GROWTH PERFORMANCE IN *CLARIAS GARIEPINUS* BURCHELL FINGERLINGS FED BLOOD MEAL – BOVINE RUMEN DIGESTA BLEND DIETS

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ABSTRACT

The nutritive value of blood meal-bovine rumen digesta (BMBRD) as a potential protein source in the diet of the African catfish *Clarias gariepinus* Burchell was evaluated using 144, six-weeks old *C. gariepinus* fingerlings (10.32±1.96 g) with a view to producing a cheap fish feed. Five approximately iso-nitrogenous (35% crude protein) experimental diets were prepared with 0%, 25%, 50%, 75% and 100% BMBRD meal inclusion respectively to replace the fishmeal standard component of the control commercial diets. The prepared experimental diets were fed in duplicate to *C. gariepinus* fingerlings in each dietary group for 86 days. A commercial feed was exclusively fed as the control diet. The fish stocked in 12 glass tanks (60 cm x 30 cm x 30 cm) at the rate of 12 fish per tank were fed at the rate of 5% of their body weight per day, in two equal instalments. The highest weight gain (68.07 ±2.70 g) was recorded in the fish fed the control diet followed by the fish fed 50% BMBRD diet (57.68±10.52 g) while the least weight gain occurred in the fish fed 100% BMBRD diet. However, the mean weight gain of the fish fed 75% and 100% BMBRD diet were significantly different (P<0.05) from the mean weight gain of fish fed other experimental diets. The fish fed 50% BMBRD diet had better protein efficiency ratio (PER) (0.32 ±0.01%), feed conversion ratio (FCR) (0.86 ±0.12) and specific growth rate (SGR) (1.03 ±0.07%) than the fish fed the other test diets. However, there was no significant difference (P>0.05) in the mean SGR of the fish fed experimental diets and the control. The proximate composition of the carcass of the fish fed the different experimental diets showed that the protein content of the fish fingerlings fed the control feed was significantly higher (P<0.05) than in the fishes fed the experimental diets. The study concluded that fishmeal could be adequately replaced with BMBRD meal of up to 50% in *C. gariepinus* fingerlings diets without obvious deleterious effects on growth and survival.

Keyword: Blood meal, rumen digesta, *Clarias gariepinus*, diet.

INTRODUCTION

Fish is a rich source of animal protein throughout the world. Due to its nutritional value (Tingman *et al*., 2010), the demand for fish food has been on the increase with increasing human population (FAO, 2010; 2012). Fish culture which is an important source of protein and employment for many people (Gabriel *et al*., 2007) has been used to bridge the gap between demand and supply of fish from capture fisheries.

High cost of imported fish feeds with fish meal as the primary protein source constitute 40-60% of the recurrent cost of most intensive fish farm ventures (Jamu and Ayinla, 2003). The high cost of feeding the fish affects the viability of the fish farms when cheaper protein alternatives are not available (Madu *et al*., 2003). The expensive fish meal component of a fish diet is undoubtedly the best source of protein for artificial fish culture because its protein quality and palatability supports good fish growth (Miles and Chapman, 2012). The high cost of fish meal-based diet ultimately leads to high cost of fish production. There is therefore the need to identify, explore and utilize cheaper non-conventional feedstuff which attracts less competition.

Majority of alternative protein feedstuffs have been found to be deficient in one or more essential amino acids and/or contained various quantities of anti-nutritional factors (Soltan *et al.,* 2008). Blends of animal by-product meals have however been combined with other feed ingredients with complementary amino acid profiles to satisfy the nutritional requirements of wide range of farmed fish species (Laporte *et al.,* 2009). Several nutritional evaluations indicated that the utilization of animal by-product blends in aquafeed could help the aquaculture industry grow into a sustainable, ecological and ethical bio-industry (Glencross *et al.,* 2007).

