Insecticidal effect of three essential oils and Beauvericin nano gel on *Sitophilus oryzae* and *Sitophilus granarius* (Coleoptera :Curculionidae)

Magda M. A. Sabbour

ABSTRACT

Sitophilus oryzae and *Sitophilus granarius* (Coleoptera :Curculionidae) harmful insects cause a damages to stored product seeds. These pests controlled by chemical materials which pollute the environments. Essential oils are a natural compound used as insecticide to a lot of pests. In our research we controlled these pests by essential oils, *Cinnamomum zeylancium, Zingiber officinale, Cuminum cyminum* and Beauvericin nano gel 2%. Results showed that, the LC_{50}s of *S. Oryzae* were 38, 44, 151 and 18 ppm for Beauvericin nano gel 2% *C. zeylancium, C. cyminum* and *Z. officinale,* respectively. Also LC_{50s} for *S. granarius* obtained by the corresponding treatments were, 41, 144, 11and 29ppm. The accumulative of *S. oryzae* significantly increased after 48 (H) by 2.8 fold after application of *Cinnamomum zeylancium* oil. When *Zingiber officinale* Oil applications the accumulative mortality increased by 3,3fold. The Beauvericin nano gel 2% showed that the accumulative increased by increasing the exposure time.*Cinnamomum zeylancium* showed a higher effect on the wheat weevil *S. granarius,* where the accumulative mortality recorded 91 after 48 (H). The lower accumulative mortality after Beauvericin nano gel 2%, recorded 38 after 48(H). The repellency test showed that, the highest repellant found among the Beauvericin nano gel 2% treatments. Data presented show that the persistence effectiveness of oil significantly decreased by increasing the storage time. The potential of the insecticidal oils was high after 45 days of storage, against *S. oryzae* and *S. granarius.* The potential of the insecticidal effect of oil recorded the lowest percentage at the end of storage after 100 days to both *S. oryzae* and *S. granarius*.

Key words: *Cinnamomum zeylancium, Zingiber officinale, Cuminum cyminum* nano gel, persistence, control

MS History: 10.06.2020 (Received)-00.09.2020 (Revised)- 16.11.2020 (Accepted)

Citation: Magda M. A. Sabbour. 2020. Insecticidal effect of three essential oils and Beauvericin nano gel on *Sitophilus oryzae* and *Sitophilus granarius* (Coleoptera :Curculionidae). *Journal of Biopesticides* 13(2):127-134.

INTRODUCTION

The pest infestation of the stored grains is one of the main problems which causing damage of about ten % of the food crops stored grains in the world. The rice weevil *Sitophilus oryzae* and *Sitophilus granarius* (Coleoptera: Curculionidae) are among the common types that attack stored grains. They are serious grain insects because the female live more about 2 years and lay eggs reach to 290 to 300 eggs (Hong *et al*., 2018). They attack several economic stored seeds in the field and store by strong moth parts and chewing the seed causing holes. These pests cause a seeds loss and decrease its quality (Boudreaux, 1969). These pests developed inside the grains seed then the adults emerged leave crushed and destroyed seeds behind Trematerra *et al*. (1999). Some chemical pesticides were used to control these insects of the stored. These chemical materialsharmful to humans due to the toxic effect of them. Natural Pesticides that are safe for humans and the environment. In recent years, many researchers have been interested in searching for alternatives safe materials to control these insects (Mostafa,

1999; Ismail *et al.*, 2014, 2015; Sabbour and Abdel-Raheem, 2016, Sabbour *et al*., 2020; Sabbour and Shadia, 2020) Including the use of natural products of plants as a successful and effective natural control of their qualities. Desirable as they are rapidly degradable and highly effective compounds against harmful insects and little harm to (Petrson *et al*., 2000). Use plant parts extract act as buffers to feed insects, repellents, or growth regulators (Mustafa, 1999, Abdel-Raheem *et al.*, 2015, 2019). Beauvericin extracted from fungi, has insecticidal, repellent and antibiotic effects on insects (Logrieco et *al*.,2002; Mohamed Abdel-Raheem *et al*, 2020; Sabbour, 2019). As a result of the above, this study aimed to assess the effect ofnano gel Beauvericin and by using three powdered essential oils in two *Sitophilus* beetles espices insect by knowing its fatal and repellent effect the insect as alternatives to chemical pesticides, reduce pollution and protect the environment.

