Asian Journal of Aquatic Sciences, April 2025. Vol 8, Issue (1) 86-94
e-issn: 2716-4608
p-issn: 2655-366X

APPLICATION OF POC FORMULATION FROM BANANA PEEL WASTE AND PATIN FISH OFFAL IN *Lemna* sp AND GOURAMI (*Osphronemus goramy*) CULTIVATION MEDIA

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ABSTRACT

The gourami (*Osphronemus gouramy*) cultivation faces challenges in terms of relatively slow growth. *Lemna* sp. plants can be a natural food for gourami and improve water quality to support gourami cultivation. However, *Lemna* sp. plants require NPK elements that can come from POC formulations from banana peel waste and catfish offal. This study aims to determine the effect of POC formulations from banana peel waste and catfish offal on *Lemna* sp biomass and to determine the best dose of POC formulations from banana peel waste and catfish offal on *Lemna* sp and goramy cultivation media. The research was conducted from August to November 2024 at the Hatchery and Environmental Quality Laboratory of Aquaculture, Faculty of Fisheries and Marine Sciences, Universitas Riau. The experimental study used a completely randomised design (CRD) with four treatments and three replicates. The treatments used were P0 (as control), P1: 1.625 mL/L, P2: 2.625 mL/L, and P3: 3.625 mL/L. The results showed that POC formulations from banana peel waste and catfish offal affected Lemna sp.'s biomass and goramy's growth. With treatment P1 (1.625 mL/L), the best dose was in *Lemna* sp. cultivation media and gourami (with treatment P1 (1.625 mL/L). Treatment P1(1,625 mL/L) is the best dose on the biomass of *Lemna* sp, which amounted to 767.47 g/m^2, and the specific growth rate of *Lemna* sp. plants of 6.17%/day.

Keywords: Giant goramy, *Lemna* sp, POC Formulation

1. INTRODUCTION

The gurami fish (*Osphronemus goramy*) is a freshwater fish. Gourami fish contain 19% protein, higher than other freshwater fish[1]. Based on production data, gourami fish production has grown over the last few decades, especially on a small scale[2]. However, in gourami fish farming, the growth rate is relatively slow compared to other freshwater fish, so the growing period is more extended than that of other freshwater fish.

To enhance growth during cultivation, gurami require suitable natural feed. *Lemna* sp is one such natural feed for gourami. *Lemna* sp, or duckweed, is a weed that grows abundantly in reservoirs, lakes, and calm waters. The protein content of duckweed is quite high, at around 20.51%. In addition to its benefits as a natural feed, *Lemna* sp is also beneficial for maintaining water quality. According to Safitri et al.[3], *Lemna* sp can improve water quality and reduce CO_2 and nitrate content in laundry wastewater.

Lemna sp requires easily absorbable NPK nutrients, which can be obtained from POC formulations. POC formulations are rich in NPK nutrients. Nasution et al.[4] reported that the nutrient content in banana peel liquid fertilizer is as follows: total nitrogen (N) 0.18%; phosphorus (P) 0.043%; potassium (K) 1.137%; organic carbon (C) 0.55%; carbon-to-nitrogen ratio (C/N) 3.06%; and pH 4.5. Wardana et al.[5]

Received: 2 March 2025
Accepted: 4 April 2025

found that POC from catfish waste contains Nitrogen (N) 0.35%, Phosphorus (P) 0.24%, Potassium (K) 0.16%, and Organic Carbon 1.56%.

Therefore, this study is necessary to determine the optimal dosage of POC formulation from banana peel and catfish offal waste on the culture medium of *Lemna* sp and gourami on the biomass of *Lemna* sp and the growth of gourami.

2. RESEARCH METHOD

Time and Place

The study was conducted from August to November 2024 at the Hatchery and Environmental Quality Laboratory, Faculty of Fisheries and Marine Sciences, Universitas Riau.

