EGYPTIAN ACADEMIC JOURNAL OF

BIOLOGICAL SCIENCES

ENTOMOLOGY

A

ISSN
1687-8809

WWW.EAJBS.EG.NET

Vol. 16 No. 3 (2023)

Citation: *Egypt. Acad. J. Biolog. Sci. (A. Entomology) Vol. 16(3) pp.55-61 (2023)*
DOI: 10.21608/EAJBSA.2023.318392

Egypt. Acad. J. Biolog. Sci., 16(3):55-61 (2023)

Egyptian Academic Journal of Biological Sciences
A. Entomology

ISSN 1687- 8809
http://eajbsa.journals.ekb.eg/

Insecticidal Potential of Essential Oils against *Tribolium castaneum* (Herbst.)

Akash Bagade[1], Pallavi Takawane[1], Rashmi Morey[1], Bithika Baidya[1], Abhay Khandagle[2*] and Ashwini Jamble[1]

[1]Department of Zoology, Prof. Ramkrishna More Arts, Commerce and Science College, Akurdi, Pune.

[2]Department of Zoology, Annasaheb Waghire College of Science, Arts & Commerce Otur, Pune.

*E-mail: bagadeakash4@gmail.com ; moreyrashmi@gmail.com ; ajkhandagle@gmail.com ;

ARTICLE INFO

Article History
Received:8/8/2023
Accepted:19/9 /2023
Available:23/9/2023

Keywords:
Larvicidal, adulticidal, *Azadirecta indica*, *Brassica juncea*, Ecofriendly biopesticides.

ABSTRACT

The red flour beetle, (*Tribolium castaneum*), stands as a notable primary pest, with a global presence in infesting a wide variety of stored commodities. The current investigation explores the adulticidal and larvicidal properties of oils derived from *Azadirachta indica* (neem) and *Brassica juncea* (mustard) plants**.** Larvicidal bioassay tests were conducted, revealing that concentrations of 13.47% and 17.67% of *A. indica* and *B. juncea* oils, respectively, resulted in 50% mortality (LC_{50}) of the fourth instar larval stage of *Tribolium castaneum*. Furthermore, adulticidal activity was observed at LC_{50} concentrations of 22.91% and 25.16% for *A. indica* and *B. juncea* oils, respectively, against *Tribolium castaneum* adults. The results indicated that both *A. indica* and *B. juncea* oils exhibit significant efficacy against both the larval and adult stages of *Tribolium castaneum*. These findings suggest that these plant oils hold promise as potential natural insecticides for managing *Tribolium castaneum* infestations and present nature-friendly alternatives to synthetic pesticides. These findings indicate that the plant oils, *A. indica* and *B. juncea*, hold promising potential as natural insecticides for effectively managing *Tribolium castaneum* infestations. Furthermore, they present eco-friendly alternatives to synthetic pesticides.

INTRODUCTION

Insects are of great economic importance they are both useful and harmful to man. Across the world, a staggering count of over 10,000 insect species have been documented as culprits causing substantial harm to stored grain products. (Rajendran and Sriranjini, 2008). A pest refers to any creature whose population, when it exceeds a certain threshold, can lead to economic harm, creating a clash with human well-being, convenience, and financial gain. *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae) holds a crucial status as an insect pest that significantly impacts food grains, earning its reputation as a primary adversary in stored grain ecosystems (Howe, 1965). As per FAO's assessment, pests infesting stored grains have been wreaking havoc on food supplies. Each year, an

DOI: 10.21608/EAJBSA.2023.318392

estimated 10% to 25% of the global harvest is lost due to the destructive impact of insect and rodent pests, with instances even reaching an alarming 80%, as documented by reports (Matthews, 1993; Dwivedi and Shekhawat, 2004). The pest is generally found in grain storages, flour mills, and warehouses. Wheat is global crop, serving as a primary protein source in impoverished and developing nations. Proper storage is crucial during transportation and throughout the year to safeguard grains from pests, especially in hot and humid summer months when crops aren't grown (Khalil, F. M. A *et al.,* 2022)

