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EFFECT OF LIQUID ORGANIC FERTILIZER (LOF) FROM CATFISH SOLID WASTE ON PEAT WATER QUALITY PARAMETERS IN THE CULTIVATION OF CLIMBING PERCH (*Anabas testudineus*)

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ABSTRACT

Liquid organic fertilizer (LOF) derived from the solid waste of catfish processing is a fermented organic product containing macronutrients such as nitrogen (N), phosphorus (P), and potassium (K), as well as micronutrients, amino acids, and decomposer microorganisms that improve water quality. This study aims to analyze the effects of LOF application on peat water quality and the growth performance of climbing perch (*Anabas testudineus*), and to determine the optimal dosage for cultivation. The research was conducted from June to July 2025 at the Aquaculture Environmental Quality Laboratory, Faculty of Fisheries and Marine, Universitas Riau, with fish rearing carried out in the hatchery using aquarium. The study employed a Completely Randomized Design (CRD) consisting of five treatments: P0 (0 ml/L), P1 (1.5 ml/L), P2 (2 ml/L), P3 (2.5 ml/L), and P4 (3 ml/L), each with three replications. The results showed that water quality parameters remained within acceptable ranges, with temperature of 28.73–28.9°C, pH of 4.96–5.2, TDS of 108.26–124.6 ppm, transparency of 7.66–9.1 cm, DO of 5.23–5.36 mg/L, alkalinity of 17–28 mg/L, nitrate of 4.0045–8.7292 mg/L, and orthophosphate of 1.5397–3.5454 mg/L. The application of POC increased pH, TDS, nitrate, and orthophosphate concentrations. The best growth performance was observed in treatment P2 (2 ml/L), which produced the highest absolute weight gain (2.15 g) and absolute length growth (2.72 cm), while the survival rate reached 100% across all treatments. Therefore, the P2 dosage is considered the most effective treatment for improving peat water quality and enhancing the growth of climbing perch.

Keywords: Catfish-Waste LOF, Peat water, Water quality, Nutrients, Climbing perch.

1. INTRODUCTION

Peatlands in Indonesia, especially in Riau Province, form when organic material from plant and animal remains accumulates under anaerobic conditions for thousands of years. Peat water is surface water that comes from peatland as a result of the accumulation of plant remains that have undergone incomplete decomposition, so that it has a high content of organic matter[1]. The process produces a thick, carbon-rich layer of organic soil across about 3.8 million hectares in the Riau region.

However, the water in peat ecosystems is generally very acidic, so it is less supportive of fish life. This acidity has implications for the low dissolved oxygen levels in the water, which, in turn, can inhibit respiration and fish growth[2]. In aquaculture, water quality is a crucial factor that must meet specific standards to support fish's physiological needs. The main parameters to monitor include temperature, pH, and dissolved oxygen. In the temperature range of 22–29°C, fish show a positive response to feeding, especially in the morning and evening, when feeding activity is higher[3].

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Liquid organic fertilizer (LOF) is a solution produced through the process of decay or fermentation of organic matter, such as plant residues, agro-industrial waste, and animal manure, that contains more than one nutrient essential for the growth of organisms[4]. Catfish waste, a freshwater fish with a protein content of 68.6%, has the potential to serve as a raw material for POC production. The utilization of catfish waste not only helps reduce environmental pollution but also produces nutrient-rich fertilizers. Content analysis showed that POC derived from catfish waste contained 5.43% carbon (C), 0.16% nitrogen (N), 0.22% phosphorus (P), and 0.09% potassium (K)[5].

The nutrient content in LOF derived from fish waste plays an important role in supporting the growth of phytoplankton and aquatic plants, thereby improving the quality of water as a medium for fish farming. However, fish waste, such as offal or stomach contents, is still very underutilized and is generally discarded, even though it is readily available in the community. Fishery waste consists of solid and liquid waste, including bones, heads, offal, and fish caught side by side that have no economic value. The use of solid waste as LOF raw materials is expected to improve water quality and benefit the organisms maintained[6]. Fish waste consists of offal (stomach contents), liver, intestines, and kidneys. Almost 3/4 of the total weight of fish is waste[7].

