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Histopathological alteration in the foregut of *Musca domestica* induced by *Datura innoxia* aqueous seed extract

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ABSTRACT

The insecticidal potential *of Datura innoxia* aqueous seed extract against *Musca domestica* (Housefly) was evaluated by examining histopathological changes in the foregut (stomodaeum) of treated adult flies. The extract was prepared using the Soxhlet method with distilled water and analysed through FT-IR to identify bioactive compounds. The analysis indicated the presence of water-soluble compounds such as alkanes, alkynes, alkyl halides and aliphatic amines. Adult houseflies collected from the Nashik region were reared to the F1 generation in the laboratory and exposed to the extract through a 10% sugar-milk solution. Tissue pathology observations showed degeneration of epithelial cells, disruption of the cuticle, and vacuolization of the gut lining. Increased concentration and exposure time intensified the damage, significantly reducing epithelial thickness and microvilli height. These findings indicate that *Datura innoxia* seed extract exhibits strong insecticidal activity by causing cytotoxic damage to the foregut of *Musca domestica.*

Figures : 02 References : 25 Table : 00

KEY WORDS : Bioactive compounds, Cytotoxic effects, *Datura innoxia*, FT-IR analysis, Insecticidal activity, Insecticide, *Musca domestica,* Soxhlet method, Stomodaeum, Tissue pathology.

Introduction

Musca domestica is an everyday nuisance. As one of the most widespread pest species in the world, it poses serious problems for public health and animal welfare. By feeding and breeding in waste, garbage, and animal manure, houseflies can pick up and spread harmful pathogens. As a synanthropic insect, *M. domestica* is found in close association with humans and animals, facilitating the transmission of a wide range of diseases, including typhoid, cholera, dysentery and food poisoning[8]. The species is also a major pest in agricultural farms, causing significant economic losses

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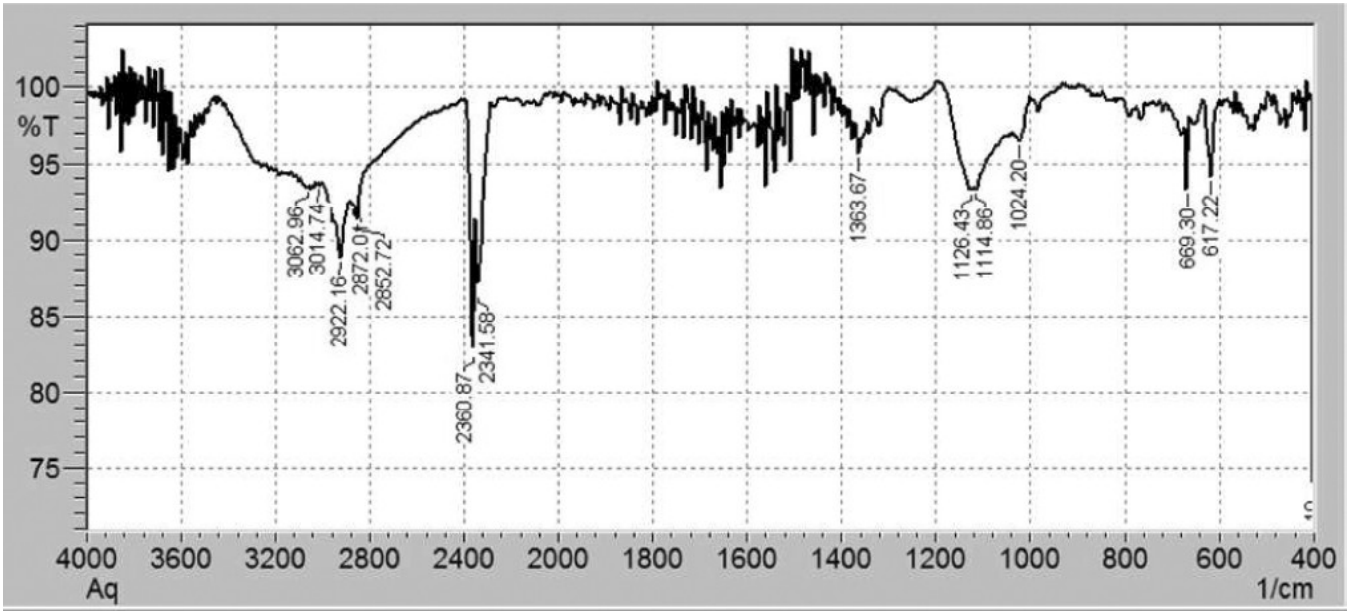

