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Effectiveness of Using Organic Waste Fermentation as Eco-Enzyme Fertilizer on the Growth of Water Spinach Plants (Ipomoea Aquatica)

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ABSTRACT

Excessive use of inorganic fertilizers in agriculture can damage soil structure and health. Eco-enzyme, a fermentation product of organic waste such as fruit peels, offers a solution as an environmentally friendly, nutrient-rich liquid organic fertilizer. This study aims to investigate the effects of eco-enzyme on the growth of water spinach (Ipomoea aquatica). Eco-enzyme was produced from pineapple peels, orange peels, and water spinach stems, fermented for 60 days. The testing was conducted in the Health Microbiology Laboratory of Universitas Islam Lamongan with varying concentrations of eco-enzyme (0%, 5%, 7%, 10%, 15%, and 17%). The observed parameters included plant height, fresh weight, and leaf count. The results showed that higher concentrations of eco-enzyme led to better growth outcomes across all three parameters. The 17% concentration produced the highest average height, fresh weight, and leaf count. In conclusion, eco-enzyme effectively enhances the growth of water spinach and holds significant potential as an alternative organic fertilizer in agriculture.

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I. Introduction

The use of inorganic fertilizers as plant nutrients is a common issue in the agricultural sector. Continuous use of inorganic fertilizers can lead to problems such as: a decrease in soil nutrient levels, damage to soil structure, and a reduction in soil microbiology [1]. If fertilizers are used in high doses without adding organic matter, the levels of nutrients and organic content in the soil will decrease, so it is necessary to add organic fertilizer. Therefore, to reduce excessive use of inorganic fertilizers, organic fertilizer is the best alternative. Organic fertilizer is certainly more environmentally friendly, easy to obtain, and inexpensive [2].

Eco-enzyme was discovered by an expert named Dr. Rosukon Poompanvong, a scientist from Thailand. *Eco-enzyme* is a liquid made from fermented fruit and vegetable waste mixed with molasses and water. It can fertilize and promote the growth of plants. Farmers can use eco-enzyme to enrich their soil so they can produce better and more environmentally friendly crops [3]. Liquid organic fertilizers like *eco-enzyme* contain micro and macro nutrients that plants need. In addition, using fruit peels, which have natural organic acids, as raw materials for eco-enzyme can increase the nutrient content in the solution [4]. The acid content in eco-enzyme is beneficial for the production of phytohormones (auxin, gibberellin, and cytokinin), which play a role in enhancing vegetative growth, generative growth, and fruit ripening. The use of fruit waste in the production of eco-enzyme is due to its enzyme content, which helps improve essential nutrients needed by plants, such as Nitrogen (N), Phosphorus (P), Potassium (K), vitamins, Calcium (Ca), Iron (Fe), Sodium (Na), Magnesium (Mg), and etc [5]. The production of eco-enzyme using pineapple peels, watermelon rinds, and orange peels as raw materials, based on their nutritional content, shows that pineapple peels contain relatively high amounts of carbohydrates and sugars. This makes them suitable to be used as raw materials for making fertilizer through a fermentation process. Organic fertilizer is beneficial for enriching the soil because it is made from organic materials such as animal manure and plant waste [6].

Based on this, this research can serve as an effort to provide an alternative to the use of organic fertilizers in addition to inorganic fertilizers on plants, by utilizing organic waste from pineapple peels, watermelon rinds, and orange peels, which are processed into eco-enzyme to serve as nutrients for cultivating water spinach (Ipomoea aquatica). The aim of this research is to determine the effects of eco-enzyme application on the growth of water spinach plants.

1. Water spinach *(Ipomoea aquatica)*

Water spinach *(Ipomoea aquatica)* is a plant classified as a vegetable and cultivated as a horticultural crop. However, water spinach can also grow wild in swamps and is even considered a weed because of its rapid growth. Water spinach is widely sold in markets. It is commonly found throughout Asia. Its country of origin is unknown, and it is a plant that can be found almost everywhere, especially in watery areas [7].

