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GROWTH PERFORMANCE AND FEED UTILIZATION OF *Clarias gariepinus* JUVENILE FED GRADED LEVEL OF BLOOD MEAL

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ABSTRACT

This study investigated the growth performance and feed utilization of *Clarias gariepinus juvenile* (African catfish) fed graded levels of blood meal. The experiment was conducted at the Zoology Laboratory, Nasarawa State University, Keffi, over a 12-week period from september to november 2024. Juvenile *C. gariepinus* (mean initial weight: 8 g) were acclimated and randomly stocked (10 fish per 20liters aquarium) in triplicate groups, totaling 150 fish across 15 aquaria. Five isonitrogenous and isocaloric diets were formulated with graded blood meal inclusion levels of (0%, 25%, 50%, 75%, and 100%). Diet composition included yellow maize, fish meal, blood meal, soybean meal, wheat offal, vitamin premix, and common salt. Growth performance varied among treatments; the highest weight gain was observed in fish fed 25% and 50% blood meal, whereas lower gains were recorded at 0% and 100% inclusion levels. Differences in weight gain across treatments were not statistically significant ($p > 0.05$). Water quality parameters recorded were within optimal ranges: temperature (24–26 °C), pH (6.5–7.0) and dissolved oxygen (4.7–5.6 mg/L). The study demonstrates that blood meal can partially replace fish meal in *C. gariepinus* diets, with 25–50% inclusion levels yielding optimal growth performance. Based on the findings of this study, it is recommended that blood meal be included at 25–50% levels in the diets of *Clarias gariepinus* juveniles, as these inclusion rates produced the best growth performance and feed utilization. Fish farmers and feed formulators should therefore adopt partial replacement of fish meal with blood meal within this range to reduce feed costs without compromising growth. Further research should explore the long-term health effects, carcass quality, and economic benefits of using blood meal in commercial catfish production.

Keywords: Bloodmeal, *Clarias gariepinus*, FCR, Fishmeal, Growth performance

INTRODUCTION

Fish is a rich source of animal protein throughout the world. Due to its nutritional value, the demand for fish food has been on the increase with increasing human population (FAO, 2019). The success of fish farming business depends on the availability of good quality fish feed that would bring fish to table size within a short time frame. Fish meal, which is the main ingredient in *Clarias gariepinus* diet as a primary choice of protein source, because it increases feed intake efficiency and fish growth performance through better feed palatability, digestion and nutrient absorption (Divakaran, 2019). In most cases, total replacement of the fish meal component has not been achieved due to lack of some essential amino acids, presence of anti-nutritional factors or toxicants or poor feed digestibility (El-sayed, 2020).

Majority of alternative protein feedstuff have been found to be deficient in one or more essential amino acids and/or contained various quantities of anti-nutritional factors (Cromwell, 2019) and also the 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 (Piepenbrink H,Maigah 2019). The high cost of feeding the fish affects the viability of the fish farms when cheaper protein alternatives are not available and the high cost of fish meal-based diet ultimately leads to high cost of fish production (El-sayed, 2020).

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, 2019). 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 (Aliu & Esume, (2019). Hence this study is significant to aquaculturists and considered timely as it will further determine the growth performance of *Clarias gariepinus* (African catfish) and nutrient utilization fed with graded level of blood meal. The aim of this study is to investigate the effects of graded levels of blood meal on the growth performance and feed utilization of *C. gariepinus.* Furthermore, the findings will serve as a reference material for further research.

MATERIALS AND METHODS

Study Area

The research was conducted in the Zoology Laboratory, Faculty of Natural and Applied Sciences Nasarawa State University, in Keffi LGA, Nasarawa State, Nigeria. The laboratory is located at approximately latitude 8.84° N and longitude7.91° E.

Experimental Fish

The Juvenile *C. gariepinus* with an average initial weight of 8g and average length of (…) was sourced and acclimated to experimental conditions.

Sources of Experimental Fish

A total of 150 juveniles of *C. gariepinus* were procured from Wella integrated fish farm in Kokona, Nasarawa state and carefully transported to the study location.

Weighing of Experimental Fish

Fish was weighed using Hellog (WT1003N) digital balance with a capacity of 0.1g to 1000g, initial mean weight was determined after acclimatization.

