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Research Article

Efficacy of Alcoholic Plant Extracts in Controlling Nymphs of the Jasmine Whitefly (*Aleuroclava jasmini*)

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ABSTRACT

The jasmine whitefly, *Aleuroclava jasmini* (Takahashi), is an economically damaging pest affecting citrus cultivation in Iraq, necessitating the development of environmentally benign control alternatives to synthetic pesticides. This study evaluated the insecticidal activity of alcoholic extracts from three medicinal plants: *Piper nigrum* (black pepper), *Laurus nobilis* (laurel), and *Nerium oleander* (oleander) against nymphs of *A. jasmini* under controlled laboratory conditions. Alcoholic extracts were prepared using 97% ethanol via Soxhlet extraction for *P. nigrum* fruits and maceration for *L. nobilis* and *N. oleander* leaves. Three concentrations (1.5%, 2.5%, and 5.0% w/v) of each extract were tested on cucumber leaves naturally infested with *A. jasmini* nymphs. Mortality was recorded at 24, 48, 72, and 96 h post-treatment and corrected using Abbott's formula. Data were analyzed using factorial analysis of variance within a completely randomized design. All extracts exhibited concentration- and time-dependent efficacy with significant variations in corrected mortality rates. *N. oleander* mean mortality of 22.38%, followed by *P. nigrum* (17.52%) and *L. nobilis* (17.03%). Notably, *N. oleander* at 2.5% concentration achieved the highest early mortality (35.20% at 24 h), indicating rapid knockdown potential. Peak mortality for most treatments occurred at 72 h post-treatment, followed by a significant decline at 96 h, suggesting limited residual activity. These findings highlight the potential of botanical extracts as sustainable alternatives, particularly *N. oleander*, as eco-friendly alternatives for integrated pest management. However, formulation improvements are needed to enhance the stability and residual efficacy of *P. nigrum* and *L. nobilis* extracts for practical field applications.

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Introduction

The jasmine whitefly, *Aleuroclava jasmini* (Takahashi) (Hemiptera: Aleyrodidae), represents one of the most economically damaging insect pests affecting citrus cultivation in Iraq and numerous other countries worldwide. First detected in Iraq during the 2001 growing season, this invasive pest has subsequently established itself throughout all major citrus-producing regions (Manjy, 2015). Despite its small size, *A. jasmini* exhibits a high reproductive capacity, with populations potentially reaching thousands of individuals per host plant. The direct damage caused by phloem sap extraction is compounded by the secretion of honeydew, a sugar-rich exudate that serves as a substrate for the development of sooty mold fungi (Capnodiaceae). These fungi colonize leaf surfaces,

reducing photosynthetic efficiency, impairing fruit quality, and ultimately diminishing the commercial value of agricultural production (Manjy 2015).

Plants at all developmental stages are susceptible to infestation by diverse arthropod pests, including insects, mites, and pathogenic organisms. The escalating threat posed by agricultural pests has been paralleled by intensive and frequently injudicious application of synthetic chemical pesticides. This overreliance on conventional insecticides has precipitated multiple adverse consequences, including disruption of ecological equilibrium, contamination of environmental matrices, emergence of pest populations resistant to active ingredients, and potential health hazards to humans and non-target organisms (Al-Omar et al., 2022). Consequently, modern pest management strategies emphasize reducing dependence on synthetic pesticides and promoting environmentally sustainable alternatives that safeguard human and animal health while maintaining agricultural productivity. Among the most promising alternatives are natural products derived from plants, particularly botanical extracts with insecticidal properties have received considerable attention (Al-Omar et al., 2022).

The family Apocynaceae includes two notable oleander species: *Thevetia peruviana* (Pers.) K. Schum. (Yellow oleander), native to tropical America, and *Nerium oleander* L. (common oleander), which is widely distributed throughout the Mediterranean region basin and parts of Asia. Historically, the toxic properties of *N. oleander* have been well recognized in ancient India, it was referred to as "Kajamaraka", meaning "the plant that kills horses". The toxicity of *N. oleander* extends to humans, animals, and certain insect species, due to the presence of cardiac glycosides collectively known as cardenolides, including oleandrin, neriin, digitoxigenin, and olinerin. Among these, oleandrin is the principal bioactive compound, characterized by high lipophilicity rapid absorption, and relatively slow elimination (Shridhar, 2022).