In animal nutrition, blood meal is one of the commonly sustainable sources of protein because large quantities of it are still being discarded as wastes in abattoirs (Otubusin *et al.,* 2009). Unlike fish meal however, blood meal has a poor essential amino acid balance with lysine being relatively high and isoleucine being very low (Sauvant, 2004). The observed deficiency prevents the use of blood meal as a wholesale substitute for fish meal in fish feeds. A relatively high level (7-8%) of lysine in blood meal makes it an excellent supplemental protein source to use in combination with plant derived feed ingredients that are low in lysine (Sauvant, 2004).

Cattle rumen digesta, which is also an abbatoir waste, has been used variously in animal feed preparation (Agbabiaka *et al.,* 2012) and has also been reported to complement the amino acid in-balance in the blood meal (Odunsi, 2003, Dairo *et al.,*, 2005). Studies on blend of bovine blood meal and rumen digesta (BBRDM) as a replacement for fishmeal have been reported in the diet of some fishes (Adewumi, 2012). The objective of the present study is to evaluate the nutritive value of blood meal-bovine rumen digesta (BMBRD) blend as a potential protein source in the diet of the catfish *C. gariepinus* fingerlings.

MATERIALS AND METHODS

Diet Preparation and Experimental Design

Fresh bovine blood and rumen digesta obtained from a slaughter slab were mixed in the ratio of 1:1 (weight/weight) and cooked for 60 minutes with constant stirring at 80^0C until it formed a paste which was sundried on a clean drying slab for 4 days. The dried BMBRD blend was later ground into a meal and analyzed for the proximate composition (A.O.A.C., 1990). Five 35% isonitrogenous crude protein diets were then formulated using fish meal, wheat offal and yellow maize (Table 1) with BMBRD meal replacing the fish meal component at 0, 25, 50, 75 and 100% (Table 2). The ingredients were weighed according to formulation, moistened and mixed thoroughly before being pelleted using 2 mm die in a pelleting machine. The moist pellets were sundried for 3 days until crispy and stored at room temperature in a polythene bag. The formulated diets were tagged 0% BMBRD, 25% BMBRD, 50% BMBRD, 75% BMBRD and 100% BMBRD respectively for subsequent trial feeding. The experimental diets were analyzed for the proximate composition (AOAC, 1990) to confirm the formulations (Table 3).

Table 1: Proximate Composition* of the Feedstuffs Used in Formulating the Experimental Diets

Ingredients	Crude protein (%)	Crude fibre (%)	Lipid (%)	Ash (%)
Fish meal	68.50	0.40	10.40	20.40
BMBRD	45.50	9.48	1.15	10.93
Wheat offal	16.34	12.34	1.69	6.58
Yellow maize	10.80	3.50	3.60	8.40

*Mean of 3 determinations

Table 2: Ingredient Compositions in the Formulated Experimental diet (g/100g)

Ingredients	**0% BMBRD**	**25% BMBRD**	**25% BMBRD**	**75% BMBRD**	**100% BMBRD**
Fish meal	52.0	39.0	26.0	13.0	-
BMBRD	-	1.3	2.6	39.0	52
Wheat offal	23.0	23.0	23.0	23.0	23.0
Yellow maize	23.0	23.0	23.0	23.0	23.0
Vit/Min Premix *	1.0	1.0	1.0	1.0	1.0
Vegetable oil	0.5	0.5	0.5	0.5	0.5
Salt	0.5	0.5	0.5	0.5	0.5
Total	100	100	100	100	100

*Biomix from Bio-organics production were provided per kg of diet: Vitamin A, 12,500 IU; Vitamin D, 2,500 IU; Vitamin E, 40 mg; Vitamin K, 2 mg; Vitamin B1, 3 mg; Vitamin B2, 5.5 mg; Niacin 55 mg; Calcium pantothenate, 11.5 mg; Vitamin B 6, 5mg; Vitamin B 12, 0.025 mg; Choline chloride, 500 mg; Folic acid, 1 mg; Biotin, 0.08 mg; Manganese, 120 mg; Iron, 100 mg; Zinc, 80 mg; Copper, 8.5 mg; Iodine, 1.5 mg; Cobalt, 0.3 mg; Selenium, 0.12 mg; Anti-oxidant, 120 mg.