The management of these insects heavily depends on the utilization of synthetic insecticides and fumigants; however, the extensive application of these agents has given rise to significant challenges, notably the emergence of insect strains that have developed resistance to insecticides. (Dubey*, et al,* 2008)

Higher plants offer a wealth of unique natural compounds that hold the potential to foster the creation of ecologically sound approaches for insect management, as highlighted by Jbilou, *et al.,* 2006. Plants naturally synthesize secondary metabolites, a considerable portion of which serve as innate defences against both insects and pathogenic microorganisms (Potenza et al. 2004). Plant-derived compounds exhibit not only a high level of safety for endothermic organisms but also demonstrate enhanced biodegradability, coupled with reduced susceptibility to insect resistance (Oparaeke *et al.,* 2005).

*Azadirachta indica A. Juss (*Meliaceae*)*, commonly known as Neem, boasts a plethora of valuable compounds, notably azadirachtin and tetranortriterpenoid limonoids, which play pivotal roles as active ingredients in numerous neem-based insecticides, as noted by Mordue and Blackwell in 1993. Every facet of the neem plant, particularly its seed oil, harbours antifeedant, repellent, growth-disrupting, and larvicidal attributes, effectively countering a diverse range of pests. (Chaudhary, S. *et al.,* 2017 Neem oil exhibits a promising efficacy against *Tribolium castaneum*. Mustard essential oil, along with its prominent constituent allyl isothiocyanate, exhibits remarkable fumigant toxicity against insects infesting stored grains. Notably, mustard oil encompasses glucosinolate, recognized for its anti-carcinogenic qualities, effectively impeding the formation of cancerous tumors, and showing promise for controlling stored grain insects. Furthermore, the application of mustard oil leads to mortality in both larvae and adults of these stored grain pests. (Attia A. *et. al.,* 2014; Worfel *et al.,* 1997; Paes J. *et al.* 2011). With the aim of finding eco-friendly alternatives to conventional pesticides for controlling storage insects, the present study was designed to experiment with essential oils from *Azadirachta indica* (neem) and *Brassica juncea* (mustard), two potential medicinal plants renowned for their pesticidal properties.

MATERIALS AND METHODS

Tribolium castaneum, commonly known as the red flour beetle, was collected from infested wheat grains. The collected cultures were then reared and maintained in laboratory conditions at 25±1ºC and 65±5% relative humidity. For the toxicity assay, both adult beetles and fourth developmental stage larvae were utilized.

Neem (*Azadirachta indica*) and Mustard (*Brassica juncea*) essential oils were procured from R. V. Essential Delhi. To attain the desired concentrations, the essential oils were meticulously dissolved in acetone, resulting in the preparation of the necessary solutions.

Larvicidal Bioassay:

An experiment was designed to determine the LC_{50} value of the effect of *A. indica* and *B. juncea* oils on fourth developmental stage larvae. A range of dilution percentages, specifically 10%, 12%, 14%, 16%, 18%, and 20%, were subjected to testing. Control

larvae were kept under the same condition
mixed with acetone but without any essential oils. All tests were replicated five times. The mortality rate of treated larvae was calculated after 48 hrs. LC_{50} was calculated by using log probit analysis.

Adulticidal Bioassay:

Adulticidal bioassay experiment was designed to determine the lethal concentration (LC) value of the effect of *A. indica* and *B. juncea* oils on adult *T. castaneum*. Twenty adult beetles were released into a jar containing thirty grams of wheat grains treated with various dilutions (21%, 23%, 25%, 27%, and 30%) of *A. indica* and *B. juncea* oils. The data collected from this experiment underwent thorough log probit analysis.

