The influence of turmeric supplementation in feed on the growth performance of Asian Redtail Catfish (*Hemibagrus nemurus*)

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Abstract. Asian redtail catfish farming faces challenges with low seed production, necessitating improved feeding strategies to boost production. Antioxidants, such as those found in turmeric, are considered crucial feed ingredients. This research investigated the impact of turmeric-enriched feed on the growth performance of Asian redtail catfish. Five experimental treatments were formulated with varying turmeric concentrations: P1: 0.0 g kg^{-1} feed, P2: 0.5 g kg^{-1} feed, P3: 1.0 g kg^{-1} feed, P4: 1.5 g kg^{-1} feed, P5: 2.0 g kg^{-1} feed; each treatment had three replications. 20 juveniles of Asian redtail catfish were reared in 10-liter aquariums. The study duration was 55 days. Fish were fed to satiation three times a day (8:00 AM, 1:00 PM, 6:00 PM). Turmeric-supplemented diets resulted in increased final body weight, greater absolute length, higher specific growth rate, enhanced feed intake, and improved feed conversion ratio. Meanwhile no significant differences were observed in feed efficiency and survival rate. The study demonstrates that incorporating turmeric into the feed can effectively promote growth in Asian redtail catfish. These findings suggest that turmeric supplementation could be a valuable strategy for improving production in Asian redtail catfish culture.

1 Introduction

The Asian redtail catfish (*Hemibagrus nemurus*) holds a prominent position in Indonesia's fishery sector, with particular popularity in Riau Province [1]. Despite high consumer demand, the majority of the supply continues to come from wild catches rather than aquaculture [2]. In aquaculture, feed plays a crucial role in fish development. Optimal feed should meet several criteria: high quality, sufficient quantity, appropriate size and shape for the fish's mouth. These factors are essential as feed provides the energy necessary for fish survival and growth. When fish can digest the feed efficiently, they can better utilize the energy for growth [3].

One of effective strategy to boost fish growth is the addition of immunostimulants to their

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feed [4]. Research has shown that immunostimulants can increase resistance to disease in both fish and shrimp; and promote overall growth [5]. Turmeric has emerged as a promising natural immunostimulant in aquaculture. It has shown potential to improve fish growth rates and enhance appetite [6]. This natural approach to growth stimulation could offer significant benefits in Asian redtail catfish culture.

Turmeric (*Curcuma longa* Linn.) is a widely available and cost-effective herbal ingredient. This rhizomatous plant has gained global popularity due to its diverse applications in culinary, aesthetic, and therapeutic fields [7]. As a tuberous species, turmeric is rich in bioactive compounds, including phenolic compounds, flavonoids, β-carotene, vitamin C and vitamin E. The composition of turmeric includes 9.61% curcumin, 3.18% essential oils, phytosterols, carotene, and vitamin E [8]. Multiple studies have demonstrated the positive effects of turmeric supplementation in fish feed. In Bonylip barb (*Osteochillus kappeni*) with 6 mL kg^{-1} of turmeric extract led to a 90% survival rate [9]. The next research was in Nile tilapia (*Oreochromis niloticus*) used 1.5 g of turmeric resulted in the highest survival rate [10]. Curcumin, a key component of turmeric, has shown benefits for various species: Climbing perch (*Anabas testudineus*) [11], Striped snakehead fish (*Channa striata*) [12], Abalone (*Haliotis squamata*) [13], Grass carp (*Ctenopharyngodon idella*) [14] and Goldfish (*Carrasius auratus*) [15]. These studies reported improvements in both survival and growth rates.

Given the significant potential of turmeric to enhance fish growth and survival rates, further research is warranted. Specifically, there is a need to investigate the effects of turmeric powder supplementation in feed on the survival and growth performance of Asian redtail catfish juveniles.

2 Method

The research was conducted at the Laboratory of Fish Nutrition, Fisheries and Marine Science Faculty, Riau University, Pekanbaru. This setting ensured a thorough and rigorous research process.

Commercial fish feed was used as the foundation for the experimental diets. Turmeric flour was incorporated into the feed at varying doses, as per the experimental treatments. The turmeric was added to the feed using a coating technique. For each kilogram of feed, the following were added: turmeric flour (amount varied by treatment), 1 egg white and 100 mL of water. The ingredients were blended with a hand mixer for 15 minutes to achieve a uniform mixture. The coated feed was then dried in an oven at 40 degrees Celsius for about 5 hours. Once dried, the feed was stored in airtight containers until feeding time for the fish. The prepared feed underwent proximate analysis following the procedures outlined by AOAC [16]. The results of this analysis were presented in Table 1 of the original study.

