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The Effect of Adding Cassava Peel to Liquid Organic Fertilizer on Kale

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ABSTRACT
The utilization of organic waste as a raw material for liquid organic fertilizer (LOF) is an environmentally friendly alternative to support sustainable agriculture. Cassava peels contain simple carbohydrates and nutrients that can improve the quality of LOF and promote plant growth. This study aimed to determine the effect of adding cassava peels to vegetable waste-based LOF on the growth of water spinach (Ipomoea aquatica). The experiment was conducted using a Completely Randomized Design (CRD) with four treatments: P0 (control), P1 (LOF + 10% cassava peels), P2 (LOF + 20% cassava peels), and P3 (LOF + 30% cassava peels), each replicated three times. Parameters observed included plant height, leaf number, leaf length, root length, fresh weight, and soil pH. Data were analyzed using ANOVA, followed by LSD test at a 5% significance level. Results showed that adding cassava peels improved plant growth, with P3 giving the best numerical results for most parameters, such as plant height (31.8 cm), leaf length (6.78 cm), and soil pH (8.20). Although not all parameters were significantly different, the overall trend indicated that LOF enriched with cassava peels could improve fertilizer quality and support the vegetative growth of water spinach.

Keywords: *liquid organic fertilizer; cassava peels; experiment; water spinach; plant growth.*

INTRODUCTION
Indonesia is an agrarian country that depends on the agricultural sector as a support for the economy and food security. Excessive use of chemical fertilizers can lead to soil damage, environmental pollution, and increased production costs. One environmentally friendly alternative is the use of liquid organic fertilizers (POCs) derived from vegetable waste. POC has the advantage of being quickly absorbed by plants, easy to apply, and can increase the activity of soil microbes.

Cassava peel (Manihot esculenta) contains simple carbohydrates and macronutrients such as N, P, and K that can enrich POC. The addition of cassava peel has the potential to improve the quality of POC and support vegetative growth of plants. Kale (Ipomoea aquatica) was chosen as the object of the study because it has a short life cycle and is responsive to fertilization.

This study aims to find out:
1. The effect of adding cassava peels to vegetable waste POC on kale growth.
2. The concentration of adding cassava peel gives the best results.

METHOD
The research was conducted at the Jaten Hamlet Experimental Garden, Jatipelem Village, Diwek District, Jombang Regency, in May-July 2025. The plan used is **the Complete Random Plan (RAL)** with four treatments:

- P0: POC vegetable waste (control)
- P1: POC + 10% cassava peel

- P2: POC + 20% cassava peel
- P3: POC + 30% cassava peel

Each treatment was repeated three times. The parameters observed included plant height, number of leaves, leaf length, root length, wet weight, and soil pH. The data was analyzed using **ANOVA** and **BNT test** at the level of 5%.

RESULT AND DISCUSSION

This section explains the results of the research obtained during the experiment, then interpreted according to the foundation of theory and previous research. The data presented included observations of plant height, leaf length, number of leaves, and other supporting parameters. All results are described systematically, starting from general descriptions, presentation of data in tables/figures, to discussions that connect research findings with literature.

In general, the addition of cassava husks to the POC of vegetable waste shows an increasing trend in almost all kale plant growth parameters. Treatments with a higher percentage of cassava peel (P3) tended to give better results than controls (P0) and other treatments. This is suspected because the content of carbohydrates and nutrients in cassava peel is able to enrich fertilizer nutrients and increase nutrient availability for plants.

Result

Height of the Kale Plant

The height of the plant is an important indicator of vegetative growth. Data on average plant height in each observation week are presented in Table 1.

Table 1. Average height of kale plants on various treatments

Treatment	1 MST	2 MST	3 MST	4 MST
P0	2.83	8.00	13.50	18.00
P1	3.83	9.03	15.20	19.70
P2	4.83	14.17	22.10	25.30
P3	6.17	18.50	26.30	31.80

P3 treatment resulted in the highest plant height throughout the observation week. This increase is most likely related to a more optimal availability of nitrogen (N), as explained by Rahmadina (2019) that N plays an important role in leaf formation and stem growth.

Kale Leaf Length

The length of the leaves describes the growth of the plant's photosynthetic organs. The average leaf length in the various treatments is presented in Table 2.

Table 2. Average length of kale leaves

Treatment	1 MST	2 MST	3 MST	4 MST
P0	3.21	3.52	4.13	4.46
P1	3.81	4.23	5.09	4.71
P2	4.83	5.31	5.52	5.53
P3	5.04	6.23	6.61	6.78

The P3 treatment again showed the highest value. This indicates that the increased availability of macro and micronutrients from cassava husks can affect cell division and elongation activity in the leaves.

