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Organic Fertilizer from Amino Acid and Eco-Enzyme Combinations for Repairing Plant Metabolism

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Abstract—At Gadog Fresh, eco-enzymes and amino acids are the revolutionary combination of liquid organic fertilizers used to attain a zero-waste lifestyle. This research determined the effect of various liquid organic fertilizers on improving the metabolism of leek plants. This research was conducted at the Gadog Farm. The method applied liquid organic fertilizers from eco-enzymes and chicken eggs in the treatment labeled K, P1, P2, and P3 with various doses of 0.0; 2.5; 5.0; and 7.5 mL/L into spring onions. It was applied as much as 250 mL four times every seven days. The results obtained were plant height, namely 36.45; 47.63; 41.52; 42.62; stem diameter 7.30; 8.92; 10.42; 9.42; and dry weight percent 7.07; 7.38; 9.05; 7.09. The increase in height, diameter, and dry weight showed that liquid organic fertilizer applications improved the metabolism of leek plants. However, variations in the concentration of liquid organic fertilizer did not significantly affect all research points.

Keywords—Amino acid; Eco-enzyme; Fertilizer; Liquid organic; and Metabolism.

1. INTRODUCTION

Liquid Organic Fertilizer (LOF) is more easily absorbed by plant roots than fertilizers in solid form. Available nutrients in liquid organic fertilizers are optimally utilized by plants for better effects [1]. Since the establishment of the plant-mineral nutritional theory, little attention has been paid to the contribution of amino acids in the soil as nitrogen sources for plants [2]. Some soil ecosystems have limited amounts of inorganic nitrogen. In forests, grasslands, and arctic or less fertile soils, amino acids are the predominant N-form [3], and plant roots tend to absorb organic rather than inorganic nitrogen [4].

Nutrients, such as nitrogen (N), can increase shoot growth, stem growth, and leaves, while phosphorus (P) increases the biomass of growing roots, fruits, and seeds. Potassium (K) can enhance plant immunity from disturbance and attack pests and diseases [5]. Processing waste into liquid organic fertilizer usually uses fermentation technology using microorganisms in the form of bacteria. The manufacturing of liquid organic fertilizer involves providing equipment to produce liquid organic fertilizer, providing raw materials, mixing all the ingredients, and fermenting it for two weeks until it is ready to use [6].

Eco-enzyme is a multifunctional liquid made from lean organic matter through an anaerobic fermentation process. The eco-enzyme has light to dark brown and slightly sour odor. Eco-enzymes are made from fruit or leaf waste. During fermentation, brown sugar is a source of carbon and nutrients for microorganisms to break down organic matter into simpler ones. Eco-enzyme products are environmentally friendly products that are highly functional, easy to use, and easy to manufacture. Making eco-enzymes requires fruit or vegetable residue, water, and sugar. Eco-enzyme is the same as a type of homebrew vinegar reduced from alcohol by fermenting kitchen waste as a substrate with sugar. The raw material for making eco-enzymes is waste from vegetables and fruits. Differences in raw materials will certainly have a different effect on the results of the conversion process carried out. Microbes use added sugars as nutrients. The eco-enzyme works as an antifungal, antibacterial, and insecticidal agent.

Gadog Farm, a company on the plantation, has used

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zero-waste product guidelines. In developing this program, Gadog Farm has used crop residues and other waste products as fertilizers and insecticides, one of which is in the form of eco-enzyme fermentation. The concentration of eco-enzyme formulas with nitrogen or amino acid sources to become a liquid organic fertilizer is the main objective in the research and development section. In providing information, this study aims to determine the concentration of organic fertilizers capable of increasing growth metabolism in leek plants. Leek is used in this research because it can provide results and is easy to plant [7]. Leeks are a type of seasonal leaf vegetable plant (short-lived).

2. EXPERIMENTAL SECTION

This research was conducted at the Gadog Farm for four months. This research was divided into three stages: making eco-enzymes, combining eco-enzymes with eggs, and applying them to lake plants.

2.1. Materials

Materials used in this work were pineapple, papaya, orange, melon, custard apple, sugar (Gulaku), egg (Gadog Farm), water, compost (handmade Gadog Farm), and phosphate fertilizer (Fertiphos).

2.2. Instrumentations

Instrument used in this research is pH meter (Hanna), TDS meter (Hanna), EC meter (Hanna), and Oven (Rastar).

2.3. Procedures

This research contained physical and chemical examinations. Physical examinations included plant height and diameter. The chemical examinations were total dissolved organic using EC and TDS meters, calculation of pH, and water content in leek plants.

2.3.1. Eco-enzyme

The production of an eco-enzyme from fruit uses the remaining, unsellable production. The total weight of fruit as organic matter was 30 kg, consisting of pineapple, papaya, orange, custard apple, and melon was 5 : 3 : 2 : 1 : 1. The fruits were mixed with 10 kg sugar and 100 L of water. The resulting mixture was closed for fermentation for 90 days. After the eco enzyme was completed, the sample was taken to check the pH and total dissolved liquid.