Method

This experimental study employed a completely randomised design (CRD) with four treatment levels and three replications of POC formulation doses:

P0: Control (without POC formulation)
P1: 1.625 mL/L POC formulation
P2: 2.625 mL/L POC formulation
P3: 3.625 mL/L POC formulation

Procedures

POC Formulation Preparation

The POC formulation was produced using two organic materials: banana peel waste from street vendors around the Universitas Riau campus and fresh patin fish offal (maximum 12 hours after harvest) from a patin fishing village. The POC formulation was prepared from banana peel waste and patin fish offal following the procedure described by Tanti et al.6, using an aerobic process: 1) Banana peel waste and fish offal were each used in quantities of 500 g. Both materials were first cleaned of impurities using water. The materials were then mixed with water and ground using a blender. The ratio of each material to water was 1:5. 2) Dissolve 100g of brown sugar and mix with 100mL of Effective Microorganism (EM4).

3) Mix the banana peel and fish offal in a 1:1 ratio. Add the EM4 solution and brown sugar mixture. Mix all ingredients until homogeneous. 4) The container is aerated to provide oxygen to the POC formulation solution, and holes are made in the lid to allow air to enter. 5) The POC formulation can be harvested and filtered after 7-10 days. The POC liquid will have the following characteristics: the colour will turn brown, there will be no maggots, and there will be no foul odour.

Lemna sp. and Gurami Fish Stocking

The *Lemna* sp plants used were sourced from the Faculty of Fisheries and Marine Sciences, Universitas Riau. The Lemna sp. biomass used was 35 g/container (142.9 g/m^2). Gourami fish were introduced into the research containers at a stocking density of 45 fish/m^2 [7]. The containers used were styrofoam containers with an area of 0.245 m^2. Based on the container area used, the stocking density of gourami fish per container was 11 fish/container with a fish length of 5–6 cm. The gourami were not fed pellets but only utilised *Lemna* sp as feed during the study.

Application of POC Formulation

The POC formulation was applied directly to the containers filled with water and *Lemna* sp. Fertilisation was carried out every 14 days, so the POC formulation was applied thrice during the study. POC formulation administration was conducted according to the experimental design: P0 (control) did not use POC formulation, P1 used a POC formulation dose of 1.625 mL/L, P2 used a POC formulation dose of 2.625 mL/L, and P3 used a POC formulation dose of 3.25 mL/L.

Research Parameters

The test parameters in this study were water quality, including temperature, pH, DO, nitrate, and phosphate, as well as biomass and specific growth rate of *Lemna* sp and absolute weight and specific growth rate of gourami. Temperature and pH measurements were taken every 2 days, while DO was measured every 15 days based

on[8]. Nitrate and phosphate were measured three times at the study's beginning, middle, and end. Nitrate and phosphate measurements were based on Arizuna et al.[9], using a spectrophotometer.

Biomass measurements were calculated using the formula from Effendie[10], as follows:

$$W = Wt-Wo$$

Description:

W = Biomass of *Lemna* sp (g/m^2)
Wt = Average weight of *Lemna* sp at the end of the study (g)
Wo = Average weight of *Lemna* sp at the beginning of the study (g)

Lemna sp and gourami specific growth rate was calculated using the Zonneveld et al.[11] formula.

$$LPS = \frac{\ln Wt - \ln Wo}{t} \times 100\%$$

Description:

LPS = Specific Growth Rate (%)
Wt = Final weight (g)
W0 = Initial weight (g)
t = Maintenance period (days)

The absolute weight of gurami fish was measured using the Effendie10 formula, as follows:

$$W=Wt-Wo$$

Description:

W = Biomass of fish
Wt = Average weight of fish at the end of the study (g)
Wo = Average weight of fish at the beginning of the study (g)

Data Analysis

The research data were analysed and presented in tabular and descriptive forms.

3. RESULT AND DISCUSSION

Water Quality

In this study, POC formulation was administered to Lemna and gourami (*O. gouramy*) culture media for 30 days, and water quality measurements were conducted, including temperature, pH, DO, nitrate, and phosphate levels. The measurement results during the study are presented in Table 1.

