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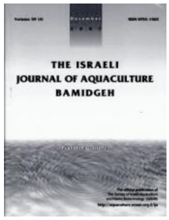

Replacement of Fishmeal Using Poultry Offal Meal in Practical Feeds for Fry of the African Catfish (*Clarias gariepinus*)

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Abstract

A 70-day feeding trial was conducted to test the effect of partial replacement of fishmeal by poultry offal in the diet for fry of the African catfish, *Clarias gariepinus*. Four isonitrogenous rations containing replacement of 0 (control), 30%, 60%, or 90% fishmeal by poultry offal were fed to three replicate groups of *C. gariepinus* fingerlings (0.74 g). Growth performance and nutrient utilization of the fish were evaluated based on weight gain, protein intake, protein efficiency ratio, specific growth ratio, gross efficiency of food conversion, and carcass analysis. The average weight gains of fingerlings fed the control (2.43 g) and 30% replacement diet (2.31 g) were higher than in fish fed the 60% (2.09 g) and 90% (2.0 g) replacement diets. The feed conversion ratio (1.48-1.62) was lowest in fish fed the control diet and highest in fish fed the 90% replacement diet. The specific growth rate, protein efficiency ratio, and apparent net protein utilization significantly decreased ($p<0.05$) as the level of dietary poultry offal increased. It was concluded that replacement of up to 30% fishmeal by chicken offal meal enhances growth performance of *C. gariepinus* fry.

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Introduction

Fish nutrition is the most expensive component of intensive aquaculture, representing over 50% of the total operating costs (Falaye, 1992). The protein part of fish feed represents almost 60% of the feed cost. Fishmeal is the major protein source in aquaculture feeds. However, the global supply of fishmeal is not growing and fishmeal must be used more sparingly to improve profitability and sustainability of aquaculture. Besides cost considerations, it is important that practical or alternate fish diets contain all the essential amino acids, fatty acids, vitamins, and minerals required by a fish for rapid growth, sound health, and economic profitability.

Poultry offal is an interesting economic alternative to fishmeal. Chicken offal meal is highly digestible by fish and has a high nutrient composition (Bureau et al., 1999). Studies show that poultry by-product meals can partially replace fishmeal in diets for African catfish (Sadiku and Jauncey, 1995; Abdel-Warith et al., 2001), Nile tilapia (Sadiku and Jauncey, 1995; El-Sayed, 1998), gilthead seabream (Nengas et al., 1999), and seabass, *Dicentrarchus labrax* (Altan et al., 2010).

The African catfish, *Clarias gariepinus,* is a commercially important cultured species in Africa. This study was designed to determine the level of poultry offal that could be used to replace fishmeal in practical diets for *C. gariepinus* fingerlings.

Materials and Methods

Experimental procedure and fish. A total of 120 *Clarias gariepinus* fingerlings were procured from the University of Ibadan, Department of Wildlife and Fisheries Management Fish Farm. They were acclimatized in the Wildlife and Fisheries Department Laboratory for one week during which they were fed a 0.3-mm 40% crude protein commercial diet (Coppens Feed®). They were starved for 24 h before commencement of the feeding trial, then ten fish (0.75±0.15 g) were stocked into each of twelve 15-l circular plastic tanks in a static renewal system. A 12-h photoperiod was maintained by fluorescent lighting with an automatic control switch. Water quality in the fish tank was monitored biweekly for temperature, dissolved oxygen, pH, ammonia, and nitrate.

Experimental diets. Chicken offal was collected from Zartech Farm (a commercial poultry farm) at Oluyole Area Ibadan, Nigeria. The offal was washed, cooked at 100°C for 15 min, then dried in an oven at 60°C for 8 h. This was later ground into powdery form using an attrition mill. The offal meal contained 10.06% moisture, 67.12% crude protein, 12.01% crude lipid, 5.15% crude fiber, and 5.65% ash. The offal was used to replace 0 (control), 30%, 60%, or 90% (by weight) of the fishmeal in four isonitrogenous (40% protein) diets, in which commercial Danish fishmeal (72% crude protein) was the main protein source (Table 1). The ingredients were thoroughly mixed and moistened, then fed into a pellet mill and extracted under pressure through a 0.3-mm die. The pellets were air-dried with an electric air blower at 30°C for 4 h and stored in air-tight polythene bags in a refrigerator.

Feeding. The fish were fed at the daily rate of 5% biomass. The diets were administered thrice daily in equal portions at 8:00, 14:00, and 16:00. The daily rations were adjusted accordingly after each biweekly weighing.

Calculation of growth and nutrient utilization parameters. The specific growth rate was determined as SGR (%/day) = $(\log W_2 - \log W_1)/(T_2 - T_1)$, where W_1 is the weight at time T_1 and W_2 is the weight at time T_2; the feed conversion ratio as FCR = total dry feed fed/total wet wt gain; the protein efficiency ratio as PER = wet wt gain/amount of protein fed; the apparent net protein utilization (%) as ANPU = 100[(body protein at end of feeding trial) - (body protein at start of feeding trial)]/(amount of protein consumed).

Analytical methods. The proximate analyses of the experimental diets, chicken offal meal, and composite samples of fish carcass at the start and end of the experiment were determined using methods described by AOAC (1990). Dissolved oxygen, pH, ammonia, nitrate, and temperature were analyzed by methods described by Boyd (1981).

Table 1. Composition (% by weight) of diets containing chicken offal meal as a replacement of fishmeal for *Clarias gariepinus* juveniles.

