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EFFECT OF CHROMIUM PICOLINATE SUPPLEMENTATION IN ARTIFICIAL FEED ON THE GROWTH PERFORMANCE OF HOVEN'S CARP (*Leptobarbus hoevenii*) FINGERLINGS

Pengaruh Penambahan Kromium Picolinate dalam Pakan Buatan Terhadap Kinerja Pertumbuhan Benih Ikan Jelawat (*Leptobarbus hoevenii*)

Feby Yanti[1], Adi Susanto[2*], Sumoharjo[3]

[1]Aquaculture Study Program, Faculty of Fisheries and Marine Science, Mulawarman University
[2]Fish Nutrition Laboratory, Faculty of Fisheries and Marine Science, Mulawarman University
[3]Aquaculture Technology Systems Laboratory, Faculty of Fisheries and Marine Science, Mulawarman University

Kampus Gunung Kelua, Jalan Gunung Tabur No.1 Samarinda, 75123

*Corresponding Author: adisusanto@fpik.unmul.ac.id

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ABSTRACT

This study evaluated the effects of dietary chromium picolinate (Cr-Pic) supplementation on the growth performance and feed efficiency of Hoven's carp (*Leptobarbus hoevenii*) fingerlings, and aimed to determine the optimal dosage. A Completely Randomized Design (CRD) was applied with four treatments and four replications: P0 (0 mg/kg), P1 (1.5 mg/kg), P2 (3.0 mg/kg), and P3 (4.5 mg/kg). The observed parameters included absolute weight gain, total length growth, specific growth rate (SGR), and feed conversion ratio (FCR). The results showed that dietary Cr-Pic supplementation significantly affected ($P<0.05$) absolute weight gain, total length growth, and FCR, but had no significant effect on SGR. The best performance was observed in treatment P2 (3.0 mg/kg), which produced the highest growth and feed efficiency compared to other treatments. In conclusion, chromium picolinate supplementation at a dose of 3.0 mg/kg feed is recommended to improve growth performance and feed utilization efficiency in Hoven's carp fingerlings.

Keywords: Efficiency, Feed, Length, Supplementation, Weight

ABSTRAK

Penelitian ini bertujuan untuk mengevaluasi pengaruh suplementasi kromium pikolinat (Cr-Pic) dalam pakan buatan terhadap kinerja pertumbuhan dan efisiensi pakan benih ikan jelawat (*Leptobarbus hoevenii*), serta menentukan dosis terbaiknya. Penelitian menggunakan Rancangan Acak Lengkap (RAL) dengan empat perlakuan dan empat ulangan, yaitu P0 (0 mg/kg), P1 (1,5 mg/kg), P2 (3,0 mg/kg), dan P3 (4,5 mg/kg). Parameter yang diamati meliputi pertumbuhan berat mutlak, pertumbuhan panjang total, laju pertumbuhan harian spesifik (SGR), dan rasio konversi pakan (FCR). Hasil penelitian menunjukkan bahwa suplementasi

Cr-Pic berpengaruh nyata (P<0,05) terhadap pertumbuhan berat mutlak, pertumbuhan panjang total, dan FCR, namun tidak berpengaruh nyata terhadap SGR. Perlakuan terbaik diperoleh pada P2 (3,0 mg/kg), yang menghasilkan pertumbuhan dan efisiensi pakan tertinggi dibandingkan perlakuan lainnya. Suplementasi kromium pikolinat pada dosis 3,0 mg/kg pakan dapat direkomendasikan untuk meningkatkan kinerja pertumbuhan dan efisiensi pemanfaatan pakan pada benih ikan jelawat.

Kata Kunci: Berat, Panjang, Pakan, Suplementasi, Efisiensi

INTRODUCTION

The Hoven's carp (*Leptobarbus hoevenii*) is a freshwater fish commodity with high economic value and significant potential for development in aquaculture systems in Indonesia, particularly in Kalimantan (Beolens et al., 2023). However, during the fingerlings stage, Hoven's carp growth remains relatively low, and feed utilization efficiency is suboptimal. This situation is a major obstacle to increasing aquaculture productivity, given that feed contributes approximately 60–70% of total production costs (Kumar, 2024). Therefore, strategies to improve feed efficiency are crucial to support the sustainability of Hoven's carp farming (FAO, 2022).