Climbing perch (*Anabas testudineus*) is a freshwater species of high economic value and is loved by the community, making it highly promising for cultivation[8]. Unfortunately, climbing perch cultivation activities are still limited due to constraints in the quality of peat waters, which are not optimal [9]. Peat waters have characteristics with high humic acid content, low pH, and temperature fluctuations that can inhibit the growth of POC fish from catfish waste. However, it is expected to improve water quality, increase the productivity of climbing perch farming, and add value to fishery waste.

The cultivation of climbing perch in peat water has great development potential. Still, the main obstacle faced is the quality of peat water, which tends to be suboptimal. POC, rich in organic nutrients, helps increase aquatic fertility and improve water quality, potentially supporting the success of fish farming in peatlands. Based on these problems, this study was conducted to examine the effect of providing the LOF of catfish solid waste on peat water quality parameters in climbing perch maintenance.

2. RESEARCH METHOD

Time and Place

This research was carried out in April - July 2025. The research was conducted at the Hatchery, Faculty of Fisheries and Marine, Universitas Riau.

Preparation of Liquid Organic Fertilizer (POC) Catfish Waste

The process of making liquid organic fertilizer (LOF) made from catfish waste in this study was carried out based on the fermentation method of Kurniawati et al.[10]. Catfish solid waste in the form of stomach, intestines, bile, heart, and liver that has been aged for 1 day, up to 750 g, is mashed in a blender until homogeneous, then placed in a 10 L jerry can, and 7.5 L of clean water is added. Furthermore, 75 mL of EM4 is added to the mixture as a microbial inoculant, 150 g of brown sugar as an energy source for fermentative activities, and 75 g of salt, and the mixture is stirred until all components are evenly mixed. The mixture of ingredients is then tightly sealed and allowed to ferment for 14 days. During this process, the microorganisms in EM_4 effectively break down the organic matter into simpler compounds.

Fermentation is considered successful when the solution emits a distinctive sour aroma and undergoes a brownish-yellow discoloration, indicating that the POC is ripe and ready for use. The characteristics of a successful fermentation process are a decrease in pH to acidic, sour, the presence of white hyphae on the surface of the fermentation container as a sign of bacterial activity in the fermenting material, the change in color of the fermentation material to blackish-brown, and the presence of bubbles on the fermentation surface[11].

Container Preparation

The containers used in this research are 15 aquariums measuring 40 cm x 30 cm x 30 cm. Before use, the aquarium is washed with clean water, then rubbed with a sponge to remove any remaining dirt from the base and walls, and finally rinsed again with water until clean. The aquarium is washed, then filled with water to a height of 15 cm (20 L), after which the water in the aquarium is aerated.

Fertilization

Fertilization is carried out directly in each research container containing 20 L of peat water, then aerated for 24 hours to ensure homogenization of the solution and increase dissolved oxygen availability before treatment application. The nutrient administration is carried out based on the treatment that has been determined, namely P0 as a control without the addition of POC of catfish waste, P1 with the addition of POC as much as 1.5 mL/L, P2 as much as 2.0 mL/L, P3 as much as 2.5 mL/L, and P4 as much as 3.0 mL/L. After the POC is added to each container, the solution is aerated for 24 hours to optimize dissolution and ensure even nutrient distribution in the peat-water medium. Furthermore, each culture container is clearly labeled with a treatment and repeat code, making it easier to identify and minimize errors during maintenance and data collection.

Maintenance of Test Fish

The climbing perch used in this study were obtained from the Bungus Fish Seed Center (BBI) and measured 4-7 cm in length[11]. The stocking density used is based on Wardana et al.[12], which is up to 1 head per 2 L of water. Sampling is conducted every 7 days to measure increases in body length and weight of climbing perch. The number of fish sampled was 50% of the population in each treatment container. In addition to growth measurement, media quality is maintained through container sampling every 7 days.

