

## Analysis of the Quality of Ecoenzymes and Their Effect on the Growth of Mustard Greens (*Brassica juncea* L.)

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### ABSTRACT

Making ecoenzymes is one of the solutions to reduce the quantity of organic waste which has been increasing lately. Ecoenzymes are liquid extract products produced from fermentation of vegetable and fruit residues with brown sugar or molasses as a substrate. Types of vegetables and fruits used as ecoenzyme ingredients can affect the levels of minerals or nutrients contained in ecoenzymes. Information about this will be an important consideration in the process of making ecoenzymes as Liquid Organic Fertilizer. This study aims to determine the quality of ecoenzymes from fruit and vegetable combinations, and to determine the effect of ecoenzymes on the periodic growth of mustard plants. Analysis of the quality of ecoenzymes was carried out through physical and chemical observations using laboratory tests, while analysis of the effect of ecoenzymes was carried out quantitatively by statistical tests using the SPSS application. The results showed that the ecoenzyme liquid contains macro nutrients (N, P, and K), and has a significant effect on the growth parameters of mustard plants.

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## 1. INTRODUCTION

The waste problem has become an important global issue to be noticed recently, especially in Indonesia. Garbage is material that comes from the results of human activities or from nature which does not yet have economic value and its presence tends to disrupt and reduce the quality of life of the community. Therefore, waste management is not only a matter for the government, but its handling requires broad community participation (Defitri, 2023).

The amount of waste in Indonesia continues to increase every year in line with increasing population, economic activities, population activities, and shifts in people's lifestyles that tend to be consumptive. Households contribute 42.23% to the total national waste of 21.88 million tons in 2021 (Mahdi, 2022). Based on data from the Ministry of Environment and Forestry, the composition of waste in Indonesia is dominated by organic waste, which reaches 60% of the total waste (Widowati, 2019). Organic waste that is not managed properly can cause unpleasant odors, interfere with aesthetics, become a breeding ground for microbes or disease vectors and rodents, reduce plastic recycling rates, produce methane gas and have the risk of causing an explosion at the Final Disposal Site. Therefore, efforts to overcome the negative impacts of organic waste are still needed.

One alternative solution that can be done in order to reduce the amount of organic waste is by change it become useful products, including by processing it into ecoenzymes. Ecoenzymes are liquid extract products produced from fermented vegetable and fruit waste using brown sugar or molasses as a substrate. Ecoenzyme is an environmentally friendly product that is very easy to make and has many benefits, such as being used as liquid organic fertilizer for plants, as an ingredient in detergent floor cleaners, pesticide residue cleaners, scale cleaners, lowering the temperature of car radiators, and has several medical benefits for humans (Supriyani *et al*, 2020).

In this study, the authors took the initiative to utilize ecoenzymes as Liquid Organic Fertilizer which can be applied to the cultivation of mustard greens (*Brassica juncea* L.). Climatologically, technically, and economically, mustard is a type of vegetable that has good potential to be cultivated in Indonesia (Sarif *et al*, 2015). Community demand for mustard greens also continues to increase in line with increasing population and public awareness of the importance of nutrition. The results of Hermansyah *et al* (2021) research showed that the predicted trend of estimated consumption of mustard greens in 2020 to 2029 tends to increase based on the analysis of the least squares method.

The types of vegetables and fruit used in the manufacture of ecoenzymes will affect the mineral or nutrient content in the ecoenzymes. Information about this is very important to know, especially in the manufacture of ecoenzymes with the main purpose as Liquid Organic Fertilizer. Therefore, the author took the initiative to make ecoenzymes from a combination of fruits and vegetables, as well as to conduct laboratory analysis to ensure the nutrient content in them, especially the content of macronutrients (Nitrogen/N, Phosphorus/P, and Potassium/K). Then, the author will examine the effect of these ecoenzymes on the growth of mustard plants. The results of this research are expected to bring benefits to handle the accumulation of organic waste, can be information for various parties who need quality, environmentally friendly Liquid Organic Fertilizer, and can be an alternative fertilizer which can change the chemical fertilizers.

