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The Effectiveness of Turmeric and Maggot Enriched Pellets to Improve Growth and Survival of *Osphronemus goramy*

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ABSTRACT

Turmeric (*Curcuma longa*) contains curcumin, a bioactive compound with antioxidant, antimicrobial, and immunostimulant properties. Maggot meal, derived from the larvae of *Hermetia illucens*, is a high-protein ingredient rich in essential fatty acids and minerals. This study was conducted from March to July 2024 at the Laboratory of Fish Parasites and Diseases, Faculty of Fisheries and Marine Sciences, Riau University, Pekanbaru, Indonesia. The objective was to evaluate the effects of turmeric- and maggot-enriched feed on the growth and survival of *Osphronemus goramy* infected with *Aeromonas hydrophila*. The experiment followed a completely randomized design (CRD) with five treatments and three replications. The treatments consisted of a negative control (CN), in which fish received no maggot-enriched feed and were not infected with *A. hydrophila*; a positive control (CP), in which fish received no maggot-enriched feed but were infected with *A. hydrophila*; and three experimental groups fed with maggot-enriched diets at levels of 20g/ kg (T1), 30g/ kg (T2), and 40g/ kg (T3). A single dose of turmeric at 0.7g/ kg feed was applied to all treatment groups. The results showed that turmeric- and maggot-enriched feed significantly improved fish survival, immunity, and growth, even under pathogen challenge. The T2 group, which received 30g/ kg maggot meal combined with 0.7g/ kg turmeric, exhibited the best performance, with the highest survival rate (93.33%) and optimal growth. In contrast, the positive control group showed the lowest survival rate (36.67%) and developed severe clinical symptoms, including ulcerated lesions. Based on these findings, it can be concluded that feed enriched with turmeric and maggot meal is effective in enhancing gourami resistance to *A. hydrophila* infection by reducing clinical symptoms and accelerating wound healing.

INTRODUCTION

Osphronemus goramy is a high-value freshwater aquaculture species that enjoys significant demand in Indonesia. The cultivation of gourami continues to expand in response to increasing market demand, both for domestic consumption and export. However, a major challenge in gourami farming is the high risk of disease outbreaks,

which can severely affect fish productivity and survival. One of the most common diseases is caused by *Aeromonas hydrophila*, a widespread freshwater pathogen that can lead to hemorrhagic septicemia, skin ulcers, and mass mortality in fish.

The use of antibiotics is often the primary strategy for controlling bacterial diseases in aquaculture. However, prolonged use can result in serious drawbacks, such as bacterial resistance, chemical residues in fish meat, and negative impacts on aquatic ecosystems. Consequently, safer and more environmentally friendly alternatives are needed to boost fish immunity and to prevent infections, one of which is the incorporation of natural ingredients into feed.

Turmeric (*Curcuma longa*) and black soldier fly (BSF) maggots are two natural feed ingredients with significant potential to improve fish health. Turmeric contains curcumin, an active compound with antioxidant, antimicrobial, and anti-inflammatory properties, which has been shown to strengthen animal immune systems. Supplementing fish feed with turmeric is expected to increase resistance to stress and bacterial infections, including *A. hydrophila*. In addition, BSF maggots are an excellent source of high-quality protein, essential fatty acids, and amino acids, making them highly beneficial for fish growth and metabolism. Their high nutritional value also allows them to partially replace conventional protein sources in aquafeed while supporting overall fish health.

Research indicates that combining natural ingredients such as turmeric and BSF maggots in fish feed can enhance immunity and promote optimal growth. However, studies examining their combined effects on the growth and survival of gourami infected with *A. hydrophila* remain limited. Therefore, it is important to explore the effectiveness of turmeric- and maggot-based diets in enhancing gourami growth, survival, and disease resistance.

