Effects of Replacing Fish Meal with Poultry Meal on Growth Performance, Feed Utilization, Digestive Enzyme Activity, and Antioxidant Capacity in Juvenile Yellow Catfish (Pelteobagrus fulvidraco) Postprint

Authors: Luo Jiaxiang, Huang Wenwen, Yuan Ye, Li Chenchen, Zhu Tingting, Zhou Qicun

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Abstract

This experiment aimed to investigate the effects of replacing fish meal with chicken meal on growth performance, feed utilization, digestive enzyme activity, and antioxidant capacity in juvenile yellow catfish (Pelteobagrus fulvidraco).

Full Text

Effects of Fish Meal Replacement with Poultry By-Product Meal on Growth Performance, Feed Utilization, Digestive Enzyme Activities and Antioxidant Capacity of Juvenile Yellow Catfish (Pelteobagrus fulvidraco)

LUO Jiaxiang, HUANG Wenwen, YUAN Ye, LI Chenchen, ZHU Tingting, ZHOU Qicun*

Laboratory of Fish Nutrition, School of Marine Sciences, Ningbo University, Ningbo 315211, China

Abstract: An 8-week feeding trial was conducted to evaluate the effects of replacing fish meal (FM) with poultry by-product meal (PBM) on growth performance, feed utilization, digestive enzyme activities, and antioxidant capacity of juvenile yellow catfish (*Pelteobagrus fulvidraco*). Six iso-nitrogenous and iso-lipidic diets were formulated with PBM replacing FM at 0%, 10%, 20%, 30%, 40%, and 60% (corresponding to PBM supplementation levels of 0, 5.25%, 10.51%, 15.77%, 21.03%, and 31.54%, respectively). All diets contained 45% crude protein and 10% crude lipid. A total of 540 juvenile yellow catfish with

an initial body weight of (2.17$±$0.02) g were randomly allocated into 6 groups with 3 replicates per group and 30 fish per replicate. The results showed that survival rate was not significantly affected by FM replacement level (P>0.05). Weight gain rate (WGR), specific growth rate (SGR), feed efficiency (FE), and protein efficiency ratio (PER) significantly increased when FM replacement increased from 0% to 20% (P<0.05), but significantly decreased when FM replacement increased from 30% to 60% (P<0.05). Condition factor (CF), intraperitoneal fat ratio (IPF), and viscerosomatic index (VSI) were not significantly affected by FM replacement (P>0.05). No significant differences were observed in dry matter, crude protein, crude lipid, or ash contents of whole body and muscle among all groups (P>0.05). Stomach pepsin (PEP) activity in the control group was significantly lower than in other groups (P<0.05). Stomach amylase (AMY) activity significantly increased when FM replacement exceeded 10% compared to the control (P<0.05). Foregut AMY activity in the 10% FM replacement group was significantly higher than in the control (P<0.05), and liver AMY activity in the 30% FM replacement group was significantly higher than in the control (P<0.05). Serum aspartate aminotransferase (AST) activity showed no significant differences among FM replacement groups compared to the control (P>0.05). However, serum alanine aminotransferase (ALT) activity and triglyceride (TG) and total cholesterol (TC) contents reached their highest values in the 30% FM replacement group, which were significantly higher than in the control (P<0.05). Liver superoxide dismutase (SOD) activity peaked in the 20% FM replacement group and was significantly higher than in the control (P<0.05). Liver malondialdehyde (MDA) content in the 40% and 60% FM replacement groups was significantly higher than in the control (P<0.05). No significant differences were found in liver catalase (CAT) activity among all groups (P>0.05). Using WGR as the evaluation index, broken-line model analysis estimated the optimal FM replacement level with PBM to be 20.84%.

Keywords: *Pelteobagrus fulvidraco*; poultry by-product meal; fish meal; growth performance; feed utilization; antioxidant capacity

1. Introduction

Fish meal has traditionally been the primary protein source in aquafeeds due to its balanced amino acid profile, high digestibility, and palatability. However, increasing demand and limited supply have driven up costs and raised sustainability concerns. Poultry by-product meal has emerged as a promising alternative protein source, with crude protein content ranging from 65% to 73% and crude lipid content from 9% to 12%. Previous studies have demonstrated successful FM replacement with PBM in various fish species including *Nibea miichthioides*, *Scophthalmus maeoticus*, and *Rachycentron canadum*. However, the optimal replacement level varies among species, and excessive replacement may negatively affect growth performance, feed utilization, and physiological status. This study investigated the effects of graded levels of FM replacement

with PBM on juvenile yellow catfish to determine the optimal inclusion level.

1.1 Experimental Diets

Six experimental diets were formulated to be iso-nitrogenous (45% crude protein) and iso-lipidic (10% crude lipid). PBM was included at 0, 5.25%, 10.51%, 15.77%, 21.03%, and 31.54% to replace 0, 10%, 20%, 30%, 40%, and 60% of FM, respectively. The diet compositions and nutrient levels are presented in , and amino acid compositions are shown in .

1.2 Experimental Animals and Feeding Management

Juvenile yellow catfish were obtained from a commercial hatchery and acclimated for two weeks. A total of 540 fish with an initial body weight of (2.17$±$0.02) g were randomly distributed into 18 fiberglass tanks (300 L capacity) at a density of 30 fish per tank. Each diet was randomly assigned to three replicate tanks. Fish were hand-fed to apparent satiation twice daily (07:30 and 17:00) for 8 weeks. Water temperature was maintained at 26.0–29.5°C, pH at 7.5–8.0, and dissolved oxygen above 6.0 mg/L.