## 2. RESEARCH METHOD

This research was divided into several main activities, among others; (1). Making ecoenzymes from a combination of vegetables and fruit and laboratory tests of ecoenzyme samples (Septiani et al., 2021) (2). Test the effect of ecoenzymes on mustard cultivation, and (3) Analysis of research data. The materials needed in this research, among others; well water, label paper, vegetables and fruits (chayote, watermelon, and apples), molasses, mustard seed, and soil. While the equipment used includes: knife (merk: Stein), plastic jar (merk: Lion Star), stirrer, bottle of mineral water, sprayer (merk: Rain), ruler, measuring cup, scales (merk: Camry), camera of hand phone (Realme UI 3.0), stationery, and a 25×30 cm poly bag.

The step for making ecoenzymes begins with providing 10 parts of water, with a volume of water equal to 60% of the volume of the container used. Then, put the molasses into 1 part of the water and stir until smooth, followed by adding 3 parts of the vegetable and fruit combination waste. Then close the jar or container and leave it for ten days. The first observation was made on the 10th day after closing the container because at this time the temperature of the solution usually increases, so it needs to be opened to prevent the ecoenzyme solution from detonating. Subsequent observations were made at the 1st month, 2nd month, and 3rd month after closing the container. The ripe ecoenzyme is characterized by its characteristically fragrant aroma of fermentation and brownish color. Furthermore, the ecoenzyme solution can be filtered or separated from the raw material, resulting liquid organic fertilizer. Parameters observed at this stage include; ecoenzyme liquid color, pH, temperature, viscosity, presence of fungi and bacteria, aroma, and macronutrient content (N, P, and K).

Then, the liquid organic fertilizer applied to the cultivation of mustard green plants, with the following procedure: 1). Sow the mustard green seeds until the mustard seeds grow with a minimum number of 3 leaves (about 2 weeks after sowing); 2). Prepare polybags that have been filled with soil; 3). Put mustard seeds into polybags and arrange polybags according to treatment.

This study consisted of several ecoenzyme concentration treatments, including; negative control (without ecoenzyme application), positive control with application of chemical fertilizer (NPK, 30 g/15 liter), 25% ecoenzyme, 50% ecoenzyme, 75% ecoenzyme, and 100% ecoenzyme.

Mustard plant growth was observed periodically once a week until harvest time (4 weeks). Parameters observed, among others; plant height (m), number of leaves (strands), leaf area (m<sup>2</sup>), except for the parameters of root length (m), fresh weight (kilo grams), and dry weight (kilo grams) were only observed in the 4<sup>th</sup> week (at harvest). Then, the research data were analyzed using the Anova test through the SPSS program.

## 3. RESULT AND DISCUSSION

The production of ecoenzymes in this study went well, was not contaminated by harmful fungi or bacteria, and was able to produce good quality liquids (Figure 1).



Figure 1. (A). The condition of the ecoenzyme solution on the 30th day; (B). Ecoenzyme liquid results of filtering process (already separated from the raw material)

The process of making ecoenzymes require a relatively long range of time (3 months), but the resulting liquid has many benefits (Gultom *et al*, 2022). Ecoenzyme liquid that has been finished or cooked is usually characterized by its brownish color, smells like typical fermented alcohol, does not smell bad, is not slimy, pH is below 4, and sometimes a mushroom layer or jelly-like layer appears, but this type of fungus does not damage the quality of the ecoenzyme. The fungal layer is a bonus that does not always appear in the manufacture of ecoenzymes and is usually known as "Mama Enzyme". Mama Enzyme has several benefits, including being used as a face mask, covering wounds, and reducing fever (Poompanvong *et al*, 2020).

The ecoenzymes produced in this study met the criteria for success in making ecoenzymes, although they did not produce mama enzymes. This ecoenzyme liquid was then tested in the laboratory to determine the macro-nutrient content in it. The physical and chemical qualities of the ecoenzymes in this study are detailed in Table 1 as follows.