RESULTS AND DISCUSSION

To assess the lethal effects of *A. indica* and *B. juncea* oils on fourth developmental stage larvae and adults of *T. castaneum,* toxicity experiments were performed. The results revealed positive toxic effects of these essential oils on the overall mortality of both larvae and adults of *T. castaneum*. Toxicity effects on the fourth developmental stage larvae were assessed at different concentrations of *A. indica* and *B. juncea* oils, resulting in an LC_{50} value of 13.47% for *A. indica* and 17.67% for *B. juncea* (Table 1). The adulticidal activity of *A. indica* and *B. juncea* showed LC_{50} value at 22.91% and 25.16% (Table 2) concentration respectively against adult *T. castaneum.* As the concentration of oils increases the mortality also increases simultaneously. Tables 1 and 2 present the 95% confidence intervals and regression coefficients obtained from larvicidal and adulticidal bioassays carried out using the essential oils extracted from *A. indica* and *B. juncea*, in relation to their effects on *T. castaneum*. In Figures 1a and 1b, the 95% confidence intervals and regression coefficients are depicted, specifically highlighting the larvicidal activity of A. indica and B. juncea essential oils against T. castaneum larvae. Figures 2a and 2b also illustrate the 95% confidence intervals and regression coefficients, focusing on the adulticidal bioassays involving *A. indica* and *B. juncea* essential oils against *T. castaneum* adults.

Table 1. Effect of *A. indica* and *B. juncea* on 4th instar larvae of *T. castaneum.*

Essential oils	LC_{50} (%)	95% Confidential limits		Regression equation
		LCL	UCL	
A. indica	13.47	12.37	14.67	Y=7.2595x-3.1868
B. juncea	17.67	15.00	20.70	Y=6.1939x-2.6949