Table 1. Scientific classification of water spinach (*Ipomea aquatica)*

Kerajaan:	*Plantae*
Klad:	*Tracheophyta*
Klad:	*Angiospermae*
Klad:	*Eudikotil*
Klad:	*Asterid*
Ordo:	*Solanales*
Famili:	*Convolvulaceae*
Genus:	*Ipomoea*
Spesies:	***I. aquatica***

The morphology of the terrestrial water spinach plant consists of three main parts: the root (radix), stem (caulus), and leaf (folium). The vegetative organs of the plant are divided into two parts: those above the ground (stem and leaves) and those below the ground (roots). The characteristics of the root are that it does not contain chlorophyll, has no nodes, is without segments, and can branch out as well as produce buds. The tip of the root functions to absorb nutrients. The part of the root known as the embryonic root (radicle) penetrates the soil. On the stem, there are nodes (nodus) and internodes (internodus). The nodes on the stem can produce leaves, and in the leaf axils, branches or inflorescences can develop. Leaves are thin green blades that develop from leaf primordia located at each bud at the end of the stem [8].

2. *Eco-enzyme*

Eco-enzyme is the result of processing organic kitchen waste such as fruit and vegetable residues, combined with a sugar substrate (cane sugar or palm sugar) and water, which are then fermented [9]. The result of this fermentation is a dark brown liquid with a strong odor. *Eco-enzyme* adheres to the principles of green chemistry by using environmentally friendly materials sourced from renewable resources, such as domestic waste from vegetable residues and fruit peels. It can be used to increase efficiency in the use of synthetic chemicals as part of sustainable environmental protection, a practice usually applied in green chemistry. The production of *eco-enzyme* uses fermentation techniques. This fermentation involves leftover organic materials under anaerobic conditions, assisted by living organisms present in the organic matter itself. The process that occurs with *eco-enzyme* can reduce carbon dioxide (CO_2) in the atmosphere and trap heat in clouds by releasing ozone gas or O_3, ultimately reducing the greenhouse effect and global warming. In addition, eco-enzyme can convert ammonia into nitrate (NO_3), a natural hormone and plant nutrient, thus containing both macro and micronutrients, and can be used as a liquid organic fertilizer (LOF). *Eco-enzyme* contains substances such as acetic acid (H_3COOH), which can kill bacteria, germs, and viruses. The enzymes it contains include lipase, amylase, and trypsin, which are capable of preventing or eliminating pathogenic bacteria. Furthermore, *eco-enzyme* can produce NO_3 (Nitrate) and CO_3 (carbon trioxide), which serve as nutrients needed by the soil for plant growth.

II. Research Methods

Eco-enzyme is made using materials from various types of organic waste, namely pineapple peels, orange peels, and water spinach. The preparation of the *eco-enzyme* solution uses ingredients such as 10 kg of molasses, 30 kg of waste (organic materials), and 100 L of water that does not contain chlorine. The process of making *eco-enzyme* begins by first cutting all the organic waste materials, such as fruit and vegetable waste, into smaller pieces, then placing them into a reactor (plastic container) that has already been filled with water up to 60% of the container, after which molasses is added and all the ingredients are stirred until well mixed and homogeneous. The preparation container is tightly closed (anaerobic fermentation). The *eco-enzyme* solution is fermented for a minimum of 60 days before research is conducted, and afterward, it is harvested by filtering to separate the filtrate from the residue, and the *eco-enzyme* is then ready to be sampled for nutrient content testing.

