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Comparative evaluation of tulsi plant (*Ocimum sanctum*) extracts against *Trogoderma granarium* infesting stored wheat grains

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Abstract
The present investigation was conducted to evaluate the insecticidal and repellent efficacy of *Ocimum sanctum* (Tulsi) extracts against the Khapra beetle, *Trogoderma granarium* Everts, a serious pest of stored wheat grains. Excessive use of synthetic insecticides in grain storage systems has resulted in environmental contamination, insect resistance, and toxic residues in food materials. Therefore, botanical alternatives are receiving increasing attention for sustainable pest management.
In the present study, ethanolic and aqueous extracts prepared from Tulsi leaves were tested at concentrations of 5%, 10%, and 15% against adult *Trogoderma granarium* under laboratory conditions. Parameters including mortality percentage, repellency activity, feeding deterrence, grain weight loss, and reproductive inhibition were evaluated over a period of 45 days.
Results indicated that Tulsi extracts possessed significant bioactive properties against Khapra beetles. Higher concentrations produced stronger insecticidal and repellent effects. Maximum mortality (87%) was observed at 15% ethanolic extract after 14 days of exposure. Grain damage and weight loss were significantly reduced in treated grains compared to untreated controls. Germination studies revealed that treated wheat grains maintained high viability, indicating the safety of Tulsi extracts for stored grain protection.
The findings suggest that *Ocimum sanctum* extracts may serve as effective, eco-friendly, and economical botanical protectants for the management of *Trogoderma granarium* infestation in stored wheat grains.

Keywords: Khapra beetle, tulsi extract, wheat storage, botanical pesticide, repellency, insecticidal activity

Introduction
Wheat (*Triticum aestivum* L.) is one of the major cereal crops cultivated worldwide and constitutes an important source of carbohydrates, proteins, and dietary nutrients. In India, wheat occupies a significant position in agricultural production and food security. However, post-harvest losses during storage remain a major challenge due to insect infestation.
Among the stored grain pests, *Trogoderma granarium* Everts, commonly known as the Khapra beetle, is considered one of the most destructive insect pests of stored cereals. The larvae and adults feed on grains and contaminate food products with cast skins, hairs, and excreta, thereby reducing grain quality and market value. Severe infestations also adversely affect seed germination and nutritional composition.
Chemical insecticides and fumigants have traditionally been employed for pest control in grain storage structures. Although these chemicals provide rapid suppression of pests, prolonged use has created serious concerns including insect resistance, environmental hazards, residual toxicity, and harmful effects on human health.
Botanical insecticides derived from medicinal plants have emerged as promising alternatives due to their biodegradability, selective toxicity, and environmental safety. Medicinal plants possess numerous phytochemicals such as alkaloids, terpenoids, phenolics, flavonoids, and essential oils that exhibit insecticidal, repellent, antifeedant, and growth-disrupting activities.
Ocimum sanctum (Tulsi), belonging to the family Lamiaceae, is an important medicinal plant widely distributed throughout India. Tulsi contains several biologically active compounds including eugenol, methyl eugenol, ursolic acid, and linalool which are known to possess antimicrobial and insecticidal properties.
The present study was therefore undertaken to investigate the efficacy of Tulsi leaf extracts against *Trogoderma granarium* infesting stored wheat grains under laboratory conditions.

Materials and Methods
Collection and Culture of Insects
Adult *Trogoderma granarium* insects were collected from naturally infested wheat storage units in Agra district. The

insects were reared on sterilized wheat grains in the Entomological Research Laboratory of R.B.S. College, Agra.
The cultures were maintained in glass containers covered with muslin cloth under controlled laboratory conditions of 30 ± 2°C temperature and 60 ± 10% relative humidity.

Collection of Plant Material
Fresh leaves of *Ocimum sanctum* were collected from medicinal plant gardens and local agricultural fields. The leaves were washed thoroughly with distilled water and shade-dried for several days.
The dried leaves were pulverized into fine powder using an electric grinder and stored in airtight containers until extraction.

