Caspian Journal of Environmental Sciences

Online ISSN: 1735-3866
Print ISSN: 1735-3033

Effects of ginger oil on the life of *Rhyzopertha dominica* (Beetles: Bostrichidae)

Estabraq Mahmood Mahdi[1]*, Warqaa Latef Salman[2], Marwan Q.AL-Samarraie[2]

1. Deprtment of Biology, College of Science, Tikrit University, Tikrit, Iraq
2. Colleg of Applied sciences,University of samarra, Iraq

** Corresponding author's Email: Abk_mm@yahoo.com*

ABSTRACT
This study was conducted to investigate the effect of different concentrations of ginger oil on the roles of Rhyzopertha dominica. The results showed that by a concentration of 8% after 48 h of treatment, ginger oil exhibited the highest mortality rate for the second larval instar, reaching 86.7%, while the lowest for the second larval instar, 16.7% at a concentration of 2% after 24 h. The lowest mortality rate for females was 0% at 2% after 24 h of therapy, reaching 86.7% after 72 h at a dosage of 8%.

Key word: Ginger oil, Grain borers, Rhyzopertha dominica.
Article type: Short Communication.

INTRODUCTION
One of the most significant cereal crops, *Triticum aestivum* L., ranks highly among nations worldwide in terms of its significance as a source of food for people (Jagshoran *et al*. 2004). Little grain borers, or *Rhyzopertha dominica*, are the most prevalent type of these pests, causing significant grain losses throughout the time of storage (Perišić *et al*. 2018). Given that their widespread usage has led to issues with the formation of genetic resistance against the action of chemical pesticides, as well as the threat that their leftovers provide to humans, animals, and key insect enemies, it is necessary to find acceptable alternatives to eradicate them (Soujanya *et al.* 2016), that each of them should switch back to secure alternate methods, such using plant extracts (Rieberio *et al*. 2002). The plant derivatives are thought to be less poisonous or not hazardous to mammals, vertebrates, and invertebrates. They are also thought to be a source of food for insects and to be repulsive or enticing to them (Cox 2006). *Zingiber officinale* Roscoe (Zingiberaceae), widely known as ginger, is one of the world's most ancient known medicinal plants. Its essential oil is primarily composed of gingerol and gingerona (Balachandran *et al*. 2006; Rostamzad *et al.* 2019; Naser AL-Isawi 2022). On the other hand, numerous authors documented the utilization of compounds obtained from plants. Ahmed (2001) investigated how certain vegetable oils affected the growth of *Sitophilus granaries* and *Rhyzopertha dominica*. The study aimed to evaluate the effect of different concentrations of ginger oil in controlling the vitality of the *R. dominica*.

MATERIALS AND METHODS
Collection and breeding the lesser grain borer beetle *R. dominica*
R. dominica was created as a laboratory colony by sterilizing 20 pairs of entire male and female insects for 48 h in the freezer before placing them in glass bottles with intact wheat grains and pasta that were 15 cm tall and 8 cm in diameter. Before the studies were conducted on the bottles, they were bred and multiplied in the incubator under the aforementioned circumstances. To keep adults from escaping the bottles, the lips were closed with muslin cloth and secured with a rubber band. The colony was carefully watched as it regenerated after each generation (Al-Hadithi 2016).

Isolation and identification of *R. dominica* larvae at the second instar

While the head capsule does not grow and the Camp deiform of the second-age larvae is flattened, the larval stages of *R. dominica* beetle were differentiated based on shape under a light microscope at 40X magnification.

Isolation and identification of whole grain borer *R. dominica*

Since the infestations were removed from the food medium containing infected wheat grains using a soft brush and without the use of a light microscope and transferred to dishes for experimentation, the procedure for isolating the integuments of *R. dominica* minor grain borer beetle is less involved than the isolation of other roles.

Preparing and preparing vegetable oils for the study

Then we get ginger oil from the local markets, produced by Al-Emad Herbal Oil Factory, Mosul, Industrial District, Left Coast, with a concentration of 100% and in a special packaging for the product.