Absolute Weight Growth

According to Effendie[13], absolute weight growth is calculated using the following formula: W= Wt - Wo

Description:

W	:	Absolute Weight Growth (g)
Wo	:	Average weight of climbing perch at the beginning of the study (g)
Wt	:	Average weight of climbing perch at the end of study (g)

Absolute Growth Length

According to Effendie[13], the absolute length increase is calculated using the following formula: T= Lt−Lo

Description:

T	:	Absolute absolute length growth (cm)
Lo	:	Average length of fish at the start of the study (cm)
Lt	:	Average length of fish at the end of the study (cm)

Survival Rate (SR)

According to Effendie[13], survival can be calculated using the following formula:

$$\text{SR: } \times 100\% \frac{Nt}{No}$$

Description:

SR	:	Survival rate (%)
Nt	:	Number of fish at the end of the rearing (tail)
No	:	Number of fish at the beginning of the rearing (tail)

Data Analysis

Data on water quality parameters, absolute weight growth, absolute length, and survival rate are presented in tables and descriptions. To determine the effect of treatment on the tested parameters, a statistical test was carried out using the RAL model. Then it was statistically analyzed using the SPSS application with the variance analysis method (ANOVA) to determine the effect of providing POC of catfish waste on water quality in the climbing perch rearing media.

3. RESULT AND DISCUSSION

Water Quality

The observed water quality parameters include Temperature, pH, TDS, brightness, DO, alkalinity, nitrates, and orthophosphates. The results of the water quality measurement are as follows.

Table 1. Average temperature values in peat water media

Repetition	Treatment				
	P0	P1	P2	P3	P4
1	28,6	28,7	28,7	29	28,7
2	28,6	28,8	28,8	28,8	28,8
3	28,5	28,9	28,7	28,9	28,9
Average	28,56±0,03^{a}	28,8±0,10^{b}	28,73±0,05^{b}	28,9±0,11^{b}	28,8±0,08^{b}

Table 2. Average pH values in peat water media

Repetition	Treatment				
	P0	P1	P2	P3	P4
1	4,7	4,9	5,2	5,0	4,7
2	4,7	5,0	5,2	5,0	5,1
3	4,6	5,0	5,2	5,0	5,1
Average	4,66±0,02^{a}	4,96±0,02^{b}	5,2±0,01^{b}	5,0±0,03^{b}	4,96±0,23^{b}

Table 3. Average TDS value in peat water media

Treatment	Treatment				
	H1	H7	H14	H21	H28
P0	64,3±12,09^{a}	87,3±5,68^{a}	101±7,94^{c}	82,3±5,69^{a}	112±9,84^{a}
P1	60,6±4,04^{a}	84,3±7,09^{a}	99±4,00^{b}	119,3±4,50^{b}	141±6,55^{b}
P2	67±4,00^{a}	80,6±6,02^{a}	91±3,00^{a}	114±12,2^{b}	132,3±4,50^{b}
P3	74±3,60^{a}	93±4,58^{a}	105±7,00^{b}	126,3±5,68^{bc}	143±7,00^{b}
P4	99,8±3,78^{b}	118±3,00^{b}	127±3,00^{c}	135,6±3,51^{c}	142,6±4,04^{b}

Based on Table 1, the temperature in peat-water media for fish farming with different LOF doses ranges from 28.5°C to 29°C. The highest temperature was observed in P3, at 28.9°C, while the lowest was recorded in P0, at 28.56°C. Maintaining an organism requires good water quality, including temperature. The temperature at P2 is 28.7–28.8°C, which is within the range reported by Zuryani et al.[14] as ideal for climbing perch growth (25–29 °C). This is in line with Muslim & Muslimin[15], who found that temperature can increase enzymatic and metabolic activity. The increase in temperature that occurred was allegedly caused by direct sunlight exposure to the maintenance container. During the research, the climbing perch were kept outdoors.