This study aimed to investigate the effects of a turmeric- and maggot-enriched diet on the growth and survival of *Osphronemus goramy* infected with *A. hydrophila*. The findings are expected to contribute to the development of natural functional feeds that support sustainable aquaculture while reducing reliance on antibiotics. The adoption of such natural feed ingredients aligns with environmentally friendly aquaculture practices and could be implemented more widely across the fisheries sector.

MATERIALS AND METHODS

This research was conducted from May to November 2024 at the Fish Parasitology and Disease Laboratory, Faculty of Fisheries and Marine Science, Riau University. The study applied an experimental method using a Completely Randomized Design (CRD) with one factor, namely the addition of turmeric powder and maggots to the feed of *Osphronemus goramy*. Five treatment levels were tested, each replicated three times, resulting in a total of 15 experimental units. In treatments T1, T2, and T3, a single dose of turmeric powder (0.7g/ kg feed) was administered. The treatments consisted of CN (feed without turmeric powder and maggots, not challenged with *Aeromonas hydrophila*), CP

(feed without turmeric powder and maggots, challenged with *A. hydrophila*), T1 (feed supplemented with 20g/ kg maggots and challenged with *A. hydrophila*), T2 (30g/ kg maggots and challenged), and T3 (40g/ kg maggots and challenged).

The research was carried out in several stages. Feed enriched with turmeric and maggots was prepared by slicing fresh turmeric, drying it, and grinding it into powder using a blender. The powder was then mixed with commercial fish pellets. A coating method was used in which turmeric powder was blended with water, mixed with the pellets, and combined with tapioca flour as a binder. Two tablespoons of tapioca flour were dissolved in moderate-temperature water and thickened with boiling water before being mixed with maggot flour and combined with the pellets according to the treatment dosage. The feed was then sun-dried until being completely dry. Fish were fed three times daily (morning, afternoon, and evening) ad libitum.

Test fish maintenance lasted for 46 days. Gourami fry measuring 10– 12cm were acclimatized for seven days prior to the experiment. After acclimatization, baseline body weight and blood samples were collected before the fish were randomly distributed into aquaria at a density of 10 fish per unit. Throughout the experiment, fish were provided commercial feed containing a minimum of 35% crude protein, 2% crude fat, 3% crude fiber, 13% ash, and 12% moisture, supplemented with turmeric powder at 0.7g/ kg feed. Feeding was conducted three times daily at 08:00, 12:00, and 18:00. Growth was monitored every 10 days by randomly sampling three fish from each aquarium for measurement of body length and weight.

On day 31, a challenge test was carried out using *A. hydrophila* at a density of 10^8 CFU/mL, administered intramuscularly at a dose of 0.1mL per fish with a 1mL syringe. Prior to injection, fish were anesthetized with clove oil at a concentration of 0.1 mL/L water. After infection, fish were maintained for another 14 days, during which survival and clinical symptoms were observed.

Blood samples were collected at three stages: prior to treatment (baseline), on day 30, and 14 days post-challenge with *A. hydrophila*. For sampling, fish were anesthetized with clove oil at 0.1 mL/L water until fully immobilized. Syringes and Eppendorf tubes were pre-rinsed with 10% EDTA to prevent clotting. Blood was withdrawn from the caudal vein using a 1 mL syringe and stored in Eppendorf tubes placed in a cool box with ice for subsequent hematological analysis.

The parameters measured in this study were survival rate, growth rate, and clinical symptoms after infection with *A. hydrophila*. Fish survival was monitored twice daily, and dead fish were removed immediately. Growth parameters were assessed every 10 days by measuring the total length with a ruler and body weight with a digital scale. Following infection, clinical signs such as ulceration, hemorrhage, and behavioral changes were observed and recorded along with growth and survival data.

Absolute growth of the fish was calculated using this following formula:

$$Wm = Wt - Wo$$

Description:

Wm = Absolute Growth (g)
Wt = Average weight of fish by the end of the research (g)
Wo = Average weight of fish in the initial day of the research (g)

Daily growth rate was calculated using this following formula:

$$SGR = \frac{LnWt - LnWo}{t} \times 100\%$$

Description

SGR = Specific Growth Rate (%/day),
Wo = Average weight of fish in the initial day of experiment (g),
Wt = Average weight of fish in the -t day (g),
T = Experiment duration (days).

