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Utilization of Processed Bonga (*Ethmalosa fimbriata*) Fish in the Diet of Clarias Gariepinus Fingerlings (Burchell 1882)

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Abstract: The relative abundance of Bonga, *Ethmalosa fimbriata*, a clupeid schooling pelagic trash fish in the Nigerian Coastal waters coupled with the low price because of its numerous tiny bones promotes its use for fish meal as an alternative to the expensive conventional fish meal. This study aims to test the suitability of using processed Bonga (fish meal) and determining its level of supplementation with conventional fish meal in promoting *Clarias gariepinus* fingerlings growth. Twentyfive (25 kg) kilograms fresh weight *Ethmalosa fimbriata* was ovendried for 45 h at 80-90°C, ground, sieved into fine powder and supplemented into 6 isonitrogenous diets each of 38% crude protein level (0, 20, 40, 60, 80 and 100%) diets. The Crude Protein (C.P) level of the processed Bonga fish meal was 57.79%. A twelve week nutritional experiment was carried out in which *Ethmalosa fimbriata* fish meal based diets were fed to (90) ninety fingerlings of *Clarias gariepinus* distributed in 6 graduated plastic bowls at the rate of 15 fingerlings per bowl with a weight range of 2.40 gm-2.51 gm/fingerling. The 6 isonitrogenous diets (0, 20, 40, 60, 80 and 100%) were fed ad libitum twice daily at 09.30 and 16 h, respectively after daily changing of water in the plastic bowls. Analysis of variance (ANOVA) for the growth and nutrient utilization parameters showed significant ($p<0.05$) variations for specific growth rate, protein efficiency ratio, food conversion ratio, productive protein value, feed intake and gross food conversion efficiency. The highest Specific Growth Rate (SGR) of 1.95 least Food Conversion Ratio (FCR) of 2.02 and the highest average daily growth rate (DGR) 0.120 gm/day showed the 40% diet as the best. This was closely followed by the 20% diet with SGR (1.90), FCR (2.02) and DRG (0.115). While the least grow out of *Clarias gariepinus* fingerlings was recorded for the 100% diet with SGR (1.37), FCR (2.97) and average DRG (0.067). This study shows that supplementation of Bonga (*Ethmalosa fimbriata*) fish meal of C.P 57.79% with the conventional Danish fish meal (of C.P 72.00%) is best at the 40% level of supplementation while 100% supplementation of *Ethmalosa fimbriata* fish meal will not give the best growout result for *Clarias gariepinus*.

Key words: Bonga (*Ethmalosa fimbriata*) fish meal, conventional fish meal, supplementation in diets, *Clarias gariepinus* growth

INTRODUCTION

The species Bonga *Ethmalosa fimbriata* is a clupeid schooling pelagic fish. It is a target species in the artisanal fishery of Nigeria and account for about 30,000 metric tones annually Fisher[1]. According to Bainsbridge[2] the distribution of the species along the West African coast shows two main areas of concentrations. One area stretches from the mouth of River Senegal to the cost of Sierra Leone and the other along the coast of Nigeria and Cameroon to the coast of Congo river.

The Nigerian inshore waters covers a distance of 853 km from east to west and extends up to 50 m as the maximum depth. Within this inshore water is the territorial water which covers a distance of 5 nautical miles from the shoreline and it is reserved exclusively for small scale fishing.

The Nigerian inshore water is rich with both living and non-living resources which include black coal and gravel while the living resources include both pelagic (Bonga, Ilisha and Sardines) and demarsal fin and small fishes such as grayfish, crab, croaker, barracuda etc). The inshore water is characterized by turbulent and surf beaten coast and lots of nutrient brought in by river effluents and mangrove swamp drainage. Longhurst[3] observed that the occurrence and migration of the species were limited to the extensive estuaries and lagoons (nursery grounds) and the adjacent coastal waters of the Atlantic Ocean.

In the inshore waters of Eastern Nigeria, Moses[4] estimated the mean catch of bonga to be 25,030 tonnes per year, maximum sustainable yield of 30,075 tonnes per year and 83.1% of all clupeid landing. The fish is eaten by all the local people and provide cheap protein. Its pronounced problem is the numerous bones encountered when eaten.