Table 1. Comprehensive compositional assessment of experimental fish feed

Treatments	Fat (%)	Protein (%)	Crude Fiber (%)	Ash (%)	Moisture (%)
P1	8.67	34.78	8.20	5.70	7.86
P2	8.52	34.86	8.01	5.58	7.64
P3	8.30	35.30	7.95	5.36	7.50
P4	8.10	35.55	7.80	4.90	7.38
P5	7.85	35.69	7.73	4.87	7.15

Note: P1 = 0.0 g turmeric, P2 = 0.5 g turmeric, P3= 1.0 g turmeric, P4 = 1.5 g turmeric, and P5 = 2.0 g turmeric.

The experimental fishes were obtained from a local fish cultivator in Pekanbaru. Prior to the study, fish underwent a 15-day adaptation period, during which they were fed commercial feed (35% protein content) to satiation three times daily. The study commenced on day 17, following a 24-hour fasting period for the test fish. Fishes were weighed to determine their starting weight. Fish were placed in experimental containers at a density of three fish per liter. The rearing period lasted 55 days. Fishes were fed three times daily at 08:00 AM, 01:00 PM, and 06:00 PM (GMT+7). The quantity of feed provided was carefully recorded to assess feed consumption and efficiency.

Regular measurements were taken to ensure consistent water quality across treatments: Dissolved Oxygen (DO): measured using a DO meter, pH: measured using a pH meter, temperature: measured using a thermometer, Total Ammonia Nitrogen (TAN): quantified using the phenate method. The results of these measurements were presented in Table 2 of the original study. Notably, all four parameters (temperature, pH, TAN, and DO) remained consistent across all treatment groups. This meticulous approach to fish care and environmental monitoring ensured that any observed differences in fish growth or health could be attributed to the experimental treatments rather than variations in water quality or other environmental factors.

Table 2. Aquatic environment quality metrics for extended Asian redtail catfish culture

Parameters	Treatments				
	P1	**P2**	**P3**	**P4**	**P5**
pH	6.5-7.0	6.7-7.1	6.6-7.0	6.5-7.0	6.7-7.2
Temperature (°C)	27.6-28.4	27.5-28.6	28.1-28.6	28.0-28.5	27.6-28.4
TAN (mg L^{-1})	0.19-0.31	0.10-0.32	0.17-0.35	0.19-0.33	0.18-0.30
DO (mg L^{-1})	3.45-4.15	3.47-4.97	3.53-4.98	3.52-4.99	3.55-4.00

Note: P1 = 0.0 g turmeric, P2 = 0.5 g turmeric, P3= 1.0 g turmeric, P4 = 1.5 g turmeric, and P5 = 2.0 g turmeric.

The following equations were employed to assess fish growth performance and survival rates:

1) Feed Intake (g) = Total quantity of feed consumed daily over 55 days
2) Specific Growth Rate (SGR, % day^{-1})
   $SGR = [(\ln Wt - \ln W0) / t] \times 100\%$ (1)
3) Feed Conversion Ratio (FCR):
   $FCR = Total\ feed\ consumed / Initial\ total\ fish\ biomass$ (2)
4) Rate of Survival (%):
   $SR = (Final\ fish\ count / Initial\ fish\ count) \times 100\%$ (3)
5) Feed Efficiency (%):
   $FE = [(Wt - W0) / F] \times 100\%$ (4)
   Where:
   - W0: Initial fish biomass weight (g)
   - Wt: Final fish biomass weight (g)
   - F: Total amount of feed given

This study was conducted by using a Complete Randomized Design (CRD) with five levels of turmeric supplementation and three replications. Maintenance aquariums were arranged and place randomly using random numbers [17]. The data collected was arranged in tables using Microsoft Excel. Growth performance data was analyzed through ANOVA with a 95% confidence level, and any significant differences were noted., further analysis was conducted using Duncan's test with SPSS Version 22. This detailed approach to data analysis allowed for an in-depth assessment of the effects of turmeric supplementation on fish growth performance and survival rates. The randomized design and statistical methods added

strength to the study's conclusions.

