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Plant-Based Bioinsecticide for Controlling Houseflies (Musca domestica): Efficacy of Leaf Extracts

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ABSTRACT

Introduction: One of the vectors of disease spread is flies. House flies (Musca domestica) are often found alive in almost all types of environments. Several previous studies have shown that pandanus leaves (Pandanus amaryllifolius), basil leaves (Ocimum sanctum), and bay leaves (Syzygium polyanthum) contain active compounds that are toxic to insects, but no one has compared the effectiveness of the four types of plants. This research aims to determine the effectiveness of administering extracts from various plant leaves as a bioinsecticide for houseflies (Musca domestica).
Methods: This type of research is experimental using a completely randomized design with 6 treatments. The treatment consisted of administering Pandan Leaf extract (Pandanus amaryllifolius), Basil Leaf extract (Ocimum sanctum) and Laurel Leaf extract (Syzygium polyanthum) each with a concentration of 5 ml, 10 ml and 15 ml and using a control for comparison. Observations were carried out for 24 hours observing the number of dead flies.
Results: The results of this study indicate that pandan leaf extract (Pandanus amaryllifolius), basil leaf extract (Ocimum sanctum), and bay leaf extract (Syzygium polyanthum) are effective in killing houseflies (Musca domestica). The most effective concentration being 15 ml.
Research Implications: This research demonstrates that the use of natural bioinsecticides from plant extracts can control the population of house flies (Musca domestica) so that the risk of disease transmission in the community can be significantly minimized
Conclusion: Pandan leaf extract (Pandanus amaryllifolius), basil leaf extract (Ocimum sanctum) and bay leaf extract (Syzygium polyanthum) can be used as natural alternative ingredients to exterminate houseflies (Musca domestica)
Limitations of the research: This research did not control environmental conditions such as sunlight, temperature, and humidity. Other than that, neither the effects on fly resistance nor the effects on non-target organisms have been studied.
Recommendations for Future Research: It is hoped that future research can examine the effects of fly resistance and killing on non-target organisms and control environmental conditions.

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INTRODUCTION

Vector-borne diseases are one of the diseases that pose a threat to public health worldwide (1,2). One of the vectors of disease spread is flies. House flies (Musca domestica) are usually found in almost all types of environments (3). A bad environment often becomes a breeding ground for flies. Low level of Healthy Clean-Living Behaviour (PHBS) allows flies to act as vectors and transmit diseases to humans (4)(5,6).

WHO data indicates that in 2009, 45 countries reported 221,226 cases of cholera, an increase of 16% compared to 2008, with 190,130 cases. The Asian continent has the highest incidence of typhoid fever cases in the world, with 274 cases per 100,000 inhabitants. Estimated case fatality rate rates for the disease range between 1% and 4%.

Control of the vector fly (Musca domestica) can be carried out mechanically, physically, biologically and through environmental control, both from the development of the fly to the adult fly (7–9).

Nowadays, the control that is usually carried out is chemical prevention using chemical products including organophosphorus compounds, organochlorines, carbamates and pyrethroids. However, continued use of these chemicals will have negative impacts such as death of non-target organisms, environmental pollution, and danger to public health. Apart from that, this method is also cost-intensive and may cause vector resistance (7–9).

Various efforts have been made to prevent vector resistance to various chemicals. Therefore, control methods are needed, especially insecticides, that are more environmentally friendly, effective and efficient, and safe for health (10,11). Biological control can be an alternative to vector control, specifically reducing vector populations and using natural ingredients (12,13).

It has been shown that natural insecticides contribute significantly as a new alternative in efforts to reduce the number of diseases caused by fly vectors. Eugenol, alkaloids, flavonoids, saponins and other active ingredients in plants can be toxic to flies. Plant essential oils can interfere with the metabolic, biochemical, physiological and behavioural processes of insects (14,15).

