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# Eco-friendly management of pulse beetle (*Callosobruchus chinensis* L.) in stored black gram (*Vigna mungo* L. Hepp.) seeds using quercetin

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## Abstract

Stored pulses become highly susceptible to pests, leading to heavy losses in developing countries. *Callosobruchus chinensis* L. is a storage pest of legumes, and managing it with insecticides negatively impacts the environment. Pesticides are harmful to nature and have adverse effects on human health. Management of pulse beetle by using plant-based products is called biopesticides. Awareness of a safe environment to seek environmentally friendly alternatives to pest management practices. An alternative strategy using bioactive compounds from botanicals can be easily adopted due to low health hazards. Bioactive compounds from herbs provide a better solution for pest management in pulses and for insecticide safety. This study evaluated the effect of the natural flavonoid, quercetin, on the emergence of *C. chinensis* in stored black gram seeds. Attention has been given to quercetin (a flavonoid) to control bruchids in black gram stored grains. The effect of quercetin is tested against *C. chinensis* in black gram seed storage, and the experiment is conducted on insect mortality, adult emergence, and seed weight loss and germination percentage on the treatment of quercetin for sixty-three days. It is noteworthy that the highest mortality, lowest seed weight loss, no egg lying, and less adult emergence, high germination in quercetin (0.5%) treated seeds, when compared to the control. The complete mortality observed with quercetin treatments recorded the potency of quercetin as an insecticidal agent and a natural seed protectant, with significant advantages for pulse preservation. In the future, it could be used naturally for pest control by farmers to reduce post-harvest losses against pests in a budget friendly way.

## 1. Introduction

Pulses are important in global farming due to high protein and other nutrient content and are adapted to diverse agro-climatic conditions. However, despite their importance, pulses remain highly vulnerable to post-harvest losses due to inadequate storage infrastructure, pest infestation, poor handling practices, and environmental conditions. One of the key issues in pulse storage is the high susceptibility of seeds to insect infestation, especially by bruchid, which lay eggs on the seed surface. Bruchids are a serious threat to leguminous grains, such as black gram, and due to the damage of this pest, the world suffers from malnutrition. People living in poorer tropical countries suffer from protein deficiency in their daily lives (Raja *et al.* 2000; Mulatu and Gebremedhin, 2000), which can lead to severe damage in pulses for huge economic loss. Despite its multifaceted benefits, black gram is highly susceptible to post-harvest storage losses, primarily caused by the pulse beetle, within just 3 to 6 months of storage. Qualitatively and quantitatively, pulse seed damage is very serious and results in a heavy loss in seed weight (70%) and in protein (66%) during storage. Synthetic chemical methods have several health hazards to consumers, and residual toxicity, pollution and resistance to bruchids are developed.

The pest control board makes a large number of efforts to control pests with plant-derived compounds. In recent years, the management of pests by the effect of various botanicals has been studied (Satwika *et al.*, 2024; Rathod *et a*l., 2019). Effective post-harvest management of pulses begins at the point of harvesting. Hence, while synthetic insecticides may offer quick results, their long-term impacts on human health, plant vitality, and environmental sustainability raise serious concerns. The use of synthetic chemical insecticides in grain storage, while effective in pest control, poses several serious disadvantages and side effects for both humans and plants. Researchers have found that botanical pesticides like neem oil, eucalyptus extract, and mustard oil are found to be effective in reducing bruchid infestation. Biopesticides are less toxic to mammals and are readily biodegradable. *T. bellirica* has constituents such as belleric acid, β-sitosterol, quercetin, gallic acid, chebulagic acid, arjungenin, ellagic acid, glycosides, bellericosides, hexahydroxy diphenic acid, ethyl gallate, galloyl glucose, mannitol, glucose, galactose, and rhamnose. It was reported that plant bark, leaf, seed powder, oil, and flower extracts when mixed with stored grains,

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reduced seed damage rates and emergence of pests (Kaur *et al*., 2019; Keita *et al.,* 2001; Shaaya *et al*., 1997). Numerous plant extracts are known to have antimicrobial properties, and the phytochemical azadiractin from neem is commonly used in India as both an oviposition deterrent and insecticide (Lale *et al.,* 2004). Products from plants such as quercetin are easily accessed by small-scale industries and can be easily produced from crude or purified extracts. Many studies indicated that plant oils and other plant products are the best alternative insect control agents for stored grain pests. The dual benefit of quercetin as both a medicinal drug and pest-control agent makes it an ideal candidate for eco-compatible storage practices. Literature survey on pest management of quercetin revealed that limited information is available regarding the use of quercetin against *C. chinensis* in stored black gram. With this background, quercetin treatment for pest management is adapted for this research work, and particular attention has been focused on quercetin against *C. chinensis* infesting stored black gram seeds.