Figure 1. The resulting *eco-enzyme* solution

The research was conducted at the Health Microbiology Laboratory, Environmental Health Study Program, Islamic University of Lamongan for nutrient testing. The parameters tested included pH levels using a digital pH meter, as well as the effectiveness of the eco-enzyme solution on the growth of water spinach, with observation indicators measured by the number of leaves, the fresh weight of the water spinach (grams), and the length of the water spinach plants (cm). The water spinach plants were initially planted in polybag pots with loose soil as the growing medium, and each was watered with 50 mL of water three times a day. The table below shows the variation design of the treatments in this research:

Table 2. Research design and treatment variations

Variation Code	*Eco-enzyme* solution concentration (mL)
P1	0% (Kontrol)
P2	5%
P3	7%
P4	10%
P5	15%
P6	17%

The research design above can be seen in the following image:

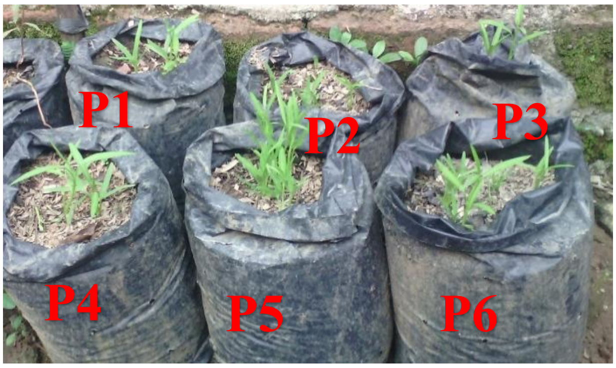

Figure 2. Treatment for water spinach plants (*Ipomea aquatica)*.

III. Results and Discussion

1. Plant height (cm)

The results of observations on the height of water spinach plants after measurement show that there is an effect of eco-enzyme solution application on the height of water spinach plants, which was observed every 5 days, as shown in the table below:

Table 3. Height of water spinach plants

Treatment	Length of water spinach (cm)				
	Day 3	**Day 8**	**Day 13**	**Day 18**	**Mean**
P1	0.5	5.8	7.5	8.2	5,5
P2	1	6.4	7.4	9.5	6,075
P3	1	7.2	8.9	9.5	6,65
P4	0.8	7.1	10	12.1	7,5
P5	1.1	7.9	10.2	12.5	7,925
P6	1	8	10.1	12.8	7,975

Based on the table above, the highest average height of water spinach plants was observed in treatment P6. The higher the concentration of *eco-enzyme* added to the water spinach (*Ipomea aquatica*), the taller the plants grew. However, on the 18th day, it was not yet time for harvest.

2. Wet weight (grams)

The results of the water spinach plant weight observations, measured using a digital scale, can be seen in table 4 below:

Table 4. Wet weight of water spinach plants

Treatment	Wet weight of water spinach(gram)				
	Day 3	**Day 8**	**Day 13**	**Day 18**	**Mean**
P1	9.8	21.2	31.6	48.5	27,775
P2	10.2	21.4	31.9	48.9	28,1
P3	10.4	21.7	32.4	49.2	28,425
P4	10.3	21.4	36.1	51.6	29,85
P5	10.9	22.1	36.8	52.4	30,55
P6	10.9	22.1	36.8	53.2	30,75

In Table 4, it is shown that the interaction of Eco-enzyme application affects the fresh weight per water spinach plant.

3. Number of leaves

The results of the weight measurements of water spinach plants using a digital scale can be seen in Table 4 below:

Table 5. Height of water spinach plants

Treatment	Number of leaves				
	Day 3	**Day 8**	**Day 13**	**Day 18**	**Mean**
P1	5	15	28	41	22,25
P2	6	16	26	42	22,5
P3	5	15	28	42	22,5
P4	6	16	28	44	23,5
P5	6	18	27	48	24,75
P6	6	18	28	49	25,25

