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ECO-ENZYME : LIQUID ORGANIC FERTILIZER ON THE GROWTH OF MUSTRAIN PLANTS (*Brassica chinensis*)

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ABSTRACT

Eco-enzyme is a mixture of organic fruit peel waste fermented with brown sugar and water. It can be used as an organic fertilizer. The research aims to discover how eco-enzymes help literacy and numeracy in the growth of mustard greens (Brassica chinensis). Eco-enzymes comprise 10:3:1: 10 liters of water, 3 kilograms of vegetable waste or fruit peels, and 1 kilogram of brown sugar. In a fifteen-liter plastic container, dissolve brown sugar in water. Then, add the skins and vegetable waste, cover tightly, and ferment for three months. Mustard seeds are sown and planted in polybags. Watering is done with water every day; watering with an eco-enzyme solution is carried out once every three days. The amount of eco-enzyme used is 0 ml, 7.5 ml, 15 ml, and 22.5 ml in one liter of water. The parameters measured for mustard plants are height (cm) and number of leaves (sheets). The research results showed that applying eco-enzymes as organic fertilizer at a concentration of 7.5 ml positively impacted the height and number of leaves of mustard plants but hurt eco-enzyme concentrations of 15 ml and 22.5 ml. Thus, it can be concluded that administering eco-enzymes as organic fertilizer provides the most effective effect at the level of 7.5 ml

INTRODUCTION

Eco-enzymes can be used to reduce household waste, especially kandu because they are made from organic kitchen waste, including sugar, fruit, and vegetable peels (brown, red, or sugar cane) and water (Mahali et al., 2022). Recycling organic and inorganic household waste is one way to protect the environment (Pujiati, 2018). One initiative to prevent environmental damage is recycling domestic waste into environmentally friendly enzymes through biological processing. Fermentation of organic waste, such as fruit and

vegetable peels, with sugar as a nutrient and molasses and water, produces Eco-enzymes (Prasetio *et al.,* 2021).

Fruit waste is a type of waste that can be reused. One of the most important foods for humans is fruit. Humans usually only use the skin of the fruit to make juice, jam, salad, and syrup. The skin is simply thrown into the trash. Piles of rubbish can cause diseases such as diarrhea, typhus, cholera, and fungus. Therefore, leather waste must be disposed of so as not to cause environmental and health problems (Naibaho et al., 2021).

Leather waste can be used as an alternative raw material for Eco-enzyme production. Eco-enzymes are multipurpose natural liquids from fruit and vegetable waste, sugar, and water. It is an antifungal, antibacterial, insecticide, fertilizer for plants, insect repellent, and cleaner. Organic fertilizer can be in solid or liquid form, and both are more effective than solid organic fertilizer (POP). Liquid organic fertilizer (POC) dissolves quickly in the soil. It has many advantages, such as being easy to make, not requiring a long time, being easily absorbed by plants, improving soil structure, and being easy to use.

The low level of waste management in Indonesia still needs to be a public concern. Because every household always produces organic and inorganic waste, households are one of the most significant sources of waste. Organic waste, such as fruit and vegetable peels, must be thrown away immediately because they rot quickly (Eskundari et al., 2023). Continuous dumping will increase environmental pollution and the amount of waste if there is no good management and processing. Therefore, waste must be managed, processed, and recycled to reduce the amount and make various useful and economically valuable products.

Eco-enzyme is a processing method, and eco-enzyme is another. It recycles household organic waste. This is a mixture of vegetable and fruit waste with sugar (molasses or palm sugar) for at least three months (Eskundari & Purwanto, 2023). The fermentation process involves mixing the waste with sugar and water in a container, stirring it regularly, and allowing it to ferment for the specified period. This process will produce a dark brown Eco-enzyme liquid with a distinctive sour and sweet aroma (Singh, 2019). Due to aromatic compounds with a pH <5, the Eco-enzyme solution has a fragrant odor and an acidic pH (Studi et al., 2022). In addition, the Eco-enzyme solution contains active substances (vitamins), microorganisms, and antioxidants. It can be used as a

cleaning or hand-washing liquid or as an environmentally friendly organic liquid fertilizer (Eskundari & Purwanto, 2023).