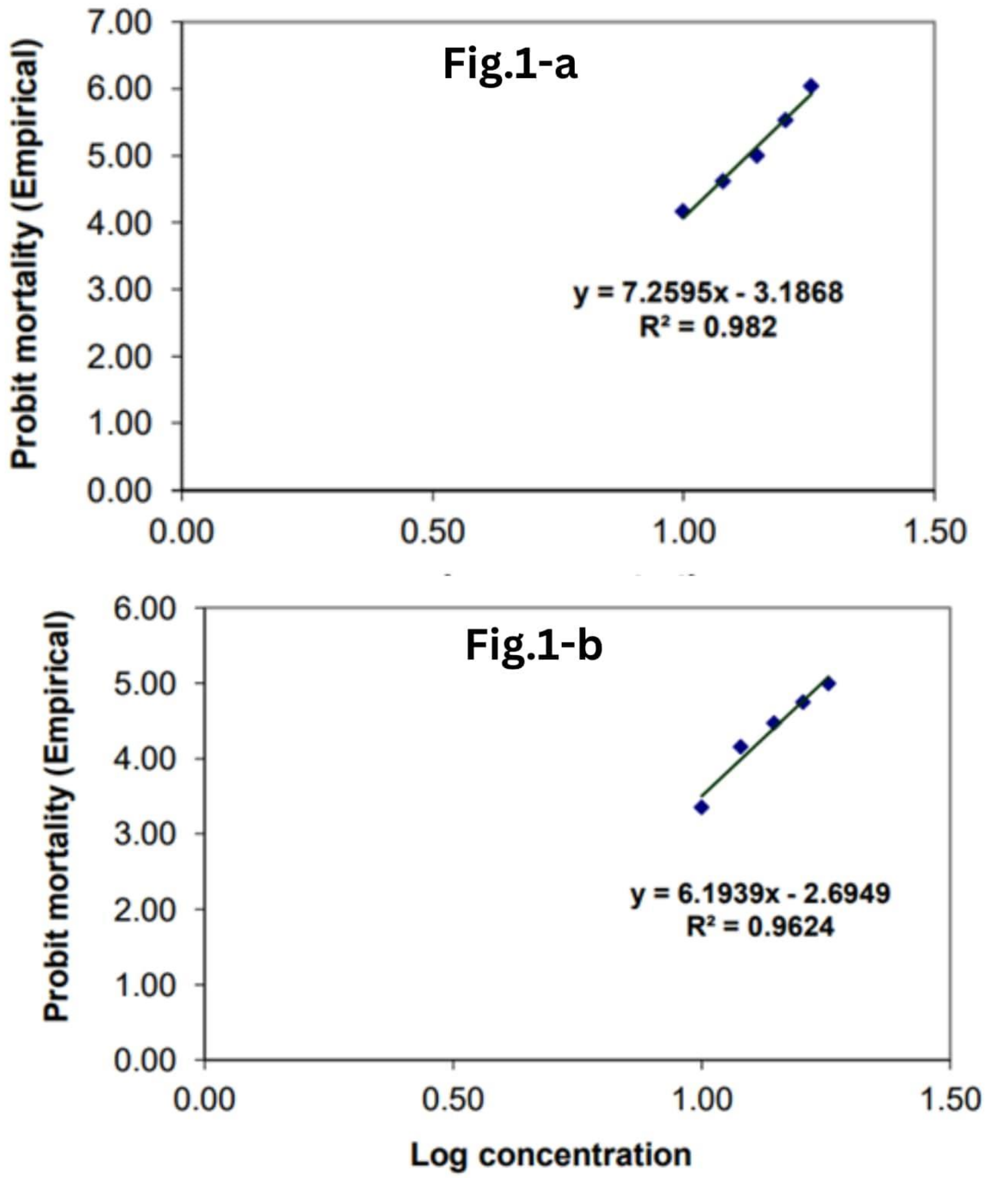

Figure-1: a & b: Regression line of probit mortality of *T. castaneum* against E. oils of **a.** *A. indica*. **& b**. *B. juncea*.

Table 2. Effect of *A. indica* and *B. juncea* against Adult of *T. castaneum*

Essential oils	LC_{50} (%)	95% Confidential limits		Regression equation
		LCL	UCL	
A. indica	22.91	21.76	24.12	Y=14.122x-14.249
B. juncea	25.16	23.75	26.64	Y=10.588x-9.8297