A lot of studies has been done on bonga in West Africa, much of which are on the biology and management of the fishery. Fagade[5] observed that the female bonga in Lagos lagoon showed mature gonads at a length of 17.0 cm. Whereas in Ghanaian inshore water, Blay[6] reported that bonga mature at a total length of 22.0cm and spawns in the sea from October to March. Blay[7] also studied the biology of bonga in the coastal waters of Cape Coast concluded that the condition factor started increasing from 2 in May and reached a peak of 2.42 in August every year. Bainsbridge[8] noted that the species spawn either in the sea or in the estuaries and lagoons.

Solarin[9] recommended monofilament gill net with a mesh size not less than 48 mm for the rational exploitation of bonga in Lagos lagoon. Bonga fishing offers employment opportunities to thousands of Nigerians living in coastal regions. The fishing techniques is known by everybody; it is cheap and does not require huge investment in the processing. It is also easily fished because the fish migrate to the near shore water lagoon and estuaries thereby becoming accessible to fishermen. The fish is eaten by all the local people and provide cheap protein.

It is low priced because of its numerous bones when cooked fresh and is mainly consumed by those below the poverty line. It is relatively cheap and of relative abundance when compared with other fish sold in the same market, hence the proposal for its use in fish meal production is foresighted as an alternative to the use of the rather expensive conventional fishmeal for the formulation of fish feed.

It is therefore the objectives of this study to

- Prepare a low economic value fish meal from trash fish like Bonga (*Ethmalosa fimbriata*).
- To determine the suitability of Bonga fish meal as a supplement to the conventional fish meal.
- To determine the level of supplementation that is optimal for the growth of *Clarias gariepinus*

MATERIALS AND METHODS

Twenty five kilogram fresh weight of bonga fish *Ethmalosa fimbriata* was ovendried for 45 h at 80°C-90°C. The fish were taken to be dried when the pieces of fish, flesh crumbled between fingers. The dried *Ethmalosa* fish were later ground into meal form using an electric grinder. The meal was sieved with fine mesh and large particle sizes collected for regrinding. Proximate composition of the bonga fish was carried out. Also purchase of other ingredients used for the diet formulation were carried out and their proximate analysis were also done.

Previous studies done on *Clarias gariepinus* put the protein requirement at between 35 to 50% Faturoti[10], Viveen[11] depending on the stage of development. A 38% crude protein level was used to formulate six isonitrogenous diets with 0, 20 40, 60, 80 and 100% *Ethnalosa* fish meal supplementation with conventional fish meal. In addition to the test fish meals, the following ingredients were used. Danish fish meal (conventional fish meal), palm kernel cake, maize, soybean meal, groundnut cake, bone meal, oyster shell, growers premix and salt. Ingredients for each feeding level were weighed using the acculab electronic digital scale. Feed prepared at each level was placed in a well labeled 42 litre plastic bowl where they were thoroughly mixed with hand.

The formulated fish diet for each level was pelleted to avoid wastage and water pollution, using 10% starch paste (i.e starch prepared with boiling water) and mixing with boiling water. That is 10% starch paste of weight of feed to be pelleted is used; by vigorously turning the diet prepared against the starch pap the stickiness disappeared and a uniform dough was got. The dough from each level was hand pressed to pass through a 1.5 m.m sieve plastic die producing a spaghetti-like noodles. The pelleted wet feeds were dried in the sun until dryness. On drying the pellets had a size diameter of 1 m.m. Proximate composition of each level of the pelleted feed were carried out to determine the quality of each feed

Six plastic bowls labeled 0, 20, 40, 60, 80 and 100% were set up in the departmental laboratory island table, the bowls were covered with nylon mosquito nettings to prevent the fish from jumping out. The bowls were calibrated living a 15 and 20 Litre mark on each bowl, this serving as the minimal and maximal level of water during the culture of the experimental fish. The total volume of each plastic bowl was 42 Liters. Water for the project was from the laboratory tap.

