International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 12-05-2024, Accepted: 02-06-2024, Published: 27-06-2024
Volume 9, Issue 6, 2024, Page No. 135-137

Studies on the effectiveness of various plants oils in suppression of store grain pest *Callosobruchus Analis* (fab.) (Coleoptera: Bruchidae)

Monika Airi, Priyanka Khera, Charan Kamal Sekhon
Department of Zoology, Sri Guru Granth Sahib World University, Fatehgarh Sahib, Punjab, India

Abstract
In India, agriculture is a major occupation for people, where the bulk of crops are cultivated, stored and consumed. During storage, various biotic and abiotic factors affect the quality of grains. Among biotic factors, maximum damage to the store grains is caused by insect pests of family bruchidae. Among all the genera of this family, members of genus *Callosobruchus* are the major pests of stored grain as they cause extensive damage to the grains and hence are responsible for great economic loss to farmers. *C. analis* is one of major pest, which exclusively attack seeds of family Leguminosae in stores. For the control of these pest populations, lots of chemical pesticides are being used but these are not safe for consumption as it causes serious health hazards to consumers, therefore, during past few years, the focus has been shifted towards the use of botanicals for the control of these store-bruchids. Hence, laboratory experiments were conducted to assess the efficacy of four plants oil namely, *Cocos, Nigella, Eucalyptus* and *Syzygyium* against *C. analis* infesting stored *Vigna radiata.* The test plant oils were applied at four levels of concentrations (0.2, 0.6, 0.8 and 1.0mL/100g seed) and control in which no test plant oil was applied. The studies reveal that these plant oils show significant level of adult mortality, reduced oviposition by female adult *C. analis*, and reduced F1 progeny emergence from infested *V. radiata.*

Keywords: Bruchid, plant oils, insecticides, callosobruchus analis, botanicals, oviposition, mortality, adult emergence

Introduction

Callosobruchus. analis (F.) commonly called cowpea or bean weevil belonging to the family bruchidae, is one of the major pests of stored grains. These bruchids cause extensive damage to grains and hence are responsible for great economic loss of farmers (Pajni and Gupta 2012) [14]. The members of this species attack the seeds of family Leguminosae in stores (Southgate, 1979, Pajni and Gupta 1991) [13].

In stores, *C. analis* attack seeds of around 15 genera namely, *Cajanus cajan* Linn. (arhar, pigeon pea), *Cicer arietinum* Linn. (kala channa), *Glycine max* (Linn.) Merril (soybean), *Lablab purpureus* Linn. (Sem, Hyacinth bean), *Vigna aconitifolia* (Jacq.) (Moth), *Vigna mungo* Linn. (mash, urd), *Vigna radiata* Linn., *Vigna unguiculata* (Rongi) (Bhalla *et al.,* 2006, Pajni and Gupta 2012) [1, 13]. Out of all these, *Vigna radiata* (moong, mung bean, mash and mungo) is one of the most common sources of protein for the majority of Indian population and hence it is considered as important leguminous crop of India. It also plays a crucial role in nitrogen fixation and maintain the fertility of soil. The moong pulse is rich source of carbohydrates (51%), proteins (24%), minerals (4%) and vitamins (3%) (Nair *et al.,* 2006, Raghu *et al.,* 2016) [15].

In storage, various biotic and abiotic components affect quality and quantity of grains. Therefore, reducing the post-harvest losses of pulses is one of the major concerns throughout the world. Among the biotic factors, maximum damage to the stored grains is caused by insect pest of family bruchidae.

Hence, for the control of these pests, indiscriminate use of chemical pesticides is being practiced to great extent which is not safe for human consumption because these pesticides cause serious health hazards to consumers (Shaaya *et al.,* 1997) [16]. Moreover, these synthetic pesticides are also associated with destruction of natural enemies, environmental pollution, ozone depletion and contamination of food. Hence, during past few years, the efforts are being made to use plant based products for the suppression of pest population.