Studying the effect of different concentrations of ginger oil on the second larval age of *R. dominica* minor grain borer after 24 and 48 h

For every concentration of the second-instar larvae and each of the three duplicates, 10 larvae were collected. By separating the eggs, until they reach the required larval stage, we should keep an eye on their progress and count the number of skins that are shed. The second-instar larvae were acquired. For each of the three concentrations, they received 3 mL oil to guarantee thorough covering. Spraying 10 larvae with 3 mL sterile distilled water served as the control treatment. Following the spraying procedure, 5 g food made for lab was use and feeding larvae was added to each plate containing the identical amounts of the aforementioned oil. Each dish was placed 15 cm away from the control treatment. Under incubator conditions, the dishes were incubated at 30 ± °C and 70 ± 5% relative humidity. After 24 and 48 h, the dishes were checked, and the number of dead lightning strikes was noted.

Study the effect of different concentrations of ginger oil on whole grain borer *R. dominica* after 24, 48 and 72 h

From the lab colonies, 10 whole minor grain borer beetles were isolated and reproduced three times. Due to the males' lower size than the females', as well as their antennae, it was possible to tell the males from the females. Separated Petri dishes containing the pupae were sprayed with 3 mL of each of the three oil concentrations. The average lifespan of the females was observed when they were incubated at a distance of 15 cm under the prior incubation circumstances. After 24, 48, and 72 h, observations were made from each dish by dumping the contents onto white paper to identify the dead individuals.

Statistical Analysis

Using the ANOVA test, complete random design (CRD), and Dunken's multiple range test with a probability threshold of 0.05% and 0.01%, the findings were statistically assessed (SAS 2012).

RESULTS AND DISCUSSION

Effect of ginger oil on second instar larvae of *R. dominica*

Table 1 shows the killing percentages of ginger oil after 24, 48 h of treatment of the third larval instar at concentrations of 2%, 4% and 8%, if the results showed an effect of each concentration in causing killing rates for the third larval instar, in addition to the presence of variation and differences. Significant in the killing rates among the treatment concentrations of the third larval instar, as the concentration of 8% displayed the third larval instar's highest killing rate, reaching 56.7% and 86.7% during 24 and 48 h, respectively. In addition, it showed notable variations from the control treatment, when no killing occurred, and the third larval instar's lowest death rate were16.7% and 46.7%, respectively, during 24 and 48 h at 2%, while the killing rates at a concentration of 4% for the third larval instar were 46.7% and 63.3%, respectively, during 24 and 48 h. It is concluded that increasing the concentration and length of exposure causes an elevation in the killing rates of the insect since the data demonstrate a substantial difference in the killing rates compared to the control treatment, in which no killing occurred.

Table 1. Percentage percentages of the second larval instar of *R. dominica* treated with ginger oil

Concentration	Time / hour		Average concentration
	24	48	
2 %	16.7	46.7	31.7 c
4 %	46.7	63.3	55.0 b
8 %	56.7	86.7	71.7 a
Average time	40.0 B	65.6 A	

*Similar capital letters indicate that there are no substantial distinctions between them when they appear in the same row; ** Similar lowercase letters indicate no discernible distinctions when they are grouped together in a column.

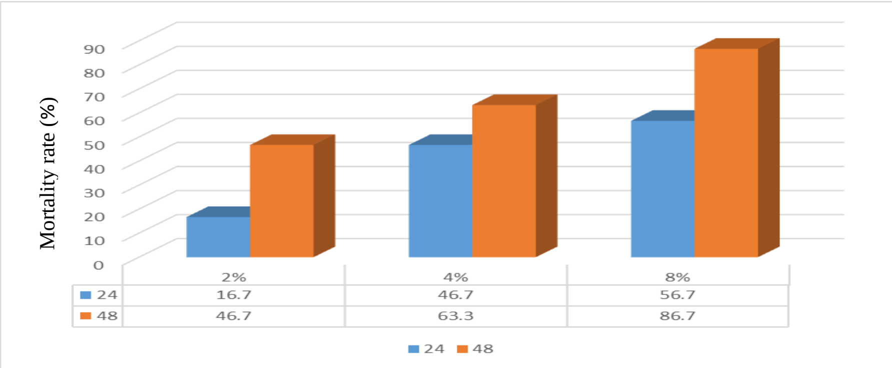

Fig. 1. Effect of ginger oil on second instar larvae of *R. dominica*

Effect of ginger oil on adults of *R. dominica*

Table 2 shows the females killing rates (%) by ginger oil after 24, 48, and 72 h at concentrations of 2%, 4%, and 8%. The results exhibited an effect of each concentration on killing rates of females, in addition to the presence of significant differences in killing rates between the concentrations in female adults, as the concentration of 8% revealed the highest percentage, reaching 16.3%, 46.7%, and 86.7% during 24, 48, and 72 h, respectively, with notable differences from the control treatment, where no killing took place, and the lowest percentage. Killing of adults reached 0.0%, 36.7%, and 66.7%, respectively, during 24, 48, and 72 h at a concentration of 2%, While the killing rates at the concentration of 4% for the full females reached 6.7%, 46.7%, and 76.7%, during 24, 48, and 72 h respectively. According to the findings, the killing rates differed significantly from those of the control treatment, where no killing took place. Insect killing rates were elevated as exposure time increased.