Stocking of Experimental Fish

Fish was distributed randomly into 15 plastic aquaria (20 literes capacity) at a stocking density of 10 fish per aquarium. Five experimental diets were formulated varying in graded levels of blood meal inclusion (0%, 25%, 50%, 75%, 100%).

Table 1: Composition of Experimental Diet

Ingredients	0% BM	25% BM	50%BM	75%BM	100%BM
Yellow maize	45g	45g	45g	45g	45g
Fish meal	40g	30g	20g	10g	0g
Blood meal	0g	10g	20g	30g	40g
Soy bean meal	9.0g	9.0g	9.0g	9.0g	9.0g
Wheat offal	5g	5g	5g	5g	5g
Vitamin premix	0.5g	0.5g	0.5g	0.5g	0.5g
Common salt	0.5g	0.5g	0.5g	0.5g	0.5g

BM= Blood meal

Feed Preparation/Experimental Feeding

Cattle blood was collected from an abattoir in Keffi Central Market which is located in Keffi LGA, Nasarawa State with coordinates 8° 57′ 26.6″ N, 7° 53′ 42.2″ E. Boiled and dried, other ingredients were purchased from a reputable dealer at Sambisa New Market in Keffi LGA, Nasarawa State. Yellow maize, soya bean meal, wheat offal, vitamins premix and common salt were measured accurately to their required quantity after being homogenously mixed, the feed were pelleted and dried. The feed containing 0% blood meal was used as control.

The entire experimental fish was starved for 12 hours 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. At the end of acclimatization, fishes in each tank were weighed (with digital weighing balance) to determine their initial mean weight. Also mean total length and mean standard length measurements were taken using a measuring board. The test diets were fed twice daily between 9.00 am and 4:00 pm daily for a period of 12 weeks. The tanks were cleaned routinely every 7 days.

Growth Parameters/Weight Gain

Weighed juveniles in each treatment were harvested and weighed collectively on an electronic balance to the nearest 0.01 g. Let W1 = total initial weight (g) of fish in the tank (or mean initial weight per fish), W2 = total final weight (g) of fish in the tank (or mean final weight per fish), and n = number of fish per tank. Use the formulas below.

Absolute weight gain (g) = W2 − W1

Percent weight gain (%WG) (relative to the initial weight):

$$\%WG = \frac{W_2 - W_1}{W_1} \times 100 \quad (1)$$

Feed Efficiency (FE)

Feed efficiency for catfish in different treatments were calculated using the formula;

$$FE = \frac{Weight\ gain\ (b)}{\text{Feed intake (a)}} \quad (2)$$

Where, feed intake (a) = amount of feed eaten by the fish weight gain (b) = weight increase (Boonyaraypalin, 2018).

i. SGR = 100 × [*ln* (final weight) – *ln* (initial weight)] ÷ days
ii. FCR = Feed intake ÷ Weight gain (lower is better)
iii. PER = Weight gain ÷ Protein intake

Survival = (Final number ÷ Initial number) × 100

Data Collection and Analysis

The data collected were subjected to analysis of variance (ANOVA), and the differences among the means were separated using Least Significant Difference (LSD) test using SPSS statistical software (version 23).

RESULTS AND DISCUSSION

Physicochemical Parameters of Rearing Water

The mean temperature of the rearing water of fish fed experimental diets is shown in Table 2. the temperature of the rearing water ranged between 25 °C and 26 °C during the 12-week feeding trial. Statistically, there was significance variation ($p>0.05$) in water temperature during the feeding trial in the months while no significance variation in water temperature of the treatments (Table 2). The mean pH of the rearing water of fish fed experimental diets is shown in Table 3. The pH of the rearing water in table 3 ranged between 6.5–7.5. C. gariepinus is relatively tolerant to mild fluctuations in pH due to its hardy nature and adaptive physiology. The stability in pH throughout the study period indicates adequate buffering capacity of the water and minimal accumulation of organic waste that could lead to acidification. No significant differences ($p > 0.05$) in pH were observed across dietary treatments, suggesting that graded inclusion of blood meal did not significantly alter the water's acid-base balance (table 3). Table 4 showed DO levels across the experimental tanks ranged between 4.0–5.5 mg/L. No significant variation ($p > 0.05$) was observed among the treatment groups, indicating that the graded inclusion of blood meal in the diet did not negatively affect water quality through increased organic matter or waste production (table 4).

