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Comparative Utilizations of Fish Waste Meal with Imported Fishmeal by African Catfish (*Clarias gariepinus*)

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Abstract: Performance of dietary fish waste meal (FWM) and imported fishmeal (FM) were evaluated at 10 and 15% inclusion levels in catfish diets towards the utilization of fish wastes as a cheap alternative animal protein source for sustainable aquaculture. Five isonitrogenous diets (40% C.P) were formulated {FWM 10%, 15%, FM 10%, FM 15% and control (non fishmeal base diet)} and were fed to juveniles of *Clarias gariepinus* of 18.20± 0.40g for 70 days in triplicates. Results of the study showed an overall good growth performances and survival rate of experimental fish. Dietary fishmeal contents influenced specific growth rate (SGR), protein efficiency ratio (PER) and feed conversion ratio (FCR) statistically ($p<0.05$). All parameters assessed gave superior values in fish fed diets containing dietary fishmeal-based diets over the control diet which cost the least N185-50/kg. There was no significant difference between values of SGR, PER, FCR and protein intake between FWM and FM based-diets at the same level of inclusions. Dietary FWM at 15% inclusion was better on the overall due to a superior economic conversion ratio it has over FM15% with marginal differences.

Key words: Dietary protein · *Clarias gariepinus* · Plant protein sources · Animal protein sources · Sustainable aquaculture

INTRODUCTION

Fishmeal still constitutes a substantial part of feeds formulated for diverse fish species that are commercially cultivated globally. This widespread used is as a result of its excellent amino acid profile, palatability and high nutritive value [1] However, due to rising cost and uncertainties about fishmeal availability and quality [2], fish nutritionist and feed manufactures are already adopting the use of less expensive, readily available plant protein sources (PPS) as substitute for fishmeal [3-5]. Much as many alternative protein sources (APS) have been used in the replacement of fishmeal in fish diets [6-9] through feeding trials, poor quality of such APS especially due to presence of certain anti nutritional substances in them have limited their use [10, 11]. Fishmeal has therefore been described as the single most important ingredient that must be present in fish diet at least 10% inclusion level [12] in fish diets. It has been distinguished however, that animal protein sources should be used as replacement for fishmeal in fish diet while plant protein source should be used also replace another plant protein source in fish diet for profitable fish production [13]. In the central fish market in Lafia, Nigeria, fish wastes and by-products are regularly generated which include heads, tails, viscera, scales and whole fish unsuitable for human consumption. It has been reported that fish by-products are a valuable protein source in animal feeds includeing fish [14, 15].

This study therefore, investigated the nutritional quality and utilization of fish wastes meal (FWM) in catfish diets for commercial purpose.

MATERIALS AND METHODS

Fish by-products (head, guts, tails) of tilapia and catfish were obtained from the city main fish market. The wastes were rinsed in clean water and cooked for 20 minutes to reach 95°C in order to prevent contamination by disease pathogens. The mixture was then drained, sundried for 2 days and grounded with an electric grinding machine. Sample was taken for proximate analysis. The prepared fish waste meal (FWM) was used to formulate isonitrogonous catfish diets (40% CP) at 10% and 15% inclusion rates. Imported fishmeal (72% CP) was also used to formulate diets at 10% and 15%

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inclusion rate while the control diet (0% Fish) had no fishmeal. One hundred and fifty *Clarias gariepinus* juveniles of 18.20±0.40g were collected from a reputable fish farm within Lafia and were allowed to acclimatize for 7 days during which they were fed 2mm coppens for 5 days. Feeding trial commenced after one day starvation when they were distributed randomly into rectangular concrete tanks of 1.2 x 1.0 x 1.0m size in triplicates. Fish were fed *ad libitum* for 70 days. All diets formulated and fish carcasses were analyzed for proximate analysis according to [16]. Water quality in the culture media was monitored for pH, ammonium nitrogen and dissolved oxygen to ensure favourable culture systems for the fish, throughout the 10-week experiment. From the experiment, data were obtained fortnightly and were used to calculate the following:

Weight gain (MWG) = W_2-W_1
Specific Growth Rate (SGR) = (Ln W_2-Ln W_1/T_2-T_1) x 100

Where:
W_2 = final weight of fish,
W_1 = initial weight (g) of fish,
T_2 = end of experiment
T_1 = begin of experiment (days)

Protein efficiency ratio (PER) = weight gain (g)/Protein intake (g) Feed conversion Ratio (FCR) = Total feed intake/Weight gain (g)
Protein intake = Feed fed x crude protein of the feed.