Fig. 1 : FT-IR Analysis of Aqueous Extract of *Datura innoxia* Seed Extract

and compromising food hygiene.[1]

The traditional method of controlling *M. domestica* populations depends on synthetic insecticides and continuous use of causes resistance development in *M. domestica*, environmental pollution, and adverse effects on non-target organisms[19]. The limitations and risks associated with synthetic insecticides have evoked growing interest in alternative, eco-friendly methods of insect control, including plant-derived insecticides.

Datura innoxia is a member of the family Solanaceae, known for medicinal and insecticidal properties[6]. The seeds contain a range of bioactive compounds, including scopolamine, hyoscyamine and atropine, which have been shown to exhibit insecticidal activity against various insect species.[6]

The foregut of insects, including *M. domestica*, plays a crucial role in digestion, nutrient absorption and detoxification. Any disruption to the foregut structure and function has significant consequences for the survival of the insect. Despite its potential, the insecticidal effects of *D. innoxia* seed extract on *M. domestica* remain poorly understood, particularly with regard to its impact on the foregut.

This novel study aims to investigate the histopathological alterations in the foregut of *M. domestica,* including *D. innoxia* aqueous seed extract, providing insight into its potential as a natural insecticide.

Materials and Method

1. Collection of Plant Sample

Plant samples were collected from the Nashik region of Maharashtra, India. The collected aerial parts were identified and authenticated at the herbarium of Agharkar Research Institute (ARI), Pune. Fruits were thoroughly washed under running tap water and carefully dissected to separate the seeds. The seeds were then cleaned properly with tap water and left to dry in the shade for one week. Once completely dried, the seeds were ground into coarse powder using an electric grinder. The powdered material was stored in a clean, dry and sterile container for further use.[12,15]

2. *Datura innoxia* Seed Extraction

Datura innoxia seed powder (50 g) packed in a thimble of W. filter paper 1, extraction was carried out in a Soxhlet extractor in 500 ml of distilled water at 100ºC for 8 hours. Sufficient extract was collected after 5 rounds of extraction.[13,16]

3. Phytochemical Screening

Datura innoxia seed extract was analysed using Fourier Transform Infrared (FTIR) spectroscopy within the infrared range of 400-4000 cm^{-1} to identify the associated functional groups. [4,21] FTIR is a reliable and widely used technique for determining the chemical identity and functional groups present in plant extracts.[5,25] The FTIR spectrum of a pure compound is typically distinctive, making it useful for compound identification. Unknown functional groups and plant constituents can be characterised by comparing their spectra with those of known reference compounds.[11,13]

4. *Musca domestica* Rearing

Adult *Musca domestica* were collected from nearby areas of the Nashik region and maintained in a laboratory in a metallic rearing cage measuring 50 x 50