## 2. Materials and Methods

A laboratory experiment was carried out at Dr. M. S. S. Agricultural College and Research Institute, Thanjavur, Tamil Nadu, India. *T. bellirica* leaves were authenticated by Dr. M. Ayyanar, Taxonomist, Sri A.V.V.M. Poondi Pushpam College, Thanjavur. The herbarium (Specimen Number SPCH-1194) of the plant samples has been deposited in the department for future use. The extracted quercetin from *T. bellirica* was used for the seed treatments and it was dissolved in 1% ethanol as a coating agent against *C. chinensis* infestation in black gram seeds. The treatments and dosage used were: $T_1$ - control, $T_2$ - 0.5% of quercetin/100 g seeds, $T_3$ - 1.0% of quercetin/100 g seeds, $T_4$ - 1.5% of quercetin/100 g seeds. Local variety of whole black gram seeds (100 g) was taken in clean glass jars and treated quercetin (1.5 ml) per jar to ensure uniform coating. In the experiment, four treatments and five replications were maintained for each treatment and exposure period of 63 DAS (Phadtare *et al*., 2021). Five pairs of newly emerged adult beetles per jar were released into each bottle containing quercetin and control seeds. Parental mortality, insect fecundity, seed weight loss, seed damage and seed germination of treated and control seeds were recorded at 7, 14, 21, 28, 35, 42, 49, 56, and 63 days after storage (DAS) and the recorded data were analyzed statistically. At 7 DAS interval after exposure, adult mortality of the pulse beetle was categorized on the basis of the number of dead bruchids. The percentage of weight loss of seeds was categorized by infested and not infested grains, and was calculated. Parental mortality was recorded at seven DAS intervals of bruchid release, and the beetle mortality rate was calculated as follows:

$$\text{Corrected morality (\%)} = \frac{\text{Test \% mortality} - \text{Control \% mortality}}{100 - \text{Control \% mortality}}$$

Seeds were carefully checked for eggs using a magnifying glass after a 7 DAS interval. Seeds without eggs were separated and their total number determined afterwards. The number of emerged adult beetles was counted after 7 DAS interval and removed every day before removing them from the bottles up to the last day of work. The seeds were separated from dust and dead bodies of pulse beetle by winnowing, and the clean seeds in each bottle were separately weighed. The weight loss of seeds was calculated as follows:

$$\text{Weight loss (\%)} = \frac{A - B}{A} \times 100$$

where A= Initial weight, B=Final weight.

During storage, about 10 seed sub-samples were germinated under laboratory conditions using the rolled paper towel method, in five replicates. The number of seedlings in each replicate after 7 days was recorded to determine the germination rate:

$$\text{Germination percentage} = \frac{\text{Number of germinated seeds}}{\text{Total number of seeds tested}} \times 100$$

NG = Number of seeds that germinated;

TG = Total number of test seeds

## 3. Results

Phytochemical screening of *T. belerica* leaf revealed the contents of quercetin, a flavonoid compound, which possessed the highest insecticidal activity (Sambandam, 2016). Compound, quercetin from the *T. belerica* leaves, is studied for its effect on bruchids and exhibited the death of bruchids at all concentrations. Quercetin was found to be most effective with higher per cent mortality when compared to the control, as shown by samples. It was found that compound quercetin (0.5%**)** treatment was markedly superior to control treatments at a significance of ($p$<0.05), and it has a profound influence on the bruchid eggs deposition. When seeds were treated with quercetin at different ratios, the number of eggs laid on the untreated seeds was higher than in all the quercetin treatments. The highest weight loss (14.08 %) is recorded in untreated control seeds when compared with the quercetin treatments. The results are consistent with the findings reported by Chaitanya *et al*. (2022), which indicated that biopesticides inhibited the oviposition in stored seeds. Tapondjou (2002) also studied the adult mortality of stored seeds that are treated with some indigenous plant powders and oils.