Table 2. Killing rates (%) in adults of *R. dominica* treated with ginger oil.

Concentration	Time (h)			Average concentration
	24	48	72	
2 %	0	36.7	66.7	34.5 c
4 %	6.7	46.7	76.7	43.4 b
8 %	16.7	46.7	86.7	50.0 a
Average time	7.8 C	43.4 B	76.7 A	

Note: *Similar capital letters indicate that there are no substantial distinctions between them when they appear in the same row.
** Similar lowercase letters indicate no discernible distinctions when they are grouped together in a column.

The results of the toxicology trials support Al Qahtani *et al*. (2012) assertion that ginger was the most potent plant against *O. surinamensis*. Moreover, according to Al-Jabr (2006), *C. camphora, M. chamomill,* and *M. viridis* were responsible for the complete mortality of *Oryzaephilus surinamensis*, while complete mortality of *T. castaneum* was provided in *P. amygdalus* and *C. winterianus* after two weeks of administration. Moreover, *Teucrium polium capitatum*'s sesquiterpene-rich essential oils were investigated by Khani & Heydarian (2014) for their fumigant and repellant effects on *T. castaneum* and *C. maculatus* adults reporting that significant variations in insect mortality to essential oil vapor were observed in all cases at all doses and exposure periods. They came to the conclusion that essential oils high in sesquiterpene could be used as a possible insecticide for stored-products.