MATERIALS AND METHODS

Insect rearing

Cereal weevils, *Sitophilus oryzae*, and *S. granarius* adults were collected and preserved at a temperature of 25 ° C, in the Insect Laboratory, Department of Pests and Plant Protection. A week for the purpose of adapting it to laboratory conditions before conducting the experiment. Then make artificial diet and reared the two pests on it according to Sabbour (2012).The artificial diet consists of wheat powder, glycine (16%) yeast powder (7%) and one drops of antibiotic. The last all compounds mixed together then feed the newly larvae in the laboratory of NRC.

Extraction of essential oil

Cuminum cyminum, *Cinnamomum zeylancium* and *Zingiber officinale* seeds extracted their essential oils by hydro distilled. The tested seeds (100 g) taken then grinded, put in a flask (one L),then covered with boiled water around (100º C). After six hours the volatile oil were collected in the reservoir Sabbour and Shadia Abd El-Aziz (2016a), the same obtained by Sabbour and Shadia Abd El-Aziz (2016). Also these experiments protocol followed by Sabbour and Shadia Abd El-Aziz (2020). After the extraction of oils, remove the excess of water by Sabbour and Nayera (2019a,b) (Sahaf *et al*., 2007).

The tested essential oils tested at the concentrations of 20, 40, 60,100 and 120ppm. Small pieces of foams dipped in each of the last concentrations, then left for drying. The foam put between (500gm) of rice seeds for *S. oryzae*, and wheat seeds for *S. granius* in glass container (tree L)covered with muslin, left till the end of the experiment Sabbour and Shadia Abd El-Aziz (2016a, 2016b).. The control experiments left without any treatments. The number of the dead beetles in each jar was counted every day and the percentages of mortality were corrected by using the Abbott formula (Abbott, 1925), the LC_{50}s were determined through the probit analysis (Finney 1971). The experiment was carried under laboratory conditions; 25± 3°C and 65 ± 5 R.H %.All of experiment were replicated five times.

Sublethal on the accumulative mortality

The effect of the sublethal dose of the Beauvericin 2% at 11 ppm. The beetles of both s. *oryzae* and *S. granarius* treated by sublehal dose of three tested oils at 12 for the oil *Cinnamomum zeylancium* and 42ppm for the oil, *Zingiber officinale* and *Cuminum cyminum* at 22 ppm. Twenty five beetles of both tested *S. oryzae* and *S. granarius*, were exposed to sprayed disk of foam at the last concentrations mentioned for 7, 17, 24, 36 and 48 hrs. The mortality estimated and determined till the end of the experiments.

Preparation of nano gels

Beauvericin Nano gels were prepared by self-assembly prepared method by of Chen *et al*.(2003). The nanoparticles preparations made by Fusaric acid –modified beauvericin. Dissolving1000mg Fusaric acid , 50 mL dimethyl sulfoxide, (DMSO, Sigma Aldrich, C99.9 %, Mw = 78.13 g/mol). Beauvericin (2 g) obtained from (Sigma Aldrich company) then added 2 % acetic acid solution (200 mL).

Persistence bioassay

LCs75which obtained from the last made experiments used to persistence calculations of the oil and nano gel Beauvericin 2%. Thirty of adult beetles from the two *Sitophilus* especies were introduced to each vial every three days of the experiments. The mortality counted every day after exposure. The persistence experiment was continued until 100 days and the essential oils and Beauvericin nano gel 2% lost their insecticidal effects.

Repellency test

The repellency experiments were made by choice test used an arena chambers. A tested oils were applied at the concentrations of (1%) sprayed on a filter paper (Whatman No. 1) the nit placed in the cell A. A filter paper sprayed by distilled water put in the next arena B for control experiments. Thirty of the newly hatched beetles were put in each of the last designed arenas. Then , the number of beetles found in each arena cells A and B were detrained each 1, 3,5, 7 days. The repellency percentages numbers calculated by the following Equation: $D = [1 - (T/C)] \times 100$ (Lwande *et al*., 1985) where T and C represent the mean number of beetles in cells A and B treated and untreated, respectively.