### 3.1 Effect of quercetin on insect emergence

It was noted that in the present study, the number of insect eggs was greatly decreased by the application of quercetin. Among the experimental seeds, the highest number of adult emergences is noted in the control seeds. Remarkably, seeds treated with quercetin exhibited no insect emergence throughout the entire observation period, from day 1 to day 63. Adult beetles that emerged were not recorded in quercetin (0.5%) treated black gram seeds, and high numbers of adult beetles emerged from the untreated control. This was consistent across all replications, including the lowest dose (0.5%). The absence of emergence indicates that quercetin not only kills existing pests but also prevents larval development and adult emergence, likely through ovicidal or growth-inhibitory mechanisms. This result is supported by the findings of Latif *et al*. (2012), who indicated that indigenous plant powders inhibited the adult emergence in stored seeds.

### 3.2 Effect of quercetin on seed weight loss

Across all treatments, no seed weight loss is recorded in quercetin-treated seeds up to two weeks. In the control, a gradual decline in seed weight is observed over the 63-day period, consistent with ongoing beetle activity (Figure 1). At 45 DAT, in seeds treated with quercetin, a minimum seed weight loss is (14.83%) observed as compared to the untreated control. However, the extent of weight loss varied significantly depending on the treatment applied. The untreated control seeds showed the highest weight loss, declining from 100.37 g to 86.18 g on day 63. This represents 15% reduction in weight, indicating severe beetle damage on seeds. Quercetin treatments significantly reduced weight loss, showing the least reduction (only 3 g over 63 days) in weight. This efficacy was dose-dependent, with higher concentrations offering better protection.

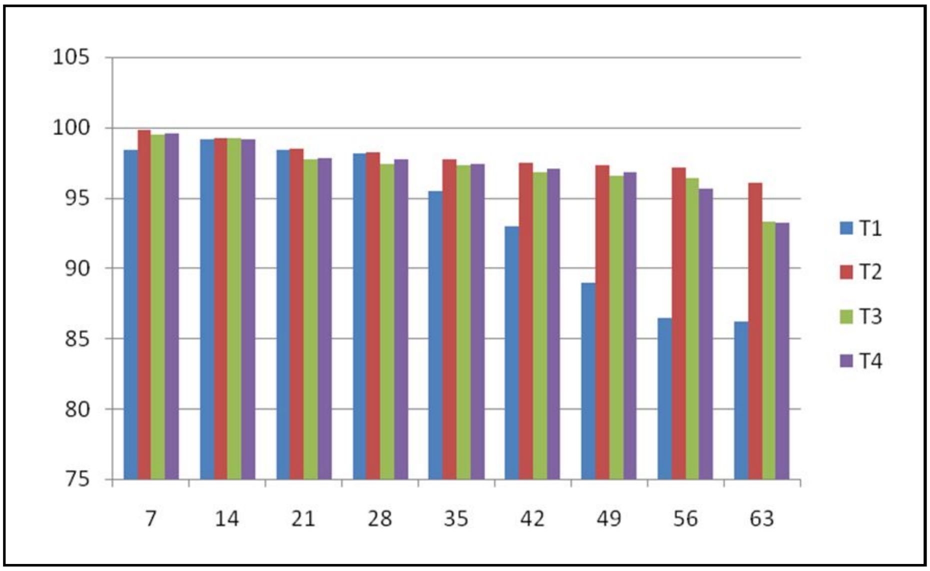


**Figure 1:** **Effect of quercetin on the weight loss of black gram seeds. ($T_1$ - Control, $T_2$ - 0.5%, $T_3$ - 1.0%, $T_4$ - 1.5%)**

### 3.3 Effect of quercetin on the seed germination

Germination of seeds starts from 84% and declines to 47% at the end of the 63 DAS (Figure 2) in control seeds, and this decline reflects progressive seed deterioration due to bruchid damage. Quercetin treatments showed improvement in germination over time, and 0.5% achieved the best germination rate at 94%, up to 63 DAS, with minimal variability. This treatment not only preserves seed viability but also enhances germination potential during storage. This study indicates the potential use of quercetin as a potent bio-insecticide for post-harvest seed protection on black gram seed storage. In the present study, the germination percentage of untreated seeds after one month of treatment is 80.0 per cent, which ranges between 81 and 90 per cent in the quercetin treated seeds and gradually reduced over the period of storage.