The plants and their products used in different formulations like plants extracts, powders and oils have provided best results for ovicidal, larvicidal, adulticidal, repellency and antifeedant activities (Ekoja and Ogah, 2020, Mehat *et al.,* 2010) [3]. Various workers have investigated the effect of different plant oils on two species of *Callosobruchus* i.e., *C. maculatus* and *C. chinensis.* In 1990, Singh *et al*., assessed the insecticidal activity of mustard oil along with other oils i.e. palm oil, coconut oil, ground nut and rape seed oil where they found that palm and coconut oils are more effective than other oils. Even ground nut and rape seed oil also gave better results than mustard oil. Pajni *et al.,* (1991) [13] found that Citriodora oil of *Corymbia* and *Eucalyptus* oil is effective against *C. maculatus* with LD-50 of 37.40 mg/100ml and 46 mg/1000ml respectively. The fumigant toxicity, ovicidal and oviposition-deterrent bioactivities of the essential oil of *Anethum sowa* was investigated by *Tripathi et. al* (2001) against the grain beetle, *C. maculatus*. The grain damage and weight loss of green gram infested with pulse beetle

C. chinensis was analyzed by the use of edible and non-edible oils *viz*., Neem, Karanja, Sesamum, Castor, Palm, Mustard, Groundnut and Sunflower oil (Mishra S.N. *et al*., 2013) [10]. It was observed that the most effective oil in managing grain damage and its weight loss was Neem and Karanja oil. Chaubey (2014) [2] found that the essential oil of *Allium sativum* provided both fumigant and contact toxicity at variable concentrations against *C. chinensis* and at low dosage, it also provided repellent, insecticidal, ovipositional activities. The insecticidal activity of five essential oil of plants namely, *Tetrapleura tetraptera*, *Annona muricata*, and *Aframomum melegueta*, *Eucalyptus globulus* and *Ficus exasperate* was investigated by Idoko and Ileke (2020) [5] and they found that *A. melegueta* essential oil was the most effective with 50% lethal concentration (LC50) value. Therefore, in current years, the research has been focused more towards the use of plant products for the protection of store grains.

The perusal of literature reveals that much work has been done for the suppression of *C. maculatus* and *C. chinensis* using botanicals but very little research has been carried out of *C. analis* and that also in North India using North Indian indigenous plants. Therefore, in present study, efficacy of four commonly available North Indian plant oils namely, coconut, kalonji, nilgiri and clove have been tested against *C. analis* on *V. radiata* seeds.

Material and Methods

The experiments were carried out at the Research Laboratory, Department of Zoology, Sri Guru Granth Sahib World University, Fatehgarh sahib, Punjab, India during 2021-22. To maintain the stock culture, seeds of *V. radiata* infested with *C. analis* were procured locally from wholesale shops of district Fatehgarh Sahib. The stock cultures of *C. analis* were maintained on the sterilized *Vigna radiata* (moong) seeds kept in glass jars of 1Kg capacity. The culture jars were covered with muslin cloth for ventilation and secured firmly with rubber bands to prevent the escape of bruchids. These jars were kept in BOD under controlled conditions of temperature and humidity (26^{O}C and 70% RH). The insects were allowed to oviposit and this culture was reared to have at least 3-4 generations of bruchids which were then used for experimentation.

For investigating the efficacy of plants oils, the oils of four commonly available plants namely, *Cocos* (coconut), *Nigella* (kalonji), *Eucalyptus* (Nilgiri) and *Syzygium* (clove) were used. All these oils were procured from the local market of district Fatehgarh Sahib, Punjab.

To test the efficacy of plants oil against *C. analis*, 100g of sterilized moong (*Vigna* radiata) seeds were weighed and placed in jars. The test plant material (oil) was introduced at the concentration of 0.2, 0.6, 0.8 and 1ml/100gm of seeds. One jar was kept as control in which no plant oil was introduced. Each jar containing moong seeds and oil was shaken properly for even coverage of grains. Five pairs of freshly emerged male and female adult beetles were introduced into the test and control jars which were then covered with muslin cloth. The experiment was laid out in five replicates of each dose. The jars were kept in BOD under controlled conditions of temperature and humidity (27^{O}C and 70% RH) (Khinchi et. al 2017) [8].

To test the effectiveness of these plant oils, three parameters namely, adult mortality, oviposition deterrence and emergence of adults from seeds were assessed. The adult mortality count was taken on 2nd, 4th, 6th and 7th day after the treatment of moong seeds with each test plant oil. Insects were considered dead if they failed to respond when their abdomen was rubbed with camel hair brush. Dead adults were removed at each evaluation. The oviposition by *C. analis* females on *V. radiata* seeds was recorded by counting the number of eggs laid on the surface of seeds at 7th day after infestation (DAI). The infested moong seeds were carefully placed back in the experimental glass jars for further reading on adult emergence. For checking the emergence of adults from the eggs laid in experimental jars, the freshly emerged adults were counted from each jar. The data was further analyzed by using statistical tools.

