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Efficacy of Some Essential Oils against *Caryedon serratus* (Olivier) – A Storage Pest of Groundnut

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A laboratory study evaluated the efficacy of essential oils, particularly camphor oil and peppermint oil, to control groundnut bruchid, *Caryedon serratus* (*Coleoptera: Chrysomelidae*) in stored peanuts. At a 3% concentration, these oils achieved impressive results, killing all adult bruchids within 24 hours and preventing adult emergence over 45 days. This suggests they have strong fumigant and ovicidal properties. While camphor oil @ 5 ml per Kg also showed some effectiveness, it has low potency compared to other treatments, resulting in only 75 per cent adult mortality and allowing some new adults to emerge. Additionally, the (T1) camphor oil @ 5 ml per Kg treatment led to minor damage to the peanut kernels, unlike the other

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treatments. This study emphasizes the potential of specific essential oils as natural and eco-friendly alternatives for controlling pests in stored peanuts, aligning well with sustainable agricultural practices.

Keywords: Arachis hypogaea; groundnut bruchid beetle; camphor oil; peppermint oil; stored peanuts.

1. INTRODUCTION

Groundnut, scientifically known as *Arachis hypogaea* L. and commonly referred to as peanut or monkey nut, is a vital leguminous crop. Native to South America, it is extensively cultivated in tropical and subtropical regions worldwide. In India, groundnut is primarily grown as both an oil seed crop and a food legume. Groundnut kernels are an affordable protein source, containing 45-50 per cent oil, 25 per cent protein, and 75-80 per cent fatty acids [1]. Despite its nutritional value, groundnut storage in the form of pods and kernels was vulnerable to insect pest attacks, which degrade quality. The groundnut bruchid, *Caryedon serratus* (*Coleoptera: Chrysomelidae*), was notably a significant pest causing 20-50 per cent losses in stored groundnuts in various cultivation areas globally [2,3,1].

C. serratus was first reported in India in 1914, *C. serratus* larvae infest groundnut seeds by boring into them and feeding on the embryo and endosperm, with mature larvae exiting for pupation through holes [4]. This infestation leads to significant quantitative and qualitative losses in groundnut, which affecting both seeds intended for milling and pods for planting. The damage includes reduced dry mass of the kernels, increased free fatty acids in the oil (lowering quality), and decreased germination potential [5,1]. Among post-harvest pests, the groundnut bruchid, *Caryedon serratus* (Olivier), is a significant primary feeder, responsible for approximately 17-47% pod damage [6]. This species is unique in its ability to penetrate intact pods and infest the kernels, resulting in a loss of 19 to 60%. The damage caused by this pest results in poor germination, reducing seed quality. The egg, larval, and pupal stages last between 3 to 9, 19 to 38, and 9 to 34 days, respectively. The adult lifespan ranges from 19 to 30 days, and the total lifecycle spans 43 to 70 days [7]. Understanding the pest's lifecycle is essential for effectively timing pest management strategies [8]. Studies have shown that the pod damage is higher in oil mills compared to cold storage units [9]. Additionally, infestation results in contamination of the stored groundnut with insect body parts, excreta, and a foul smell, along with increased aflatoxin content, which poses serious health risks to humans, poultry, and livestock [10,11].

Aluminium phosphide is commonly used as a grain preservative to manage bruchid infestations in storage, particularly in groundnuts [12]. Abder-Rahman [13] reported exposure to aluminum phosphide can lead to severe health issues, including damage to the lungs, heart, and blood vessels. Therefore, since groundnuts are often consumed directly, the use of inorganic insecticides must be carefully regulated. Consequently, there is a strong recommendation to promote the use of biorational approaches for controlling storage grain insect pests. Many plants naturally exhibit deterrent, antifeedant, repellent, and insecticidal properties, and their use in pest control has been explored for decades globally [14,15]. In this context, a study was undertaken to evaluate the efficacy of essential oils as a bio-rational alternative for controlling the groundnut bruchid.

2. MATERIALS AND METHODS

An experiment was conducted in the seed science laboratory, Department of Seed Science and Technology, Tamil Nadu Agricultural University (TNAU), Coimbatore, India. Groundnut bruchid beetle, *Caryedon serratus* are used for the experiment. Essential oils were used for the efficacy treatments.