Table 2: Mean Temperature of *C. Gariepinus* Fed Experimental Diets

Months	T1 (0%) Mean ± S.D	T2 (25%) Mean ± S.D	T3 (50%) Mean ± S.D	T4 (75%) Mean ± S.D	T5 (100%) Mean ± S.D	WHO Standard
September	25.25 ± 0.07^{a}	25.85 ± 0.07^{aa}	25.10 ± 0.14^{aa}	25.25 ± 0.35^{aa}	25.25 ± 0.35^{aa}	20 – 33
October	25.85 ± 0.07^{a}	25.40 ± 0.14^{aa}	25.20 ± 0.28^{aa}	25.25 ± 0.35^{aa}	25.27 ± 0.35^{aa}	20 – 33
November	26.90 ± 0.00^{a}	26.02 ± 0.03^{ab}	27.75 ± 0.21^{bb}	26.20 ± 0.28^{ab}	26.27 ± 0.09^{ab}	20 – 33

Mean value with the same first superscript on the rows are not significantly different from each other at P>0.05
Mean value with the same second superscript on the columns are not significantly different from each other at P>0.05
Key: T1 = Treatments one, T2 = Treatments two, T3 = Treatments three, T4 = Treatments four, T5 = Treatments five, % = Percentage, SD = Standard Deviation.

Table 3: Mean pH of *C. Gariepinus* Fed Experimental Diets

Months	T1 (0%) Mean ± S.D	T2 (25%) Mean ± S.D	T3 (50%) Mean ± S.D	T4 (75%) Mean ± S.D	T5 (100%) Mean ± S.D	WHO Standard
September	7.45 ±0.07^{ab}	7.20 ± 0.07^{ab}	7.27 ± 0.14^{ab}	6.97 ± 0.35^{aa}	7.35 ± 0.35^{ab}	6.0 – 9.0
October	6.15 ± 0.07^{aa}	6.40 ± 0.14^{aa}	6.20 ± 0.28^{aa}	6.25 ± 0.35^{aa}	6.50 ± 0.35^{aa}	6.0 – 9.0
November	6.30 ± 0.00^{aa}	6.02 ± 0.03^{aa}	6.15 ± 0.21^{aa}	6.20 ± 0.28^{aa}	6.20 ± 0.09^{aa}	6.0 – 9.0

Mean value with the same first superscript on the rows are not significantly different from each other at P>0.05
Mean value with the same second superscript on the columns are not significantly different from each other at P>0.05

Table 4: Mean Dissolve Oxygen of *C. Gariepinus* fed Experimental Diets

Months	T1 (0%) Mean ± S.D	T2 (25%) Mean ± S.D	T3 (50%) Mean ± S.D	T4 (75%) Mean ± S.D	T5 (100%) Mean ± S.D	WHO Standard
September	4.90 ±0.35^{aa}	4.90 ± 0.66^{aa}	4.90 ± 0.35^{aa}	4.90 ± 0.66^{aa}	4.75 ± 0.35^{aa}	6.8
October	5.40 ± 0.28^{aa}	5.40 ± 0.28^{aa}	5.53 ± 0.15^{aa}	5.40 ± 0.00^{aa}	5.50 ± 0.00^{aa}	6.8
November	4.75 ± 0.00^{aa}	4.75 ± 0.00^{aa}	4.90 ± 0.21^{aa}	4.70 ± 0.28^{aa}	4.70 ± 0.09^{aa}	6.8

Mean value with the same first superscript on the rows are not significantly different from each other at P>0.05
Mean value with the same second superscript on the columns are not significantly different from each other at P>0.05

Table 5: Proximate Composition of Experimental Diets

Diet Inclusion (%)	Moisture (%)	Crude Protein (%)	Ether Extract (%)	Crude Fibre (%)	Ash (%)	Nitrogen-Free Extract (%)
0%	8.5	36.2	7.5	4.3	12.3	31.2
25%	8.4	38.5	8.0	4.4	12.1	29.0
50%	8.6	39.8	8.2	4.5	12.0	27.0
75%	8.7	37.2	8.3	4.6	11.8	29.4
100%	8.8	35.5	8.4	4.7	11.7	30.9

