Research

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Evaluation of Insecticidal Efficacy of Calotropis Procera and Annona Squamosa Ethanolic Leaf Extracts Against Musca domestica

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1. Abstract

In the present investigation, the larvicidal efficacy of crude ethanolic leaf extracts of Calotropis procera and Annona squamosa was evaluated against the common housefly, Musca domestica. Third-instar larvae were exposed to varying concentrations of the extracts using a dipping method for 48 hours. The LC_{50} values were calculated as 282.5 mg L^{-1} for C. procera and 550 mg L^{-1} for A. squamosa. Phytochemical screening revealed the predominance of alkaloids in both extracts. Sub-lethal concentrations (5% and 10% of LC_{50}) significantly affected larval development, metamorphosis, and biochemical parameters, including nucleic acid and protein content. C. procera extract exhibited greater insecticidal activity, inducing higher mortality, severe pupal deformities, delayed development, and reduced adult emergence. The findings suggest that ethanolic leaf extracts of these plants, particularly C. procera, have strong potential as eco-friendly and cost-effective bioinsecticides for the control of M. domestica.

2. Keywords: Musca domestica, Calotropis procera, Annona squamosa, bioinsecticide, larvicidal activity, LC_{50}

3. Introduction

The extensive use of synthetic insecticides has resulted in serious environmental and health concerns, including toxicity to non-target organisms, environmental contamination, and the development of insecticide resistance. These issues have increased interest in plant-based alternatives that are biodegradable, environmentally safe, and economically viable.

Plants synthesize a wide range of secondary metabolites that function as natural defense mechanisms against herbivores and pathogens. Numerous studies have demonstrated that plant extracts possess insecticidal, antifeedant, growth-regulating, and reproductive-inhibitory effects on insects. Exposure to toxic agents can also induce biochemical and molecular alterations in insects, particularly affecting nucleic acids and proteins, which serve as important indicators of cellular metabolism and developmental potential.

The housefly, Musca domestica (Diptera: Muscidae), is a major mechanical vector of pathogenic microorganisms responsible for several human and animal diseases. Continuous exposure to chemical insecticides has resulted in the development of resistance to several compounds, including spinosad, diflubenzuron, and other synthetic insecticides, necessitating the search for alternative control strategies.

Calotropis procera (Asclepiadaceae) is a perennial shrub widely distributed in tropical and subtropical regions. The plant is rich in latex containing alkaloids and defense-related proteins that may confer resistance against insects. Although its medicinal properties are well documented, limited studies have evaluated its insecticidal activity against M. domestica.

Similarly, Annona squamosa (Annonaceae) is traditionally used for pest control. Members of this family contain acetogenins with known pesticidal and antifeedant properties. However, the larvicidal potential of A. squamosa leaves against the housefly remains poorly explored.

The present study was therefore undertaken to evaluate the larvicidal efficacy of ethanolic leaf extracts of C. procera and A. squamosa against M. domestica, to identify their phytochemical constituents, and to assess their effects on metamorphosis and key biochemical parameters.

4. Materials and Methods

4.1. Rearing of Musca domestica

Adult houseflies were collected from local areas and reared under laboratory conditions at 26 ± 2°C, 60 ± 10% relative humidity, and a 12:12 h light–dark photoperiod. Adults were fed milk and powdered sugar. A mixture of wheat flour and milk (1:3) served as the oviposition and larval rearing medium.

4.2. Collection and Processing of Plant Material

Fresh leaves of C. procera and A. squamosa were collected from the Botanical Garden, University of Allahabad. Leaves were washed, shade-dried for 5–7 days, and ground into a fine powder. The powdered samples were stored in airtight containers until

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extraction.

4.3 Preparation of Ethanolic Extracts

Leaf powders were extracted using 90% ethanol in a Soxhlet apparatus. The extracts were concentrated at 50°C, and the residues were stored at 4°C for further experimentation.

4.4 Phytochemical Analysis

Qualitative phytochemical screening was performed to detect alkaloids, tannins, saponins, flavonoids, terpenoids, and phenolic compounds using standard chemical tests.

4.5 Preparation of Test Concentrations

Stock solutions were prepared by dissolving the extracts in ethanol. Working concentrations ranged from 100–500 ppm for C. procera and 200–1000 ppm for A. squamosa.

4.6 Larvicidal Bioassay

Twenty late third-instar larvae were exposed to each concentration using a dipping method for two minutes and then transferred to rearing media. Control groups were treated with water and ethanol alone. Mortality was recorded after 24 and 48 hours. LC_{50} values were calculated using Karber's method.

4.7 Assessment of Metamorphosis

Larval development, pupation, adult emergence, and morphological abnormalities were recorded following exposure to the extracts.

4.8 Biochemical Analysis

Larvae exposed to sub-lethal concentrations were homogenized, and total protein, DNA, and RNA contents were estimated using standard biochemical methods.

4.9 Statistical Analysis

Data were expressed as mean ± SEM of three independent experiments. Statistical analysis was performed using GraphPad software.

5. Results

5.1 Larvicidal Activity

Both extracts caused significant, dose- and time-dependent mortality of M. domestica larvae. C. procera extract exhibited higher toxicity, causing 100% mortality at 500 ppm after 48 hours, whereas A. squamosa required 1000 ppm to achieve similar mortality.

5.2 LC_{50} Determination

The LC_{50} values were calculated as 282.5 ppm for C. procera and 550 ppm for A. squamosa, indicating greater potency of C. procera

5.3 Effect on Metamorphosis

Both extracts significantly reduced pupation and adult emergence. Treated larvae exhibited delayed development, reduced pupal size, and severe deformities. Adult emergence was completely inhibited at the highest concentrations.

5.4 Phytochemical Composition

Alkaloids were detected as the major phytochemical component in both extracts, with higher levels in C. procera. Phenolics were present in low amounts, while flavonoids and terpenoids were detected only in A. squamosa.

5.5 Biochemical Alterations

Sub-lethal exposure resulted in a significant reduction in DNA, RNA, and protein content in treated larvae, indicating impaired cellular metabolism and growth.

6. Discussion

The results demonstrate that ethanolic leaf extracts of C. procera and A. squamosa possess strong larvicidal activity against M. domestica. The higher efficacy of C. procera may be attributed to its higher alkaloid content. The observed developmental abnormalities and biochemical disruptions suggest interference with hormonal regulation and metabolic pathways essential for insect growth and metamorphosis.

7. Conclusion

The present study confirms that C. procera and A. squamosa leaf extracts, particularly C. procera, exhibit significant larvicidal and growth-inhibitory effects against Musca domestica. These plant extracts represent promising candidates for the development of safe, eco-friendly bioinsecticides as alternatives to synthetic chemical insecticides.

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