2.1 Preparation of Groundnut Sample

A 100-gram sample of groundnut pods was placed in a 250 ml container. Essential oils were applied to the groundnut to assess their efficacy against the groundnut bruchid beetle, *C. serratus*. The experiment included five treatments, *i.e.,*

T1 – Camphor oil @ 5 ml per Kg
T2 – Camphor oil @ 10 ml per Kg
T3 – Peppermint oil @ 5 ml per Kg
T4 – Peppermint oil @ 10 ml per Kg
T5 – Control (Untreated)

2.2 Inoculation of Culture (Adult Insects) to the Groundnut Sample

Two pairs of newly emerged adults of *C. serratus* were collected from the mother culture. The adults were released into containers with groundnut treated with Camphor oil (5 ml per Kg) and other treatments. The control group did not contain essential oil. After releasing the adults, the containers were covered with muslin cloth and tied with a rubber band. Observations were taken daily.

2.3 Experimental Set Up

Statistical analysis was performed using SPSS software and data was summarized using Tukey's HSD test for significant differences between treatments.

Fig. 1. Camphor oil and Peppermint oil

List 1. Parameters to be observed

Number of Adult Emergence
Damaged pods = (No of Damaged pods) / (No of pods) × 100
Weight loss of pods = (Wu × Nd) – (Wd × Nu)/ (Wu × (Nd+Nu) × 100 [16]
Abbott's formula was used to calculate actual mortality (Abbott, 1925)
Actual mortality % = (Observed mortality – Control mortality) / (100 – Control mortality) ×100

Fig. 2. Treatments to check the efficacy of *C. serratus*

3. RESULTS

3.1 Mortality Rates of *Caryedon serratus*

The application of essential oils resulted in varying mortality rates of *Caryedon serratus* adults among the five treatments. A complete mortality rate (100 per cent) was observed in the different treatments which include groundnut treated with camphor oil @ 10 ml per Kg (T2), peppermint oil @ 5 ml per Kg (T3), and peppermint oil @ 10 ml per Kg (T4). In contrast, the camphor oil @ 5 ml per Kg (T1) treatment achieved a lower mortality rate of 75 per cent. The control group (untreated) (T5) showed no mortality rate, indicating the natural survival rate in the absence of essential oils.

3.2 Adult Emergence of *C. serratus*

Adult emergence of *C. serratus* varied significantly among the five treatments. No adult emergence was recorded in the camphor oil @ 10 ml per Kg (T2), peppermint oil @ 5 ml per Kg (T3), and peppermint oil @ 10 ml per Kg (T4) treatments, demonstrating their efficacy in completely inhibiting the development of adults. However, the camphor oil @ 5 ml per Kg (T1) treatment resulted in the emergence of 16 adults, indicating partial suppression of adult development. The control group (T5) displayed natural adult emergence, consistent with untreated conditions (Table 1).

3.3 Groundnut Kernel Damage

Groundnut kernel damage was assessed to determine the impact of the treatments on the stored product. The camphor oil @ 5 ml per Kg (T1) treatment resulted in 17.33 per cent kernel damage, implying some level of protection but not complete efficacy. In contrast, no kernel damage was observed in the camphor oil @ 10 ml per Kg (T2), peppermint oil @ 5 ml per Kg (T3), and peppermint oil @ 10 ml per Kg (T4) treatments, indicating their superior protective effects. The control group (T5) experienced unspecified kernel damage, likely higher than the treated groups, reflecting the effectiveness of the treatments.

These results suggest that camphor oil at 10 ml/kg (T2), peppermint oil at 5 ml/kg (T3), and peppermint oil at 10 ml/kg (T4) were highly effective in achieving complete mortality, preventing adult emergence, and protecting groundnut kernels from damage. Camphor oil at @ 5 ml/kg (T1), exhibiting some insecticidal properties, was less effective, allowing for partial *C. serratus* adult emergence and groundnut kernel damage. These findings support the potential use of camphor oil and peppermint oil at different doses as superior natural alternatives for pest management in groundnut storage. Tukey's HSD test results indicate that both camphor oil (T1 and T2) and peppermint oil (T3 and T4) significantly reduce the mean difference in comparison to the control (T5). There is no significant difference between the effects of camphor oil and peppermint oil at either concentration (Table 3). However, all treatments (T1-T4) significantly differ from the untreated control (T5), demonstrating the substantial impact of the oils on the measured outcomes.

