Effects of Blood Meal Inclusion Diet on Growth Performance, Feed Utilization and Survival Rate of *Clarias gariepinus* (Burchell 1822) in Concrete Pond.

Abstract

The inclusion of blood meal as a substitution for commercial fishmeal in the practical fish diets was evaluated in *Clarias gariepinus* juveniles (initial weight: 11.45±0.25g and initial length: 9.00±0.91cm) for a period of 39 weeks. The proximate analysis of blood meal had 50.04%, 4.95%, 0.98%, 3.05%, 16.51% and 19.00% representing value of crude protein, lipid, fibre, ash, moisture and nitrogen free extract, respectively. Five isonitrogenous diets (40% crude protein) containing fishmeal which was replaced by blood meal at graded level of 0% as control, 25%, 50%, 75% and 100% were formulated. A total of 300 juveniles were used and randomly distributed into five treatments with each having triplicates of 20 fish per pond respectively. Fish were fed twice daily at 5% body weight in equal proportions at 8.00am and 4.00pm. At the end of the feeding trial, the results showed that growth performance were significant higher ($p<0.05$) in fish fed control diet (1263.55g) and 25%BM diet (1068.67g), mean length gain (54.16cm and 50.85cm), protein efficiency ratio (31.59% and 24.22%) and percentage weight gain (11035.3% and 8476.03%) compared to other treatments diets with the lowest values of (675.35g, 46.86cm, 11.73% and 4190.63%, respectively) recorded in fish fed 100% BM diet. However, Feed conversion ratio, specific growth rate, average daily growth and survival rate were not significantly difference ($p>0.05$) in all the dietary treatments. The water quality parameters monitored were within recommended ranged and were not affected by the supplemented diets. It can be concluded that inclusion of blood meal up to 25% can efficiently replace fish meal without any deleterious effects on growth, feed utilization and survival rate. The use of blood meal as an

alternative protein source in diets of farmed fish species will reduce the cost of feeds; boost the profitability and sustainability of the fish production.

Keywords: *Clarias gariepinus*, protein, growth performance, blood meal

Introduction

Fish is an important source of rich protein food for human consumption and it has a major source of high-quality dietary essential amino acids, vitamins, minerals and other micro-nutrients. They are the cheapest source of animal protein which accounts for about 38% of Nigeria's total protein requirements [1, 2]. Due to its tremendous value, it creates employments, recreation/sports, enhance national health and wealth.

The African catfish, *Clarias gariepinus* (Burchell, 1822) belong to the family *Clariidae* and a native fish species in African countries [3]. It is the most cultured fish species in Nigeria and other developing countries because of its fast growth performance, good feeding conversion, tolerates poor water quality conditions, feeds on agricultural by-products, hardiness and high commercial value [4, 5].

The interest of every fish farmers is to produce table-sized fish within the shortest possible time [6] with a balanced nutrient composition of the feed. However, feeding is one of the constraints facing fish farming in Nigeria due to its high cost of fish feeds; imported fish feed are very expensive and often scare thereby reducing the growth performance, profitability and sustainability of the fish culture industry, since its cost constitutes about 60-70% of the production cost [7]. Protein is a major dietary nutrient component of formulated feeds [8] and the commonest source is fishmeal which is very expensive. Fish meal is the conventional source of animal protein in aqua feeds because of its high protein and amino acids profile, vitamins content, high digestibility and growth factors [9].

Due to high quest for protein source, numerous emphases on suitable alternative of various local protein sources has been put into consideration to ensure rapid increase in fish food production to meet the high population demand of fish consumers and aqua-farmers [9, 10, 11]. According to [12], feed cost is the major constraint in aquaculture and to reduce the price of a complete feed, locally available feedstuff should be included in the feed especially agricultural by-products. However, feedstuffs of animal protein origin which can easily be combined with other feed ingredients have attempt to partially or completely replace fish meal component in fish diets with varying degree of success without affecting the growth performance and survival rate since fish utilizes both animal and agricultural by-product [14, 4, 6, 16]. They are cheaper, have complementary amino acid profiles, affordable and available in large commercial quantities.