RESULTS

Clinical symptoms in fish treated with feed containing turmeric and maggot differed notably from those in untreated fish. In the positive control (CP) group, the injection site became red and swollen, which later developed into severe ulcers. As the ulcers worsened, the fish became weak, stopped eating, and experienced high mortality. In contrast, fish receiving feed supplemented with turmeric and maggot developed only mild wounds at the injection site, which gradually healed. By day 10, the wounds in these groups was fully recovered. This result suggests that turmeric- and maggot-enriched feed enhances the general immunity of fish, helping them minimize the pathological effects of *Aeromonas hydrophila* infection. Therefore, such feed formulations can be applied in the cultivation of *Osphronemus goramy* to prevent the fatal impacts of *A. hydrophila* outbreaks.

The study highlights the potential of turmeric (*Curcuma longa*) and maggot meal as both preventive and therapeutic dietary strategies against *A. hydrophila* infection in gourami. Clinical observations revealed clear differences between the treatment groups (T1, T2, and T3) and the CP group. Fish in the CP group displayed severe ulceration, redness, swelling, reduced appetite, and high mortality, reflecting their weakened ability to resist infection. Conversely, fish in the treatment groups showed only mild wounds at the injection site, which did not progress into severe ulcers. Complete wound recovery occurred within 14 days, demonstrating that turmeric- and maggot-enriched feed effectively accelerated the healing process and improved immune function.

In terms of growth performance, fish body length and weight were monitored every 10 days. Results showed that fish in all treatment groups grew well throughout the 45-day rearing period, including the 14 days following infection with *A. hydrophila*. Survival

rates were calculated on day 45 and showed significant variation across treatments. The negative control and treatment groups achieved survival rates ranging from 36.67% to 93.33% (Table 1). These findings confirm that supplementation of feed with turmeric and maggot meal positively influenced both growth and survival, while also reducing the severity of clinical symptoms caused by *A. hydrophila* infection.

Table 1. Survival rate of *Osphronemus guramy*

Treatment	Survival rate (%)	
	Pre treatment	45 days
CN	100	$93,33 \pm 11,55^{c}$
CP	100	$36,67 \pm 5,77^{a}$
T1	100	$60,00 \pm 20,00^{b}$
T2	100	$93,33 \pm 5,77^{c}$
T3	100	$76,67 \pm 5,77^{bc}$

Note: *Different superscripts indicate significant differences at $P<0.05$. CN = No turmeric and maggot-enriched feed and not infected with *A. hydrophila*, CP = No turmeric and maggot-enriched feed and infected with *A. hydrophila*, Maggot-enriched feed given at doses of 20 g/kg feed (T1), 30 g/kg feed (T2), 40 g/kg feed (T3)

The results of the study showed that the survival rate of *O. goramy* on day 45 varied among treatments, ranging from 36.67 to 93.33%. The highest survival rate was recorded in the negative control (CN) group and in fish fed with turmeric- and maggot-enriched diets (Table 1). In contrast, the positive control (CP) group, which did not receive turmeric- and maggot-enriched feed and was challenged with *A. hydrophila*, exhibited the lowest survival rate of 36.67%. These findings underscore the important role of natural feed additives such as turmeric (*Curcuma longa*) and maggot meal in enhancing fish resistance to pathogenic bacterial infections.

The absolute growth observed 14 days after bacterial challenge with *A. hydrophila* also varied across treatments. The highest growth (8.10cm) was observed in fish receiving turmeric at 0.7g/ kg feed combined with maggot meal at 30g/ kg feed, which outperformed both T1 and T3. In contrast, the CP group, which was not fed turmeric- and maggot-enriched diets, recorded the lowest growth (1.93cm) (Figs. 1, 2).

