

Bio-insecticidal potential of methanolic seed extract of *Datura innoxia* (Solanaceae) against housefly *Musca domestica* L. (Diptera, Muscidae)

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ABSTRACT: A study was undertaken to evaluate the insecticidal potential of methanolic seed extract of *Datura innoxia* against *Musca domestica*. Phytochemical analysis by FTIR spectroscopy revealed the presence of bioactive compounds. The toxicity of the extract assessed, at varying concentrations and exposure times revealed that the mortality rate increased with concentration and exposure time, and a significant effect was observed @31.65 µg mL⁻¹ after 24 hours.

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KEYWORDS: Bioactive compounds, alkyl and aromatic groups, cumulative toxic effect, log-probit regression, FTIR, LC₅₀

The housefly *Musca domestica* L. (Diptera, Muscidae) is cosmopolitan, of significant public health importance, and is a primary vector for numerous enteric and systemic pathogens. It is responsible for the mechanical transmission of disease to humans and cattle by spoiling food and water sources (Wanaratana *et al.*, 2013). Management of *M. domestica* has depended heavily on synthetic insecticides and the indiscriminate use of synthetic chemicals poses substantial risks to non-target organisms and environment (Geden, 2012). In response to these challenges, research was shifted toward botanical insecticides (Scott *et al.*, 2017). *Pithecellobium*

dulce leaf extract was found to be a potent insecticide against *Pediculus humanus*, while the stem extract is effective in inhibiting egg hatching (Susmita Gudulkar *et al.*, 2025). *Camphor* extract on melon fruit fly (*Zeugodacus cucurbitae*) has significant potential to control the development of the pupa (Mawtham *et al.*, 2020). Silver nanoparticles from *Datura* extract are effective against larval development of *Epilachna vigintioctapunctata* (Sundareswari *et al.*, 2023). Aqueous, methanolic and acetone extract of *Centella asiatica* showed macromolecular alterations, glycogen total body protein increased, and free amino acid concentration decreased in

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Callosobruchus chinensis (Bindhu *et al.*, 2014). Significant inhibition of the activities of acetylcholinesterase, antioxidant enzymes and Glutathione-S-transferase (GST) mediated by *Streblus asper* (PBSA) on *Dysdercus cingulatus* (Anila *et al.*, 2023). The current research was to evaluate the insecticidal efficacy of *D. innoxia* seed extracts against *M. domestica*.

Datura innoxia seeds, collected from Nashik, were washed, shade-dried for 7 days and pulverised. The resulting powder was stored in an

airtight container (Ayub *et al.*, 2011). Seed powder (50g) underwent Soxhlet extraction with 500mL of methanol at 60 °C. The crude extract was concentrated and dried using a rotary evaporator under reduced pressure (Ali Eltayeib *et al.*, 2021). Potassium bromide pellets (containing 1% extract @2mg) were prepared using a hydraulic press. Fourier Transform Infrared Spectroscopy Spectra were recorded from 400 to 4000 cm^{-1} to identify primary functional groups. Chemical characterisation was achieved by comparing recorded spectra against reference standards

