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Growth performance and feed utilization of African catfish, *Heterobranchus bidorsalis* (Geoffroy Saint-Hillaire, 1809) fingerling fed commercial diet supplemented with animal slaughter waste meal

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ABSTRACT: Growth performance and feed utilization of *Heterobranchus bidorsalis* fingerling fed commercial diet supplemented with animal slaughter waste meal was evaluated. The aim of this investigation is to assess the utilization of animal slaughter waste in feeding fish. A total of two hundred *H. bidorsalis* fingerlings were purchased. The experiment lasted fifty-six days. The commercial feed and combination of animal slaughter waste meal were the treatments. The five treatments employed were: I (100% commercial feed, 0% slaughter waste meal), II (80% commercial, feed/20% slaughter waste meal), III (60% commercial feed,/40% slaughter waste meal), IV (40% commercial feed,/60% slaughter waste meal) and V (20% commercial feed,/80% slaughter waste meal). The treatments were administered at 5% fish body weight. Initial body weight ranged between 24.83±1.11g (Treatment II) and 26.76±2.72g (Treatment IV). Final body weight fluctuated from 64.96±3.55g (Treatment III) to 77.93±15.06g (Treatment I). Both initial and final body weight of fish did not differ significantly (p>0.05) among the treatments. Fish in treatment V recorded the lowest ((41.00±10.46g) total body weight gain while those in treatment I had the highest (55.96±14.88g). Result on percentage weight indicates Treatment V with lowest (60.42±6.59%) and Treatment II with highest (69.91±2.04%) percentage weight gain. Statistical analysis suggests no significant variation in total body weight gain and percentage weight gain. The ranking order of specific growth rate is Treatment V (0.741%); II (0.934%); III (0.840%); IV (0.835%) and I (0.992%). For PER Treatment V recorded the highest (0.228%) value followed by 0.126% (Treatment I); 0.125% (Treatment II); 0.119% (Treatment III) and 0.113% (Treatment IV). Values of feed conversion ratio ranged from 2.439% (Treatment I) to 3.100% (Treatment V). The highest survival rate (66.6%) was recorded in Treatment II. There was no significant (p>0.05) variation with regards in specific growth rate, protein efficiency ratio, feed conversion ratio and survival. Fish assigned to 80% commercial feed, 20% slaughter waste meal supplement performed close to or better than the control. It is recommended that feeding *H. bidorsalis* 80% commercial feed, 20% slaughter waste meal supplement will yield good result.

KEY WORDS: Growth, utilization, *Heterobranchus bidorsalis*, slaughter waste

I. INTRODUCTION

Fish is an important animal inhabiting inland and coastal waters. It is a major source of food for humans. This aquatic species of bear gills but lack limbs with digits and are cold-blooded animals [1] [2].noted one of the sources of high quality protein is fish. The resultant effect of lacking this quality food nutrient in diet of human and livestock is nutrient deficiency diseases which could be life threatening.

Fish production is mainly by capture fisheries and aquaculture. The latter being production of water based species including fish in controlled environment. Fish feed that is of good quality enhances healthy growth and development. Decline in fish production could result in increased poverty and nutritional deficiency. Aquaculture production remains the best option to bridge the gap between demand and supply. According to [3] between 1961 and 2017 there has been

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an increase in world fish consumption, the increase on the average is about 3.1 percent. Nigeria's population estimate suggests that the gap between fish demand and supply is wide. The ultimate effect is food insecurity [4].
Feeding cost is critical in aquaculture production [5] [6]. Good quality feed play vital role in the production of marketable adult fish within optimum period. Investigations involving cat fish fed various protein sources to assess growth performance and feed utilization have been documented [4]. [7]. [8].
Freshwater fish genera *Clarias* and *Heterobranchus* belong to the family clariidae. *Heterobranchus* comprise of three species, namely *H. bidorsalis*, *H. isopterus* and *H. longifilis* [9]. [10]. The species are scale-less and naturally inhabit lakes, ponds, reservoirs, rivers, etc. The species of interest is widely cultured in Nigeria. Due to its palatability the fish is sought by many consumers. The fish commands good commercial value in Nigerian markets. Furthermore, the fish exhibit great ability to grow on a wide range of natural and low-cost artificial feeds and ability to withstand low oxygen and pH levels [8].
One factor militating against fish farming is high cost of feed. Animal slaughter waste is a source of water pollution. Utilizing the slaughter waste in feeding fish can reduce the waste that get into water.In this study *Heterobranchus bidorsalis* was fed commercial diet supplemented with animal slaughter waste meal to determine the fish growth performance and feed utilization

II. MATERIALS AND METHODS

A. Fish Collection and Feeding

Samples of pure bred fingerlings numbering 200 were purchased from Faith Agro Fish farm, Zaria. The fish were transported in plastic containers to the Fisheries Laboratory, Department of Biology, Ahmadu Bello University, Zaria.
Commercial feed (Coppens, Holland) was purchased from the market. Animal slaughterhouse waste (blood, chicken offal and feathers) was collected from the abattoir. In the laboratory, the wastes were washed thoroughly with clean tap water. Thereafter the chicken offal and feathers was oven dried at 50^0C for two weeks and homogenized.
During acclimatization, the fish were fed commercial feed at 5% of their body weight for one week after which the fish were transferred to the experimental tanks. Fish weight was taken prior to and after feeding trial.