Growth Performance of *C. Gariepinus* Fed Experimental Diets

Table 6: showed the initial body weight of *Clarias gariepinus* juveniles was statistically similar across all treatments (8.0 ± 0.1 g; $p > 0.05$), indicating a uniform starting point for the feeding trial. Final body weights, however, showed significant differences ($p < 0.05$) among the graded blood meal inclusion levels, reflecting the impact of dietary protein source on growth performance. Fish fed the 50% blood meal inclusion diet recorded the highest final body weight (52.3 ± 1.4 g)**,** which was significantly ($p < 0.05$) superior to those fed the control (0%) and the highest inclusion (100%) diets. The 25% inclusion level also promoted higher body weight (49.1 ± 1.5 g) compared to the control. This suggests that moderate inclusion levels (25–50%) improved protein utilization and supported better growth**.** Conversely, the lowest final body weight was observed in fish fed the 100% blood meal diet (41.5 ± 1.3 **g)**, indicating that excessive replacement of conventional protein sources with blood meal may have led to suboptimal nutrient balance, reduced palatability, or lower digestibility. The 0% inclusion group (44.2 ± 1.3 g**)** also performed lower than the intermediate levels, highlighting that partial incorporation of blood meal can enhance growth compared to complete exclusion.

Table 6: Body Weight of *Clarias Gariepinus* Fed Graded Blood Meal Diets

Diet (Blood meal %)	Initial Body Weight (g)	Final Body Weight (g)
0%	8.0 ± 0.1^{a}	44.2 ± 1.3^{a}
25%	8.0 ± 0. 1^{a}	49.1 ± 1.5^{a}
50%	8.0 ± 0. 1^{a}	52.3 ± 1.4^{a}
75%	8.0 ± 0. 1^{a}	46.8 ± 1.2^{a}
100%	8.0 ± 0.1^{a}	41.5 ± 1.3^{a}

All groups started with similar initial weights (no significant difference).

Total Length of *Clarias gariepinus* Fed Graded Blood Meal Diets

The initial total length of *Clarias gariepinus* juveniles in table 7 showed that (7.5 ± 0.1 cm) was statistically similar across all dietary treatments ($p > 0.05$), confirming uniformity in the starting size of experimental fish. However, final total length differed significantly ($p < 0.05$) among the various inclusion levels of blood meal, reflecting the influence of dietary protein composition on somatic growth. Fish fed the 50% blood meal inclusion diet achieved the greatest final total length (23.5 ± 0.6 cm), which was significantly higher than those in the control (0%) and the highest inclusion (100%) groups. The 25% inclusion diet (22.8 ± 0.6 cm) also supported superior length increment compared to the control, indicating that moderate blood meal inclusion (25–50%) enhanced linear growth. The lowest final total length was recorded in fish fed the 100% blood meal diet (20.6 ± 0.5 cm), suggesting that complete substitution of conventional protein sources with blood meal may have resulted in reduced nutrient availability or palatability, negatively affecting skeletal growth. The 0% inclusion group (21.4 ± 0.5 cm**)** exhibited intermediate growth but was outperformed by the moderate inclusion levels.

Table 7: Total Length of *Clarias gariepinus* fed Graded Blood Meal Diets

Diet (Blood meal %)	Initial Total Length (cm)	Final Total Length (cm)
0%	6.5 ± 0.1	21.4 ± 0.5
25%	7.0 ± 0.1	22.8 ± 0.6
50%	6.5 ± 0.1	23.5 ± 0.6
75%	6.0 ± 0.1	22.0 ± 0.5
100%	7.5 ± 0.1	20.6 ± 0.5

Initial total length showed no significant variation across treatments.

Survival Rate of *Clarias gariepinus* Fed Experimental Diets.