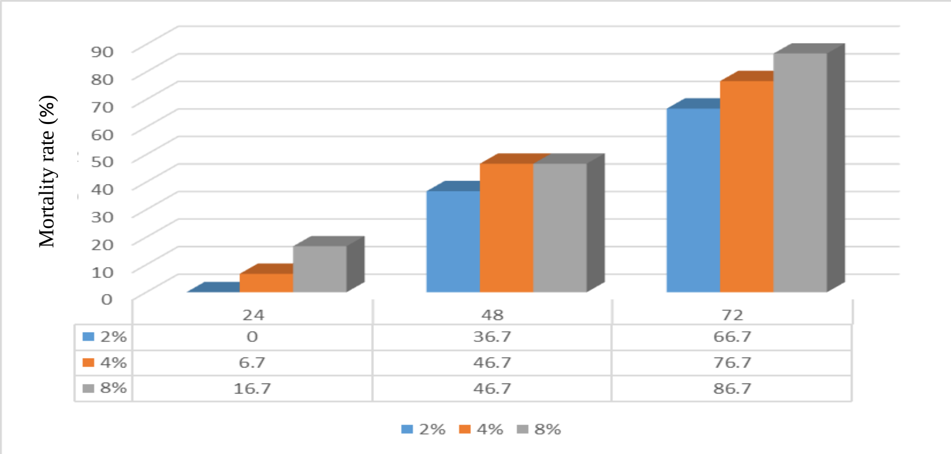

Fig. 2. Effect of ginger oil on adults of *R. dominica.*

Some authors discovered that *Z. officinale* oil has antifeedant activities on the adult of *T. castaneum*. The investigated plant oils exhibited adverse effects on adult beetles by inhibiting insect feeding (Abdel-Rahman & Mahmoud 2018) or by destroying the insect's midgut (De ABritto *et al*. 2005) respectively, which reduced the amount of food consumed by insects and ultimately resulted in growth reduction and death. Moreover, plant oil vapor may exert an indirect effect by disguising the intended stored product's stimulatory effects (Papachristos & Stamopoulos 2002). These findings are consistent with Regnault Roger's (1997) assertion that natural plant components have a variety of functions, including fumigant, contact, and antifeedant or repellent effects. Cost-effective, essential oils pose less of a threat to the environment and healthy creatures (Alagawany *et al*. 2021; El-Tarabily *et al*. 2021), in addition to displaying an impact on the insect's biology, physiology, and nervous system (Mann & Kaufman 2012). Hence, employing essential oils could make farming more environmentally friendly (Isman, 2006). According to Zhou *et al*. (2006), zingiberene is the main component of ginger roots. It has been found to exhibit several pharmacological effects, including analgesic effects, anticancer, and antioxidant properties (Mahdavi *et al*. 2018). It is a member of the vast class of volatileand lipophilic chemicals known as monoterpenes, which can quickly enter insects' bodies and disrupt their physiological processes (Saad *et al*. 2018). According to the current study, mortality rate was elevated significantly as oil concentrations and exposure times upraised. The outcomes of Abdel-Rahman *et al*. (2011) and Alagarmalai *et al*. (2016) concur with these findings. The main issue that worries all countries in the globe is how to prevent pest infestations in grain products and stored grains. *T. castaneum* and *T. confusum* are two economically significant bugs that target several stored goods. In order to safeguard stored goods against an infestation of these beetles, it is crucial to look for effective protective materials. The therapeutic plant oils used in this study were selected for their potential outcomes after a review of the literature. According to some studies, the plant oils had therapeutic uses and were not toxic to vertebrates (Al Qahtani *et al*. 2012).

REFERENCES

Abdel-Rahman, H, Abdel-Moty, H, Nabawy, E & Eman, I 2011, Evaluation of twenty botanical extracts and products as sources of repellents, toxicants and protectants for stored grains against the almond moth, Cadra cautella. *Functional Plant Science and Biotechnology*, 5: 36-44.

Abdel-Rahman, YA & Mahmoud, MA 2018, Toxic and repellent effects of four plant oils against the red flour beetle, *Tribolium castaneum* (Herbst). *Journal of Plant Protection and Pathology*, 9(4), 277-281.

Ahmed SDS 2001, Lupine seed (*Lupinus termis*) extracts as grain protectants against the rice weevil (*Sitophilus oryzae* L.) and the lesser borer (*Rhyzopertha dominica* F.). *Egyptian Journal of Agricultural Research*, 79: 50-56.

Al Qahtani, AM, Al-Dhafar, ZM & Rady, MH 2012 Insecticidal and biochemical effect of some dried plants against *Oryzaephilus surinamensis* (Coleoptera-Silvanidae). *The Journal of Basic & Applied Zoology*, 65: 88-93.

Alagarmala J, Chennaiyan V, Chinnamani T 2016, Evaluation of five essential plant oils as a source of repellent and larvicidal activities against larvae of *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae). *Journal of Entomology*, 13: 98-103.

Alagawany, M, El-Saadony, MT, Elnesr, SS, Farahat, M, Attia, G, Madkour, M & Reda, FM 2021, Use of lemongrass essential oil as a feed additive in quail's nutrition: its effect on growth, carcass, blood biochemistry, antioxidant and immunological indices, digestive enzymes and intestinal microbiota. *Poultry Science*, 100(6): 101172.

Al-Hadithi, OTHA 2016, Use of microwaves and the bioactive fungus *Beauveria bassiana* in the control of two hairy grain beetle insects *Trogoderma granarium* (Coleoptera: Dermestidae) and the red rusty flour beetle (*Tribolium castaneum* (Coleoptera: Tenebriondae), MSc. Dissertation, College of Agriculture-University of Tikrit, Iraq, 90 p.

Al-Jabr, AM 2006, Toxicity and repellency of seven plant essential oils to *Oryzaephilus surinamensis* (Coleoptera: Silvanidae) and *Tribolium castaneum* (Coleoptera: Tenebrioidae). *Scientific Journal of King Faisal University (Basic and Applied Sciences)*, 7: 49-60.

Balachandran, S, Kentish, SE & Mawson, R 2006, The effects of both preparation method and season on the supercritical extraction of ginger. *Separation and Purification Technology*, 48: 94-105.

Cox, PD 2004, Potential for using semiochemicals to protect stored products from insect infestation. *Journal of Stored Products Research*, 40: 1-25.

De ABritto, J, Arockiasamy, S & Pravin, SA 2005, Antifeedant effect of some medicinal plants on *Tribolium castaneum* (Herbst) adult. *Journal of Economic and Taxonomic Botany*, 29(3), 655.

El-Tarabily, KA, El-Saadony, MT, Alagawany, M, Arif, M, Batiha, GE, Khafaga, AF & Abd El-Hack, M E 2021, Using essential oils to overcome bacterial biofilm formation and their antimicrobial resistance. *Saudi Journal of Biological Sciences*, 28(9): 5145-5156.