Blood meal is a source of animal protein gotten from abattoirs that has high protein contents of (85%) and heme-iron [17, 18]. It has been recognized as one of the most efficiently good substitute for fish meal. Furthermore, it is rich in lysine (7-9%), valine, leucine, phenylalanine and low methionine [19, 20, 21]. Several studies have been reported on the potential use of blood meal to replace fish meal component in fish diets such as *Oreochromis niloticus* [22, 23, 24], gilthead sea bream [25], largemouth bass [27] and *Clarias gariepinus* [21, 28] with vary degree of successes. Blood meal provides a cheap and effective replacement for fish meal in fish diets, with no adverse effects on growth rate, survival and feed conversion ratio [17].

For fish to grow well, a well balanced diet containing the essential nutrient in the right proportions is needed by the fish and at the most economic profit to the farmer using a cheaper alternate protein source to replace the fish meal without compromising the quality, acceptability and palatability of the feed [12]. Although blood meal has been recognized as a rich protein source and good substitute of fishmeal regarding its effects on growth, survival and yield of fish, there is need to conduct a feeding trial to determine the growth performance of fish this waste by-product. This research is aimed to evaluate the growth

performance, feed utilization and survival rate, and also the optimum inclusion level of blood meal in the diets for juveniles of *Clarias gariepinus* in concrete pond.

Materials and methods

Study site:

The research study was conducted at Amas fish farm at Ezihe in Isiala-mbano, Local Government Area of Imo State. It is located in North-East of Imo State within Latitude 5^0 40^0 4' N and Longitude of 7^0 12^0 2' E. The fish ponds are made of concrete and designed in rectangular forms of (4m×4m×1.5m) and the main source of water at the farm is bore-hole water.

Processing of blood meal and feedstuff

The blood was collected raw from the slaughter house at Isiala-mbano L.G.A. it was boiled for 30 minutes to reduce the water content and to congeal the blood. It was then oven-dried for 4 hours at a temperature of 105^0C. The dried blood was then grounded finely using Victorian hand grinding machine. Fishmeal, soybean meal, maize, palm kernel cake and other feedstuffs purchased from commercial mill in Owerri, Imo State were separately milled, screened to fine and analyzed for the proximate composition (AOAC, 2005).

Experimental diets

Base on feed ingredients proximate composition (table 2), five iso-nitrogenous diets containing (40% crude protein) were formulated using Pearson's square method with blood meal replacing fish meal component at 0% served as control, 25%, 50%, 75% and 100% inclusion level respectively. A commercial feed (Vital) used as the control diet for the experiment was purchased from a commercial shop in Owerri. Prior to processing, the ingredients were milled individually to a fined powder, weighed according to formulation, manually mixed together and moistened thoroughly using the method described by [30]. The

mixed diets were pelleted using electrical pelletizing machine set at 2mm, 4mm and 6mm, sun-dried for 4 days to remove moisture, packaged into separate bags, labeled and stored in a cool dry place. The experimental diets were analyzed in triplicate for the proximate composition (AOAC, 2005) to confirm the formulation (table 3).

Table 1: Ingredient composition of the experimental diets (g/100g)

Ingredients	Control (0%)	T2 (25% BM)	T3 (50% BM)	T4 (75% BM)	T5 (100% BM)
Fish meal	24.0	18.0	12.0	6.0	----
Blood meal	----	6.0	12.0	18.0	24.0
S.M.B	24.0	24.0	24.0	24.0	24.0
Maize flour	40.0	40.0	40.0	40.0	40.0
Bone meal	2.0	2.0	2.0	2.0	2.0
P.K.C	5.0	5.0	5.0	5.0	5.0
Starch (binder)	2.0	2.0	2.0	2.0	2.0
Salt	0.5	0.5	0.5	0.5	0.5
Vit/min premix	1.5	1.5	1.5	1.5	1.5
Palm oil	1.0	1.0	1.0	1.0	1.0
Total	100.0	100.0	100.0	100.0	100.0

