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Growth of Pakcoy (*Brassica rapa* L.) Hydroponic System Using Nutrients of Catfish Cultivation Waste

Pertumbuhan Pakcoy (Brassica rapa L.) Sistem Hidroponik dengan Nutrisi limbah Budidaya Ikan Lele

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ABSTRAK

Sistem budidaya hidroponik secara organik diperlukan nutrisi pengganti selain pupuk anorganik sebagai sumber nutrisi tanaman. Limbah budiaya ikan lele salah satu potensi yang dapat dimanfaatkan sebagai nutrisi hidroponik. Penelitian ini bertujuan untuk menentuan konsentrasi Pupuk Organik Cair (POC) limbah budidaya ikan sebagai nutrisi pengganti nutrisi anorganik komersil terhadap pertumbuhan pakcoy (*Brassica rapa* L.). Penelitian ini dilakukan 2 tahap yaitu pembuatan POC dari limbah budidaya ikan lele dan percobaan penggunaan POC sebagai nutrisi hidroponik. Hasil penelitian ini didapatkan peningkatan kandungan hara POC yang fermentasi anaerobic lebih tinggi dibandingan fermentasi aerobik. Penggunaan POC sebagai nutrisi hidroponik, berdasarkan parameter tinggi tanaman, jumlah daun, nilai SPAD, berat akar, berat tajuk, dan berat kering didapatkan nilai yang lebih kecil yang berbeda sangat nyata dibandingkan dengan perlakuan nutrisi anorganik AB mix. Konsentrasi POC 20% baik yang difermentasi secara aerobic maupun anaerobic, memberikan pertumbuhan lebih baik jika dibandingkan perlakuan konsentrasi lebih tinggi. Kandungan hara dalam POC sulit untuk disesuaikan dengan kebutuhan pakcoy hidroponik, sehingga akan memberikan dampak toxisitas pada hara makro disisi lain juga memberikan respon defisiensi hara mikro.

Kata kunci: aerob, anaerob, pupuk organik cair, nutrisi

ABSTRACT

Organic hydroponic cultivation systems require substitute nutrients other than inorganic fertilizers as a source of plant nutrients. Catfish cultivation waste is one of the potentials that can be used as hydroponic nutrients. This study aimed to find out the concentration of Liquid Organic Fertilizer (LOF) from fish cultivation waste as a substitute for commercial inorganic nutrients on the growth of pakcoy (*Brassica rapa* L.). This research was carried out in 2 stages, namely the manufacture of LOF from catfish culture waste and experiments using LOF as hydroponic nutrients. The results of this study showed that the increase in LOF nutrient content in anaerobic fermentation was higher than in aerobic fermentation. The use of LOF as a hydroponic nutrient, based on the parameters of plant height, number of leaves, SPAD value, root weight, crown weight, and dry weight obtained a smaller value that was significantly different compared to the inorganic nutrient treatment of AB mix. LOF concentration of 20% both fermented aerobically and anaerobically, gave better growth when compared to higher concentration treatments. The nutrient content in LOF is difficult to adjust to the needs of hydroponic pakcoy, so that it will have a toxic impact on macro nutrients on the other hand, it also provides a response to micro nutrient deficiency.

Keywords: aerobic, anaerobic, liquid organic fertilizer, nutrition

INTRODUCTION

Narrow land is not an obstacle for agricultural activities, hydroponic cultivation technique is an effort that can be carried out to increase efficiency and effectiveness in land and water use (Verdoliva et al., 2021). In the hydroponic system, plant nutrient needs are fully supplied through the media in the form of inorganic nutrients. Hydroponic nutrition consists of 16 essential nutrients needed for plant growth (Roosta et al., 2011). The hydroponic nutrients available in the market are in the form of inorganic chemicals in the form of macro and micro salts which are dissolved into stock A and B. The formulation of hydroponic fertilizers is adjusted based on the allotment of vegetable or fruit commodities. Nutrient solution is one of the most important determinants in determining crop yield and quality (Toshiki, 2012).

