differences when treating larvae of Khapra beetle larvae with different concentrations of aqueous extractions (clove, thyme, eucalyptus, red hot pepper, Black Arum, sage, and garlic). where the best extraction remained was sagebrush, which gave the highest mortality percentage reached 100% at concentration 5% also the general mortality average was 92.67%. This confirms this result, its LC50 value, which was reached 10.199 ppm, and the slope value of 3.26, which indicate the homogeneity of the larvae response to the extract. (Table2), This is consistent with what they pointed out each of (Abdouni Khiyari et al., 2014; Santana-Mé-ridas et al., 2014) mention that the This feature has been extensively explored from Rosemary and other medicinal plants are one of the Source of Botanical Insecticides, which are active against Lepidoptera and Coleoptera larvae, by Allelopathic properties content and volatile growth inhibitors produced by Salvia species were extracted from sagebrush.
While, the lowest mortality percentage was when treating with each of the eucalyptus and red hot pepper extracts, where reached to 0 and 3.33% respectively at concentration 1.5%, and the mean average mortality rate of the extracts were 18.00, and 15.33%. respectively. when Ali, and Ragaa (2017) studies evaluates the effect of Kaphor Eucalyptus against the third (3rd) instar of Khapra beetle larvae *Trogoderma granarium* (Everts) in

wheat seeds. they found the highest concentration (10%) of Kaphor leaves for ethanolic and aqueous after 24 hours of exposition, extracts gave higher mortality percentages (33.3%) and (20%) respectively.

In the main, the results exposed that the mean average of % mortality in Khapra larvae treated with aqueous extracts of sage gave the highest average mortality degree reached 92.67%, whereas aqueous extract of red hot pepper gave the lowest mean number reached 15.33%. Confirms the result, a value of LC50 115.128 and 237.403 respectively, which confirmed the toxicity to the larvae. (Table 2).

Finally, from (table 3) depending on the LC50 values of aqueous extracts used in this study of toxicity calculate the toxicity index, relative toxicity, and Relative efficiency attendant to ensure that the most toxic aqueous extracts against the Khapra beetle larvae are sagebrush extract followed by Black Arum, reached (100, 1, and 23.28) also (44.4, 0.444, and 10.34) respectively. In addition to the least toxic extract was red hot pepper where the data of toxicity index, relative toxicity and Relative efficiency reached (4.3, 0.043, and 1) respectively.

The replant and the attractive effect of the aqueous extracts:

Table (4) showed significant differences effect According to the Lc25 result between tested aqueous extracts On Khapra larvae, the results of a study on the effect of aqueous extracts of some above- noted plants on the rate of attraction and expulsion of Khapra larvae showed significant differences in the rate at which the larvae responded to the plants According to Table (4), the highest percentage of attraction which was 73.33 percent when using aqueous clove extract in larvae, followed by eucalyptus extract with a rate of attraction of 71.67 percent when compared to the other extracts. It was also shown from Table (4) that the highest larval repellency rate was 63.33%, when using sagebrush aqueous extract, while the lowest larval repellency was 26.67% when using clove aqueous extract on larvae. The final result of the effect of plant type on attraction and expulsion ratios can be seen in Table (4), which shows the balancing values between attraction and replant percentage. They differed for sage, and Black Arum extraction, both of which supported the expulsion process, reached -26.66, -13.34 respectively. As for the aqueous extracts of cloves, thyme, garlic, hot red pepper, and eucalyptus, they tended to favor the attraction process, and the highest equilibrium value was +46.66, +23.43, +6.66, +23.43, +43.34, respectively.

In light of the results obtained from this research, we conclude that plant extracts (garlic, eucalyptus, sage, Black Arum, cloves, thyme, and hot red pepper) have a clear and moral effect on some aspects of the life of the Khapra beetle and that the best water extract is sagebrush extract belong to the concentration of 5%. Accordingly, it can be recommended to include the extracts of these plants in programs to combat this pest as part of the integrated management due to its case of use, its strong impact on the life of the insect at low concentrations, and it is being safer on the environment.

Acknowledgements

The author grateful to everyone who provided assistance to complete this article.

Table 1. Showed mortality effect of some aqueous extracts against Khapra beetle larvae.

aqueous extracts	mortality effects Concentration %					mean
	1.5	3	5	7.5	10	
Garlic	20.00 i-m	23.33 i-l	20.00 i-m	53.33 d-g	73.33 b-d	38.00 cd
Sage	73.33 b-d	90.00 ab	100.00 a	100.00 a	100.00 a	92.67 a
Black Arum	23.33 i-l	73.33 b-d	86.67 ab	76.67 bc	93.33 ab	70.67 b
Thyme	20.00 i-m	23.33 i-l	46.67 e-h	56.67 c-f	73.33 b-d	44.00 c
Red pepper	10.00 k-m	3.33 lm	10.00 k-m	30.00 h-k	23.33 i-l	15.33 e
Eucalyptus	0.00 m	3.33 lm	16.67 i-m	33.33 g-j	36.67 f-i	18.00 e
Clove	13.33 j-m	16.67 i-m	23.33 i-l	53.33 d-g	63.33 c-e	34.00 d
Mean	22.86 e	33.33 d	43.33 c	57.62 b	66.19 a	

Table 2. Showed the Lc25, and Lc50 values, slop, and confidant limited values of some plant's aqueous extract on larvae of Khapra beetle.

