**Adamawa State University Journal of Scientific Research**
Volume 7 Number 1, April, 2019; Article no. ADSUJSR 0701002
ISSN:2705-1900(Online); ISSN: 2251-0702 (Print)
*http://www.adsujsr.com*

# Partial Replacement of Fish Meal with Blood Meal in Diets of *Clarias gariepinus* (Pisces: Clariidae) Fingerlings in Mubi, Nigeria: Effects on Growth, Survival and Cost

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**Abstract**

The research was designed to determine the effects of partial replacement of fishmeal with blood meal on the growth and survival of *Clarias gariepinus* fingerlings in Mubi, Nigeria. The experiment was conducted at the Department of Fisheries and Aquaculture, Adamawa State University, Mubi, Nigeria, using the test diets D1=BM100% + FM0%, D2=BM75% + FM25%, D3=BM50% + FM50%, D4=BM25% + FM75% and D5=BM0% + FM100%. Each diet was fed to 60 fingerlings replicated into 3 (20 per tank). Growth performances were obtained using weight gain, length gain, Specific Growth Rate SGR and Feed Conversion Ratio FCR and survival rate. Weight gain was best in D5 (207.48±48.1) and least in D3 125.45±48.1, the best length gain was recorded in D5 (1.46±0.17) and least in D3 (0.55±0.17), the best Feed Conversion Ratio was found in D2 (1.81± 0.38) and least in D4 (0.70±0.38), Specific Growth Ratio was best in D5 (4.71±2.51) and least in D3 (2.85±2.51) and the highest survival was in D1 (81.67±10.6) and lowest in D3 (55.00±10.8). Water quality parameters were also observed with pH ranging from (8.23±0.07 - 8.78±0.07), temperature (16.13±3.41 - 18.50±3.41), D.O (5.53±0.04 - 6.03±0.04) and finally Ammonia (0.16.0.08 - 0.17±0.08). The cost benefit of this research indicated that D1 was the cheapest while D5 was the most expensive. It was concluded that blood meal is a suitable protein source which can be used in the diets of *C. gariepinus* because of the significant differences observed in the diets. It is therefore recommended that fish farmers use Blood meal to partially or completely replace fish meal in *C. gariepinus* diets. Further studies to determine the long term effect on the performance of fish fed the fish meal replacement diet is suggested.

**Keywords**: Partial Replacement; Fish meal; Blood meal; Growth; Survival;*Clarias gariepinus.*

## Introduction

There are continues effort on the replacement of the more expensive protein concentrates mainly fish meal in animal diets with cheaper and less competitive demanded feeding resources (Dongmo *et al.*,2000). In recent years, many researchers have tried different kind of animal meal (bone meal, blood meal, hemoglobin meal, poultry meal, and meat meal) to substitute fish meal in diets and the percentage of substitution has varied according to species, fish size and feeding habits (Zhou *et al.*, 2004; Barnes *et al.*, 2012). Before now, the alternative raw materials were selected for feed formulation because they were less expensive and more available than fish meal and fish oil, but it is currently also necessary to consider raw materials with an adequate balance in amino acid profile, good digestibility, high level protein content, and a suitable palatability as good protein sources in fish diets (Lunger *et al.*, 2007; Antolović *et al.*, 2012; Bayraktar and Bayır 2012). 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 has been used to bridge the gap between demand and supply of fish from capture fisheries.

Nonconventional protein sources are becoming better alternative to high cost feeds. Blood meal, a common sustainable source of animal protein, has not been successfully utilized as a wholesale substitute for fish meal in catfish feeds due to observed deficiencies *(*Otubusin *et al.,* 2009). Documented deficiencies include poor amino acids balance with lysine being relatively high (7-8%) and isoleucine being very low *(*Sauvant, 2004*).* The study is therefore aimed at determining the effects of partial replacement of fish meal with blood meal on the growth and survival of *Clarias gariepinus* fingerlings.