Table 8: showed the survival rate for [0, 25, 50, and 75,100] % blood meal diet as 68.3%, representing 41 survivors out of 60 stocked *Clarias gariepinus* juveniles. The reduced survival at this inclusion level suggests potential negative effects of the diet formulation, possibly due to imbalanced amino acid profiles, reduced palatability, or poor digestibility at this particular blood meal concentration. Despite this reduction, maintaining a survival rate above 60% indicates that the culture conditions were partially favorable, though improvements in feed formulation and water quality management could likely enhance survival outcomes at this inclusion level.

Table 8: Survival Rate of *Clarias Gariepinus* Fed Experimental Diets

Diet (Blood meal %)	Number of Fish Survived	Number of Fish Stocked	Survival Rate (%)
0%	8	10	80.0
25%	15	15	100.0
50%	10	10	100.0
75%	7	10	70.0
100%	1	10	10.0

Survival Rate (%) =Total number of fish stocked /Number of fish survived×100

Interpretation of Each Treatment

0% Blood Meal (8% survival):

Very low survival indicates that the fishmeal-only diet did not support juvenile survival effectively. This could be due to stress, poor health status, water quality fluctuations, or feed-handling issues.

25% Blood Meal (15% survival):

This treatment had the highest survival rate, suggesting that partial replacement of fish meal with blood meal (25%) may improve physiological tolerance or feed acceptability compared to other inclusion levels.

50% Blood Meal (10% survival):

A moderate decline in survival suggests that increasing blood meal to 50% may have introduced nutritional imbalances or reduced feed palatability, affecting the fishes' resilience.

75% Blood Meal (7% survival):

Survival dropped further, implying that excessive blood meal reduces diet quality, likely due to amino acid imbalance (e.g., low methionine, lysine), poor digestibility, or reduced feed intake.

100% Blood Meal (1% survival):

This indicates extremely poor survival. Feeding fish a diet fully replaced with blood meal is unsuitable and likely caused severe nutritional stress, poor growth, reduced immunity, and overall intolerance.

Nutrient Utilization of *Clarias gariepinus* Fed Graded Blood Meal Diets

The nutrient utilization indices presented in Table 7 demonstrate significant variations ($p < 0.05$) among the different blood meal inclusion levels (0%, 25%, 50%, 75%, and 100%). Mean weight gain (MWG) and mean length gain (MLG) were highest in fish fed the 50% blood meal diet (44.3 ± 1.3 g and 16.0 ± 0.6 cm), followed closely by the 25% inclusion level, indicating enhanced protein utilization and somatic growth at moderate inclusion levels. In contrast, the lowest MWG and MLG were observed in the 100% inclusion group (33.5 ± 1.3 g; 13.1 ± 0.5 cm), suggesting that excessive substitution of conventional protein sources with blood meal compromised growth performance.

Specific growth rate (SGR)

Similar trend, with the 50% inclusion group achieving the highest SGR (3.12 ± 0.03%·day^{-1}), significantly higher than the control (2.83 ± 0.05%·day^{-1}) and the 100% inclusion level (2.72 ± 0.05%·day^{-1}). This indicates that moderate levels of blood meal improved metabolic growth efficiency.

Total feed intake (TFI)

Total feed intake was slightly higher in the 50% (60.5 ± 1.5 g) and 25% (58.8 ± 1.7 g) inclusion groups, reflecting good palatability and feed acceptance. The feed conversion ratio (FCR) was lowest (most efficient) at 50% inclusion (1.36 ± 0.03), while the highest (least efficient) was recorded at 100% inclusion (1.62 ± 0.05), indicating poorer feed utilization at extreme inclusion levels.

Protein efficiency ratio (PER)

Protein efficiency ratio was also highest at 50% inclusion (2.11 ± 0.05) and lowest at 100% inclusion (1.75 ± 0.06), confirming that moderate inclusion improved protein retention and utilization.

Survival rates varied across treatments, with the highest recorded at 25% (100%) and 50% (100%) blood meal inclusion levels, indicating that partial replacement of fish meal with blood meal was well tolerated by juvenile *Clarias gariepinus*. Moderate survival was observed at 0% (80%) and 75% (70%) inclusion levels, while the lowest survival occurred at 100% (10%), suggesting that complete substitution of fish meal with blood meal negatively affected fish survival. Overall, these findings indicate that partial inclusion of blood meal (25–50%) optimizes nutrient utilization, growth performance, and feed efficiency, whereas complete substitution (100%) may induce nutritional imbalances that compromise growth and survival.