Increasing consumer awareness about health and the need for food consumption free from chemicals also raises the demand for organic food products. Besides being free of chemicals, research shows that organically grown *pakcoy* has better performance with higher chlorophyll and carotene content and lower glucosinoate levels than conventionally grown (Conversa et al., 2016; Verdoliva et al., 2021). Organic hydroponics is one way to meet the needs of organic vegetables, although the results of organic hydroponic production are not equivalent when compared to using inorganic nutrients (Martin-Gorriz et al., 2021; Riera-Vila et al., 2019). The use of liquid organic fertilizers can be used as a substitute for inorganic nutrients in hydroponic systems. The content of macro and micro nutrients in organic fertilizers is expected to meet the nutrient needs of hydroponic plants. Liquid organic fertilizer is the result of fermentation of organic matter that contains nutrients that are beneficial to plants. One of the organic materials that can be used is catfish cultivation wastewater.

Catfish farming wastewater has the potential to be used as hydroponic nutrients. So far, catfish cultivation waste has not been utilized and is only dumped into the environment so that it will pollute the environment. Utilization of catfish culture water is generally conducted by integrating the aquaculture system with hydroponics so that it is known as aquaponic (Goddek et al., 2018; Kyaw & Ng, 2017). Aquaponic system plant growth is not optimal because the nutrient content is still low. The waste water of catfish cultivation in which there are metabolic residues and leftover feed which will be a source of plant nutrition (Van Tung et al., 2021). Wastewater from catfish farming ponds contains an average of 1.32% N, 2.64% P and 0.35% K macro nutrients (Ahuja et al., 2020). Improving the nutrition of catfish wastewater can be done by adding organic matter and fermenting it aerobically and anaerobically. The results of the study of mineralization of organic material waste carried out anaerobically produced higher nutrients than those of aerobic (Delaide et al., 2019;

Gustiar, et al., 2020). The final product resulting from the mineralization process is a rich mixture of nitrate and minerals (Iron, Potassium, Calcium and Magnesium) (Shinohara et al., 2011). However, further research needs to be done on its effect on hydroponic plant growth. This study aimed to find out the concentration of Liquid Organic Fertilizer from catfish farming waste as hydroponic nutrients to obtain optimal plant growth.

MATERIALS AND METHODS

Time and Place

This research was conducted in the greenhouse of the Faculty of Agriculture, Universitas Sriwijaya, Indralaya Ogan Ilir, South Sumatra. This research was conducted from April to June 2021.

Preparation of Hydroponic Media

The first stage in this research activity was to make LOF made from catfish cultivation wastewater by adding 2.5 kg of Indigofera leaves and 130 g of banana stems, then 500 g of cocopeat, and 1.25 kg of chicken manure. then carried out aerobic and anaerobic fermentation for 4 weeks. Furthermore, a trial plant study was carried out, with 2 separate research units between aerobic LOF and anaerobic LOF. The study used a floating raft hydroponic system (Gustiar et al., 2020; Lenni et al., 2020), with the method of Completely Randomized Design (CRD). Each consisted of 6 treatments, each treatment consisted of 3 replications. The treatment factors used in this study were:

P0 (inorganic nutrients)
P1 (20% LOF concentration)
P2 (40% LOF concentration)
P3 (60% LOF concentration)
P4 (80% LOF concentration)
P5 (100% LOF concentration)

The variables observed in this study included plant height, number of leaves, leaf greenness, crown weight, root weight, and plant dry weight.

Data Analysis

The obtained data were analyzed using Analysis of Prints of Variety (Anova Test) with F table. This analysis was carried out by comparing the calculated F. If the calculated F was real or very real, then it was continued with the Honest Significant Difference (HSD) test to see the difference between the treatment levels.