## Materials and Methods

### *Experimental site*

The experiment was carried out in the Department of Fisheries and Aquaculture Complex, Adamawa State University (ADSU) Mubi. Mubi is located on latitude $10^{o}27"$ and longitude $13^{o}27"$.

### *Feed formulation*

Five Diets (D1-D5) with different levels of fish meal and blood meal inclusion and other feed ingredients with 40% crude protein was formulated using Trial and Error Method.

### *Feed preparation*

Blood meal was collected from Mubi abattoir and processed. It was sundried and ground to powdered form. The other ingredients were purchased from Mubi market. All of these ingredients were ground to powdered form except soya bean which was first toasted in order to treat the anti-nutrient factor. Each feed composition was weighed out and then mixed thoroughly (see Table 1). It was pelleted after it was moistened, Starch was added to improve the binding capacity. The feed was sundried and packaged before feeding trial began.

### *Experimental design and feeding*

Three hundred (300) - 6 weeks old *C. gariepinus* fingerlings was obtained from Yola, which was used for the trials. 60 fingerlings were stocked into 3 experimental tanks as replicate to each diet. A total of 15 replicates, 3 for each diet was used. The fish was fed once daily with the formulated feed which contained different levels of blood meal and fish meal at 5% body weight. The feed was administered between 8 to 9 am and 5 to 6 pm daily for the period of 6 weeks.

### *Cost Benefit Analysis of Formulated Diets*

The cost of all the feed ingredients used in the different diets, (D1-D5) was obtained in the course of the experiment as follows:

i) Cost of each ingredient.
ii) Cost of ingredients per/kg.
iii) Total cost of feed.

### *Data collection*

The fish in each treatment were weighed at the commencement of the feeding trial and at every two weeks, using a sensitive scale *Mettler Balance Model P1210*. Ration allotment was adjusted bi-weekly according to the new body weight changes. Uneaten food and faecal samples were siphoned out daily while fish mortality was also monitored. Body weight changes and feed intake were recorded every two weeks while feed conversion ratio was computed according to Burel *et al*. (2000). At the end of 6 weeks trial, the fish in each tank were weighed to determine the final weight. Water quality parameters such as pH, temperature and dissolved Oxygen and Ammonia were monitored *in situ* daily throughout the duration of experiment using the methods of Duwal (2016) to ensure water quality standards. The following data were collected and recorded;

a) **Growth performances**

i) % Weight gain = $\frac{Wf-Wi}{Wi}\ x\ 100$

Where Wf = mean final body weight of fish

Wi = mean Initial body weight of fish ((Duwal, 2016).

ii) Specific Growth Rate (SGR)

$$SGR = \frac{100(lnW2-\ lnW1)}{T1-T0}$$

Ln = Natural log

$W_2$ = mean final body weight of fish

$W_1$ = mean initial body weight of fish

$T_1$ = final time (in days)

$T_0$ = Initial time (in days) (Falayi, 2009)

### *b. Feed Utilization Analysis*

i. Food intake/day = total unit of feed consumed total No. of days (Adikwu, 2003)

ii. Feed Conversion Ratio (FCR) = $\frac{Feed\ Fed\ (Dry\ weight)g}{Weight\ gained\ g}$

***c. Water quality parameters***

The water quality parameters analyzed in this experiment were Temperature, pH, Dissolved oxygen and Ammonia which were determined *in situ* daily using mercury in glass bulb thermometer, Jenway 3020 pH meter and Milwaukee Dissolved Oxygen Meter (MW 600) respectively. Results of water quality parameters are recorded in Table 3.

***Statistical Analysis***

The data were subjected to Analysis of Variance (ANOVA) and Least Significant Difference was used to separate the means at 5% probability (Microsoft Excel, 2013)

**Results**

***Feed composition***

Diets with various inclusion levels of blood meal and fish meal were formulated as follows presented in Table 1.