Table 3: Proximate Composition of the Experimental Diets and the Control

Sample	**Crude protein (%)**	**Crude fibre (%)**	**Lipid (%)**	**Ash (%)**	**Moisture (%)**	**Nitrogen Free Extract (NFE) (%)**	**Dietary Energy (Kcal/g)**
CONTROL**	45.00	2.60	14.00	7.50	11.00	19.9	
0%BMBRD	35.90 [a] ±0.11	2.14 [a] ± 0.16	3.40 [a] ± 0.02	8.17 [a] ± 0.58	9.99 [a] ± 0.40	40.4	3.78
25%BMBRD	35.99 [a] ±0.01	2.91 [a] ± 0.19	3.50 [a] ± 0.02	7.85 [a] ± 0.34	11.54 [a] ± 1.12	38.21	3.82
50%BMBRD	35.98 [a] ±0.02	3.85 [b] ± 0.09	3.10 [a] ± 0.02	8.40 [a] ± 0.23	10.78 [a] ± 1.46	37.89	3.34
75%BMBRD	35.59 [a] ±0.05	3.87 [b] ± 0.16	4.00 [a] ± 0.02	7.82 [a] ± 1.15	10.49 [a] ± 1.19	38.23	4.17
100% BMBRD	35.48 [a] ±0.02	4.78 [c] ± 0.07	3.90 [a] ± 0.02	8.32 [a] ± 0.24	9.66 [a] ± 0.55	37.86	3.94

*Means within column with different superscripts are significantly different ($p<0.05$).
**Manufacturer's nutrient specification
NFE = Nitrogen-free Extract = 100 – (Crude protein + Crude fibre + Lipid content + Moisture content + Ash) (A.O.A.C, 1990).

Experimental Feeding

One hundred and fifty (150) - 6 weeks old *Clarias gariepinus* fingerlings (8.76±1.03 g) obtained from Ako Fish Farm, Ile-Ife were used for the trials. The fish which were sorted and stocked in glass tanks (60 cm x 30 cm x 30 cm) were acclimated and fed a commercial feed to ensure the fish have the same nutritional history at the rate of 5% of their body weight per day in two instalments for 2 weeks. After acclimatization, 144 healthy specimens (10.32 ±1.96 g) were selected and distributed into each of 12 labelled glass tanks (60 cm x 30 cm x 30 cm) at stocking density of 12 fingerlings per tank. The fish were stocked in duplicates for each dietary treatment and the control. The entire test fish were starved for 24 h prior to the commencement of the experimental feeding to allow for digestion of already eaten food and also prepare the fish for the test diets. The test diets were fed twice daily at 5% biomass, administered between 8 to 9 am and 5 to 6 pm daily for a period of 86 days.

Measurements/Data Collection

The fish in each treatment were weighed at the commencement of the feeding trial and forthnightly subsequently, using a top-loading Mettler Balance Model P1210. Ration allotment were adjusted bi-weekly according to the new body weight changes. Uneaten food and feacal samples were siphoned out daily while fish mortality was also monitored daily. Body weight changes and feed intake were recorded forthnightly while feed conversion ratio was computed according to Burel *et al.* (2000). At the end of 86 – day trials, the fish in each tank were sacrificed, fillet dissected out and pooled for each treatment. The fillet samples were later subjected to proximate analyses (A.O.A.C 1990). Water quality parameters such as pH, temperature and dissolved oxygen were monitored *in situ* daily while calcium, magnesium and nitrate levels were monitored weekly throughout the duration of experiment using the methods of Golterman *et al.* (1978); APHA (1992) and Ademoroti (1996) as applicable to ensure water quality standards for culture were met. From weight data and the quantity of feed consumed, the growth performance and feed utilization data were generated by the following formulae:

Mean Weight gain (MWG) = $W_2 - W_1$ (Pitcher and Hart, 1982)