S.M.B = soya bean meal, P.K.C = palm kernel cake. Vitamin/mineral premix supplied per gram of diet. Vitamin A: 20,000 IU; vitamin D_3: 4,000 IU; Vitamin E: 200,000 IU; Vitamin K: 1,200mg; Vitamin B: 10,000mg; VitaminB_2: 3,000mg; Vitamin K: 2.5mg; Vitamin B_{12}: 1,000mg; Niacin: 0.088mg; Folic acid: 5,00mg; Antioxidant: 3,000mg; panthothenic acid: 4,000mg; Biotin: 400mg; Riboflavin: 0.020mg; Vitamin C: 200mg; Iron: 0.300mg; Magnesium: 0.088mg; Manganese: 30mg; Copper: 4g; Zinc:40g; Iodine: 1,000mg; Calcium pantothenate: 11.5mg; Chlorine chloride: 500mg and Selenium:200mg.

Experimental Fish

Three hundred (300) juveniles of *Clarias gariepinus* with mean body weight of approximately (11.45±0.25g) were used for the study and obtained from a private fish farm

in Owerri, Imo State. The fish were transported in 50 liters open plastic rubber half filled with water to the experimental site. The initial length and initial body weight of the fishes were measured with a meter ruler (to the nearest 0.1cm) and electronic weighing balance (Ohaus-30064419 scout pro, to the nearest 0.01gram) in order to establish the mean individual weight and length at the start of the experiment.

Experimental design and feeding

Fifteen concrete ponds (4m×4m×1.5m) were used for the feeding trial. The experiment consisted of five treatments (diets) with three replicates. A total of three hundred (300) juveniles of *Clarias gariepinus* with an average weight (11.45±0.25g) and length (9.21±0.91cm) were randomly assigned in a completely randomized design (CRD) at a rate of twenty (20) juveniles per replicate. Prior to the experiment, the fish were acclimatized for seven days before the commencement of the experimental feeding in order to increase appetite and utilize the test diets. Fishes were fed at 5% of their total body weight daily [31]. Feeding was administered twice daily between (8.00 – 8.30am and 4.00 – 4.30 pm) for the period of 39weeks. Subsequently, growth data were taken fortnightly and quantity of feed fed adjusted in accordance with the fish new, also the leftover feeds together with fecal residues were siphoned out every three days siphoned out and replaced with fresh water described by [32].

Growth and feed utilization parameters.

The weights of fish were taken every two weeks. The following growth performance and feed utilization analyzed, calculated and recorded for each treatment using the methods of [11, 33, 34, 35]. These parameters includes; mean weight gain (MWG), specific growth rate (SGR), feed conversion ratio (FCR), Mean length gain (MLG), average daily growth (ADG), protein efficiency ratio (PER), percentage weight gain (PWG), protein intake (PI), feed intake (FI) and survival rate (SR),

Mean weight gain (MWG) = finial mean weight – initial mean weight (g)

Specific growth rate (SGR %) = $100(\log W_f - \text{Log } W_i) / T$

Where; W_f and W_i = the logarithms of initial and finial mean weights of fish respectively, T= the rearing period in days.

Feed conversion ratio (FCR) = total feed intake (g) / Fish weight gain (g)

Protein efficiency ratio (PER) = fish weight gain (g) / Protein intake (g)

Average daily growth (ADG) = mean weight gain (g) / No of days

Protein intake (PI) = total feed consumed × % protein in feed / 100

Total feed intake (TFI) = initial weight of feed – final weight of feed (g)

Survival Rate (SR) % = No of fish survived / Initial fish stocked × 100

Water quality parameters

Physico-chemical parameters in the various fish ponds were monitored during the experimental period early in the morning using the methods of Boyd, (1979) and APHA *et al*, (2005) prior to siphoning and feeding. The temperature was measured using mercury hand thermometer (Boyd, 1979), pH and dissolve oxygen were measured using Hanna digital multipurpose meter (H12210), and ammonia was measured using spectrophotometer (HACH/2000) to ensure the water quality standards for fish culture were met.

