



Protectant Effect of Vegetable Oils against Cowpea Weevil (*Callosobruchus maculatus*) on Stored Cowpea [*Vigna unguiculata* (L.) Walp]

Kennedy Poloma Yoriyo^{1*}, Garba Usman¹, Ezra Abba¹ and Michael Mamman Degri²

¹Department of Zoology, Faculty of Science, Gombe State University, Gombe, Nigeria.

²Department of Agronomy, Faculty of Agriculture, Federal University Kashere, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Authors KPY and GU designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors EA and MMD managed the analyses of the study and literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Cowpea is one of the common edible annual herbaceous legume. *Callosobruchus maculatus* is one of the common post-harvest pest of cowpea. This work was aimed at determining the protectant effect of five vegetable oils; coconut oil, cotton seed oil, groundnut oil, palm oil and sesame oil for the protection of stored cowpea against cowpea weevil (*Callosobruchus maculatus*). The study was conducted in Gombe State University between October, 2018 and April, 2019. Black eye seeds were used for the experiment. A completely randomized design with five replicates per treatment was used. Black eyed seeds (susceptible variety) used for the experiment were subjected to different oil treatments namely: coconut, cotton, groundnut, palm and sesame oils applied at 0.4, 0.8 and 1.2 ml/100 g of cowpea equivalent to 4, 8 and 12 kg. Effect of the oils on weight lost and seed germination was also tested. Percentage adult mortality at 12 ml/Kg revealed that all the five oils killed 100% of the insects. Among the different edible oils evaluated, cotton seed oil was more effective killing 95% of the insect at 4 ml/kg and 100% at 8 ml/kg. The lowest mortality was recorded in the treatment with palm oil with 60 and 91.67% mortality at 4 and 8 ml/kg

*Corresponding author: Email: kennedypoloma@gmail.com;

dose treatment respectively. Minimum percentage weight loss after 90 days of storage was observed in grains treated with cotton seed oil (1.95%) followed by sesame oil (2.00%) and groundnut oil (2.38%) at 12 ml/kg grains. Cotton seed oil, groundnut oil and sesame oil at doses between 8 and 12 ml/kg could be effective for protecting cowpea in storage against cowpea weevil for 90 days of storage. All the treatments indicated minimal effect on the germination of cowpea. The 8 ml/kg of cotton seed, groundnut and sesame oils investigated are promising bio friendly preservatives that could serve as an alternative formulations to synthetic chemical based insecticides for storage of cowpea.

Keywords: Coconut; cotton seed; groundnut; palm; sesame oil; protectant.

1. INTRODUCTION

The primary insect pest responsible for causing losses to stored cowpea is the cowpea weevil, *Callosobruchus maculatus*. Infestation mostly begins at low level while in the field. After the crop is placed in store; the insect population continues to thrive until it becomes obvious and severe [1-3]. The larval stage of *C. maculatus* has been reported to be most destructive as the adult do not feed. It was noted that farm storage of cowpea for six months is repeatedly accompanied by about 30% loss in weight, with up to 70% of the seeds being damaged, rendering them virtually unfit for consumption [4,5].

The bulk of food consumed in Northern Nigeria is produced by small-scale farmers using traditional methods and there is widespread misuse of insecticides with serious consequences. However, storage losses are substantial despite the use of storage insecticides by many merchants. Consequently, most farmers sell cowpea shortly after harvest, in part because they do not want to deal with the storage problems [6].

The steady escalation in the cost of synthetic pesticides, the health hazards as well as the development of insecticides resistance by the insects posed a great threat in the management of the storage pest [7]. Other findings noted that the use of conventional pesticides lead to the reduction in crop yield by up to one-third through impaired nitrogen fixation. Hence, the suggestion to have an alternative control measure that can enhance yield in an adequately managed organic farming system [8]. Vegetable oils are reported as one of such viable alternatives to control some insect pests of stored products, including *C. maculatus*. It has been reported that they have the potentiality of having bioactive compounds against several species of insect pest and vectors and have been proven to be

environmentally friendly less hazardous to human health [9-13].