Table 1. Water quality measurement results

No	Parameter	Observation results				Reference
		P0	P1	P2	P3	
1.	Suhu (^{0}C)	25,77-25,95 25,85±0,0^a	25,76-26,14 25,95±0,1^a	25,70-25,96 25,86±0,1^a	25,74-26,02 25,85±0,1^a	24-28[12]
2.	pH	7,06-7,13 7,09±0,04^c	7,50-7,57 7,53±0,04^d	6,61-6,76 6,71±0,08^b	6,20-6,26 6,23±0,03^a	6,5-8,5[7]
3.	DO (mg/L)	6,33-6,73 6,60±0,23^b	6,93-7,13 7,02±0,35^c	6,83-6,90 6,87±0,04^b	6,03-6,23 6.11±0,11^a	4-9[13]
4.	Nitrate (mg/L)	0,69-0,79 0,74±0,05^a	3,13-3,19 3,16±0,03^d	2,70-2,85 2,80±0,08^c	1,22-1,32 1,27±0,05^b	2-5[14]
5.	Phosphate (mg/L)	0,09-0,10 0,09±0,01^b	0,36-0,38 0,37±0,01^d	0,27-0,27 0,27±0,00^c	0,16-0,19 0,18±0,02^a	<1[14]

Notes: P0 = Control treatment; P1 = Application of POC formulation 1.625 mL/L; P2 = Application of POC formulation 2.625 mL/L; P3 = Application of POC formulation 3.625 mL/L; and Different script letters on the same row indicate significant differences ($P < 0.05$)

Based on Table 1, it can be concluded that the best water quality was achieved in the treatment with POC formulation P1 (1.625 mL/L), with temperature (25.76–26.14 °C), pH (7.50–7.57), dissolved oxygen (DO) (6.93–7.13 mg/L), nitrate (3.13–3.19 mg/L), and phosphate (0.36–0.38 mg/L). Quality parameters in P1 after adding POC formulation to the culture medium of *Lemna* sp and gourami can increase the abundance of *Lemna* sp and support the growth of gourami. According to Leng et al.[15], Lemna plants grow well at 6–33°C temperatures and pH ranging from 6.5 to 7.5.

Temperature

The overall temperature of the treatment ranged from 25.87°C. The temperature range in treatment P1 was 25.76–26.14°C, and there was no significant difference in temperature between treatment P1 (1.625 mL/L) and other treatments. The application of POC formulations at different doses in the growth medium did not affect the temperature in the growth medium. According to Dismayanti et al.[16], applying POC from catfish waste did not significantly affect the culture medium.

Based on the temperature measurement data of treatment P1, it can be concluded that the temperature is suitable for the growth of *Lemna* sp and gourami. *Lemna* sp. grows optimally at temperatures of 6–33°C[15], and according to Effendi[17], the optimal temperature for aquatic plants generally ranges from 25–30°C. According to Andreas[12], the optimal temperature for gourami fish growth ranges from 24-28 ^{0}C. Temperatures that are too high or too low can reduce or disrupt the development of gourami. According to Khairuman & Amri[18], the growth of gourami is relatively fast at temperatures of 24.9-28^{0}C.

pH

Based on pH measurements during the study, the highest ph was observed during the application of POC formulation on the cultivation medium *Lemna* sp and gourami, in treatment P1 with the highest pH reaching 7.57, and in treatment P3, the lowest pH reached 7.50. Meanwhile, in the control treatment (P0), the pH ranged from 7.06 to 7.13. The treatments administered with POC formulation doses showed decreased pH during measurements on days 1, 16, and 28. The pH decrease occurred temporarily, and the pH value gradually increased after a few days, becoming stable.

The decrease in pH of the culture medium in treatments administered with POC formulation is suspected to be due to differences in the application of POC formulation, which is acidic (pH 4), causing the pH of the water to decrease each time POC formulation is applied. The pH decrease occurred three times during the study, on days 1, 16, and 28. This happened because POC was used thrice on days 1, 15, and 28. According to Yulianto[19], carbon dioxide (CO_2) concentration and acidic compounds are factors that can lower pH.