	Replacement level			
	0	*30%*	*60%*	*90%*
Ingredient				
Fishmeal	20.85	14.60	8.34	2.08
Groundnut cake	25.00	25.00	25.00	25.00
Soya bean	20.85	20.85	20.85	20.85
Chicken offal meal	-	6.30	12.51	18.80
Maize	28.30	28.30	28.30	28.30
Bone meal	1.50	1.50	1.50	1.50
Oyster shell	0.50	0.50	0.50	0.50
Oil	2.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	0.25
Vitamin premix*	0.75	0.75	0.75	0.75
Proximate composition				
Moisture	12.50	12.54	12.40	12.30
Crude protein	39.90	39.80	40.20	40.00
Lipid	3.20	4.20	4.90	6.20
Ash	11.80	11.90	12.60	11.20
Crude fiber	2.50	3.50	3.80	6.30

* 100 g contains: vitamin A 960,000 IU; vitamin D_3 160,000 IU; vitamin E 0.89 g; vitamin K 0.16 g; vitamin B_1 80 mg; vitamin B_2 0.32 g; vitamin B_6 0.12 g; vitamin B_{12} 0.8 mg; pantothenic acid 0.89; niacin 1.6 g; folic acid 80 mg; biotin 4 mg; choline chloride 40 g

Statistical analysis. Results were pooled for each treatment, computed, and analyzed using one-way analysis of variance (ANOVA) as described by Steel and Torrie (1960). Significant differences between means of treatments were tested by multiple range test (Duncan, 1955). Differences in means were considered significant when $p<0.05$.

Results

The processed chicken offal meal was rich in protein and adequate for inclusion in fish feed either as partial or complete replacement of fishmeal. The experimental fish remained active and healthy throughout the study, and no mortality was recorded. There were no observed deleterious effects of diets on the fish in any treatment, and water quality remained stable throughout the experimental period.

SGR was highest in fish fed the control diet and significantly dropped as the offal content of the diets increased (Table 2). Control fish had the significantly best FCR and PER. The lipid and ash compositions in the initial fish carcass significantly differed from those in the final fish carcass. Carcass protein increased as the content of poultry offal meal increased.

Table 2. Growth, feed utilization, and carcass composition in *Clarias gariepinus* fed diets containing poultry offal meal as a replacement for fishmeal.

		Replacement level				
	Initial	*0*	*30%*	*60%*	*90%*	*SEM**
Growth parameter						
Initial mean wt (g)	-	0.74	0.74	0.74	0.75	0.01
Final mean wt	-	3.18^c	3.05^c	2.84^b	2.76^a	0.03
Mean wt gain (g)	-	2.43^c	2.31^c	2.09^b	2.01^a	0.08
SGR (%/day)	-	0.81^c	0.79^b	0.75^b	0.72^a	0.03
FCR	-	1.48^a	1.55^b	1.55^b	1.62^c	0.02
PER	-	2.39^c	2.18^b	2.20^b	2.03^a	0.03
ANPU (%)	-	69.40^d	64.27^c	50.44^b	46.32^a	2.47
Proximate composition						
Moisture	19.85	20.72	21.23	21.35	22.10	0.31
Crude protein	57.52	60.13	60.41	65.16	67.14	0.08
Lipid	6.80*	3.15	3.30	3.76	4.05	0.24
Ash	12.99*	14.35	14.19	15.45	16.11	0.15

SEM = standard error, calculated from residual mean square in analysis of variance

Values in a row with the same superscript do not significantly differ ($p<0.05$).

* Significantly differs from final body compositions

Discussion

The positive growth in fish fed diets with offal indicates that poultry offal is acceptable to *C. gariepinus*. The high survival rate, coupled with the absence of negative effects on the fish and water quality, shows the safety of the dietary poultry offal at the examined inclusion levels. Poultry byproduct meals are acceptable and nutritionally suitable for cultured fish species (El-Sayed, 1998; Emre et al., 2003; Shapawi et al., 2007; Altan et al., 2010).

The control and the 30% diet were best in terms of growth and further increase in poultry offal composition led to a reduction in growth performance. In contrast, high quality poultry by-product meal replaced 100% dietary fishmeal in a diet for gibel carp without adversely affecting growth performance or feed utilization, although 66.5% replacement was recommended (Yang et al., 2006). Likewise, poultry by-product meal was successful when no more than 50% of the fishmeal was replaced in diets for European eel (Gallagher and Degani, 1988), Chinook salmon (Fowler, 1991), African catfish (Abdel-Warith et al., 2001), and Black Sea turbot (Yigit et al., 2006).

The reduction in growth performance that accompanied the increase in poultry offal content may be attributed to limiting amino acids such as histidine, methionine plus cystine, lysine, and phenylalanine in the poultry offal (Gaylord and Rawles, 2005; Yu, 2006). Also, the processing technique by which a product is subjected to high temperature (60-100°C) for long hours leads to lysine and cystine plus cysteine losses (Nengas et al., 1999) and subsequent reduction in digestibility of protein and amino acids (Opstvedt et al., 1984; McCallum and Higgs, 1989).

The inclusion of poultry offal in the diets did not significantly influence the whole-body moisture contents of the fish, however, whole-body protein significantly increased as the poultry offal content increased, while ash tended to increase with the increase of poultry offal. These results agree with findings of Hasan et al. (1993) and Nengas et al. (1999).

Based on the results of this study, poultry offal can replace up to 30% of the fishmeal in diets for *C. gariepinus*. In spite of the nutritional disadvantages of poultry offal when compared to fishmeal, poultry offal is much cheaper and more easily available. Further study is required to thoroughly evaluate the level of poultry offal that can be used in diets of *C. gariepinus* using different processing techniques.

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