Dennis [14] reported that coating legume seeds with oils extracted from plant is effective in bruchid damage control. Also, the findings of [15] compared the effectiveness of groundnut oil, steam treatment and pirimiphosmethyl for the control of *Callosobruchus maculatus* and reported that groundnut oil was nearly as effective as pirimiphosmethyl. Pacheco et al. [16] reported that refined soybean oil and castor-oil inhibited the population growth of *C. maculatus* and *Callosobruchus phaseoli* (Gyllenhal) as compared to the untreated seeds. Several other studies have demonstrated the effectiveness of different vegetable oils in protecting grains against major stored product insect pests [17-20]. Oil induced reduction or complete inhibition of oviposition of female bruchids and mortality of the developmental stages has been reported by a number of workers [21].

The work is aimed at determining the protectant effect of some vegetable oils for protection of stored cowpea against *C. maculatus* infestation with the specific objectives of determining the adult mortality, seed weight loss and germination.

2. MATERIALS AND METHODS

The experiment was conducted under laboratory conditions at the Insectary, Department of Biological Sciences, Gombe State University. Black-eyed cowpea variety used for this experiment was obtained from Gombe main market ("Tudun Hatsi"). The coconut oil, cotton seed oil, groundnut oil, palm oil and sesame oil were obtained from Gombe Old market.

2.1 Experimental Design

Five treatments each consisting of coconut oil, cotton seed oil, groundnut oil, palm oil and sesame oil applied at different concentrations of

0.4, 0.8, and 1.2 ml/100 g grains of cowpea equivalent to 4, 8, and 12 ml/Kg grains of cowpea and a control were laid out in a Completely Randomized Design in three (3) replicates according to the methods prescribed in [22-25] with minor modifications.

2.2 Culturing of Experimental Insects

Culturing of experimental insects was done using the procedure described by [26-27]. Cowpea grains were sterilised for 2 hours in an oven at 60°C. 5 kg of the sterilized cowpea grain were put in separate clean jars. Adult cowpea weevils (*C. maculatus*) obtained from heavily infested cowpea were introduced into the jars and then covered with muslin cloth held in place by rubber bands. This ensured that aeration was maintained in the jars and also prevented the escape of introduced insects. The jars were placed in plastic trays and the culture maintained in the laboratory at 25±2°C and 65-70% relative humidity. After 20 days of setting up the experiment, the cultures were set up; the jars were emptied and all the insects (both the living and the dead) were removed and the jars refilled with the same grains. From the 30th day of each culture, the first adult began to emerge and these were used for the experiment. Forceps and camel hair brushes were used for transferring the grains and insects respectively. Hand lens and microscope were used to view laid eggs, hatched eggs as well as adults' sex separation.

2.3 Sample Preparation of Test Oils

The three oils were thoroughly mixed with 100 g grains in a plastic container (capacity 250 g). The quantity of oil (0.4, 0.8, and 1.2 ml/100 g grains) for all the treatments were measured with the help of micro-pipette and discharged on the grains.

2.4 Effect of Grain Protectant Oils

In each plastic container, 100 g of treated/untreated cowpea grains and 10 pairs of freshly emerged cowpea weevil adults were released. The containers were covered with muslin cloth held in position with the help of rubber band kept at a temperature of 28 ± 1°C and 70 ± 5% relative humidity. The adults released were removed after 10 days. Effect on adult mortality, F1 Progeny emergence, grain weight loss and seed germination were evaluated [22,24].

Mortality of adult *C. maculatus* was assessed after 3 days of introduction into various treatments. Numbers of dead adults in each container were counted after 72 hours. To determine the effect of tested oils on the adult emergence, total number of adults (F1 Progeny) emerged from each treatment were counted 35 days after oviposition. The percentage of grain weight loss caused by *C. maculatus* at 45 and 90 days after treatment were calculated as follows:

Percentage weight loss =

$$\frac{\text{initial weight} - \text{weight of sound and damaged grains}}{\text{initial weight}} \times 100$$

To examine the effect of test materials on viability of the treated grains, the germination of untreated and treated grains were observed. For this, 20 grains from each treatment in three replications were taken at random and placed in petri dishes lined with moistened blotting/filter paper. These petri dishes were kept at room temperature for 6 days which allow the grains sufficient time to germinate. Numbers of sprouted/unsprouted grains were counted and germination percentage determined. The germination percentage of seed was calculated according to [9] thus:

$$G.P. = \frac{(TG - UG)}{2TG} \times 100$$

Where G.P. = Germination percentage; T.G. = Number of total grains; U.G. = Number of ungerminated grains

2.5 Data Analysis

The data was analyzed using 2-Way Analysis of Variance (ANOVA) at $P \leq 0.05$ with SPSS version 16.0 and results presented in a Standard Error bar chart.