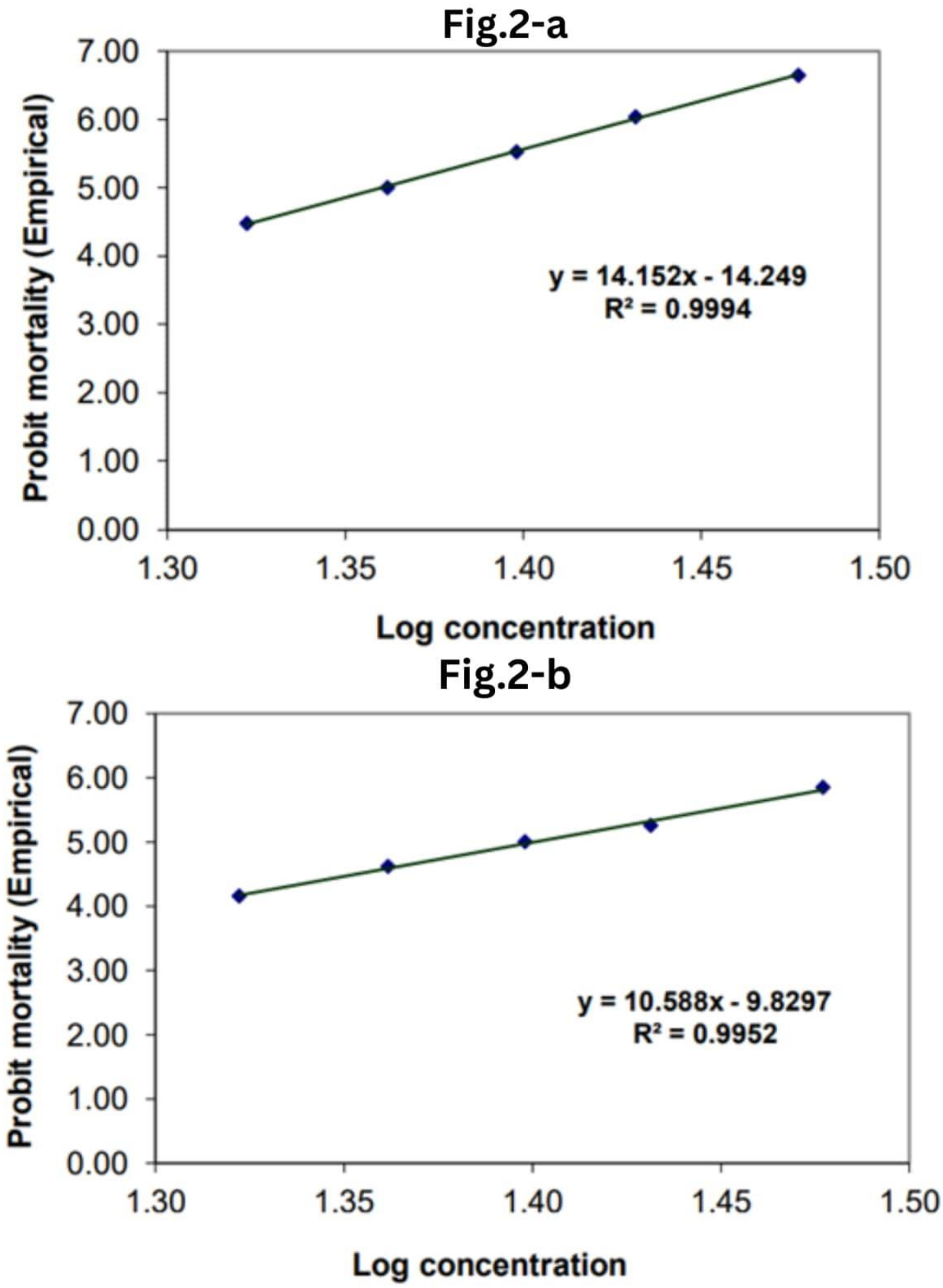

Figure-2: a & b: Regression line of probit mortality of *T. castaneum* against E. oils of **a.-** *A. indica*. **b-** *B. juncea*.

There is a growing interest among scientists in studying the bioactivity of plant essential oils and extracts against stored-grain insect pests. (Dubey *et al.,* 2008; Benzi *et al.,* 2009; Padin, S. B *et al.,* 2013). In this investigation, *Azadirachta indica* and *Brassica juncea* oils demonstrated significant potential as insecticidal agents against *T. castaneum*. The insecticidal activity showed variations depending on the concentrations of the oil and the duration of exposure. An observed correlation between dose and response was evident, as larval and adult mortality increased while larval survival and adult emergence declined with rising concentrations of the essential oil by Scott *et al.,* (2003); Upadhyay and

Jaiswal, (2007); Kraikrathok *et al.*, (2013) same was stated by the experiment conducted with *A. indica* and *B. juncea* against *T. castaneum*. Azadirachta stands out as a crucial plant-derived compound in the realm of insect pest management. Its remarkable trait of low mammalian toxicity and its compatibility with beneficial insects make it a standout choice, as highlighted by Schmutter in 1990. It has mainly antifeedant effects (Zehnder and Warthen, 1988; Schmutterer, 1990) and is an insect growth regulator (IGR) property.

REFERENCES

Attia, A. N., Badawi, M. A., El-Moursy, S. A., & Mohammed, A. A. (2014). Effect of some Plant Oils treatment on Storage Efficacy of Wheat grains. *Journal of Plant Production*, 5(9), 1573-1584.

Benzi, V. S., Stefanazzi, N., & Ferrero, A. A. (2009). Biological activity of essential oils from leaves and fruits of pepper tree (Schinus molle L.) to control rice weevil (*Sitophilus oryzae* L.) Chilean *journal of agricultural research* 69 (2), 154-159.

Chaudhary, S., Kanwar, R. K., Sehgal, A., Cahill, D. M., Barrow, C. J., Sehgal, R., & Kanwar, J. R. (2017). Progress on *Azadirachta indica* based biopesticides in replacing synthetic toxic pesticides. *Frontiers in plant science*, 8, 610.

Dubey, N. K., Srivastava, B., & Kumar, A. (2008). Current status of plant products as botanical pesticides in storage pest management. *Journal of biopesticides*, 1 (2), 82-186.

Dwivedi, S. C., and Shekhawat, N. B. (2004). Repellent effect of some indigenous plant extracts against *Trogoderma granarium* (Everts). *Asian J Exp Sci*, 18 (1), 47-51.