Chemical analysis

Proximate analysis of blood meal, feed ingredients, experimental diets and fish carcass (initial and finial) were performed in triplicate according to the methods of AOAC (2005) at Laboratory of Fisheries and Aquaculture, Federal University of Technology, Owerri, Imo State. Moisture content determined after drying samples in an oven for 4hrs at 105^0 C until a constant weight was obtained. Crude protein (N×6.25) was determined using the routine semi-Kjeldahl method. Ash content was determined by igniting feed sample in a muffle

furnace for 24hrs at 550^0 C. Crude fat was determined by ether extraction using soxhlet method Crude fiber was quantified by acid/base digestion followed by ashing the dry residue at 550^0C in a muffle furnace for 4 hours. Nitrogen free extracts content was determined by subtracting the percentage of moisture, crude protein, ash and fat from 100.

Statistical analysis

All data collected were subjected to one-way analysis of variance (ANOVA) as described by Steel and Torrie (1980). Significant differences between mean were determined by Duncan's multiple range tests ($p<0.05$) using statistical package for social sciences (SPSS) version 20. Values were expressed as means (± S.E)

Results

Results from this study are presented in tables 2, 3, 4, 5, and 6. Proximate composition of the feed ingredient is presented in table 1.

Table 2: proximate composition of feed ingredients

Ingredients	Crude Protein (%)	Fiber (%)	Lipids (%)	Ash (%)	NFE (%)	Moisture (%)
Fish meal	58.04	0.72	10.00	10.71	14.24	11.33
Blood meal	50.10	0.98	4.95	3.05	19.00	16.51
Maize flour	10.80	5.78	4.28	6.58	23.30	10.42
S.B.M	48.74	5.10	6.18	4.48	12.03	10.70
P.K.C	30.73	3.60	6.50	4.03	9.52	11.52

S.B. = soya bean meal, P.K.C = palm kernel cake, NFE = nitrogen free extract.

Table 3: Proximate Composition (% dry matter) of the Experimental Diets.

Parameters	Control**	T2	T3	T4	T5

	(0%)	**(25%)**	**(50%)**	**(75%)**	**(100%)**
C.P (%)	40.00	38.29	38.84	38.25	38.42
Fiber (%)	5.33	5.20	5.14	5.53	5.19
Lipid (%)	12.20	12.09	11.34	12.10	11.28
Ash (%)	7.50	8.17	7.85	7.40	7.62
Moisture (%)	12.17	13.19	11.00	11.54	11.69
NFE (%)	27.32	27.08	27.64	27.12	29.35
D. M (%)	93.16	91.33	91.09	91.13	91.38
C.V (kcal/g)	10.44	10.22	10.34	10.17	10.27

CP = crude protein, NFE= nitrogen free extract, C.V=caloric value, DM = dry matter.

**Manufacturer's nutrient specification

The proximate composition of the experimental diets (table 3) shows that crude protein was highest in control (40.00%) and lowest in T3 (38.25%). Crude fiber was highest in T3 (5.33%) and lowest in T3 (5.14%). Ash content was highest in T1 (8.17%) and lowest in T3 (7.40%). Lipid was highest in control (12.20%) and lowest in T4 (11.28%). Dry matter was highest in control (93.16%) and lowest in T2 (91.09%). NFE was highest in T4 (29.35%) and lowest in T1 (27.08%). Caloric value was highest in control (10.44kc/g) and low in T3 (10.17kc/g).

The growth response, feed utilization and survival of *C. gariepinus* juveniles being fed with different inclusion levels of blood meal are presented in table 4 with 100% fish meal constituent serving as the control.

TABLE 4: Growth response, feed utilization and survival of *C. gariepinus* juveniles fed graded level of blood meal.

