Development of Composite-Based Liquid Smoke Pesticides for Sustainable and Eco-Friendly Pest Control

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Abstract

This paper presents a community service initiative aimed at educating local communities about the use of botanical pesticides derived from composite wood-leaf materials. The study details the development of composite-based liquid smoke pesticides, which involves stages such as raw material collection (e.g., bark, leaves, and twigs), material refinement, pesticide production by mixing composites with solvents, and testing its effectiveness on plant pests. The initiative, conducted at SMK Panca Budi Medan, incorporated lectures, hands-on training, and evaluations with 20 students. The effectiveness of the program was measured based on the participants' understanding of using composite-based liquid smoke as an environmentally friendly and effective pest control solution. The results highlight the potential of composite-based liquid smoke as a viable, eco-friendly pest control method with low environmental impact.

Keywords: *Eco-Friendly, Organic Pesticide, Smoke Distillate, Composite Materials*

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Introduction

Botanical pesticides are known for their effectiveness and environmental friendliness, but they often face challenges such as inconsistent efficacy and higher production costs compared to synthetic pesticides. Liquid smoke, produced by the pyrolysis of biomass such as wood and organic waste, offers a promising alternative. This substance contains bioactive components like phenols and organic acids, which are effective for controlling pests and plant diseases. Recent innovations in this field include the development of composite-based liquid smoke pesticides, combining liquid smoke with other natural ingredients to enhance their efficiency.

SMK Panca Budi has consistently demonstrated its commitment to improving education in alignment with modern agricultural practices. Collaboration with the educational community is key to fostering future generations equipped with both Islamic values and global competencies. The initiative, titled "Utilizing Composite-Based Liquid Smoke Botanical Pesticides for Effective and Eco-Friendly Pest Control," was conducted at SMK Panca Budi Medan as a part of this mission.

Literature Review

Integrated Pest Management (IPM) faces significant challenges in agricultural communities, particularly the continued reliance on chemical pesticides. The lack of trust in alternative pest control methods leads to irresponsible pesticide use [1]. Although chemical pesticides increase crop yields, their overuse has resulted in severe environmental, health, and biodiversity impacts. The development of natural pesticides, such as liquid smoke, presents a sustainable solution to these problems [2].

Research indicates that liquid smoke can inhibit various plant pathogens, including Curvularia sp. and G. boninense, through its phenolic compounds [3]. These findings support the use of liquid smoke as a botanical pesticide and enhance public awareness of utilizing organic waste for environmental conservation [4].

Moreover, liquid smoke helps reduce dependence on toxic chemical pesticides, herbicides, and repellents [5]. Studies on pests such as P. xylostella show that liquid smoke from coconut shells significantly affects larval mortality, reduces feeding activity, and inhibits pupation [6]. Liquid smoke from palm oil waste has also demonstrated excellent insecticidal properties against brown planthopper (Nilaparvata lugens), suppressing populations by up to 91.67%. Further research is needed to explore the full potential of liquid smoke against other pests and its active chemical properties [7].

The development of composite-based liquid smoke pesticides presents an affordable, sustainable solution by utilizing locally available raw materials such as wood and plants. This approach targets plant pests while safeguarding non-target organisms, such as pollinators and natural predators, thus preserving agricultural biodiversity and ecosystem balance.

Research Methodology

The community service initiative began with participant registration, followed by educational lectures delivered by the service team. Collaborative discussions were conducted to increase participants' understanding of using composite plant extracts to create effective, environmentally friendly botanical liquid smoke pesticides. The next phase involved collecting the necessary tools and materials for pesticide production. The program then progressed to hands-on training, where participants actively engaged in formulating composite-based liquid smoke pesticides.

The methodology involved several stages:

1. Raw Material Collection: This included bark, leaves, and twigs, which were processed into finer forms.

2. Pesticide Production: The composite materials were mixed with solvents to produce the pesticide.
3. Effectiveness Testing: The final product was tested on plant pests to determine its efficacy.
4. Training and Education: Students participated in practical sessions to learn the production process, followed by field applications.

The project involved 20 students from SMK Panca Budi. They were trained on the procedures for creating liquid smoke pesticides and participated in field trials, monitoring the effects on pest populations.

Results

The community service initiative was successfully conducted on February 12, 2025, at SMK Panca Budi Medan, involving 35 participants, including students from the agricultural program and their instructors. The program commenced with a series of educational lectures, during which the service team discussed key concepts, including the potential of composite-based liquid smoke pesticides, the technical procedures for pesticide production, and the use of additional natural materials such as neem and tobacco extracts as active agents. These lectures sparked dynamic discussions, with students showing significant interest in exploring safer, cost-effective pest control alternatives.

4.1 Hands-On Training and Practical Implementation

After the theoretical sessions, participants actively engaged in gathering materials, which included wood powder, twigs, dried leaves, fermentation bottles, and extracts of local plants (neem and tobacco). The participants were divided into small groups and conducted pyrolysis to produce liquid smoke. The process involved the careful heating of organic materials in the absence of oxygen, resulting in the formation of liquid smoke. The resulting liquid smoke was then combined with plant extracts and natural binders, such as clay, to form the composite-based pesticide.

The participants then packaged the final product in labeled plastic bottles for later use. The production process was carefully supervised, with step-by-step guidance provided to ensure the correct formulation. All activities were documented through photographs and video recordings, ensuring transparency and a comprehensive record of the procedure.

4.2 Application and Initial Results

Following the production of the pesticide, a demonstration session was held in the school's practice field. The composite-based liquid smoke pesticide was applied to chili plants cultivated by the students. The plants were selected as they are commonly affected by various pests, including aphids. Initial observations were made three days after the application of the pesticide to assess its effectiveness in reducing pest populations and improving plant health.