One emerging approach to fish nutrition is the use of microminerals as feed additives, particularly those that play a role in metabolic regulation. Chromium is an essential mineral known to play a role in increasing insulin sensitivity through the glucose tolerance factor (GTF) mechanism (Vincent, 2017; Costello et al., 2019). Increased insulin sensitivity accelerates glucose transport into cells, resulting in more efficient utilization of carbohydrates as an energy source. Thus, protein in feed can be better utilized for tissue synthesis (protein sparing effect), which ultimately contributes to increased fish growth (Vincent, 2017; Shivkumar et al., 2025).

In practice, chromium is available in both inorganic and organic forms, with organic forms such as chromium picolinate (Cr-Pic) reportedly having higher bioavailability (Giri et al., 2021). Several studies have shown that Cr-Pic supplementation in feed can improve growth performance, feed efficiency, protein retention, and glucose metabolism in various fish species, such as tilapia and carp (Ren et al., 2018; Li et al., 2018). However, the response to chromium supplementation is strongly influenced by fish species, dosage, and environmental conditions. Most previous research has focused on common farmed fish species such as *Labeo rohita*, catfish (*Clarias* sp.), tilapia (*Oreochromis niloticus*), carp (*Cyprinus carpio*), and freshwater pompano (*Colossoma macropomum*) (Shivkumar et al., 2025; Putri et al., 2020; Li et al., 2018; Ahmed et al., 2012; Susanto et al., 2007), while information on the utilization of chromium picolinate in local Indonesian species, particularly the Hoven's carp (*Leptobarbus hoevenii*), remains very limited. Furthermore, data on the optimal dose of chromium supplementation that is effective in increasing growth and feed efficiency in the Hoven's carp fingerlings phase has also been scarce. This limited information presents an important research gap requiring further study.

Based on the above description, this study was conducted to evaluate the effect of chromium picolinate supplementation in artificial feed on the growth performance and feed utilization efficiency of Hoven's carp fingerlings, and to determine the optimal dosage that produces the best results. This research is expected to provide scientific contributions to the development of micromineral-based nutritional strategies, as well as serve as a basis for more efficient and sustainable feed formulations for Hoven's carp cultivation.

RESEARCH METHODS

This research was conducted over 60 days, from October to December 2025, at the Fish Nutrition Laboratory, Faculty of Fisheries and Marine Sciences, Mulawarman University, Samarinda.

Test Materials and Feed

The main materials used included Hoven's carp (*Leptobarbus hoevenii*) fingerlings and artificial pellet feed supplemented with chromium picolinate (Cr-Pic). The test feed was formulated with a crude protein content of approximately 30% and an energy content tailored to the needs of the freshwater fingerlings. Chromium picolinate was added to the feed according to the treatment dosage, then mixed homogeneously using a dry-wet mixing method, molded into pellets, and dried at room temperature until the moisture content stabilized. The feed formulation used in this research is presented in Table 1.

Table 1. Hoven's carp Feed Formulation with Cr-Pic Supplementation

Source of Feed Ingredients	Composition (mg/kg feed) (dry weight)			
	P0 (0.0 mg Cr-Pic)	P1 (1.5 mg Cr-Pic)	P2 (3.0 mg Cr-Pic)	P3 (4.5 mg Cr-Pic)
Fish Meal	21.50	21.50	21.50	21.50
Soybean Meal	25.00	25.00	25.00	25.00
Bran Meal	28.00	28.00	28.00	28.00
Fish Oil	2.80	2.80	2.80	2.80
Corn Oil	2.80	2.80	2.80	2.80
Vitamin Mix	3.00	3.00	3.00	3.00
Coline Chlorida	2.00	2.00	2.00	2.00
CMC	3.00	3.00	3.00	3.00
	100.00	100.00	100.00	100.00
Protein Content (%)	30.06	30.06	30.06	30.06
Fat Content (%)	8.08	8.08	8.08	8.08
KH Content (%)	31.88	31.88	31.88	31.88
Energy (Calories)	241.15	241.15	241.15	241.15
C/P (Calories/Protein)	8.02	8.02	8.02	8.02

Test Animals and Maintenance Conditions

The Hoven's carp fingerlings used had an average initial weight of 2.5 ± 0.3 g and relatively uniform initial length. The fish were acclimatized for 7 days prior to the experiment. Sixteen plastic tanks measuring approximately 29 × 40 × 30 cm^3 were used, filled with 35 L of water and equipped with a semi-closed aeration system. Each experimental unit housed 20 fish, for a total of 320 fish. During the rearing period, water quality was maintained by replacing 30–50% of the water every 2–3 days.