B. Proximate Composition of Slaughter Waste

Methods described by [11] were used to analyze the nutrient content of blood, chicken offal and feathers. Corn flour was added as energy source and binder. Person's square method was used to formulate 40% protein diet.

C. Design of Experiment

Ten rectangular plastic aquaria with dimensions 60cm x 30cm x 30cm were used for the experiment and each filled with 30 litres of water. The acclimatized fish were randomly stocked at a density of ten fish per aquarium. Required amount of commercial feed and animal slaughter waste meal were weighed for each treatment and then mixed thoroughly to obtain five treatments.
Five treatments were employed as follows: Treatment I contained 0% slaughter waste meal and 100% commercial feed; Treatment II: 20% slaughter waste meal and 80% commercial feed; Treatment III: 40% slaughter waste meal and 60% commercial feed; Treatment IV: 60% slaughter waste meal and 40% commercial feed. Treatment V: 80% slaughter waste meal and 20% commercial feed. Each treatment was assigned to one aquarium containing the fish. The treatments were replicated. The weight of individual fish was measured at the commencement of the study and then fortnightly. The fish were fed a day after stocking and daily thereafter, twice a day, at 8:00am and at 6:00pm at a feeding rate of 5% of the body weight. A total feeding period of 56 days was employed.

D. Growth Performance and Feed Utilization

This was calculated using the formula:

%Weight Gain = $W_{i/}/W_f \times 100$ [12]. (Oso *et al*., 2011)
Where: W_f is the final weight and W_i the initial weight
Specific Growth Rate (%) = $(\log_e W_f - \log_e W_i \times 100) / t$ [12].

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Where: log_eW_f = the logarithm of the final weight; log_eW_i = the logarithm of the initial weight; t= time between log_eW_f and log_eW_i
Protein Efficiency Ratio = increment in body weight (g) / protein intake (g) [13].
Feed Conversion Efficiency (%) = [(Gain in wet weight of fish / Feed fed)] × 100 [13].
Survival Rate (%) = Number of fish after rearing/ Number of fish stocked × 100 [14].
Economic assessment of utilizing commercial feed supplemented with slaughter waste meal was conducted [15]. [16]. [17].
Profit Index (PI) = Fish value (N)/Feed cost (#)
Incidence of Cost (IC) = Feed cost (#)/Fish weight gain (g)
Benefit: cost ratio (BCR) = Cost of fish harvested (#) Cost incurred (#)
Hanna instrument was used to measure water temperature, pH and electrical conductivity. Dissolved oxygen was assessed using DO meter.

E. Data Analysis

Descriptive statistics with data represented as (Mean ± SE) and Tukey HSD was used to carry out the separation of means for physic-chemical parameters. A confidence level of 0.05 was used all through the analysis. Principal Component Analysis (PCA) was used to correlate all the findings and physicochemical parameters. The Statistical Analysis Program version 3.6.3 for Mac OS X was used for all statistical analysis.

III. RESULTS

Table 1 is the result on nutrient content analysis of the meal ingredients used. Dry matter varied from 84.66% in chicken feather to 96.89% in chicken offal. The range of crude protein variation was between 11.21% in corn flour and 76.15% in blood. Corn flour contain more (2.56%) crude fibre than other ingredients. Oil, ash and nitrogen free extract were higher in chicken offal (3.65%), corn flour (4.95%), and chicken offal (67.96%), respectively.

Table 1: Proximate composition of the meal ingredients used

Description	DM (%)	CP (%)	CF (%)	OIL (%)	ASH (%)	NFE (%)
Blood	91.73	76.15	0.00	0.12	3.33	20.40
Chicken feather	84.66	65.10	1.70	2.20	2.00	29.00
Chicken offal	96.89	25.00	0.00	3.65	3.39	67.96
Corn flour	94.62	11.21	2.56	2.75	4.95	ND

DM= Dry Matter, CP= Crude Protein, CF= Crude Fibre, NFE= Nitrogen Free Extract, Not Determined

Figure 1 show initial body weight ranged between 24.83±1.11g (Treatment II) and 26.76±2.72g (Treatment IV). Final body weight of *H. bidorsalis* fluctuated from 64.96±3.55g (Treatment III) to 77.93±15.06g (Treatment I). Both initial and final body weight of fish did not differ significantly (p>0.05) among the treatments. Fish in treatment V recorded the lowest ((41.00±10.46g) total body weight gain while those in treatment I had the highest (55.96±14.88g) (Figure 2). Result on percentage weight indicates Treatment V with lowest (60.42±6.59%) and Treatment II with highest (69.91±2.04%) percentage weight gain. Statistical analysis suggests no significant variation in total body weight gain and percentage weight gain (Figure 3).
The calculated values of the specific growth rate are presented in Figure 4. The ranking order of this index is Treatment V (0.741%); II (0.934%); III (0.840%); IV (0.835%) and I (0.992%). Figure 5 is the plot for values of protein efficiency ratio. Treatment V recorded the highest (0.228%) value followed by 0.126% (Treatment I); 0.125% (Treatment II); 0.119% (Treatment III) and 0.113% (Treatment IV). Different values of feed conversion ratio were obtained (Figure 6). The values ranged from 2.439% (Treatment I) to 3.100% (Treatment V). The highest survival rate (66.6%) was recorded in Treatment II. The fish did not exhibit significant (p>0.05) variation with regards in specific growth rate, protein efficiency ratio, feed conversion ratio and survival.
Result on some of the physico-chemical parameter assessed showed variation (Table 2). The lowest mean value of hydrogen-ion concentration (pH) was found to be 6.80±0.04 in Treatment II and highest (6.97±0.04) in Treatment IV