Several types of plants that are capable of being natural insecticides include pandan (Pandanus amaryllifolius) leaves which contain active compounds such as alkaloids, saponins, flavonoids, tannins, polyphenols, dyes and essential oils (16). Basil leaves (Ocimum sanctum) and bay leaves (Syzygium polyanthum) contain several compounds including alkaloids, flavonoids, saponins, tannins, triterpenoids and essential oils. Flavonoids, saponins and tannins are useful as stomach poisons that can interfere with the ability of insects to digest food (17,18)

Pandan (Pandanus amaryllifolius) leaves contain compounds such as alkaloids and tannins that are toxic to insects and effective in repelling house flies because insects do not like their distinctive aroma. Basil leaves (Ocimum sanctum) contain eugenol and linalool, which have insecticidal properties and attack the nerves of insects, according to research by Purnamasari, 2019 that basil extract can significantly kill houseflies. Meanwhile, research on the ability of bay leaves (Syzygium polyanthum) as a natural bioinsecticide was conducted by Nugroho, 2021, who stated that the extract is rich in terpenoid and flavonoid compounds that function as a contact poison or housefly repellent (19).

Novelty This research explores the interactions of bioactive compounds, such as eugenol, tannins, flavonoids and terpenoids, that come from the three leaves. Previous research tended to focus on one type of plant, while this study studied how comparing compounds from three different sources can provide more effective results against house flies. Furthermore, this research is an innovation for the development of bioinsecticides that are safe for the environment and health and at the same time reduce the use of synthetic chemical insecticides.

METHOD

Research design

In this research, basil leaf extract was used with concentrations of 5 ml, 10 ml and 15 ml and 10 house flies, using 4 treatments (site) with an observation time of 1 hour each accompanied by a control, the three treatments They were carried out alternately with a total of 40 flies. And the supplies needed are 50 flies.

Investigation procedures

Make extracts: 1) Put the leaves in a different blender, 2) Once it is soft, it is electromatized with ethanol, 3) Filter to separate the grounds that have been extracted, 4) Leave a few moments for the remaining unfiltered grounds to settle, 5) Pour pandan leaf extract and basil leaves into different spray bottles.

Research stage: 1) Prepare a test cage that has been labeled and prepare pandan leaf and basil leaf extract in a spray bottle. 2) Put the flies (Musca domestica) that have been captured in each cage that has been labeled according to the concentration that has been determined, put 10 Musca domestica in each cage, the total number of Musca domestica analysed is 40. 3) Air temperature and humidity were then measured and recorded in each test cage containing Musca domestica before treatment. 4) Spray 5 times the extract and basil leaves in each cage at the same time, then observe and record the number of Musca dometica that die every 1 hour for 6 hours, make in each treatment 1, 2 and 3 extracts of Pandan leaves, leaves of laurel. and basil leaves. 5) After that, count and record the number of Musca domestica that die each minute in each cage. 6) Enter the data in the prepared format

Ethical Approval

This research followed the guidelines for testing the use of natural insecticides based on the 2009 WHO Standards for Guidelines for Efficacy Testing of Insecticides for Indoor and Outdoor Ground-Applied Space Spray Applications.

RESULTS

This research was carried out at Environmental Health Laboratory of Palu Health Polytechnic of Ministry of Health using 3 types of plants namely pandan leaf extract (Pandanus amaryllifolius), bay leaf extract (Syzygium polyanthum) and basil leaf extract (Ocimum sanctum) as a natural bioinsecticide for house flies (Musca domestica).

Table 1. Number of house fly (Musca domestica) deaths after fumigation Pandan Leaf Extract (Pandanus amaryllifolius)

No	Concentration	Flies Mortality Rate	Flies Mortality Percentage (%)
1	5 ml	23	92
2	10 ml	23	92
3	15 ml	24	96
4	Control	0	0

Based on the above table, it can be seen that the three concentrations of pandan leaf extract (Pandanus amaryllifolius) with sizes of 5 ml, 10 ml and 15 ml are effective in killing house flies (Musca domestica) exceeding the achievement percentage of 80. % for each test box containing 25 house flies (Musca domestica) with a concentration of 5 ml can kill 23 flies (92%), 10 ml can kill 23 flies. (92%), while a concentration of 15 ml can kill up to 24 flies (96%).