Isman, MB 2006, Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. *Annual Review of Entomology*, 51: 45-66.

Jagshoran, A Sharma, RK & Tripathi, S C 2004, New varieties and production. The Hindu, Survey of Indian Agric., 4 :33 – 35.

Jeyasankar, A, Chennaiyan, V & Chinnamani, T 2016, Evaluation of five essential plant oils as a source of repellent and larvicidal activities against larvae of *Tribolium castaneum* (Herbst: Coleoptera: Tenebrionidae). *Journal of Entomology*, 13(3): 98-103.

Khani, A & Heydarian, M 2014, Fumigant and repellent properties of sesquiterpene-rich essential oil from *Teucrium polium* subsp. c*apitatum* (L.). *Asian Pacific Journal of Tropical Medicine*, *7*(12), 956-961.

Mahdavi, V, Rafiee-Dastjerdi, H, Asadi, A, Razmjou, J & Fathi Achachlouei, B 2018, Synthesis of *Zingiber officinale* essential oil-loaded nanofiber and its evaluation on the potato tuber moth, *Phthorimaea operculella* (Lepidoptera: Gelechiidae). *Journal of Crop Protection*, 7: 39-49.

Mann SR & Kaufman EP 2012, Natural product pesticides: Their development, delivery and use against insect vectors. *Mini-Reviews in Organic Chemistry*, 9: 185-202.

Naser AL-Isawi, HI 2022, Effects of applying cold and hot aqueous extracts of ginger to control onion rot disease caused by *Aspergillus niger*. *Caspian Journal of Environmental Sciences*, 20: 611-616

Papachristos, DP & Stamopoulos, DC 2002, Repellent, toxic and reproduction inhibitory effects of essential oil vapours on *Acanthoscelides obtectus* (Say: Coleoptera: Bruchidae). *Journal of Stored Products Research*, 38: 117-128.

Perišić, V, Hadnađev, M, Perišić, V, Vukajlović, F, Dapčević-Hadnađev, T, Luković, K & Đekić, V 2018, Technological quality of wheat infested with *Rhyzopertha dominica* F. (Coleoptera: Bostrichidae). *Advanced Technologies*, 7: 35-40.

Regnault-Roger, C 1997, The potential of botanical essential oils for insect pest control. *Integrated Pest Management Reviews*, 2: 25-34.

Ribeiro, BM, Guedes, R N C, Oliveira, E E, & Santos, J P 2003 Insecticide resistance and synergism in Brazilian populations of *Sitophilus zeamais* (Coleoptera: Curculionidae). *Journal of Stored Products Research*, 39: 21-31.

Rodriguez Hernandez, C & Djair Vedramim, J 1998, Use of nutritional indices to measure the insectstatic effect of meliaceae extracts on *Spodoptera frugiperda* 600 (Es). *Integrated Pest Management (Costa Rica).*

Rostamzad, H, Abbasi Mesrdashti, R, Akbari Nargesi, E, Fakouri, Z 2019, Shelf life of refrigerated silver carp, *Hypophthalmichthys molitrix*, fillets treated with chitosan film and coating incorporated with ginger extract. *Caspian Journal of Environmental Sciences*, 17: 143-153

Saad, MG, Abou-Taleb, HK & Abdelgaleil, SAM 2018, Insecticidal activity of monoterpenes and phenylpropenes against Sitophilus oryzae L. and their acetylcholinesterase and adenosine triphosphatases inhibitory effects. *Applied Entomoloy and Zoology*, 53: 173-181.

SAS. 2012. Statistical Analysis System, User's Guide. Statistical. Version 9.1th edition, SAS Institute, Cary, North Carolina, USA.

Soujanya, PL, Sekhar, J C, Kumar, P, Sunil1, N, Prasad, ChV & Mallavadhani, UV 2016, Potentiality of botanical agents for the management of post harvest insects of maize: A review. *Journal of Food Science and Technology*, 53: 2169-2184.

Zapata, N, Budia, F, Viñuela, E & Medina, P 2006, Insecticidal effects of various concentrations of selected extractions of *Cestrum parqui* on adult and immature Ceratitis capitata. *Journal of Economic Entomology*, 99: 359-365.

Zhou, HL, Deng, YM & Xie, QM 2006, The modulatory effects of the volatile oil of ginger on the cellular immune response *in vitro* and *in vivo* in mice. *Journal of ethnopharmacology*, 105(1-2): 301-305.