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USE OF FISH WASTE MEAL AS A REPLACEMENT FOR FISH MEAL IN THE PRACTICAL DIETS OF AFRICAN MUD CATFISH *Clarias gariepinus* FINGERLINGS

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ABSTRACT

A feeding trial was conducted to investigate the effect of fish waste meal (FWM) on growth performance, nutrient utilization, hepatosomatic index and blood parameters of *Clarias gariepinus.* 150 fingerlings of *C. gariepinus* of average weight of 5.2±0.13g were stocked. Five (5) iso-nitrogenous diets containing 40% crude protein in which fish meal protein (67.70%) was replaced by fish waste meal protein (45.94%) at 0% (FWM0), 25% (FWM25), 50% (FWM50), 75% (FWM75) and 100% (FWM100) levels were formulated. The fingerlings were fed at 5% body weight per day for 56 days. Values for growth response and nutrient utilization parameters decreased ($p<0.05$) with increasing levels of FWM in diets from 50% FWM inclusion level. Feed conversion ratio showed no significant difference ($p>0.05$) between fish fed diets FWM0 (1.25), FWM25 (1.26) and FWM50 (1.30). Net protein utilization was highest in fish fed diet FWM0 (43.62%) but not different ($p>0.05$) from fish fed diets FWM25 (42.82%) and FWM50 (41.11%). Hepatosomatic index was highest significantly ($p>0.05$) in fish fed diet FWM100 (1.13%) and lowest in fish fed diet FWM50 (0.65%). The haematological profile was higher ($P<0.05$) in all parameters in fish fed diets FWM0 and FWM50. Pack cell volume (PCV) was 36.2% in fish fed diet FWM0. This was statistically similar only to 35.9% of fish fed diet FWM50. From the study, it is concluded that fish waste meal can replace as much as 50% of fish meal in the diet of African catfish, *C. gariepinus.*

Keywords: African catfish, growth, Fish meal, fish waste, protein.

INTRODUCTION

Traditionally, fishmeal and lately soybean meal are the major sources of protein in animal feeds. There is however limitation in the use of these feed ingredients as a result of their relevance in human nutrition coupled with decline in productivity (IITA, 1990). Fish meal is a high quality protein source considered indispensable in fish diet because of its superior profile of indispensable amino acids and its value as an attractant. It is relatively expensive and not readily available. Fish nutritionists, however, sought for alternative protein sources to replace fish meal partially or totally with inexpensive plant and animal sources that are available (Tacon and Jackson 1985 and Mayano *et al.*, 1992).

The non-conventional feedstuffs of animal origin are high quality feed ingredients that could compare to some extent with the conventional types. These are cheaper by virtue of the fact that there is no competition for human consumption. Many scientists have reported the possible use of some alternative animal protein feedstuffs to fish meal such as Earthworm meal (Tacon and Jackson, 1985), Toad meal (Annune, 1990), Life maggot (Ayinla *et al.,* 1994), Fermented fish silage (Faturoti *et al.,* 1998), Maggot meal (Ugwumba *et al.,* 2001 and Sogbesan *et al.* 2005), Frozen maggot (Otubusin and Ifili, 2000), Poultry dung meal (Fasakin *et al.,* 2000) and Garden snail meal (Sogbesan and Ugwumba, 2006).

Fish waste comprises of discarded heads, fins, skin and entrails of smoked bonga fish (*Ethmalosa fimbriata)* and *Sardinella sp*. As a waste in many Nigerian markets, it is collected by fish and livestock farmers at little or no cost. Fish waste is relatively high in protein and fat which may probably make it compete favorably with fish meal in fish diet.

Blood is a good indicator in determining the health of an organism (Joshi *et al.,* 2002), it also acts as a pathological indicator of the whole body, and hence haematological parameters are important in diagnosing the functional status of an animal exposed to suspected toxicant (Omitoyin, 2006). Haematological characteristics of most fish have been studied with the aim of establishing normal value range and any deviation from it may indicate a disturbance in the physiological process (Rainz-apaiva *et al*., 2000).

Catfish of the genus *Clarias* are widely distributed in Africa and have been the focus of long-term aquaculture interest. A variety of species of the genus *Clarias* and their hybrids were cultured, for reasons of their high growth rate, disease resistance, ability to adapt to high density culture, and high consumers' acceptance (Viveen *et al.,* 1985; and Huisman and Richter, 1987). Therefore, this study was carried out determine the level of replacement of fish meal with dry fish wastes meal in the practical diets of African catfish *C. gariepinus*.

