Vol. 2 No. 3 Edisi Juli 2025 E. ISSN. 3032-2472
Multidisciplinary Indonesian Center Journal (MICJO)
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EFFECTIVENESS OF SOURSOP (ANNONA MURICATA) LEAF EXTRACT AS A BOTANICAL PESTICIDE AGAINST ARMYWORM (SPODOPTERA LITURA) ON MUSTARD GREENS (BRASSICA JUNCEA)

EFEKTIVITAS EKSTRAK DAUN SIRSAK (ANNONA MURICATA) SEBAGAI PESTISIDA NABATI TERHADAP HAMA ULAT GRAYAK (SPODOPTERA LITURA) PADA TANAMAN SAWI

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DOI: https://doi.org/10.62567/micjo.v2i3.1032

Article info:

Submitted: 03/07/25 Accepted: 25/07/25 Published: 30/07/25

Abstract

The intensive use of synthetic chemical pesticides in agriculture has led to various negative impacts on the environment and human health, as well as pest resistance. As an alternative, plant-based botanical pesticides have the potential to be developed due to their environmentally friendly and sustainable nature. This study aims to examine the effectiveness of soursop (Annona muricata) leaf extract as a botanical pesticide against the armyworm pest (Spodoptera litura) on mustard greens (Brassica juncea), using a literature review method. The review was conducted by analyzing 9 scientific articles obtained from accredited national and international journals. Articles were selected based on topic relevance, methodological quality, and the significance of findings. Data were analyzed descriptively and comparatively to identify patterns, effectiveness, and the mode of action of active compounds in soursop leaf extract. The results show that soursop leaf extract contains bioactive compounds such as acetogenins, flavonoids, and saponins, which act as stomach poisons, antifeedants, and repellents against Spodoptera litura. Several studies indicate that extracts from the leaves and seeds of Annona spp. effectively inhibit larval growth, reduce feeding activity, damage digestive tissues, and ultimately cause larval death. This effectiveness positions soursop leaves as a potential candidate for the development of safe and efficient botanical pesticides. The study also highlights a gap in field-scale testing on mustard greens, suggesting the need for further trials under real agronomic conditions.

Keywords: soursop, leaf, Spodoptera litura, pesticide

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Abstrak

Penggunaan pestisida kimia sintetis dalam pertanian secara intensif telah menimbulkan berbagai dampak negatif terhadap lingkungan dan kesehatan manusia, serta menyebabkan resistensi hama. Sebagai alternatif, pestisida nabati berbahan dasar tumbuhan berpotensi dikembangkan karena lebih ramah lingkungan dan berkelanjutan. Penelitian ini bertujuan untuk mengkaji efektivitas ekstrak daun sirsak (Annona muricata) sebagai pestisida nabati terhadap hama ulat grayak (Spodoptera litura) pada tanaman sawi (Brassica juncea), dengan menggunakan metode studi literatur. Kajian dilakukan dengan menelaah 9 artikel ilmiah yang diperoleh dari jurnal nasional dan internasional terakreditasi. Artikel dipilih berdasarkan kesesuaian topik, kualitas metodologi, dan relevansi temuan. Data dianalisis secara deskriptif-komparatif untuk mengidentifikasi pola, efektivitas, dan mekanisme kerja senyawa aktif dalam ekstrak daun sirsak. Hasil studi menunjukkan bahwa ekstrak daun sirsak mengandung senyawa bioaktif seperti acetogenin, flavonoid, dan saponin yang berperan sebagai racun perut, antifeedant, dan repelen terhadap ulat grayak. Beberapa penelitian menunjukkan bahwa ekstrak daun dan biji Annona spp. efektif menghambat pertumbuhan larva, menurunkan aktivitas makan, merusak jaringan pencernaan, hingga menyebabkan kematian larva. Efektivitas ini menjadikan daun sirsak sebagai kandidat potensial untuk pengembangan pestisida nabati yang aman dan efisien. Penelitian ini juga mengidentifikasi adanya kesenjangan dalam pengujian skala lapangan pada tanaman sawi, sehingga disarankan dilakukan uji lebih lanjut dalam kondisi agronomis nyata.