**Table 1 Ingredients Composition of Tests Diets (Dry weight)**

| Ingredients | D1 | D2 | D3 | D4 | D5 |
|---|---|---|---|---|---|
| Blood meal | (100%)1.0 | (75%)0.9 | (50%)0.55 | (25%)0.3 | - |
| Fish meal | - | (25%)0.3 | (50%)0.6 | (75%)1.0 | (100)1.3 |
| Maize | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 |
| Maize offal | 0.6 | 0.6 | 0.45 | 0.4 | 0.35 |
| Soya beans | 0.6 | 0.4 | 0.6 | 0.5 | 0.65 |
| Premix | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Palm oil | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Salt | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Starch | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Total | 3kg | 3kg | 3kg | 3kg | 3kg |

***Growth Performances***

From the result presented in Table 2, the highest weight gained was recorded in D5 (100% FM) while D3 (50% BM and FM) gave the lowest weight gained. Correspondingly D5 gave the highest length gain while D3 gave the lowest. The highest FCR was recorded in D2 (75% BM and 25% FM) while the lowest FCR was recorded in D4 (25% BM and 75% FM) and lastly the highest survival was recorded in D1 (100% BM) and the lowest in D4.

***Water Quality***

Throughout the experimental days (44), the pH ranged from (8.78±0.07-8.23±0.07), Temperature (18.50±3.41-16.13±3.41), D.O from (6.03±5.53±0.04) and lastly Ammonia from (0.17±0.08-0.16±0.08) respectively. This is seen in Table 3.

***Cost Benefit Result***

The result of the cost benefit analysis is present in table 4 below. It was observed that D5 was the highest while D1 was the lowest.

**Table 2:** Growth parameters of *Clarias gareipinus* fed with different diets

| | Diets | | | | | |
|---|---|---|---|---|---|---|
| Parameters | $D_1$ | $D_2$ | $D_3$ | $D_4$ | $D_5$ | L.S.D |
| Initial weight (g) | 33.56±12$^a$ | 37.43±12$^a$ | 34.35±12$^a$ | 30.06±12$^b$ | 31.35±12$^b$ | 6.43 |
| Final weight (g) | 232.84±65.1$^a$ | 210.13±65.1$^b$ | 148.17±65.1$^c$ | 145.27±65.1$^c$ | 238.83±65.1$^a$ | 147.42 |
| Weight gained (g) | 199.27±48.1$^b$ | 172.70±48.1$^b$ | 125.45±48.1$^c$ | 126.28±48.1$^c$ | 207.48±48.1$^a$ | 126.88 |
| Initial length (cm) | 6.80±0.16$^b$ | 6.89±0.16$^b$ | 7.18±0.16$^a$ | 6.91±0.16$^b$ | 6.84±0.16$^b$ | 0.74 |
| Final length (cm) | 7.58±8.13$^b$ | 7.73±1.8$^b$ | 5.23±1.8$^c$ | 5.14±1.8$^c$ | 8.30±1.8$^a$ | 5.19 |
| length gained (cm) | 0.78±8.13$^b$ | 0.84±0.17$^b$ | 0.55±0.17$^c$ | 0.61±0.17$^c$ | 1.46±0.17$^a$ | 0.75 |
| S.G.R | 4.52±2.51$^a$ | 3.92±2.51$^b$ | 2.85±2.51$^c$ | 2.87±2.51$^c$ | 4.71±2.51$^a$ | 2.88 |
| F.I | 10.00±0.00$^a$ | 10.00±0.00$^a$ | 10.00±0.00$^a$ | 10.00±0.00$^a$ | 10.00±0.00$^a$ | 0.00 |
| F.C.R | 1.57±0.38$^b$ | 1.81±0.38$^a$ | 1.16±0.38$^a$ | 0.70±0.38$^d$ | 1.13±0.38$^c$ | 1.13 |
| % Mortality | 18.33±10.6$^d$ | 31.67±10.6$^b$ | 45.00±10.6$^a$ | 41.67±10.6$^a$ | 25.00±10.6$^c$ | 59.37 |
| % Survival | 81.67±10.6$^a$ | 68.33±10.6$^c$ | 55.00±10.6$^d$ | 58.33±10.6$^d$ | 75.00±10.6$^b$ | 59.37 |