The type of waste most widely produced and easily found around us is organic waste because it can be recycled. The process of utilizing and processing organic waste includes converting it into Eco-enzyme. Eco-enzyme is a solution of complex organic substances made from the fermentation stages of organic waste, sugar, and water. This liquid is dark brown and has a distinctive sour and fresh aroma. Eco-Enzyme has many advantages, such as it can be used as a multifunctional cleaner, plant fertilizer, and pest repellent. For instance, it can be used to clean kitchen surfaces, as a natural fertilizer for home plants, or as a non-toxic pest repellent. They can also help keep the environment clean by neutralizing polluting smoke and air. The use of various organic materials produces eco-enzymes. Chemicals that convert organic waste into coenzymes are part of utilizing and processing organic waste. Eco-enzyme is a solution of complex organic substances made from the fermentation stages of organic waste, sugar, and water. Its characteristic is Eco-enzyme fluid. It is generally dark brown and has a strong aroma of sour and fresh. Eco-Enzyme has many advantages, such as it can be used as a multifunctional cleaner, plant fertilizer, and pest repellent. They can also help keep the environment clean by neutralizing polluting smoke and air. Eco-enzyme comes from using various organic ingredients, mainly from fruit and vegetables.

Eco-enzyme fertilizer products, which are environmentally friendly, can help farmers and cultivated land because they can reduce dependence on the use of inorganic fertilizers. Continuous use of inorganic fertilizers can also cause the soil to become less fertile and of poor quality (Nurnawati et al., 2022). It is hoped that Eco-enzyme liquid fertilizer can improve and improve plant growth due to the various nutrients contained in this solution. (Eskundari & Purwanto, 2023). With the help of Eco-enzyme, this liquid organic fertilizer can increase the growth of several plants, such as pak choy mustard greens. (Salsabila, n.d.), and kale (Ritonga & Anhar, 2022).

MATERIALS AND METHODS

Materials

Key materials for our research include Eco-enzymes, which are a blend of liquid fertilizer, *Brassica chinensis* seeds, vegetable waste, fruit peels, brown sugar, and water. The equipment used in the process includes scissors, knives, pipettes, buckets, 50x50 cm polybags, writing instruments, and 1.5-liter plastic bottles.

Research Procedure

The process of making Eco-enzymes is a meticulous one. It begins with the preparation of vegetable waste and fruit peels, which are then cut into small pieces. The mixture of brown sugar and water, in a ratio of 10:3:1, is carefully prepared in a 15-liter plastic container, followed by the addition of the remaining vegetables and fruit peels. The container is then tightly covered and protected from sunlight to initiate the fermentation process.

The fermentation process is thorough and carefully monitored. The mixture is left to ferment for three months, with the lid being opened to release any gas if the mixture expands. The bottles are opened and stirred in the first week, and in the second week, they are checked to ensure that fermentation is progressing well. This means that the bottle is free from mold, unpleasant odors, and maggots. After three months, the liquid fermentation mixture is carefully filtered to separate it from the solid, resulting in a high-quality, environmentally friendly solution.

The research was carried out using three treatments, each with a different concentration of eco-enzyme solution. The growth of *Brassica chinensis* was observed for nine days. *Brassica chinensis* seeds are sown and planted in a planting medium containing soil, such as a polybag. The Eco-enzyme solution is used for watering every three days and is done daily. A is 0 milliliters of Eco-enzyme in 1 liter of water, B is 7.5 milliliters of Eco-enzyme in 1 liter of water, C is 15 milliliters of Eco-enzyme in 1 liter of water, and D is 22.5 milliliters of Eco-enzyme in 1 liter of water for control. Once every three days, The morphology of *Brassica chinensis* was observed by measuring the height (in cm) and the number of leaves (strands) using a measuring ruler.

Statistic analysis

Brassica chinensis growth data obtained were analyzed using descriptive statistics, which aims to describe a situation objectively.

RESULTS AND DISCUSSION

The effect of Eco-enzymes as liquid fertilizer on the height and number of leaves of *Brassica chinensis* can be seen in Table 1.

Table 1. Plant height measurement

Observation/day	Ecoenzyme treatment (ml)			
	0	7.5	15	22.5
1	0	0	0	0
2	2	2	1	2,5
3	5	7	6	6
4	6	9	8	8
5	8	11	10	0
6	10	13	12	0
7	13	16	14	0
8	14	20	17	0
9	15	25	21	0
Amount	73	103	89	14
Average	8.11	11.44	9.89	1.75

Table 1 shows that the results of measuring plant height in the positive control (not given Eco-enzymes) had a height of 8,11 cm, a concentration of 7,5 ml, a plant height of 11,44 cm, a concentration of 15 ml, a plant height of 9,89 ml, a plant height of 1,75 cm, the research results show at a concentration of 7,5 ml it is more effective on plant growth. Table 1 shows that *Brassica chinensis* experienced high growth with three treatments, each showing significantly different results. The proper nutrients will quickly enter the root tissue, allowing optimal growth and development (Rohmah et al., 2016). Nitrogen, the primary nutrient, is responsible for plant height growth. Suppose the N element is in sufficient quantities in the planting medium used. In that case, photosynthesis runs smoothly and produces a lot of photosynthesis, which leads to an increase in plant height. The amount of sunlight plants receive also affects plant height (Nugroho, 2015).