The toxic mechanism of cardiac glycosides involves inhibition of the Na^+/K^+-ATPase transmembrane pump in cardiac myocytes, resulting in elevated intracellular sodium concentrations. This perturbation secondarily affects Na^+/Ca^{2+} exchange channels, leading to increased intracellular calcium levels, enhanced myocardial contractility, and elevated resting membrane potential (Shridhar, 2022). Human fatalities associated with oleander exposure predominantly result from intentional ingestion of boiled plant material in suicide attempts, although accidental poisoning cases have been documented, particularly among pediatric populations, where consumption of a single leaf may prove fatal (Shridhar, 2022).

Ratiba et al. (2022) investigated the insecticidal efficacy of *N. oleander* leaf extract against aphids at a concentration of 5.15 g/m^2, achieving 100% mortality within four days of treatment. This finding underscores the potential of oleander-derived formulations as botanical insecticides.

Black pepper, *Piper nigrum* L. (Piperaceae), constitutes one of the most commercially significant spice crops globally, with cultivation history in India extending to prehistoric times. The species originated in the evergreen tropical forests of the Western Ghats region of India, which remains the world's largest producer, cultivating approximately 215,000 ha with annual production of 70,000 tons and exports reaching 29,300 tons valued at 427.63 crore Indian rupees. Despite ranking first in cultivated area, Indian productivity (315 kg/ha) remains comparatively low relative to other producing nations (Thangaselvabal et al., 2008). Yap (2019) evaluated the efficacy of *P. nigrum* fruit extract against the whitefly *Aleurodicus dispersus* Russell (Hemiptera: Aleyrodidae), demonstrating significant control activity against both adults and second-instar nymphs under laboratory conditions.

Bay laurel, *Laurus nobilis* L. (Lauraceae), is a well-characterized medicinal plant species indigenous to the Mediterranean region and Europe. This evergreen tree attains heights of 5-10 m, with the family Lauraceae encompassing approximately 32 genera and 2,000-2,500 species. *L. nobilis* is distinguished by lanceolate leaves with undulate margins, aromatic properties, dimensions of 8-14 cm length and 3-4 cm width, yellowish-white inflorescences, and cherry-sized black fruits at maturity (Akunna et al., 2013). The phytochemical composition of *L. nobilis* includes flavonoids, alkaloids, phenols, and tannins, conferring antioxidant, antifungal, antibacterial, and anticancer properties. Additionally, bay leaves are rich in vitamins A, B, and C, and minerals including potassium, iron, zinc, magnesium, and calcium (Guenane et al., 2016).

L. nobilis has extensive applications in traditional medicine and as a flavoring agent in the food and spice industries (Bianchi, 2015). The essential oil, obtained

through distillation, is utilized in food processing (particularly meat and fish products), perfumery, soap manufacturing, and cosmetic formulations, with documented efficacy in psoriasis management (Kivrak et al., 2017). Traditional medicinal applications include treatment of rheumatism, dermatological conditions, digestive disorders, snake envenomation, and as a diuretic agent. Recent investigations have explored its potential in diabetes management (Gasparyan et al., 2015); wound healing promotion, menopausal symptom alleviation, and treatment of cramps, colic, and sclerosis (Caputo et al., 2017).

Saleh and Jamal (2017) evaluated aqueous extracts of *Catharanthus roseus* (L.) G. Don and *Tamarix ramosissima* Ledeb. against corn leaf aphids, reporting 64% mortality with *C. roseus* extract at 2.5% concentration after 72 h of exposure.

The present investigation was undertaken to identify effective alternatives to synthetic pesticides that demonstrate enhanced efficacy against target insect pests while minimizing ecological disruption, consistent with contemporary integrated pest management principles (Muhammad et al., 2021). Given the economic significance of *A. jasmini* infestations in Iraqi citrus production, this study aimed to evaluate the insecticidal potential of alcoholic extracts derived from three plant species *P. nigrum*, *L. nobilis*, and *N. oleander* against nymphal stages of the jasmine whitefly under controlled laboratory conditions.

Materials and Methods

Study location and plant material

The experiment was conducted in a 500 m^2 greenhouse facility at the Department of Plant Protection, College of Agricultural Engineering Sciences, University of Baghdad, during the spring season of 2023. The greenhouse soil was prepared by plowing and incorporating organic fertilizer prior to transplantation. Five experimental plots were established, each measuring 36 × 0.5 m, with 1 m inter-plot spacing and 0.75 m buffer zones on each side. Cucumber seedlings (*Cucumis sativus* L., F1 hybrid "Al-Mustaqbal") were transplanted at 50 cm spacing between plants. No insecticides were applied throughout the experimental period, allowing natural pest infestation to occur.