RESULTS

Data found in table 1, show that the LC_{50} of the tested two oils and nano gel Beauvericin on *Sitophilus oryzae*. Results proved that LC_{50} of Beauvericin nano gel 2% decreased by 1.1 fold that LC_{50} of *Cinnamomum zeylancium* and decreased by 3.9 and 8.3 of *Cuminum cyminum*as compared by *Zingiber officinale* LC_{50} (Table 1).

Table 1. Effect of the tested oils and nano-gel chitosan 5% on *Sitophilus oryzae* and *Sitophilus granarius*

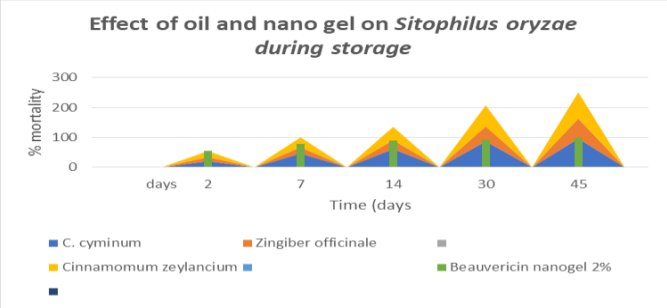
Tested substance	LC_{50} (ppm)	Confidence limits 95%
Sitophilus oryzae		
C. zeylancium	44	12-78
Z.officinale	151	141-177
Beauvericin nano gel 2%	38	11-54
C. cyminum	28	20-48
Sitophilus granarius		
C. zeylancium	41	22-68
Z. officinale	144	140-167
Beauvericin nano gel 2%	29	10-64
C. cyminum	20	10-44

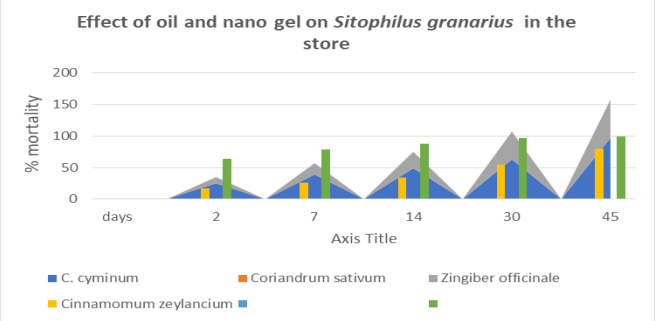
The effect of the tested essential oils and nano gel on *S. granarius*, showed that the LC_{50} of Beauvericin nano gel 2% decreased by 1.4 fold of LC_{50} of *Cinnamomum zeylancium*, by 12.8 fold of *Cuminum cyminum* and 4.9 fold of LC_{50} of *Zingiber officinale* (Table 1). The accumulative mortality of *S. oryzae* showed in (Table 2).

Table 2. Accumulative mortality of *Sitophilus oryzae* and *Sitophilus granarius* exposed to the tested essential oils and Nano gel at 5%.

Insect	Tested materials time (H)	Concentrations (ppm) at Sublethal dose				
		7	14	24	36	48
Sitophilus oryzae	*C. zeylancium*	28	35	48	59	80
	Z. officinale	19	22	33	42	63
	Beauvericin nano gel 2%	7	11	23	35	37
	C. cyminum	20	43	62	82	93
	F value/Lsd5%	34/19.8				
Sitophilus granarius	*C. zeylancium*	23	38	50	78	91
	Z. officinale	17	26	44	68	81
	Beauvericin nano gel 2%	8	11	23	37	38
	C. cyminum	22	45	66	84	96
	F value/Lsd5%	22/16.4				

The accumulative of *S. oryzae* significantly increased after 48 (H) by 2.8 fold after application of *C.zeylancium* oil. When *Zingiber officinale* Oil applications the accumulative mortality increased by 3.3 fold. The Beauvericin nano gel 2% showed that the accumulative increased by increasing the exposure time (Table 2).





C. zeylancium showed a higher effect on the wheat weevil *S. granarius*, where the accumulative mortality recorded 91% after 48 hrs the lower accumulative mortality after Beauvericin nano gel 2% , recorded 38 after 48 hrs (Table 2). The repellency test showed in figures 1 and 2, the highest repellant found among the Beauvericin nano gel 2% treatments. Figure 2. Repellency of the oils and nano gel on *S. granarius* in storage period the lowest repellant on *S. oryzae* and *S. granarius* was the oil *Z. officinale*.