Table 1. Qualitative Ecoenzyme Analysis Results

Parameters	Result of Ecoenzymes Characters
Liquid Color	Clear Brownish
pH	3,5
Viscosity Level	Not thick
The presence of fungi or bacteria	There was not
Aroma	Like alcohol, typical of fermentation
The Content of Nitrogen/N	0,02
The Content of Phosfor/P <sub>2</sub> O <sub>5</sub>	0,00025
The Content of Kalium/K <sub>2</sub> O	0,0012

The results of chemical tests in the laboratory showed that the pH of the ecoenzyme produced in this study was 3.5, and the total content of N, P, and K was 0.02145. Low pH levels in ecoenzymes were caused by high organic acid content (Viza, 2022). Organic acids in ecoenzymes are acetic acid and lactic acid (Samriti, Sajal, S., and Arti, 2019). The higher the organic acid content, the lower the pH of the ecoenzymes (Rasit *et al*, 2019). Ecoenzyme pH levels below 4 actually did not met with the Indonesian National Standard for Liquid Organic Fertilizer. The pH level according to SNI quality standards should be in the range of 4-9 (Kepmen Pertanian, 2019). Therefore, in subsequent studies the application of ecoenzyme POC was carried out by diluting it into several concentrations as a treatment. This dilution can reduce the acidity of the ecoenzyme Liquid Organic Fertilizer.

Based on the table above, the content of macro nutrients (N, P, and K) of eco enzymes is not in accordance with the minimum standards of SNI liquid organic fertilizer (Kepmen Pertanian, 2019), so in this study a test was carried out in mustard cultivation to determine the effects of eco enzyme fertilizer on mustard green growth. The results of the application of ecoenzymes in the cultivation of mustard green plants showed a significant effect on all research parameters. In terms of plant height parameters, the application of ecoenzymes had a significant effect on each growth period, except for the 2nd week. In the first week, 100% ecoenzyme treatment produced the best effect and was significantly different on plant height compared to other treatments. In week 3, 100% ecoenzyme treatment still had the best effect and was significantly different from other treatments. At this stage, the control treatment (without fertilization) showed the lowest results among the other treatments. At week 4, the ecoenzyme treatment of 75%, 100%, and application of chemical fertilizers showed results that were not significantly different and had the best effect on plant height compared to other treatments (Figure 2).

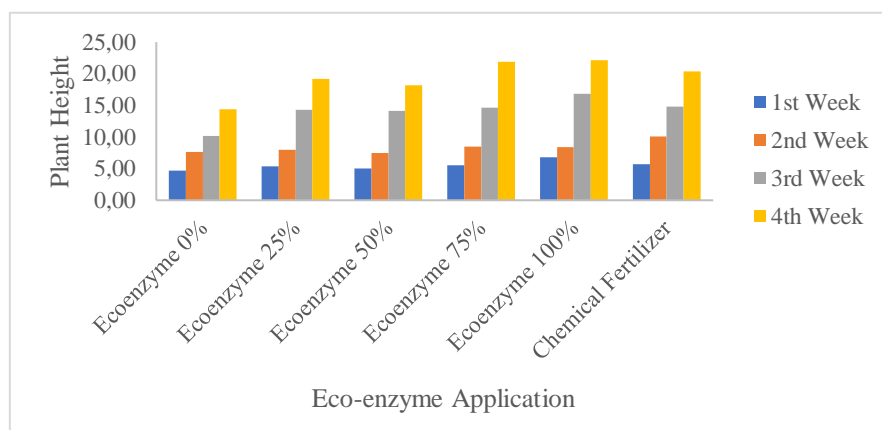


Figure 2. Effect of ecoenzyme treatment on mustard green plant height every week

Based on Figure 2. above, it can be seen that the application of ecoenzyme Liquid Organic Fertilizer doses of 75% and 100% can replace the application of chemical fertilizers. Even though the macro nutrients (N, P, K) contained in ecoenzyme liquid organic fertilizer in this research are relatively small, they are capable of increasing the growth parameters of green mustard plants. This can be caused because liquid organic fertilizer is more easily absorbed by plants because of the elements inside is decomposed. Liquid organic fertilizer can improve its physical, chemical and chemical properties soil biology, can also help increase crop production and reduce the use of fertilizers inorganic substances that can damage soil quality (Kasmawati *et al.*, 2023). In addition, liquid ecoenzyme liquid organic fertilizer does not only contain macro nutrients, but also micro nutrients and other nutrients needed for the growth of mustard plants. The results obtained in this study are in line with the research results of Salsabila & Winarsih (2023) which showed that the application of ecoenzyme liquid organic fertilizer with low levels of N, P and K actually had a significant effect on all observed parameters of pakcoy mustard and the results were better than the control treatment.