2.3.2. Liquid organic fertilizer

Two kg of eggs were crushed (shell and contents) until they became liquid eggs. The eco enzyme was mixed with eggs in a volume ratio of 6:4. Re-fermented for two weeks before being applied to plants. After the liquid organic fertilizer was finished, the sample was taken to check the pH and total dissolved liquid.

2.3.3. Application

Before treatment, 50 green onion plants had been grown by providing fertilizers, namely 250 g of compost and 25 g of phosphate fertilizer. Plants were grown in polybags for two weeks. Leek plants were divided into four groups, then labeled K, P1, P2, and P3. This group was distinguished based on the concentration of organic fertilizer solution, respectively 0; 2.5; 5.0; and 7.5 mL/L. This liquid organic fertilizer was given as much as 250 mL, four times at intervals of 7 days.

2.3.4. Evaluation

Leek, which had been treated, examined physiologically and chemically. Physiologically, plant height and stem diameter were measured. The dry weight of the sample was calculated chemically using thermogravimetry. The method of determining the water content by drying according to AOAC [8] is follow the described procedure: ten g of sample was weighed and put into a cup that had been dried and the weight was known. Then the sample and cup were dried in an oven at 135 ^{0}C for 2 h. The cup was cooled and weighed, then dried again until a constant weight was obtained. The formula for the percentage of water content is

$$\%water\ content = \frac{W1 - W2}{W1} \times 100$$

with the W1 = weight before heating and W2 = weight after heating.

3. RESULT AND DISCUSSION

The idea of this eco-enzyme is to process enzymes from waste or organic waste. Eco-enzymes accelerate biochemical responses in nature by producing enzymes from organic waste. Enzymes from organic waste are a way of managing waste that uses kitchen scraps for something useful [9]. Eco-enzyme products are environmentally friendly products that are highly functional, easy to use, and easy to manufacture.

Gadog farm, one of the fruit producers, produces much organic waste, such as fallen fruit, unfit-for-sale fruit, and rotten fruit. Fruit waste must be used as a new source for the plants produced. Fermentation of fruit into eco-enzymes has reduced the use of inorganic fertilizers and pesticides in the company. In addition to eco-enzyme fermentation, the company has independently produced other organic fertilizer products from livestock waste, such as animal manure, liquid organic fertilizer from eggs, and so on. They are administered individually. The idea of this research is to combine fruit and egg waste to create a liquid organic fertilizer. The Gadog Farm enterprise has historically handled both the composition of the fermentation and the selection of the fruit. As part of a zero-waste initiative, fruit selection is modified for the Gadog Farm's production outcomes.

Vitamins and sugar components in fruits are the main components in fermentation by anaerobic bacteria to produce acetic acid. The content in eco-enzyme is acetic acid (CH_3COOH), which can kill germs, viruses, and bacteria as well as enzymes of lipase, cellulase, invertase, laccase, xylanase, pectinase, tannase, trypsin, and amylase, which can help fertilize the soil [9]. In addition, NO_3^- (nitrate ion) and CO_2 (carbon dioxide) are also produced, which are needed by the soil as nutrients [10]. The chemical reactions that occurred in the eco-enzyme fermentation process are as follows:

$$C_6H_{12}O_6 \rightarrow 2CH_3CH_2OH + CO_2$$

$$\underset{\text{Ethanol}}{CH_3CH_2OH} + \tfrac{1}{2}O_2 \rightarrow \underset{\text{Acetaldehyde}}{CH_3CHO} + H_2O$$

$$\underset{\text{Acetaldehyde}}{CH_3CHO} + \tfrac{1}{2}O_2 \rightarrow \underset{\text{Acetic acid}}{CH_3COOH}$$

The existence of metabolism in anaerobic bacterium settings, which naturally contain eco-enzyme elements, such as fruit waste, aids in the process [11]. The pH of the waste enzymes is acidic in nature, thus when carbohydrates are resolved into volatile acids, the organic acids present in the waste materials also dissolve into the boiling solution. Due to the acidic composition of the waste, the enzyme in it has the greatest ability to reduce or inhibit pathogens. Enzymes also aid in the early morning extraction of extracellular enzymes from organic wastes into solution. Pyruvic acid is created during the roasting process when glucose is broken down.

Pyruvic acid under anaerobic conditions will experience decomposition by pyruvate decarboxylase to acetaldehyde, then acetaldehyde is converted by alcohol dehydrogenase to ethanol and carbon dioxide, which Acetobacter bacteria will convert alcohol into acetaldehyde and water, which in turn acetaldehyde will be converted into acetic acid [12]. The eco-enzyme subsidence process occurs for 3 months.