MATERIALS AND METHODS

The feeding trial was conducted in 15 circular plastic tanks (44L) in the laboratory of the Department of Aquaculture and Fisheries Management, Federal University of Agriculture, Abeokuta, Nigeria. Each tank was filled to 2/3 of its volume with water supplied from the university's water reservoir. The system was a flow-through with water exchange rate of one litre per minute in order to sustain optimal culture environment.

150 fingerlings of catfish, *C gariepinus* with average weight of 5.2±0.13g were obtained from a reputable Hatchery in Abeokuta, Ogun State, Nigeria. The fish were transferred to the wet laboratory and acclimatized for one week. They were then starved for 24hours prior to being placed on the experimental diets. Five randomly selected fish samples were sacrificed for proximate analysis before the commencement of the completely randomized designed (CRD) experiment.

Five iso-nitrogeneous diets were formulated to contain 40% crude protein. Danish fishmeal (67.67% crude protein) was replaced by fish waste meal (FWM) (45.94% crude protein) at 0% (FWM0), 25% (FWM25), 50% (FWM50), 75% (FWM75) and 100% (FWM100). The formulation was based on the proximate composition of the ingredients (Table 1). Table 2 shows gross percentage composition of the experimental diets. Dried fish waste was collected from Oshodi market, Lagos, Nigeria. They comprised discarded heads, fins, skin and entrails of smoked bonga fish (*Ethmalosa fimbriata)* and *Sardinella sp*. The dried fish waste and all the other ingredients were milled with hammer mill and sieved through a 595µm to remove chaff and ensure homogenous size profile. The ingredients for each diet were mixed thoroughly in a bowl and pelletized in a manually-operated pelletizer. The moist pellets were oven-dried at 80°C for 12hours, packaged in tagged air-tight polythene bags and stored in a dry place at room temperature.

Table 1: Proximate composition (%) of the experimental feed ingredients

Ingredient	Crude Protein	Ether extract	Crude fibre	Ash
Fish meal	67.7	4.1	1.3	14.8
Soybean meal	45.3	18.0	5.0	4.6
Groundnut cake	34.5	8.8	4.3	13.8
Fish waste meal	45.94	16.40	2.20	33.0
Maize	10.8	5.5	1.4	1.4

Table 2: Gross composition (%) of the experimental diets

Treatments Ingredients	FWM 0	FWM 25	FWM 50	FWM 75	FWM 100
Fish meal	27.6	22.1	15.7	8.45	-
Fish wastes	-	7.36	15.7	25.5	36.5
Groundnut cake	13.8	14.7	15.7	16.9	18.6
Soybean meal	27.6	29.4	31.6	31.8	32.5
Yellow maize	24.2	19.7	14.6	10.7	5.94
Vegetable oil	5.00	5.00	5.00	5.00	5.00
*Vitamin premix	1.00	1.00	1.00	1.00	1.00
Dicalcium phosphate	0.50	0.50	0.50	0.50	0.50
Salt	0.25	0.25	0.25	0.25	0.25

*RADAR VIT. PREMIX supplies per 100 g diet. Palmitate (A) 1000 IU; cholecalciferol (D) 1000 IU; a-tocopherol acetate (E) 1.1 mg; Menadione (K) 0.2 mg; Thiamine (B_1) 0.63 mg; Riboflavin (B_2) 0.5 mg; Panthothenic acid, 0.9 mg; Pyridoxine (B_6) 0.15 mg; Cyanocobalamine (B_{12}), 0.001 mg: Nicotinic acid 3.0 mg; Folic acid 0.1 mg; Choline 31.3 mg; Ascorbic acid (C), 2.5 mg; Fe, 0.05 mg; Cu 0.25 mg Mn 6.0 mg; Co, 0.5 mg; Zn 5.0 mg; I, 0.2 mg; S, 0.02 mg.

C. gariepinus fingerlings were randomly distributed into 15 plastic bowls representing five treatments replicated thrice, at the rate of ten fish per bowl. All the experimental fish were fed the experimental diets twice daily at 5% of total biomass, between the hours of 07:00 – 08:00 and 16:00 – 17:00 for eight weeks. Fish were batch weighed weekly with a sensitive electronic balance (METTLER TOLEDO, PB602). Mortality was monitored daily. Water temperature (^{0}C) was monitored daily using mercury-in glass thermometer; dissolved oxygen (DO) was measured using Jenway DO meter model 9071 while the pH was measured using glass electrode pH meter (E520) Metrolin model.

