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Analysis of Kale Vegetable Production (*Brassica oleracea* var. sabellica) in Catfish Pond Water Media Using Floating Net Aquaponics Technology

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ABSTRACT

Kale (*Brassica oleracea* var. sabellica) is a horticultural plant that looks like broccoli and cabbage, but its leaves are headless. This study aims to analyze the production of kale (*Brassica oleracea* var. sabellica) vegetables in catfish pond water media using floating net aquaponics technology, focusing on the impact of various doses of organic fertilizer on plant growth. The method used was the analysis of variance, and if a significant difference were found, Duncan's Multiple Range Test at the 5% level would be applied further. The results showed that various doses of organic fertilizer did not produce significant differences in plant height, although higher doses tended to increase. However, applying organic fertilizer significantly increased the number of kale plant leaves, with a dose of 100 ml/L producing the highest number of leaves compared to the control. This indicates that organic fertilizer effectively supports kale plants' vegetative growth. On the other hand, the treatment using AB Mix and catfish ponds as media did not show significant differences in the fresh weight of kale plants at various observation periods. Variations in plant wet weight were not statistically different enough to affect the study's conclusions. These findings indicate that although organic fertilizer significantly increased the number of leaves, aquaponic media with AB Mix and catfish ponds did not significantly affect plant wet weight.

Keywords: *Aquaponics, Catfish Pond Water, Kale Growth, Kale Plants, Kale Production*

1. INTRODUCTION

Kale, scientifically known as *Brassica oleracea* var. sabellica, is a type of horticultural plant resembling broccoli and cabbage, yet distinguishes itself with its headless leaves. Despite its nutritional richness, kale remains relatively unpopular in Indonesia. The general public is still unaware of the various health benefits associated with kale, which is abundant in antioxidants such as vitamin E, vitamin C, and carotenoids (Acikgoz, 2011). As the demand for improved community nutrition grows, Indonesia has a rising emphasis on enhancing horticultural production. Like kale, cabbage varieties of vegetables are packed with essential nutrients. For instance, in every 100 grams of kale, one can find 49 calories, 0.9 grams of fat, 38 mg of sodium, 491 mg of potassium, 9 grams of carbohydrates, 4.3 grams of protein, 9,990 IU of vitamin A, 120 mg of vitamin C, 150 mg of calcium, 1.5 mg of iron, and 47 mg of magnesium (Purnamasari, 2014).

Catfish are fish bred in pond environments, either concrete or earthen ponds, which contain potential nitrogen content from their water waste (Habibullah et al., 2020).

Kale and catfish are typically grown separately. Catfish can only be farmed in ponds, whereas kale is typically grown in a hydroponic system or on agricultural land. In order to minimize land usage, kale and catfish are grown together in a practice similar to aquaponics, requiring only a tiny amount of land.

Aquaponics is a method that integrates aquaculture and hydroponics in a mutually beneficial environment, offering a viable option for cultivating crops in confined areas. The fish waste, serving as the primary source of nutrients in aquaponics, is easily accessible. In traditional aquaculture, the waste produced by the fish typically builds up in the water and, if left unaddressed, can elevate the water's toxicity levels. This fish waste is converted into nitrates and nitrites through natural processes, which the plants then utilize as essential nutrients. The hydroponic system functions as a means of purifying the fish habitat in this process (Handayani, 2018)

AB Mix Nutrients is a commonly used nutrient solution in aquaponic systems for cultivating plants like kale. It is composed of two distinct solutions, A and B, each containing a variety of essential macronutrients and micronutrients required by plants. Solution A typically consists of calcium nitrate and iron chelate, while solution B contains potassium, phosphorus, magnesium, and other microelements. These nutrients are readily soluble in water and provide an optimal balance for kale growth in aquaponic systems, ensuring that plants receive all the necessary nutrients for maximum growth (Pohan & Oktoyournal, 2019). However, using AB Mix in aquaponic research may encounter challenges such as pH imbalance, salt accumulation, and reliance on fish pond water quality. Other obstacles include maintaining the aquaponic system, managing plant diseases, and monitoring water quality and nutrients regularly. It is crucial to conduct research to identify optimal solutions that can enhance the efficiency and yield of kale plant production in aquaponic systems while ensuring the entire system's sustainability (Hidayanti & Kartika, 2019). This study aimed to assess the outcomes of kale (*Brassica oleracea* var. sabellica) vegetable production in catfish pond water media using floating net aquaponic technology".