One hundred and twenty *Clarias gariepinus* fingerlings were purchased from a fish breeding farm-Hilary Syndeham fish breeding centre, Ibadan. The fish were distributed into the 6 graduated plastic bowls and acclimatised in the bowl by starving for 24 h. 15 fingerlings with weight range of 2.40 to 2.51 gm were introduced into each bowl. The fish were initially fed at about 3% body weight but this was later adjusted to about 5%. The volume of water was maintained between 12 and 20 Litres and this was changed every morning between 08 and 09.30 h. The fish were fed ad-libitum twice daily, at 09.30 and 16.00 h, respectively after daily changing of water. The fish were fed ad libitum within the range 3-5% body weight of feed. Observations of the feeding behaviour in each bowl was noted.

Table 1: Feed formulation

Ingredients (KG)	0% wt	0% Ep	20% wt	20% Ep	40% wt	40% Ep	60% wt	60% Ep	80% wt	80% Ep	100% wt	100% Ep
Fish meal	1.0	6.81	0.8	5.45	0.6	4.09	0.4	2.72	0.2	1.36	-	-
Ethmalosa meal	-	-	0.2	1.16	0.4	2.31	0.6	3.47	0.8	4.62	1.0	5.78
PKC meal	1.0	1.80	1.0	1.80	1.2	2.16	1.4	2.52	1.5	2.70	1.6	2.88
Maize meal	1.0	1.01	1.0	1.01	0.8	0.81	0.6	0.60	0.5	0.50	0.4	0.41
Soyabean meal	2.5	10.54	2.0	8.43	2.0	8.43	1.5	6.21	1.0	4.21	0.5	2.11
GNC meal	4.0	18.10	4.5	20.40	4.5	20.40	5.0	22.63	5.5	24.89	6.0	27 16
Bone meal	0.3	-	0.3	-	0.3		-	0.3	-	0.3	-0.3	-
Oyster shell	0.125	-	0.125	-	0.125	-	0.125	-	0.125	-	0.125	-
Grower premix	0.025	-	0.025	-	0.025	-	0.025	-	0.025	-	0.025	-
Common salt	0.05	-	0.05	-	0.05	-	0.05	-	0.05	-	0.05	-
Total	10 kg	38.25	10 kg	38.29	10 kg	38.20	10 kg	38.20	10 kg	38.30	10 kg	38.30

The fish were weighed at the beginning of each week by first draining the water from the bowl. A small plastic bowl weighing 58 gm was standardized by zeroing in the Acculab electronic digital scale. A plastic perforated sieve was used to collect the fish from each experimental bowl and after draining of excess body water, were transferred to the 58 gm plastic bowl and the fish weight recorded. The culture bowl was taken one at a time and were quickly scrubbed and raised. After weighing the fish were carefully transferred into its appropriate bowl containing water.

From the result of weekly weight of fish, adjustments were made on the feed supplied on a weekly basis. The 3-5% body weight of feed was shared into two, morning and afternoon and this was calculated for 7 days enbloc. Unfed feed were deducted from the total feed weighed for the week and used in calculating the feed conversion ratio.

Water quality assessment was conducted weekly based on the principles of Boyd[12]. The following water quality parameters-pH (Alkalinity/Acidity), dissolved oxygen, carbondioxide, temperature were monitored weekly.

The proximate analysis of both feed and experimental fish were determined using the A.O.A.C[13] method. The total protein equivalent was determined by multiplying nitrogen content by 6.25. The nitrogen content was determined by the micro-kjedhal technique of Fel and Veatch. Crude fat was measured in a soxhlet apparatus of lipid by petroleum ether (b.pt. 40-60°C) dry weight by drying at 105°C for a day and ash by combusting for 12 h at 550°C.

The following growth and nutrient utilization parameters Viz:-Mean Weight Gain per day (MWDG) Specific Growth Rate (SGR), Net Protein Utilization on (NPU), Protein Efficiency Ratio (PER), Productive Protein Value (PPV), Net Nitrogen Retention (NNR), Food Conversion Ratio (FCR), Daily rate of growth DRG, Daily Rate of Feeding (DRF), Gross Efficiency of Food Conversion (GEFC) were monitored.

RESULTS

The proximate composition of Bonga (*Ethmalosa fimbriata*) showed a high crudeprotein of 57.79% which is much higher than 13.55% Ash, followed by 12.34% fat and moisture content of 8.23% as shown in Table 2.