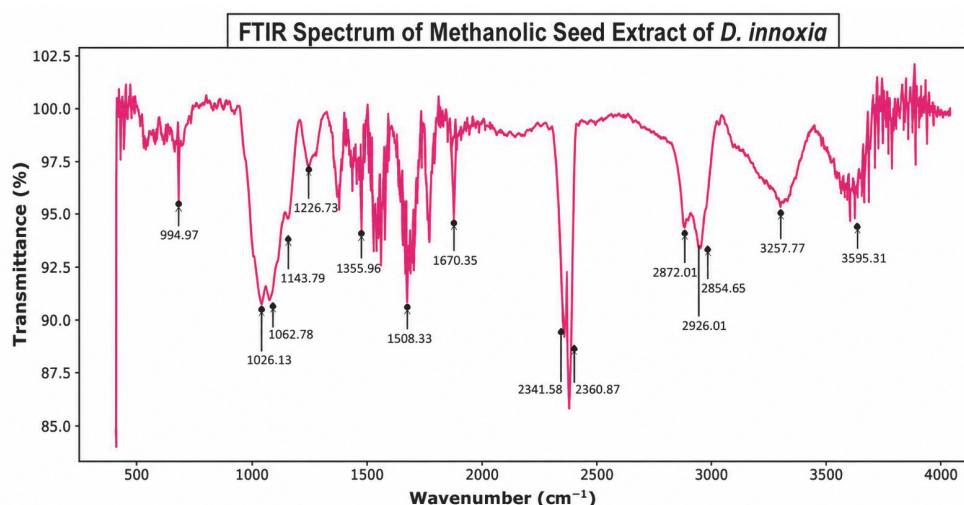


Fig. 1 FTIR transmittance spectrum of the methanolic seed extract

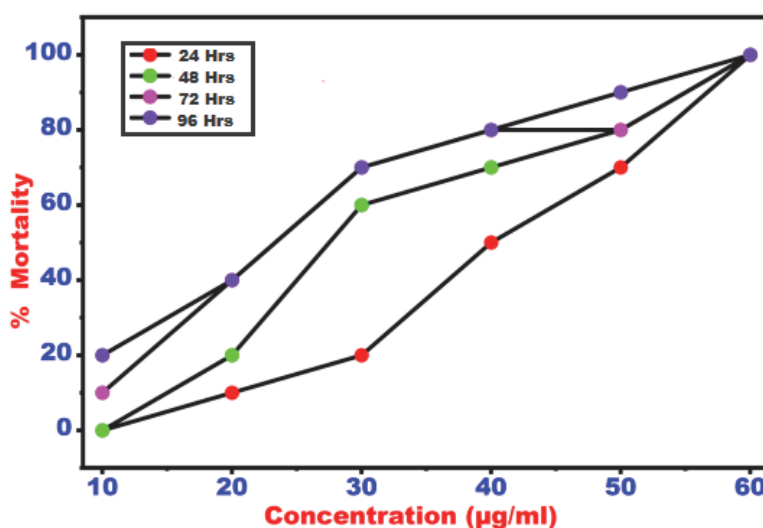


Fig. 2 Mortality (%) of adult *Musca domestica* across varying concentrations of *Datura innoxia* seed extract over a 96-hour exposure

Table 1. Functional groups and FTIR peaks were found in the methanolic *Datura innoxia* seed extract

No.	Wave number (cm ⁻¹)	Functional group	Compound
1	3595.31	O–H stretch, free hydroxyl	Alcohols, Phenols
2	3277.06	Ca”C –H, C–H stretch	Alkynes (Terminal)
3	3257.77	N–H stretch	Primary, Secondary Amines, Amides
4	2926.01	C–H stretch	Alkanes
5	2872.01	C–H stretch	Alkanes
6	2854.65	C–H stretch	Alkanes
7	2360.87	OH Stretching	Carboxylic acid
8	2341.58	H–C=O: C–H stretch	Aldehydes
9	1670.35	C=O stretch	Alpha, Beta–unsaturated aldehydes, Ketones
10	1508.33	C–C stretch (in–ring)	Aromatics
11	1355.96	N–O symmetric stretch	Nitro compounds
12	1226.73	C–O stretch	Esters, Ethers, Alcohols, Carboxylic acids,
13	1143.79	C–H wag (–CH ₂ X)	Alkyl Halides
14	1062.78	C–N stretch	Aliphatic Amines
15	1026.13	C–O stretch	Esters, Ethers, Alcohols, Carboxylic acids,
16	994.97	C–H “loop”	Aromatics

(Durak and Depciuch, 2020). Crude extract (4g) stock solution dissolved in 10mL of 99.9 per cent ethanol, final volume adjusted to 200mL using distilled water. From this stock (20 mg mL⁻¹), specific exposure doses of 1, 2, 3, 4, and 5mL were prepared for the bioassays, following the methodology described by Ali and Siddige (2021). *M. domestica* were laboratory-reared in a 50 cm³ metallic cage [28±3°C, 55-60(%) RH, 12:12 L:D], in the laboratory. Insecticide-free F₁ generations were maintained to ensure susceptibility. Sugar-milk mixture (10 % w/v) was provided for adult nutrition (Abbas, and Hafez, 2021). Ingestion lethality assays (Mallick *et al.*, 2016) were conducted on 4-to-5-

day old flies across six experimental groups (n=10/group). Treatments included *D. innoxia* extract, a 90:10 water-methanol negative control and a pyrethrin positive control. Mortality rates were monitored at 24, 48, 72, and 96h intervals. LC₅₀ values were determined via probit analysis (Finney, 1971) based on triplicate bioassays. Data processing, including regression (R²), mean mortality and standard error, was performed in Microsoft Excel 2007. Significance was evaluated using analysis of variance.