Experimental design and sample collection

The experiment employed a randomized complete block design (RCBD) with three blocks. From each plot, five cucumber plants were randomly selected weekly, and three leaves were collected per plant. Leaf samples were transported to the laboratory and examined under a dissecting stereomicroscope (Olympus SZ51, Olympus Corporation, Tokyo, Japan) to enumerate larval and nymphal stages of insect pests.

Preparation of alcoholic extracts

Alcoholic extraction was performed at the Central Laboratory Unit, College of Agricultural Engineering Sciences, University of Baghdad, following the methodology of Harborne (1984) with modifications.

P. nigrum fruit extract

Dried black pepper fruits were obtained from local markets in Baghdad, Iraq, and pulverized using an electric grinder (JFSD-100 Pulverizer, Shanghai, China). Twenty grams of the resulting powder were subjected to Soxhlet extraction using 400 ml of 97% ethanol for 6 h at 60°C. The extract was stirred for 30 min and maintained at room temperature (25 ± 2°C) for 24 h. Filtration was performed sequentially through multiple layers of sterile gauze and Whatman No. 1 filter paper (Whatman plc, Maidstone, UK). The solvent was evaporated in a forced-air oven (Memmert GmbH + Co. KG, Schwabach, Germany) at 45°C until constant weight. The resulting dry powder was stored in clean, airtight containers at 4°C until use.

L. nobilis leaf extract

One hundred grams of fresh bay laurel leaves were placed in a 500-ml flask containing 250 ml distilled water and 250 ml 97% ethanol. The mixture was agitated on a magnetic stirrer for 30 min at ambient temperature, and then filtered through Whatman No. 1 filter paper. The filtrate was transferred to glass Petri dishes and dried in an oven at 40-60°C for 24 h until complete solvent evaporation yielded a dry powder, which was stored at 4°C until utilization (Muhammad et al. 2021).

N. oleander leaf extract

Fresh *N. oleander* leaves were collected from naturally occurring populations in Baghdad, Iraq. Leaf material was washed with distilled water, air-dried at ambient temperature, and pulverized. Extraction followed the identical procedure described for *L. nobilis*.

Bioassay procedure

Stock solutions of each extract were prepared by dissolving the dried powder in distilled water. Three concentrations (1.5%, 2.5%, and 5.0% w/v) were prepared for each extract type. Each treatment was replicated three times. For each replicate, three

cucumber leaves naturally infested with *A. jasmini* nymphs were placed in 9-cm diameter glass Petri dishes lined with moistened filter paper to maintain turgor. Initial nymphal counts were recorded for each leaf prior to treatment application.

Leaves were sprayed with the respective extract concentrations using a hand-held sprayer (30 ml capacity) held approximately 15 cm from the leaf surface, delivering approximately 1 ml per leaf. Control treatments received distilled water only. Petri dishes were maintained in an incubator at 25±1°C and 65±5% relative humidity with a 16:8 h light: dark photoperiod. Each treatment was applied once, and nymph mortality was recorded at 24, 48, 72, and 96 h post-treatment. Nymphs were considered dead if they showed no movement when probed with a fine camel-hair brush.

Mortality percentages were corrected for control mortality using Abbott's formula (Abbott 1925):

Corrected Mortality (%) = [(T - C) / (100 - C)] × 100

Where:

T = Percentage mortality in treatment and

C = Percentage mortality in control

Statistical analysis

Data were analyzed using a completely randomized design within a factorial arrangement (3 extract types × 3 concentrations × 4 exposure periods × 3 replicates). Prior to analysis, mortality percentages were arcsine square-root transformed to normalize variance. Treatment means were compared using the Least Significant Difference (LSD) test at the 0.05 significance level. Statistical analyses were performed using GenStat software (version 12, VSN International Ltd, Hemel Hempstead, UK).

Results

Insecticidal activity of *P. nigrum* extracts against *A. jasmini* nymphs

The results in Table 1 demonstrate significant variations ($P \leq 0.05$) in corrected mortality of *A. jasmini* nymphs treated with different concentrations of *P. nigrum* alcoholic extract across exposure periods.