W_2 = the mean final weight of fish

W_1 = the initial mean weight of fish

$$\text{Daily weight gain} = \frac{\text{MWG} \times 100}{\text{Initial mean weight}}$$

(Pitcher and Hart, 1982)

Specific growth rate (SGR)

$$= \frac{100\,(\log W_2 - \log W_1)}{T}$$

(Brown, 1957)

where; W_1 and W_2 = the logarithms of initial mean and final mean weights of fish, respectively, T = the number of days for the feeding trial

Feed Conversion Ratio (FCR)

$$= \frac{\text{Dry weight of diet fed (g)}}{\text{Fish weight gain (g)}}$$

(Wilson, 1989)

Protein Intake =
Protein content in the diet x Daily Feed Intake
(Sveier *et al.,* 2000)

Protein Efficiency Ratio (PER)

$$= \frac{\text{Mean Weight Gain}}{\text{Mean Protein Intake}}$$

(Burel *et al.,* 2000)

Statistical Analysis

The data were subjected to Analysis of Variance (ANOVA) and Duncan's Multiple Range Test ($P < 0.05$) using the statistical software package SPSS 16.0

RESULTS

Feed Utilization and Growth Performance Evaluation

All the experimental feeds were well utilized by fish as shown by the feed utilization indices (Table 4) as well as the percentage survival rate. Appreciable mortality however occurred in the fish fed the control diet and those fed on 100% BMBRD diet. The total feed intake in the fishes fed the experimental diets which varied between 39.1 ±4.3 g/fish (100% BMBRD) and 60.9 ±3.2 g/fish (0% BMBRD) was not significantly different ($P>0.05$) from those fed the control diet (84.4 ±24.5 g/fish). Fish fed 100% BMBRD diet consumed the least amount of the experimental feeds while those fed 0% BMBRD diet consumed the highest. Comparatively however, the fish fed the control diet consume roughly twice the amount of food eaten by those fishes fed 100% BMBRD diet (Table 4).

Table 4: Growth response and nutrient utilization* of the cultured fish fed different experimental diets

Parameters	CONTROL	0% BMBRD	25% BMBRD	50% BMBRD	75% BMBRD	100% BMBRD
Growth Performance Indices						
Initial Mean Weight (g)	10.85[a] ± 0.01	9.45[b] ± 0.39	11.53[c] ± 3.50	8.83[ac] ± 2.92	13.30[abc] ± 4.20	7.96[ac] ± 1.75
Final Mean Weight (g)	78.92[a] ± 2.71	59.36[b] ± 6.95	62.65[abc] ± 49.99	66.50[ab] ± 13.44	49.64[ac] ± 30.19	27.16[ac] ± 5.43
Mean Weight Gain (g)	68.07[a] ± 2.70	49.88[b] ± 7.35	51.12[abc] ± 43.50	57.68[ab] ± 10.52	36.34[ac] ± 25.99	17.40[c] ± 6.41
Specific Growth Rate (SGR) %	1.00[a] ± 0.14	0.99[a] ± 0.21	0.80[a] ± 0.16	1.03[a] ± 0.07	0.63[b] ± 0.16	0.52[b] ± 0.15
Feed Utilization						
Total Feed Intake (g/fish)	84.4[a] ± 24.5	60.9[a] ± 3.2	60.3[a] ± 32.9	50.1[a] ± 15.8	52.9[a] ± 22.4	39.1[a] ± 4.3
Protein Intake (%)	4.59[a] ± 1.59	4.15[a] ± 2.45	2.45[a] ± 1.49	2.10[a] ± 0.49	2.10[a] ± 0.99	1.58[a] ± 0.25
Protein Efficiency Ratio	0.17[a] ± 0.04	0.24[a] ± 0.04	0.22[a] ± 0.07	0.32[b] ± 0.01	0.19[a] ± 0.06	0.15[a] ± 0.09
Feed Conversion Ratio	0.94[a] ± 0.32	1.17[a] ± 0.02	1.33[a] ± 0.43	0.86[a] ± 0.12	1.67[a] ± 0.57	1.97[a] ± 0.92
Survival Rate %	85.0	95.0	95.0	100.0	100.0	75.0

*Row means with the different superscript are significantly different (P<0.05) from each other.