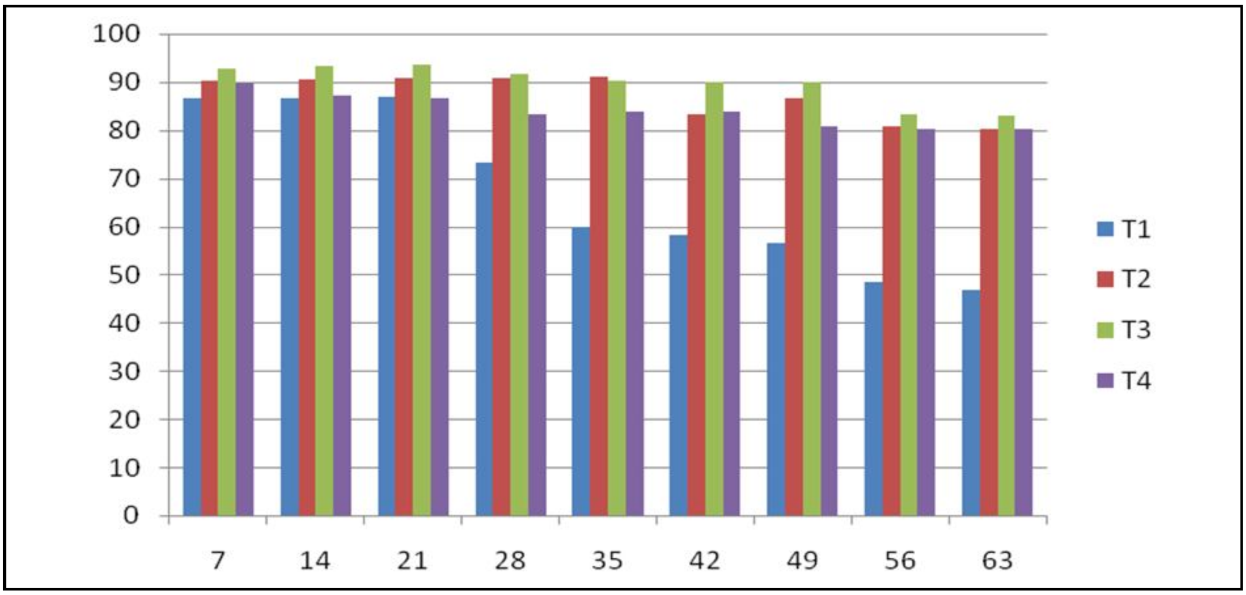


**Figure 2:** **Effect of quercetin on the germination of black gram seeds. ($T_1$ - Control, $T_2$ - 0.5%, $T_3$ - 1.0%, $T_4$ - 1.5%)**

Insects exposed to the toxic secondary metabolites of plants are affected physiologically, with targets ranging from proteins to other macromolecules (Phadtare, 2023; Kishore *et al.,* 2021). Black gram seeds in the jars are damaged by pulse beetle, and the larvae feed on the internal contents of the seeds for their growth and development. Inside the seeds, adults emerge to create hole(s) on stored pulse seeds and destroy them. Plants' essential oils are an alternative to pest control agents in stored grains (Ezhil *et al*., 2017), and studies have already documented and confirmed this by Rathod *et al.* (2019). In quercetin treatments at 45 DAT, the least percentage of seed weight loss (3.64%) was observed as compared to untreated seeds. Quercetin treatments significantly reduced weight loss, due to strong protective effects, likely due to its antioxidant and insect-repellent properties. In control seeds, germination declined to 46.67% at day 63. This decline reflects progressive seed deterioration due to beetle damage. Better retention in quercetin treatments showed remarkable improvement in germination over time, achieving the highest final germination rate with minimal variability. These treatments not only preserved seed viability but also enhanced germination potential during storage. Quercetin treatments provided better protection against infestation, preserving seed integrity and physiological activity. The antioxidant and antimicrobial properties of quercetin may have contributed to the enhanced seed vigor and reduced deterioration. Kavitha *et al*. (2021) study on resistance in certain green gram genotypes to pulse bruchid indicated that the phenol content reflected higher resistance to pulse beetles. Quercetin treatments are markedly superior and achieved complete mortality indicating uniform and potent insecticidal action, confirming their sustained and reliable insecticidal action and complete mortality, confirming their sustained and reliable insecticidal action.