The persistence of essential oils and nano gel Beauvericin is presented in Fig. 3, 4. The data presented show that the effectiveness of oil significantly decreased by increasing the storage time. The potential of the insecticidal oils was high after 45 days of storage, against *S. oryzae* and *S. granarius*. The potential of the insecticidal effect of oil recorded the lowest percentage at the end of storage after 100 days to both *S. oryzae* and *S. granarius* (Fig. 3 and 4).

Fig.3 .persistence of tested oils in the store on *S. oryzae*.

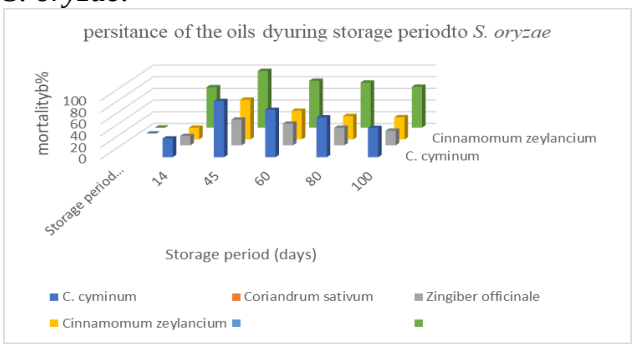
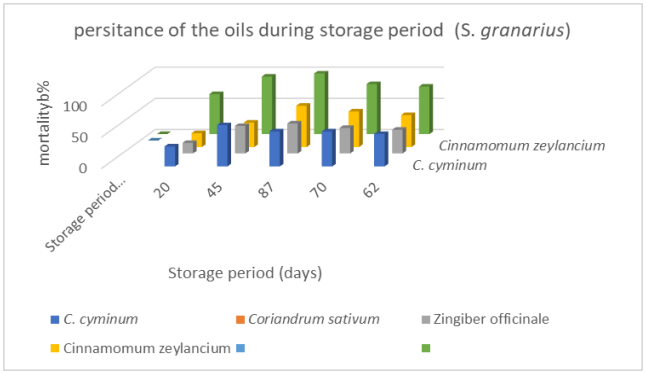


Fig.4 .persistence of tested oils in the store on *S. granarius*.



DISCUSSIONS

Results show that the decrease in $LC_{50}$of the tested Beauvericin to38 and 29 PPm for *S. oryzae* and *S. granarius*, respectively. These results agree with Sabbour (2007), how found that the LC_{50} of bioagent used decreased this agree with Sabbour and Shadia (2015). Our results showed highly confirmed with Sabbour (2013a and b) who reported that the essential plant oils have a strongly repellency effect an *S. oryzae* and *Ephestia Küehniella* in both laboratory and store. Su (1989) who strongly confirmed that, when using acetone extract for *Myristica fragrans* which showed a strongly repellency on rice weevil, *S. oryzae* L. using a nine essential oils extract *C. zeylancium* which protect the wheat seeds from yellow corn weevil *S. zeamais* infestations. Nat *et al*. (2013) mentioned that, the aqueous extracts are an exothermic efficacy and strong repellency on stored product insects. Ishii *et al*. (2010) stated that, when using five plant extract including *Cinnamomum*, *Cinnamon Zingiber* officinal