At the beginning of the feeding trial, composite samples of ten whole fish and a random sample of five fish per aquarium at the end of 56 days experimental period were analyzed for proximate composition. Nitrogen content was determined by A. O. A. C. (2000) methods and the factor of 6.25 was used to convert the nitrogen to protein. Fat, fibre, ash and moisture content of the diets and composite fish samples were also analyzed using A.O.A.C. (2000) method. The hepatosomatic index of fish at the end of the experiment was computed as: Hepatosomatic index (H.S.I) = 100(liver weight/ body weight).

Blood samples for analyses were collected from the caudal peduncle with a fine syringe and drawn into haematocrit bottle for analysis. Analysis for the following blood parameters were carried out: Erythrocyte counts (RBC), white blood cell count (WBC) and pack cell volume were analyzed according to Blaxhall and Daseley, (1973). Haemoglobin was according to Roberts, (1978) while, mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH) were analyzed according to Meyer *et al.* (1992). Diet performance was evaluated on experimental fish according to Olivera *et al.* (1990). Statistical comparisons of growth performance and protein utilization values were made by using analysis of variance (ANOVA) system (SAS, 1988) and the differences among means were tested for significance ($P<0.05$) using Duncan Multiple Range Test (DMRT) (Duncan, 1955).

RESULTS

The result of proximate analyses of experimental diets are presented in Table 3. Diet FWM100 had the lowest crude protein value (39.20%) while the highest (40.60%) was recorded in diet FWM0. Both crude fat and ash increased as fish waste meal increased in diet while crude fibre had its highest value (12.10%) in diet FWM25 and lowest (9.0%) in diet FWM75. The proximate composition of the experimental fish is presented in table 4. Crude protein decreased as fish waste meal increased in the diets. Crude fat did not present any definite pattern. The highest crude fat value (8.80%) was found in fish fed diet FWM50, while fish fed diet FMW75 had the lowest (7.40%).

The growth response and nutrient utilization (Table 5) decreased as fish waste meal increased in the diet but similar ($p>.0.05$) in fish fed diets FWM0, FWM25 and FWM50.The hepatosomatic index was higher and different ($p<0.05$) in fish fed diet FWM100 than in other diets. The highest percentage survival of 90% recorded in fish fed diets FWM0, FWM75 and FWM100 was different ($p<0.05$) than in other diets. Figure 1 shows the growth response of *C. gariepinus* fed fish waste meal based diets. Growth decreased as fish waste meal increased in the diets with fish fed FWM0 maintaining steady increase all through the rearing period.

Table 3: Proximate composition (%) of the experimental diets

Treatments Parameters	FWM 0	FWM 25	FWM 50	FWM 75	FWM 100
Crude protein	40.6	40.2	39.5	39.9	39.2
Moisture	8.80	7.79	8.10	7.50	7.40
Ether extract	9.30	10.5	11.1	11.5	12.1
Ash	4.90	5.31	4.96	6.80	7.30
Crude fibre	5.98	6.00	5.95	5.04	5.32
Nitrogen free extract	30.5	30.2	30.4	31.2	29.9

Table 4: Carcass composition (%) of the experimental fish

Treatments Parameters	Initial	FWM 0	FWM 25	FWM 50	FWM 75	FWM 100
Crude protein	8.4	13.2	12.8	12.5	10.5	11.1
Moisture	82.6	74.5	72.5	74.1	77.3	75.9
Ether extract	7.0	7.9	7.6	8.8	7.4	8.2
Ash	2.4	2.0	1.7	2.2	2.3	2.1
Crude fibre	1.2	1.3	1.3	1.41	1.5	1.7

Table 5: Growth response, nutrient utilisation and gonadosomatic index of *Clarias gariepinus* fingerlings fed varying levels of fish waste meal based diets