In Table 5, it is shown that the application of Eco-enzyme has an effect on the number of leaves in water spinach plants. The increase in the height of a plant occurs due to the processes of cell division and elongation, which are predominantly concentrated at the tip of the plant's shoot. According Safitri *et. al.* [10] as the fertilizer dosage increases, there is a corresponding rise in plant height growth. This occurs because as the plant matures, its root system becomes more developed and complete, enabling the plant to absorb nutrients in the form of enzymes, as well as anions and cations, more effectively [11]. In this case, enzymes are essential and closely related to the yield potential of crops. Enzymes are used in the selection of crop production, in relation to the plant's nutrient status. Enzymes are the key to the synthesis pathways of compounds in plants. The addition of liquid organic fertilizer from agricultural waste, namely Eco-enzyme, contains the enzymes α-amylase, maltase, and protein-breaking enzymes. These enzymes function to break down starch compounds found in the food reserve endosperm into glucose compounds. Glucose serves as an energy source for plant growth. [12].

Amylase (Alpha-amylase) found in Eco-enzyme is an enzyme that catalyzes the hydrolysis of the alpha-1,4-glycosidic bonds of amylose starch to produce glucose. The working mechanism of the α-amylase enzyme consists of two stages: the first stage is the degradation of amylose into maltose and maltotriose, which occurs randomly. This degradation happens very quickly and is accompanied by a rapid decrease in viscosity. The second stage involves the formation of glucose and maltose as the final products in a non-random manner. Both are the actions of the α-amylase enzyme on the amylose molecule. On the amylopectin molecule, the action of α-amylase will produce glucose, maltose, and a series of α-limit dextrins, as well as oligosaccharides consisting of four or more glucose units containing α-1,6-glycosidic bonds [13]. Further details from Nurhayati [14] states that glucose is distributed throughout the plant's tissues, serving as food for the plant, which is then converted into energy. With this energy, the plant is able to grow and develop, including influencing its height until it becomes large enough to produce flowers, which then leads to the fruiting stage. For plants that do not bear fruit, glucose will still provide benefits, helping the plant become larger, denser, and stronger.

Research findings of Pramushinta [15], regarding the effect of pineapple peel eco-enzyme combined with water hyacinth on the growth of tomato plants (Lycopersicon esculentum L.) and chili plants (Capsicum annuum L.), it is stated that for chili plants, with increasing concentrations (0%, 4%, 8%, 12%), the results also increase in plant height, number of leaves, root length, and dry weight. The increase in plant weight is due to the ability of vermicompost to improve aggregate stability and increase the total porosity of the soil. The contribution of nutrients to the soil from the organic matter in the eco-enzyme stimulates increased photosynthesis, thereby increasing plant weight. The fresh weight of a plant consists of 70% water, with water as its main component, and the physical form of the growing medium also affects the plant's fresh weight. Plants more easily absorb nutrients if the texture and structure of the soil are good, so nutrients can be optimally utilized by the plants. The presence of micro and macro nutrients helps in the formation of leaf sheaths, and the element P acts as a raw material for the formation of certain proteins. Meanwhile, the element K is essential during vegetative growth, with only a small amount being absorbed into the fruit and seeds. The balanced availability of nutrients will affect the plant's metabolic processes. The elements P and K are required by plants for forming proteins, carbohydrates, and amino acids, which are the main components for plant cell growth and development, including cell division, enlargement, elongation, and differentiation. Through this process, plants are able to produce tillers, new leaves, flowers, branches, and new stems. The elements N, P, and K, which are crucial for the growth of leaf sheaths, are obtained from the eco-enzyme, with N (nitrogen) in the eco-enzyme present as NO3 (nitrate), which is a form of nitrogen readily absorbed by plants without the need for further conversion.

IV. Conclusion

The application of eco-enzyme solution affects all observed parameters, namely plant height, fresh weight, and the number of leaves of water spinach. The higher the concentration of the *eco-enzyme* solution added, the faster the growth of the water spinach plants (*Ipomea aquatica)*.

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VI. References

[1] U. A. Rahmah, "The Effect of Fermentation Time in the Production of Black Soldier Fly Frass Liquid Organic Fertilizer (LOF) on Nutrient Content," State Islamic University of Raden Intan Lampung, 2021.