Based on Table 2, the pH value in peat water media for fish farming with different POC doses was 4.6–5.2. The highest pH is 5.2 at P2, while the lowest is 4.66 at P0. The results of the Variance Analysis Test (ANOVA) showed that the different superscript letters indicated a significant difference ($P < 0.05$) between the treatments. The increase in pH in the climbing perchrearing media is suspected to be caused by the provision of POC from catfish solid waste, which enriches the nutrients in the peat water, making the water more neutral.

The increased pH indicates that the addition of POC can reduce the acidity of peat water, creating a more conducive environment[16]. The pH value at P2 is 5.2, indicating that the pH in the research container is within the range reported by Karmani et al.[17] for climbing perch habitat in swamps: 5.74-5.82.

Based on Table 3, the TDS value in peat-water media for fish farming shows a tendency to increase with increasing maintenance time in all treatments, both at P0 and in the treatment with the provision of catfish waste POC (P1–P4). On day 1, the TDS value was still relatively low in the range of 60.6–99.86 ppm; it then increased on H7 and H14 and reached the highest value on H28, with a range of 112–146.6 ppm. The increase in TDS is suspected to result from the decomposition of organic matter, feed residues, fish metabolites, and POC-derived nutrients.

The TDS value at P4 is 124.6 ppm, which is within the optimal threshold of 1000 mg/L, indicating that the water quality remains suitable for cultivation. The increase in TDS is thought to be due to an increasing number of solutes derived from POC organic nutrients, such as nitrogen, phosphorus, and carbon compounds, which dissolve into water during decomposition. This aligns with Hamid & Patitis[18], who also explain that an increase in TDS can be triggered by humic acids and dissolved compounds resulting from plant decay and the metabolic activity of aquatic organisms.

Table 4. Average brightness value in peat water media

Treatment	Brightness Measurement (cm) Day				
	H1	H7	H14	H21	H28
P0	7,2±0,40[b]	8,6±0.56[d]	9,7±0,60[b]	10.9±0.60[d]	12,5±0,26[c]
P1	6,9±0,10[b]	8,0±0,43[cd]	9,2±0,30[b]	10±0,26[cd]	11,1±0,45[b]
P2	6,7±0,26[b]	7,9±0,35[bc]	9±0,43[b]	9,8±0,20[bc]	11,2±0,15[b]
P3	6,1±0,35[a]	6,8±0,45[b]	8,1±0,52[a]	9.2±0.47[b]	10,1±0,75[c]
P4	5,7±0,10[a]	6,6±0,25[a]	7,7±0,25[a]	8,7±0,15[a]	9,6±0,15[c]

Table 5. Average DO value in peat water media

Treatment	Measurement of DO (mg/L) Day		
	H1	H15	H30
P0	5,0±0,10	5,7±0,20	5,5±0,05[b]
P1	5,0±0,10	5,5±0,20	5,3±0,11[a]
P2	4,8±0,10	5,7±0,10	5,5±0,05[b]
P3	5,0±0,10	5,5±0,20	5.4±0.05[b]
P4	4,9±0,10	5,5±0,10	5,3±0,05[a]

Based on Table 4, the water brightness value in peat-water media for fish farming shows a tendency to increase with increasing maintenance time across all treatments, both at P0 and in the treatment with catfish waste POC (P1–P4). At the beginning of the observation, the brightness value was still relatively low in the range of 5.7–7.2 cm, then survival increased in H7 and H14, and reached higher values in H21 and H28 in the range of 9.6–11.5 cm. The increase in brightness is thought to be related to the deposition of organic matter, nutrient utilization by microorganisms, and the stabilization of aquatic conditions during the maintenance period.

The decrease in brightness is thought to be caused by an increase in dissolved organic matter and suspended particles derived from the decomposition of POC of catfish solid waste. According to Rahmi[19], the brightness level is closely related to the number of suspended particles, the amount of organic matter, and the presence of microorganisms in the water. The higher the organic matter content, the lower the light penetration rate in the water.

Based on Table 5, the DO value in peat-water media for fish farming was relatively stable during the maintenance period across all treatments, both at P0 and in treatments with the provision of POC from catfish waste (P1–P4). The DO value at the beginning of the H1 observation ranged from 4.8–5.0 mg/L; there was a slight increase in H15 to 5.5–5.7 mg/L; and at the end of the observation, H30 ranged from 5.3–5.5 mg/L. The results of the Variance Analysis Test (ANOVA) showed that the treatment and the control did not differ significantly ($P > 0.05$).