Apart from being safe and environmentally friendly, ecoenzymes contain nutrients, compounds, and hormones which play an important role in plant growth and development (Rijal *et al.*, 2021). The levels of nutrients contained in ecoenzymes were influenced by the type of organic waste that was processed into ecoenzymes. The results of the study by Lumbanraja *et al.* (2021) also showed that the application of ecoenzyme fertilizer combined with SP-36 fertilizer has a significant effect on the height of mustard plants. Ecoenzymes also produced the enzymes lipase, cellulose, invertase, lactase, tannase, trypsin, and amylase which can help increase the fertility of the planting medium (soil). In addition, nitrate (NO<sup>3</sup>) and Carbonate (CO<sup>3</sup>) contained in ecoenzymes were needed as nutrients for plants (Rochyani *et al.*, 2020).

Meanwhile, the effect on the number of leaves of the eco-enzyme application was only visible in the 3rd and 4th weeks. In the 3rd and 4th weeks, the 100% ecoenzyme treatment showed significantly different results from the other treatments and gave the best response to the number of leaves (Figure 3.).

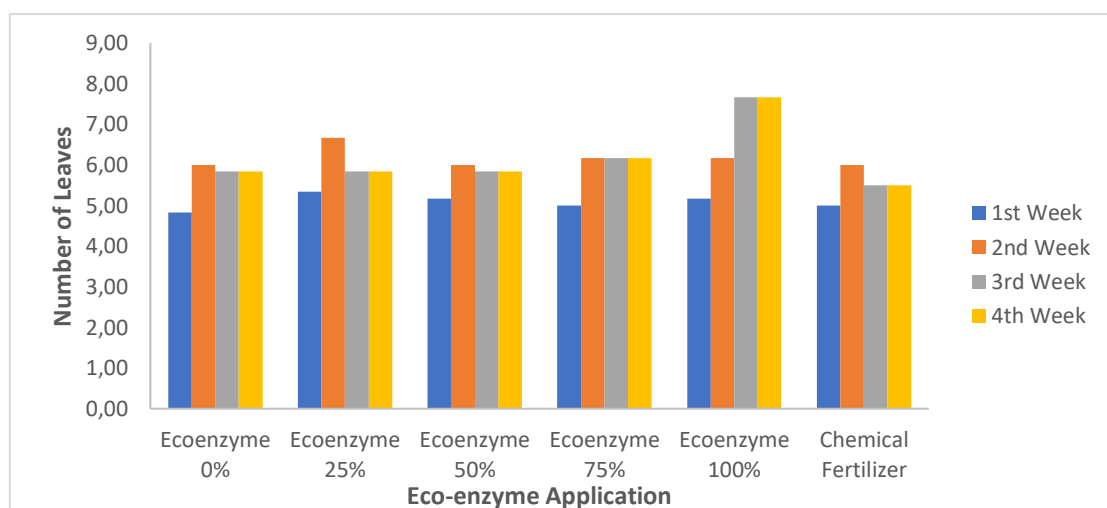


Figure 3. The effect of ecoenzyme treatment on the number of leaves of mustard green plants every week

Figure 3 above showed that the application of 100% ecoenzyme gave the highest number of leaves compared to other treatments. This was supporting data proving that the application of ecoenzymes can replace the application of chemical fertilizers. Nitrogen (N) in the ecoenzyme Liquid Organic Fertilizer can be absorbed by plants in the form of nitrate (NO<sup>3</sup>) and a good supply of N in plants can accelerated the rate of vegetative growth in plants, both in stems, branches, as well as the number and size of leaves. In addition, these nutrients can encouraged an increase in chlorophyll synthesis in plant tissues, so that photosynthetic activity and carbohydrates from photosynthesis can increased (Azis and Nani, 2015).