FTIR analysis of *D. innoxia* seed extract identified key phytochemical fractions (Table 1). The

Table 2. LC₅₀ of *Datura innoxia* seed extract against adult *Musca domestica* at different exposure intervals and log-probit regression parameters

Exposure (hrs)	Regression equation {Y = y + b (x - x')}	R ² - values	LC ₅₀ (µg mL ⁻¹)
24	Y=5.7520X-3.63	0.7840	31.65
48	Y=5.8983X-3.4523	0.8821	26.11
72	Y=4.5390X-1.0740	0.8068	21.78
96	Y=4.2697X-0.5297	0.8080	19.74

spectrum illustrates (Fig. 1), the complex chemical fingerprint of the methanolic fraction within the 400-4000 cm⁻¹ scanning range. Absorption bands revealed bioactive secondary metabolites with C-H stretching vibrations, indicating alkyl and aromatic groups. The presence of alkaloids and flavonoids was confirmed by C=O stretching in esters and carbonyls, while C-H bending and phosphate groups suggested the presence of terpenoids and anthraquinones (Mardare *et al.*, 2022). The seed extract mortality was directly tied to both dose and exposure time. While the control group showed no mortality throughout the 96-hour study, the LC₅₀ value of the extract dropped steadily from 31.65 µg mL⁻¹ at 24 hours to 19.74 µg mL⁻¹ at 96 hours (Table 2). This progressive decline highlights a cumulative toxic effect; even the lowest dose (10 µg mL⁻¹) eventually achieved significant mortality by the 96-hour mark. The graph (Fig. 2) shows a rise in mortality 24-hour exposure (Red): Indicates the first hazardous reaction; only at greater concentrations does detectable mortality take place. Green and Pink for 48 to 72 hours: shows a progressive change. The highest recorded efficacy is attained after 96 hours of treatment (purple), smaller concentrations (such as 10 µg mL⁻¹) start to show notable mortality. A high R² value across all the treatments confirms a strong linear relationship between concentration and mortality, suggesting that the impact of the extract is both predictable and persistent.

Medicinal plants have the ability to kill *M. domestica* through bioinsecticidal effects (Sharma

et al., 2011). Physiological alterations in treated *M. domestica*, indicating that the *Datura innoxia* seed extract affects essential metabolic functions and contributes to *M. domestica* mortality (Jangam & Patil, 2026). Late *et al.*, (2026) demonstrated significant larvicidal and repellent activity of ethanolic extracts of *Datura innoxia* and *Datura stramonium* against white grub larvae, the authors attributed the observed toxicity to the presence of bioactive phytochemicals capable of interfering with normal physiological processes in insects by damaging vital digestive tissues. According to Jemberie *et al.* (2016) essential oils *Otostegia integrifolia*, *Echinops kebericho*, *Stephania abyssinica*, and *Milletia ferruginea* show significant repellence against *Aedes arabiensis*. The ethanolic leaf extract of *Calotropis procera* was observed to be more toxic and have notable larvicidal activities at concentrations of 1.923 ppm and 8.83 ppm for LC₅₀ and LC₉₀, respectively (Kaushik *et al.*, 2022). Similarly, it was shown by Attaullah *et al.* (2019) that native weeds, such as *Datura stramonium* (62.78%) and *Peganum harmala* (63.87%), showed substantial toxicity at 25 per cent concentration after 72 hours. The finding of the current research provides the first evidence that a methanolic extract of *D. innoxia* seed possesses significant adulticidal potential against *M. domestica*. The bioactivity is likely driven by a synergistic blend of phytochemicals, specifically alkaloids such as atropine and hyoscyne, alongside flavonoids, triterpenes and phenolic compounds identified in the analysis. These results position *D. innoxia* as a promising candidate for a

viable, eco-friendly option for the development of biopesticides to manage housefly populations in domestic and livestock settings.

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