Fish fed the control diet had the highest Protein Intake (PI) (4.59 ±1.59%) while the lowest PI (1.58 ±0.25%) was recorded in the fish fed 100 % BMBRD diet. Irrespective of the variation in PI between the diets, there were no significant differences (P>0.05) between the PI values recorded between the treatments (Table 4). Fish fed 50% BMBRD diet had the best Protein Efficiency Ratio (PER) (0.32 ±0.01%) which was significantly higher (P<0.05) than for other experimental diets while fish fed 100 % BMBRD diet had the lowest value (0.15 ±0.09%).

As shown in Table 4, the fish fed diet 100 % BMBRD had the highest FCR while the fish fed diet 50% BMBRD had the least value. Although no significant difference (P>0.05) was recorded between the FCR in the fish fed the experimental diets, the FCR in the fish fed 100% BMBRD diet was almost twice those fed the control diet.

Growth performance indices (Table 4) revealed that the fish fingerlings fed control diet had the highest mean weight gain (68.07±2.70g) which was however not significantly different (P>0.05) from the weight gained by the fingerlings fed 25% and 50% BMBRD diets. Among the BMBRD based dietary treatments, the fish fed diet 50% BMBRD had the highest weight gain (57.68 ±10.52g) while the fish fed 100 % BMBRD diet had the least weight gain (17.40±6.41g). The weight gain translated to 5768% of the initial weight in the fingerlings fed 50% BMBRD diet and 1740% in the fish fed 100% BMBRD diet. The specific growth rate (SGR) was highest (1.03 ±0.07%) in the fish fingerlings fed 50% BMBRD diet while the value was least (0.52 ±0.15%) in the fish fed 100% BMBRD diet. However, the difference recorded in the mean SGR between the treatments and the control were not significantly different (P>0.05)

Carcass Composition

The proximate composition of the carcass of the fish fed the different experimental diets varied with treatment (Table 5). Apart from the fish fed 75% BMBRD diet, the crude protein content of the fish carcasses were higher in the experimental fish than in the pre-treatment fish, though not significantly (P>0.05). The result also showed that the protein content of the fish fingerlings fed the control feed was significantly higher (P<0.05) than in the fishes fed the experimental diets. Among the BMBRD treatment diets, analyses however showed that the fish fed 100% BMBRD diet had the highest carcass protein (67.25 ±2.36%) while the fish fingerlings fed 75% BMBRD diet had the least (60.20 ±1.72%).

The carcass lipids content of the experimental fishes varied widely between 6.80±1.17% (control diet) and 27.00 ±12.37% (75% BMBRD diet). Statistical analyses showed no significant differences (P>0.05) between the carcass lipid levels in the pre-treatment fish and those fed the experimental diet. However, significant difference (P<0.05) were recorded between the fish carcass lipid content in the fish fed the control diet and those fed the experimental diets.

Table 5: Proximate Analysis* of the Fish Carcass Before and After the Experiment

Proximate composition	Pre-Cultured Fish	CONTROL	0% BMBRD	25% BMBRD	50% BMBRD	75% BMBRD	100% BMBRD
Crude protein	63.50[a] ±1.54	76.85[b] ±1.04	66.14[a] ±2.12	66.68[a] ±1.43	63.53[a] ±1.52	60.20[a] ±1.12	67.25[a] ±2.36
Crude fibre	0.53[a] ± 0.12	1.34[a] ± 0.11	0.08[a] ± 0.19	0.33[a] ± 0.99	0.95[a] ± 0.16	0.40[a] ± 0.82	2.25[b] ± 0.32
Lipid	21.00[a] ± 6.55	6.80[b] ± 1.17	16.55[a] ± 0.63	12.01[a] ± 1.38	19.70[a] ± 1.25	27.00[a] ± 12.37	17.01[a] ± 3.47
Ash	9.69[a] ± 1.15	9.70[a] ± 1.58	12.12[a] ± 0.13	14.88[a] ± 4.26	11.17[a] ± 0.67	11.05[a] ± 0.70	6.81[b] ± 1.09
Moisture	5.24[a] ± 1.85	5.23[a] ± 0.38	5.06[a] ± 0.11	6.02[a] ± 0.45	4.58[a] ± 0.70	11.33[a] ± 9.60	6.58[a] ± 0.28