### 3.4 Effect of quercetin on insect mortality

In the untreated control group, insect emergence began as early as day 28 and escalated rapidly throughout the experiment. The aggressive infestation highlights the vulnerability of untreated black gram seeds to storage pests, particularly bruchid beetles. The emergence pattern was consistent across all replications, with visible damage and reduced seed viability observed. The infestation had peaked, resulting in significant deterioration of seed quality and germination potential at the 63rd day (Figure 3). Seeds treated with quercetin exhibited insect emergence that was not seen throughout the entire observation period and was consistent across all concentrations, including the lowest dose. The absence of adult emergence indicates that quercetin not only kills existing pests but also prevents adult emergence, likely through ovicidal or growth-inhibitory mechanisms. However, all treatments are superior to control seeds, which could be evinced from the reduction of beetle population in quercetin-treated pulse seeds. The reason for the beetle reduction could be due to the oviposition deterrent activity of quercetin. Previous works of Singh (2003) found that botanicals offer ovicidal and repellent activity due to active compounds, which protect the pulse seeds treated with different botanicals and oils. 100% mortality up to two months is recorded at all concentrations of quercetin treatments.

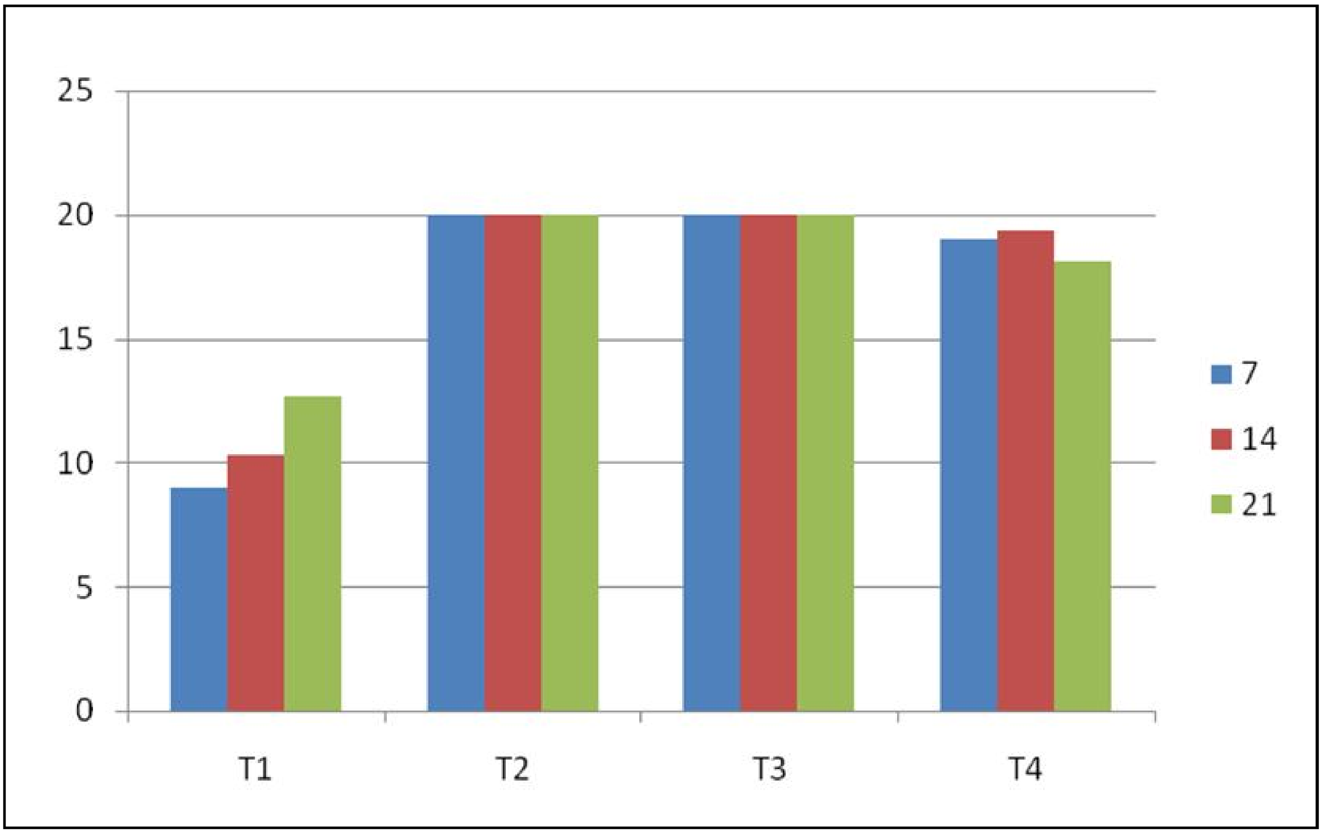


**Figure 3: Effect of quercetin on the germination of black gram seeds. ($T_1$ - Control, $T_2$ - 0.5%, $T_3$ - 1.0%, $T_4$ - 1.5%)**

## 4. Discussion

Researchers make a large number of efforts to control the pests with plant-derived compounds. Developing new methods can have minimal side effects on the environment and organisms are essential to protect grain storage. Use of the compounds obtained by aromatic plants to control the pests of stored goods is the best alternative insect control agent of stored grain pest (Ezhil *et al.,* 2017). Using plant-based derivatives effectively control beetles to prevent egg-laying (oviposition), protects grain viability without leaving toxic chemical residues: Black gram seeds are coated with neem oil, mustard oil, pongamia oil destroy eggs and deters adult beetles. Dried and powdered leaves of neem (*Azadirachta indica*), nirgundi (*Vitex negundo*) and sweet flag (*Acorus calamus*) act as natural repellents and insecticides. Turmeric rhizome powder, garlic clove extracts are also acts as a strong natural deterrent against weevils and beetles. Spraying or dusting 1% Neem kernel suspension powder on bulk storage grains has been proven to significantly reduce infestation levels and adult emergence.