No.	Plant Aqueous extract	Lc25 value\ppm	Lc50 value\ppm	Slope	Confidant limited
1	Eucalyptus	57.564	115.128	2.873	98.612 - 145.313
2	Garlic	34.341	68.682	1.74	46.0763- 484.432
3	Black Arum	11.484	22.968	2.351	0.640 - 40.798

4	Red hot pepper	118.702	237.403	1.389	41.132- 58.621
5	Sage	5.099	10.199	3.26	7.149- 12.600
6	Thyme	25.827	51.655	1.673	44.086 - 61.363
7	Clove	38.455	76.91	1.926	47.039- 565.143

Table 3. The index toxicity, relative toxicity, and efficiency toxicity for some aqueous extracts.

No.	Plant Aqueous extract	Index toxicity	Relative toxicity	Efficiency toxicity
1	Eucalyptus	8.88	0.088	2.06
2	Garlic	14.8	0.148	3.45
3	Black Arum	44.4	0.444	10.34
4	Red hot pepper	4.3	0.043	1
5	Sage	100	1	23.28
6	Thyme	19.7	0.197	4.595
7	Clove	13.2	0.132	3.09

Table 4. The Attract and repellent effect of seven plant's aqueous extracts on Khapra beetle larvae.

No.	Extract	Repellent	Attract	Balance
1	Eucalyptus	28.33 d	71.67 a	+43.34
2	Garlic	46.67 b	53.33 c	+6.66
3	Black Arum	56.67 a	43.33 d	-13.34
4	Red pepper	38.33 c	61.67 b	+23.34
5	Sage	63.33 a	36.67 d	-26.66
6	Thyme	38.33 c	61.67 b	+23.34
7	Clove	26.67 d	73.33 a	+46.66

References

[1] Al-Ghadban, Z. A. M. (2019). Effect of Essential Oils Artemisia herba alba and Eucalyptus camaldulensis against Larvae and Adult of Khapra Beetle *Trogoderma granarium* E.(Dermestidae: Coleoptera).

[2] Ali, Aamer Alfadel Abdallah., and Ragaa M.E. E. (2017). Effect of Some Plant Extracts on Mortality of Khapra beetle (*Trogoderma granarium* Everts) (Coleoptera: Dermestidae). Sudan University of Science and Technology.

[3] Al-Iraqi, Riyadh Ahmed, (2003). Effect of some plants' powders on the capillary beetle (*Trogoderma granarium* Everts (Coleopters: Dermestidae), Arab Journal of Plant Protection, No. 21.

[4] Al-Jourani, Reda Sakab, (1991). Effects of myrtle extracts on the Khabra beetle and the Great hearing worm. PhD thesis, College of Agriculture, University of Baghdad, 111 pages.

[5] Al-Jubouri, Abdul Razzaq Younis, (1997). Biological evaluation of extracts of some medicinal plants in the hairy grain beetle. PhD thesis, College of Agriculture and Forestry, University of Mosul, 146 pages.

[6] Al-Mallah, Nazar M., and Abdul-Razzaq Y. Aljubuory, (2011). Practical applications in pesticides, Dar Al Yazouri for Scientific Publishing, Amman, Jordan, 350 p.

[7] Asiry, K. A., and Zaitoun, A. A. (2020). Evaluation Of The Toxicity Of Three Plant Extracts Against The Khapra Beetle *Trogoderma granarium* Everts (Coleoptera: Dermestidae) Under Laboratory Conditions. *Revista De La Sociedad Entomológica Argentina,* 79.

[8] Boukouvala, M. C., and Kavallieratos, N. G. (2020). Effect of six insecticides on egg hatching and larval mortality of *Trogoderma granarium* Everts (Coleoptera: Dermedtidae). *Insects* **11**, 263.

[9] Bowers, W. S. (1992). Bioration approaches for insect control. Korean J. Applied Entomol 31: 289-303.

[10] Demis, e., and yenewa, w. (2022). Review on major storage insect pests of cereals and pulses. *Asian journal of advances in research*, 41-56.

[11] Dey, T. K., and Wang, Y. (2022). *Computational Topology for Data Analysis*. Cambridge University Press.