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and V. Water temperature ranged between 23.96±0.15ºC in Treatment II and 24.95±0.88ºC in Treatment IV. Electrical conductivity fluctuated from 76.08±1.49µs cm^{-1} in Treatment I to 77.67±0.82µs cm^{-1} in Treatment IV.

Mean value of 2.37±0.07 mg L^{-1} in Treatment V for dissolved oxygen was the highest while 2.58±0.11 mg L^{-1} in Treatment III was the lowest. Analysis of variance indicate no significant/non variation in all the physico-chemical parameters measured at $p<0.05$.

The results showed a positive correlation in pH, DO, protein efficiency ratio and specific growth rate while Temperature, EC , survival rate and feed conversion ration which are positively correlated shows a negative correlation when compared to each other throughout the study period (Figure 8).

Economic assessment of utilizing commercial feed supplemented with slaughter waste meal conducted indicates benefit cost ratio range of 1.42 to 2.05. Among the combinations that had commercial feed supplemented with slaughter waste meal, treatment II (80% commercial feed, 20% slaughter waste meal) recorded the highest benefit cost ration.

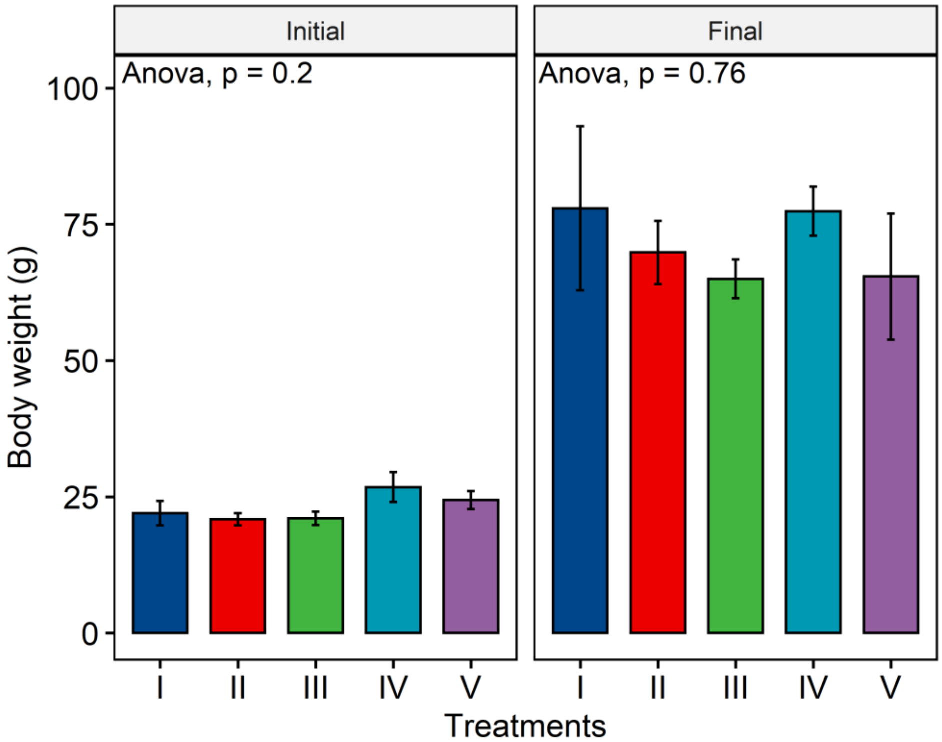

Figure 1: Plot with statistics combining initial and final body weight of fish

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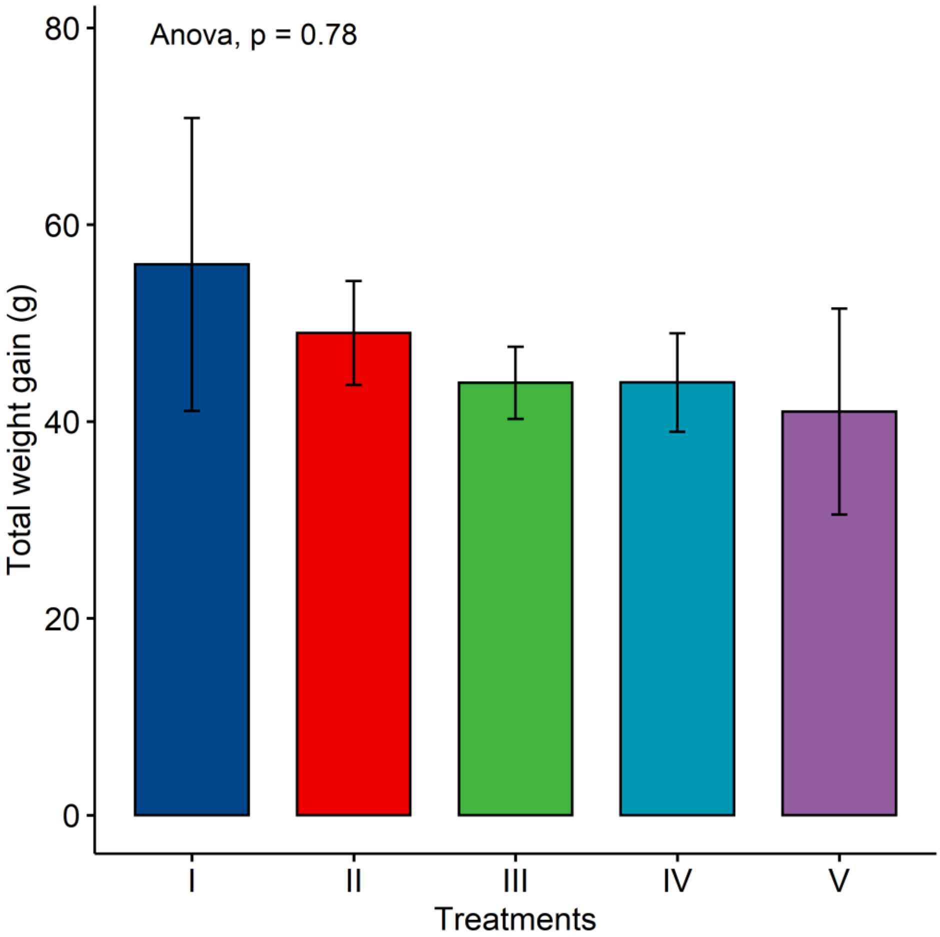

Figure 2: Plot with statistics for total weight gain

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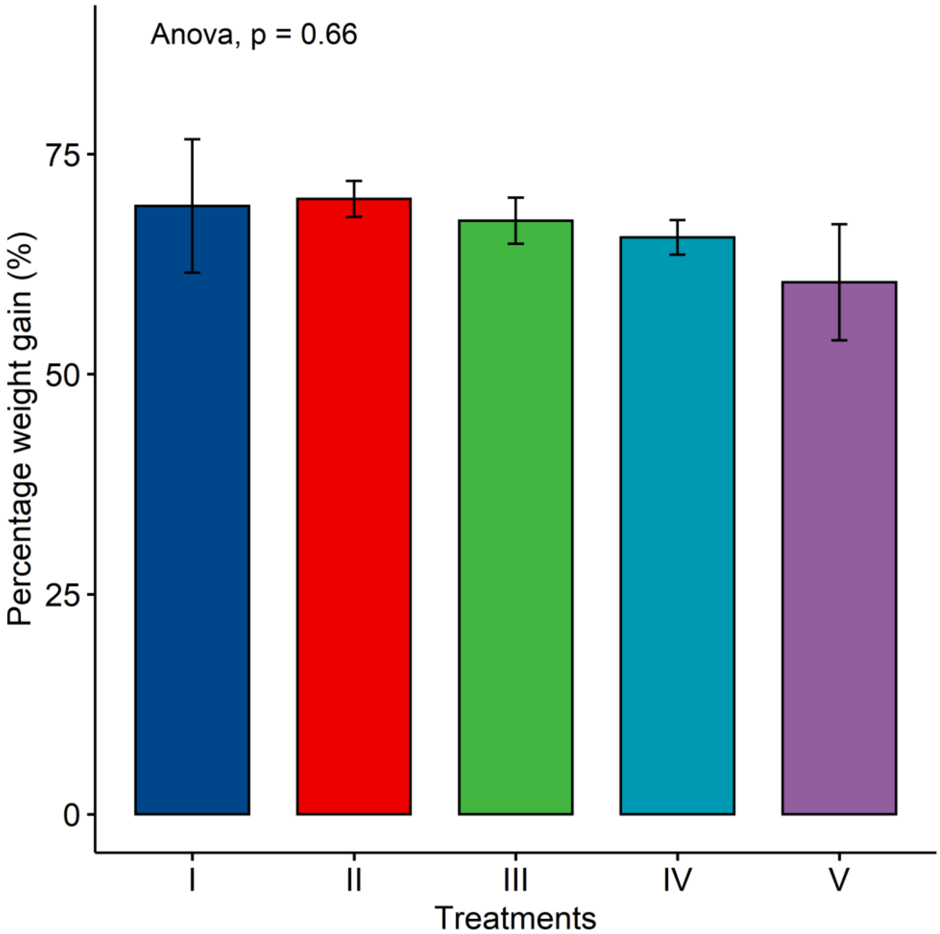