The pH decrease only occurred after fertilisation, after which the pH increased. The water's pH increase results from microorganisms converting organic nitrogen into nitrite and nitrate through nitrification and denitrification. According to Pulungan et al.[20], the processes of nitrification and denitrification by bacteria can increase pH levels. The increase in pH during the study is also thought to be due to the role of the plant *Lemna* sp, which can perform phytoremediation in water. In the study by Safitri et al.[3] the plants *L. minor* and *H. verticillata* increased the pH value of laundry wastewater. The plant *Lemna* sp. can also contribute O_2 and reduce CO_2 levels in water, which are factors in decreasing water pH through photosynthesis. This opinion is consistent with that of Yulianto[19], who stated that several factors influence water pH, including photosynthetic activity, temperature, and the presence of anions and cations.

Dissolved Oxygen (DO)

The overall DO values for all treatments ranged from 6.93 to 7.13. The highest DO value was observed in treatment P1 with a POC dose of 1.625 mL/L. Meanwhile, the lowest DO value was found in treatment P3 with a dose of 3.625 mL/L. The dissolved oxygen results in water showed a range of 5.4-8 mg/L. This value is still optimal for maintaining gourami[13].

Oxygen sources in water can come from aerators that help oxygen dissolve easily in water. In addition to aerators, oxygen in water can also come from the photosynthesis of *Lemna* sp plants. *Lemna* sp plants can utilise CO_2 in water for photosynthesis and produce O_2, which is then released through their roots. This statement follows the opinion of Nuraini et

al.[21], who stated that photosynthesis by plants can increase the dissolved oxygen value in water.

DO is a compound that is very important for aquatic organisms. Dissolved oxygen plays a vital role in various aspects, especially for fish, which require oxygen to convert food into energy. According to Gadekar et al.[22], dissolved oxygen in water is needed by aquatic organisms for respiration. This oxygen-requiring respiration process supports the growth of gurami fish. The optimal dissolved oxygen level in water for gourami fish maintenance ranges from 3-8 mg/L. Excess dissolved oxygen in water can cause rapid algae growth, leading to oxygen competition between gurami fish and algae. Insufficient dissolved oxygen in water can hinder the growth of gourami.

Nitrate

Based on Table 1, the nitrate concentration in treatment P1 ranged from 0.09 to 5 mg/L. Treatment P1 had the highest nitrate content in the *Lemna* sp and gourami culture medium. The lowest nitrate concentration in the culture medium of *Lemna* sp and gourami was found in treatment P0 (control). Treatment P1 was still within the optimal range for the growth of *Lemna* sp and gourami in the culture medium of *Lemna* sp and gourami.

Treatment P1 was the best because it had the highest nitrate concentration compared to the other treatments. Treatment P1 had a concentration of 3.13–3.19 mg/L, which aligns with the quality standards for gourami fish maintenance based on Boyd[14], where the optimal nitrate concentration for gourami maintenance ranges from 2–5 mg/L. Nitrate concentrations in water suitable for maintenance will protect the fish and optimise their growth. Nitrate availability in water is also crucial for the development of *Lemna* sp. High nitrate content indicates that the water is fertile with a nitrogen source. Nitrogen is one of the elements required for the growth of *Lemna* sp. According to Ullah et al.[23], nitrogen and phosphorus can enhance growth in *Lemna* sp.

According to Setiyawan et al.[24], nitrogen compounds in the form of nitrate are toxic when their concentration exceeds the quality standard and can have adverse effects such as a decrease in dissolved oxygen in water, eutrophication, and toxicity to aquatic life, which can cause the death of aquatic biota such as fish. In addition, it can also be harmful to human health.

Phosphate

Based on measurements during the study of POC formulation application on the cultivation medium of *Lemna* sp and gourami fish, the highest phosphate concentration in water was found in P1 with a POC formulation dose of 1.625 mL/L. The lowest phosphate concentration in water was observed in the P0 treatment or control. Treatment P1 (1.625 mL/L) had a phosphate concentration of 0.36–0.38 mg/L. Treatment P1 had the highest phosphate concentration and was within the optimal range for gourami cultivation. This result is still considered optimal based on Boyd[14], which states that the optimal phosphate concentration for cultivating gourami is < 1 mg/L.