The results of measuring *Brassica chinensis'*s leaves can be seen in **Table 2**.

Table 2. Measurement of Number of Leaves

Observation/day	Ecoenzyme treatment (ml)			
	0	7,5	15	22,5
1	0	0	0	0
2	2	2	2	2
3	3	4	4	3
4	4	6	6	3
5	5	8	7	0
6	6	10	8	0
7	7	11	9	0
8	8	12	10	0
9	9	14	12	0
Amount	44	67	58	8
Average	4,89	7,44	6,44	0,89

Table 2 shows that the results of measuring the number of leaves of *Brassica chinensis* in the positive control (not given Eco-enzymes) had an average number of leaves of 4,89, a concentration of 7,5 ml, an average number of leaves of 7,44, a concentration of 15 ml, an average number of leaves of 6, 4 and the average number of leaves at a concentration of 22.5 ml was 0.89. The research results unequivocally showed that a concentration of 7,5 ml was significantly more effective in increasing the number of leaves, namely 7,44, instilling confidence in the effectiveness of this concentration.

The nutritional content of the Eco-enzyme is said to contain the elements Nitrogen (N) and Molybdate (Mo) (Wiryono et al., 2021). The nitrogen (N) element in plants helps accelerate the growth of leaves and stems because plant roots absorb nitrogen in NO3- and NH4- (Wiryono et al., 2021). It's important to note that the number of leaves is also influenced by external factors such as sunlight, temperature, and humidity, adding a layer of complexity to plant growth.

The research results consist of Eco-enzyme solutions and nutrient quality. The levels of N, P, and K in Eco-enzymes are included in this quality. Eco-enzymes are a mixture of vegetable waste, fruit waste, brown sugar, and water. The resulting solution is orange-brown, has a sweet and sour aroma, and has a pH of 3.33. The nutrient quality of the Eco-enzyme solutions is further analyzed in Table 3, providing a detailed breakdown of the N, P, and K levels and their potential impact on plant growth.

Table 3. Results of ecoenzyme nutrient quality tests

No	Parameter	Nutrient analysis results (%)	Comparative Level (%)	Criteria
1	Nitrogen (N)	0,07	<0,10	Very low
2	Fosfor (P)	0,04	<0,1	Very low
3	Kalium (K)	0,004	<0,1	Very low

Table 3 displays the results of the test analysis for the nutrient content N of 0.07%, P of 0.04%, and K of 0.004%. These results reveal a concerning issue-the three nutrients are included in the very low criteria. The results of measuring plant height and number of leaves are shown in **Figure 1**.

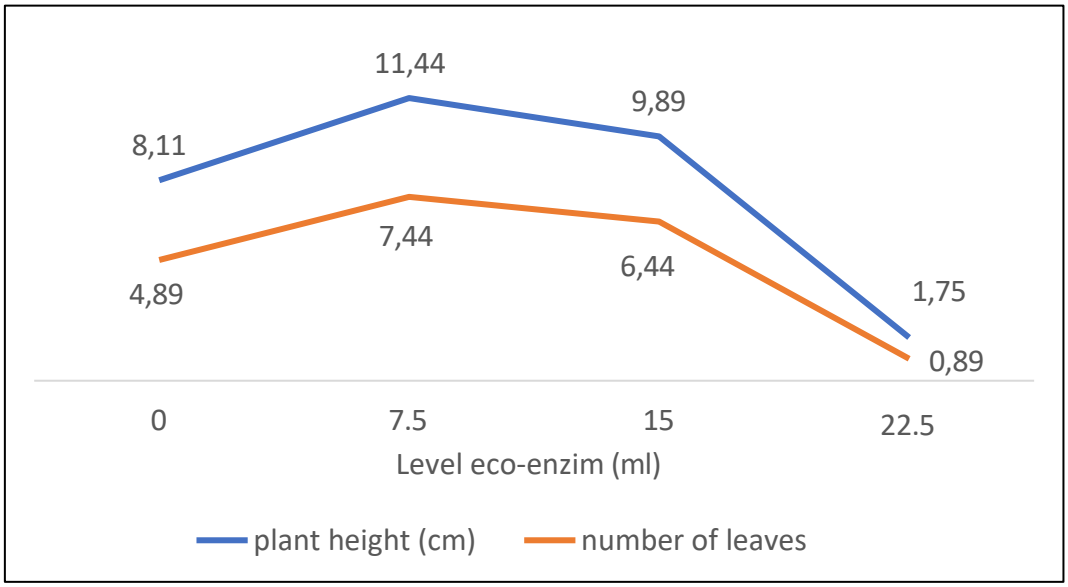

Figure 1. Plant height (cm) and number of mustard leaves (strands) given ecoenzyme organic liquid fertilizer varied..

