



Article

Zoology

INSECTICIDAL EFFICACY OF ZOOCHEMICAL FROM FRESHWATER CRAB SHELL ON RICE WEEVIL *Sitophilus oryzae*

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ABSTRACT

Globally, needed eco-friendly insecticides for grain storage with the advantages of specific targets, improved seed germination, low non-targeted species toxicity, and reduced environmental hazards. In the present study, the insecticidal efficacy of freshwater zoochemicals from *Ozietelphusa* species shell extract on *Sitophilus oryzae*. The *Ozietelphusa* species shell was extracted in ethanolic solvent containing rich alkaloids and terpenoids, known as freshwater zoochemicals, which significantly contribute to biological activity. *Ozietelphusa sp.* zoochemicals had a potential insecticidal efficacy against rice weevil (*Sitophilus oryzae*), and the adult toxicity was found in LC_{50} (LCL-UCL) = 146.290 (105.293 - 210.162) $\mu\text{g/mL}$ and dose-dependent activity ($R^2 = 0.9$), which is contributed to by the presence of zoochemicals. Overall, it concluded that this study of the freshwater crab *Ozietelphusa sp.* shell zoochemical extract in the potential role of eco-friendly insecticide is an alternative to chemical insecticides. According to our knowledge, the freshwater crab *Ozietelphusa sp.* shell-provided insecticide is equal to botanical insecticide, which responds to the presence of secondary metabolites to control the insect as a natural adulticide in the grain storage industry to reduce the risk of rice weevil damage and improve grain quality.

Keywords: Freshwater zoochemicals, *Ozietelphusa sp.*, freshwater crab, zoological insecticide, rice weevil.

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INTRODUCTION

In 2050, there will be 9.1 billion people on the globe, and almost 70% more food will be needed. Postharvest loss from insect pests is one of the major issues with food security (Bezabih *et al.*, 2022). In agriculture, grain storage is essential for food safety and the next generation. Insect pests are economically relevant among the several biotic and abiotic elements that impact the fate of grains during storage because they cause significant loss (Vijayan *et al.*, 2023). The Indian economy is heavily reliant on agriculture, and technological advancements have led to a steady increase in grain production. However, post-harvest loss remains at

10% of total grain production (Sharon *et al.*, 2014). Common stored grain pests of the granary, the granary weevil (*S. granarius*), rice weevil (*S. oryzae*), broad-nosed grain weevil (*C. oryzae*), coffee bean weevil (*A. fasciculatus*), lesser grain borer (*R. dominica*), and larger grain borer (*P. truncates*), significantly damage wheat, oats, barley, rice, maize, cotton, nuts, flour, millet, corn, coffee, seeds, dried fruits, and cornstalks (Demis and Yenewa, 2022; Ahmad *et al.*, 2021). Rice (*O. sativa*) is placed as the world's second most important food grain after wheat. It provides 20% of the calories consumed worldwide by humans and is a staple food in Asia and Africa (Bitew,

2016). Insect metamorphosis, the transformation from larvae to adults, is regulated by hormones such as juvenile hormone (Malhotra and Basu 2023). By targeting this hormone, researchers aim to develop novel zoo-insecticides to control mosquito populations (Karnan *et al.*, 2025b). In order to address this issue, natural insecticides and fungicides, remarkable solutions for pest control alternatives, were analyzed (Raksha *et al.*, 2024).