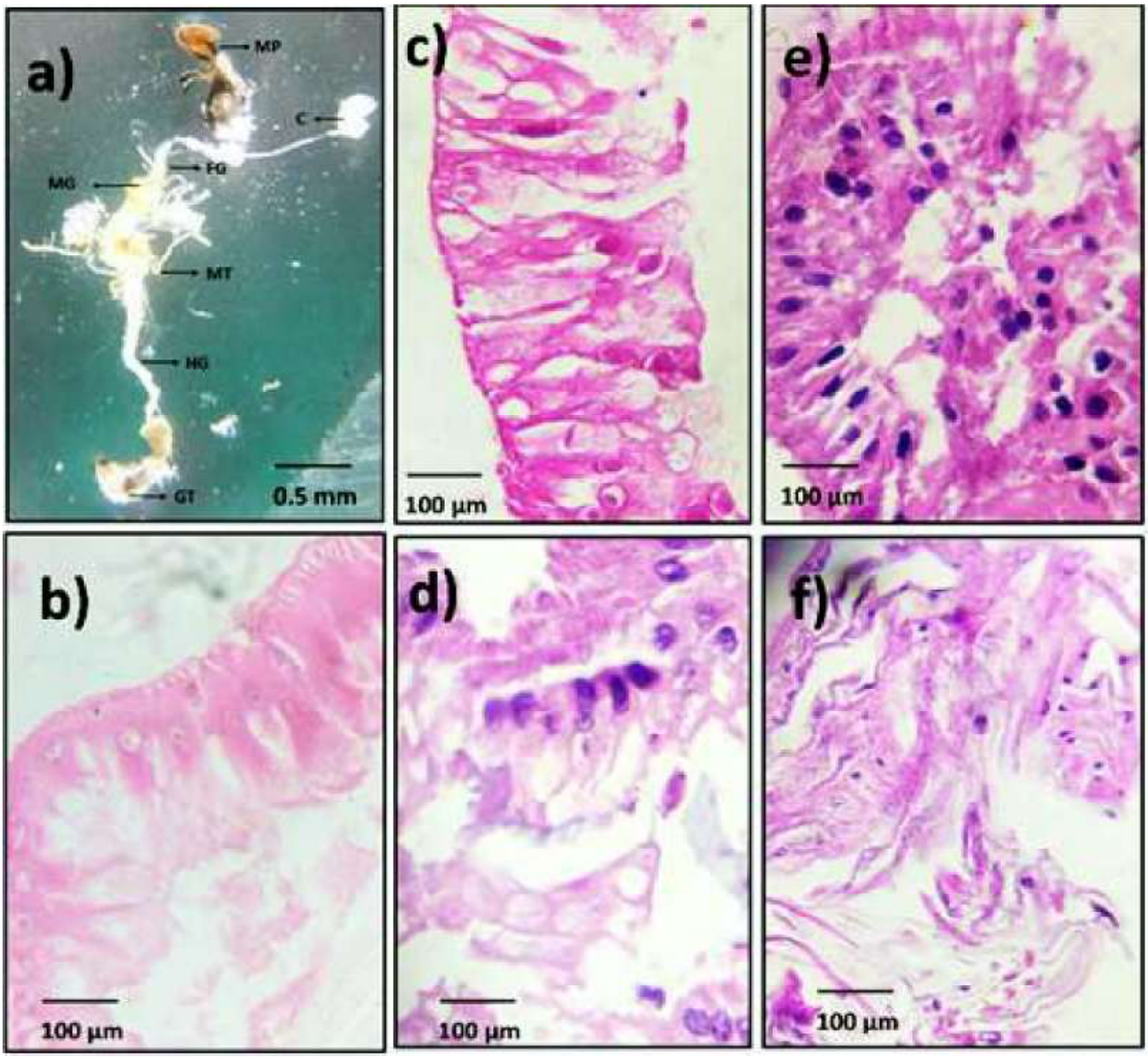

Fig. 2 : Histopathological observations (HE) under light microscope at 45x (a) *Musca domestica*- Digestive system (b-f) Foregut section of *Musca domestica* (b) Control, (c) 24-hour, (d) 48-hour, (e) 72-hour, (f) 96-hours

x 50 cm. The flies were provided with a small cup of water and a cotton ball soaked in 10% (w/v) milk and sugar solution as a food source, at 28 ± 3° C, 55-60% relative humidity, and a 12:12 h light-dark cycle. The colony was maintained for more F1 generations without any exposure to pesticides.[12,14]