Research Design

This study employed an experimental method with a Completely Randomized Design (CRD) consisting of four treatments and four replications. The treatment assignment to each experimental unit was randomized. The treatment was the addition of chromium picolinate to the feed at the following doses:

P0 : 0.0 mg kg^{-1} feed (control)
P1 : 1.5 mg kg^{-1} feed
P2 : 3.0 mg kg^{-1} feed

P3 : 4.5 mg kg^{-1} feed

Research Procedure

Fish were fed three times daily (morning, noon, and evening) at a feeding rate of ±3% of their biomass weight per day, adjusted every 10 days based on weighing results. Feed was provided in a controlled manner to minimize feed waste in the rearing medium. Throughout the study, the amount of feed given and any remaining feed (if any) were recorded to calculate the feed conversion ratio.

Data Collection

Data collection was conducted on growth data by weighing and measuring the length of the fish at the beginning and end of the study. The observed parameters were calculated using the following standard formula:

a. Absolute weight growth (g) was calculated using the Tacon & Metian (2015) formula as follows:

$$W = Wt - W0$$

Where:
W : Absolute weight growth (g).
Wt : Final maintenance weight (g).
Wo : Initial maintenance weight (g).

b. Total length growth (cm) was calculated using the Lucas et al. (2015) formula as follows:

$$\Delta L = Lt - Lo$$

Where:
ΔL : Total length growth (cm)
Lt : Final average total length (cm)
L0 : Initial average total length (cm)

c. The specific daily growth rate was calculated using the Muchlisin et al. (2016) formula as follows:

$$SGR = \left(\frac{LnWt - LnWo}{t}\right) \times 100\%$$

Where:
SGR : Specific daily growth rate (%/day)
Wt : Fish weight at the end of the study (g)
Wo : Fish weight at the beginning of the study (g)
t : Length of study (days)

d. The Feed Conversion Ratio was calculated using the Tacon & Metian (2015) formula as follows:

$$KP = \frac{F}{((Wt - Wo) + D)}$$

Where:
KP : Feed conversion rate
Wt : Total fish weight at the end of the study (g)
Wo : Total fish weight at the beginning of the study (g)
D : Total weight of fish that died during the study (g)
F : Total amount of feed given (g)

Water Quality

The water quality parameters observed included temperature (daily), pH, dissolved oxygen (DO), and ammonia (weekly). Measurements were made using a thermometer, pH

meter, DO meter, and ammonia test kit. Throughout the study, water quality was maintained within a range that supports freshwater fish growth.

Data Analysis

The obtained data were analyzed using analysis of variance (ANOVA) at a 95% confidence level to determine the effect of the treatments on the observed parameters. If the results showed significant differences, Duncan's Multiple Range Test (DMRT) was further used to determine differences between treatments. All statistical analyses were performed using SPSS statistical software.

RESULT

Absolute Weight Growth

The results showed that chromium picolinate supplementation significantly affected the absolute weight growth of Hoven's carp fingerlings ($P<0.05$), with the highest value obtained in treatment P2 (3.0 mg/kg feed) (Figure 1). This indicates that chromium supplementation at the optimal dose significantly increased fish biomass growth compared to the control.