The proximate composition of the experimental diets 0,20,40,60,80 and 100% showed all diets to be isonitrogenous at 38.00%, crude protein as shown in Table 3.

Table 4, the proximate composition of all the fish fed the 6 isonitrogenous experimental diets had higher crude protein than the initial crude protein of 70.05% of the fish before the commencement of the experiment. However fish fed diet 3 had the highest crude protein of 74.26%, (this is followed by diet 4 with crude protein of 73.81%), the least moisture content of 4.59%, ash 3.70% ,fat 1.80%,crude fibre 0.23%,highest N.F.E 15.42% was recorded in diet 3.

Fish fed on Diet 3 containing 40% Bonga (Ethmalosa fimbriata) fish meal inclusion had the best grow out and nutrients utilization pattern as shown in Table 5, it recorded the highest mean weight gain 10.08 gm, survival rate 73.30%, specific growth rate 1.95 also highest protein efficiency ratio 0.1060 and lowest Food Conversion Ratio (FCR) 2.02.

Table 2: Proximate composition of bonga (*Ethmalosa fimbriata*) fish meal

% Crude protein	% Fat	% Crude fibre	% Ash	% Moisture ocntent	% NFE
57.79	12.34	0.00	13.55	8.23	8.09

Table 3: Proximate compostion of experimental diets

Diets	% Crude protein	% Fat	% Crude fibre	% Ash	% Moisture ocntent	% NFE
0%	38.25	8.89	6.08	8.70	13.55	25.00
20%	37.98	9.58	7.68	9.52	11.44	23.80
40%	38.15	10.12	5.50	8.10	10.83	26.30
60%	38.35	10.36	7.14	9.26	9.52	25.10
80%	37.96	11.46	7.85	6.90	10.10	25.73
100%	38.04	10.65	8.03	8.20	11.60	23.48

Table 4: Initial and final proximate composition of experimental fish, *Clarias gariepinus* fingerlings

		Final proximate analysis					
Parameters	Initial Proximate analysis%	1 0% Diet	2 20% Diet	3 40% Diet	4 60% Diet	5 80% Diet	6 100% Diet
Moisture	7.05	7.86	8.50	4.59	5.10	5.78	6.93
Ash	10.86	15.56	6.87	3.70	4.12	4.67	5.60
Fat	5.32	7.57	3.34	1.80	2.00	2.27	2.72
Crude fibre	2.88	0.97	0.43	0.23	0.26	0.29	0.35`
Crude protein	70.05	70.50	72.26	74.26	73.81	73.35	73.78
NFE	3.03	13.92	8.60	15.42	14.71	13.64	11.62

Table 5: Growth and nutrient utilization of *Clarias gariepinus* fingerlings

	Diets					
Parameters (GM)	0%	20%	40%	60%	80%	100%
Initial mean wt.	2.51	2.47	2.43	2.40	2.49	2.40
Final mean wt.	12.28	12.16	10.51	9.63	8.14	7.56
Mean wt. Gain	9.77	9.69	10.08	7.23	5.65	5.16
% wt. Gain	389.20	392.30	414.80	301.30	226.90	215.60
Survival rate %	73.30%	73.30%	73.30%	66.70%	73.30%	73.30%
Feed Intake (gm)	251.80	239.20	249.10	210.902	09.30	191.10
SGR	1.89	1.90	1.95	1.60	1.41	1.37
FCR	2.85	2.02	2.02	2.52	2.90	2.97
PER	0.1014	0.1054	0.1060	0.0890	0.0730	0.0560
NPU	5.60	5.85	5.84	4.95	3.90	3.89
PPV	0.023	0.019	0.029	0.015	0.008	0.014
Nm	-225.30	-223.40	-232.40	-166.70	-130.30	-118.98
GFCE	0.462	0.500	0.565	0.400	0.333	0.306
NNR	2.25	1.87	2.86	1.45	0.80	0.14
DRF	0.026	0.024	0.023	0.030	0.036	0.036
DRG	0.012	0.012	0.013	0.012	0.012	0.011

DISCUSSION

Proximate composition of bonga (*Ethmalosa funibriata*) fish meal showed a crude protein of 57.79% lower than the 72.00% crude protein of the conventional Danish fish meal with which it was supplemented in the formulation of the 6 isonitrogenous diets (0, 20, 40, 60, 80 and 100%) all maintained at 38.00% crude protein level as shown in Table 2 and 3.