RESULTS

The nutrient content of catfish culture waste was still relatively low and after the fermentation process was carried out, there was an increase in the nutrient content. This was an implication of adding organic matter in the form of indigofera leaves containing a lot of nitrogen and banana trees containing a lot of potassium. The nutrient content of organic fertilizers that were fermented aerobically was higher than that of aerobic fermentation. The increase in the nitrogen content of anaerobically fermented nitrogen would increase up to 271% higher than that of aerobically fermented nitrogen nutrients. Phosphate nutrient content was 45% higher, while the potassium content was 10% higher (Table 1).

The growth of *pakcoy* height at the age of 7 days after planting (DAP) seemed relatively the same without any significant difference, but when the plant was 14 DAP the growth of *pakcoy* using commercial inorganic nutrients AB mix grew faster than the treatment using LOF. The *pakcoy* plants with LOF treatment both anaerobic and aerobic relatively did not increase the plant height. Even in the 100% aerobic LOF concentration treatment, the plants had a symptom of necrosis poisoning at the tips of the leaves so that the plant height seemed to decrease (Figure 1). The results of the observation of the growth parameters of the number of leaves and the SPAD value of the treatment using commercial inorganic nutrients AB mix got the best results. In *pakcoy* plant, its nutrient content was in accordance with the needed of leaf vegetable plants.

Table 1. Results of analysis of nutrient content in catfish culture wastewater and anaerobic and aerobic LOFs

	Analysis				
	N (ppm)	P (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)
Catfish Cultivation Waste	159.62	30.92	37.00	36.53	8.98
Anaerobic LOF	611.38	81.66	688.09	325.95	120.70
Aerobic LOF	164.59	56.07	626.03	198.80	76.65

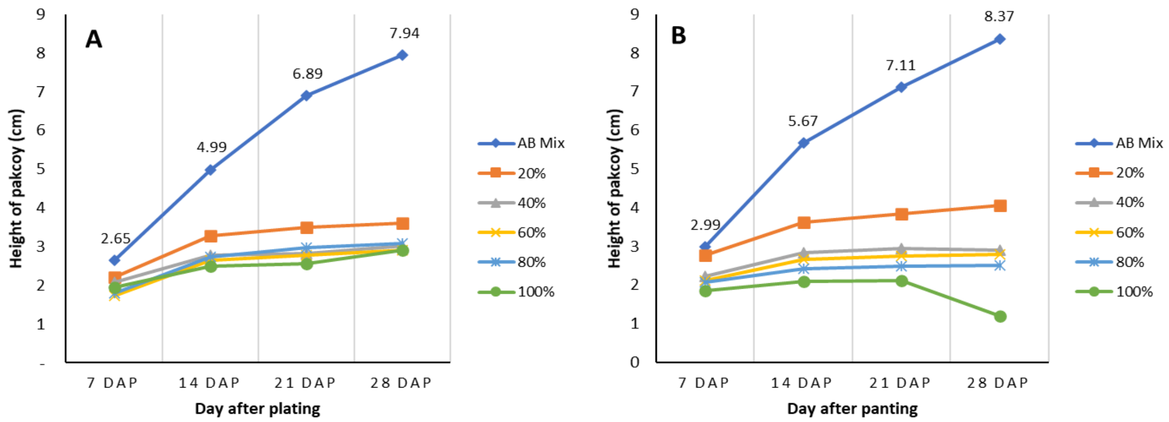

Figure 1. The increase in height of *pakcoy* with anaerobic (A) and aerobic LOF treatments (B)