Results

From the investigation, it was found that significant values were observed among various treatments on adult mortality, oviposition by *C. analis* and emergence of F1 progeny from *V.radiata* seeds at different days of infestation. The mean adult mortality of *C. analis* under different treatments of plants oil at various doses has been shown in table 1. It shows that all four plant oils treatment (coconut, kalonji, nilgiri and clove) has affected the mortality of *C. analis* adults. However, Clove oil at 0.2, 0.6,

0.8 mL/100g seeds was observed to be most effective as it caused 100 percent mortality even at 4th day after infestation (DAI). The highest dose of clove oil (1.0 mL) showed 100 percent mortality even at 2nd day after infestation. The nilgiri oil and coconut oil were fairly toxic to adult beetles while the kalonji oil showed little toxicity (54%) at 0.2 mL dose on 2 DAI. There was no significant difference in adult mortality of bruchids was found when compared among all four plant oils. However, all the four plant oils show significant ($p<0.05$) reduction in longevity of *C. analis* as compared to control where only 16 percent mortality was observed at 7th day after infestation.

All four oils (coconut, kalonji, nilgiri and clove) effectively reduced the oviposition by adult female *C. analis* on *V. radiata* seeds. The data in table 2 showed that except coconut, other three plants oil *viz*., kalonji, nilgiri and clove were found to be most effective in suppressing oviposition as the mean oviposition was found to be zero even after 7th day of infestation at all concentrations. However, coconut oil suppresses the fecundity rate only at highest dose of 1.0 ml/100g seed whereas other oils *viz*., kalonji, niligiri and clove completely inhibited the oviposition even at lowest dose of oil i.e., 0.2ml/100g seeds. While comparing effect plants oils on oviposition of *C. analis* with the control, it was found that there was significant reduction ($p<0.05$) in oviposition by all the oils.

While checking the last parameter of adult emergence it was found that as in the jars treated with kalonj, nilgiri and clove oil, there was no any oviposition so obviously there will be no adult emergence and hence the *V. radiata* seeds treated with these oils are completely safe. Moreover, in case of coconut oil there was a mean oviposition of 7 eggs at 0.2 ml dose and 4 eggs on 0.4 ml dose, but no adult was emerged from these seeds also. So it can be interpreted that there was 100% larval mortality by coconut oil also whereas in control, the mean 54.4 adults were emerged from the seeds of moong pulse.

Table 1: Effect of different plant oils on adult mortality of *C. analis*

Plant oils	Doses (mL)	Adult mortality (Mean±SD)			
		Day 2	Day 4	Day 6	Day 7
Coconut	0 (control)	0±0	0.4±0.44	0.4±0.44	0.8±0.36
	0.2	7.40± 0.54***	1.60±0.54***	1±0.70	0±0
	0.6	8.20±0.70***	1.80±0.70	0±0	0±0
	0.8	9.40±0.54***	0.60±0.54	0±0	0±0
	1.0	9.80±0.44***	0.20±0.44	0±0	08±0
Kalaunj	0 (control)	0±0	0.4±0.44	0.4±0.44	0.8±0.36
	0.2	5.80±1.30***	2.60±0.54***	1±0	0.60±0.89
	0.6	8.40±0.54***	1.60±0.54*	0±0	0±0
	0.8	9.60±0.54***	0.40±0.54	0±0	0±0
	1.0	9.80±0.44***	0.20±0.44	0±0	0±0
Nilgiri	0 (control)	0±0	0.4±0.44	0.4±0.44	0.8±0.36
	0.2	8.40±0.54***	1.20±0.44*	0.40±0.54	0±0
	0.6	8.60±0.54***	1.40±0.54	0±0	0±0
	0.8	9.40±0.54***	0.60±0.54	0±0	0±0
	1.0	9.80±0.44***	0.20±0.44	0.60±0.54	0±0
Clove	0 (control)	0±0	0.4±0.44	0.4±0.44	0.8±0.36
	0.2	9.20±0.44***	0.80±0.44	0±0	0±0
	0.6	9.40±0.54***	0.60±0.54	0±0	0±0
	0.8	9.80±0.44***	0.20±0.44	0±0	0±0
	1.0	10±0***	0±0	0±0	0±0