3. RESULTS AND DISCUSSION

3.1 Effect of Oils on Adult Mortality

The result showed that with increase in dose of edible oils, mortality of insects also increased. All the oils showed the maximum (100%) mortality at 12 ml/kg grain. At 8 ml/kg, cotton and groundnut oils showed the maximum adult mortality of 100% followed by sesame oil (96.67%), palm oil (91.67%) and coconut oil (85.00%). At 4 ml/kg cotton oil recorded highest adult mortality (95.00%) followed by groundnut oil (85.00) and coconut oil (75.00). The least, 60.00% was

observed in palm oil “Fig. 1”. These findings revealed that the adult mortality gradually increased with the increase in dose of each treatment. This concur with the findings of [27-28] who reported that groundnut oil at 0.3 ml/100 g gave complete protection of green gram against *C. maculatus*. Udo [29] reported mortality in cowpea grains treated with groundnut oil after 24 hours of application.

3.2 Effect of Vegetable Oils on Grain Weight Loss after 45 and 90 Days

The effect of the vegetable oils on the weight of the Cowpea were assessed. At 45 days the percentage weight loss of the grain generally in the whole treatment were between 1.17 and 10.37% while the control showed 19.73% weight loss. The highest weight loss for the treated grains (10.37%) were observed in treatment with 4 ml/kg palm oil treatment while the lowest (1.17) was noted in the treatment with cotton seed oil at 12 ml/kg. (Fig. 2). Generally, there is a negative correlation between dose of oils and weight loss as reported by [30]. After 90 days, the weight of the grains were evaluated again. Fig. 3 showed that at 4 ml/kg, the maximum (20.88%) percent weight loss was recorded in grains treated with coconut oil while the lowest was recorded in cowpea treated with cotton seed oil (8.32%). At the dosage level of 8 ml/kg the maximum (12.59%) weight loss was recorded in palm oil treated grains while the least weight loss of 4.43% was recorded in groundnut and cotton

seed oils. Then, at 12ml/kg the maximum (8.77%) weight loss was also in palm oil treated grains whereas the least were noted in groundnut oil treated grains (1.95%). The effect of different edible oils on grain weight loss caused by *C. maculatus* as shown in Fig. 2 and 3 revealed that the edible oils at all concentrations significantly reduced the loss of weight of Cowpea attributed to *C. maculatus* especially when compared to the control. These findings is in agreement with [27,31-34] who reported that grains treated with vegetable oils ranging from 5 – 20 ml/kg significantly reduced loss in weight of pulses as compared to untreated grains. Udo [29,35-36] also reported similar findings in their work using palm oil, groundnut oil, custard and mustard grain extract at varying dosage levels ranging from 0.1 - 1.4 ml/100 g grains.

3.3 Effect of Oils on Seed Germination

It was observed that all the grains treated with 12ml/kg of the five different oils including the control showed a germination rate between 81.67 and 88.35. For the dose of 8 and 4 ml/kg the percentage germination range between 83.33 and 88.35% including the control (Fig. 4). All the treatments indicated minimal effect on the germination of cowpea with each other as well as with control. This implies that these oils could be safe for seed storage purposes. Several reports also concur with this finding [37-40]. Similarly, [41,42] reported that seed viability was not affected by the oils treatment.