As for the observations every 1 hour within 6 hours after the observation, it can be seen that the longer the observation time and the higher the concentration of Pandan (Pandanus amaryllifolius) leaf extract placed in the test box, the greater the lethal power of the aroma of the extract.

Table 2. Number of house fly (Musca domestica) deaths after fumigation Salam Leaf Extract (*Syzygium polyanthum*)

No	Concentration	Flies Mortality Rate (Ekor)	Flies Mortality Percentage (%)
1	5 ml	19	76
2	10 ml	20	80
3	15 ml	22	88
4	Control	0	0

Based on the above table, it can be seen that the concentration of bay leaf extract (Syzygium polyanthum) can kill house flies (Musca domestica) with details of a concentration of 5 ml that can kill up to 19 flies (76%), 10 ml can kill 20 flies (80%), while a concentration of 15 ml can kill up to 22 flies (88%).

As for the observations every 1 hour within 6 hours after the observation, it can be seen that the longer the observation time and the higher the concentration of bay leaf extract (Syzygium polyanthum) placed in the test box, the greater the lethal power of the aroma of the extract.

Table 3. Number of house fly (Musca domestica) deaths after fumigation Kemangi Leaf Extract (*Ocimum sanctum*)

No	Concentration	Flies Mortality Rate (Ekor)	Flies Mortality Percentage (%)
1	5 ml	20	80
2	10 ml	22	88
3	15 ml	25	100
4	Control	0	0

Based on the above table, it can be seen that the three concentrations of basil leaf extract (Ocimum sanctum) with sizes of 5 ml, 10 ml and 15 ml are effective in killing house flies (Musca domestica) exceeding the achievement percentage of 80. % for each test box containing 25 House flies (Musca domestica). A concentration of 5 ml of basil leaf extract (Ocimum sanctum) can kill up to 20 flies (80%), 10 ml can kill 22 flies (88%), while a concentration of 15 ml can kill up to 25 flies (100 %).

DISCUSSION

According to research results, pandan leaf extract (Pandanus amaryllifolius), bay leaf extract (Syzygium polyanthum) and basil leaf extract (Ocimum sanctum) have the ability to act as natural insecticides for flies. domestic plants (Musca domestica), test results show the fastest death. rate after spraying the extract, that is, at a concentration of 15 mL and the lowest mortality was at a concentration of 5 mL. The increase in mortality of the house fly (Musca domestica) was in line with the increase in the concentration of leaf extract in the solution. This shows that the higher the concentration (Ocimum sanctum), the faster the flies die. On the other hand, the lower the concentration of basil leaves (Ocimum sanctum), the slower the flies die.

The death of these flies was caused by the fumigation process which aims to create direct contact between the bandotan leaf extract and the house flies. The flavonoid compounds contained in bandothan leaves enter the mouth of the fly through the respiratory system in the form of spiracles on the surface of the body and cause withering of the nerves, as well as damage to the spiracles resulting in the fly not can breathe and eventually die (19–21).

The high or low number of fly deaths may be due to the presence of chemical compounds in the solution that play a role in biological activity in the growth and development of flies. The compounds contained in pandan leaves (Pandanus amaryllifolius), bay leaves (Syzygium polyanthum) and basil leaves (Ocimum sanctum) according to contain saponins, flavonoids, polyphenols, essential oils and alkaloids (22).