Economic conversion ration (ECR) = cost of diet x feed conversion rate [17] cost of feeds was based on the current prices of feed ingredients as obtained in Lafia (Nigeria) during the experimental period. All data collected from the completely randomized design experiment were computed and subjected to two-way analysis of variance (ANOVA). Significant mean differences were separated by Duncan's multiple range test (P<0.05) using SPSS for windows (version 12). Values were expressed as mean±S.E.

RESULTS

Fish wastes meal (FWM) prepared in the study contained 61.62% crude protein and 9.55% crude fat as shown in Table1. The ingredients used in formulating the test diets and their proximate compositions are contained in Table 2. All the five test diets had high crude protein contents which ranged from 40.81% in diet 5 (15%FM) to 41.57% in diet 1 (control) crude fat was highest in diet 5

Table 1: Proximate composition of fish wastes meal diet used in diet formulation (%DM)

Nutrient	%
Dry matter	90.40
Crude protein	61.62
Crude fat	9.55
Ash	22.40
NFE	3.17
Gross energy (KJ/g)	26.70

Table 2: Gross ingredient and proximate composition of experimental diets

Ingredients (%)	(1) control	(3) 10% FWM	(2) 15% FWM	(4) 10% FM	(5) 15% FM
Fishmeal 72%	-	-	-	10.00	15.00
Fish waste meal (FWM)	-	10.00	15.00	-	-
Groundnut cake	32.10	35.13	32.21	34.08	30.42
Soyabean meal	47.50	33.78	27.15	28.00	21.63
Maize	12.40	13.09	17.64	19.92	24.95
D-calcium phosphate	2.00	2.00	2.00	2.00	2.00
Fish premix	2.00	2.00	2.00	2.00	2.00
Salt	1.50	1.50	1.50	1.50	1.50
Vegetable oil	2.50	2.50	2.50	2.50	2.50
Proximate composition (%)					
Crude protein	41.57	41.02	41.13	40.92	40.81
Crud lipid	7.19	7.66	6.19	7.83	8.23
Crude fibre	4.92	4.30	4.13	3.85	3.64
Ash	13.48	12.61	12.49	12.55	12.79
NFE	22.88	25.06	25.73	25.84	24.04
Moisture	14.88	13.65	14.46	12.86	14.13

*Biomix fish vitamin/mineral providing per kg of diet at 5kg per tonne inclusion: 20,000 iu, vitamin A, 200 i.u, Vit. D3, 200 mg Vit E, 8 mg Vit k3, 20mg Vit B1, 30 mg Vit B2, 12 mg Vit B6, 50 mg Pantothenic acid, 0.8 mg Biotin, 150 mg Niacin, 0.05mg Vit B12, 160mg Vit. C, 4.0mg Cobalt, 40 mg Iron, 5.0 mg Iodine, 30 mg Manganese, 4 mg Copper, 40 mg Zinc, 0.2 mg Selenium, 100 mg Lysine, 100 mg Methionine, 100 mg Anti-oxidant.

Table 3: Growth performance and nutrient utilization of fish fed FWM and FM based –diets.

	Diets				
Variables	1	2	3	4	5
Initial weight (g)	18.32	17.86	18.44	18.60	17.80
Final weight(g)	38.61±1.04	39.87±0.35	42.87±1.22	41.35±1.03	41.82±1.12
Weight gain(g)	20.29±0.91[c]	22.01±1.17[b]	24.43±0.77[a]	22.75±1.21[b]	24.01±0.61[a]
Specific growth rate	1.07±0.02[c]	1.15±0.10[b]	1.21±0.40[a]	1.14±0.05[b]	1.22±0.17[a]
Total fed intake/fish	42.33±1.34[c]	43.18±0.20[b]	44.58±1.10[a]	44.15±1.12[a]	44.28±1.35[a]
Feed conversion ratio	2.09±0.12[a]	1.96±0.14[b]	1.82±1.30[c]	1.94±0.66[b]	1.84±0.42[c]
Protein efficiency ratio	1.20±0.32[c]	1.27±0.43[b]	1.37±0.09[a]	1.29±0.22[b]	1.36±0.05[a]
Survival (%)	100	100	100	100	100
Cost of feed (N)/kg	185.50[d]	194.50[c]	202.00[b]	200.00[b]	210.50[a]
Economic conversion ratio	387.70[a]	381.22[a]	367.64[b]	388.00[a]	386.40[a]