Figure 3: Plot with statistics for percentage weight gain

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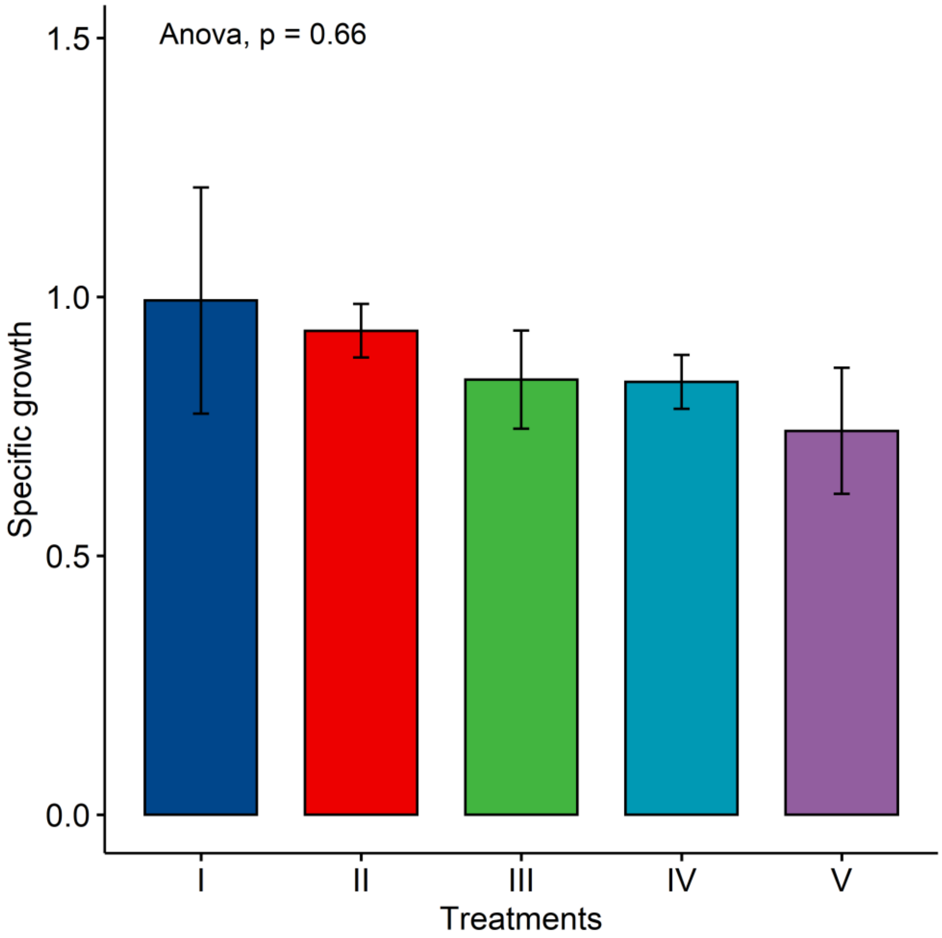

Figure 4: Plot with statistics for specific growth rate

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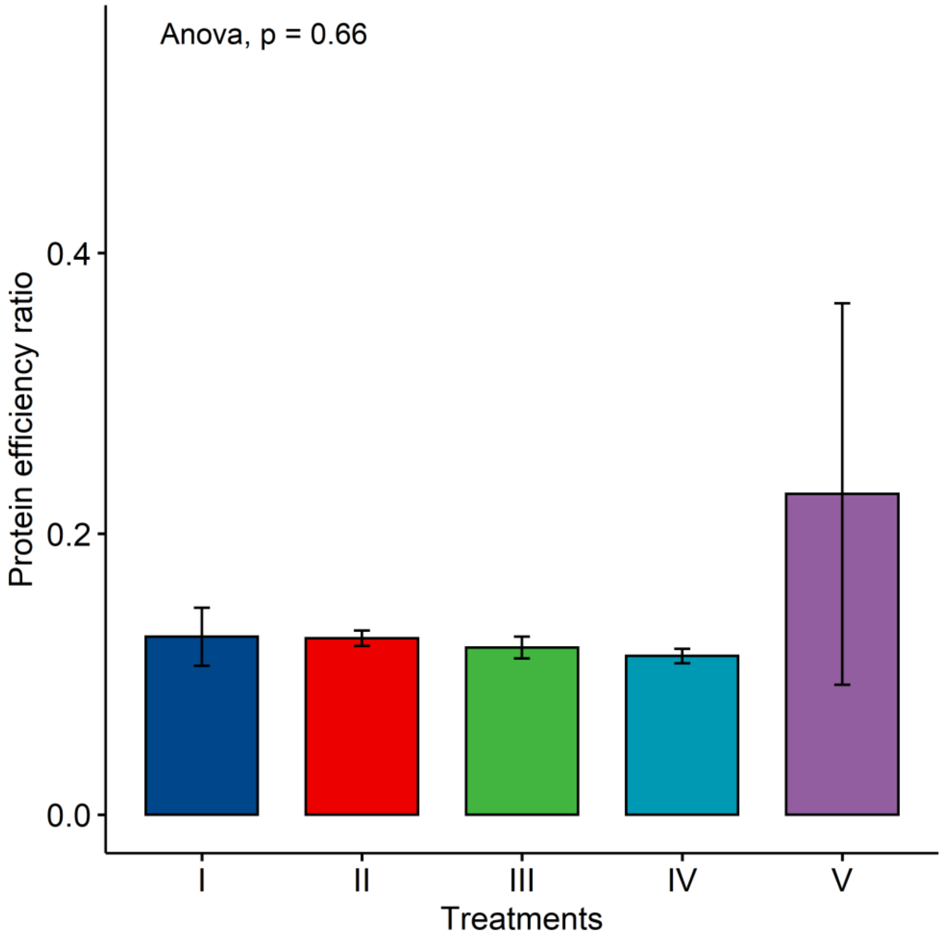