Howe, R.W. (1965). Losses caused by insects and mites in stored foods and feeding stuffs. *Nutrition Abstracts and Reviews* Vol. 3, 285-303.

Jbilou, R., Ennabili, A., & Sayah, F. (2006). Insecticidal activity of four medicinal plant extracts against *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae). *African Journal of Biotechnology*, 5(10), 936-940.

Khalil, F. M. A., ALshahari, E. A. A., Abo Arab, R. B., and Abouelatta, A. M. (2022). Toxicoligical study of *Ocimum basilicum* and *Jasminum grandiflorum* essential oils against *Rhyzopertha dominica* and *Tribolium castaneum*. *Ama, Agricultural Mechanization in Asia, Africa & Latin America* (ISSN 0084-5841), *53*(10), 10017-10031.

Kraikrathok, C., Ngamsaeng, S., Bullangpoti, V., Pluempanupat, W., & Koul, O. (2013). Bio efficacy of some piperaceae plant extracts against *Plutella xylostella* L. (Lepidoptera: Plutellidae). *Commun Agric Appl Biol Sci*, 78 (2), 305-310.

Matthews, G.A. (1993). Insecticide application in stores. In: Matthews, G.A., Hislop, E.C. Application technology for crop protection. *CAB International, Wallingford*, UK: 305-315.

Mordue, A. J., and Blackwell, A. (1993). Azadirachtin: an update. *Journal of insect physiology*, 39 (11), 903-924.

Oparaeke, A. M., Dike, M. C., & Amatobi, C. I. (2005). Evaluation of botanical mixtures for insect pests' management on cowpea plants. *Journal of Agriculture and Rural Development in the Tropics and Subtropics* (JARTS), 106 (1), 41-48.

Padin, S. B., Fuse, C. B., Urrutia, M. I., & Dal Bello, G. (2013). Toxicity and repellency of nine medicinal plants against *Tribolium castaneum* in stored wheat. *Bulletin of Insectology*, 60 (1), 45-49.

Paes, J. L., Faroni, L. R., Martins, M. A., Dhingra, O. D., & Silva, T. A. (2011). Diffusion and sorption of allyl isothiocyanate in the process of fumigation of maize. *Revista Brasileira de Engenharia Agrícola e Ambiental*, 15, 296-301.

Potenza, C., Aleman, L., & Sengupta-Gopalan, C. (2004). Targeting transgene expression in research, agricultural, and environmental applications: promoters used in plant transformation. *In Vitro Cellular & Developmental Biology-Plant*, 40 (1), 1-22.

Rajendran, S., and Sriranjini, V. (2008). Plant products as fumigants for stored-product insect control. *Journal of stored products Research*, 44 (2), 126-135.

Schmutterer, H. (1990). Properties and potential of natural pesticides from the neem tree, *Azadirachta indica*. *Annual review of entomology*, 35 (1), 271-297.

Scott, I. M., Jensen, H., Scott, J. G., Isman, M. B., Arnason, J. T., & Philogène, B. J. R. (2003). Botanical insecticides for controlling agricultural pests: piperamides and the Colorado potato beetle *Leptinotarsa decemlineata* Say (Coleoptera: Chrysomelidae). Archives of *Insect Biochemistry and Physiology*: Published in Collaboration with the Entomological Society of America, 54 (4), 212-225

Upadhyay, R. K., and Jaiswal, G. (2007). Evaluation of biological activities of *Piper nigrum* oil against *Tribolium castaneum*. *Bulletin of Insectology*, 60 (1), 57.

Worfel, R. C., Schneider, K. S., & Yang, T. C. S. (1997). Suppressive effect of allyl isothiocyanate on populations of stored grain insect pests. *Journal of Food Processing and Preservation*, 21 (1), 9-19.

Zehnder, G., and Warthen, J. D. (1988). Feeding inhibition and mortality effects of neem-seed extract on the Colorado potato beetle (Coleoptera: Chrysomelidae). *Journal of Economic Entomology*, 81 (4), 1040-1044.