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Potential of *Nerium oleander* as a Botanical Pesticide: A Review of Its Phytochemical and Insecticidal Properties

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With the growing concern over the environmental and health impacts of synthetic pesticides, there is increasing interest in plant-based pest control agents. Botanical pesticides offer a more biodegradable and eco-friendlier alternative. *Nerium oleander*, although primarily known for ornamental use and toxicity, has shown promising insecticidal, antifungal, and antimicrobial properties due to its diverse phytochemical profile (Zaid *et al*., 2022).

Ornamental Applications

Nerium oleander isn't just known for its bioactive compounds—it's also a favorite in landscaping due to its hardy and attractive features:

Evergreen Foliage: This plant retains its lush green leaves throughout the year, adding consistent color and coverage to gardens, parks, and roadsides—even during dry or cold seasons.

Long Flowering Season and Color Variety: *Nerium oleander* blooms over an extended period, producing vibrant flowers in a range of colors, including pink, red, white, and yellow. This long-lasting floral display enhances aesthetic appeal in both private and public spaces.

Tolerance to Harsh Conditions: The plant is remarkably tolerant to environmental stress, such as drought, soil salinity, and urban air pollution. This resilience makes it ideal for low-maintenance settings, including urban landscapes, hedgerows, and roadside plantations.

Fig. 1. Botanical description of *Nerium oleander*

Because of this combination of beauty and toughness, Nerium oleander is widely used in city planning and landscape architecture (Pandey *et al*., 2024).

Phytochemical Composition

Nerium oleander contains numerous secondary metabolites that contribute to its biological activity:

Table 1. Role of secondary metabolites and their activities (Upadhyay, 2024)

Compound Class	Major Constituents	Known Activity
Cardiac glycosides	Oleandrin, neriifolin, digitoxigenin	Neurotoxic and cytotoxic effects on pests
Flavonoids	Quercetin, rutin	Antioxidant, insect deterrent
Alkaloids	Oleandrine-related alkaloids	Neurotoxic effects
Saponins	Triterpenoid saponins	Insecticidal, surfactant
Tannins and phenols	Polyphenolic compounds	Antimicrobial

Insecticidal Properties

Studies have demonstrated that *Nerium oleander* leaf and flower extracts have strong insecticidal activity against several pests:

Target Pests

- *Aphis craccivora* (aphids)
- *Helicoverpa armigera* (cotton bollworm)
- *Spodoptera litura* (armyworm)
- *Sitophilus oryzae* (rice weevil)
- *Tribolium castaneum* (red flour beetle)

Antifungal and Antibacterial Activity

Nerium oleander extracts have also demonstrated antimicrobial properties against various phytopathogens, including:

- *Fusarium oxysporum*
- *Alternaria alternata*
- *Pseudomonas syringae*
- *Xanthomonas campestris*

These properties make it a potential dual-purpose agent for pest and disease management

Modes of Action

Neurotoxicity: Certain compounds like cardiac glycosides disrupt the normal function of nerve cells. They interfere with an important enzyme called Na^+/K^+-ATPase, which helps maintain the balance of sodium and potassium ions across cell membranes. When this balance is disturbed, it leads to cell malfunction and death, especially in nerve and muscle cells—making these compounds toxic to insects and other pests.

Feeding Deterrence: Some phytochemicals in Nerium oleander, such as bitter alkaloids and flavonoids, act as natural feeding repellents. Their strong taste or toxic effects discourage herbivorous insects from chewing on the leaves, effectively protecting the plant from damage.

Reproductive Inhibition: Even at low (sub-lethal) doses, some compounds in the plant can interfere with an insect's ability to reproduce. They may reduce egg laying, slow larval development, or impair fertility, ultimately reducing pest populations over time (Ali *et al*., 2008).

Methods of Application

Crude Leaf Extract Sprays: Simple preparations using ethanol or water-based (aqueous) extracts of Nerium oleander leaves can be sprayed directly onto crops. These natural sprays help deter or kill pests without synthetic chemicals**.**

Enhanced Effect with Methanolic Extracts: Extracts made using methanol have shown higher pest-control effectiveness. This is because methanol dissolves the plant's active compounds more efficiently, making the spray more potent.

Advanced Biopesticide Formulations: Scientists are working on biopesticide powders and emulsifiable concentrates made from Nerium oleander extracts. These controlled, ready-to-use formulations aim to provide safer and more reliable pest control for farmers.

Conclusion

Nerium oleander is a potent source of bioactive compounds with demonstrated insecticidal and antimicrobial activity. With proper formulation and regulation, it holds promise as a **natural, plant-derived pesticide**. However, due to its high toxicity, any use must prioritize safety in application and environmental exposure.

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