Make Eco-enzymes, brown sugar, fruit peels, and water are used. Brown sugar was chosen because it does not contain bleaching (bleaching) chemical residues and is more energetic than white sugar (Surtikanti et al., 2021). Sugar functions as carbon, which helps microorganisms produce energy, and as a substrate for the fermentation process that produces alcohol (Low et al., 2021; Mallikarjuna & Balasubramanyam, 2021). Fruit peels use natural organic acids as a source of organic material to be processed into an enzyme solution. (Rasit & Mohammad, 2018). Microorganisms make liquid Ecoenzymes using air, a final product that is easier to use. (Yulistia & Chimayati, 2021).

Through a fascinating process of fermentation, microorganisms transform organic materials such as carbohydrates, proteins, mineral salts, and organic acids from fruit peel waste. (Nazim & Meera, 2021) The main principle of fermentation is to activate these microorganisms to break down the organic material in the fruit skin, turning it into simple

compounds. This intricate process produces Eco-enzymes that plants can absorb more easily, a testament to the intricate balance of nature.

The research results showed that giving Eco-enzymes as organic fertilizer at a level of 7,5 milliliters increased the growth and number of *Brassica chinensis'*s leaves, while giving it at 15 milliliters slowed plant growth, and many plants even died. Giving 22,5 milliliters of Eco-enzyme resulted in a decrease in the development and number of *Brassica chinensis'*s leaves. Still, the nutrient content in the eco-enzyme of 7,5 milliliters increased the growth and number of *Brassica chinensis'*s leaves.

Nitrogen (N), phosphorus (P), and potassium (K) are crucial nutrients for plant growth and are found in Eco-enzymes. Nitrogen is vital for vegetative growth, protein formation, chlorophyll, and nucleic acids, making it a must-have for plants (Rahmah, 2018). This information is key to understanding the nutritional needs of plants and the role of Eco-enzymes in meeting these needs.

Phosphorus (P) can encourage root development, flower emergence, fruit ripening, and seed formation, and it plays a vital role in storing and distributing energy to all plant cells. According to Jalaluddin and Syafrina (2017) and Suwardiyono and Harianingsih (2017), Potassium (K) helps plant vegetative growth by increasing the transport of assimilates, regulating the opening and closing of stomata to reduce water consumption, and increasing plant immunity to prevent pests or diseases from attacking (Mahdiannoor et al. al., 2016).

In this research, we found that different concentrations of Eco-enzymes, made from vegetable and fruit waste as liquid organic fertilizer, can have a significant influence on various *Brassica chinensis'*s growth parameters, such as plant height and the number of leaves. This highlights the importance of carefully considering the concentration of Eco-enzymes used, as it can greatly affect plant growth.

Cell formation, division, and cell elongation are part of leaf growth and development. These processes are driven by compounds such as proteins and carbohydrates. Nitrogen, a protein-forming component, forms chlorophyll for photosynthesis, which triggers the formation and growth of leaves (Pramushinta & Yulian, 2020).

By producing enzymes that accelerate plant growth, produce dry matter and leaves, stimulate branch growth, and increase the number of tillers, plants that receive an

adequate supply of nitrogen (N) can improve the structure of plant vegetative growth. Plants that receive an adequate supply of nitrogen (N) will form leaves that have wider blades and contain more chlorophyll, allowing plants to produce large amounts of assimilate to support vegetative growth (NASA, 2020) states that when sufficient nutrients are available during plant growth, photosynthesis will be carried out more quickly and perfectly, which helps the formation of carbohydrates, fats, and proteins run smoothly, which helps increase plant height, number of leaves and leaf area. (Nanda et al., 2022) states that photosynthesis will run smoothly with sufficient nutrients, and assimilation can spread throughout the plant, increasing the fresh weight of the plant. In this research, different concentrations of Eco-enzymes made from vegetable and fruit waste as liquid organic fertilizer can influence different *Brassica chinensis'*s growth parameters, such as plant height and the number of leaves.

CONCLUSION

Providing eco-enzymes as an organic fertilizer has the best effect at a level of 7.5 ml, which can offer optimal vegetative growth (plant height and the number of leaves) for *Brassica chinensiss* in polybags.

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