5. Histopathology of *Musca domestica* Foregut

Adult *Musca domestica* were anesthetized and dissected under a stereomicroscope to isolate the foregut in insect saline, The tissue was fixed in 10% formalin for 24 hours to preserve cellular structure. After fixation, Samples were dehydrated in graded ethanol, cleared in xylene, and embedded in paraffine wax. Thin section 6 um were cut using rotary microtome, mounted on adhesive-coated and stained with haematoxylin and eosin (HE). Finally, slides were examined under light microscope, and images were captured for comparative histopathological evaluation of control and treated groups.[9]

Result and Discussion

1. Phytochemical Screening by FT-IR

The FTIR spectrum of the aqueous extract of *Datura innoxia* seed revealed several characteristic absorption peaks within the range of 400-4000 cm^{-1} indicating the presence of diverse bioactive compounds.

A broad and prominent band observe around 3200-3400 cm^{-1} corresponds to O-H stretching vibrations, suggesting the presence of alcohols and phenolic compounds. These groups are commonly associated with antioxidant and biological activities. Peaks detected near 2900-2950 cm^{-1} are attributed to C-H stretching vibrations of alkanes, indicating the presence of organic molecules such as lipids and other hydrocarbons chains. The absorption band around 1600-1650 cm-1 may be assigned to C=O stretching or C=C stretching vibrations, pointing to the presence of carbonyl compounds, amides or aromatic rings. Such as functional groups are often sound in alkaloids and other secondary metabolites of *Datura* species.[17]

Bands observed in the region of 1000-1300 cm^{-1} correspond to C-O stretching vibrations, suggesting alcohol, or ester groups. The fingerprint region below1000 cm^{-1} displayed multiple small peaks, reflecting the complex of phytochemical constituents in the extract (Fig. 1).

The FTIR analysis confirms that aqueous seed extract of *Datura innoxia* contains important functional groups indicate the presence of bioactive phytochemicals, which may contribute to the plant's reported insecticidal and medicinal properties. The result support the potential of *Datura innoxia* seed as a natural source of biologically active compounds.

2. Histopathology of *Musca domestica* Foregut

The foregut of *Musca domestica* in the control group show normal structure with intact cuticular intima, organised epithelial cells, and compact muscle layers, indicating healthy tissue integrity. In contrast, exposure to *Datura innoxia* seed aqueous extract caused progressive time dependent damage.[9]

After 24 hours, mild epithelial disorganization and cytoplasmic vacuolization suggested early cellular stress. Similar early alterations have been reported in botanical insecticidal studies, where plant derives compounds disrupt membrane permeability and metabolism.[15,2] By 48 and 72 hours, increased vacuolization, epithelial detachment, nuclear pyknosis and cytoplasmic shrinkage indicated more severe degeneration, consistent.

At 96 hours, extensive epithelial disintegration and collapse of foregut structure were observed, suggesting loss of digestive integrity that would impair feeding and nutrient absorption. Recent investigations highlight gut epithelial disruption as a key mechanism of plant-based insecticides, leading to mortality in dipteran pests (Fig.2).

Overall, the clear time-dependent deterioration confirms the cumulative toxic effects and strong bioactivity of *Datura innoxia* Seed extract, supporting its potential as an eco-friendly alternative to synthetic insecticides.

The present study demonstrated that *Datura innoxia* seed aqueous extract possesses significant bioactive potential against *Musca domestica*. FTIR analysis confirmed the presence of important functional groups associated with alkaloids, phenolics, flavonoids, and other secondary metabolites, indicating a rich phytochemical composition. Extract exhibited clear dose and time-dependent adulticidal activity with decreasing LC_{50} value over prolonged exposure, confirming enhanced toxicity with time. Histopathological observations further supported these findings, revealing progressive structural damage to the foregut tissues, ultimately leading to severe epithelial disintegration and loss of digestive integrity. Together, these results suggest that the bioactive compounds present in *D. innoxia* seeds interfere with physiological and cellular processes in the *Musca domestica*, leading to mortality. The study highlights the strong potential of *Datura innoxia* seed extract as an effective, eco-friendly plant-based alternative to synthetic chemical insecticides.

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