Efficacy was concentration-dependent, with the highest overall mean mortality recorded at 5.0% (19.32 ± 1.82%), statistically comparable to 2.5% (18.80 ± 1.83%), while 1.5% showed the lowest efficacy (14.43 ± 1.67%). Temporally, maximum mortality occurred at 72 h post-treatment (26.27 ± 2.33%), differing significantly from days 1 and 4.

Notably, the significant concentration × time interaction (LSD = 8.72) revealed that nymphal response depended on exposure duration. The 5.0% concentration achieved peak mortality at 72 h (33.69 ± 2.87%), yet efficacy declined markedly by 96 h (13.35 ± 1.42%). Similarly, 2.5% mortality dropped from 28.10% at 72h to 7.90% at 96 h, suggesting possible compound degradation or insect recovery. Conversely, 1.5% maintained relatively stable activity throughout.

These findings confirm the insecticidal potential of *P. nigrum* extract against *A. jasmini*, with optimal control achieved using 5.0% concentration at 72 h exposure. The temporal efficacy decline highlights the need for formulation improvements to enhance residual activity for practical IPM applications.

Insecticidal activity of *L. nobilis* leaf alcoholic extract against *A. jasmini* nymphs

The results in Table 2 demonstrate significant variations ($P \leq 0.05$) in corrected mortality percentages of *A. jasmini* nymphs treated with different concentrations of *L. nobilis* leaf alcoholic extract across exposure periods.

Efficacy was concentration-dependent, with the highest overall mean mortality recorded at 5.0% (22.52 ± 2.04%), statistically comparable to 2.5% (20.10 ± 1.95%), while 1.5% showed the lowest efficacy (8.46 ± 1.05%). Temporally, maximum mortality occurred at 72 h post-treatment (25.38 ± 2.27%), differing significantly from all other exposure periods, with the lowest mortality recorded at 96 h (9.79 ± 1.12%).

Table 1. Corrected mortality percentages (mean ± SE) of *A. jasmini* nymphs treated with *P. nigrum* fruit alcoholic extract at different concentrations and exposure periods.

Concentration	Day 1 (24 h)	Day 2 (48 h)	Day 3 (72 h)	Day 4 (96 h)	Mean
1.5%	9.81 ± 1.24	19.05 ± 1.87	17.01 ± 1.56	11.82 ± 1.28	14.43 ± 1.67
2.5%	14.80 ± 1.52	24.50 ± 2.28	28.10 ± 2.55	7.90 ± 0.98	18.80 ± 1.83
5.0%	7.27 ± 0.95	22.98 ± 2.05	33.69 ± 2.87	13.35 ± 1.42	19.32 ± 1.82
Mean	10.63 ± 1.24	22.18 ± 2.07	26.27 ± 2.33	11.02 ± 1.23	

$LSD_{0.05}$ (Concentrations) = 3.65; $LSD_{0.05}$ (Days) = 5.22; $LSD_{0.05}$ (Concentration × Day interaction) = 8.72.

Notably, the significant concentration × time interaction (LSD = 9.35) revealed that nymphal response depended on exposure duration. The 5.0% concentration achieved peak mortality at 72 h (34.80 ± 2.91%), representing the highest efficacy overall. Similarly, the 2.5% concentration showed maximum activity at 72 h (29.10 ± 2.61%). However, both concentrations exhibited a sharp decline in efficacy by 96 h, with mortality dropping to 17.81% and 8.20%, respectively. The 1.5% concentration maintained consistently low mortality throughout, with minimal activity at 96 h (3.37 ± 0.67%).

These findings confirm the insecticidal potential of *L. nobilis* leaf extract against *A. jasmini* nymphs, with optimal control achieved using 5.0% concentration at 72 h exposure. The significant mortality decline at 96 h suggests possible degradation of active compounds or insect recovery, highlighting the need for formulation improvements to enhance residual activity for practical IPM applications.

Insecticidal activity of *N. oleander* leaf alcoholic extract against *A. jasmini* nymphs

Data in Table 3 show significant variations ($P \leq 0.05$) in the efficacy of *N. oleander* extract against *A. jasmini* nymphs across concentrations and exposure times.

The 2.5% concentration recorded the highest overall mean mortality (25.00 ± 2.33%), statistically comparable to 5.0% (23.36 ± 2.11%), while 1.5% was the least effective (18.77 ± 1.72%). Unlike other extracts, 2.5% outperformed 5.0%, suggesting a threshold beyond which higher concentration does not increase efficacy.