Parameter	Control (0%)	T1 (25%)	T2 (50%)	T3 (75%)	T4 (100%)
Fish stocked	60	60	60	60	60
Initial mean weight (g)	11.45±0.25	11.43±2.76	11.30±3.17	11.3±3.17	11.20±0.30
Finial mean weight (g)	1275.00±0.00[a]	1080.10±10.03[b]	980.00±0.07[c]	786.05±26.05[d]	675.35±80.85[e]
Mean weight gain (g)	1263.55±140.59 a	1068.67±142.58 b	968.70±141.50 c	774.68±143.48 d	664.15±142.56 e
Initial mean length (cm)	9.26±2.84	9.15±3.04	9.25±2.07	9.21±0.91	9.23±1.67
Finial mean length (cm)	63.42±2.66[a]	60.00±0.00[b]	59.21±8.97[c]	59.00±0.00[d]	56.09±5.30[e]
Mean length gain (cm)	54.16±1.56	50.85±1.48	49.96±1.36	49.79±1.28	46.86±1.27
SGR	0.76±0.02	0.71±0.05	0.70±0.10	0.64±0.12	0.64±0.17
ADG	4.68±0.52	3.59±0.57	3.11±0.63	2.18±0.75	1.74±0.81
FCR	2.25±0.11	2.17±0.23	1.59±0.17	1.98±0.25	2.09±0.20
PER	31.59±3.51[a]	24.22±3.67[b]	20.98±4.07[c]	14.73±4.11[d]	11.73±4.17[e]

PI	168.94±12.01[a]	159.28±12.09[b]	147.70±12.12[c]	136.67±12.06[d]	99.53±1.19[e]
TFI	7650±347.92[a]	6300±348.90[b]	4350±346.89[c]	3900±345.91[d]	3450±346.75[e]
SR (%)	100±1.16	100±1.18	98.00±1.20	96.00±1.23	100±1.19

Mean values within the rows with different superscripts are significantly different at ($p \leq 0.05$).
T = Treatment, SGR= specific growth rate, ADG= average daily growth, PER = protein efficiency ratio, SR = survival rate, TFI = total feed intake, FCR = feed conversion ratio and PI = protein intake.

Results from the growth performance and feed utilization of *C. gariepinus* (table 4) showed that the initial mean length and initial body weight of fish among the treatment were not significantly different ($p \geq 0.05$), but where significantly different ($p < 0.05$) at the finial body weight with the control diet (1275.00g) recorded the highest, followed by T1 (1080.10g), T2 (980.00g) and T3 (786.05g), while T4 (675.35g) recorded the least value. Similarly, the control diet had the highest weight gain (1263.55g), followed by T1 (1068.67g), T2 (968.70g), T3 (774.68g), while T4 had the lowest weight gain of (664.15g). Highest length gain was recorded in control (54.16cm± 1.56), while lowest length gain was recorded in T4 (46.86cm± 1.27). Specific growth rate in control and T1, T2, T3, T4 showed no significant difference ($p \geq 0.05$) from each other with control (0.76%± 0.02) having the highest value, while T3 (0.64%± 0.12) having lowest value. The average daily growth for control (4.68), T1 (3.59) and T2 (3.11) were not significantly different ($p \geq 0.05$) from each other and also, T3 (2.18) and T4 (1.74) were not significantly different. Control (4.68) had the highest value and T4 (1.74). The feed conversion ratio (FCR) showed no significant difference ($p \geq 0.05$) between all the treatments, control diet (2.25%) had the highest value and T2 (1.59%) being the lowest. The protein efficiency ratio (PER) and protein intake (PI) of the treatments showed significant difference ($p \leq 0.05$) from each other, control had the highest value of (31.59 and 168.94) while T4 had the least value of (11.79 and 99.53) respectively. Total feed intake (FI) were significant difference ($p \leq 0.05$), the highest feed intake was recorded in control (7650g) and lowest feed intake was recorded in T4 (3450g). The survival rate of fish showed no significantly different ($p \geq 0.05$), among the treatments.