Preparation of Plant Extracts
Fifty grams of Tulsi leaf powder were extracted separately using ethanol and distilled water through Soxhlet extraction for 6 hours.
The obtained extracts were filtered through Whatman No. 1 filter paper and concentrated using a rotary evaporator. Concentrated extracts were stored at 4°C for further experimental use.
Different concentrations (5%, 10%, and 15%) were prepared by dilution with respective solvents.

Antifeedant Activity
Ten grams of sterilized wheat grains were treated with 1 ml of prepared extract and placed in separate plastic containers. Twenty-five adult insects were introduced into each container. Grain consumption was determined after every 24 hours for 14 days by recording changes in grain weight.
Antifeedant activity was calculated using:
Feeding Deterrence (%) = (C − T) / C × 100
Where:
C = Grain consumption in control
T = Grain consumption in treatment

Repellency Test
Repellent activity was assessed using a Y-tube olfactometer. One arm contained cotton soaked with Tulsi extract while the other arm contained solvent alone.
Ten adult insects were released at the base of the apparatus and the number of insects entering each arm was counted after 45 minutes.
Percentage repellency was calculated using:
PR = (Nc − Ne) / (Nc + Ne) × 100
Where:
Nc = Number of insects in control arm
Ne = Number of insects in treated arm

Mortality Assessment
Ten adult insects were introduced into containers containing treated wheat grains. Mortality observations were recorded after 1, 3, 5, 7, and 14 days.
Corrected mortality was calculated using Abbott's formula:
Corrected Mortality (%) = (T − C) / (100 − C) × 100
Where:
T = Mortality percentage in treatment
C = Mortality percentage in control

Reproductive Inhibition Test
Twenty adult insects comprising equal numbers of males and females were introduced into treated grain samples and maintained for 15 days.
Egg laying and adult emergence were recorded to evaluate the effect of Tulsi extracts on reproductive performance.

Estimation of Grain Weight Loss
Ten grams of wheat grains treated with different extract concentrations were stored with insects for 45 days.
Final grain weight was recorded and compared with initial weight.
Weight loss percentage was calculated using:
Weight Loss (%) = (Initial Weight − Final Weight) / Initial Weight × 100

Germination Test
The effect of Tulsi extracts on seed viability was determined using standard germination procedures.
Treated grains were placed on moist filter paper in Petri dishes and observed for seven days. Germinated seeds were counted and germination percentage was calculated.

Results and Discussion
Antifeedant Activity
Tulsi extracts significantly reduced feeding activity of *Trogoderma granarium*. Feeding deterrence increased with concentration of extract.
The ethanolic extract exhibited stronger antifeedant effects than aqueous extract, possibly due to better extraction of volatile bioactive compounds.

Repellency Effect
Tulsi extracts showed considerable repellency against adult Khapra beetles. Maximum repellency was recorded at 15% concentration.

Table 1: Repellency Percentage of Tulsi Extracts Against *Trogoderma granarium*

Concentration	Aqueous Extract (%)	Ethanolic Extract (%)
5%	49	61
10%	66	76
15%	79	86

Mortality Assessment
Mortality increased gradually with increase in concentration and exposure period. The highest mortality (87%) was observed at 15% ethanolic extract after 14 days.

Table 2: Mortality Percentage of *Trogoderma granarium*

Days	5%	10%	15%
1	10	18	27
3	22	35	48
5	37	52	66
7	49	67	79
14	63	76	87

The insecticidal activity may be attributed to essential oils and phenolic compounds present in Tulsi extracts that interfere with insect nervous and endocrine systems.

Reproductive Inhibition
Tulsi-treated insects laid significantly fewer eggs compared to untreated insects. Adult emergence was markedly reduced at higher concentrations.
The reduction in reproductive potential indicates that Tulsi extracts may interfere with oviposition behavior and larval development.

Grain Weight Loss

Wheat grains treated with Tulsi extracts showed considerably lower weight loss after 45 days compared to untreated grains.

Table 3: Grain Weight Loss in Treated Wheat Samples

Treatment	Weight Loss (%)
Control	17.9
Aqueous Extract	8.1
Ethanolic Extract	4.8

Germination Test

The germination percentage of treated wheat grains remained above 91%, demonstrating that Tulsi extracts did not adversely affect seed viability.