Mortality increased progressively from Day 1 (22.18%) to peak at Day 3 (25.67%), and then declined sharply at Day 4 (16.92%), indicating maximum efficacy occurs within 48-72 h post-treatment.

The concentration × time interaction (LSD = 9.81) was significant. The 2.5% concentration achieved the highest early mortality at 24 h (35.20%), while 5.0% showed delayed peak at 48 h (28.91%) with sustained activity. The 1.5% concentration followed a bell-shaped curve, peaking at 72 h (28.03%) before dropping sharply at 96 h (7.63%).

In conclusion, *N. oleander* extract exhibits potent insecticidal activity against *A. jasmini* nymphs, with concentration-specific patterns. The rapid action of 2.5% offers quick knockdown potential, while 5.0% provides extended protection, emphasizing the need for optimized concentration and timing in IPM programs.

Table 2. Corrected mortality percentages (mean ± SE) of *A. jasmini* nymphs treated with *L. nobilis* leaf alcoholic extract at different concentrations and exposure periods.

Concentration	Day 1 (24 h)	Day 2 (48 h)	Day 3 (72 h)	Day 4 (96 h)	Mean
1.5%	5.78 ± 0.89	12.46 ± 1.34	12.24 ± 1.28	3.37 ± 0.67	8.46 ± 1.05
2.5%	21.60 ± 2.05	21.50 ± 2.10	29.10 ± 2.61	8.20 ± 1.02	20.10 ± 1.95
5.0%	14.96 ± 1.48	22.49 ± 2.11	34.80 ± 2.91	17.81 ± 1.67	22.52 ± 2.04
Mean	14.11 ± 1.47	18.82 ± 1.85	25.38 ± 2.27	9.79 ± 1.12	

$LSD_{0.05}$ (Concentrations) = 5.33; $LSD_{0.05}$ (Days) = 4.66; $LSD_{0.05}$ (Concentration × Day interaction) = 9.35.

Table 3. Corrected mortality percentages (mean ± SE) of *A. jasmini* nymphs treated with *N. oleander* leaf alcoholic extract at different concentrations and exposure periods.

Concentration	Day 1 (24 h)	Day 2 (48 h)	Day 3 (72 h)	Day 4 (96 h)	Mean
1.5%	14.26 ± 1.45	25.14 ± 2.11	28.03 ± 2.34	7.63 ± 0.98	18.77 ± 1.72
2.5%	35.20 ± 2.98	21.00 ± 2.08	23.10 ± 2.21	20.90 ± 2.03	25.00 ± 2.33
5.0%	17.08 ± 1.58	28.91 ± 2.43	25.89 ± 2.34	22.24 ± 2.08	23.36 ± 2.11
Mean	22.18 ± 2.00	25.02 ± 2.21	25.67 ± 2.30	16.92 ± 1.70	

$LSD_{0.05}$ (Concentrations) = 4.15; $LSD_{0.05}$ (Days) = 5.44; $LSD_{0.05}$ (Concentration × Day interaction) = 9.81.

Figure 1 compares the overall insecticidal activity of three plant alcoholic extracts, *P. nigrum*, *L. nobilis*, and *N. oleander*, against *A. jasmini* nymphs based on the mean corrected mortality percentages. The results indicate that *N. oleander* exhibited the highest overall efficacy (22.38% mortality), suggesting a stronger insecticidal potential compared with the other tested extracts. In contrast, *P. nigrum* (17.52%) and *L. nobilis* (17.03%) showed relatively similar and moderate levels of activity.

Overall, the insecticidal effectiveness of the tested

extracts followed the order: *N. oleander* > *P. nigrum* ≈ *L. nobilis*, indicating that *N. oleander* may represent a more promising botanical candidate for the management of *A. jasmini* within (IPM) strategies.