Mean values with the same superscript along the same row are not significantly different (p>0.05)

Table 4: Fish carcass proximate composition before and after experiment

		Final				
Nutrient (%)	Initial	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Moisture	12.62±0.4[b]	12.85±0.3[a]	13.16±0.8a	12.74±0.2[b]	12.19±0.3[c]	12.60±0.1[b]
Crude protein	63.59±1.2[d]	66.42±1.6[c]	67.84± 0.7[b]	68.93±0.3[a]	68.64±0.4[b]	69.17±0.3[a]
Crude lipid	6.42±0.4[c]	6.81±1.2[c]	7.17±0.2[b]	7.30±1.1[a]	7.12±1.3[b]	7.11±0.6[b]
Ash	4.33±0.5[b]	6.01±0.3[a]	6.08±0.3[a]	6.14±0.4[a]	6.19±0.2[a]	6.18±0.7[a]
NFE	25.66±0.45[a]	20.76±1.07[b]	18.91±1.66[b]	17.83±1.19[b]	18.23±1.38[b]	17.00±1.20[b]

Mean values with the same superscript along the same row are not significantly different (p>0.05)

(8.23%) and least in diet 3 (6.19%) while ash content was highest in diet 1 (13. 48%) and least in diet 3 (12.49%). All test diets were well accepted by fish as values of feed intake ranged from 42.33g to 44.58g (Table 3). FCR, PER, SGR and weight gain were all significantly influenced (P<0.05) due to diets. Specific growth rate (g/day/%) was marginally different between diet 3 and 5 but they were significantly (P<0.05) higher than values in other treatment with the least being 1.07 in control. Mean weight gain also followed the same trend where the least value was found in fish fed control diet (20.29g). PER was higher in diet 3 (1.37) and 5 (1.36) and least in the control diet (1.20). Survival rate was generally high in all diets which ranged from 93% to 100% and economic conversion ratio was marginally difference among diets (P>0.05) except in diet 3 (FWM 15%) which had the least value being the best. Fish carcass protein was highest in fish fed diet 5 (69.17%) and least in fish fed diet 1 (66.42%). Both fish carcass protein and crude lipid however increased from their initial values 63.59% and 6.42% respectively in all diets at the end of the 70 day experiment (Table 4).

DISCUSSION

In the current study, weight gain, FCR and PER of fish improved as dietary FWM and FM inclusions increased from 10% to 15%. The superior performance at this level suggests that more nutrients rich in amino acids are made available for fish to utilize since both are from fish source. This finding is similar to the reports of [5, 18] that biological fish wastage supplementation to diet improved egg weight, weight gain, egg shell thickness and yolk percentage in laying Japanese quails. The overall growth performance and high survival rates in all treatments suggest that all diets including control (no fishmeal based-ingredients) diet were suitable for fish and met its nutritional requirement but the significantly low weight gain, SGR, PER and poor FCR indicates further that plant protein sources alone contained in the diet were not well utilized like those diets containing fish meal base. This observation may be due to the presence of certain substances that impede nutrient utilization in legume grains especially and other plant sources [19-22] therefore corroborates the minimum level of 10% fishmeal inclusion in fish diets by [12]. Significant mean differences recorded for weight gain, SGR, FCR and PER between 10% FWM and 15% FWM suggest that the 15% FWM provided fish with more nutrients. The study revealed that the fish waste meal is capable of supplying adequate nutrient as the imported fishmeal since both ingredients performed well at the same level which include 10% and 15% inclusions without any significant difference. These results could be due to high nutrient values recorded for fish by-products [24-27]. The increasing fish carcass proteins and lipids with increase in dietary fishmeal inclusions followed the trend of reports of [6, 28-30]. Although the economic conversion ratio of all lest diets were marginally different except diet 3 that was least (FWM 15%), the cost of producing FWM 15% was lower compared with its corresponding FM 15%. This economic aspect involving the two diets suggests that FWM 15% should be better adopted by fish farmer whose intention is profit maximization since both conferred excellent fish performance without significant difference.

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