Number of Kale Leaves

The number of leaves reflects the photosynthesis capacity of the plant. Table 3 shows the average

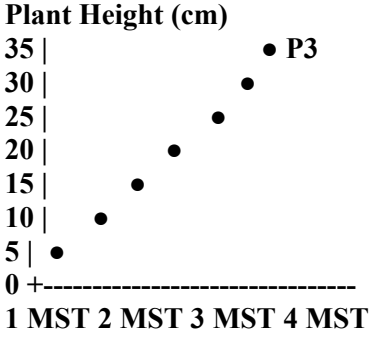
number of leaves per plant.

Table 3. The average number of leaves of kale

Treatment	1 MST	2 MST	3 MST	4 MST
P0	4.00	7.67	10.70	15.30
P1	6.00	11.00	12.00	16.00
P2	5.67	11.00	12.00	16.70
P3	6.00	11.00	12.30	23.00

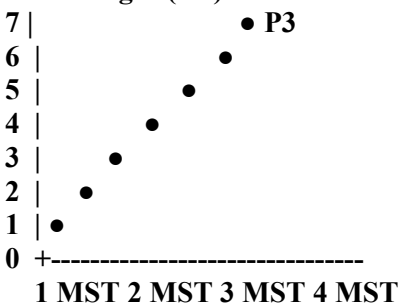
At week 4, the P3 treatment resulted in the highest number of leaves (23 leaves), well above the control. These results are in line with the research of Nahrisah et al. (2020) who reported that the addition of cassava peels can increase the vegetative growth of leafy vegetable plants.

Figure 1. Average height of kale plants



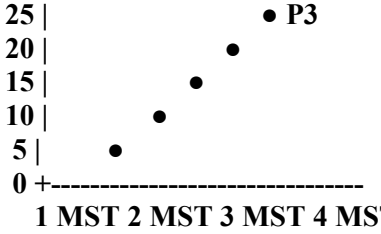
Remarks: P3 showed the highest plant height in all observation weeks.

Figure 2. Average length of kale leaves



Remarks: P3 provides the highest leaf length consistently.

Figure 3. Average Number of Leaves



Remarks: P3 gives the highest number of leaves especially in the 4th week.

Discussion

The results of the observations showed that the addition of cassava husks to the POC of vegetable

waste consistently increased kale growth at all measured parameters. The P3 treatment (30% cassava husk) yielded the highest values on plant height, leaf length, and leaf count, indicating that this dose provides optimal nutrient availability for vegetative growth.

The increase in plant height at P3 (31.80 cm in week 4) compared to P0 (18.00 cm) is likely due to an increase in nitrogen (N) content which plays an important role in the formation of vegetative tissue. This is in line with the findings of Rahmadina (2019) who stated that N has a great effect on the growth of stems and leaves.

The larger leaf length at P3 (6.78 cm) indicates the presence of phosphorus (P) and potassium (K) support which affects cell division and elongation. According to Purnomo et al. (2020), phosphorus plays a role in the formation of new tissues, while potassium helps regulate turgor pressure, so that leaf cells can extend optimally.

The highest number of leaves in P3 (23 leaves) suggests that POC with cassava husks is able to stimulate the formation of new leaves significantly. This is relevant to the report of Nahrisah et al. (2020) who found that cassava peels are rich in simple carbohydrates that are a source of energy for soil microbes, thereby accelerating the mineralization process and increasing nutrient availability.

Overall, the study shows that the addition of cassava husks improves POC quality and has the potential to reduce dependence on chemical fertilizers, supporting the principles of sustainable agriculture. This finding can be a reference for farmers in utilizing agricultural waste to increase crop yields in an environmentally friendly manner.

CONCLUSIONS

Based on the results of the research that has been carried out, it can be concluded that the addition of cassava peel to liquid organic fertilizer (POC) made from vegetable waste has a positive effect on the growth of kale plants. Treatment with the addition of cassava husks of 30% (P3) showed the highest growth on all observed parameters, such as plant height, leaf length, and number of leaves. This indicates that the nutrient content in cassava husks, especially nitrogen (N), phosphorus (P), and potassium (K), is able to enrich POC so that it is more effective in supporting vegetative growth of plants.

In addition to having a positive influence on growth, this study also shows that the use of cassava peel as an additive ingredient in POC is a strategic step in managing agricultural organic waste. The utilization of this waste not only reduces environmental pollution, but also reduces production costs by utilizing abundant local resources. This is in line with the concept of sustainable agriculture that emphasizes resource efficiency, waste reduction, and natural restoration of soil fertility.

The findings of this study open up opportunities for further research, especially in testing the effectiveness of POC by adding cassava husks to other types of crops or in a longer planting period. Further research may also explore the combination of cassava husks with other organic ingredients to improve the quality of fertilizers and extend their benefits. Thus, the results of this research are expected to be a reference for farmers, academics, and policymakers in encouraging the wider application of local waste-based organic fertilizer technology.

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