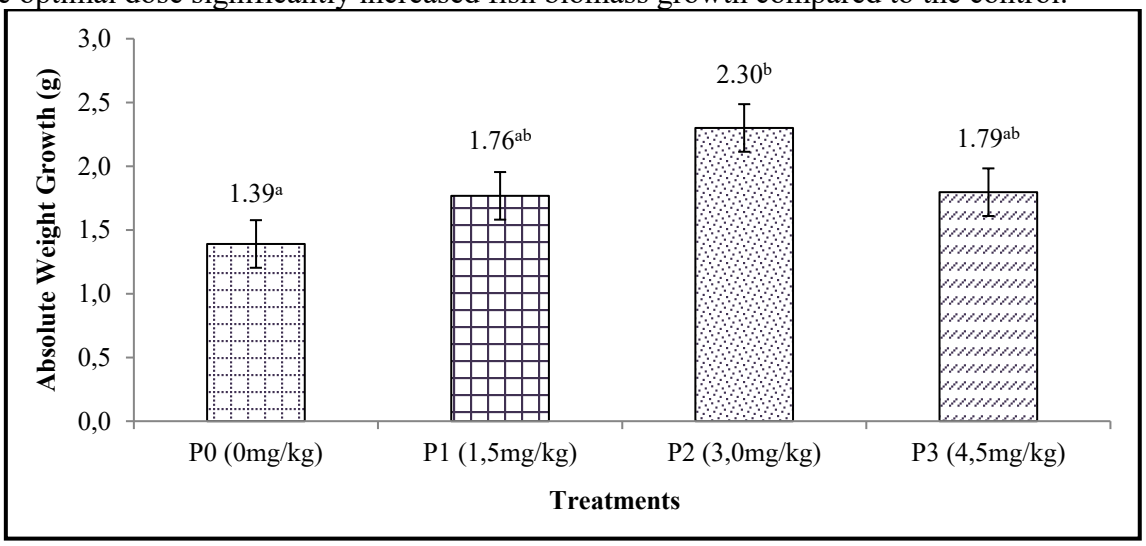

Figure 1. Absolute Weight Growth

Note: Mean values followed by the same letter indicate no significant difference at the 5% level ($p>0.05$).

Total Length Growth

Chromium picolinate supplementation also significantly affected the total length growth of Hoven's carp fingerlings ($P<0.05$), with the highest value in treatment P2 (Figure 2). This indicates that growth increases not only occur in biomass but also in the structural growth of the fish's body.

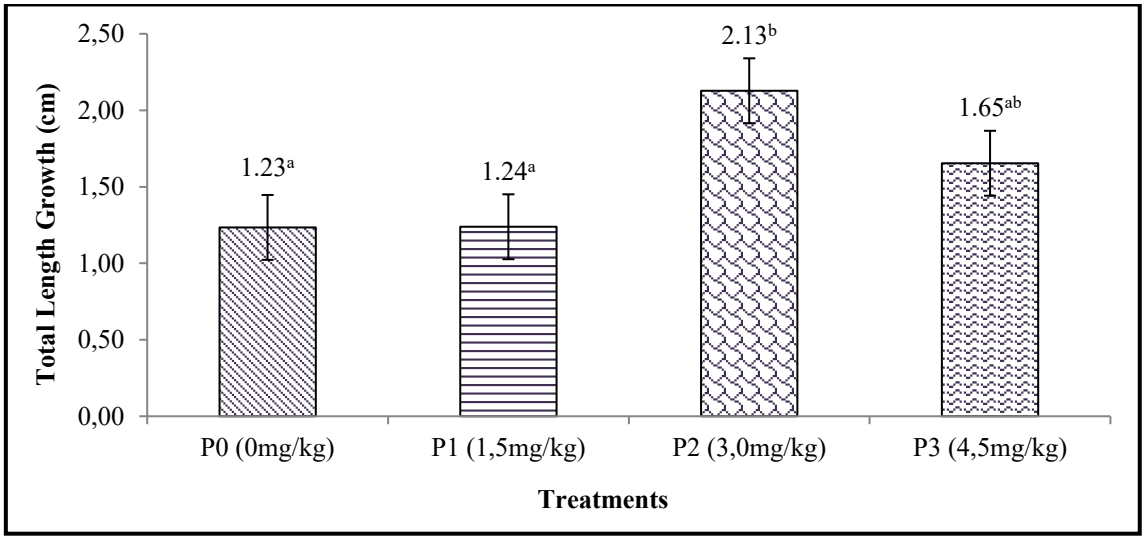

Figure 2. Total Length Growth

Note: Mean values followed by the same letter indicate no significant difference at the 5% level (p>0.05).

According to Figure 2, treatment P2 also demonstrated the highest length growth value. ANOVA results (α = 0.05) indicate that the treatment significantly affected length growth. The DMRT test showed that P2 was not significantly different from P3, but was significantly different from P0 and P1.

Specific Growth Rate (SGR)

The analysis results showed that chromium picolinate supplementation had no significant effect on SGR (P>0.05), although descriptively, the highest value was still obtained in treatment P2 (Figure 3). This indicates that the relative growth response of the fish to the treatments tended to be homogeneous across treatments.