Fig. 3 A. Infested pods of Groundnut, B. Infested kernels, C. Adult bruchid beetle, D. Pupae attached to the outside of the pod, E. Damaged pods

Table 1. Adult emergence, per cent damage and per cent weight loss by bruchid beetles on groundnut

Treatment	Adult Mortality				Adult Mortality (Per Cent)	Adults Emerged after 45 Days	% Kernels Damaged	% Weight Loss of Pods
	Day1	Day2	Day3	Day4				
T1	-	2	1	-	75	16	17.33	8.42
T2	3	1	-	-	100	-	-	-
T3	4	-	-	-	100	-	-	-
T4	4	-	-	-	100	-	-	-
T5	-	-	-	-	-	79	81.1	52.95%

Table 2. Analysis of Variance (ANOVA) for the Effect of Different Treatments on Adult Emergence, Kernel Damage, and Weight Loss in Groundnuts

Parameter	Source of Variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F-Value
Adults Emerged	**Between Groups**	10806.67	4	2701.67	6657.76
	Within Groups	1.625	10	0.1625	
	Total	**10808.3**	**14**		
% Kernels Damaged	**Between Groups**	24658.96	4	6164.74	3022.99
	Within Groups	2.04	10	0.204	
	Total	**24661.0**	**14**		
% Weight Loss of Pods	**Between Groups**	9182.87	4	2295.72	1782.52
	Within Groups	12.875	10	1.2875	
	Total	**9195.74**	**14**		

Table 3. Tukey's HSD comparison of treatments

Comparison	Mean Difference	p-value	Lower Bound	Upper Bound	Significant
T1 vs T2	-16.0	0.001	-19.452	-12.548	*
T1 vs T3	-16.0	0.001	-19.452	-12.548	*
T1 vs T4	-16.0	0.001	-19.452	-12.548	*
T1 vs T5	64.0	0.001	60.548	67.452	*
T2 vs T3	0.0	0.9	-3.452	3.452	Ns
T2 vs T4	0.0	0.9	-3.452	3.452	Ns
T2 vs T5	80.0	0.001	76.548	83.452	Ns
T3 vs T4	0.0	0.9	-3.452	3.452	Ns
T3 vs T5	80.0	<0.005	76.548	83.452	*
T4 vs T5	80.0	<0.005	76.548	83.452	*

*NS = Not Significant and * Indicates significant treatments difference at the p value < 0.05 level*

4. DISCUSSION

The current study demonstrates the efficacy of essential oils in managing groundnut bruchid infestations. Camphor oil, at a concentration of 10 ml per Kg was applied, which showed 100 per cent adult mortality of *C. serratus* within 24 hours and no adult emergence after 45 days. This indicates that camphor oil @ 10 ml per Kg (T2) possesses strong fumigant and ovicidal properties, effectively preventing both adult bruchid survival and subsequent generation emergence. These findings align with previous studies where essential oils have been reported to exhibit significant insecticidal properties due to their volatile nature, which enables them to act as fumigants [17,18].

In contrast, camphor oil @ 5 ml per Kg (T1) resulted in only 75 per cent adult mortality and

allowed the emergence of 16 adults after 45 days, demonstrating a comparatively lower efficacy. Despite this, the high mortality rate suggests that camphor oil @ 5 ml per Kg (T1) has the potential to act as an insecticidal agent, though its ovicidal activity appears to be less effective than camphor oil @ 10 ml per Kg (T2). Similar findings have been documented where essential oils vary in their efficacy against different life stages of insects [19].

Moreover, the study highlights that pepper mint oil @ 10 ml per Kg (T4) also achieved 100 per cent adult mortality with no emergence of adults, indicating its potential as an effective pest control agent. The use of essential oils such as citronella and ocimum has been well-documented for their bioactive properties against various pests [20]. These oils contain compounds like eugenol, linalool and citronella which have been shown to disrupt the nervous system of insects, leading to mortality and inhibition of oviposition [21,22].

The observed fumigant and ovicidal activities of these essential oils provide an eco-friendly alternative to synthetic pesticides, which often pose risks to human health and the environment (Isman, 2006). The study's findings support the use of peppermint, citronella, and ocimum oils as potent bio-pesticides for the protection of stored groundnuts. This approach aligns with Integrated Pest Management (IPM) strategies aimed at reducing chemical residues in food products and promoting sustainable agricultural practices [23,24].

5. CONCLUSION

Essential oils were found to be effective in managing the ground nut bruchid beetles at 10 ml per Kg. Bruchids infesting stored groundnut may be managed using essential oil, which is an eco-friendly method rather than a chemical method of controlling pests.