Flavonoid compounds act as antibacterials by damaging the cell membrane in the phospholipid section, thus reducing permeability and altering the metabolism of flies (23). Several studies have shown that plant essential oils contain compounds that have a pungent odor, one of which is geraniol, a natural chemical compound that is effective in repelling insects (3,21,24–26). Another active ingredient that also influences is saponin, which can cause a slowdown in the absorption of food from the digestive tract, especially cholesterol, and can cause hermolysis by increasing the permeability of the plasma membrane, so both mechanisms cause alterations in the organism's metabolism and death in insects.

The research results showed that basil leaves (Ocimum sanctum) had the highest effectiveness because they could kill 100% of house flies. This is because its main ingredients, such as eugenol and linalool, are known as natural neurotoxins. This compound directly attacks the central nervous system of the fly and causes paralysis and death in a short time. Apart from that, the stability of the two active compounds has a long and optimal duration of action, making basil leaves (Ocimum sanctum) a more effective option compared to bay leaves (Syzygium polyanthum) and leaves of pandan (Pandanus amaryllifolius) (27,28).

The mortality rate of house flies (Musca domestica) using pandan (Pandanus amaryllifolius) leaf extract is slightly lower than that of basil (Ocimum sanctum) leaves because the content of compounds such as alkaloids, tannins and volatile compounds in Pandan leaves also work as poison. as a natural repellent, but the volatility of the active compounds causes their effectiveness to decrease over time, so pandan leaves are more optimal to use as a combination of insecticide and repellent (29-31).

Bay leaves contain flavonoids, terpenoids and tannins that function as contact poisons, but they take longer to reach maximum toxicity, so the mortality rate is lower than basil and pandan leaves (28,30).

Basil leaf extract is the best choice as a natural insecticide, especially for applications that require fast and maximum results. Pandan leaves are more suitable for dual use as an insecticide and repellent, while bay leaves are suitable for applications that require a long-term protective effect.

Limitations and Cautions

Plant-based bioinsecticides come with several limitations that need to be considered. Their efficacy tends to be specific to certain pest species, requiring more targeted applications. Their stability is also influenced by environmental factors such as sunlight, temperature, and humidity, which can reduce their effectiveness. Additionally, bioinsecticides often have a shorter residual effect compared to synthetic pesticides, necessitating more frequent applications. Overuse may also lead to resistance development in houseflies, highlighting the importance of rotating them with other pest control methods. While generally safer, some plant extracts can have negative impacts on beneficial insects or other non-target organisms. Another challenge is production standardization, as variability in plant extract composition can lead to inconsistent results, necessitating strict quality control during the production process.

Recommendations for Future Research

Investigate the long-term efficacy and environmental impact of plant-based bioinsecticides against houseflies in various ecological settings. Explore the synergistic effects of combining multiple plant extracts to enhance bioinsecticide potency and reduce resistance development in houseflies. Conduct molecular studies to understand the mode of action of active compounds in plant extracts on housefly physiology. Develop formulations for commercial application, ensuring stability, safety, and cost-effectiveness. Assess the impact of bioinsecticides on non-target organisms and overall ecosystem health. Evaluate the scalability of bioinsecticide production and its integration into sustainable pest management programs.

CONCLUSION

Pandan leaf extract (Pandanus amaryllifolius), basil leaf extract (Ocimum sanctum) and bay leaf extract (Syzygium polyanthum) can be used as natural alternative ingredients to exterminate houseflies (Musca domestica).

AUTHOR'S CONTRIBUTION STATEMENT

The author has contributed to this article from ideas, data preparation and analysis, article preparation to the review process according to the input of the reviewers and is responsible for all aspects of this article

CONFLICTS OF INTEREST

There is no conflict of interest in this research because all research and writing processes were carried out independently and transparently.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

The authors declare that generative artificial intelligence (AI) and AI-assisted technologies were used only for language editing and readability improvement during the preparation of this manuscript, and all intellectual content, data interpretation, and conclusions are the sole responsibility of the authors, who have thoroughly reviewed and validated the final version.

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