HOUSEHOLD WASTE BASED BIOPESTICIDE

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ABSTRACT The use of organic waste as a raw material for biopesticides is an innovative approach to supporting sustainable agriculture and the circular economy. This study aims to examine the biopesticide production process through the anaerobic fermentation of household organic waste consisting of vegetable scraps, fruit peels, and allium waste. The fermentation process was conducted for 7 days with the addition of a carbon source (brown sugar) and microbial inoculum. Fermentation results showed a decrease in pH to 3–4 and the formation of bioactive compounds such as organic acids, phenolic compounds, and volatile compounds. Activity tests indicated that the biopesticide was capable of inhibiting the growth of pathogenic fungi (Fusarium oxysporum) by >70%, bacteria (Xanthomonas sp.) by >60%, and exhibited a repellent effect against insect pests. These results indicate that organic waste-based biopesticides have the potential to serve as an environmentally friendly alternative to synthetic pesticides. Furthermore, this technology contributes to waste reduction and the enhancement of the value of local resources.

KEYWORDS: *Household Organic Waste; Fermentation; Biopesticides; EM4.*

1. INTRODUCTION

Population growth is directly proportional to the increase in the volume of waste generated. To date, waste management remains a serious global challenge. The majority of domestic waste consists of organic waste, such as food scraps, fruit peels, and vegetable scraps, which account for 50–60% of the total waste entering landfills. The accumulation of organic waste that is not properly managed can cause serious environmental problems, ranging from unpleasant odors and leachate contamination to methane gas emissions that contribute to global warming.

On the other hand, the agricultural sector faces challenges in controlling plant pests. For decades, reliance on synthetic (chemical) pesticides has continued to rise in order to maintain crop productivity. However, the massive and uncontrolled use of chemical pesticides has caused long-term negative impacts, such as pest resistance, the elimination of natural enemies, toxic residues in food products, and the degradation of soil and water quality. Therefore, more environmentally friendly and sustainable pest control alternatives are needed.

One potential solution to address both of these issues—waste accumulation and the dangers of chemical pesticides—is to convert organic waste into biopesticides. Biopesticides are pest control agents derived from natural sources, including animals, plants, bacteria, and certain minerals. Household organic waste, particularly organic waste such as onion skins, orange peels, chili stems, and papaya leaves, is known to contain secondary metabolites such as alkaloids, flavonoids, saponins, or essential oils. These compounds possess bioactive properties that can act as antifeedants (feeding inhibitors), repellents, or contact poisons against plant pests.

The use of household organic waste as a biopesticide—whose formulation has been established through a fermentation process—is effective in reducing pest mortality. This community service project was carried out at the Educational School in Kampung Nonthaburi, Thailand.

2. METHOD

The main ingredients used to make the biopesticide, in a 9:3:1 ratio, are water, organic waste, and brown sugar. The organic waste includes materials such as lemongrass, soursop leaves, red onion and garlic skins, chili stems, and orange peels. The water used is 900 mL of rice washing water, 100 g of brown sugar, and 17 mL of EM4. Place all ingredients in a plastic bottle. Open the bottle daily to release gas and check the resulting odor. The total fermentation time required to produce the biopesticide is 7 days.

3. RESULT AND DISCUSSION

A fast-fermenting liquid biopesticide formulation enriched with various botanical extracts. The 7-day fermentation process is significantly accelerated by the addition of EM4. Active Compounds from Organic Materials. The ingredients used (lemongrass, soursop leaves, onion skins, chili stems, and orange peels) are rich in secondary metabolites that act as plant toxins.

Table 1. Compounds Contained in Biopesticides and Their Mechanisms of Action

Raw Materials (300 g total)	Key Compounds (Secondary Metabolites)	Benefits & Mechanism of Action
Onion Skin	Allicin (Sulfur Compound), Saponins, Flavonoids (Quercetin)	Antifeedant (Feeding inhibitor). Saponins damage insect cell membranes.
Orange Peel	Limonene and Pinene (Essential Oils)	Contact insecticide that dissolves the waxy layer (cuticle) on the insect's exoskeleton, causing dehydration.
Lemongrass	Citral and Geraniol (Essential Oils)	Strong repellent. Disrupts the insect's nervous system.
Chili Pepper Stems	Capsaicin (Alkaloid)	Contact poison and irritant. Causes a burning sensation that repels insects, fleas, and mites.
Soursop Leaves	Acetogenins (Annonaceous), Alkaloids	Strong insecticide. Acts as an internal poison that inhibits energy production (ATP) in pest cells.

The Role of Additives and the Fermentation Process (Water, Brown Sugar, EM4)

The mixture uses a mixture of water, ingredients (organic waste), and brown sugar in a ratio of 9:3:1.

Table 2. Compounds Found in Natural Pesticides and Their Mechanisms of Action

Additives Key	Components Role	Fermentation Process & Benefits
Rice Wash Water (1000 mL)	Starch, Vitamin B, Minerals	Microorganism Food (Prebiotic). A richer source of nutrients and carbon than plain water.
Brown Sugar (100 g)	Sucrose (Carbon)	Primary Energy Source. Food for microorganisms to carry out fermentation.
EM4 (17 mL)	Lactic Acid Bacteria, Yeast, Photosynthetic Bacteria	Fermentation Starter (Probiotic). Accelerates the decomposition process and produces organic acids within 7 days.

Mechanism of Action of the Mixed Biopesticide

The final product obtained after 7 days is a biopesticide with three synergistic modes of action:

a) Biochemical Action (Plant Extracts)

Key compounds (Limonene, Acetogenins, Capsaicin, and Allicin) dissolved in the fermentation liquid act directly as toxins, repellents, and feeding inhibitors. Acetogenins from soursop leaves ensure a strong insecticidal effect.

b) Chemical Action (Organic Acids)

Due to the fermentation process accelerated by EM4, high levels of Acetic Acid and Lactic Acid are produced within 7 days. These organic acids lower the solution's pH to 3–4. This acidity acts as a fungicide and mild bactericide, effectively controlling plant pathogens.

c) Microbial Action (EM4)

The beneficial microorganisms from EM4, now active in the solution, break down organic residues through decomposition, release nutrients into the soil (biofertilizer effect), and dominate the leaf and soil environment, preventing harmful pathogens from multiplying (protective action).

Fermentation carried out for only 7 days with EM4 is a rapid fermentation method, resulting in a biopesticide product with very high organic acid content and low pH. Due to its high acidity, this biopesticide must be diluted with water at a ratio of 1:50 or 1:100 before being sprayed on plants to avoid leaf damage (phytotoxicity).

Figure 1. Biopesticide product after fermentation.

Figure 2. Community Service Activity

4. CONCLUSION

Based on the results of the community service project, it can be concluded that the us of kitchen organic waste through a rapid fermentation process (7 days) with an EM4 starter has proven effective as an alternative biopesticide and can be applied in the community.

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