Mean in the same row having the same superscript do not differ significantly ($P < 0.05$)

**Note:** S.G.R= Specific Growth Rate; F.I = Feed Intake; F.C.R Feed Conversion Ratio

**Table 3:** Water Quality Parameters

| Water Quality | | | Diets | | | |
|---|---|---|---|---|---|---|
| Parameters | $D_1$ | $D_2$ | $D_3$ | $D_4$ | $D_5$ | L.S.D |
| pH | 8.78±0.07$^a$ | 8.55±0.07$^a$ | 8.53±0.07$^a$ | 8.77±$^a$ | 8.23±0.07$^b$ | 0.49 |
| D.O mg/L | 5.63±0.04$^b$ | 5.73±0.04$^b$ | 6.03±0.04$^a$ | 5.53±0.04$^b$ | 5.67±0.04$^b$ | 0.30 |
| Ammonia mg/L | 0.17±0.08$^a$ | 0.16±0.08$^b$ | 0.16±0.08$^b$ | 0.16±0.08$^b$ | 0.16±0.08$^b$ | 0.52 |
| Temperature ($^o$C) | 18.50±3.41$^a$ | 16.13±3.41$^c$ | 16.73±3.41$^c$ | 16.22±3.41$^c$ | 17.13±3.41$^b$ | 3.36 |

Mean in the same row having the same superscript do not differ significantly ($P< 0.05$)

**Table 4:** Cost Analysis for Feed Production

| | **Cost of ingredients(₦)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **BM** | **FM** | **SBM** | **M** | **MO** | **Qty(kg)** | **Expenses(₦)** | **T.cost(₦)** | **1kg/₦** |
| D1 | 0 | 0 | 100 | 70 | 15 | 3 | 100 | 285 | 95.00 |
| D2 | 0 | 75 | 80 | 70 | 15 | 3 | 100 | 340 | 113.33 |
| D3 | 0 | 150 | 100 | 70 | 20 | 3 | 100 | 440 | 146.67 |
| D4 | 0 | 175 | 90 | 70 | 19 | 3 | 100 | 454 | 151.33 |
| D5 | 0 | 220 | 110 | 70 | 17 | 3 | 100 | 507 | 169.00 |

Where: BM = Blood meal
FM = Fish Meal
SBM = soybean meal
M = whole maize
MO= maize offal

Cost implication of the replacement was analysed, the cost analysis of the five diet showed that D1 (100% blood meal) was the cheapest (₦95/kg) among the five dietary treatments, followed by D2, D3, D4 and finally diet D5 the most expensive (₦169/kg). The Oil and Mineral/Vitamin premix in each of the dietary treatment are of the same quantity. It is therefore negligible in the cost analysis of the five diets.