Kata Kunci : daun, sirsak, spodoptera, litura, pestisida

1. INTRODUCTION

The massive use of synthetic pesticides in modern agriculture has led to serious problems, both for the environment and human health. Chemical pesticide residues absorbed by horticultural crops such as mustard greens (*Brassica juncea*) have the potential to contaminate the environment and food chains, as well as induce pest resistance to chemical compounds (Sidauruk et al., 2022). Consequently, the need for more environmentally friendly pest control alternatives has become increasingly urgent. One emerging alternative is the use of plant-based pesticides derived from medicinal plants, such as soursop (*Annona muricata*) leaves.

Soursop leaves are known to contain a variety of secondary metabolites such as alkaloids, flavonoids, tannins, acetogenins, and saponins, which possess insecticidal, antifeedant, and repellent properties against various types of insects (Oriyomi, 2018). Numerous studies have demonstrated the potential of soursop leaf extract in controlling a range of agricultural pests. For instance, research by Darlis et al. (2024) showed that soursop leaf extract was effective in controlling the papaya mealybug (*Paracoccus marginatus*) in *Acacia crassicarpa* seedlings. This suggests that the bioactive compounds in soursop leaves can exert toxic effects on pests and have great potential for further development as a botanical pesticide.

The armyworm (*Spodoptera litura*) is one of the major insect pests affecting vegetable crops such as mustard greens. Infestations by this pest can cause severe leaf damage, reduce crop yields, and even lead to total crop failure. Controlling this pest with synthetic pesticides often results in negative consequences for both the environment and consumers. Therefore, the

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use of plant-based extracts such as soursop leaf extract as a biological control agent presents a promising solution that requires in-depth investigation. Awan et al. (2022) demonstrated that soursop leaf extract effectively caused mortality in *S. litura* larvae under laboratory conditions, while Firdausiah et al. (2022) reported that a combination of soursop leaf extract and cigarette butt waste was effective as a biopesticide against *Spodoptera frugiperda*.

Moreover, Irwan et al. (2021) added that not only the leaves but also other parts of the *Annona* plant, such as the seeds, have high insecticidal potential. However, most existing studies remain preliminary and are largely limited to laboratory trials. Few have specifically examined the effectiveness of soursop leaf extract against *Spodoptera litura* on mustard greens in a comprehensive manner. In this context, further research that takes into account specific host plants and pest species is essential to develop more targeted and applicable botanical pesticide formulations for sustainable agricultural management.

Based on this review, a research gap exists regarding the lack of studies that specifically evaluate the effectiveness of soursop leaf extract as a botanical pesticide against armyworm (*Spodoptera litura*) on mustard greens (*Brassica juncea*). Most studies have been limited to general laboratory tests and have not targeted specific horticultural crops that are part of daily human consumption. This study presents an innovation and novelty by broadening the utilization of soursop leaves as a more specific and applicable botanical pesticide, with the potential to support sustainable agriculture and food safety. By systematically assessing its effectiveness against *Spodoptera litura* on mustard greens, this research is expected to make a significant scientific contribution to the development of efficient, affordable, and environmentally friendly botanical pesticides.

2. RESEARCH METHOD

This study employed a literature review (library research) method, which involved examining, analyzing, and synthesizing various relevant and up-to-date scientific sources on the effectiveness of soursop (*Annona muricata*) leaf extract as a botanical pesticide against the armyworm (*Spodoptera litura*) on mustard greens (*Brassica juncea*). To ensure a systematic and comprehensive literature review, this study followed a structured procedure consisting of several stages. Each step was carefully designed to enhance the validity and relevance of the findings. The flow of the literature review process is illustrated as follows:

Problem Identification
↓
Formulation of Research Objectives
↓
Systematic Literature Search
(databases: Google Scholar, DOAJ, ScienceDirect, etc.)
↓
Screening Based on Inclusion/Exclusion Criteria
↓
Critical Evaluation of Selected Articles
(credibility, relevance, methodology)
↓
Data Extraction

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(extract type, application method, mortality rate, etc.)
↓
Descriptive-Comparative Analysis
(pattern identification, research gaps)
↓
Presentation of Findings
(using narrative synthesis + comparison tables)
↓
Conclusion and Recommendations

3. RESULTS AND DISCUSSION

Results

The following is a synthesis of findings from various studies related to the use of *Annona muricata* (soursop) and other members of the Annonaceae family as botanical pesticides against caterpillar pests, particularly *Spodoptera litura*. A summary of these findings is presented in the comparison table below to enhance clarity and comparative analysis.

Table 1. Summary of Literature on the Effectiveness of Annonaceae Extracts Against Caterpillar Pests

No.	Author(s) & Year	Plant Part / Species	Target Pest	Key Findings	Notes / Mode of Action
1	Amalia & Yusa (2018)	Soursop leaf	Plutella xylostella	Reduced larval feeding, increased mortality	Antifeedant and insecticidal activity
2	Fathoni et al. (2013)	Soursop leaf vs. Mahogany seed	Spodoptera litura	Soursop extract showed significant mortality and feeding inhibition	Competitive LC_{50} value
3	Leatemia & Isman (2004)	Seeds of various Annona spp.	Lepidopteran larvae	Strong insecticidal activity at low concentrations	Presence of acetogenins (contact and stomach poison)
4	Sakul (2017)	A. muricata & Pangium edule seeds	Plutella xylostella	Reduced larval survival; toxicity linked to annonacin & acetogenins	Damaged digestive system
5	Pardeshi & Vetal (2019)	Annona squamosa seed (ethanol, hexane)	Spodoptera litura	Both extracts effective; hexane extract had lower LC_{50}	Lipophilic insecticidal compounds
6	Muthu et al. (2023)	A. muricata seed	Spodoptera litura	Larval mortality, midgut tissue damage	Disruption of digestion and nutrient absorption

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7	Mahmoud & Hassan (2022)	A. squamosa seed	Spodoptera littoralis	Interfered with larval development at multiple stages	Contact and systemic poison
8	Supriyono et al. (2024)	Review of A. muricata research	General application	Identified commercial potential and challenges in field implementation	Emphasized need for field trials
9	Isman & Seffrin (2014)	Annonaceae family (general)	Broad spectrum	Highlighted acetogenins' role in mitochondrial disruption	Unique systemic cell death mechanism

Discussion

The application of botanical pesticides has become a vital alternative in reducing dependence on synthetic chemical pesticides, which negatively impact the environment, human health, and contribute to pest resistance. One of the most promising plants as a raw material for botanical pesticides is the soursop (*Annona muricata*). This plant, a member of the Annonaceae family, is known to contain various bioactive compounds such as acetogenins, alkaloids, flavonoids, and tannins, which play significant roles in insecticidal and antifeedant activities against crop pests (Isman & Seffrin, 2014; Oriyomi, 2018).

Numerous studies have confirmed that the active compounds in both the leaves and seeds of soursop are capable of causing mortality in insect pests. Awan et al. (2022) demonstrated that soursop leaf extract significantly increased the mortality rate of *Spodoptera litura* larvae under laboratory conditions. The bioactive compounds in soursop leaves act by disrupting the insect nervous system, inducing paralysis, and inhibiting feeding activity, ultimately leading to larval death (Fathoni et al., 2013).

Similar findings were reported by Firdausiah et al. (2022), who combined soursop leaf extract with cigarette butt waste and successfully reduced the population of *Spodoptera frugiperda*, a pest species with similar feeding behavior to *S. litura*. Furthermore, Muthu et al. (2023) revealed that treatment with soursop seed extract caused histological damage to the midgut tissues of *S. litura* larvae, including epithelial degeneration, swelling, and cellular disorganization. This damage directly impaired the larvae's ability to digest food, thereby accelerating mortality.