The results were promising, showing a noticeable reduction in pest populations, particularly aphids. The students reported observing fewer pests on the plants, and some plants exhibited healthier leaves, with a reduction in damage caused by the pests. The application also appeared to stimulate new growth on the chili plants, further indicating the potential of the pesticide to promote plant health. These early observations were encouraging, suggesting that composite-based liquid smoke can effectively control pests while being safe for the environment.

The service team conducted a follow-up discussion with the students to gather their feedback. The students expressed their appreciation for the natural, environmentally friendly nature of the pesticide, emphasizing that it provided a viable alternative to chemical pesticides.

Many students were particularly interested in how the use of organic waste products, such as wood and plant extracts, could contribute to more sustainable agricultural practices.

4.3 Challenges and Areas for Improvement

Despite the promising results, some challenges were encountered during the implementation phase. One of the main difficulties was the time-consuming pyrolysis process, which requires careful monitoring and precise temperature control. Additionally, there was a need for more advanced distillation equipment to refine the liquid smoke more efficiently. However, these challenges were mitigated by the recognition that the overall environmental footprint of the process remained minimal, and the benefits of using natural, locally sourced materials far outweighed these operational hurdles.

The need for more advanced equipment and the optimization of the pyrolysis process were identified as areas for improvement in future iterations of the program. The students also proposed experimenting with different organic materials to determine the most effective combinations for liquid smoke production, which could enhance the pesticide's efficacy.

Conclusion

This community service initiative successfully demonstrated the feasibility and effectiveness of composite-based liquid smoke pesticides as an eco-friendly alternative to synthetic pesticides. By combining instructional seminars, interactive discussions, and practical workshops, the program equipped students with the necessary theoretical and practical skills to produce and apply these natural pesticides. The program also significantly raised ecological awareness among participants, offering a viable method for reducing reliance on chemical pesticides in agriculture.

References

[1] Udayanga, H. L. S., Bellanthudawa, B. K. A., & De Zoysa, “Sustainable agriculture and responsible use of pesticides : commercial crop cultivators ’ knowledge , attitudes , and practice perspectives regarding pesticide use,” no. December, pp. 1–17, 2024, doi: 10.3389/fsufs.2024.1490110.

[2] Wahjono, T. E, Suhatman A., Wihermanto W., and Hadiyanto H., “Neem (Azadirachta indica A . Juss ; Meliaceae) as the source for plant-based pesticides as an effective and sustainable biocontrol al- ternative,” vol. 3, no. 3, pp. 128–141, 2024, doi: 10.61435/jbes.2024.19928.

[3] Setiawan C. S., Majid. W, Putri. M., Tambunan S. D. P., & Wibowo V. B., “In Vitro Liquid Smoke Potential as Biopesticide on Major Oil Palm Diseases,” no. December, 2024, doi: 10.22146/jpti.95130.

[4] Bria D., Hoar O., Nino J., Klau A. M., and Veronika L., “P embuatan Asap Cair Sebagai Pestisida Nabati Di Kebun Dinas Pertanian Dan Ketahanan Pangan , Kabupaten Belu Making Liquid Smoke As A Botanical Pesticide In The Garden Of The Department Of Agriculture And Food Security , Belu District,” vol. 1, no. 1, pp. 9–16, 2025.

[5] Wibowo S., Syafii W., Pari G., and Herliyana E. N., “Journal of Environmental Health,” vol. 15, no. 3, pp. 196–216, 2023, doi: 10.20473/jkl.v15i3.2023.196-216.

[6] Bilqis Z. A. and Ikawati S., “The Effectiveness of Grade C Coconut Shell Liquid Smoke Insecticide and Broflanilide Active Ingredient Insecticide Against Plutella xylostella L . (Lepidoptera : Plutellidae) on Cabbage Plants,” vol. 6, no. 2, pp. 58–67, 2025.

[7] Soedijo S., Pramudi M. I., and Aisah S., “Introduction Study of Potential of Natural Insecticide Liquid Smoke from Solid Waste Oil Palm to Brown Plant Hopper (Nilaparvata lugens Stall) in South Kalimantan,” vol. 03, no. 01, pp. 196–198, 2015.

[8] Lubis, N ., Wasito. M., Marlina. L., Girsang, R., Wahyudi. H., Respon Pemberian Ekoenzim Dan Pupuk Organik Cair Terhadap Pertumbuhan Dan Produksi Bawang Merah Merah (Allium ascalonicum L.), Agrium, Volume 25 No.2 Oktober 2022.

[9] Lubis. N., Wasito. M., Marlina. L., Ananda.S.T. R., Wahyudi. H., Potensi Ekoenzim Dari Limbah Organik Untuk Meningkatkan Produktivitas Tanaman. Prosiding, 2022 - journal. uniba.ac.id

[10] Tarigan. M.S., Wasito. M., Socialization of Strategies for Improving the Competitiveness of Local Horticultural Products Through the Application of Ecoenzymes From Organic Waste in Klambir Lima Kebun Village. Journal of Information Technology, computer science and Electrical Engineering, Vol. 2 No. 2 (2025): June-September 2025.

[11] Wasito. M, RE Putri., Training on Making Eco Enzymes from Fruit Waste in Suka Damai Village, Kuala Sub-District, Langkat District.,vol. 2. no. 2, 2023.

[12] Lubis. N., Tarigan. RRA., Ramadhan. S.R., Miswanto. M., Sosialisasi Pemanfaatan Sampah Organik Rumah Tangga dalam Produksi Eco-enzim di Desa Suka Mulia Kecamatan Secanggang Kabupaten Langkat, Abdimas Galuh, Volume 7, Nomor 1, Maret 2025, 53-57