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Analysis of Organic Content of Ecoenzyme Solution and its Effect on the Growth of Chili Pepper Supporting the Program of Gerakan Indonesia Menanam (Gerina)

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A B S T R A C T

Chili pepper (*Capsicum frutescens* L.) requires good care, and one of the treatments is regular fertilization. This study aims to determine the organic content of several ecoenzyme solutions and their effects on the early growth of chili peppers. Several ecoenzyme solutions were analyzed for their nitrogen, phosphate, potassium, and organic C content. The results showed that ecoenzyme solution 3 had the highest nitrogen, phosphate, potassium, and organic C content, and the pH value of the three solutions was in the range of 3-4. This ecoenzyme is also best for getting root length. The results of this study are expected to add scientific information related to chili pepper fertilization using organic materials, i.e. ecoenzyme solution.

INTRODUCTION

Chilli pepper (*Capsicum frutescens* L.) is a horticultural crop from the Solanaceae family. The plant is known for its small fruit and intensely spicy flavor. This plant has several regional names in Indonesia, such as "lombok japlak" in Javanese and "cengek" in Sundanese. Internationally, chili pepper is known as "Thai pepper" (Arafa et al., 2024).

Chili pepper consumption in Indonesia continues to increase annually. In 2023, its total consumption reached 610,000 tons, a 7.2% increase from the previous year (Sekjen Kementan, 2024). Furthermore, the quantity of its consumption in Indonesia tends to fluctuate, with an average consumption of 3.71 kg per capita per year (Padapi et al., 2022).

Over the past three years, chilli pepper production in Indonesia has tended to fluctuate, with an increase in 2022 and a 3% decrease in 2023 (BPS, 2024). Average chili productivity in Indonesia reached 7.3 tons per hectare in 2021 (BPS, 2021), while its maximum potential is around 22.4 tons per hectare (Ridho & Suminarti, 2020). The suboptimal production of chilli pepper in Indonesia is likely influenced by pest attacks, the use of low-quality seeds, and inappropriate fertilization, which are the main causes of this low productivity (Pratiwi et al., 2022).

In chili cultivation, proper fertilizer application is crucial to ensure the plants receive the necessary nutrients. For example, applying manure has been shown to enhance vegetative growth of chili plants, as indicated by an increase in the number of leaves produced (Kurniawan et al., 2022). Furthermore, a combination of organic and inorganic fertilizers can provide optimal growth and yield for chili plants (Rahma et al., 2024).

Organic fertilizer application not only provides nutrients for plants but also improves soil structure, increases water retention capacity, and stimulates soil microbial activity, all of which contribute to better plant growth (Singh et al. 2020). The use of cow and chicken manure has been reported to have a positive effect on chili plant growth and yield (Meida et al., 2020). Liquid organic fertilizer (POC) made from bamboo shoots in hydroponic chili cultivation has been shown to positively impact vegetative growth, such as increased plant height and leaf number (Rosmiah et al., 2024).

Ecoenzyme is one example of an organic fertilizer. Ecoenzyme has been reported to positively correlate with mustard plant growth by increasing plant height and leaf number (Marian & Tuhuteru, 2019). However, Faozi et al. (2021) reported that ecoenzyme solution did not provide the best positive effect on the growth of cassava cuttings. This is likely due to differences in the composition of the raw materials used to make ecoenzymes, which ultimately affect the chemical compounds contained in the ecoenzyme solution, both in terms of quantity and quality. Therefore, further analysis of the compound composition of ecoenzyme solutions is needed to obtain optimal results in supporting the growth and development of propagated plants.

To date, no chemical compounds analysis have been reported in several ecoenzyme solutions, which will be used to determine which ecoenzyme solution is better and faster at increasing chili plant growth. Therefore, the research team considers it necessary to conduct research on this matter. The results of this study are expected to contribute to the success of one of the government's latest efforts to increase chilli pepper production, i.e. the launch of the "Gerina" program in April 2025. This movement aims to raise public awareness of the importance of reforestation and environmental preservation through plant planting activities. Thus, planting chilli pepper plants by the community is expected to meet food needs, especially chili plants, independently (https://www.gerina.id/id).

METHODOLOGY

This research was conducted in several stages, beginning with testing the nitrogen, phosphorus, organic carbon, and potassium content, also pH of tested ecoenzyme solutions. After that, the effects of several ecoenzyme solutions on the growth of chilli pepper seeds were tested.

