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Bio-Efficacy of Different Medicinal Plant Extract Against *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae): A Review

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Abstract: The stored grains are susceptible to infestation by *Sitophilus oryzae*, resulting in significant degradation of nutritional value due to contamination by these pests. The adult larvae voraciously feed on various commodities, including cereals, pulses, rice, and wheat, thereby compromising both nutritional quality and agricultural productivity. Unchecked, stored cereal crops can incur devastating losses of up to 100%. The mobile adult pests migrate between storage facilities, exacerbating the deterioration of stored products' quality and quantity. This destruction leads to a diminution of essential amino acids in maize, wheat, and cereals, while also impairing seed germination capacity and viability. Consequently, the spoiled stored products emit unpleasant odors, fostering secondary pest infestations and fungal growth (Okam and Hath, 2019).

The alarming rate of destruction prompts farmers to resort to synthetic pesticides, which, however, pose detrimental consequences to human health and beneficial insects within the ecosystem (Ishtiaq *et al.*, 2016). Therefore, there exists an imperative need to develop biodegradable pesticides derived from various medicinal plant parts, such as leaves, roots, stems, seeds, and flowers. These eco-friendly alternatives would mitigate harmful effects on human health and beneficial insect populations.

Keywords: Stored grain, *Sitophilus oryzae*, Nutritional value, Medicinal plants, Biodegradable pesticides

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Introduction

The global issue of stored grain pests necessitates urgent attention, as the world's population approaches 8.6 billion by 2030 and 9.8 billion by

2050. The Food and Agriculture Organization warns of an impending food deficiency unless global yield production increases by 70% by 2025.

Currently, approximately 70% of food is stored using traditional methods in villages (Singh *et al.*, 2021). Secure storage of food grains poses a significant challenge worldwide. Long-term storage of cereals, pulses, nuts, and spices is compromised by insect pests, resulting in substantial losses in quality and quantity (Dang and Rela, 2020). *Sitophilus oryzae*, a pervasive pest, thrives in elevated temperatures and humidity, infesting cereals, wheat, and other grains due to inadequate storage practices (Okram and Hath, 2019). Plants possess anti-insecticidal compounds in various parts, including leaves, seeds, roots, stems, rhizomes, and flowers. These secondary metabolites, non-essential for plant development, play a crucial role in protecting against exploiters and disease-causing agents. Botanical extracts have been employed since the 1940s as eco-friendly alternatives to synthetic pesticides, offering high efficacy without harming beneficial insects (Martina and Kristina, 2013).

In India, unscientific storage methods result in approximately 10% destruction of food grains by pests, rodents, mites, and pathogens. Regions like North East India face exacerbated affliction due to high humidity. Maintaining optimal humidity, moisture, and oxygen levels in stored grains ensures safe preservation (Chayengiya *et al.*, 2010). Botanic substances, derived from plants, offer an integrated pest management solution. Floral insecticides are eco-friendly, harmless to ecosystems, and easily produced from plant extracts. Essential oils in botanicals exhibit promising pesticidal effects (Tawfeek *et al.*, 2021). Rice weevil (*Sitophilus oryzae*) is a severe pest infesting stored grains and products, favoring soft wheat varieties (Saljoqi *et al.*, 2006). Various plant species demonstrate insecticidal properties, warranting further research for developing advanced, eco-friendly pesticides (Tembo *et al.*, 2018).

S. oryzae, a widespread stored grain pest, develops resistance to synthetic pesticides, which pollute the environment and harm beneficial insects. Plants contain naturally occurring

chemical components effective against pests (Yankanchi and Gadache, 2010). Cereals, a primary source of nutrition, are vulnerable to insect infestation due to inadequate storage. *Sitophilus oryzae* causes significant losses in quantity and quality during storage (Akhtar *et al.*, 2013).

Sitophilus oryzae (Rice weevil)

Rice weevil is one of the grave pests of wheat, sorghum, millet, paddy, barley, maize causing quantum loss of quantity and quality meantime of storage. Length of full grown larvae is 5mm and fleshy, plummy legless composition. Length of adult *S. oryzae* is 3 mm and reddish brown in colour. They have a cylindrical body, rostrum is curved, long and slender, elytra contains four yellow spots. Breeding season is April to October and inactivates in winter. Majorly rice weevil cranny the storage bags of cereals. Adult female rice weevil lay nearby 400 eggs in their active season, after laid eggs grain holes seal by gelatinous substances. After 6-7 days larvae are hatched into the eggs and it feeds on the grains till maturity. Then, 6-14 days pupa is formed, it emerged out from grains and lives near about 4-5 months (Deshwal *et al.*, 2020).