The highest phosphate concentration in treatment P1 is likely due to the presence of phosphorus compounds from applying POC formulation at a 14-day interval in the cultivation medium of *Lemna* sp and gourami. This was evidenced by the lowest phosphate concentration in treatment P0, which did not receive POC formulation in the culture medium. According to Adawiah et al.[25], additional phosphate in water can come from fertiliser additions. The primary source of phosphate during the study was POC formulation, although phosphate could also originate from fish faeces. This opinion is in line with Affan[28], who stated that phosphate compounds in water can originate from animal waste.

Phosphate is one of the elements in water that is needed for the growth of plants and algae. The availability of phosphate in

water indicates that the water is fertile. The phosphate absorption by *L. minor* plants is carried out by accumulating phosphate in their roots, which is then used for their growth[27]. According to Kuncoro et al.[28], *Lemna minor* can use N and P from duck droppings as nutrients for growth.

According to Caesar et al.[31], high phosphate concentrations can disrupt fish metabolism and cause mortality. The availability of phosphate in water is a sign of water fertility, but excessive phosphate can harm farmed fish. High phosphate concentrations can stimulate excessive algae growth (eutrophication), leading to competition for dissolved oxygen in the water. According to Harsono[32], excess phosphate in water can cause algal blooms (eutrophication) with the side effect of decreasing oxygen concentrations in the water body, leading to the death of aquatic biota.

Biomass of *Lemna* sp.

The study began by applying liquid organic fertiliser formulations to the cultivation medium of *Lemna* sp and gourami. The biomass of *Lemna* sp used in each treatment was 35 g/container. The results of the measurements during the study showed differences between treatments. The biomass measurements and specific growth rates of *Lemna* sp are presented in Table 2.

Table 2. Biomass and growth rate of *Lemna* sp

Treatment	Biomass (g/m^2)	Specific Growth Rate (%/day)
P0 (control)	205,40±5,90^a	2,97±0,06^b
P1 (1,625 mL/L)	767,47±29,15^c	6,17±0,11^d
P2 (2,625 mL/L)	357,40±4,19^b	4,18±0,16^c
P3 (3,625 mL/L)	180,80±10,05^a	2,72±0,10^a

Notes: P0 = Control treatment; P1 = Application of POC formulation 1.625 mL/L; P2 = Application of POC formulation 2.625 mL/L; P3 = Application of POC formulation 3.625 mL/L; Superscript letters in the same column indicate significant differences ($P < 0.05$).

The highest plant biomass of *Lemna* sp. was found in treatment P1 (1.625 mL/L), amounting to 767.47 g/m^2, and the highest specific growth rate of *Lemna* sp was also found in treatment P1 (1.625 mL/L), amounting to 6.17%/day. The lowest absolute weight and specific growth rate were found in treatment P3 (3.625 mL/L).

The growth of Lemna sp. in treatment P1 with a POC formulation dose of 1.625 mL/L was considered the best because it had the highest values for biomass and specific growth rate, ranging from 767.47 g/m^2 and 6.17%/day. The highest growth in treatment P1 is likely due to several factors, including nutrient availability and optimal environmental conditions for the development of *Lemna* sp. Landesman et al.[29] state that *Lemna* sp biomass production can double in two days under optimal conditions. During the study, water quality in treatment P1 was appropriate, with temperatures ranging from 25.76 to 26.14°C and pH levels between 7.50 and 7.57, consistent with the findings of Leng et al.[15], who reported that Lemna plants grow well at temperatures between 6 and 33°C and pH levels between 6.5 and 7.5.

In treatment P3 with a POC formulation dose of 3.625 mL/L, the lowest values were recorded for biomass and specific growth rate throughout the study. Treatment P3 was the weakest because some *Lemna* sp plants died due to excessive application of POC formulation, which ultimately damaged the quality, particularly in the pH parameter. Factors influencing pH are carbon dioxide (CO_2) concentration and acidic compounds[19]. This study's source of acidic compounds came from POC formulation, which is acidic (pH 4). Therefore, applying POC formulations at different doses affects the pH quality of water.