On the leaf area parameter, the effect of ecoenzyme application can be observed in the 4th week. The results of Duncan's further test (Table 2.) showed that the ecoenzyme treatment of 75% gave the best response to leaf area compared to other treatments. The ecoenzyme treatment of 100% gave the higher leaf number than chemical fertilizer treatment. This was in line with the results of the research by Wiryono *et al.* (2021) which showed that providing ecoenzyme nutrition with a 100% concentration had an effect on the formation of leaves on mustard green plants.

Table 2. The Results of Duncan's Further Test on the Observation Parameters

Paramaters						
Treatments	Plant Height	Number of Leaves	Leaf Area	Root Length	Wet Weight	Dry Weight
Ecoenzyme 0%	14.4167 <sup>a</sup>	5.5000 <sup>a</sup>	4.3333 <sup>a</sup>	5.5833 <sup>a</sup>	4.8333 <sup>a</sup>	1.3333 <sup>a</sup>
Ecoenzyme 25%	19.1667 <sup>b</sup>	5.8333 <sup>a</sup>	5.0000 <sup>b</sup>	5.9167 <sup>a</sup>	7.5000 <sup>c</sup>	1.8333 <sup>a</sup>
Ecoenzyme 50%	18.1667 <sup>b</sup>	5.8333 <sup>a</sup>	4.8333 <sup>a</sup>	5.7500 <sup>a</sup>	6.3333 <sup>b</sup>	2.0000 <sup>b</sup>
Ecoenzyme 75%	21.9167 <sup>c</sup>	6.1667 <sup>b</sup>	6.0000 <sup>c</sup>	6.8333 <sup>b</sup>	9.1667 <sup>d</sup>	2.3333 <sup>b</sup>
Ecoenzyme 100%	22.1667 <sup>c</sup>	7.6667 <sup>c</sup>	5.9167 <sup>b</sup>	7.8333 <sup>c</sup>	13.1667 <sup>e</sup>	2.8333 <sup>b</sup>
Chemical Fertilizer	20.3333 <sup>c</sup>	5.8333 <sup>a</sup>	4.9167 <sup>a</sup>	6.4167 <sup>b</sup>	6.5000 <sup>b</sup>	1.1667 <sup>a</sup>

Note: Numbers followed by the same letters indicate results which is not significantly different.

On the root length parameter, the application of ecoenzymes also had a significant effect. The results of Duncan's further test above showed that the ecoenzyme treatment of 100% gave the best effect on root length compared to other treatments. Root growth was affected by the presence of the nutrient Phosphorus (P). Long roots will make it easier for plants to get the water and nutrients they need during growth and development (Rahmawati *et al.*, 2018).

The application of ecoenzymes also had a significant effect on the wet weight and dry weight of the mustard green plants. The results of Duncan's further test on the wet weight parameter showed that the ecoenzyme treatment of 100% gave the best effect on the fresh weight of mustard green plants compared to other treatments. Whereas in the dry weight parameter, ecoenzyme treatments of 50%, 75%, and 100% showed no significant different results and gave the best response. Meanwhile, the application of chemical fertilizers resulted in the lowest dry weight compared to 50%, 75%, and 100% treatments. Based on the results of this research, it can be seen that the application of eco-enzyme liquid organic fertilizer gave better results than the application of chemical fertilizer in most observations, except for plant height parameters where the results were the same as the application of 75% and 100% eco-enzyme. So, the application of eco-enzyme liquid organic fertilizer can be a substitute for the application of chemical fertilizer in mustard green cultivation.

#### 4. CONCLUSION

This research produced ecoenzymes that have good physical and chemical qualities, and contain macro nutrients, namely; Nitrogen (N), Phosphorus (P), and Potassium (K). Based on statistical data analysis, the application of ecoenzymes in mustard green cultivation showed significantly different results for all observed parameters. Ecoenzyme liquid organic fertilizer can also be a substitute for the use of chemical fertilizers.

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