Secondary metabolites and other animal chemical substances are referred to as "zoochemicals" in this context. The synthesis of secondary metabolites is not limited to bacteria and plants; animals also naturally produce these useful compounds. Alkaloids, terpenoids, saponins, and other secondary metabolites found in animals are comparable to those found in plants (Karnan *et al.*, 2022; Lindshield, 2018). New pesticides based on natural products are being developed to replace the synthetic compounds, reducing the number of synthetic pesticides available in agriculture. Today, globally, new insecticides are discovered that, armed with new tools, provide the future of insect control (Dayan *et al.*, 2009; Sparks *et al.*, 2019). Recent research successfully explored zoochemicals as a natural insecticide from sea urchins and marine crabs (Karnan *et al.*, 2025a-b; 2026). The freshwater crab species of the gecarcinucid *Oziotelphusa* Müller (1887) are generally found in rice fields, river embankments, and streams in the low-lying areas of Sri Lanka and southern India (Bahir and Yeo, 2005; Pati and Sharma, 2012; Ng and Tay, 2001; Teeni Janet Raj *et al.*, 2021). The natural components found in crab shells are the source of the bioactive compounds employed in folklore medicine (Khalaf *et al.*, 2021). The antibacterial, antifungal, antiviral, and anti-inflammatory properties of crab metabolites have been discovered to have prospective use in the pharmaceutical sector (Laith *et al.*, 2017). Crab shell extract containing polyphenols and fatty acid derivatives, while that extract has anti-inflammatory, antioxidant, and insecticidal effects (Karnan *et al.*, 2025b; Elshaarawy *et al.*, 2023; Galal-Khallaf *et al.*, 2022).

Synthetic pesticides have become an important part of contemporary agriculture to boost crop yield and decrease crop losses. This has led to the successful management of crop pests, but they are harmful to the environment. Globally, natural insecticides and fungicides are remarkable solutions for controlling storage pests. In recent days, a potential solution for pest control is using plant metabolites as a botanical insecticide. In this term, zoological derivatives are metabolites as a zoological insecticide. In this present research gap, to control the insect and fungal damage from stored grain using natural insecticides and antifungals from freshwater invertebrates, such as crab shell bio-waste, which contains rich secondary

metabolites. Rice weevil (*S. oryzae*) is one of the significant pests & has caused serious damage in grain storage. The use of synthetic pesticides to control them has had a negative effect on the environment, animals, and humans. In order to address this issue, crab shell zoo-extract-based pest control alternatives were analyzed. The aim of the present study is to determine the insecticidal efficacy of the freshwater crab zoochemical extract from *Oziotelphusa sp.* shell as an alternative in eco-friendly insecticide for pest management.

MATERIALS AND METHODS

Oziotelphusa sp. freshwater crab shell extraction

Three kg of *Oziotelphusa sp.* freshwater crab was collected from the Kodikalur village (Lat 10.799297° and Long 79.159999°), Thanjavur district. *Oziotelphusa sp.* freshwater crab was initially identified in the key of Teeni Janet Raj *et al.* (2021). The collected crabs were carefully removed from their shells, and the shells were washed several times with tap water and dried under room temperature. The dried crab shell is used to make fine powder using a mortar and pestle. Briefly, 10 grams of the finely powdered crab shell of *Oziotelphusa sp.* was first extracted with ethanolic solvent (100 mL) for 72 hours in a dark environment to prevent degradation of light-sensitive compounds, and after extraction, it was filtered and collected. The collected organic extracts were concentrated under reduced pressure at 40°C using a rotary evaporator. The resulting crude extract was stored at 4°C and used for subsequent pest control in post-harvest storage.

Insecticidal activity of freshwater zoochemicals

Insects culture

Rice weevil (*Sitophilus oryzae*) was used for *in vivo* evaluation of the insecticidal activity of *Oziotelphusa sp.* freshwater crab shell extract. A culture of *Sitophilus oryzae* was maintained in a laboratory environment without any insecticide exposure. The rice weevils were reared on wheat flour at room temperature using the insect-reared method followed by Maazoun *et al.* (2017) and Chaubey (2007).

Adult toxicity assay

The toxic effect of *Oziotelphusa sp.* freshwater crab shell extract was evaluated against adults of rice weevil (*Sitophilus oryzae*) by adult toxicity methods followed by Chaubey (2007) with mild modification. Ten adults taken from the laboratory culture were placed with 1 g of rice flour in a 90 mm petri plate. Flour was spread uniformly along the whole surface of the petri plate. A treatment with solutions of different concentrations of crab zoochemicals extract (50 to 250 µg/ml) was pasted on the inner surface of the covered and sealed petri plate. All the closed petri plates were kept in the dark. After 24 h of exposure, adult mortality was recorded.

Statistical analysis

All experiments were performed in triplicate (n = 3). Data were analyzed using IBM SPSS Version 20.0, followed by probit analysis. The LC₅₀ values (with 95% confidence limits) were calculated. It is crucial to determine the correlation coefficient (r) statistic and the linear regression equation for the independent and dependent variables.