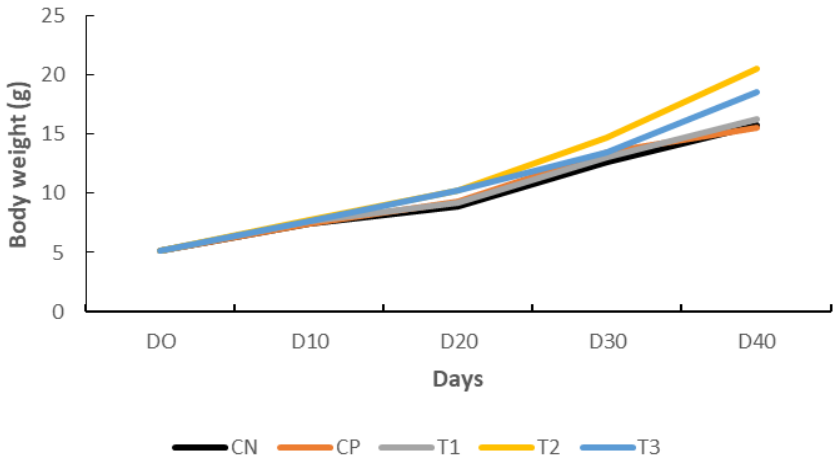

Fig. 1. Body weight of *Osphronemus goramy* that were fed with turmeric and maggot enriched pellets

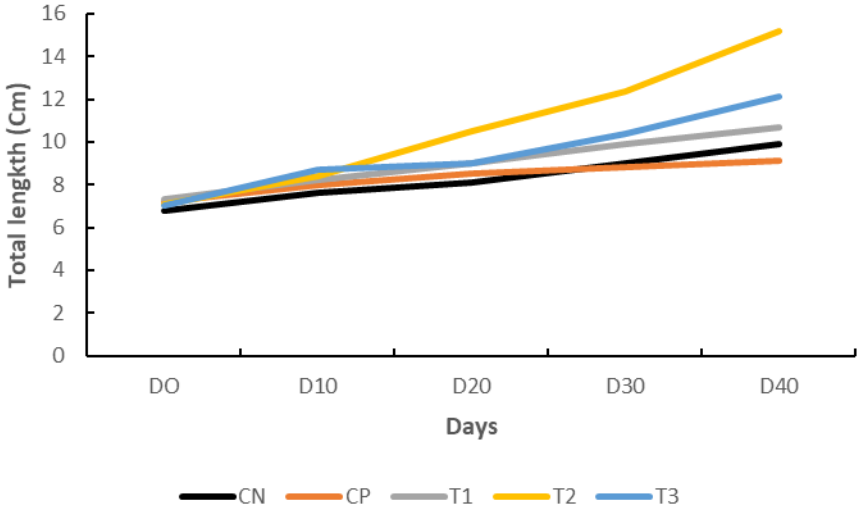

Fig. 2. Body length of *Osphronemus goramy* that were fed with turmeric and maggot enriched pellets

DISCUSSION

Turmeric (*Curcuma longa*) contains curcumin, an active compound with strong anti-inflammatory properties. Curcumin reduces local inflammation in the injection area by inhibiting the production of pro-inflammatory cytokines such as interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α) **(Arifin & Supriyadi, 2021)**. This mechanism minimizes tissue damage caused by infection. In addition, curcumin has antibacterial activity capable of inhibiting the growth of pathogenic bacteria, including *A. hydrophila*. It disrupts bacterial cell membranes, thereby reducing pathogen virulence **(Pratiwi & Nugroho, 2022)**. Curcumin also enhances the activity of immune cells such as

macrophages and neutrophils, which play crucial roles in wound healing and pathogen clearance **(Kari *et al.*, 2022)**.