2. MATERIAL AND METHODS

2.1 Research Time and Location

This research was conducted on Jl. Padang Maninjau, Desa Kampung Pajak, Kecamatan Na IX-X, Kabupaten Labuhanbatu Utara, with geographic coordinates of 2.3478° N and 99.8366° E. The site is situated at an elevation of approximately 30 meters above sea level.

The study was carried out from February 2024 to April 2024.

2.2 Research Tools and Materials

The tools and materials used in this research include 3/4 inch pipes, 3/4 inch elbows, netting, pipe adhesive, measuring tape, hacksaw, analytical balance, ruler, markers, net pots, seed trays, sprayers, rock wool, Styrofoam, utility knife, label paper, kale seeds, and AB MIX nutrients.

This research employs the floating net aquaponic technology method. The subject of this study is kale vegetables. The research utilizes a single medium, specifically floating net aquaponics. The number of plants is 12 kale plants with three treatments: treatment P0 serves as the control treatment, treatment P1 applies a dosage of 50 ml, and treatment P2 applies a dosage of 100 ml.

2.3 Research Procedure

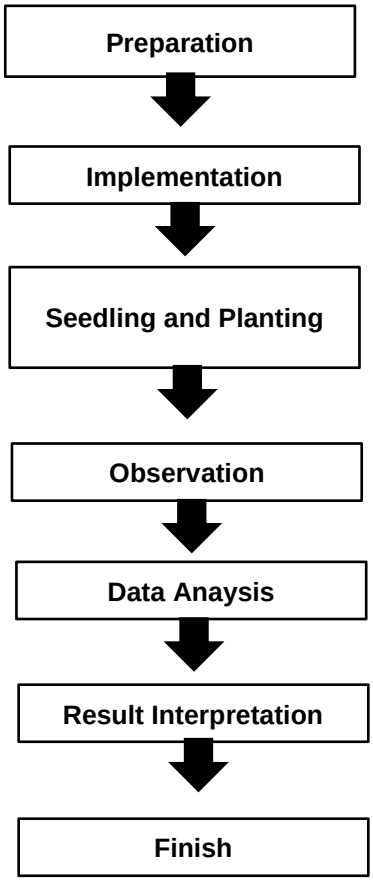

Figure 1. Research Implementation

2.4 Data Analysis

The analytical approach employed in this research involved the analysis of variance (ANOVA) utilizing SPSS version 25, which facilitated the examination of the growth and development of kale plants (Yadi et al., 2012). In instances where significant differences were identified, a subsequent test would be conducted using Duncan's Multiple Range Test (DMRT) at a 5% significance level (Femia Emilga, Darso Sugiono, 2022). Quantitative analysis refers to the systematic process of deriving insights through numerical data, serving as a means to acquire information pertinent to the research objectives. The findings from the study are illustrated through tables and graphs, which encapsulate the metrics collected throughout the investigation, including measurements of plant height, leaf width, and wet weight.

3. RESULT AND DISCUSSION

The parameters observed in the growth of kale plants are plant height,

number of leaves and wet weight of kale plants.

3.1 Plant Height (cm)

The results of observations of average plant height are presented in Table 1.

Table 1. Average Plant Height

AB-MIX Treatment	Average Plant Height (cm)		
	2 MST	4 MST	6 MST
0 ml L^{-1}	22,4±7,18a	35,3±7,18a	47,3±7,18a
50 ml L^{-1}	24,5±7,24a	36,7±7,24a	49,6±7,24a
100 ml L^{-1}	26,2±7,59a	37,3±7,59a	52,4±7,59a

Description: Numbers followed by the same letter in a column are not significantly different at the 5% level in the Duncan test.

The study results on kale plants revealed that the application of different doses of fertilizer did not lead to significant differences in plant height. At 2 weeks after planting (WAP), the average plant height for the treatment without fertilizer (0) was 22.4 cm, 24.5 cm for a dose of 50, and 26.2 cm for a dose of 100. At 4 WAP, the average plant height for treatments 0, 50, and 100 was 35.3 cm, 36.7 cm, and 37.3 cm, respectively. By 6 WAP, the average plant height increased to 47.3 cm for treatment 0, 49.6 cm for treatment 50, and 52.4 cm for treatment 100. Despite the increase in plant height with higher fertilizer doses, the differences were not statistically significant, as indicated by the same letter "a" in each treatment. This finding aligns with Yoder and Davis, 2020, who also reported that the type of organic fertilizer used did not significantly impact plant height, leaf weight, leaf area, or nutrient concentration in various kale cultivars. In contrast, Ridwan et al. (2021) found a significant interaction between the catfish population and planting media in an aquaponic system, affecting the growth and yield of spinach (Amaranthus sp.). Using pumice as a planting medium and a catfish population of 20 fish resulted in optimal spinach growth, as evidenced by plant height and number of leaves at various planting ages.