[2] Y. H. Bertham, B. Gonggo, and K. Utami, "Increasing community knowledge in the application of organic and inorganic fertilizers for crop productivity," *JMM (Jurnal Masyarakat Mandiri)*, vol. 6, no. 4, pp. 2961–2972, 2022.

[3] Y. Hasanah, "Eco enzyme and its benefits for organic rice production and disinfectant," *Journal of Saintech Transfer*, vol. 3, no. 2, pp. 119–128, 2020.

[4 N. Benny, R. Shams, K. K. Dash, V. K. Pandey, and O. Bashir, "Recent trends in utilization of citrus fruits in production of eco-enzyme," *J Agric Food Res*, vol. 13, p. 100657, 2023.

[5] I. N. Muliarta and I. K. Darmawan, "Processing household organic waste into eco-enzyme as an effort to realize zero waste," *Agriwar Journal*, vol. 1, no. 1, pp. 6–11, 2021.

[6] T. Fadlilla, Mt. S. Budiastuti, and M. M. A. R. Rosariastuti, "Potential of fruit and vegetable waste as eco-enzyme fertilizer for plants," *Jurnal Penelitian Pendidikan IPA*, vol. 9, no. 4, pp. 2191–2200, 2023.

[7] J. E. Hapsari, C. Amri, and A. Suyanto, "The effectiveness of water spinach (Ipomoea aquatica) as phytoremediation in reducing lead (Pb) levels in batik wastewater," *Sanitasi: Jurnal Kesehatan Lingkungan*, vol. 9, no. 4, pp. 172–177, 2018.

[8] S. Khaidir, M. Murrukmihadi, and A. P. Kusuma, "Formulation of water spinach (Ipomoea aquatica F.) extract tablets with variations in cassava starch content as a disintegrant," *Jurnal Ilmiah Farmasi*, vol. 11, no. 1, pp. 1–8, 2015.

[9] M. Hemalatha and P. Visantini, "Potential use of eco-enzyme for the treatment of metal based effluent," in *IOP Conference Series: Materials Science and Engineering*, IOP Publishing, 2020, p. 012016.

[10] M. D. Safitri and K. F. Hidayat, "The Effect of Goat Manure Dose and Biofertilizer on the Growth and Yield of Corn (Zea mays L.)," *Jurnal Agrotek Tropika*, vol. 5, no. 2, pp. 75–79, 2017.

[11] Y. S. Alphiani, "The Effect of Vermicompost and NPK Mutiara 16:16:16 Fertilizers on the Growth and Yield of Celery (Apium graveolens L.)," *Dinamika Pertanian*, vol. 34, no. 3, pp. 275–286, 2018.

[12] H. Sudrajad, D. Suharto, and N. R. Wijaya, "The Effect of 2,4-D and Glucose on Ant Plant (Myrmecodia pendans) Callus," *Agrovigor: Jurnal Agroekoteknologi*, vol. 9, no. 2, pp. 118–124, 2016.

[13] M. Maisaroh, E. A. Setya, and N. Ngatirah, "Characteristics of glucose syrup based on palm heart with variations in α-amylase enzyme concentration and gelatinization temperature," *Teknologi Pangan: Media Informasi dan Komunikasi Ilmiah Teknologi Pertanian*, vol. 14, no. 2, pp. 211–220, 2023.

[14] D. Nurhayati, "Bioconversion of Cassava Peel Waste into Glucose Intermediate Products using Indigenous Bacteria Scwb-17 Producing Cellulase and Amylase Enzymes," Faculty of Mathematics and Natural Sciences, University of Lampung, 2020.

[15] I. A. K. Pramushinta, "The production of liquid organic fertilizer from pineapple peel waste and water hyacinth for tomato (Lycopersicon esculentum L.) and chili (Capsicum annuum L.) Aureus plants," *Journal Pharmasci (Journal of Pharmacy and Science)*, vol. 3, no. 2, pp. 37–40, 2018.