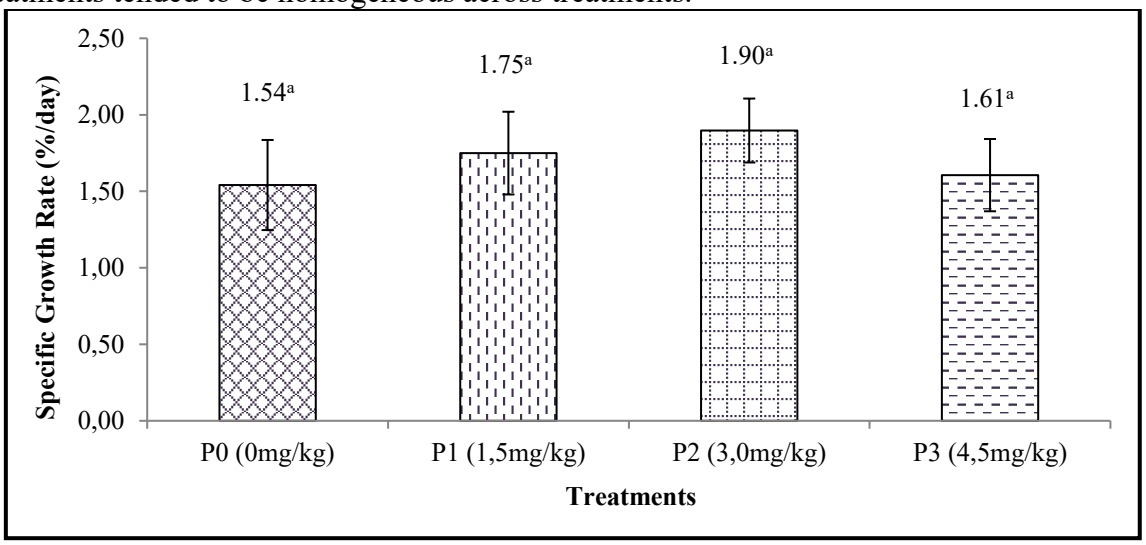

Figure 3. Specific Growth Rate

Note: Mean values followed by the same letter indicate no significant difference at the 5% level (p>0.05)

Feed Conversion Ratio (FCR)

The results showed that chromium picolinate supplementation significantly affected the FCR value (P<0.05), with the best (lowest) value obtained in treatment P2 (Figure 4). A low FCR value indicates that feed is more efficiently converted into fish biomass.

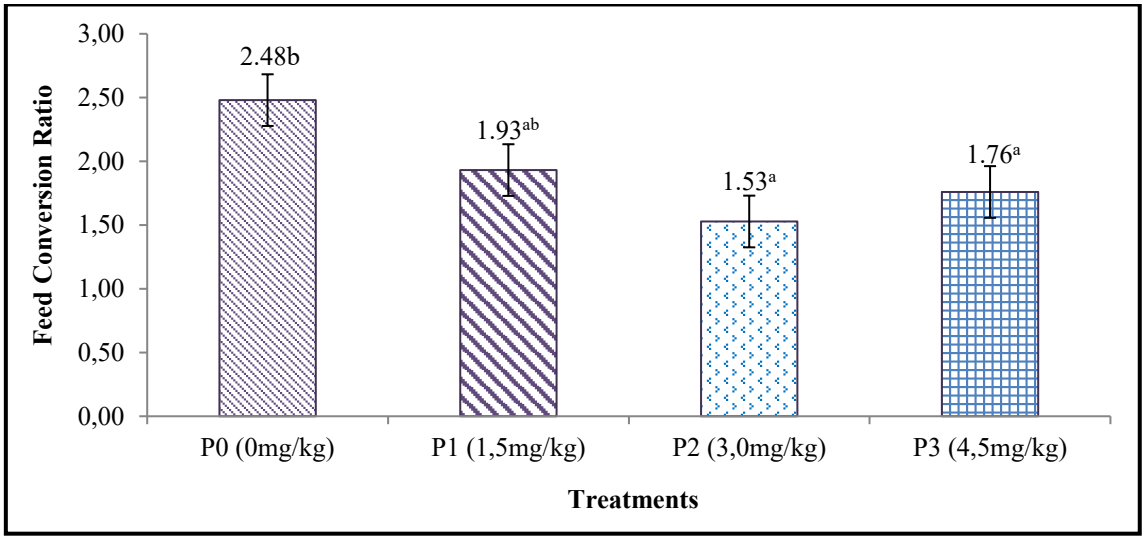

Figure 4. Feed Conversion Ratio

Note: Mean values followed by the same letter indicate no significant difference at the 5% level (p>0.05)

Water Quality

Water quality parameters during the study indicated that temperature and dissolved oxygen levels were within the range that supports freshwater fish growth. However, the pH value, which ranged from 5.37–5.58, was slightly acidic compared to the general optimal range for freshwater fish (around 6.5–8.5). The results of water quality measurements are presented in Table 2.