Treatments Parameters	FWM 0	FWM 25	FWM 50	FWM 75	FWM 100	SEM
Initial mean weight (g)	5.83^{a}	4.60^{a}	5.23^{a}	5.03^{a}	4.53^{a}	1.32
Final mean weight (g)	27.1^{a}	25.0^{a}	22.3^{b}	18.2^{c}	15.5^{d}	2.24
Mean weight gain (g)	22.1^{a}	20.4^{a}	17.1^{b}	13.2^{c}	11.1^{d}	2.08
Mean daily weight gain (g)	0.39^{a}	0.36^{a}	0.31^{ab}	0.24^{b}	0.20^{b}	0.09
Mean feed intake (g)	27.6^{a}	25.8^{a}	22.2^{b}	22.3^{b}	21.1^{b}	2.36
Specific growth rate (%/day)	2.40^{a}	2.34^{a}	2.20^{ab}	2.00^{b}	1.86^{b}	0.10
Relative growth rate (%)	378^{b}	444^{a}	327^{b}	263^{c}	243^{c}	37.0
Feed conversion ratio	1.25^{cd}	1.26^{c}	1.30^{c}	1.92^{d}	2.05^{e}	0.70
Protein efficiency ratio	2.01^{a}	1.98^{a}	1.93^{a}	1.48^{b}	1.30^{c}	0.05
Net protein utilization	43.6^{a}	42.8^{a}	41.1^{a}	23.4^{b}	23.1^{b}	4.22
Hepatosomatic index (%)	1.06^{b}	0.84^{c}	0.65^{d}	0.85^{c}	1.13^{a}	0.07
% Survival	90^{a}	70^{c}	80^{b}	90^{a}	90^{a}	7.30

NOTE: values without common superscripts in horizontal rows are significantly different ($P<0.05$)
SEM = Standard error of the mean.

The growth in *C. gariepinus* is shown in Figure 1 as being directly proportional to the level of fish meal replacement in the diets.

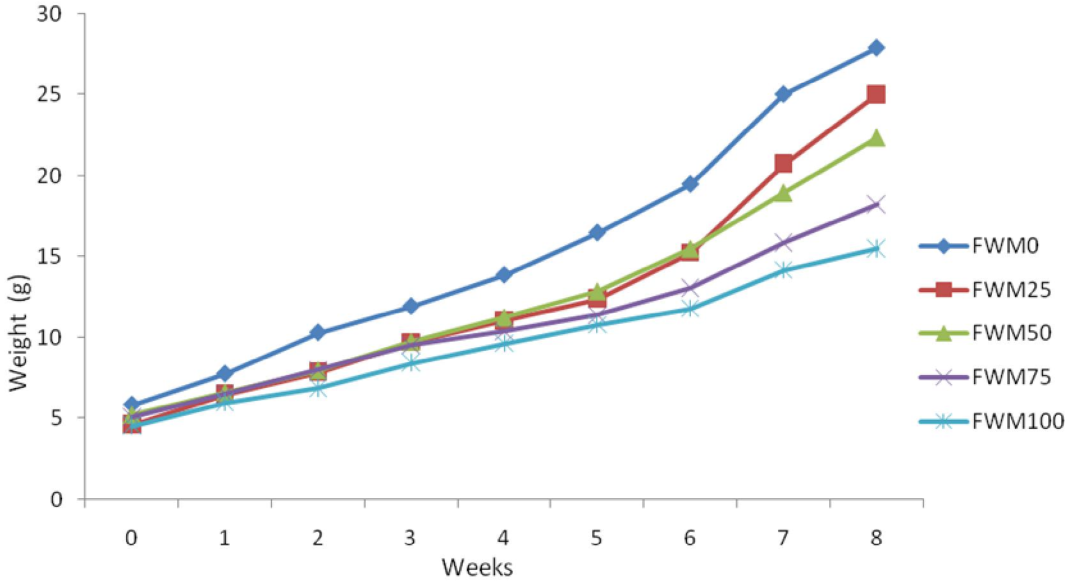

Fig. 1: Growth response of *C. gariepinus* fingerlings fed fish waste meal-based diets.

Table 6 shows the haematological profile of *C. gariepinus* fingerlings fed varying levels of fish waste meal based diets. All the haematological parameters were significantly higher (P< 0.05) in fish fed the control diet (FWM1) but similar (p>0.05) in fish fed diets FWM1, FWM2 and FWM3.