Alcohol was released during the first month of cooling. Therefore, the odor can be smelled coming from the eco-enzyme solution. In the second month, it smells sour, namely the smell of acetic acid. With so many compounds, such as minerals and vitamins, it will continue to decompose and decompose naturally from enzymes. Therefore, the recommended minimum duration is 3 months. When finished fermenting, the product will dry out. The eco-enzyme has high microbial activity, so it can be used to inhibit microbial growth. Based on the results of Win's research in 2011, fully fermented eco-enzymes have a pH content below 4 and generally occur after three months [13]. The results of the pH examination in (**Table 1**) show that the resulting eco-enzyme fermentation follows the Win theory at 3.6.

Table 1. Results of pH, TDS, and Electrical conductivity analysis

Label	pH	TDS (ppm)	Electrical conductivity
Eco-enzyme	3.6	2300	3.2
LOF	3.9	2320	3.9
Control (Water)	6.9	36	0.1
P1	5.3	53	0.13
P2	4.6	73	0.17
P3	4.2	99	0,23

In addition to the pH value, total dissolved solids and electrical conductivity affect the quality of the plant. Electrical conductivity (EC) is the ability to conduct electricity from ions contained in nutrients. EC is a parameter that shows the concentration of dissolved ions. The more dissolved ions, the higher the EC value. Low EC numbers can detect concentrations of nutrition that affect plant metabolism, enzyme activity, and potential absorption of solution ions by plant roots [14].

The TDS and EC values are equal to the minerals and solids dissolved in the liquid sample. High concentrations of liquid organic fertilizers and eco-enzymes are not suitable for direct use. High dissolved solids can affect nutrients in the soil. It also affects the pH value of the sample. Dilution of liquid organic fertilizer in the treatment is expected to improve the quality of nutrients in the soil and balance the soil pH. The composition of TDS and EC increases the amount of liquid organic fertilizer concentration added.

In general, liquid organic fertilizer does not damage the soil and plants even though it is used as often as possible. In addition, liquid fertilizer can also be used as an activator to make compost [15]. In fruit waste, there are organic materials, such as nitrogen, which can stimulate the growth of stems, branches, and leaves. Nitrogen is required to compose 1-4% of the dry plant materials, such as stems, bark, and seeds. Nitrogen in organic matter is still in the form of protein, while nitrogen that can be absorbed directly by plants is the available N form in the form of nitrate (NO_3^-) or ammonium (NH_4^+) or in combination with compounds metabolism of carbohydrates in plants in the form of amino acids and proteins.

In general (P1-P3), the use of a mixture of eco-enzymes and amino acids had a significant effect compared to no treatment (K). The data are shown in **Table 2**. In this case, it shows that liquid organic fertilizer affects plant metabolism. The availability of nitrogen elements and the ability to increase nutrients in the soil can help plants grow. The addition of eggs to the manufacture of liquid organic fertilizer increases the availability of N from the amino acids found in eggs. The amino acid content in eggs, such as alanine, arginine, leucine, serine, valine, and 18 other amino acids [16], is indispensable for plant growth. Protein hydrolysates and amino acid mixtures contain chemical and/or enzymatic hydrolysis of plant and animal feedstock. This plays multiple roles in N uptake and assimilation, factor signalling, and C-N metabolism in

Table 2. Result of height, diameter, and water content of leek

Label	Height (cm)	Diameter (mm)	Fresh weight (g)	Water content (%)
K (LOF 0 mL/L)	36.45	7.30	15.83	92.93
P1 (LOF 2,5 mL/L)	47.63	8.92	27.50	92.62
P2 (LOF 5 mL/L)	41.52	10.42	38.33	90.95
P3 (LOF 7,5 mL/L)	42.62	9.42	27.50	92.80

stores and increases microbial biomass, soil respiration, and fertility [17].

In this instance, a concentration of 2.5 mL/L causes the plant height to reach 47 cm. By providing this concentration, plants can support growth hormones, boosting their rate of growth. In P2 and P3, this circumstance is not depicted. A portion of the stem in group P2 might be filled by the application of 5 mL/L liquid organic fertilizer. According to estimates, the amino acid components are enough to fill the body sections of onion plants and speed up their development. The width of the stem diameter and the estimated 10% dry weight serve as indicators. Because plants with a dry weight greater than their water content has a higher level of hardness, customers strongly like the weight increase.

CONCLUSION

The treatment of liquid organic fertilizer based on eco-enzymes and chicken eggs significantly affected the growth plant height, dry weight, and water content in leek plants. Liquid organic fertilizer containing amino acids could promote growth metabolism. Treatment of liquid organic fertilizer based on eco-enzyme amino acids and chicken eggs at any concentration (2.5; 5.0; and 7.5 mL/L) provided growth support and yield in leek plants than 0 mL/L concentration. There were no significant concentrations that had better growth.

SUPPORTING INFORMATION

There is no supporting information of this paper. The data that support the findings of this study are available on request from the corresponding author (AKHH).

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CONFLICT OF INTEREST

All authors do not have a conflict of interest with any party in this research.

AUTHOR CONTRIBUTIONS

G. Satrio conducted the research. **A.K.H. Hasibuan** conducted the research and wrote the manuscript with the assistance of **P.W. Azzida**.

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