Figure 5: Plot with statistics for protein efficiency ratio

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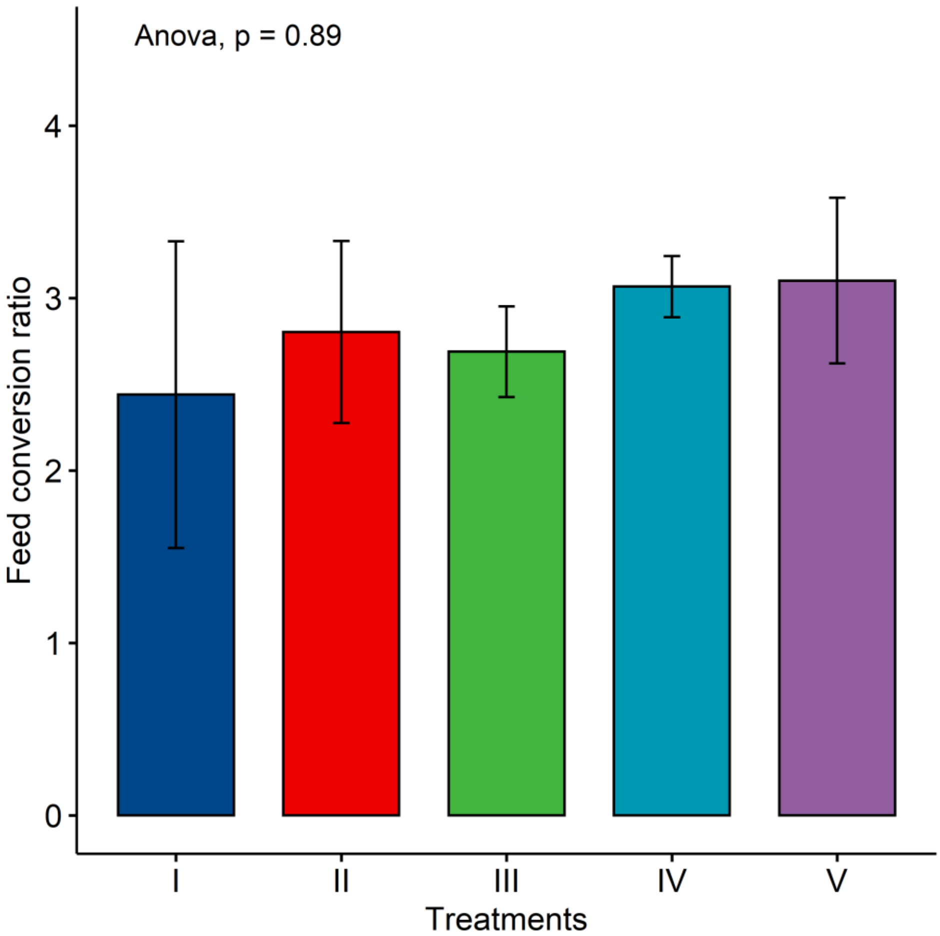

Figure 6: Plot with statistics for feed conversion ratio

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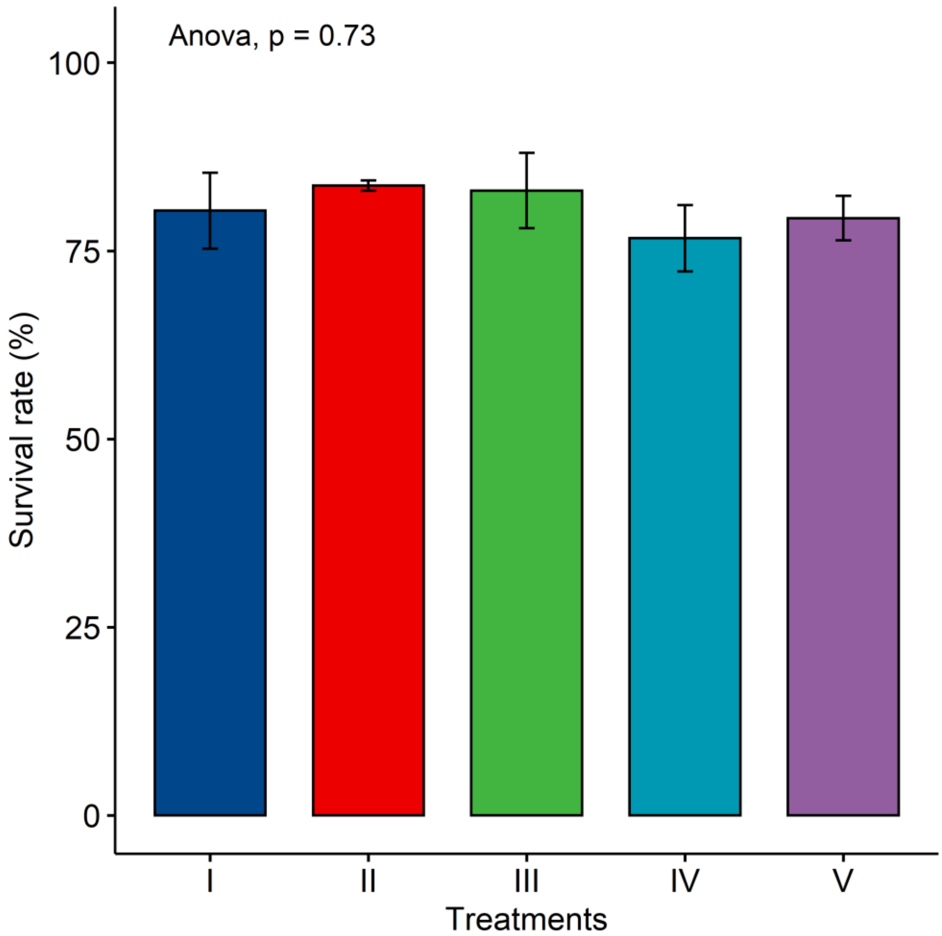