Table 5: Water Quality Parameters taken during the feeding experiment of *Clarias gariepinus*

parameters	control (0%)	T1 (25%)	T2 (50%)	T3 (75%)	T4 (100%)
DO (mg/l)	5.82±1.08	5.95±1.11	5.81±1.09	6.26±0.81	6.05±0.89
pH	6.34±0.73	6.53±0.77	6.30±0.87	6.26±0.81	5.92±0.79
T(^{0}C)	27.05±0.89	27.13±0.87	26.85±0.79	26.79±0.89	26.80±0.90
NH_3 N (mg/l)	0.24±0.17^a	0.13±0.11^b	0.21±0.08	0.09±0.08^c	0.09±0.06^d

Mean values on the same row with different superscript are significantly different ($p<0.05$).

DO=dissolved oxygen, NH_3 N= ammonia-nitrogen, T= temperature.

Table 5 gives the results of water quality parameters obtained during the experimental period, no significant difference ($P>0.05$) was observed in dissolved oxygen, temperature and pH, but was no significantly different ($p<0.05$) in ammonia-nitrogen. Dissolved oxygen ranged from 5.81±1.09mg/l – 6.26±0.81mg/l, pH ranged from 5.92±0.79 – 6.53±0.77, Temperature ranged from 26.79±0.89^{0}C – 27.13±0.87^{0}C and ammonia-nitrogen ranged 0.09±0.06mg/l – 0.24±0.17mg/l.

Table 6: Initial and final proximate carcass composition of experimental fish.

Parameters	Initial	Control (0%)	T1 (25%)	T2 (50%)	T3 (75%)	T4 (100%)
C. P.	54.30±0.18	69.50±0.06	68.00±0.11	67.50±0.40	68.30±0.19	69.10±0.32
Lipid	9.22±0.07	10.46±0.40	10.25±0.13	10.35±0.30	10.26±0.06^a	10.43±0.20
Ash	7.27±0.18	8.11±0.03	8.15±0.13	8.07±0.07	8.23±0.06	8.29±0.25
Fibre	10.40±0.35	9.16±0.10	9.30±0.12	8.51±0.36	9.45±0.27	9.24±0.04
NFE	10.26±0.14	13.88±0.56	13.59±0.45	13.40±0.24	13.43±0.23	13.33±0.19
M.C	49.22±0.03	54.19±0.16	53.41±0.33	50.20±0.17	50.20±0.16	53.19±0.08

Dry matter	80.18±0.11	91.52±0.36	91.64±0.55	91.12±0.08	91.13±0.13	89.32±0.24

Mean values without superscript are significant different ($p<0.05$). NFE= nitrogen free extract, M.C = moisture content, C.P. = crude protein.

Proximate composition of the experimental fish before and after the study is presented in table 6. There was an increase in fish carcass in respect to dry matter, crude protein, lipid, ash, N.F.E, moisture content and lower fiber content at the end of experiment. Control diet (69.50%) had the highest value, while diet T2 (67.50%) had the least value in the carcass protein content. The carcass lipid content was high in control diet (10.46%) and low in while diet T1 (10.25%). Ash content was high in fish fed with diet T4 (8.29%) and low in diet T2 (8.07%). The moisture content was highest in fish fed with control diet (54.19%) and lowest in fish fed with diet T3 (50.20%). The N.F.E carcass content was highest in control diet (13.88%) and lowest in diet T4 (13.33%). The carcass dry matter of fish fed diet T1 (91.64%) was highest and diet T4 (89.32%). The whole body carcass showed a significant difference ($p<0.05$) in fishes between the diet treatments and the initial fish sample, expect in diet T3 of lipid carcass which showed no significant difference ($p<0.05$).