and oils and ginger excelled at *S. zeamais*. They reported that *C. zeylancium* have their effective repellency over the rest of the plants, followed by *Z. officinale* (Sabbour *et al.*, 2012; Sabbour and Shadia, 2010; Sabbour, 2020a,b,c).(Odili and Epidi, 2008) study of the efficacy of *C. zeylancium* on *Tribolium castaneum* and found that it has a strongly repellent effect against the target weevils. A studying the effect of four powders of plants including ginger vs. They mentioned *C. zeylancium* good in controlling *S. oryzae.* They reported that all of the plant extracts used are useful for preserving rice from *S. oryzae* L (Sabbour, 2020 a,b,c). The variation in the mortality ratios between the plants of this study is due to a difference in the chemical components. For different plants or for a difference in the way the same plant is used as a powder or aqueous extract (hot or cold) or alcoholic extract. Mixing the grains with vegetable powders causes the insects to die due to this. Until the powder minutes stick to insect bodies absorbing water from them or the insect friction with them causes. It results in the removal of the waxy layer from the wall of its bodies (Sabbour and Shadia, 2017) where water evaporates, dries and dies (Al-Azzawi and Muhammad, 1983), and the reason for the difference in the halos is due to the variation of the active substance present in the plant powders (Sabbour *et al.,* 2012; Sabbour and Nayer, 2020). Shaaban and Al-Mallah (1993) reported that the variation in mortality rates may be due to toxic effect through contact with it The powder to the surface of the body and the penetration of the chemical compounds of kyotalk by penetrating into the elastic areas in it or through respiratory openings causing paralysis and rapid death, as it is believed that the cause of the effect is caused by containment Plants on secondary alkaline, phenolic, and terpene sub-clocoside substrates and potent compounds that work. As a preventive or repellent impediment lead to the inhibition of the process of laying eggs and the proportion of hatching and in the process of role slaughter, while Saadi (2001) explained that 64 lost larvae and adult deaths when treated *Callosobruchus maculatus* (Fab.) % of southern cowpea beetle adults. In concentration, 4% g eucalyptus powder is due to its effect on the insect's nervous and digestive systems (Halawa *et al*., 1998). While there are highly significant differences in the characteristics of killing and expulsion between concentrations of plant powders Used in the study. The results of this study were consistent with the findings of Khalaf and Ilan (2002). Al-Farhan and Khalaf (2009) reported that the increased mortality of adult insect beetle due to increased plant concentrations. Its exerting effect when increasing concentrations of powders mixed with grains. All constituents of the tested essential oils *Cinnamomum zeylancium, Cuminum cyminum, Zingiber officinale,* belong to were terpenes. Which have an insecticidal effect on insects causing a toxicity by fumigant, contact, and ingestion action on stored product insect pests (Prates *et al*., 1998; Lee *et al*.,. 2003; Rozman *et al*.,.2007; Abdelgaleil *et al*.,2009 and Sabbour 2020 c). The rapid penetration of the tested essential oils, to in the insect body, cause death to them. The essential oils found in *C. cyminum* cause inhibitions to enzymes activity to *S. oryzae* (Abdelgaleil *et al*., 2009).

REFERENCES

Abbott W.S. 1925. A method of computing the effectiveness of an insecticide. *Journal of Economic Entomology* **18**: 265–267.

Abdelgaleil, S.A, Mohamed MI, Badawy ME, El-arami SA. 2009. Fumigant and contact toxicities of monoterpenes to *Sitophilus oryzae* (L.) and *Tribolium castaneum* (Herbst) and their inhibitory effects on acetylcholinesterase activity. *Journal of Chemical Ecology* **35**:518–525.

Abdel-Raheem M. A.; Huda A. ALghamdi, Naglaa F. Reyad, 2019.Virulence of Fungal Spores and Silver Nano-particles from Entomopathogenic Fungi on the Red Palm Weevil, *Rhynchophorus ferrugineus* Olivier (Coleoptera: Curculionidae), *Egyptian Journal of Biological Pest Control* **29**(1):97. https://doi.org/10.1186/s41938-019-0200-2

Abdel-Raheem,M.A.; I.A. Ismail;R.S. Abdel-Rahman;N.A. Farag and I. E., Abdel-Rhman.2015. Entomopathogenic fungi, *Beauveria bassiana* (Bals.) and *Metarhizium anisopliae* (Metsch.) As biological control agents on some stored product insects. *Journal of Entomology and Zoology Studies* **3**(6): 316-320.

Al-Azzawi, Abdullah Falih and Mahdi, Muhammad Taher. 1983. Store bugs. Ministry of Higher Education and Research Scientific.University of Al Mosul**. PP**. 462.

Al-Farhan, E. and Khalaf, DhiQar G. 2009. The effect of powders of leaves of some plants on life performance : for the red flour beetle *Tribolium castaneum* (Herbest) (Coleoptera: Tenebrionidae). *Science Journal* **3**(1): 6-1 .

Al Saadi, Thuraya Abdul Abbas Malik. 2001. The effect of some plant extracts on adult productivity and mortality *Callosobruchus maculatus* (Fab.) (Coleoptera: Southern Cowpea Beetle, Master Thesis . Mechanism of cultivation, lbasrah University, PP 85.