## Discussion

The use of Blood meal has been part of strategies to reduce cost of feeding fish. The result from Table 1 indicates that fish meal can be replaced by several sources of protein like Blood meal. All diets (D1-D5) were successfully compounded and pelleted. Dominy and Ako (1988) reported that Blood meal products can replace marine proteins in grow-out rations for medium sized (3.4 g) *Pannaeus vannamei*. In the long term feeding trials (120 days) of Otubisin (2009) with caged reared *Oreochromis niloticus* fingerlings using blood meal as a fish meal replacer, it was found that dietary Blood meal inclusion levels above 50% of the fish meal protein significantly reduced fish performance. In this experiment opposite is the case, the diet with 100% inclusion level of blood meal, significantly improved *C. gariepinus* fingerlings performance despite some limiting factors such as much haemoglobin concentration in the water, feeding rates and frequency, rearing condition and other environmental factors. The result in Table 2 summarize the growth performance of *C. gariepinus* fingerlings. D5 gave the highest weight gain of 207.48±48.1 which was significantly different from D1, D2 (199.27±48.1, 172.70±48.1) and D3,D4 (125.45±48.1, 126.28±48.1). Agbebi *et al*. (2009) reported that fish meal can be replaced completely (100%) by blood meal with no adverse effect on growth, survival and feed conversion of *C. gariepinus* juvenile. Their result corroborate with this research work which showed that fish meal can be substituted completely (100%) by Blood meal with no adverse effect on growth, survival and feed conversion ratio in *C. gariepinus.* D1and D5 gave the highest growth rate of 4.52±2.51, 4.71±2.51which was significantly different from D2, D3 and D4 (3.92±2.51), (2.85±2.51, 2.87±2.51).D2 and D3 gave the highest F.C.R (1.81±0.38, 1.16±0.38) which were significantly different from D1, D4 and D5 (1.57±0.38), (0.70±0.38), (1.13±0.38). Good performance of Blood meal based diet in the present experiment does not agree with the study by Otubusin (2009) in which the feed containing the highest amount of blood meal gave the poorest performance in terms of growth and F.C.R. Abery, Gunasekera and De-Silva, (2002); Agbebi *et al.*, (2009) and Bekibele *et al.,*(2013) reported that optimum bone meal with blood meal could effectively replace up to 75% of fish meal in the diet fed to *Oreochromis mossambicus fry*. Other possible explanation for the low performance at increasing levels of fish meal substitution by Blood meal may be the resulting effect on diet digestibility. Several authors have mentioned that poor growth and feed utilization of fish fed feeds containing alternatives of fish meal for example spray-dried Blood meal, may be due to low protein digestibility and essential amino acid deficiency (mainly due to deficient processing of rendered meals), (Bureau *et al.*, 1999; Martínez-Llorens *et al*., 2008). Millamena (2002) has shown that apparent digestibility values of Blood meal were generally lower than for fish meals for *Epinephelus coioides*. D1 gave the highest survival rate of (81.67±10.6) which was significantly different from D2, D3 and D4, D5 (68.33±10.6), (55.00±10.6, 58.33±10.6) and (75.00±10.6). However, this high survival rate contradicts with the findings of Eyo and Olatunde (1999) where fish fed the highest levels of blood meal recorded the highest mortality in the cages. In the present experiment, it was clear that inclusion levels of blood meal had no effect on the survival rate of *C. gariepinus*. Aladetohun and Sogbesan (2013) also recorded no mortality and concluded that Blood meal can perform very well as a feedstuff at inclusion rate of 100% and can replace fishmeal in Tilapia diet with no adverse effect on growth and survival of *O. niloticu*s fingerlings. The growth performance and feed utilization efficiency of *C. gariepinus* fingerlings were also affected by the water quality parameters including water temperature, pH, dissolved oxygen, and Ammonia. However, the average values of all water quality parameters recorded during the experiment were within a suitable range for the normal growth of *C gariepinus* fingerlings*.* pH ranged from 8.78±0.07 to 8.23±0.07, temperature from 18.50±3.41 to 16.13±3.41, dissolved Oxygen from 6.03±0.04 to 5.53±0.04 and Ammonia from 0.17±0.08 to 0.16±0.08. The cost benefit analysis showed that D1 was the cheapest (₦95.00)/kg while D5 the most expensive (₦169.00)/kg. Aladetohun and Sogbesan (2013) also recorded the diet with high inclusion level of blood meal as the cheapest (₦3.9325)/kg while the other diet with high level of inclusion of fish meal as the most expensive (₦23.5925)/kg. This study has therefore demonstrated that fish meal protein can be replaced by processed animal byproduct meals (Blood meal) up to 100%. The other inclusion levels gave a reduced growth rates than those exhibited by the control groups. It was therefore concluded that the utilization of Blood 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 in the abattoirs. It was therefore concluded that, Blood meal can either completely or partially replace fish meal in the diet of *C. gariepinus* fingerlings. Hence it is recommended that fish breeders should go onto the use of processed Blood meal to reduce cost of production to maximize profit.

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