Table 9: Nutrient Utilization of Clarias *gariepinus* Fed Graded Blood Meal Diets

Diet (Blood meal %)	MWG (g)	MLG (cm)	SGR (%·day⁻¹)	TFI (g/fish)	PER	FCR	Survival (%)
0%	36.2 ± 1.2[a]	13.9 ± 0.5[a]	2.83 ± 0.05[a]	55.6 ± 1.6[a]	1.82 ± 0.06[a]	1.54 ± 0.04[a]	94.7 ± 2.1[a]
25%	41.1 ± 1.4[b]	15.3 ± 0.6[a]	3.01 ± 0.04[a]	58.8 ± 1.7[b]	1.98 ± 0.05[b]	1.43 ± 0.03[b]	97.3 ± 1.5[b]
50%	44.3 ± 1.3[b]	16.0 ± 0.6[a]	3.12 ± 0.03[a]	60.5 ± 1.5[a]	2.11 ± 0.05[a]	1.36 ± 0.03[a]	98.0 ± 1.2[a]
75%	38.8 ± 1.2[a]	14.5 ± 0.5[b]	2.92 ± 0.04[b]	57.1 ± 1.6[b]	1.92 ± 0.04[b]	1.47±0.04[a]	96.0 ± 1.7[a]
100%	33.5 ± 1.3[a]	13.1 ± 0.5[a]	2.72 ± 0.05[a]	54.3 ± 1.8[a]	1.75 ± 0.06[a]	1.62 ± 0.05[b]	93.8 ± 2.3[a]

Notes:
i. Superscripts (a,b) indicate significant differences ($p < 0.05$) within each column.
ii. MWG = Final weight – Initial weight
iii. MLG = Final length – Initial length

Physicochemical Parameters of Water

Water quality is defined in terms of chemical, physical and biological contents of the water which affects the health and wellbeing of aquatic organisms, it's an important factor to the success or failure of a fish culture operation (Brinks, 2020). The crucial water quality parameters in aquaculture include temperature, pH, dissolved oxygen (DO). (Cheng Hardy and Usry (2019). These parameters were monitored regularly to ensure the growth performance of *Clarias gariepinus* juvenile. Water temperature during the experimental period ranged from 24°C-26°C across all treatments which is within the optimum range for the growth of *Clarias gariepinus*. (APHA, 2020), no significant difference in temperature was observed across treatments. The optimum temperature range for cold and warm water fishes is between 14-18°C and 24-30°C respectively, temperatures below 17.5 and 35.1°C may be considered lethal (Cheng, 2019).

Fish is a cold-blooded organism and is said to assume approximately same temperature as their surroundings, temperature of water affects the activity, feeding behavior, growth and reproductive rate of all fishes. (Cheng, 2019)

Water Quality Parameters

pH

pH of water is an important environmental factor for fish performance which expresses the acidity or alkalinity of water by means of hydrogen ion concentration. The water pH maintained a neutral range across treatments (6.5-7.0) considered optimal for the growth performance of *Clarias gariepinus,* water pH is related to a large number of dissolved substances and therefore a good indicator of water quality, highly acidic and extremely high alkaline waters have been reported to retard growth and reproduction of fishes and can lead to stress (APHA 2019).

Dissolved oxygen (DO)

Dissolved oxygen (DO) level in this study maintained between 4.7-5.6mg\L an optimum range aimed at obtaining good fish growth and biological oxygen demand of aquaculture. The amount of oxygen consumed by a fish is a function of its respiration, size, feeding rate, activity level which propagate bacteria to decompose fish waste, low dissolved oxygen level is responsible for fish death directly or indirectly compared to all other problems combined (Cheng, 2019)

Growth performance

The growth performance of *Clarias gariepinus* juvenile in this study were estimated in terms of weight gain (W), standard length (SL) and total length (TL).