A. Nitrogen content analysis (Kjeldhal method)

The nitrogen content analysis in this study was conducted based on Ramadhanty et al. (2024). For about 2 mL ecoenzyme solution was placed in a Kjeldhal flask, followed by 25 mL of concentrated H2SO4 and heated at 350°C for 2 hours until the solution became clear. Afterward, the solution was diluted with distilled water and sodium hydroxide (NaOH) was added to convert ammonium ions (NH_4^+) to ammonia (NH_3). This solution was heated, evaporated, and captured in a boric acid (H_3BO_3) solution. The solution was then titrated with hydrochloric acid (HCl) or sulfuric acid (H_2SO_4). The amount of acid required to neutralize the ammonia was used to calculate the nitrogen content in the sample.

B. Phosphorus Content Analysis (HNO3 and HClO4 extraction Methods)

The phosphorus content analysis in this study was conducted according to the Ministry of Agriculture (2023). For about 2 ml ecoenzyme solution was added to 5 ml of HNO_3 and mixed for a while to react. Afterward, the mixture was heated until evaporation occurred and the liquid volume reduced. Then, 0.5 ml of $HClO_4$ was added to the mixture and heated. After cooling, the diluted solution was analyzed using a spectrophotometer to measure phosphorus concentration. Measurements were made at specific wavelengths corresponding to the color complex between the phosphorus and the dye reagent.

C. Organic carbon content analysis (Walley & Black Method)

The organic carbon content analysis in this study was conducted according to Sari et al. (2023). For about 2 ml ecoenzyme solution was added to a 500 ml Erlenmeyer flask and 10 ml of 1 N $K_2Cr_2O_7$ solution was added. The solution was shaken thoroughly and 20 mL of concentrated sulfuric acid (H_2SO_4) was added. The solution was then allowed to react for 30 minutes at room temperature. Approximately 200 ml of distilled water and 4 drops of ferroin indicator were titrated with a 0.5 N iron (II) sulfate ($FeSO_4$) solution until the color changed from bluish green to wine red, indicating the endpoint of the titration.

D. Potassium content analysis (HNO3 and HClO4 extraction methods)

Potassium content analysis in this study was conducted according to Rahmelia et al. (2015). For about 2 ml ecoenzyme solution was added to a container containing the sample with 5 ml of concentrated HNO_3 (65%). The mixture was left for several hours or overnight at room temperature to ensure the initial reaction. The solution was then heated to approximately 100°C until the liquid volume reduced and the yellow vapor (NO_2) disappeared. After the initial heating, 0.5 ml of concentrated $HClO_4$ (60%) was added and heated until the solution became clear, indicating that all organic matter had been oxidized, allowing potassium to dissolve. Next, 25 ml of distilled water was added to dilute the solution, and the potassium concentration was measured using a flame photometer.

E. pH analysis

pH analysis was carried out using pH paper (MQuant®).

F. Testing the effect of several ecoenzyme solutions on the growth of chilli pepper seeds

After conducting several analyses, the next step was to test the ecoenzymes on the chilli pepper seeds that would be planted and treated. First, the chilli pepper seeds were collected in a container. Twenty seeds that sank were then collected and given four treatments. The first treatment was water as a control, the second was ecoenzyme 1, the third was ecoenzyme 2, and the final was ecoenzyme 3. Once everything was ready, it was necessary to prepare a container for mixing the ecoenzyme and water. Ecoenzyme dilution was carried out by adding 1 ml of ecoenzyme solution to 24 ml of water.

The diluted ecoenzyme solution was then used to soak the chilli pepper seeds for 10 minutes before planting them in the growing medium. After soaking, the chilli pepper seeds were planted in the growing medium and watered every afternoon. The ecoenzyme treatment was carried out by sprinkling the solution every two days. Root length, stem length, and leaf length were observed on the 14th day after planting.

F. Data analysis

This research was conducted in a completely randomised design with three repetitions and five explants in each bottle. The data was analysed statistically using F-test and the means among each treatment were analysed separately using Tukey test and $P<0.05$ was considered as statistically significant.

RESULT AND DISCUSSION

The results of the chemical content analysis of the three ecoenzymes can be seen in Table 1. The best total N, total P, total K, organic C, and organic matter content were found in ecoenzyme solution 3. On the other hand, the least chemical content tested was found in ecoenzyme solution 1. Although the nitrogen, potassium, and organic C content were not as much as those contained in ecoenzyme solution 3, ecoenzyme solutions 1 and 2 also contained chemicals that were good for plant growth.