Botanical Control

Eco-friendly botanical control methods provide a risk-free alternative. Plant oils, extracts, and post-harvest waste exhibit pesticidal activity against stored grain pests (Deb, 2019). Botanical products are natural insecticides derived from plants. Synthetic pesticides contaminate grains and ecosystems, necessitating biodegradable pesticides from medicinal plants. Botanical products are inexpensive, readily available, and biodegradable (Yallappa *et al.*, 2012).

Biodegradable Pesticides: Following studies have demonstrated the efficacy of various botanical extracts in controlling *Sitophilus oryzae*, a devastating pest infesting stored grains:

- *Piper nigrum* plant extract induces 67.81% mortality in *S. oryzae* after 120 h (Arshad, 2016).

- *Acorus calamus* rhizome powder exhibits high effectiveness against *S. oryzae* (Pal *et al.*, 2021).
- Kernel powder of *Azadirachta indica* and seed powder of *Piper nigrum* demonstrate significant efficacy (Pal *et al.*, 2021).
- *Zingiber officinale* rhizome powder reduces grain damage percentage.
- Plant powders of *Azadirachta indica*, *Melia azadarch*, and *Zanthoxylum acanthopodium* display strong repellent activity (Bhubaneshwari Devi *et al.*, 2014).
- *Vitex negundo*, *Adathoda vasica*, and *Lantana camara* plant powders exhibit potent repellency (Saujanya *et al.*, 2016).
- Petroleum ether extract of Celery achieves 100% mortality rate (Al-Akhdar *et al.*, 2015).
- *Acorus calamus* rhizome powder effectively protects against *S. oryzae* (Padmasri *et al.*, 2017).
- Plant powders of *Citrus reticulata*, *Zingiber officinale* and *Psidium guajava* show high mortality rates and prevent egg hatching (Chayengia *et al.*, 2010).
- Toxicity of naturally occurring plant oil from *Artemisia camphorate*, *Cymbopogon citrates*, *Imperata cylindrical* and *Lantana camera* causes the highest effects opposed to adult *S. oryzae*. There is also change in alkaline phosphatase and acetylcholinesterase enzyme activity of adult *S. oryzae*. (Tawfeek *et al.*, 2021).
- Ethanol extract of bakain drupes (*Mela azadarch*) caused 82% mortality. *Cymbopogon citrates* (lemon grass), *Mentha longifera* (Mint), *Myrtus communis* (Habulas) and Harmal (*Peganum harmal*) show less mortality rates as compared to Bakain on *S. oryzae*. (Saljogi *et al.*, 2006).
- Efficacy of ethanol extract of *Withania somifera*, *Clerodendrum inerme*, *Cassia tora*, and *Eupatorium odoratum* affects in decreasing grain damages and higher mortality rate in *S. oryzae* (Yankanchi and Gadache, 2010).
- Ethanol extract of *Trigonella foenum graecum*, *Apium graveolens*, *Laurusn obilis* and *Thymus vulgaris* shows strongest effects on *Sitophilus oryzae* (Al-Akhdar *et al.*, 2013).
- Plant powder of *Eupatorium adenophorum*, *Ocimum sanctum* and *Ruta chalepensis* affects 100% mortality on *S. oryzae* at the end of 21 days of treatment. (Vinothkumar *et al.*, 2013).
- The post-harvest waste (leaves and stem) of *Zingiber zerumbet* and *Elettaria cardamomum* plant causes 100% effect on Rice weevil (Widiyaningrum *et al.*, 2019).
- Phytochemicals present in botanicals, such as alkaloids, terpenoids, ecdysterone, and phenolic acids, contribute to their insecticidal properties, disrupting molting patterns and exhibiting toxicity to *S. oryzae* (Gawali *et al.*, 2022).

Botanical origin of insecticides serves as widely used synthetic compound insecticides against stored grain insect pests. These are easily biodegradable in the biosphere without any hazardous effect on human being and non-targeted species (Ileke and Olaniyi, 2013). Worldwide distributed *S. oryzae* (rice weevil) is one of the most destructive insect pests. It attacks on many common agricultural products such as maize, rice and wheat. Adult rice weevil and larvae feed on grains causing heavy economic losses and decreased carbohydrates in grains and it gives bad odor to yield grains, which insist to secondary pests.

This review focuses on different botanical plants extracts such as leaf powder, ether extract, oil extract, post-harvest waste (stem and leaves), rhizome powder, kernel powder and seed powder which contain the biodegradable insecticides and shows strongest mortality, decreased growth and oviposition capacity on *Sitophilus oryzae*. Plants have different phytochemicals like, alkaloids,

terpenoids, ecdysterone and phenolic acids which helps in plant defense mechanism, affects the molting pattern of insects and highly toxic to insect pests (Gawali *et al.*, 2022). Efficacy of botanical extracts led “back to nature” to control pest substitute (Abou-Elnaga, 2015). These findings underscore the potential of botanical extracts as eco-friendly pesticides, warranting further research and development for integrated pest management strategies.

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