Table 2: Mean number of oviposition by adult female *C. analis* on *V. radiata* seeds on 7th day after infestation

Dose	Coconut oil	Kalaunj oil	Nilgiri Oil	Clove oil	Control
0.2 ml/100 g seeds	7±3.53	0±0	0±0	0±0	78.6±5.20
0.6 ml/100 g seeds	4±1.58	0±0	0±0	0±0	
0.8 ml/100 g seeds	1.4 ±0.89	0±0	0±0	0±0	
1.0 ml/100 g seeds	0.20±0.44	0±0	0±0	0±0	

Discussion

Plant based oils are the best options for cheaper, safer and eco-friendly for synthetic insecticides. The results of the present study revealed that plants oil (Coconut, Kalonji, Nilgiri and clove) had promising effect on adult mortality, oviposition and adult emergence of *C. analis*. The traditional methods for the control of bruchids have been used as alternative to chemical insecticides that pose various health hazards to consumers (Isman 2006) [6]. Various workers studied the effect of different plant oils on the *Callosobruchus* species that provide entomotoxic properties. The

oils derived from plants acts as pesticides and insect repellent. The dead insects from oil treated grains shows the sign of rapid immomobilsation, their legs are sticked to either grains or the containers. These plant based oils also possess egg killing properties, in which some eggs are unable to hatch or develop further. This leads to low emergence of adult beetles from the laid eggs on grains. Sometimes the eggs are unable to glued on grains due to sticky surface of oil treated pulses. The oviposition decreased due to the blocking of spiracles thus causing respiratory impairment that affects the metabolism of body.

In our study we found that coconut oil is least effective amongst all the other oils as it does not completely inhibit the oviposition. This is in conformity with earlier reports by S.K. Zingral and Z. Singh (2008), Khinchi *et al* (2017) [8] who also investigated the efficacy of coconut oil against pulse beetle *C. chinensis* on chickpea seeds and investigated that the coconut oil is least effective at various doses as compared to other plant oils.) Later on, Idoko and Iieke (2020) [5] studied the effect of *Eucalyptus globulus* oil against *C. maculatus* on cowpea seeds. They found that *Eucalyptus* oil inhibited the egg laying capacity of female beetle on seeds. They also noticed that oil made the surface of the seeds slippery and therefore more of eggs were unable to stick on the seeds. The results of our study for eucalyptus and clove oil are consistent with the reports of other workers who showed that application of both oils completely abolished the oviposition and adult emergence (Gonzales et. al 2015) [4]. Several studies have reported that the insecticidal activity of clove oil is due to the primary constituent present in it. Those major constituents are eugenol, beta-caryophyllene that damages the insect nervous system by disturbing the function of Gabaergic and aminergic system due to inhibition of acetyl cholinesterase activity (Keane et. al 1999) [7].

The extensive use of chemical pesticides not only produces genetic resistance by insect species but also causes serious problems of toxicity to human life and other animal species. Therefore, the oil extracted from plants represents a botanical insecticide source, since it showed a potent insecticidal activity comparable to the synthetic pesticides.

Thus, our experiment findings disclosed the adequate insecticidal activities of all the four plant oils against *C. analis* and demonstrated that, even at low doses, these botanical compounds impaired the ability of *C. analis* to damage the mooong pulse, which acts as suitable tools for the control of stored insect pest in domestic storage of pulses.

Conclusion

The statistical analysis of all the three parameters (adult mortality, oviposition and adult emergence) reveals that the plants oils contains active ingredients that protect the *V. radiata* seeds from stored grain pest *C. analis*. The best oil comes out to be clove oil as it caused 100 percent mortality on second day of infestation at each dose. Hence, these plant-based oils proved to be best alternative in place of hazardous chemical insecticides to control the bruchid population.

Acknowledgement

Authors are highly thankful to Late Dr. H.R. Pajni for providing his valuable guidance in planning this work. We are thankful to Sri Guru Granth Sahib World University and funding agency UGC for providing facilities to carry out this research work.

Authors's Statement

MA contributed to frame and implementation of research work. PK Conducted experiments, analyse the data and write the manuscript in consultation with MA and CKS. All the three authors read and finalize the manuscript.

Conflicts of Interest

All authors declared that they have no conflict of interest.