Quercetin acts as a natural plant defense metabolite to manage insects by reducing herbivores, acts as an anti-feed ant, induce mortality in species like aphids, spider mites, and caterpillars. It often induces the detoxifying enzymes to enhance susceptibility to insecticides and serves as an eco-friendly pesticide (Wang *et al.,* 2020). Flavonoid compounds such as quercetin possess promising larvicidal potential (Rajkumar *et al*., 2008). The mechanism of action includes interference with the insect's hormonal pathways, midgut enzyme activity, and nervous system signaling, leading to reduced egg viability, larval mortality, and adult deformities (Radovanovic *et al*., 2015). Quercetin is significantly superior to pest treatments in decreasing adult emergence and seed weight loss. Furthermore, when used as a grain coating or in fumigation, leaf extracts do not impair seed viability or taste, and their effectiveness may persist for several weeks without reapplication. Quercetin is a natural flavonoid found in many plants that acts as an effective bio pesticide and deterrent against stored-product pests like the pulse beetle (*C. chinensis*). It protects black gram by affecting insect growth, reducing fecundity, and deterring egg-laying. Quercetin reduces the number of eggs pulse beetles lay on black gram seeds, thereby halting the lifecycle before grubs can bore into the grain. The compound is toxic to developing larvae, significantly increasing mortality rates and decreasing adult emergence. It alters the feeding behavior of pests, acting as a natural repellent that keeps insects from consuming the seed cotyledons. When applied, it protects pulses without harming seed germination and act as an insecticide.

## 5. Conclusion

The compiled results recorded that quercetin is a promising agent for controlling *C. chinensis* in to the storage of black gram seeds up to two months. Incorporating quercetin based treatments in pulse storage can significantly reduce post-harvest losses and offer a natural, residue-free alternative to synthetic pesticides. Its effectiveness at low concentrations highlighted its potential for cost-effective application in large-scale storage systems of black gram seeds. Further studies could explore formulation stability, application methods and scalability of quercetin application on bioactivity.

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## Conflict of interest

The authors declare no conflicts of interest relevant to this article.