Table 6: Haematological profile of *Clarias gariepinus* fingerlings fed varying levels of fish waste meal based diets

Treatments Parameters	FWM 0	FWM 25	FWM 50	FWM75	FWM 100	SE M
Pack cell volume (%)	36.2^{a}	34.0^{b}	35.4^{a}	32.9^{c}	32.9^{c}	2.42
Haemoglobin (g/dl)	5.78^{a}	5.12^{a}	5.69^{a}	4.06^{b}	3.72^{c}	1.49
Erythrocyte, x 102/L	2.04^{a}	1.66^{b}	2.96^{a}	1.33^{b}	1.60^{b}	0.32
White blood cell, 106/L	6.75^{a}	4.96^{b}	4.63^{b}	4.09^{b}	4.13^{b}	2.16
Mean corpuscular volume	30.0^{a}	20.5^{b}	11.9^{c}	16.3^{b}	15.0^{c}	4.33
Mean corpuscular haemoglobin (µ/µg)	3.03^{a}	3.08^{a}	1.92^{c}	2.60^{b}	2.58^{b}	1.27

Values without common superscripts in horizontal rows are significantly different (P<0.05)

DISCUSSION

The study demonstrates that fish waste meal could be used to partially replace fishmeal in pelleted feed for *C. gariepinus*. Replacing fishmeal with as high as 50% fish waste meal in the diet of *C. gariepinus* will not compromise growth performance and feed utilization efficiency. However, supplementation at higher inclusion levels resulted in reduced growth. Moreover, the higher growth performance observed in combined feeding can be explained by the synergetic effect of combining two biological compounds to have a single and superior effect than when applied individually. This observation is in agreement with suggestions by previous authors that combined protein sources is better than single protein source for fish diets (Ugwumba *et al*. 2001; Sogbesan *et al*. 2005; Sogbesan and Ugwumba 2006).

The trend observed in this study on fish performance in terms of percentage weight gain, specific growth rate, food conversion ratio and food efficiency ratio is in agreement with the works of Sogbesan and Ugwumba (2008) who fed termite *(Macrotermis subhyalinus)* meal to *Heterobranchus longifilis* and recommended an inclusion level of 50% while Ogunji *et al*. (2008) observed that maggot meal could replace 15% of the Danish fishmeal in the diet of Nile tilapia (*Oreochromis niloticus)*.

The feed conversion ratio (FCR) of 1.25 – 2.05 and specific growth rate (SGR) of 1.25 – 2.01%/day observed in this work are rather lower and higher respectively than values of FCR (2.6 – 3.67) and SGR (0.77 – 0.92%/day) observed by Sogbesan and Ugwumba (2008) when fishmeal was replaced by termite meal in the diet of *H. longifilis.* This probably suggests that *C. gariepinus* is a better converter of feed into flesh, judging from the low feed striking time they recorded in the experiment. This suggests that termite in the diet of *H. longifilis* are very palatable and a suitable replacement for soybean, fish meal and vitamin premix without any reduction in growth performance. The high ash content of fish waste meal (Table 1) might be due to the bone and scale contents of the fish waste. This consequently might be responsible for the observed increase in ash content of test diets as fish waste meal increased in diet. This observation is in agreement with Sogbesan and Ugwumba (2008) reporting higher ash content for fish meal over termite meal just as Baker *et al.* (1998) reported that insects are low in major mineral compositions most especially in calcium and phosphorus which are the major composition of bones and scales. The lower growth performance observed in fish fed diets above 50% fish meal substitution by fish waste meal may be attributed to the presence of higher level of ash in those diets (Table 3). Olsen *et al.* (2006) and Wilfred *et al.* (2011) reported that high levels of chitin and ash could cause or result in higher FCR. The digestibility of individual ingredient in feeds according to DeSilva *et al*. (1996) and Fagbenro (1996) has been known to influence nutrient utilization and growth in fish.

The observed presence of significant difference in the hematological parameters of *C. gariepinus* in this study probably indicates that those parameters were significantly affected by the diets. This is similar to that observed by Akintayo *et al.* (2008) on *C. gariepinus* fed toasted sunflower seed meal based diets. El-baraasi *et al* (2004) reported that differences in blood parameters of fish could be ascribed to differences in diet composition. However, the trend observed in this study may not have deleterious effect on *C. gariepinus*, given that the values are within the normal range recorded for African catfish (Erondu *et al.,* 1993; Musa and Omoregie, 1999). However, under normal conditions, the blood is reasonably constant for any particular species of fish, with changes falling with fairly narrow limits (Banerjee *at al.,* 2002). In conclusion, the present study demonstrated that fish waste meal can replace as high as 50% of Danish fish meal in the diets of *Clarias gariepinus*. The relevance of this is the probable reduction in the cost of fish feed, as fish waste can be obtained locally as a byproduct in fish markets. .

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