RESULTS AND DISCUSSION

The major stored grain pest, rice weevil (*Sitophilus oryzae*), causes high economic losses, both qualitative and quantitative. In the sector of pest management, using synthetic insecticides is a potential hazard for non-targeted animals, such as mammals. There is a development of an effective target insecticide that can be less toxic to mammals and the environment. In these issues, eco-friendly insecticides are used to control insect growth and development, with reduced environmental hazard and non-toxicity effects on mammals. In this aim, the insecticide effect on the major stored grain pest, the rice weevil (*Sitophilus oryzae*), of the *Ozietelphusa sp.* freshwater crab shell metabolic zoo-extract.

Figure 1 shows the *in vivo* efficacy of the zoo-extract insecticidal examination against *Sitophilus oryzae* adult toxicity of *Ozietelphusa sp.* freshwater crab shell metabolic zoo-extract. The insecticidal activity was observed in the range of 50 to 250 (µg/mL) of zoo-extract (13.30±5.70 to 86.60±5.70% of inhibitions) and adult toxicity to be found in LC₅₀ (LCL-UCL) = 146.290 (105.293 - 210.162) µg/mL and dose-dependent activity (R² = 0.9), which is contributed to by the presence of zoochemicals, such as alkaloids and terpenoids.

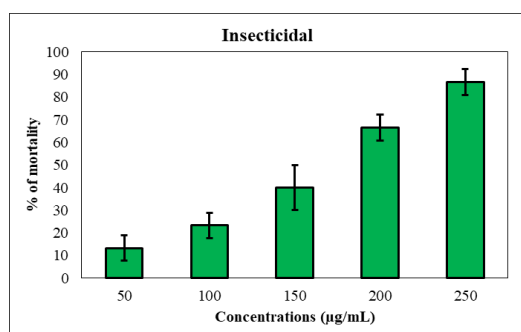


Figure 1: Insecticidal activity of *Ozietelphusa sp.* freshwater crab shell metabolic zoo-extract on *Sitophilus oryzae*

S. oryzae is one of the most economically significant pests that harm grain seeds during storage, out of a few that do so (Mehta *et al.*, 2021). Grain kernels are severely harmed by rice weevils. The quality of grains will be significantly decreased when rice weevil-damaged grain kernels are combined with normal grain kernels (Zhang *et*

al., 2021). In recent days, zoochemicals are potential insecticides, including invertebrates, through *in vitro*, *in vivo*, and *in silico* models. Sea urchin *Salmacis virgulata* against *Tribolium castaneum*, *Aedes aegypti*, and the Sf9 cell line through assays for *in vitro* acetylcholinesterase (AChE) inhibition, cytotoxicity, repellency, and larvicidal activity (Karnan *et al.*, 2025a). Additionally, the *in vitro* insecticidal activity of zoo-extract against the AChE enzyme by the marine sponge *Hyattella intestinalis* zoo-extract (Karnan *et al.* 2023a). In the current study, *Ozietelphusa sp.* freshwater crab shell metabolic zoo-extract is a promising source of zoological insecticides, as evidenced by the invertebrate zoochemical inhibitory and adulticidal activity. These bio-based pesticides offer an eco-friendly approach to pest control through their adult toxicity, being readily biodegradable, and presenting lower environmental risks compared to synthetic pesticides.

The freshwater crab *Ozietelphusa sp.* shell as an eco-friendly zoo insecticide is equal to botanical insecticide, which responds to the presence of secondary metabolites to control the insect as a natural adulticide.

CONCLUSION

Overall, it concluded that this study of the freshwater crab *Ozietelphusa sp.* shell zoochemical extract in the potential role of insecticide as an eco-friendly alternative to chemical insecticides in the grain storage industry to reduce the risk of rice weevil damage. In recommendation of the freshwater crab *Ozietelphusa sp.* Bio-waste like shell was used for zoochemical extraction and evaluating insecticidal agents, with managing storage grain production, which is contributed to by the presence of zoochemicals, including alkaloids and terpenoids.

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