Additional research has confirmed that the Annonaceae family—particularly *A. muricata* and *A. squamosa*—exhibits high insecticidal potential. Studies by Pardeshi & Vetal (2019) and Mahmoud & Hassan (2022) proved that *Annona squamosa* seed extract effectively reduced the survival of *Spodoptera* spp. through both contact and systemic toxicity. Meanwhile, Alves et al. (2016) noted that various Annonaceae species can be selectively chosen based on their secondary metabolite profiles and effectiveness against target species such as *S. frugiperda*.

From an ethnobotanical perspective, Indonesian communities have long utilized soursop as a natural pesticide. Sidauruk et al. (2022) documented the use of local plants, including *Annona muricata*, by farmers in Karo Regency to support food safety through biological pest control. This practice aligns with sustainable agricultural approaches that avoid environmental pollution from chemical residue accumulation (Darlis et al., 2024).

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Despite its promising potential, Supriyono et al. (2024) noted that the adoption of botanical pesticides in Indonesia still faces major challenges, including a lack of formulation standardization, limited field efficacy testing, and inadequate dissemination among farmers. These issues highlight the need to bridge laboratory research with practical field implementation using a multi-faceted approach.

Furthermore, effective botanical extract formulation must consider solvent types, optimal concentrations, and application methods. Bandara & Ranatunge (2020) showed that aqueous-based botanical formulations of *Annona* seeds are also effective in pest control, with added benefits of being environmentally friendly and economically viable. This implies that not only the leaves, but also other plant parts of *Annona* hold high value in pest management.

Research by Leatemia & Isman (2004) and Ribeiro et al. (2014) further emphasized that seed and leaf extracts of *Annona* spp. can exert strong toxic effects on Lepidopteran species such as *Trichoplusia ni* and *Spodoptera* spp., even at low concentrations. These findings underscore the importance of conducting formulation research and targeted application studies on specific host crops.

Overall, existing studies indicate that soursop leaves exhibit consistent effectiveness against *Spodoptera litura* and related pest species. The insecticidal activity of its bioactive compounds causes physiological and behavioral disruptions in the pests, directly contributing to population control. This opens up significant opportunities for developing botanical pesticides based on *Annona muricata*, particularly for horticultural crops like mustard greens, which are vulnerable to *S. litura* infestations.

Although numerous studies have demonstrated the efficacy of *Annona muricata* extracts, most have been limited to laboratory-scale trials and have not specifically focused on mustard greens as the test plant. Therefore, this study contributes to filling a notable research gap by specifically assessing the effectiveness of soursop leaf extract against *Spodoptera litura* on mustard greens. In doing so, this research not only reinforces the empirical evidence but also presents a form of novelty by focusing on a high-consumption horticultural crop, thereby supporting sustainable agriculture and food security.

4. CONCLUSION

Based on the results of the literature review, it can be concluded that *Annona muricata* (soursop) leaf extract is highly effective as a botanical pesticide for controlling *Spodoptera litura* (armyworm), a major pest on mustard greens (*Brassica juncea*). The effectiveness of this extract is primarily attributed to the presence of bioactive compounds such as acetogenins, flavonoids, and saponins, which function as stomach poisons, antifeedants, and repellents. Various studies reported significant reductions in larval feeding activity, growth inhibition, tissue damage, and increased mortality rates, even at relatively low extract concentrations. This supports the hypothesis that soursop leaf extract holds substantial pesticidal potential.

Furthermore, the findings answer the core research question by affirming that *A. muricata* leaf extract offers a promising, environmentally friendly alternative to synthetic pesticides. However, the review also identified a critical gap in field-level experimentation, especially on mustard green crops under real agronomic conditions. Therefore, it is recommended that future research focuses on field-scale trials, formulation development, and assessment of long-term ecological impacts. This will support the practical application and broader adoption of soursop-based botanical pesticides in sustainable agriculture.

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