*Row means with the different superscript are significantly different (P<0.05) from each other.

DISCUSSION

The proximate composition of the blood meal-bovine rumen digesta (BMBRD) (CP-45.5%; Lipid–1.15%) used to compound the experimental diets differed from 11.16% - 39.80% CP and 1.83 - 15.2% lipid content reported for some other BMBRD meals (Dairo *et al.,* 2005; Adeniji and Jimoh, 2007 and Adewumi, 2012), but was fairly close to the values (46.10% CP, 2.13% lipid) reported by Odunsi (2003). The variations in the proximate composition of BMBRD meals could be attributed to the differences in the processing methods, the proportion of the

The crude protein contents of the experimental diets (35.48% - 35.99%) were within the range recommended in *C. gariepinus* formulated test diets and it met the protein requirements (30% - 40%) recommended as being optimum for growth in the *C. gariepinus* (Faturoti *et al.,* 1986; Fagbenro *et al.,* 1992). The ability of *C. gariepinus* fingerlings to readily accept the experimental diet supplied as shown by the feed utilization indices (Fagbenro *et al.,* 2003), confirmed the plasticity of *C. gariepinus* fingerlings to efficiently utilize a wide variety of food items.

the imported commercial feed which had higher crude protein content. The improved growth performance in the fish fed 50% BMBRD based-diet over other BMBRD-included diets could be attributed to better essential amino acid balance in the blood meal–rumen digesta mixtures. The poor growth recorded in the fishes fed 75% BMBRD and 100% BMBRD diet when compared with other experimental diets probably indicated the absence of some nutrients particularly some of the essential amino acid complements present in the control diet and 50% BMBRD diets which probably conferred better growth factor on the fish fingerlings (Ogunji, 2004; Hossain *et al.,* 2001). Deficiency in methionine has been reported to lead to reduced fish growth (Adewolu and Adamson, 2011). The above average growth performances of fish fingerlings fed 75% BMBRD and 100% BMBRD diets however, could be related to the adequacy of dietary crude fibre level in BMBRD included diets. Crude fibre when in the right proportion has been reported to activate the intestine and facilitate peristaltic movement and enzyme production resulting in efficient digestion of nutrients present in fish feeds (Kekeocha, 1984; Esonu *et al.*, 2004; 2005).

Data on gross body composition of an animal provides specific information on its development and physiological state (Adewumi, 2005). The fish carcass protein for each of the dietary treatments in this study was probably reflected on the weight gained by the fish. Carcass crude protein was generally higher than the initial fish carcass protein except in the fish fed 75% BMBRD diet. The results indicated that the weight gain could be attributed to protein synthesis of new tissues which ultimately led to increase in body carcass protein (Adewumi, 2005). The marginal differences recorded in proximate composition of the fish carcass within the treatments probably indicated differences in the effectiveness of the utilization of the test diets.

CONCLUSION

Inclusion of blood meal-bovine rumen digesta meal as an alternate protein source in *C. gariepienus* fingerling diet above 50% in the fish diet caused growth depression and decrease feed utilization. The study therefore confirmed that fishmeal could thus be efficiently replaced with BMBRD meal up to 50% in *C. gariepinus* diets without obvious deleterious effects on growth. The utilization of BMBRD meal as a protein supplement in feeding *C. gariepinus* fingerlings will not only reduce the cost of production of the fish feed, but it will also alleviate the problem of environmental pollution and disposal of blood and rumen digesta in abbatoirs.

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