Table 1 Chemical analysis of ecoenzymes

No	Compound	Ecoenzyme 1	Ecoenzyme 2	Ecoenzyme 3
1	Total Nitrogen	0.06%	0.08%	0.13%
2	Total Phosphorus	0.08%	0.09%	0.11%
3	Total Potassium	0.06%	0.07%	0.09%
4	Organic Carbon	1.02%	1.2%	1.75%
5	Organic compound	1.76%	2.08%	3.02%
6	pH	3.50	3.22	3.38

Ecoenzyme 1 solution is derived from mango peel, banana peel, and melon peel. The three basic ingredients of ecoenzyme 3 include potassium, phosphorus, dietary fiber, and vitamin A. Vu et al. (2018) explained that banana peel contains many phytochemical compounds, especially phenols, and these compounds are useful as antioxidants and antimicrobials. Phenol content has also been reported in mango peel and melon peel, which also have antioxidant benefits (Tirado-Kulieva et al. 2021; Gomez-Gracia et al. 2021).

Ecoenzyme 2 solution is made from guava peel, orange peel, and long beans, all of which contain high levels of vitamin C, minerals, and fiber. Furthermore, ecoenzyme 3 solution is made from orange peel, cabbage, and long beans, all of which contain calcium, magnesium, and potassium. Tousif et al. (2023) reported that guava peel contains many secondary metabolites, including phenols. A similar finding was also reported by Ogo et al. (2024), Choi et al. (2024), and Oloyede et al. (2021) reported that orange peel, long bean peel, and cabbage also contain phenol.

Salsabila & Winarsih (2023) stated that optimal potassium content will have a positive impact on plant growth. This is in line with Haidlir et al. (2019), who stated that sufficient chemical content, such as potassium and phosphorus, in a fertilizer will enhance plant growth (Haidlir et al., 2019). Furthermore, Sun et al. (2020) reported differences in physiological aspects of plants treated with fertilizers with different nitrogen contents. Therefore, efforts to increase the fertility of the growing medium through fertilization are a concrete effort to support plant growth (Asadu et al. 2024).

The results of the pH analysis of the three ecoenzyme solutions tested showed a pH range of 3-4. This indicates that all three ecoenzyme solutions fall within the criteria for ecoenzyme solutions that are still suitable for use. This is confirmed by Soleha et al. (2023) that stated the ecoenzyme solution has a characteristic pungent and sour odor, which indicates that the fermentation process is running well and the organic material has been effectively decomposed so that it can be used as a plant growth stimulant.

Growth analysis showed that cayenne pepper treated with ecoenzymes 1 and 3 grew faster in inducing root growth. Within 3 days, ecoenzymes 1 and 3 successfully induced root growth compared to ecoenzyme 2. This is likely because ecoenzymes 1 and 3 contain chemical elements such as N, P, and K that are suitable for chili plant growth.

Table 2 Observation results on 14-HST

Treatment	Average of root length	Average of stem length	Average of leave length
Control	0.835[b]	0.825 [a]	0.3154 [a]
Ecoenzyme 1	1.595[c]	2.22 [a]	1.12 [a]
Ecoenzyme 2	0.585[a]	0.75 [a]	0.555 [a]
Ecoenzyme 3	1.68[cd]	2.055 [a]	0.95 [a]

Based on Table 2, it can be seen that on the 14th day of observation, ecoenzyme 3 solution provided the best positive effect on root length parameters, while ecoenzyme 1 provided the best positive impact on stem length and leaf length parameters. It was also seen on the 14th day of observation that ecoenzyme 2 solution provided the smallest results on root length and stem length parameters, even compared to the control. This is again likely due to the specific needs of plants in the content of nitrogen, potassium, phosphorus, and other organic elements to support their growth. This is in line with Vadillo et al. (2024) who stated that chili plants require a specific nitrogen content to support their growth.

CONCLUSIONS AND RECOMMENDATIONS

Ecoenzymes are essential for supporting plant needs and play a role in early seed growth. Ecoenzyme 3 solution is the best ecoenzyme solution for supporting early cayenne pepper seed growth. Further research is needed to determine the effect of ecoenzyme solutions on flowering and fertilization in chili peppers.

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