References

1. Bhalla S, Kapur ML, Gupta K, Lal B, Khetrapal RK. Checklist of bruchids associated with seeds of different plant genera. New Delhi: NBPGR, 2006, 38.
2. Chaubey MK. Biological activity of Allium sativum essential oil against pulse beetle, Callosobruchus chinensis (Coleoptera: Bruchidae). Herba Pol,2014:60(2):41-55.
3. Ekoja and Ogah. Efficacy of oils from nine plant species as protectants against infestation by Callosobruchus maculatus F. (Coleoptera: Chrysomelidae). World J Adv Res Rev,2020:7(30):7-15.
4. Gonzales CYDCG, Faroni LR, Haddi K, Oliveira EE, Pereira EJG. Locomotory and physiological responses induced by clove and cinnamon essential oils in the maize weevil Sitophilus zeamais. Pestic Biochem Physiol,2015:125:31-7.
5. Idoko and Ileke. Comparative evaluation of insecticidal properties of essential oils of some selected botanicals as bio-pesticides against Cowpea bruchid, Callosobruchus maculatus (Fabricius) [Coleoptera: Chrysomelidae]. Bull Natl Res Cent,2020:44:119.
6. Isman MB. Botanical insecticide deterrents and repellants in modern agriculture and on increasingly regulated world. Annu Rev Entomol,2006:51:45-66.
7. Keane S, Ryan M. Purification, characterisation, and inhibition by monoterpenes of acetylcholinesterase from the waxmoth, Galleria mellonella (L.). Insect Biochem Mol Biol,1999:29(12):1097-104.
8. Khinchi SK, Sharma MM, Khinchi MK, Bairwa DK, Acharya D, Naga BL, Naga RP. Studies on efficacy of certain vegetable oils against pulse beetle, Callosobruchus chinensis Linn. on chickpea, Cicer arietinum (L.). Int J Chem Stud,2017:5(3):255-9.
9. Mehta PS, Negi KS, Rathi RS, Ojha SN. Indigenous methods of seed conservation and protection in Uttarakhand Himalaya. Int J Tradit Knowl,2010:11(2):279-82.
10. Mishra SN, Jena BC, Guru BC. Study of impact of edible and non-edible oils on grain damage and weight loss of green gram in storage condition infested with pulse beetle Callosobruchus chinensis. Int J Sci Res,2013:4(10):1021-5.
11. Nair RM, Yang RY, Easdown WJ, Thavarajah D, Thavarajah P, Hughes JD, Keatinge JD. Biofortification of mungbean (Vigna radiata) as a whole food to enhance human health. J Sci Food Agric,2013:93(8):1805-13.
12. Nishad RN, Singh RB, Kumar S, Yadav SK. Eco-friendly management of pulse beetle Callosobruchus chinensis Linn. of stored chickpea seed. Int J Chem Stud,2020:8(3):5-8.
13. Pajni HR, Gill M, Singla A. Citriodora oil of Eucalyptus and eucalyptus oil, new fumigants against insect pests. Indian Biol,1991:2(1-2):111-2.
14. Pajni HR, Gupta IJ. Biology of bruchidae. New Delhi: Indian Council of Agricultural Research, 2012.
15. Raghu B, Kumar RP, Gowda B, Manjunatha N, Alur RS. Post-harvest seed quality of green gram as influenced by pre-harvest spray of insecticides. Indian J Agric Res,2016:50(2):113-6.
16. Shaaya E, Kostjukvski M, Eilberg J, Sukprakarn C. Plant oils as fumigants and contact insecticides for the control of stored product insect. J Stored Prod Res,1997:33(1):7-15.
17. Singh S, Singal SK, Verma AN. Evaluation of some edible oils as protectants of chickpea seeds, Cicer arietinum L. against pulse beetle, Callosobruchus chinensis (L.) by preferential feeding method. Proc 5th Int Work Conf Stored Prod Prot,1990:1715-24.
18. Southgate BJ. The importance of the Bruchidae as pests of grain legumes, their distribution and control. In: Singh SR, Van Emden HF, Taylor TA, editors. Pests of Grain Legumes: Ecology and Control. London: Academic Press, 1978, 219-29.
19. Tripathi AR, Prajapati V, Aggarwal KK, Kumar S. Insecticidal and ovicidal activity of the essential oil of Anethum sowa Kruz against Callosobruchus maculatus F. (Coleoptera: Bruchidae). Insect Sci Appl,2006:21(1):61-6.