This increase in DO is suspected to be influenced by the increased activity of decomposing microorganisms and the use of aerators that accelerate the diffusion of oxygen into the water. Meanwhile, Boyd et al.[20] stated that sufficient dissolved oxygen supports optimal metabolic processes, immune function, and growth rate in fish. In addition, climbing perch is known to have a high tolerance to low oxygen levels because it has labyrinthine organs that allow it to breathe directly from the air[21]. Therefore, the increase in DO levels due to the addition of POC from catfish solid waste and adequate aeration support indicates that aquatic conditions remain ideal for the growth and survival of climbing perch in peat-water media.

Table 6. Average values of alkalinity, ammonia, nitrate, and orthophosphate in peat water

Parameter	Measurement results					Optimal
	P0	P1	P2	P3	P4	
Alkalinity (mg/L)	17,0-20,0	18,0-22,0	18,0-26,0	19,0-25,0	19,0-28,0	≥20
Ammonia (mg/L)	0,2743-0,2977	0,0112-0,3047	0,0123-0,2865	0,0332-0,4042	0,1121-0,5342	≤ 0,1
Nitrate (mg/L)	4,0045-5,3222	4,5873-5,5813	4,4312-5,5768	4,6840-7,0708	4,5348-8,7292	10
Orthophosphate (mg/L)	1,5397-2,1540	2,2332-3,5476	2,1158-2,2959	2,6261-3,3989	2,7371-3,5454	≥ 0,20

Based on Table 6, the results of alkalinity measurements during the study show an increase across all treatments. The highest alkalinity value is found at P4 at 19.0 -28.0 ppm, and the lowest at P0 at 17.0 – 20.0 ppm. This increasing tendency is suspected to be due to the addition of LOF from catfish waste, which can increase the dissolved mineral content of the maintenance medium. The increase in mineral content improves the water's buffering capacity, increasing its alkalinity. This is in line with the statement by Boyd et al.[20], which explains that alkalinity is the ability of water to neutralize acids without causing significant changes in pH.

The results of ammonia measurements during the study, presented in Table 6, showed variation in levels between treatments, with the highest ammonia value at P0 (0.2743-0.2977 mg/L) and the lowest at P2 (0.0123-0.2865 mg/L). The difference in ammonia levels is closely related to the LOF dose of catfish solid waste, as the compound is mainly produced by the decomposition of organic matter in POC. The range of ammonia levels showed that most of the treatments were below the optimal limit of ≤0.1 mg/L as stated by Hendrawati et al.[22], and well below the dangerous threshold of 1 mg/L according to Tatangindatu et al.[23], so that this condition is still considered safe for the life of climbing perch.

Based on Table 6, the study showed an increase in nitrate levels across all treatments. The highest nitrate content was found at P4 (4.5348-8.7292 mg/L), and the lowest at P0 (4.0045-5.3222 mg/L). This increase is suspected to be related to the provision of LOF of catfish waste, which is rich in organic nitrogen compounds from the decomposition of organic matter, thereby enriching nutrients in peat waters. The range shows that nitrate levels throughout treatment remain below the optimal limit of 10 mg/L proposed by Effendi[24] as a safe threshold for aquatic organisms, thereby preventing toxic effects on climbing perch.

Based on Table 6, the level of orthophosphate in peat-water media during the study increased with treatment involving the administration of LOF from solid waste catfish. The increase in orthophosphate concentrations at the end of the study was due to the advanced decomposition of organic matter, which released phosphorus back into the dissolved orthophosphate form. This is in line with the opinion of Batubara et al.[25], who state that the decomposition of organic matter can increase the solubility of phosphate, thereby increasing the availability of dissolved phosphorus in water. According to Kordi[26], the optimal orthophosphate level for waters to support primary productivity is ≥0.20 mg/L, so that all treatments are still within optimal limits and are classified as biologically fertile.