Aswalan, E.F., U.E. Ebere and K.C. Emeasor. 2012. Effect of some plant products on the control of rice weevil *Sitophilus oryzae* (L.) (Coleoptera: Curculionida). Journal of Medical plants Research 6(33):4811 – 4814.

Boudreaux, H.B. 1969. "The Identity of *Sitophilus oryzae*". Annals of the Entomological Society of America **62** (1): 169–172.

Chen, X.G., Lee, C.M. and Park, H.J. 2003.O/W emulsification for the self aggregation and nanoparticle formation of linoleic acid-modified chitosan in the aqueous system. *Journal of Agricultural Food chemistry* **51** (3): 135–3139.

Epidi, T.T. and E.O. Odili. 2008. Biocidal activity of selected plant powders against *Tribolium castaneum* Herbst in stored groundnut (Araohishypogaeal).African Journal off *Environmental Science and Technology* **3**(1):1– 5.

Finney, D.J. 1971. Probit Analysis, Cambridge: Cambridge University Press.

Halawa, Z.A., R. Mohamed and I. H. El-kashlan. 1998. Laboratory Evaluation of some plants and insecticides against the beetle *Callosobruchus maculate*s infesting stored product. *Egyptian Journal of Agriculture Research* **76** (1): 85-93.

Ismail, I.A.; N.A. Farag; R.S. Abdel-Rahman; M.A. Abdel-Raheem and Radwan, H.M. 2014. Insecticidal activity of some plant extracts rich in coumarin against cowpea beetle, *Callosobruchus maculatus* (Fab.) (Coleoptera: Bruchidae). *Egyptian Journal of Biological Pest Control* **24**(2): 465-469.

Ismail, I.A.; R.S. Abdel-Rahaman and M.A. Abdel-Raheem. 2015.Influence of some essential oils, chemical compounds and their mixtures against *Ceroplast esrusci* L. and *Asterolcanium pustolans* Cock on fig trees. *International Journal of ChemTech Research* **8**(9):187-195.

Khalaf, Jinan Malik and Eilan, Abdul Hamid. 2002. Effect of seed powders of some plants on flour beetle *Tribolum castaneum* (Herbst) (Coleoptera: Tenebrionidae) red rust. *Basra Research Journal* **2**(1): 162-150.

Ishii,T., Matsuzawa, H. and Vairappan, C.S. 2010. Repellent activity of commonspices against the rice weevil *Sitophilus zeamais*Motsch (Coleoptera :Curculionidae). *Journal of Tropical Biology and Conservation* **7**: 75 – 80.

Hong, Ki-Jeong; Lee, Wonhoon; Park, Young-Ju; Yang, Jeong-Oh 2018. First confirmation of the distribution of rice weevil, *Sitophilus oryzae* in South Korea. *Journal of Asia-Pacific Biodiversity* **11**: 69–75.

Lee S, Peterson CJ, Coats JR 2003. Fumigation toxicity of monoterpenoids to several stored product insects. *Journal of Stored Product Research* **39**:77–85

Logrieco A, Rizzo A, Ferracane R, Ritieni A 2002. Occurrence of Beauvericin and Enniatins in Wheat Affected by *Fusarium avenaceum.* Head Blight. Applied and Environmental Microbiology. **68**(1): 82–85. doi:10.1128/AEM.68.1.82-85.200.

Lwande, W., Hassanalli, A., Njorage, P.W., Bentley M.D., Delle Monache F. and Jondiks, J.I. 1985. A new 6a-hydroxy pterocarpan with insect antifeedant and antifungal properties from the root of *Tephrosia*

hildebrandtu.Vatle. *Insect Science & Application* **6**: 537–541.

Mohamed Abdel-Raheem, Huda, A. Alghamdi and Naglaa F. Reyad. 2020. Nano essential oils against the red palm weevil, *Rhynchophorus ferrugineus* Olivier (Coleoptera: Curculionidae), *Entomological Research*, **50**(5): 215-220.

Mostafa, M.A. 1999.Growth-regulating activity of Chinaberry tree, *Meliaazedarach* L. on the khapra beetle *Trogodem agranarium* Everts. *Rafidain* Journal of Science, **10**(2): 15-26.