Figure7: Plot with statistics for survival rate

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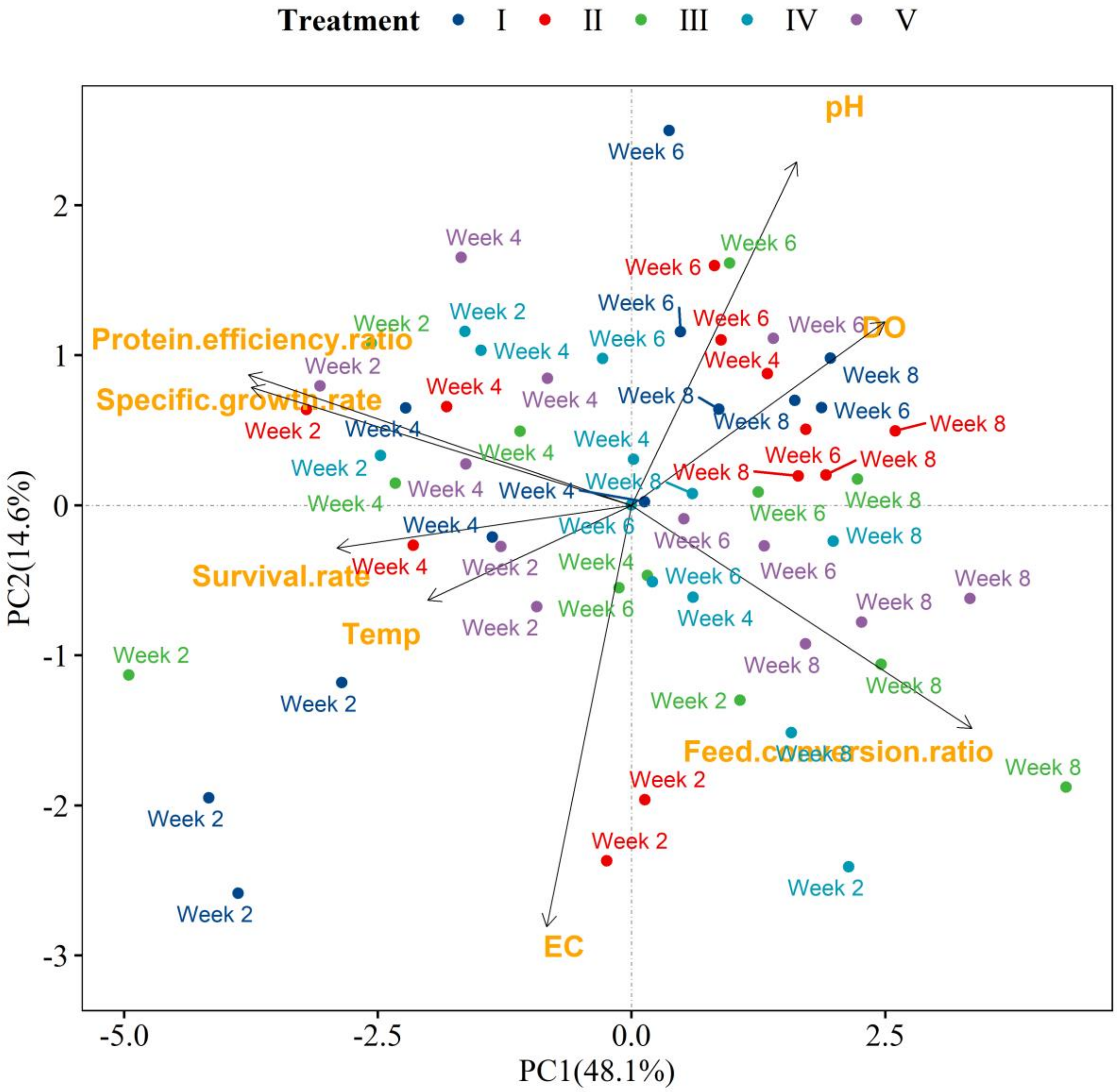