Maggot meal, derived from *Hermetia illucens* larvae, is rich in high-quality protein and essential fatty acids that support tissue regeneration in infected fish. Its nutritional content accelerates wound healing by facilitating rapid tissue formation **(Arifin & Supriyadi, 2021)**. Furthermore, maggot is known to contain antimicrobial peptides that inhibit bacterial growth, including *A. hydrophila*, by disrupting cell membranes and supporting the immune response **(Pratiwi & Nugroho, 2022)**.

The groups fed turmeric- and maggot-enriched diets demonstrated higher survival rates than the positive control (CP) group. This improvement can be attributed to the synergistic effects of curcumin and maggot nutrition. Curcumin acts as an immunostimulant, antioxidant, and antibacterial agent, stimulating phagocytic activity and enhancing white blood cell production, which strengthens resistance against *A. hydrophila* infection **(Pratiwi & Nugroho, 2022)**. Meanwhile, maggot meal serves as a high-protein source with essential fatty acids that support metabolism, reduce stress, and promote faster recovery from infection **(Arifin & Supriyadi, 2021)**.

The low survival rate observed in the CP group (36.67%) can be explained by the destructive nature of *A. hydrophila*. This pathogen causes hemorrhagic septicemia, severe skin ulceration, and systemic infections, often resulting in high mortality **(Praveen *et al.*, 2019)**. Fish deprived of turmeric and maggot-enriched feed lacked sufficient immune support to withstand infection, which explains the high mortality. Conversely, the treatment groups (T1, T2, and T3) exhibited survival rates ranging from 60.00 to 93.33% on day 45, highlighting the protective role of turmeric and maggot supplementation.

The higher survival rates in treatment groups demonstrate the ability of turmeric and maggot to enhance disease resistance through complementary mechanisms. Turmeric strengthens immune responses and reduces oxidative stress **(Semwal *et al.*, 2023)**, while maggot improves nutritional balance and provides antimicrobial peptides that directly inhibit pathogen activity. Together, these effects minimized clinical symptoms and promoted tissue repair, leading to faster recovery and higher survival rates.

Growth performance data further support these findings. On day 14 post-infection, fish fed turmeric (0.7g/ kg feed) and maggot (30g/ kg feed) exhibited the highest absolute growth (8.10cm in length and 15.37g in weight), significantly outperforming other treatments. In contrast, the CP group recorded the lowest growth (1.93cm in length and 10.40g in weight). Infection by *A. hydrophila* disrupts feeding behavior, metabolism, and organ function, leading to reduced appetite, oxidative stress, and impaired growth **(Kari *et al.*, 2022)**. The enriched diet mitigated these effects, allowing treated fish to continue growing despite pathogen exposure.

Curcumin's immunomodulatory and antioxidant properties likely reduced systemic inflammation and oxidative tissue damage, enabling better feed utilization and energy allocation for growth. At the same time, maggot meal supplied high-quality protein,

essential fatty acids, and micronutrients vital for tissue regeneration and metabolic processes **(Van Huis, 2021)**. This nutritional and immunological synergy explains the superior growth outcomes in turmeric- and maggot-fed fish.

Overall, this study demonstrates that turmeric- and maggot-enriched feed improves both survival and growth of *O. goramy* following *A. hydrophila* infection. The combination enhances immune function, accelerates wound healing, and reduces clinical severity, thereby providing a dual preventive and therapeutic effect. Feed enriched with turmeric and maggot represents a promising functional feed strategy in aquaculture to improve fish resilience, reduce reliance on antibiotics, and minimize losses from bacterial diseases.

CONCLUSION

The use of turmeric and maggot-enriched pellets in *Osphronemus goramy* significantly affects their growth and immunity. This feed has been proven to enhance the fish's resistance to *Aeromonas hydrophila* infections, allowing treated fish to survive and continue growing well despite pathogen exposure. Conversely, fish not provided with the enriched feed exhibited low survival rates due to infection. The best results were achieved with the addition of 30 grams of maggot per kilogram of feed (T2), which resulted in optimal growth and the highest survival rates.

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