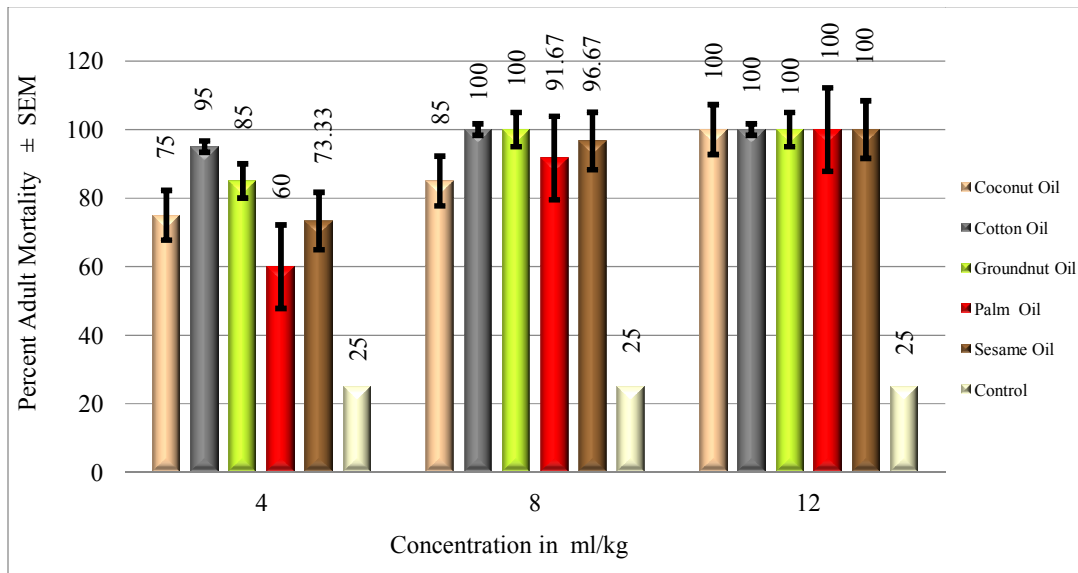


Fig. 1. Effect of vegetable oils against cowpea weevil (*Callosobruchus maculatus*)