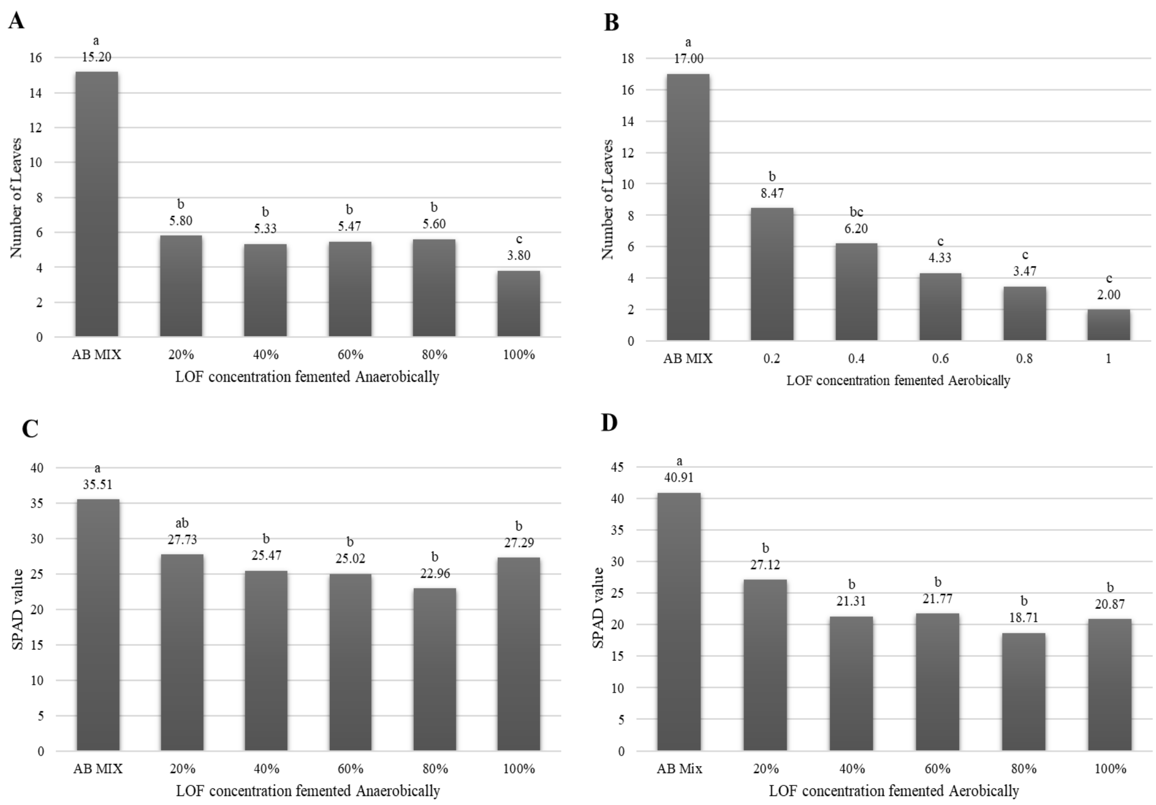

Figure 2. Left column influenced by LOF concentration fermented anaerobically, right column LOF fermented aerobically, number of leaves (A, B) and SPAD value (C,D)

Table 2. Effect of treatment on the yield of root weight, crown weight and dry weight of *pakcoy*

Treatment	Lof Anaerobically			Lof Aerobically		
	Root Weight (g)	Crown Weight (g)	Dry Weight (g)	Root Weight (g)	Crown Weight (g)	Dry Weight (g)
AB Mix	1.73 a	60.93 a	3.15 a	4.80 a	104.47 a	6.58 a
20%	0.48 b	1.25 b	0.32 b	1.30 b	4.72 b	0.93 b
40%	0.40 b	0.82 b	0.16 b	0.27 c	1.66 b	0.22 c
60%	0.30 b	0.74 b	0.12 b	0.22 c	0.76 b	0.13 c
80%	0.28 b	0.72 b	0.12 b	0.12 c	0.42 b	0.07 c
100%	0.06 b	0.23 b	0.04 b	0.02 c	0.12 b	0.02 c
BNJ 5%	0.40	6.62	0.63	0.60	6.69	0.50

Furthermore, the second best was found in the 20% concentration treatment for both anaerobically and aerobically fermented LOFs. In the variables of plant height and the number of leaves the value of 50% of growth used commercial inorganic nutrients AB mix both with anaerobic and anaerobic LOF (Figure 2).