3 Result and Discussion

The addition of turmeric led to notable enhancements in several essential growth parameters in fish ($P < 0.05$), such as final biomass (Bt), final average body weight (Wt), absolute length (Lt), specific growth rate (SGR), feed intake, and feed conversion ratio (FCR). However, it did not have a significant impact on feed efficiency (FE) or survival rate (SR) ($P > 0.05$), as detailed in Table 3

Table 3. Growth performance of Asian redtail catfish for 55 days

Parameters	Treatments				
	P1	**P2**	**P3**	**P4**	**P5**
Wt (g)	9.94±0.26^{ab}	10.90±0.55^{bc}	10.83±0.18^{bc}	11.71±0.33^{c}	9.51±0.31^{a}
Bt (g)	122.50±12.56^{a}	138.34 ±10.11^{ab}	138.29 ±6.93^{ab}	160.21 ±8.35^{b}	119.97 ±6.30^{a}
Lt (cm)	2.69±0.32^{a}	3.08±0.11^{ab}	3.05±0.20^{ab}	3.50±0.14^{b}	3.08±0.17^{ab}
SGR (%/day)	13.18±0.40^{ab}	15.06±0.89^{bc}	15.32±0.60^{c}	16.96±0.55^{c}	12.62±0.47^{a}
Feed Intake (g)	136.33±20.00^{a}	160.00±15.89^{ab}	162.00±11.93^{ab}	193.00±14.57^{b}	132.66±12.99^{a}
FCR	1.66±0.02^{c}	1.63±0.02^{bc}	1.59±0.01^{ab}	1.55±0.02^{a}	1.62±0.02^{bc}
FE (%)	63.96±1.90^{a}	64.10±1.40^{a}	65.58±0.76^{a}	66.05±1.01^{a}	65.07±1.44^{a}
SR (%)	81.33±7.86^{a}	83.67±2.33^{a}	83.67±5.61^{a}	83.67±2.00^{a}	90.00±5.61^{a}

Note: P1 = 0.0 g turmeric, P2 = 0.5 g turmeric, P3= 1.0 g turmeric, P4 = 1.5 g turmeric, and P5 = 2.0 g turmeric.

Recent rapid expansion in the aquaculture sector has led to the widespread use of intensive and stressful rearing conditions, contributing to the emergence of infectious diseases [18]. As an alternative to antibiotics, herbal remedies particularly turmeric or curcumin have shown promise in various fish species [19-20]. This study aimed to investigate the effects of dietary turmeric supplementation on Asian redtail catfish, exploring the potential benefits and applications of this important herb.

According to Table 3, feed efficiency and fish survival rates did not differ significantly across treatments ($P > 0.5$). The addition of turmeric flour at 1.5 g kg^{-1} feed (P4 treatment) yielded notable improvements. This treatment resulted in increased final fish size (Wt), final fish biomass (Bt), absolute length (Lt), specific growth rate (SGR), and total feed intake compared to other treatments. Moreover, the P4 treatment exhibited the lowest feed conversion ratio (FCR). This dosage is considered optimal as turmeric flour supplementation can enhance catfish digestion, thereby improving the absorption of feed nutrients [2]. The primary component of turmeric rhizome, curcumin, is known to stimulate appetite. Additionally, its essential oils act as antioxidants, providing substantial benefits for fish growth [21].

Research has demonstrated that turmeric powder supplementation positively affects feed utilization parameters, including feed conversion ratio (FCR) and feed consumption, in silver catfish (*Rhamdia quelen*) and Nile tilapia (*Oreochromis niloticus*) [22, 23]. From an economic perspective, even a small change in FCR can significantly impact production costs, particularly feed expenses. Beyond enhancing feed utilization, turmeric flour

supplementation in feed has also been shown to improve fish growth performance. A study by [24] found that adding turmeric to feed increased absolute growth and specific growth rates in Pomfret fish (*Colossoma macropomum*). Similarly, rainbow trout (*Oncorhynchus mykiss*) reared under high stocking density conditions exhibited remarkably improved growth performance when fed a diet supplemented with 200 mg kg^{-1} of curcumin [25]. These findings align with previous research highlighting curcumin's diverse beneficial properties, including antioxidant, anti-inflammatory, antibacterial, anticancer, antidiabetic, antiviral, antifungal, wound healing, and immunomodulatory effects [26-28].

The efficacy of turmeric flour supplementation in feed is dose-dependent. Additionally, factors such as genetics, species, nutrient composition, rearing conditions, and environmental variables can contribute to varying results across studies. However, this research concludes that turmeric flour supplementation exceeding 2 g kg^{-1} feed negatively impacts the growth and feed efficiency of Asian redtail catfish. [29] reported that excessive doses of turmeric flour in feed can disrupt metabolic processes, impede growth, and induce stress-related mortality in fish.

4 Conclusion

In conclusion, this study demonstrates that incorporating turmeric in feed can enhance the growth performance of Asian redtail catfish. The research indicates that the optimal dosage for maximizing growth is 1.5 g of turmeric per kg of feed.

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