Table 2. Water Quality of the Maintenance Media for Hoven's carp Fingerlings

Water Quality Parameters			
Temperature (°C)	pH	DO (mg/L)	Ammonia (mg/L)
24.1-28.5	5.37 – 5.58	6.39 - 6.50	0.0002 - 0.0005

DISCUSSION

The increase in absolute weight gain in the P2 treatment is thought to be related to chromium's role in increasing insulin sensitivity through the glucose tolerance factor (GTF) mechanism, which functions to increase the efficiency of glucose transport into cells. The increased utilization of carbohydrates as an energy source allows protein in the feed to be more directed toward body tissue synthesis (protein sparing effect), thus increasing fish growth (Vincent & Edwards, 2019; Shivkumar et al., 2025). However, at a higher dose (P3), growth did not increase further, indicating an optimal limit for chromium supplementation (Akter et al., 2021). Excess chromium can cause metabolic imbalances or decreased nutrient utilization efficiency, resulting in a decreased or stagnant growth response (Nur et al., 2020).

These results align with studies in several fish species, such as tilapia and carp, which show that moderate doses of chromium supplementation can increase growth, but the effect diminishes at higher doses (Ren et al., 2018; Shivkumar et al., 2025). Thus, the fish growth response to chromium is dose-response, with an optimum curve pattern.

Physiologically, length growth is related to tissue hyperplasia and hypertrophy, which are strongly influenced by energy availability and metabolic efficiency. Chromium's role in enhancing glucose utilization ensures sufficient energy to support cell division and enlargement, thus increasing fish length growth (Asad, 2017; Mehrim, 2014). The absence of significant differences between P2 and P3 indicates that at a certain dose, the fish's physiological needs for chromium have been met, so that additional doses no longer produce a

significant response. This confirms the existence of an optimum limit for micromineral supplementation in the diet.

The insignificant Specific Growth Rate (SGR) is likely due to the relatively high biological variation during the fingerlings stage, making differences between treatments less statistically detectable. Furthermore, the logarithmic SGR parameter is more sensitive to small fluctuations in individual weight than absolute growth parameters (Glencross, 2020). Other contributing factors are the relatively short rearing duration and the small initial size of the fish, which may limit the sensitivity of the SGR parameter in optimally describing the growth response. Although not statistically significantly different, the tendency for an increase in SGR values in the chromium supplementation treatment indicates a positive physiological response to the treatment given.

The improved feed utilization efficiency in the P2 treatment is thought to be related to improved glucose metabolism due to chromium's role in enhancing insulin sensitivity. With increased energy utilization from carbohydrates, protein in the feed can be utilized more efficiently for growth, thereby reducing the FCR (protein sparing effect) (Vincent, 2017; Ren et al., 2018). Conversely, at a higher dose (P3), the FCR value increased again, indicating a decrease in feed utilization efficiency. This indicates that excess chromium can disrupt metabolic balance or reduce nutrient absorption efficiency (Wang et al., 2019). These results are consistent with previous studies showing that chromium supplementation at optimal doses can improve feed efficiency. However, the effect is nonlinear and tends to decrease at higher doses (Ko et al., 2019; Qamer et al., 2019; Li et al., 2018).

Water quality parameters during the study indicated that temperature and dissolved oxygen levels were within the range that supports freshwater fish growth (Effendi, 2003). However, the pH values ranging from 5.37–5.58 are considered slightly acidic compared to the general optimal range for freshwater fish (around 6.5–8.5). Nevertheless, the Hoven's carp is known to tolerate water conditions with relatively low pH, so these conditions can still be tolerated without causing significant stress. The stability of water quality parameters during the study indicates that environmental factors were relatively controlled, so that the differences in growth that occurred were more influenced by the feed treatment than environmental factors.

CONCLUSION

Chromium picolinate supplementation in artificial feed affects the growth performance of Hoven's carp (*Leptobarbus hoevenii*) fingerlings. Chromium picolinate supplementation at a dose of 3.0 mg/kg feed (P2) provided the best results in increasing absolute weight growth, total length growth, and feed efficiency (FCR), but had no significant effect on the specific daily growth rate (SGR). Therefore, a dose of 3.0 mg/kg feed is the optimal dose for improving growth performance and feed utilization efficiency in Hoven's carp (*Leptobarbus hoevenii*) fingerlings.

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