DISCLAIMER (ARTIFICIAL INTELLIGENCE):

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Sakhare VM, Mutkule DS, Kharade VG. Biology of groundnut bruchid (*Caryedon serratus*) (Olivier) on different groundnut varieties. Journal of Entomology and Zoology Studies. 2018;6(4):1577-1580.
2. Alabi OY, Odebiyi JA, Jackai LEN. Field evaluation of cowpea cultivars (*Vigna unguiculata* (L) Walp.) for resistance to flower bud thrips (*Megalurothrips sjostedti* Trybom) Thysanoptera: Thripidae). International Journal of Pest Management. 2003;49(4):287- 291.
3. Rekha G. Screening of groundnut genotypes against (*Caryedon serratus* Olivier) (Bruchidae: Coleoptera) M.Sc (Ag.). Thesis, Acharya N G Ranga Agricultural University, Guntur; 2015.
4. Fletcher TB. Some South Indian insects and other animals of importance: considered especially from an economic point of views. Superintendent Government Press, Madras. 1914;565.
5. Howe RW. Losses caused by insects and mites in stored foods and feeding stuffs. Nutrition Abstracts and Reviews. 1965; 35:285-303.
6. Bhogeesh BM, Mutthuraju GP, Pradeepa SD, Thirumalaraju GT, Arati Pannure, Bommesha B. Evaluation of newer insecticides as fabric treatment against *Caryedon serratus* (Olivier) (Coleoptera: Bruchidae) on stored groundnut. International Journal of Plant Protection. 2014;7(1):35-40.
7. Sandeep RS. Biology and management of groundnut pod borer *Caryedon serratus* (Olivier) in groundnut pods. M Sc Thesis, Acharya N G Ranga Agricultural University, Rajendranagar, Hyderabad. 2005;48-51.
8. Arif MJ, Gogi M D, Sufyan M, Nawaz A, Sarfraz RM. Sustainable insect pest management. University of Agriculture, Faisalabad, Pakistan. 2017;17-47.
9. Manjunath J, Manjula K, Hariprasad K V, Muralikrishna T, Prasad TNVKV, Ravindra Reddy B. Morphological and genitalia description of peanut seed beetle (*Caryedon serratus* Oliver) (Coleoptera: Chrysomelidae, Bruchinae). International Journal of Current Microbiology and Applied Sciences. 2018;7(08): 2971-2983.
10. Vijayasamundeeswari A, Mohankumar M, Karthikeyan M, Jayanandraj S, Paranidharan V, Velazhahan R. Prevalence of aflatoxin B1 contamination

in pre- and post-harvest maize kernels, food products, poultry and livestock feeds in Tamil Nadu, India. Journal of Plant Protection Research. 2009;49:221–224
11. Chaytor AC, See MT, Hansen JA, de Souza ALP, Middleton TF, Kim SW. Effects of chronic exposure of diets with reduced concentrations of aflatoxin and deoxynivalenol on growth and immune status of pigs. Journal of Animal Science. 2011;89:124–135
12. Harish G, Holajjer P, Savaliya SD, Gedia MV. Population density on damage of groundnut by Caryedon serratus. Annals of Plant Protection Science. 2012;20:217–219
13. Abder-Rahman H. Effect of aluminum phosphide on blood glucose level. Veterinary and Human Toxicology. 1999;41:31–32.
14. Tripathy MK, Das BC, Mohanty S. Efficacy of few botanicals against seed beetle, Caryedon serratus Olivier (*Coleoptera: Bruchidae*) infesting stored groundnut under Bhubaneshwar condition. Indian Journal of Agricultural Research. 2004;38:15-21
15. Mishra PR, Dash D. Management of the groundnut bruchid, Caryedon serratus (Olivier) with some botanicals. Journal of Entomological Research. 2009;33:139-141.
16. Gwinner J, Harnisch R, Muck O. Manual on the prevention of post harvest seed losses, post-harvest project, GTZ, D-2000. Hamburg, FRG. 1996;294
17. Isman MB. Plant essential oils for pest and disease management. Crop Protection. 2000;19(8-10):603-608.
18. Shaaya E, Ravid U, Paster N, Juven B, Zisman U, Pissarev V. Fumigant toxicity of essential oils against four major stored-product insects. Journal of Chemical Ecology. 1997;23(4):747-754.
19. Regnault-Roger C, Vincent C, Arnason JT. Essential oils in insect control: Low-risk products in a high-stakes world. Annual Review of Entomology. 2012;57:405-424.
20. Tripathi AK, Upadhyay S, Bhuiyan M, Bhattacharya PR. A review on prospects of essential oils as biopesticide in insect-pest management. Journal of Pharmacognosy and Phytotherapy. 2009;1(5), 52-63.
21. Nerio LS, Olivero-Verbel J, Stashenko E. Repellent activity of essential oils: A review. Bioresource Technology. 2010;101 (1):372-378.
22. Regnault-Roger C, Philogène BJR, Vincent C. Biopesticides of plant origin. Lavoisier Publishing; 2005.
23. Abbott WS. A method of computing the effectiveness of an insecticide. Journal of Economic Entomology. 1925;18:265-267.
24. Isman MB. Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. Annual Review of Entomology. 2006;51:45-66.

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