Discussion

The ideal knowledge of the proximate composition of fish feeds (protein, fat, ash, NFE, fiber and moisture) contents are very important because it gives a reflection on the dietary and health importance of these nutrients in fish and also to final consumers which is man [38,14]. Fish feeds components play a vital role in growth response, body development, metabolisms, repairing worn-out tissues and survival of fish. Proximate composition of the experimental diets indicated that the crude protein values obtained (38.48% - 40%) in this study were within the protein requirement (30%-40%) recommended for growth performance in *Clarias gariepinus* as reported by [39,17].

However, the general increase in the body weight of *Clarias gariepinus* in all the treatments indicated that the diets were accepted and utilized, irrespective of their composition, thereby promoting growth, survival and tissue development [40]. This study revealed that the overall

best growth performance and feed utilization was recorded on fish fed the control diet (0%) and was consistently followed by those fed diet T1(25%), diet T2 (50%) and diet T3 (75%) blood meal inclusion, while the poorest growth performance was obtained with fish fed diet containing (100%) blood meal. Fish fed diets containing blood meal (25%) had significant better growth and feed utilization as compared to fish fed with the control diet than those of blood meal dietary treatments. This finding indicates that dietary supplementation of fishmeal with blood meal protein inclusion in the diet of *Clarias gariepinus* can only be efficiently replaced with 25% blood meal which enhanced fish growth and survival without adverse effects. and this observation agree with the result of [21], who reported that a 25% of blood meal substitution of fish meal in diet gave best growth performance. Similarly, [28] on the use of bovine blood and rumen digest in catfish diet to replace fish meal at 0%, 25%, 50%, 75% and 100% where he reported that the best performance was recorded in fish fed with the control diet and treatment diet with inclusion level of 25% of replacement diet. This observation is in contrasts with the findings of [41, 42, 5].

As the level of blood meal inclusion increased in the diets, the performance of fish reduced. Replacement of 75% – 100% fishmeal resulted in reduced growth and feed utilization when compared with other experimental diets; it probably indicated the absence of some nutrients particularly some of the essential amino acid profile presents in the control diet and 25% diet which promotes growth on the fish juveniles [34]. Blood meal has been reported to have imbalance amino profile unlike fishmeal; it is an excellent source of crude protein and high lysine [43] but low in methionine and isoleucine. According to [44], deficiency in methionine has been reported to lead to reduced fish growth. Poor growth performance indicates that blood meal cannot be used as a sole protein source in diet formulation and might be due to the nature of its imbalance amino profile, non- attractive odour and digestibility which results in low feed consumption and low performance of fish [22]. This study agreed with the study done by [45, 46] but disagrees with [23].

In this study, survival rate of fish in all the treatments were high and showed no significant difference ($p \leq 0.05$). High survival rate could be attributed to the good management precaution during the study and the experimental diets did not have any adverse effect on the health and well-being of the fish which agrees with the report of [21] and [23].

The physiochemical parameters of water in this study were not affected by the diets and were within the range recommend for *Clarias gariepinus* culture [36, 46, 47, 48].

Analysis of the carcass fish indicate more protein retained in the body at the end of experiment which revealed that incorporation of blood meal in the diets affected significantly ($p<0.05$) to the body of fish in a positive way, the converted and utilized the protein synthesis from the feed into their body which increases tissue production and real growth. The results showed an increase in the value of crude protein and lipid over the initial fish samples. This agrees with the reports of [49, 50, 51].

Conclusion

The results of this present study showed that fish fed with fishmeal based diet best performance in terms of growth rate; ironically it is also the most expensive protein source due its nutrient profile and non-availability. However, blood meal diet from this study is proved suitable for use in aquaculture sector, those fed on 25% blood meal substitution performed better that 100% blood meal, hence blood meal can substitute fishmeal partially at 25% inclusion and it has the potential to make considerable contribution to growth and survival rate of *Clarias gariepinus* with no adverse effects. The utilization of blood meal as a protein supplement in fish diets will boost the profitability and sustainability of the fish production, reduced the cost of feed and alleviate the problem of disposal of blood in abattoirs and environmental pollution.

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