Absolute Weight and Absolute Length Growth

The growth of absolute weight and absolute length in fish is closely related to good feeding and water quality suitable for survival. The provision of LOF for catfish in solid waste is expected to improve the quality of peat water and support the growth and development of climbing perch.

Table 7. Growth absolute weight, and absolute length of climbing perch

Treatment	Weight Loss (g)	Absolute Length (cm)
P0 (0 mL/L)	1,67±0,04^{a}	2,06±0,01^{a}
P1 (1.5 mL/L)	1,96±0,03^{c}	2,33±0,01^{c}
P2 (2 ml/L)	2.15±0.04^{e}	2,72±0,01^{ac}
P3 (2.5ml/L)	2,00±0,07^{d}	2,51±0,01^{d}
P4 (3ml/L	1,76±0,03^{b}	2,20±0,23^{b}

Based on Table 7, the average climbing perch weight increased in each treatment during the maintenance period. The highest absolute weight growth was obtained in the P2 of 2.15 g by the administration of catfish solid waste LOF of 40 mL/L, and the lowest absolute weight growth was obtained at P0 of 1.67 g. The results of the variance analysis (ANOVA) showed that the POC dose had a significant effect (P<0.05) on absolute weight gain in climbing perch.

The results of this study showed that administering LOF from catfish waste at a higher dose resulted in a significant increase in absolute weight compared to the control (P0), indicating that the availability of nutrients from LOF plays an important role in supporting the growth of climbing perch.

Based on Table 7, it can be seen that the highest absolute length growth of climbing perch was obtained in the P2 treatment of 2.72 cm, while the lowest was in the P0 control, which was only 2.06 cm. The results of the Variance Analysis (ANOVA) showed that the addition of LOF at different doses had a significant effect (P<0.05) on the absolute length growth of climbing perch.

The absence of POC in P0 results in peat water conditions remaining suboptimal, thereby inhibiting growth. This comparison shows that applying POC at optimal doses effectively improves the cultivation environment and stimulates growth, though responses differ across species depending on their physiological needs.

Survival Rate

Survival is the comparison of the number of test fish alive at the end of the study with the number of fish at the beginning of the study in a single period in a population during the study. Survival is also an important thing in cultivation.

Based on Table 8, all treatments with LOF added from solid waste catfish achieved 100% survival rate for climbing perch during the study period. This high survival rate indicates that the water quality during maintenance is optimal, enabling it to support the metabolism, growth, and immune system of fish. The success in maintaining 100% survival across all treatments also confirms that the physical, chemical, and biological factors of the water during aquaculture are suitable for the life needs of climbing perch. This is in line with Bakri et al.[27], who state that the survival rate of climbing perch is greatly influenced by favorable environmental conditions.

Table 8. Survival Rate (SR)

Repetition	Survival Rate (SR) (%)				
	P0	P1	P2	P3	P4
1	100	100	100	100	100
2	100	100	100	100	100
3	100	100	100	100	100
Average	100±0,00	100±0,00	100±0,00	100±0,00	100±0,00

4. CONCLUSION

The results showed that providing POC of catfish solid waste affected the quality of peat water used for climbing perch maintenance. The value of water quality in this study has increased, with values in the optimal range to support the growth of climbing perch in peat water media, with an average temperature value of 28.73 – 28.9 °C, pH 4.96-5.2, TDS 108.26-124.6 ppm, brightness 7.66-9.1cm, DO 5.23-5.36 mg/L, alkalinity 17.0-28.0 mg/L, nitrate 4.0045-8.7292 mg/L and orthophosphate 1.5397-3.5454 mg/L. The application of POC of solid waste catfish affects the growth results of absolute weight and absolute length of climbing perch reared in peat water media. The LOF treatment with 40 mL/L of catfish waste in P2 is the best, yielding an absolute weight gain of 2.15 g and an absolute length of 2.72 cm. The results of this study also show that providing POC of solid waste catfish in peat-water media does not affect climbing perch survival.

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