Naglaa F. Reyad, Huda A. ALghamdi, Abdel-Raheem, M.A.and Majed A. Al-Shaeri.2020.The Effects of Botanical Oils on The Red Palm Weevil, *Rhynchophorus ferrugineus*(Oliver) (Coleoptera:Curculionidae). *Applied Ecology and Environmental Research* **18**(2):2909-19.

Nat, A. I., Y.B. Ibiany, E. A. Uyoh, N. E. Edu, B.E. Bkanem and Q. E. John . 2013. Insect pest damage to leaves of Cowpea (*Vigna unguiculate*L.walp): Comparative effects of aqueous extract of *Piper guineensis*, *Allium sativum* and *Myristia fragrans*. *Journal Of Environmental Science, Toxicology And Food Technology* **3**(2):17-20.

Petrson, C. J., R. Tsao, A. L. Eggler and J. R. Coats. 2000. Insecticidal activity of cyanohydrin and monterpenoid compounds. *Molecules Journal* **5***:* 648-654.

Prates, H.T., Santos, J.P., Waquil, J.M., Fabris, J.D., Oliveira, A.B. and Foster, J.E. 1998.Insecticidal activity of monoterpenes against *Rhyzopertha dominica* (F.) and *Tribolium castaneum* (Herbst). *Journal of Stored Product Research* **34**:243–249.

Rozman, V., Kalinovic, I. and Korunic, Z. 2007.Toxicity of naturally occurring compounds of Lamiaceae and Lauraceae to three stored-product insects. *Journal of Stored Prod Research* **43**:349–355

Sabbour, M. M. 2007.Effect of some natural bioagents and natural enemies against aphids in wheat fields. *Journal of Biological Pest Control* **33**: 33-39.

Sabbour, M.M. 2012. Evaluations of some bioagents against the rice weevil *Sitophilus oryzae* under laboratory and store conditions. *Integrated Protection of Stored Products. IOBC-WPRS Bulletin* **81**: 135-142

Sabbour, M.M. and Shadia El-Sayed Abd-El-Aziz. 2015. Efficacy of some nano-diatomaceous earths against red flour beetle *Tribolium castaneum* and confused flour beetle, *Tribolium confusum* (Coleoptera: Tenebrionidae) under laboratory and store conditions. *Pharmacology and Life Sciences*, **4(7):** 54-59.

Sabbour, M.M. and Shadia El-Sayed Abd-El-Aziz. 2015. Efficacy of some nano-diatomaceous earths against red flour beetle *Tribolium castaneum* and confused flour beetle, *Tribolium confusum* (Coleoptera: Tenebrionidae) under laboratory and store conditions. Bulletin of Environment Pharmacology and Life Sciences **4**(7): 54-59.

Sabbour, M.M. 2013a. Evaluations of some extracted natural oils against *Bruchidius incarnates* and *Ephestia elutella.* Global *Journal of Scientific Researches* **1**(1):1-7

Sabbour M.M. 2013b. Bioactivity of natural essential oils against *Sitophilus oryzae* and *Ephestia Küehniella*. *Scientia Agriculturae* **1** (1): 15-20 .

Sabbour M.M and M.A. Abdel-Raheem 2016. Nano Imidacloprid efficacy against the desert locust, *Schistocerca gregaria* under laboratory and semi field conditions. *Der Pharma Chemica* **8**(4):133-136.

Sabbour, M.M. and Shadia El-Sayed Abd-El-Aziz. 2016a. Roll of three essential oils and their Nano against *Ephestia cautella* Lepidoptera: Pyralidae under laboratory and store conditions. *International Journal of Pharm-Tech Research*: 0974-4304.

Sabbour, M.M. and Shadia El-SayedAbd-El-Aziz. 2016b. Efficacy of three essential oils and their nano-particles against *Sitophilus granarius* under laboratory and store conditions. *Journal of Entomological Research* **40**(3):229-234.

Sabbour, M.M. and El-Sayed Hassan Shaurub. 2018. Evaluations of *Metarhizium anisopliae* and two Destruxin against cotton leaf worm *Spodoptera littoralis* (Lepidoptera: Noctuidae) under laboratory and field

conditions**.** *Bioscience Research* **15**(2): 1028-1033.

Sabbour, M.M. 2019. Efficacy of natural oils against the biological activity on *Callosobruchus maculatus* and *Callosobruchus chinensis* (Coleoptera: Tenebrionidae). *Bulletin of the National Research Centre* **43**:206.