Figure 8: Correlation of all the findings and physicochemical parameters

Table 3: Economic assessment of utilizing slaughter waste meal in feeding *Heterobranchus bidorsalis*

	Treatment				
Description	I	II	III	IV	V
Mean weight gain (g)	55.96	49.00	3.93	43.96	41.00
Cost of feed (#)	500.00	480.00	460.00	460.00	450.00
Fish cost (#)	2,050.93	1,879.15	1,609.66	1,463.86	1,435.00
Profit incidence	4.10	3.91	3.49	3.18	3.18
Incidence cost	8.93	9.79	10.93	10.46	10.97
Benefit cost ratio	2.05	1.87	1.60	1.46	1.42

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Table 2: Physico-chemical parameters of water measured during the experiment

	Parameter			
Treatment	pH±SE	Temp(ºC)±SE	EC(µS cm^{-1})±SE	DO(mg L^{-1})±SE
I	6.91±0.10a	24.05± 0.11a	76.08± 1.49a	2.51± 0.14a
II	6.90± 0.04a	23.96± 0.15a	75.25± 1.30a	2.51± 0.14a
III	6.96± 0.03a	24.95± 0.88a	77.17± 0.46a	2.58± 0.11a
IV	6.97± 0.04a	24.00± 0.17a	77.67± 0.82a	2.55± 0.07a
V	6.97± 0.04a	24.02± 0.18a	76.50± 0.67a	2.37± 0.07a
Anova, p	0.81	0.40	0.51	0.70

Mean ± SE with same latters in each column are not statistically significant ($p>0.05$).

Temp = Temperature; EC = Electrical Conductivity; DO = Dissolved Oxygen

IV. DISCUSSION

The result of proximate composition analysis revealed that waste from animal sources contain variable amount of protein which can be incorporated in fish feed. The crude protein of blood and chicken feather and chicken offal reported in this study is higher than the 50.85% snail offal meal [18]. The authors recorded a higher fat content than blood, chicken feather and chicken offal. The crude protein in earthworm (15.31%) and snail meal (31.28%) [16] is lower than those obtained for blood and chicken feather. The variation could be due to taxonomical difference of the animals involved in the study. Parts of animals are known to contain varying chemical constituents.

The fish fed the different combinations of commercial feed and slaughter waste meal exhibited fluctuation in weight gain and specific growth rates. [19] also documented variation of these indices in *Clarias gariepinus* juveniles fed five commercial feed. The size difference of fish stocked in the experimental media might account for the observe ranges. Although the variation recorded in the fish fed the combination of the commercial feed and slaughter waste meal did not differ significantly from the control, 20% slaughter waste meal supplement gave growth value next to the control.

The protein efficiency ratio range in the experimental fish is below 1.24 to 2.10 for *Clarias gariepinus* in a feeding trial [20]. Intrinsic factors such as physiological condition of the organism might attribute to the difference among the treatments while protein quality and amount in diet offered could account for variations in the two experiments.The protein efficiency ratio values of this work were not significantly different among the treatments. This is comparable to values of *H. bidorsalis* PER [4]. Fish offered 80% slaughter waste meal supplement resulted in better PER than those in the control group. Next to the control was 20% slaughter waste meal supplement.

The feed requirements per unit body weight gain among the fish assigned the treatments equally showed variation. Feed conversion ratio range in this work is higher than the FCR (1.06 to 1.48%) of *C. gariepinus* fed juveniles fed varying inclusions of defatted African palm weevils (*Rhynchophorus phoenicis*) meal [12]. Similarly, *Oreochromis niloticus* fry had lower FCR of 1.78 to 2.85% [21]. In terms of FCR, 100% commercial feed gave the lowest value while 20% and 40% slaughter waste meal supplement were close to the control. A low FCR is an indication of a high quality feed. Factors such as species, water quality and production system might be responsible for the index variation.

Experimental tank assigned 20% slaughter waste meal supplement had the lowest mortality of fish. Feeding experiment involving *H. longifilis* have documented higher survival rate range of 76.7 to 96.7% [22].

The combination 80% commercial feed, 20% slaughter waste meal (Treatment II) recorded the highest benefit cost ratio as such recommended for inclusion in the diet of *H.* bidorsalis.

Physic-chemical parameters assessed were relatively within favourable ranges. [23].described temperature range of 25 to 32ºC, pH of 6.28 to 6.79 and dissolved oxygen of 3 to 9 mg/l as favourable for warm water fishes. Solomon and Maiyaki (2022) [24].recorded temperature (26 to 30 ºC), pH (7.5) and dissolved oxygen (1.0 to 6.82mg L^{-}) ranges.

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In restricted exchange environments, there is a risk of high levels of nutrients that may cause the eutrophication of water and may potentially create undesirable effects to fish life by decreasing the oxygen content in water. It is also reported that the mortality of fish may initiate at DO content below 3.0 mg L^{-1}(Sonila *et al*., 2015) [30].

V. CONCLUSION

Fish assigned 80% commercial feed, 20% slaughter waste meal supplement performed close to or better than the control. It is recommended to fish farmers that feeding *H. bidorsalis* 80% commercial feed, 20% slaughter waste meal supplement will yield good result.

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