The analysis of POC formulations showed that the concentrations of organic

carbon, nitrogen, and potassium were relatively high. According to Syam et al.[30], POC from catfish waste contains good levels of nutrients (N, P, and K) for plant growth. The potassium concentration level was higher than the results of POC analysis used in the study by Wardana et al.[5], where the analysis of catfish waste POC yielded nitrogen 0.35%; phosphorus 0.24%; and potassium 0.16%. This difference in concentration is likely due to the POC formulation using a combination of banana peel. Banana peel has a high potassium content, which enhances the potassium content in the POC. This finding is supported by the research of Ishak et al.[31], which showed that the potassium content in banana peel is higher than in the banana fruit itself.

Growth of Catfish

The good growth of gourami fish is supported by the feed availability and optimal environmental quality that meets the fish's needs. The plant *Lemna* sp utilises the POC formulation to grow and enhance the nutrients in the plants that will serve as food for the gourami. In addition to being a food source for gourami, the *Lemna* sp plant helps maintain water quality. The absolute weight and specific growth rate of gourami can be seen in Table 3.

Table 3. Absolute weight and specific growth rate of gourami

Treatment	Absolute Weight of Fish (g/fish)	Specific Growth Rate (%)
P0 (Control)	0,47±0,05[a]	0,40±0,04[a]
P1 (1,625 mL/L)	1,81±0,06[c]	1,33±0,04[c]
P2 (2,625 mL/L)	1,03±0,04[b]	0,81±0,03[b]
P3 (3,625 mL/L)	0,39±0,06[a]	0,33±0,05[a]

Notes: P0 = Control treatment; P1 = Application of POC formulation 1.625 mL/L; P2 = Application of POC formulation 2.625 mL/L; P3 = Application of POC formulation 3.625 mL/L; Superscript letters in the same column indicating significant differences ($P < 0.05$).

Table 3 shows that treatment P1 resulted in the best absolute weight of 1.81 g/fish and a specific growth rate of 1.33% with a liquid POC formulation dose of 1.625 mL/L. Treatment P0 did not show a significant difference compared to treatment P3. Meanwhile, treatment P2 with a dose of 2.625 mL/L had an absolute weight of 1.03 g/fish and a specific growth rate of 0.81%.

P1 was the best treatment because it had the highest absolute weight growth and growth rate compared to the other treatments. The significant differences were caused by the availability of *Lemna* sp as abundant feed and optimal water quality in the cultivation of gourami. Good feed meets the nutritional needs and habits of fish. *Lemna* sp plants contain 10-45% crude protein, 7-14% crude fiber, 3-7% fat, and 35% carbohydrates[29]. This protein content meets the nutritional requirements of gourami for growth and development. This is supported by the SNI[32], which states that the protein requirement for the growth of gourami fry of 3-5 cm in size is 38%. This finding supports the use of *Lemna* sp as natural feed in gourami fry cultivation, as it can meet the protein requirements.

The lowest absolute weight growth of gurami fish was observed in P3 with a POC formulation dose of 3.625 mL/L. This was due to the acidic pH of the water, which disrupted the metabolic processes of the gurami fish. The acidic pH was caused by the excessive and repeated application of the POC formulation, leading to an acidic water pH. According to Wardana et al.[5], poor water quality can cause fish to become stressed and lose their appetite, inhibiting their growth. According to Yulianto[19], factors that influence pH are carbon dioxide (CO_2) concentration and acidic compounds.

4. CONCLUSION

The results showed that the administration of POC formulation from banana peel and patin fish offal affected the biomass of *Lemna* sp, and treatment P1

(1.625 mL/L) was the best treatment for the cultivation medium of *Lemna* sp and gourami. The biomass of *Lemna* sp was 767.47 g/m^2, and the specific growth rate of *Lemna* sp was 6.17%/day, thereby supporting the growth of the absolute weight and growth rate of gourami at 1.81 g/fish and 1.33%/day. Water quality during the study was as follows: temperature (25.76–26.14 °C), pH (7.50–7.57), dissolved oxygen (DO) (6.93–7.57 mg/L), nitrate (3.13–3.19 mg/L), and phosphate (0.36–0.38 mg/L).

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