Sabbour, M.M, Solieman, N.Y. and Abdel-Raheem, M.A. 2020. Influence of *Metarihizium anisoplae* based Destruxin A 760 and Destruxin - A 724 on the sugar beet fly, *Pegomya mixta* Vill. (Diptera: Anthomyiidae), *Journal of Biopesticide* **13**(1):21-27.

Sabbour, M.M. and Shadia E-Abd-El-Aziz .2010. Efficacy of some bioinsecticides against *Bruchidius incarnatus* (BOH.) (Coleoptera: Bruchidae) Infestation during storage. *Journal of. Plant Protection Resreach* **50**(1): *28-34.*

Sabbour, M.M. and Shadia El-Sayed Abd El-Aziz. 2017. Screening effect of three *natural* oils and their Nano against *Ephestia Kϋehniella* (Lepidoptera-Pyralidae) Under Laboratory and store conditions. *Bioscience Research* **14**(2): 408-416.

Sabbour, M. , M. and Shadia E. Abd El-Aziz.2020. Plant essential oils for the management of two serious stored pests in Egypt. *Journal of Entomological Research*, **44** (3) : 377-384.

Sabbour, M.M. and Nayera Y. Solieman. 2020. Toxicity of imidacloprid on cabbage white butterfly *Piers rapae*. *Plant Archives* **20**(2): 4675-4479.

Sabbour M.M. and Nayera Y. Solieman 2019a. Control of beet fly (*Pegomya hyoscyami*) (*Diptera : Anthomyidae*) using chitosan and nano chitosan. *Plant Archive* 19(supl) 2,. 462-465.

Sabbour M.M and Nayera Y. Solieman. 2019b. Insecticidal activity of the toxin diketopiperazines comparing with its nano composition on *Ceratitis capitata* under laboratory and field conditions. *Plant Archives* **19** (Supplement 2): 365-369.

Sabbour, M.M. 2020a. Determinations of the Effect of three natural Oils on *Rhyzopertha dominica* (Coleoptera: Bostrichidae) under laboratory and store conditions Asian *Journal of Biological Sciences*. 13:302-308. Doi:10.3923/ajbs.2020.302.308

Sabbour, M.M. 2020b. Efficacy of nano-formulated certain essential oils on the red flour beetle *Tribolium castaneum* and confused flourbeetle, *Tribolium confusum* (Coleoptera: Tenebrionidae) under laboratory and storage conditions. *Bulletin of the National Research Centre*, **44**(111): 1-7.

Sabbour, M.M. 2020 c. Toxicity of the Three Oils Extract against *Sitophilus granaries* Under Laboratory and Store Conditions. *International Research Journal of Biological Sciences* **2**: 14-18.

Sabbour, M.M.; Shadia El-Sayed Abd-El-Aziz, Marwa Adel Sherief. 2012. Efficacy of three entomopathogenic fungi alone or in combination with diatomaceous earth modifications for the control of three pyralid moths in stored grain. *Journal of Plant Protection Resreach* **52**(3): 359-363.

Shaaban, Awwad and Al-Mallah, Nizar Mustafa. 1993. Pesticides. House of Books for Printing and Publishing. University of Al Mosul. PP 512.

Sahaf, B.Z, Moharramipour, S. and Meshkatalsadat, M.H. 2007.Chemical constituents and fumigant toxicity of essential oil from *Carum copticum* against two stored product beetles. *Insect Science Research* **14**:213–218.

Su, H. C. F. 1986.Labrotary evalution of the toxicity and repellency of coriander seed to four species of stored– product insects. *Journal of Entomological Science* **21**: 169 – 174.

Su, H. C. F. 1989.Effects of *Myristica Fragrans* fruit (Myristicaceae) to Four species of stored product insects. *Journal of Entomological Science* **24** (2): 163 – 173.

Trematerra P, Sciarretta A, Mancini M, 1999. Insect pests in traditional cereal warehouses. Infestazioni da *insettiin dicereali*. *Tecnica Molitoria* **50**(9):980-989.

MAGDA M. A. SABBOUR
Pests and Plant Protection Dept. National Research Centre, 33rdElBehouse St. El-Tahrir Street, Dokki, P.O. Box 12622, Giza, Egypt.
Fax: 002 33370931; **E-mail :** sabbourm@yahoo.com