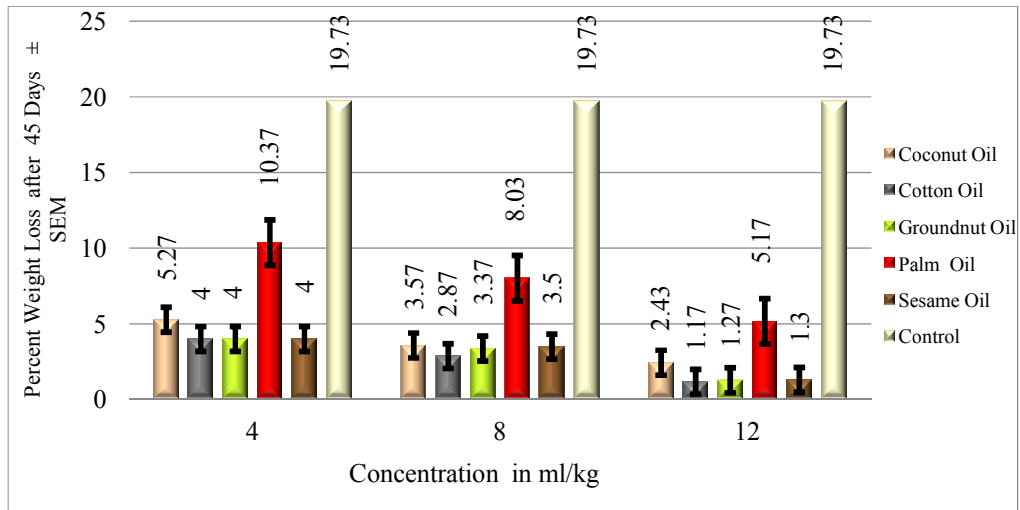


Fig. 2. Effect of vegetable oils on cowpea weight after 45 Days

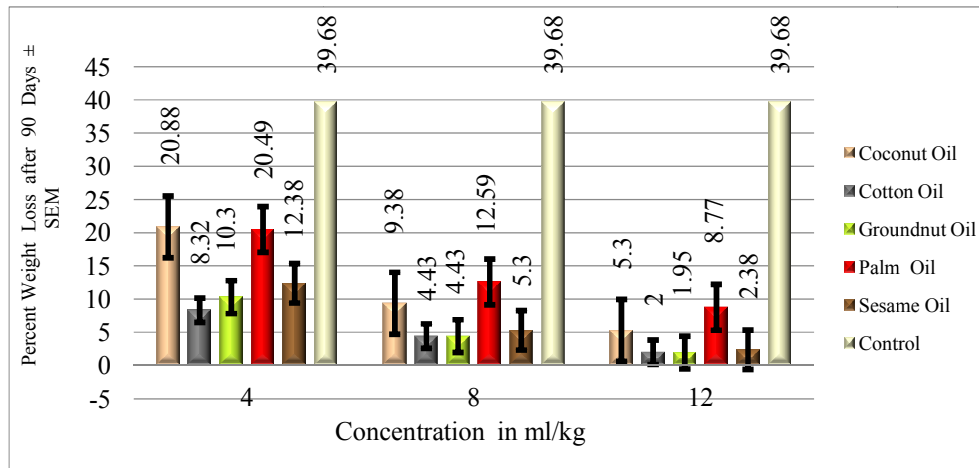


Fig. 3. Effect of vegetable oils on cowpea weight after 90 days

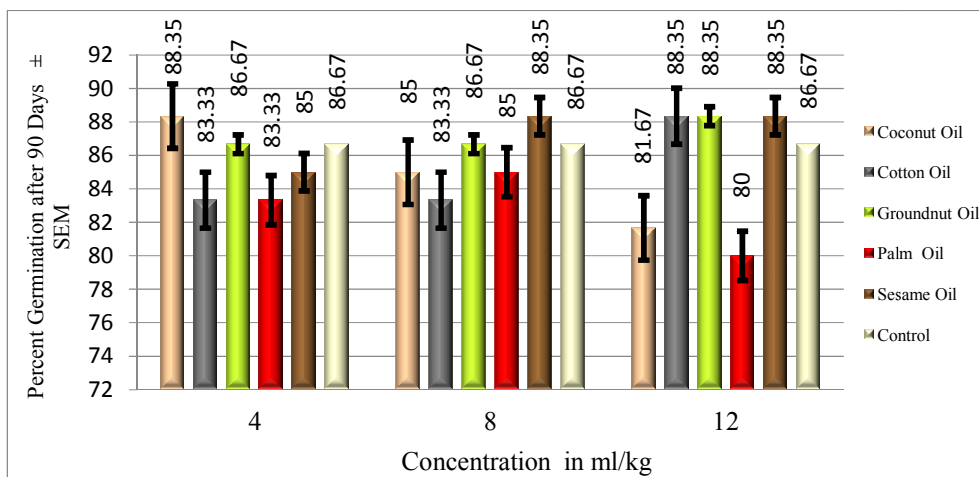


Fig. 4. Effect of vegetable oils on seed germination after 90 days

4. CONCLUSION

This work reported the efficacy of five different vegetable oils in protecting cowpea against cowpea weevil. The oils also show insignificant impact both in the weight of the cowpea and the germination rate after 45 and 90 days. This is a promising bio friendly preservative that could serve as an alternative formulation to synthetic chemical based insecticides for storage of cowpea. Further analysis of the oils is necessary to ascertain its potency for usage for storage of cowpea.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Brisibe EA, Adugbo SE, Ekanem U, Brisibe F, Figueira GM. Controlling bruchid pests of stored cowpea seeds with dried leaves of *Artemisia annua* and two other common botanicals. *African Journal of Biotechnology*. 2011;10(47):9593–9599.
2. Massango H, Faroni L, Haddi K, Heleno F, Jumbo LV, Oliveira E. Toxicity and metabolic mechanisms underlying the insecticidal activity of parsley essential oil on bean weevil, *Callosobruchus maculatus*. *Journal of Pest Science*. 2017; 90(2):723–33.
3. Kang JK, Pittendrigh BR, Onstad DW. Insect resistance management for stored product pests: A case study of cowpea weevil (*Coleoptera: Bruchidae*). *Journal of Economic Entomology*. 2013;106(6):2473–2490.
4. Lima M, Oliveira JV, Barros R, Torres JB. Identification of cowpea *Vigna unguiculata* (L.) Walp. Genotypes resistant to *Callosobruchus maculatus* (Fabr.) (*Coleoptera: Bruchidae*). *Neotropical Entomology*. 2001;30(2):289–95.
5. Ileke KD, Bulus DS, Aladegoroye AY. Effects of three medicinal plant products on survival, oviposition and progeny development of cowpea bruchid, *Callosobruchus maculatus* (fab.) [*Coleoptera: Chrysomelidae*] infesting cowpea seeds in storage. *Jordan Journal of Biological Sciences*. 2013;6(1):61-66.