## References

**Agelopoulos, N.; Birkett, M. A.; Hick, A. J.; Hooper, A. M.; Pickett, J. A.; Pow, E. M.; Smart, L. E.; Smiley, D. W.; Wadhams, L. J and Woodcock. C. (1999).** Exploiting semi chemicals in insect control. Pesticide Science, **55**(3): 225-235.

**Chaitanya, G.P.; Singh, S.; Raju. S. V. S. and Babu. R. (2022).** Screening of certain black gram varieties against pulse beetle (*Callosobruchus maculatus*) under the free choice method. J. Exp. Zool. India, **25**(2):1617-1620.

**Cock (2015).** The medicinal properties and phytochemistry of plants of the genus *Terminalia* (Combretaceae). Inflamm. Pharmacology, **23**(5):203-29.

**Deepak, K. J.; Raju, S. V. S.; Kamal, R. S. and Valluru, M. V. (2019).** Studies on life history and host preference of pulse beetle, *Callosobruchus chinensis* (L.) on different pulses. Journal of Entomological Research, **43**(2):159.

**Ezhil, V. S.; Manivannan, S.; Anila, M.; Sunny and Murugesan, R. (2017).** Phytochemical residue profiles in rice grains fumigated with essential oils for the control of rice weevil. PLOS ONE, **12**(10):1-17.

**Fan. (2017).** Plants of the genus terminalia: An insight into its biological potentials. Preclinical and Clinical Studies, **9**(3):4-11

**Hocking, D. (1993).** Trees for drylands. Oxford & IBH Publishing Co., New Delhi.

**Kaur, K. D.; Verma, S. C. and Sharma, P. L. (2019).** Efficacy of plant powders against pulse beetle, *Callosobruchus chinensis*, L. infesting pea seed. J. Ento. and Zoology Stud., **7**(1):737-741.

**Kavitha, G.; Mahalakshmi, M. S.; Reddy, K. B.; Pushpa Reni, Y. and Radhika, K. (2021).** Physicochemical basis of resistance in certain green gram genotypes to pulse beetle *Callosobruchus chinensis* (L.). Environ. Conserv. J., **22**(3):231-242

**Keita, S.M.; Vincent, C.; Schmit, J. P.; Arnason, J. T. and Belanger, A. (2001).** Efficacy of essential oil of *Ocimum basilicum* L. and *O.gratissimum* L. applied as an insecticidal fumigant and powder to control *Callosobruchus maculatus* (Fab.) (Coleoptera: Bruchidae). Journal of Stored Product Research, **37**(4): 339-349.

**Kishore, N.; Mishra, B. B.; Tiwari, V. K. and Tripathi, V. (2011).** A review on natural products with mosquito Sidal potentials. In: Tiwari VK, editor. Opportunity, challenge and scope of natural products in medicinal chemistry. Research Signpost, Kerala, **10**(3):335-365.

**Lale, N. and Kabesh, J. (2004).** Preharvest spray of neem (*Azadirachta indica.A.Juss*) seed products and pirimiphos-methyl as methanol of reducing field infestation of cowpea by storage bruchids in Nigerian sudan savannah, In. J. Agi. Biol., **6**(2):987-993.

**Latif, M. A.; Laizu, M. and Akhter, N. (2012).** Evaluation of dry leaf powder of some indigenous plants against pulse beetle *Callosobruchus chinensis* L. infesting mungbean seeds. Bangladesh Journal of Entomology, **22**(2):21-31.

**Metcalf, R. L. (1975).** Insecticides in pest management. In: Metcalf RL and Luckman, W. (eds.) Introduction to insect pest management. Willey International Science, New York, **11**(5):235-273.

**Mulatu, B. and Gebremedhi, T. (2000).** Oviposition deterrent and toxic effects of various botanicals on the Adzuki bean beetle *Callosobruchus chinensis* L insect science and its application, Journal of Pest Management, **20(1)**:33-38.

**Naidu, C.V. and Swamy P.M. (1995).** Seasonal variation of growth characteristics in some selected tree saplings. Indian Forester, **121**(9):797-801

**Phadtare, P. R.; Chaudhari, C. S.; Aghav, S. T.; Kadam, U. K.; Chavan, T. R. and Patil, M. R. (2023).** Management of pulse beetle (*Callosobruchus chinensis* L.) in chickpea using biorational products. The Pharma Innovation Journal, **12(1)**:2768-2770.