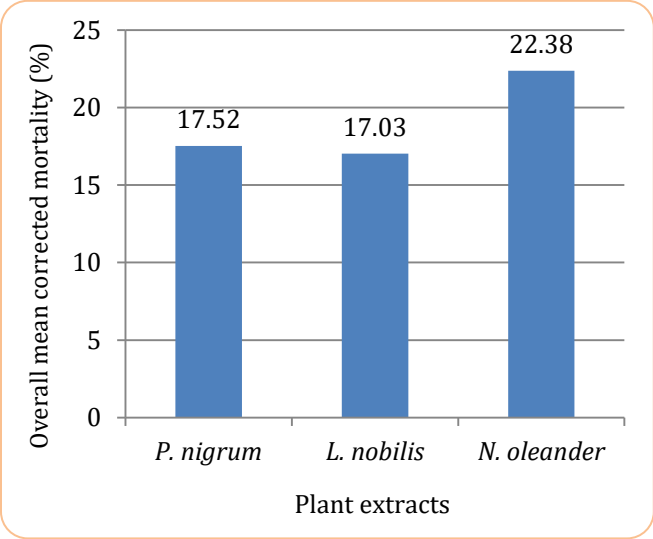


Figure 1. Comparison of the overall insecticidal activity of alcoholic extracts of *P. nigrum*, *L. nobilis*, and *N. oleander* against *A. jasmini* nymphs.

Discussion

The present investigation revealed significant variability in the insecticidal efficacy of three medicinal plant extracts against *A. jasmini* nymphs, with *N. oleander* demonstrating superior activity (22.38% overall mortality) compared to *P. nigrum* (17.52%) and *L. nobilis* (17.03%). This differential efficacy reflects the distinct phytochemical profiles and modes of action inherent to each plant species. The concentration-dependent mortality observed across all treatments aligns with established toxicological principles of botanical insecticides (Mossa, 2016). For *P. nigrum*, the primary insecticidal compounds are piperamides, which function as neurotoxins and can synergize other botanical insecticides by inhibiting detoxification enzymes in insects (Scott et al., 2008). Similarly, *L. nobilis* essential oils are rich in monoterpenoids including 1,8-cineole, linalool, and α-terpinyl acetate, which exhibit contact toxicity, fumigant activity, and repellent effects against various insect pests (Wang et al., 2019; Marzouki et al., 2025). The moderate efficacy of *L. nobilis* in our study (17.03%) corresponds with earlier findings where 5% concentrations yielded approximately 51% mortality against mites, though efficacy declined substantially at lower concentrations (Maciel et al., 2020).

The superior performance of *N. oleander* can be attributed to its cardenolide content (notably oleandrin), cardiac glycosides that disrupt sodium-potassium ATPase in insect neural membranes, leading to rapid neurotoxicity (Baz et al., 2024). This explains the quick knockdown effect observed at 2.5% concentration (35.20% mortality at 24 h). However, the non-linear dose-response where 2.5% outperformed 5.0% suggests possible behavioral avoidance or feeding deterrence at higher concentrations, phenomena documented in botanical insecticide research where concentrated phytochemicals may trigger repellency before toxic thresholds are reached (Isman, 2020).

The temporal decline in efficacy at 96 h post-treatment represents a critical finding with practical implications. This pattern likely results from photodegradation, volatilization of active monoterpenoids, and potential induction of insect detoxification enzymes (Mediouni Ben Jemâa et al., 2012; Mossa, 2016). Similar temporal dynamics have been documented in field-based residual bioassays, where insecticide residues largely degrade within the first 7 days post-application (Darwish et al., 2022). The significant concentration × time interactions statistically confirm that efficacy depends on complex relationships between dose and exposure duration, consistent with studies on essential oil toxicity where maximum mortality typically occurs within 48-72 h (Zohra et al., 2024).

For integrated pest management applications, *N. oleander* offers the most promise due to its rapid action and relatively sustained activity, though formulation improvements such as microencapsulation or incorporation of UV protectants could enhance residual activity (Isman, 2020). The use of botanical extracts with multiple active compounds may also reduce resistance development compared to synthetic insecticides (Mossa, 2016). These findings support the potential incorporation of selected botanical extracts, particularly *N. oleander*, into sustainable whitefly management programs, though field validation under realistic production conditions remains essential before practical recommendations can be formulated (Darwish et al., 2022).

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Authors' Contributions

SKF and AMA conceptualized and designed the study. ASHA conducted field surveys, collected specimens, compiled the dataset, and prepared the initial manuscript draft. SKF performed the morphological identification and taxonomic verification of the collected species. AMA contributed to data organization, critically revised the manuscript, and improved its structure and presentation. ASHA also assisted in the identification and confirmation of host plant species. All authors reviewed, revised, and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

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Conflict of Interest

The authors declare no conflict of interest.

Sustainable Development Goals Targeted

SDG 2: Zero Hunger
SDG 12: Responsible Consumption and Production
Goal 15: Life on Land

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