6. Oluwafemi AR. Comparative effects of three plant powders and pirimiphos-ethyl against the infestation of *Callosobruchus maculatus* (F.) (*Coleoptera: Bruchidae*) in cowpea seeds. *SOAJ of Entomological Studies*. 2012;1(2):108–117.
7. Yoshio T. Biological thinking for future pest control agents. *Japan Pesticides Information*. 1987;50:6-8.
8. Boakye M, Mbatchou VC, Khan ME. Protecting cowpea seeds (*Vigna unguiculata*) against cowpea weevil (*Callosobruchus maculatus*) with unripe banana peel liquid. *Pharmaceutical Biotechnology Current Research*. 2016; 1(1:1):1-6.
9. Regnault-Roger C, Vincent C, Arnason JT. Essential oils in insect control: Low-risk products in a highstakes world. *Annual Review of Entomology*. 2012;57(1):405–24.
10. Isman MB, Grieneisen ML. Botanical insecticide research: Many publications, limited useful data. *Trends in Plant Science*. 2014;19(3):140–145.
11. Nerio LS, Olivero-Verbel J, Stashenko E. Repellent activity of essential oils: a review. *Bioresource Technology*. 2010; 101(1):372–8.
12. Stevenson PC, Isman MB, Belmain SR. Pesticidal plants in Africa: A global vision of new biological control products from local uses. *Industrial Crops and Products*. 2017;110:2-9.
13. Isman MB. Pesticides based on plant essential oils: Phytochemical and practical considerations. *Medicinal and Aromatic Crops: Production, Phytochemistry, and Utilization: ACS Publications*; 2016;13–26.
14. Dennis SH. Pests of stored products and their control. *Bethaven Press London*. 2016;219-220.
15. Cockfield SD. Groundnut oil application and varietal resistance for control of *C. maculatus* (F) in cowpea grains in Gambia. *Tropical Pest Management*. 1992; 38(3):268-270.
16. Pacheco IA, Fernanda M, De Castro PM, De Paula D, Lourencao AL, Bolonhezi S, Barbieri MK. Efficacy of soybean and castor oils in the control of *Callosobruchus maculatus* (F.) and *Callosobruchus phaseoli* (Gyllenhal) in stored chick-pea (*Cicer arietinum* L.). *Journal of Stored Products Research*. 1995;31(3):221-228.
17. Lawal IH, Ibrahim II, Yaroson AY, Idris JA. Efficacy of selected botanicals against cowpea weevils (*Callosobruchus maculatus* F.) on stored cowpea (*Vigna unguiculata* (L) Walp). *International*