Conclusion

The present investigation demonstrated that *Ocimum sanctum* extracts possess significant insecticidal, repellent, antifeedant, and reproductive inhibitory effects against *Trogoderma granarium* infesting stored wheat grains.

Among the tested treatments, ethanolic extract at 15% concentration showed maximum efficacy in reducing insect population, feeding activity, and grain damage.

The botanical treatment effectively protected stored wheat grains without adversely affecting seed germination. Therefore, Tulsi-based formulations may serve as eco-friendly and sustainable alternatives to synthetic pesticides for integrated management of stored grain pests.

References

1. Adedire CO, Lajide L. Ability of extracts of ten tropical plant species to protect maize grains against infestation by the maize weevil, *Sitophilus zeamais* during storage. Nigerian Journal of Experimental Biology,2003:4(2):175–179.
2. Ahmedani MS, Haque MI, Afzal SN, Aslam M, Naz S. Varietal changes in nutritional composition of wheat kernel caused by Khapra beetle infestation. Pakistan Journal of Botany,2007:39(4):1511–1518.
3. Bhattacharya K, Chandra G. Bioefficacy of medicinal plant extracts against stored grain insect pests. International Journal of Agricultural Sciences,2014:6(1):15–21.
4. Chaubey MK. Biological activities of essential oils against rice and stored-product insect pests. Journal of Essential Oil Bearing Plants,2012:15(5):809–815.
5. Fields PG. Effect of *Pisum sativum* fractions on mortality and progeny production of stored-grain insects. Journal of Stored Products Research,2006:42(1):86–96.
6. Golob P, Moss C, Dales M, Fidgen A, Evans J, Gudrups I. The use of spices and medicinal plants as bioactive protectants for grains. Natural Resources Institute, Chatham, UK, 1999.
7. Isman MB. Botanical insecticides: for richer, for poorer. Pest Management Science,2008:64(1):8–11.
8. Jembere B, Obeng-Ofori D, Hassanali A, Nyamasyo GHN. Products derived from medicinal plants as grain protectants against the maize weevil and the red flour beetle. International Journal of Pest Management,1995:41(2):84–94.
9. Kim SI, Roh JY, Kim DH, Lee HS, Ahn YJ. Insecticidal activities of aromatic plant extracts and essential oils against stored-product pests. Journal of Stored Products Research,2003:39(3):293–303.
10. Kumar R, Mishra AK, Dubey NK, Tripathi YB. Evaluation of essential oil components as natural preservatives against fungi and insects infesting stored food commodities. Food Science and Technology,2007:40(9):1472–1478.
11. Pavela R. Effectiveness of some botanical insecticides against *Spodoptera littoralis* and stored-product pests. Industrial Crops and Products,2009:30(3):349–353.
12. Rajendran S, Sriranjini V. Plant products as fumigants for stored-product insect control. Journal of Stored Products Research,2008:44(2):126–135.
13. Tapondjou LA, Adler C, Fontem DA, Bouda H, Reichmuth C. Bioactivities of cymol and essential oils of medicinal plants against stored-product insects. Journal of Pest Science,2005:78(4):233–240.
14. Tripathi AK, Prajapati V, Verma N, Bahl JR, Bansal RP, Khanuja SPS, et al. Bioactivities of the leaf essential oil of *Ocimum* species against stored grain pests. Journal of Economic Entomology,2002:95(1):183–189.
15. Upadhyay RK, Ahmad S. Management strategies for control of stored grain insect pests in farmer stores and public warehouses. World Journal of Agricultural Sciences,2011:7(5):527–549.
16. Walia S, Saha S, Tripathi V, Sharma KK. Botanical pesticides for management of stored grain pests. Journal of Biopesticides,2010:3(1):32–37.
17. Weaver DK, Subramanyam B. Botanicals. In: Alternatives to Pesticides in Stored-Product IPM. Springer Publications, Boston, MA, 2000, 303–320.
18. Zettler JL, Arthur FH. Chemical control of stored product insects with fumigants and residual treatments. Crop Protection,2000:19(8–10):577–582.