1.3 Sample Collection

At the end of the feeding trial, fish were fasted for 24 hours before sampling. Fish from each tank were anesthetized and weighed. Five fish per tank were randomly selected for whole-body composition analysis. Blood samples were collected from the caudal vein of three fish per tank and centrifuged at 3000 r/min for 10 minutes to obtain serum, which was stored at -80°C for analysis. Liver and intestine samples were collected for enzyme activity assays.

1.5 Statistical Analysis

All data were expressed as mean±SD and analyzed using SPSS 17.0 software. One-way ANOVA was performed followed by Turkey's multiple comparison test. Differences were considered significant at $P<0.05$.

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2. Results

2.1 Growth Performance and Feed Utilization Growth performance and feed utilization parameters are presented in . Survival rate was 100% across all groups and was not significantly affected by FM replacement ($P>0.05$). WGR and SGR significantly increased when FM replacement increased from 0% to 20% ($P<0.05$), but significantly decreased when FM replacement increased from 30% to 60% ($P<0.05$). CF, VSI, and IPF showed no significant differences among groups ($P>0.05$). Based on WGR, broken-line model analysis estimated the optimal FM replacement level to be 20.84% [Figure 1: see original paper].

2.2 Digestive Enzyme Activities Feed utilization and digestive enzyme activities are shown in . FE and PER were significantly higher in the 20% FM replacement group compared to the control ($P<0.05$). Stomach PEP activity in the control group was significantly lower than in other groups ($P<0.05$). Stomach AMY activity significantly increased when FM replacement exceeded 10% ($P<0.05$). Foregut AMY activity in the 10% FM replacement group was significantly higher than in the control ($P<0.05$). Liver AMY activity in the 30% FM replacement group was significantly higher than in the control ($P<0.05$).

2.3 Body Composition Whole-body and muscle proximate composition are presented in . No significant differences were observed in dry matter, crude protein, crude lipid, or ash contents of whole body or muscle among all groups ($P>0.05$).

2.4 Serum Biochemical Indices Serum biochemical parameters are shown in . Total protein (TP) and albumin (ALB) showed no significant differences among groups ($P>0.05$). Aspartate aminotransferase (AST) activity was not significantly affected by FM replacement ($P>0.05$). However, alanine aminotransferase (ALT) activity and triglyceride (TG) and total cholesterol (TC) contents reached their highest values in the 30% FM replacement group, which were significantly higher than in the control ($P<0.05$).

2.5 Antioxidant Capacity Antioxidant indices are presented in . Liver superoxide dismutase (SOD) activity peaked in the 20% FM replacement group and was significantly higher than in the control ($P<0.05$). Liver malondialdehyde (MDA) content in the 40% and 60% FM replacement groups was significantly higher than in the control ($P<0.05$). No significant differences were found in liver catalase (CAT) activity among all groups ($P>0.05$).

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3. Discussion

The present study demonstrated that FM replacement with PBM up to 20% improved growth performance and feed utilization in juvenile yellow catfish, while higher replacement levels (30–60%) negatively affected these parameters. This is consistent with findings in other species such as *Cyprinus carpio* and *Morone chrysops* × *M. saxatilis*, where moderate PBM inclusion enhanced performance but excessive replacement impaired growth. The optimal replacement level of 20.84% determined by broken-line analysis suggests that PBM can partially substitute FM without compromising growth.

The increased digestive enzyme activities (PEP and AMY) observed with PBM inclusion indicate enhanced digestive function, possibly due to the presence of bioactive peptides in PBM. However, the elevated ALT activity and lipid metabolism indicators (TG and TC) at 30% replacement suggest potential metabolic stress at higher inclusion levels.

The antioxidant capacity results showed that SOD activity increased at 20% replacement, indicating improved antioxidant defense, while MDA accumulation at 40–60% replacement suggests oxidative damage at high PBM levels. This may be attributed to imbalanced amino acid profiles or anti-nutritional factors in PBM at high inclusion rates.

4. Conclusion

Based on growth performance, feed utilization, and physiological responses, the optimal FM replacement level with PBM for juvenile yellow catfish is 20.84%. Replacement levels up to 20% can enhance growth and antioxidant capacity, while higher inclusion levels may cause metabolic stress and oxidative damage.

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TABLE:1 Composition and nutrient levels of experimental diets (DM basis)

TABLE:2 Amino acid composition of experimental diets (DM basis)

TABLE:3 Effect of fish meal replacement with poultry by-product meal on growth performance of juvenile yellow catfish (*Pelteobagrus fulvidraco*)

TABLE:4 Effects of fish meal replacement with poultry by-product meal on feed utilization and digestive enzyme activities of juvenile yellow catfish (*Pelteobagrus fulvidraco*)

TABLE:5 Effects of fish meal replacement with poultry by-product meal on proximate nutritional components in whole body and muscle of juvenile yellow catfish (*Pelteobagrus fulvidraco*)

TABLE:6 Effects of fish meal replacement with poultry by-product meal on serum biochemical indices of juvenile yellow catfish (*Pelteobagrus fulvidraco*)

TABLE:7 Effects of fish meal replacement with poultry by-product meal on antioxidant indices of juvenile yellow catfish (*Pelteobagrus fulvidraco*)

FIGURE:1 Broken-line model analysis of the relationship between the replacement ratio of fish meal by poultry by-product meal and WGR of juvenile yellow catfish (*Pelteobagrus fulvidraco*)

Note: Figure translations are in progress. See original paper for figures.