- Journal of Scientific and Research Publications. 2018;8(10).
18. Obembe OM, Kayode J. Evaluation of the insecticidal properties of *Cassia alata* L. Against Cowpea Weevil, *Callosobruchus maculatus* Fab. (Coleoptera: Bruchidae). Budapest International Research in Exact Sciences. 2019;1(4).
 19. Hayat MA, Azhari OA, Abd ESAI, Ahmed MAH. Effects of garlic oils on the fecundity and hatchability of *Callosobruchus maculatus* L. (Coleoptera: Bruchidae). Universal Journal of Agricultural Research. 2019;7(1):63-68.
 20. Obeng-Oferi D. Plant oils as protectants against infestation of *Cryptolestes pusillus* and *Rhyzopertha dominica* in stored grain. Entomologia Experimentalis et Applicata. 1995;77:133-139.
 21. Lale NE, Abdulrahman HT. Evaluation of neem (*Azadirachta indica* A. Juss) seed oil obtained by different methods and neem powder for the management of *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) in cowpea. Journal of Stored Product Research. 1999; 35:135-143.
 22. Odeyemi OO, Daramola AM. Storage practices in the tropics, food storage and pest problems. Dave Collins Publications, Akure, Nigeria. 2000;1:60-88.
 23. Abbott WS. A method of computing the effectiveness of an insecticide. J Econ Entomol. 1925;18:265-266.
 24. Appert J. The storage of food grains and seeds. CTA Macmillan. 1987;146.
 25. Halstead DGH. External sex difference in stored products Coleopteran. Bulletin of Entomological Research. 1963;54(01):119-134.
 26. Strong RG, Partida GJ, Warner DN. Rearing stored product insects for laboratory studies, bean and cowpea weevil. Journal of Economic Entomology. 1968; 61:747-751.
 27. Khalequzzaman M, Shah H, Ahmad M, Osman-Goni SHM. Efficacy of edible oils in the control of pulse beetle, *Callosobruchus chinensis* L. in stored pigeonpea. University Journal of Zoology, Rajshahi University. 2007;26:89-92.
 28. Pandey GP, Varma BK. Treatment of stored green gram with edible oil for protection from *Callosobruchus maculatus* (F). Indian Journal of Agricultural Sciences. 1978;48:72-75.
 29. Udo IO. Protectant effect of plant oils against cowpea weevil (*Callosobruchus maculatus*) on stored cowpea (*Vigna unguiculata*). ARPN Journal of Agricultural and Biological Science. 2011;6(12):58-61.
 30. Sahoo AK, Chandrakar HK. Efficacy of edible and non-edible oils against pulse beetle (*Callosobruchus chinensis*) L. in stored chickpea. International Journal of Plant Protection. 2013;6(2):299-303.
 31. Khaire VM, Kachare BV, Mote UN. Efficacy of different vegetable oils as grain protectants against pulse beetle, *Callosobruchus chinensis* L. in increasing storability of pigeon pea. Journal of Stored Products Research. 1992;28(3): 153-156.
 32. Guzar GT, Yadav TD. Feeding of *Callosobruchus maculatus* and *Callosobruchus chinensis* Linn in green gram. Indian Journal of Entomology. 1978; 40:108-112.
 33. Singal SK. Testing some vegetable oil for protection of gram seed during storage against *Callosobruchus chinensis* hu (L). Journal of insect science. 1995;8(2):215-216.
 34. Singh KM, Doharey RB, Katiyar RN. Effect of edible oils in protection of green gram *Vigna radiata* seed from pulse beetles *Callosobruchus chinensis* and *Callosobruchus maculatus*. Journal of Agricultural Sciences. 1988;58:151-154.
 35. Ilesanmi JO, Gungula DT. Preservation of cowpea (*Vigna unguiculata* (L.) Walp) grains against cowpea bruchids (*Callosobruchus maculatus*) using neem and moringa seed oils. International Journal of Agronomy. 2010;1-8.
 36. Hossain MA, Haque MA. Efficacy of some indigenous plant extracts as grain protectant against pulse beetle, *Callosobruchus chinensis* L. Journal of Agroforestry and Environmental. 2010; 4(1):197-202.
 37. Khinchi SK, Sharma MM, Khinchi MK, Bairwa DK, Dinesh A, Naga BL, Naga RP. Studies on efficacy of certain vegetable oils against pulse beetle, *Callosobruchus chinensis* Linn. on chickpea, *Cicer arietinum* (L.). International Journal of Chemical Studies. 2017;5(3):255-259.

38. Gupta SC, Bareath SS, Sharma SK. Bio-efficacy of edible oils and non-edible oils against pulse beetle on stored pulse and their effect on germination. *Agricultural Biological Research*. 1991;7(2):101-110.
39. Raghvani BR, Kapadia MN. Efficacy of different vegetable oils as seed protectants of pigeonpea against *Callosobruchus maculatus* (Fab.). *Indian Journal of Plant Protection*. 2003;31(1):115-118.
40. Law-Ogbomo KE, Egharevba RKA. The use of vegetable oils in the control of *Callosobruchus maculatus* (F) (Coleoptera: Bruchidae) in three cowpea varieties. *Asian Journal of Plant Sciences*. 2006;5:547-552.
41. Abulude FO, Ogunkoya MO, Ogunleye RF, Akinola AO, Adeyemi AO. Effect of palm oil in protecting stored grains from *Sitophilus zeamensis* and *Callosobruchus maculatus* (Fab.) (Coleoptera: Bruchidae). *Journal of Entomology*. 2007;4:393-396.
42. UddinRO, Sanusi SA. Efficacy of olive oil, groundnut oil, soybean oil and palm kernel oil in the control of *Callosobruchus maculatus* (F.) in stored cowpea (*Vigna unguiculata* L. Walp). *Agrosearch*. 2013; 13(2): 67-72.

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