Proximate analysis of the formulated diets showed a narrow range of variation in the crude protein composition. This ranged from the least in 80% diet 37.96% to the highest in 60% diet 38.35% as shown in Table 3. Also fat composition was highest in 80% diet with 11.46% and least in 0% diet with 8.89%. The range of nitrogen free extract varied between 23.80% in the 20% diet to 26.30%.

Table 4 shows that the moisture content of the initial proximate analysis of experimental fish of 70.05% was much higher than that of the final proximate analysis of all the fishes fed the *Ethmalosa fimbriata* based experimental diets, however the 40% diet recorded the least moisture content of 4.59%. Also the least crude protein content of 70.05% was recorded in the initial proximate of experimental fish compared to the final proximate analysis. However fish fed the 40% diet recorded the highest crude protein of 74.26%, followed by 73.81% recorded in fish fed the 60% diet. Crude fibre was highest in the initial proximate analysis recording 2.88% while the least crude fibre was recorded in the final proximate analysis of fish fed 40% diet recording 0.23%. Also the least fat content of 1.80% was recorded in the 40% diet.

The highest Specific Growth Rate (SGR) of 1.95 was recorded for the 40% diet as shown in Table 5. This was followed closely by 20 and 60% diets with (SGR) specific growth rate of 1.90 and 1.60, respectively while the 100% diet gave the least with 1.37. The food conversion ratio was highest in 100% diet with 2.95 followed by 80% diet with 2.90. Others decreases in this order 60% (2.52), 0% (2.05) while the 20% diet also had the least FCR of 2.02 with the 40% diet.

Fish fed with 40% *Ethmalosa fimbriata* fishmeal supplementation in the diet gave the highest gain in weight of 10.08 gm per fish at the end of the twelve week period. This was followed by 0% supplementation (9.77 gm per fish), 20% diet (9.69 gm per fish) while decreases were observed for 100% diet (5.16 gm per fish), 80% diet (5.65 gm per fish) and 60% diet (7.23 gm per fish), respectively.

Contrary to Yves Siau[14] (findings in his studies on feeding wild scorpaenid fish in tanks the cultured fish (*Clarias gariepinus*) in this experiment accepted the pelleted feed compounded with bonga (*Ethmalosa fimbriata*) fish meal supplementation with ease. All the six diets were acceptable to the fish in varying degrees and utilized for growth with the resultant daily growth rates of 0.116, 0.115, 0.120, 0.086, 0.067 and 0.061 gm/day, respectively for the 0, 20, 40, 60, 80 and 100% diets. The highest daily growth rate of 0.120 gm/day recorded for the 40% diet (i.e. 40% bonga (*Ethmalosa fimbriata* fish meal supplementation) further confirms the 40% level of supplementation of bonga fish meal with the conventional Danish fish meal as the best and optimum level for *Clarias gariepinus* fingerling growth. This implies higher supplementation at 60, 80 and 100% which gave much lower growth rates will not be the best for growth and nutrient utilization has shown in this study.

Lovell[15] found out that at higher fish stocking densities and inadequate supplementary feeding leads to poor growth and nutritional diseases. The higher survival rates 73.30% for fish fed on 0, 20, 40, 80 and 100% diets and 66.70% for fish fed on 60% diet achieved in this study throughout the experimental culture period may be attributable to low stocking densities, adequate feeding and the daily changing of culture water which reduces the tendency for the introduction of any disease and promotes appropriate response of the fishes in terms of growth and nutrient utilization to their respective diet treatments.

Analysis of variance for the growth and nutrient utilization showed significant ($p<0.05$) variations for specific growth rate, protein efficiency ratio, feed conversion ratio, productive protein value, feed intake and gross food conversion efficiency.

CONCLUSION

The most suitable level for the optimal growth of *Clarias gariepinus* is the replacement of commercial fish meal (Danish fish meal) with bonga, *Ethmalosa fimbriata* fish meal at 40% level of supplementation.

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