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Characteristics of Bio Powder to Control Storage Pest in Rice (*Oryza sativa*)

*Kameleshwaran R, Isani, Aarthi, Nagapriya, Madhumitha, Gobika and Subashri
School of Agriculture and Animal Sciences, The Gandhigram Rural Institute (DTBU),
Gandhigram, Dindigul-624302, India

*Corresponding Author's email: psubashri3065@gmail.com

Rice feeds nearly half of the global population as a staple food crop worldwide. However, rice is susceptible to various forms of deterioration during storage. Parboiled rice is relatively more resistant to spoilage, whereas non-parboiled rice deteriorates easily due to the presence of fat and its susceptibility to oxidative rancidity. One of the major challenges associated with rice is storage. Every year, about 30–50% of the total paddy production is stored by farmers, during which losses caused by storage pests pose a serious threat to rice quality and food security. To address this issue, organic methods using different plant extracts can effectively help control storage pests. Bio-powder is a plant-based formulation prepared from neem leaves (*Azadirachta indica*), tulsi (*Ocimum sanctum*), notchi (*Vitex negundo*), garlic bulbs (*Allium sativum*), and chilli fruits (*Capsicum annuum*). These botanicals were selected for their well-known insecticidal, repellent, and antifeedant properties. Although many studies are available on individual biorepellents derived from these plants, research on their combined use is still limited. Therefore, this review aims to create awareness among the scientific and farming communities about controlling storage pests in rice using naturally occurring plant products in the form of bio-powder.

Keywords: Biopowders; Chilli; Garlic; Neem; Notchi; Plant extract; Rice; Tulsi

Characteristics of Leaf Extract

Notchi contains bioactive compounds like flavonoids, terpenoids, and phenolic acids, which contribute to its insecticidal and repellent properties (Kumar *et al.*, 2018). Studies have shown that Notchi extracts and powders can effectively repel storage pests like rice weevils and grain borers (Senthil Nathan *et al.*, 2008). Reduce pest infestation and damage to stored grains (Raja *et al.*, 2015). It also protects grains from fungal growth and mycotoxin contamination. Rajeswari and srinivasan, 2019 reported that Leaf powder of notchi (*Vitexnegundo*) caused about 90% mortality of rice weevil (*Sitophilus oryzae*) and arrested further multiplication, improving seed storability. Neem contains bioactive compounds like azadirachtin, nimbin, and nimbidin, which contribute to its insecticidal and repellent properties (Kumar *et al.*, 2018). Neem's bioactive compounds can disrupt insect development and reproduction, leading to population decline (Mordue & Blackwell, 1993) and disrupt insect feeding behavior. Leaf powder of *A. indica* achieved 100% mortality at concentrations ≥ 25 mg within 14 days, indicating strong entomocidal activity against *Sitophilus oryzae*

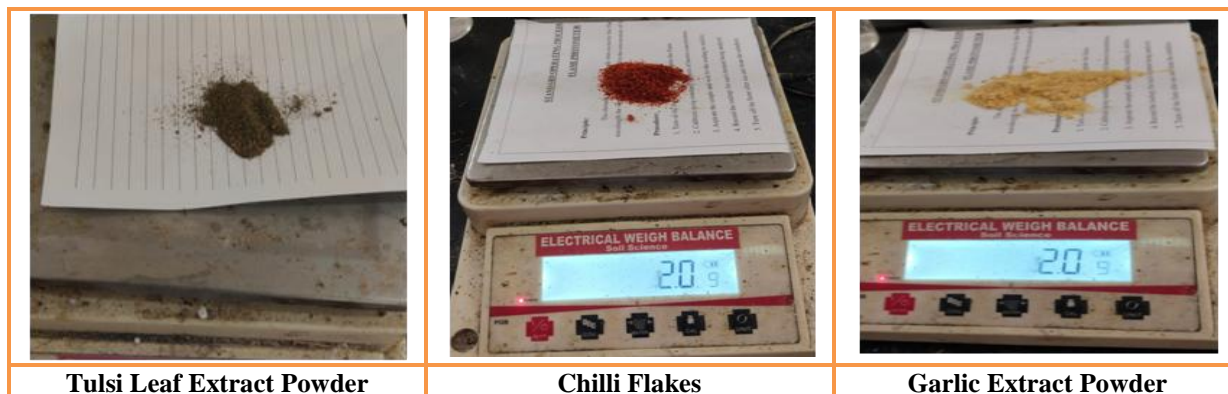


Notchi Leaf Extract Powder



Neem Leaf Extract Powder

Tulsi, also known as Holy Basil, it contains Eugenol: a phenolic compound with insecticidal and antimicrobial properties (Kumar *et al.*, 2010). It also contains Linalool: a monoterpene and Ursolic acid: a triterpenoid with antimicrobial and insecticidal properties (Prakash *et al.*, 2012; Senthil Nathan *et al.*, 2005). Several studies also reported that Tulsi (*Ocimum sanctum*) and ethyl acetate leaf extract at 5% caused about 83.33% mortality within 72 hours and nearly 90% mortality after 15 days against rice weevil, indicating strong insecticidal activity.



Chilli fruits contain several bioactive phytochemicals such as Capsaicin, Dihydrocapsaicin, Carotenoids (capsanthin, capsorubin), Flavonoids & Phenolics. Among these Capsaicin is mainly responsible for the insecticidal property (Ahmed and Khan, 2023). Ibrahim Bahet *et al.*, (2024) concluded that capsicum chinense powder applied at doses of 5, 10, 15, and 20 g per 100 kg of maize caused mortality rates of 75%, 80%, 90%, and 100%, respectively, against *Sitophilus zeamais* after two weeks, demonstrating strong insecticidal activity. Garlic contains sulfur compounds like allicin, which have insecticidal properties that can help control rice weevil populations. These insecticidal properties were evidently proved by Khanal *et al.*, (2021) and recorded about 73.34% rice weevil mortality when applied at 20 g/kg of garlic in rice. Overall, results confirm that garlic possesses significant contact, fumigant, and repellent activity and can be integrated into eco-friendly management strategies for stored-grain insects (Kanimozhiet *et al.*, 2023). Considering the proven insecticidal and antimicrobial properties of plant-based bio-powders (Notchi, Neem, Tulasi, chili and garlic) their use has gained attention as a sustainable alternative to synthetic pesticides. The combined application of different bio-powders may enhance effectiveness through synergistic action, thereby reducing rice infestation by storage pests and minimizing post-harvest losses. Botanical protectants are biodegradable, safer to handle, and less likely to cause resistance in insects, making them suitable for long-term grain storage. In addition, these plant extracts help maintain grain quality while lowering environmental and health risks associated with chemical fumigants. This review aims to provide valuable insights for researchers and the farming community on the potential of naturally occurring plant extracts for effective and eco-friendly management of storage pests in rice.

Conclusion

Several earlier studies have demonstrated the individual effectiveness of these bio-extracts. However their combined effects remain largely unexplored, and research in this area is still limited. In conclusion, this study suggests that a botanical formulation consisting of neem, notchi, tulsi, garlic, and chilli powders can provide comprehensive protection against rice storage pests through a synergistic combination of repellent and insecticidal actions. Future research is needed to evaluate the combination effect of these extracts, particularly when mixed and formulated as sachets, which may prove more effective than individual applications. Moreover, these bio-powders offer a superior alternative to synthetic pesticides, as they are eco-friendly, cost-effective, and leave the final product free from hazardous chemical residues. Consequently, this sustainable biopesticide strategy represents a practical and scalable solution for post-harvest management, addressing the critical need for safe and environmentally responsible food storage practices in modern agriculture.