The lowest plant growth rate was in the parameters of plant height, number of leaves and SPAD values found in the 100% anaerobic and aerobic LOF treatments. It was possible because the nutrient content in LOF exceeded the plant's needs so that it was toxic to *pakcoy* plants. In the parameters of the results of all treatments using AB Mix inorganic nutrients, all of them were very significantly different from the LOF nutrition treatments, both aerobically and anaerobically fermented. Parameters of canopy weight in anaerobic LOF treatment was only 2%, while the aerobic LOF treatment was only 4% of the weight produced by AB mix inorganic fertilizer treatment. The lowest yield parameter was found in 100% LOF treatment showing that the nutrient content in LOF was toxic to plants (Table 2).

DISCUSSION

Increasing the nutrient content in the material is a process of mineralization of organic matter from an unavailable form to a form available to plants. However, the increase in LOF nutrients in this study in addition to the influence of the mineralization process, which is the greatest due to the addition of organic matter in the form of Indigofera leaves as a nitrogen source, the banana trees as a source of phosphate and potassium cocopeat (Xie et al., 2021). The anaerobic fermentation process increased the LOF nutrient content much higher than that of aerobic fermentation. This is different from the previous studies stating that aerobic biodegradation would result in a higher level of humification of dissolved organic matter compared to anaerobic degradation (Liu et al., 2021). This difference is due to the previous research testing carried out on biodegradation under the field conditions where there is the influence of other abiotic factors (Zhou et al., 2020).

Parameters of growth and yield of *pakcoy* are with the variables of plant height, number of leaves, SPAD value, root weight, crown weight and dry weight. All of the best measurement results are in the treatment of commercial inorganic nutrients, this is because the nutrient content contained in commercial inorganic nutrients met the nutritional needs of plant growth (Majid et al., 2021). The nutrients contained in the inorganic hydroponic nutrients contained essential macro and micro nutrients needed for *pakcoy* growth (Ezzahoui et al., 2021).

In the treatment of using LOF as a nutrient, both aerobic and anaerobic, *pakcoy* growth did not grow well so that the pakcoy plant grew stunted. It is possible that some of the nutrients needed by the plants in LOF are not complete or sufficient, due to incomplete fermentation process, or organic matter as an incomplete source. Hydroponic nutrients contained at least 5 macro nutrients (N, P, K, Ca, Mg) and 6 micro nutrients (Fe, Mn, Zn, B, Cu, Mo) (Mattson and Lieth, 2019). Lack of one of the essential macro and micro nutrients would cause disturbed growth (Roosta et al., 2011). Deficiency of nitrogen and phosphate nutrients can inhibit plant growth because most of the constituents of plant tissue cells are nitrogen and phosphate elements (Azimi et al., 2021; Gao et al., 2021).

In the 100% LOF treatment in both research units, the lowest value is obtained, possibly due to the poisoning of nutrients, one of which is Nitrogen. The higher the concentration of LOF given, the higher the nutrient content received by the plant. However, the provision with excessive doses will actually inhibit growth. Toxicity of nitrogen is the result of partial nitrification of organic matter (Lee et al., 2021). As a result, the plant is not able to grow properly and even it occurred necrosis on the leaves.

The LOF nutrient content of catfish culture waste that is fermented aerobically and anaerobically is difficult to determine. The LOF nutrient content is not suitable for hydroponic needs. The presence of nutrients in LOF is the result of microorganism activity, therefore the amount is difficult to standardize. The consequence of the activity of microorganisms can reduce or eliminate the nutrients contained in LOF (Lee et al., 2018).

CONCLUSION

Nutrient content of catfish culture waste that is fermented aerobically and anaerobically is difficult to be nutrients hidroponic standardize. The growth of *pakcoy* with LOF nutrition shows the symptoms of macronutrient poisoning, but on the other hand the plant also shows the symptom of micronutrient deficiency. This study concludes that the use of LOF as a hydroponic nutrient, it can not provide *pakcoy* growth equivalent to the use of commercial inorganic nutrients AB mix.

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