[12] Domingue, M. J., Scheff, D. S., Leva, N., and Myers, S. W. (2022). Climbing ability of *Trogoderma granarium* larvae on artificial household and insecticide-treated materials. *Journal of Stored Products Research* **95**, 101922.

[13] Dwivedi, S., and Shekhawat, N. B. (2004). Repellent Effect Of Some Indigenous Plant Extracts Against *Trogoderma granarium* (Everts). *Asian J Exp Sci,* 18**,** 47-51.

[14] Finney, D J., (1977). Phytochemical methods, Halsted Press. John wieley and Sonns, New York. 278 P.

[15] Hiakal, M. A., and Omer, A. A. (1993). Medicinal and aromatic plants. *Escandrya, Egypt. 514p*.

[16] Khader, Sahand Kamal, (2002). Comparison of toxicity of some plant extracts with chemical pesticides against the southern cowpea beetle Callosobruchus maculatus (Fab.) (Coleoptera: Bruchidae). Master's Thesis, College of Agriculture, Salah al-Din University, 66 pages.

[17] Khalique, U., Farooq, M. U. and Niaz, U. (2018). Khapra Beetle: A Review Of Recent Control Methods. *Current Investigations In Agriculture And Current Research,* 5**,** 730-735.

[18] Khiyari, M. E. A., Kasrati, A., Jamali, C. A., Zeroual, S., Markouk, M., Bekkouche, K., ... and Abbad, A. (2014). Chemical composition, antioxidant and insecticidal properties of essential oils from wild and cultivated *Salvia aucheri* subsp. blancoana (Webb. and Helder), an endemic, threatened medicinal plant in Morocco. *Industrial Crops and Products*, *57*, 106-109.

[19] Mahmoud, A., Bedawi, M. and Satti, A. (2015). Efficacy Of Some Botanical Extracts In The Control Of Khapra Beetle (*Trogoderma granarium*). *J Sci,* 5**,** 213-217.

[20] Mohammed, A. A., Kadhim, J. H. and Hasan, A. M. (2019). Laboratory Evaluation Of Entomopathogenic Fungi For The Control Of Khapra Beetle (Coleoptera: Dermestidae) And Their Effects On The Beetles' Fecundity And Longevity. *Journal Of Agricultural And Urban Entomology,* 35**,** 1-11.

[21] Omar, K., Faraj, N. M., Malik, S. A. and Al-Farhani, I. M. (2012). Effect Of Some Medicinal Plants Extracts And Cypermthrin Against Khapra beetle (*Trogoderma granarium* Everts). *Emirates Journal Of Food And Agriculture***,** 120-127.

[22] Raju, M. ; Thakur, S. S. and Maruthi, R.G. (1990). Sterilizing activity of the flower extract of *Thevitia neriifolia* on the male fifth instar nymphs of red cotton bug Dysdercus similes F. (Heteroptera : Pyrrhocoridae). J. Anim. Morphol. Physiol. 37:77-78.

[23] Rose, J. 2., M C., Recio and A. Villar (1987). Antimicrobial activity of selected plant Employed in the Spanish Mediterranean area. Journal of Ethno pharmacology, 21: 139- 152.

[24] Santana-Méridas O., Polissiou M, Izquierdo-Melero, M.E., Astraka K., Tarantilis, P.A. and Herraiz,Herraiz-Peñalver D. (2014). Polyphenol composition, antioxidant and bioplaguicide activities of the solid residue from hydrodistillation of Rosmarinus officinalis L. Ind Crop Prod. 2014; 59:125–34.

[25] Sun, Y P., and E. R Johnson, (1960). Synergistic and antagonistic actions insecticide- synergist combination and their mode of action. Journal of Agricultural and Food Chemistry, 8 (4): 261.

[26] Tang, G. B., Song, B. Z., Zhao, L. L., Sang, X. S., Wan, H. H., Zhang, J., and Yao, Y. C. (2013). Repellent and attractive effects of herbs on insects in pear orchards intercropped with aromatic plants. Agroforestry Systems, 87(2), 273-285.

[27] Tsumura, Y., Hasegawa, S., Sekiguchi, Y., Nakamura, Y., Tonogai, Y., and Ito, Y., (1994). Residues Of Post-Harvest Application Pesticides In Buckwheat After Storage And Processing Into Noodles. *Food Hygiene And Safety Science (Shokuhin Eiseigaku Zasshi),* 35**,** 1-7_1.

[28] White, N., D. (1995). Insects, Mites, And Insecticides In Stored-Grain Ecosystems. *Stored Grain Ecosystems***,** 123-168.

[29] Yadav, S., and Srivastava, C. (2021). The Toxicity Of Phosphine Against Susceptible And Resistant Strains Of *Trogoderma granarium* (Coleoptera: Dermestidae). *African Entomology,* 29**,** 414-422.