**Radovanovic, B.; Mladenovic, J.; Radovanovic, A.; Pavlovic, R. and Nikolic, V. (2015).** Phenolic composition, antioxidant, antimicrobial and cytotoxic activities of *Allium porrum* L. (Serbia) extracts. Journal of Food and Nutrition Research, **3**: 564-569.

**Raja, N.; Albert, S.; Babu, A; Ignacimuthu, S. and Dorn, S. (2000).** Role of botanical protectants and larval parasitoid *Dinarmus vagabundus* (Timberlake) (Hymenoptera: Pteromalidae) against *Callosobruchus maculatus* Fab. (Coleoptera: Bruchidae) infesting cowpea seeds. Malaysian Applied Biology, **29**(12):55-60.

**Rajkumar, S. and Jebanesan, A. (2008).** Bioactivity of flavonoid compounds from *Poncirus trifoliate* L. (Family: Rutaceae) against the dengue vector, *Aedes aegypti* L. (Diptera: Culicidae). Parasitol. Res., **104**:19-25.

**Rathod, L.; Sasane, A. R.; Kawre, P. R.; Chaware, G. G. and Rathod, P. K. (2019).** Effect of botanicals on pulse beetle and per cent seed germination of stored green gram. Pharmacognosy and Phytochem., **8(3)**:2428-2430

**Sambandam, B.; Thiyagarajan, D.; Ayyaswamy, A. and Raman, P. (2016).** Extraction and isolation of flavonoid quercetin from the leaves of *Trigonella foenum graecum* and their antioxidant activity. International Journal of Pharmacy and Pharmaceutical Sciences, **8**:120-124.

**Satwika, M.; Madhumathi, T.; Kumari, B. R. V. and Kumari, P. (2024).** Influence of inert minerals and botanicals on adult emergence of pulse beetle, *Callosobruchus maculatus* (Fabricius), in stored black gram. Indian Journal of Agricultural Research, **59(**8):1232-1235.

**Senthil, N. S.; Choi, M. Y.; Seo, H. Y.; Paik, C.H.; Kalaivani, K. and Kim, J.D. (2008).** Effect of azadirachtin on acetyl cholinesterase (AChE) activity and histology of the brown planthopper *Nilaparvata lugens* (Stal). Ecotox. Environ. Safety, **70**:244-50.

**Shaaya, E.; Kostjukovski, M.; Eilberg, J. and Sukprakarn, C. (1997).** Plant oils as fumigants and contact insecticides for the control of stored-product insects. Journal of Stored Product Research, **33(1)**:7-15.

**Singh, S. and Sharma, G. (2003).** Preference of pulse beetle to some cowpea varieties. Indian Journal of Entomology, **65**(2):273-276.

**Soe, T. N.; Aran, N. and Wisut, S. (2020).** Bioactivity of some plant essential oils for seed treatment against pulse beetle, *Callosobruchus maculates* F. (Coleoptera: Bruchidae) on mung bean. Bulgarian Journal of Agricultural Science, **26** (1):141-147.

**Srinivasan,T.; Durairaj, C. and Vinoth Kumar, B. (2008)**. Damage potential of bruchids in different edible legumes and inter specific competition between two species of *Callosobruchus* spps (Bruchidae: Coleoptera), Madras Agricultural Journal, **25**(3):400-406.

**Talukder, F. A. and Howse, E. (1994).** Repellent, toxic and food protectant effects of pithraj, *Aphanamixis polystachya* extracts against the pulse beetle, *Callosobruchus chinensis* in storage. Journal Chemical Ecology, **20**(4):221-232.

**Tapondjou, L. A.; Adler, C.; Boud, H. and Fontem, D. A. (2002).** Efficacy of powder and essential oil from *Chenopodium ambrosioides* leaves as post-harvest grain protectants against six-stored product beetles. Journal of Stored Product Res., **38**(4):395-402.

**Wang, Y.; Huang, X.; Chang, B. H. and Zhang, Z. (2020).** Growth performance and enzymatic response of the grasshopper, *Calliptamus abbreviatus* (Orthoptera: Acrididae), to six plant-derived compounds. J. Insect Sci., **20**(3):1-8

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