3.2 Total leaves (strands)

The observation results indicated a rise in the average number of leaves for each treatment. There was no significant difference in the increase for each treatment. Table 2 presents the results of the observations on the average leaf width.

Table 2. Average Number of Leaves

AB-MIX Treatment	. Average Number of Leaves		
	2 MST	4 MST	6 MST
0 ml L-1	5±2,90a	9±2,90a	15±2,90a
50 ml L-1	6±3,17a	11±3,17a	17±3,17a
100 ml L-1	7±3,17a	12±3,17a	18±3,17a

Description: Numbers followed by the same letter in a column are not significantly different at the 5% level in the Duncan test.

The findings indicated that using organic fertilizer on kale plants led to a notable increase in leaf count compared to the untreated control group. At 2 Weeks After Planting (WAP), the control group exhibited 5 leaves, whereas the treatments with 50 and 100 ml/L of organic fertilizer resulted in 6 and 7 leaves, respectively. By 4 WAP, the leaf count rose to 9 in the control group, while the 50 ml/L and 100 ml/L treatments yielded 11 and 12 leaves, respectively. At 6 WAP, the control group had 15 leaves, in contrast to the 50 ml/L and 100 ml/L treatments, which reached 17 and 18 leaves, respectively. These results suggest a positive correlation between the dosage of organic fertilizer and the increase in leaf production in kale plants, highlighting the effectiveness of organic

fertilizer in promoting the vegetative growth of kale. This study contrasts with the research conducted by Fauziah et al. (2022), which demonstrated that the application of liquid organic fertilizer derived from bamboo shoots significantly influenced various growth parameters of hydroponic mustard plants, including plant height, leaf width, stem diameter, root length, fresh weight, dry weight, and survival rate, with the optimal concentration found in the P2 treatment (POC 100 mL + water 1000 mL). However, it is noteworthy that the bamboo shoot-derived liquid organic fertilizer did not significantly affect the leaf count of mustard plants (Fauziah *et al*., 2022).

3.3 Wet Weight of Kale Plants (grams)

Table 3 presents the findings from field observations and the ANOVA test on the average wet weight of plants.

Table 3. Average Wet Weight of Kale Plants

AB-MIX Treatment	Average Wet Weight of Kale Plants (gram)		
	2 MST	4 MST	6 MST
0 ml L-1	25,6±26,14a	60,4±26,14a	115,4±26,14a
50 ml L-1	34,7±26,86a	78,6±26,86a	127,7±26,86a
100 ml L-1	39,5±27,76a	95,8±27,76a	135,2±27,76a

Description: Numbers followed by the same letter in a column are not significantly different at the 5% level in the Duncan test.

The research outcomes indicated that utilizing AB Mix and catfish ponds as growing media for kale plants did not yield significant variations in plant wet weight across different observation periods. The average plant wet weight at 2 MST, 4 MST, and 6 MST for both the AB Mix and catfish pond treatments fell within a relatively similar range, ranging from 25.6 to 115.4 grams, 60.4 to 127.7 grams, and 115.4 to 135.2 grams respectively. Despite some fluctuations in the wet weight measurements, the observed differences were not statistically significant enough to impact the conclusions drawn regarding the efficacy of the treatment on kale plant development. This study contrasts with the findings of Femia Elmiga and Darso Sugiono (2022), who demonstrated that a combination of rice husk charcoal and peat as planting media in a 2:1 ratio produced optimal outcomes in a wick hydroponic system for kale plants. The average plant height reached 28.13 cm, with 18.79 leaves and a stem diameter of 6.51 mm. Furthermore, this treatment resulted in a leaf area of 64.80 cm², a root length of 37.03 cm, and a fresh root weight of 20.19 grams. Analysis of variance and DMRT test revealed that the differences in results were statistically significant at the 5% level (Femia Emilga, Darso Sugiono, 2022).

The research documentation is presented in the image below.

Figure 2. Sowing kale seeds

Figure 3. Growth of kale plants

Figure 4. kale growth

4. CONCLUSION

The findings indicated that using different amounts of organic fertilizer on kale plants did not lead to notable variations in plant height, although higher doses tended to increase height. Conversely, applying organic fertilizer had a significant positive effect on the number of leaves produced by the kale plants, with a concentration of 100 ml/L yielding the highest leaf count compared to the control group. In contrast, the treatments involving AB Mix and catfish pond water as growth media did not demonstrate significant differences in the wet weight of kale plants across various observation periods, suggesting that the fluctuations in wet weight were not statistically significant enough to influence the overall outcomes of the

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