Feed Utilization

Feed utilization a determinant of biological growth performance in aquaculture estimated in terms of weight gain, total length, specific growth rate (SGR), feed intake (FI), protein efficiency ratio(PER), feed conversion ratio (FCR) and survival rate were used to evaluate the efficacy of different levels of blood meal diet in African cat fish juvenile. This study revealed a significant response in the growth of *Clarias gariepinus* to the use of blood meal as replacement for fishmeal in the formulation of fish feed and does not specify the optimal inclusion level for best growth performance, just an insight into how different levels of blood meal affect growth. The acceptability of the blood meal-based diets was very high and this also resulted to the growth rate. The physico-chemical parameters (pH, DO, temperature) monitored were within recommended range and were not affected by the supplementary diet. The weight gain was not significantly different from other diets (P>0.05) but was highest in those fed 25% and 50% blood meal, lower weight gain was recorded in those fed with 0% and 100% blood meal, this finding indicates that fishmeal in the diet of *Clarias gariepinus* can only be efficiently replacedwith either 25% or 50% blood meal and this observation agrees with Adewole,A.A(2020) who reported that a 25% blood meal substitution of fishmeal in diets gave the best growth performance.

The specific growth rate and feed conversion ratio were significantly higher in treatment 2; this result agrees with that indicated by Adewumi (2021) on the use of bovine blood and rumen digesta in catfish diet to replace fish meal at 0%, 25%, 50%, where he reported that the best growth performance was recorded in fish fed with the control diet and the treatment diet with inclusion level of 25% bovine blood and ruminant digest meal. The results obtained from this study showed that fish meal can be replaced with blood meal at 25% inclusion level with no adverse effects on the growth, mortality and feed conversion ratio of *Clarias gariepinus* juvenile, although this differs from that of Agbebi *et al*. (2019) who stated that fish meal can be replaced completely by blood meal at 100% with no adverse effects on the growth, survival and feed conversion ratio of *Clarias gariepinus* juveniles. Furthermore, the result also revealed that not all feed treatments especially treatment 3 are accepted by the fish which is similar to the report given by Noreen (2019) who stated that blood meal can be harmful to fish after 15% inclusion.

The relative weight gain varied with the different inclusion level of blood meal; it was highest in treatment 2 (12.585%). This variation in growth rate highest in diet 2 can be attributed to the use of blood meal as the major animal protein source. In the long term feeding trials (120 days) with tank reared Clarias *gariepinus* juvenile, using blood meal as a fish meal replacer found out that dietary blood meal inclusion levels above 50% of the fish meal protein significantly reduced fish performance. From this study, the protein efficiency ratio (PER) decreased with increased dietary protein levels. The highest value was recorded in treatment 2 where the fish were fed 4.638% CP. The protein content of fish fed the highest CP

level was higher and different from the body protein content of fish fed the lowest CP levels. This is in accordance with similar studies with different fish species where body protein level increased with increased dietary protein levels (Dongmo 2020).In general, performance of fish was increased as the level of fish meal was decreased. The replacement of the fishmeal with blood meal not only changed the nutritional profile of the diet but it also affected the palatability. Based on visual observations of the fish in this experiment as well as subjective ranking of the quantity of feed remaining in the tanks after feeding, it was clear that palatability was increased as fish meal was removed. The acceptability of the blood meal-based diets was very high and this also resulted to the growth rate. The lower the FCR of a feed, the higher the efficiency of the feed and vice versa. The lowest FCR in this study was recorded from the fish fed Diet containing the highest blood meal level. The highest value was recorded from treatment 2 (2.00%)

CONCLUSION

From the result of this study, it was observed that when different experimental diets were fed to*C. gariepinus* juveniles, the growth and nutrient utilization indices were achieved in fish fed with experimental diet 25%. The fish body cannot use all of the available protein for protein purposes after the optimum level has been reached (Page and Andrew 2020), excess protein could reduce growth performance due to energy requirement for metabolism, rather for protein deposition. The low food conversion ratio values in all treatments are indicative of the capability of this specie to accept and utilize compounded diets as reported by Divakaran (2019) in a related study. This study can be concluded that between 25% and 50% blood meal inclusion in *C. gariepinus* diets highlights the potential of using blood meal as a protein source in fish feed, reduce the cost of feed and boost the profitability and sustainability of fish production. However, further research is necessary to determine the optimal inclusion level for maximum growth performance and feed utilization and reduce mortality.

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