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Assessment of Commercial Fish Feeds on the Growth Performance and Biochemical Condition of African Catfish (*Clarias Gariepinus*)

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Abstract

This study examined the effects of various commercial fish diets on the biochemical state and growth performance of juvenile Clarias gariepinus. 240 fish samples were used in the investigation, with mean weights of 136±5.12g and lengths of 19.3±1.03cm. They were examined in a completely randomized design (CRD) with three replicates, using conventional procedures. Four treatments were assigned to them: T1 (Vital feed), T2 (Blue crown), T3 (Aquaboom), and T4 (Coppens). The study included monitoring of the following data: proximate composition, mean weight gain, specific growth rate, condition factor, percentage survival rate, protein efficiency, and experimental water quality parameters. The findings showed that the mean physiochemical parameter compared between treatments and control were within the FAO (2020) guideline limits. It is evident from the proximate composition that fish grow more effectively when fed with vital meals that have high content of protein and fat. The results showed that test fish fed Vita feed had higher feed conversion rates and considerably (p<0.05) higher specific growth rates than test fish fed the other treatments. All of the treatments showed high survival rates (>80%). The fish fed with Blue Crown feed had the highest weight growth of 913.24±0.78g, followed by those fed with Coppens feed (867.06±1.21g), while the fish fed Aquaboom had the lowest (797.31±1.0). Specific growth rate was lowest in those fed Coppens (0.46) and highest in those provided with Vital feed (0.78), followed by Blue Crown (0.64). The activities of Alanine Amino Transferase (ALT), Alkaline Phosphate (ALP), and Aspartate Amino Transferase (AST) in each test fish did not significantly change. It is therefore concluded that, in relation to the parameters analyzed, there were variations among the brands of fish feed. In order to achieve optimal growth, it is advised that fish feed manufacturers should carefully create a nutritionally balanced fish feed.

Keywords: Fish feed, Growth Performance, Biochemical condition, Catfish, Fish culture

INTRODUCTION

Fish makes up almost 37% of Nigeria's total protein needs and is the most affordable and significant source of animal protein (FAO, 2014). According to the FAO (2014), fish accounts for about 16% of the animal protein consumed worldwide. In areas with comparatively limited cattle, it is significant source of protein for billions of people, primarily in developing nations (FAO, 2014). FAO (2024) predicted that by end 2024, the demand for fish will rise by roughly 223.5 million metric tons. A significant obstacle to the growth of Nigeria's aquaculture sector is the supply of reasonably affordable fish feed. The type of feed, feeding frequency, feed intake, and the fish's capacity to absorb nutrients all affect growth and survival rate (Arebu *et al.,* 2017). Enough nourishment must be provided for fish to grow once they are transplanted from their natural habitat to an artificial one. Both intensive and semi-intensive fish culture systems require the use of complete commercial feed, which can make up as much as 60% of production costs (Jamabo *et al*., 2013). If the right feed is not utilized, it occasionally make a fish farm unprofitable. For many aspiring fish farmers in Nigeria, fish feed selection has grown to be a significant cause of anxiety and phobia. If fish farming is to be profitable, and sustainable, an immediate remedy must be proposed (Paul *et al*., 2013).

Nigeria is seeing a rise in fish farming; if this trend continues, aquaculture will have a significant economic impact and supply the country's people with protein-rich food (Umaru *et al*., 2016). Accordingly, aquaculture continues to be the sole practical option for boosting fish output to satisfy human need for protein (Olapade and Kargbo, 2015). Increasing fish output and growth rates to satisfy the demands of the growing population is one of aquaculture's goals.

Heterobranchus bidorsalis, Heteroclarias sp., and *Clarias gariepinus* are the preferred catfish species in Nigerian aquaculture (FAO, 2014). Africa catfish is well-liked by consumers and has a lot of promise to support Nigeria's rapidly expanding aquaculture industry. According to Madhusoodanan *et al*. (2016), *Clarias gariepinus* is widely regarded as one of the most significant tropical freshwater fish species for aquaculture, with established aquaculture potential. According to Bruton (1979), *C. gariepinus* develops more quickly, has a high fecundity rate, and can withstand extremes in environmental conditions and large densities.In expanding habitats, it also adapts to a variety of feeding techniques and consumes a broad spectrum of natural and artificial food. According to Olaniyi *et al*. (2013), fish rely on feed as a critical resource for energy needed for daily activities. As a result, the quality of the feed has a direct impact on the growth of any given fish. Taking the aforementioned into consideration, the purpose of this study was to evaluate how commercial feeds affected the growth performance and biochemical indicators of African catfish (*Clarias gariepinus*).

MATERIALS AND METHODS

Source of Experimental Fishes

A total of 240 healthy Juveniles African catfish (*C. gariepinus*) with mean weight of 136±5.12g and mean length of 19.3±1.03cm were procured from Rumbun Kifi Fish Farm, along Dorayi Road, behind BUK old site, Kano State, Nigeria located between latitude 12^{o} 40^{o}-10^{o} 30^{o} and longitude 7^{o} 40^{o}- 9^{o} 40^{o}.The fish were maintained in a 1000L dark plastic tank filled with borehole water and renewed daily. They were fed twice with 2mm pellet diet containing 42% crude proteins with 2mm in size produced by Vital fish feed Nigeria. Feeding was terminated 24h prior to the experimental take up.

Experimental Design

Fish samples were subjected to Completely Randomized Design (CRD) using GenSta version 2.4 with four levels exposure treatment. A set of twenty fishes with four treatments and three replications were randomly exposed to varying fish feed making a total of twelve experimental units. The fish feeds used are designated as T1 (Vital fish feed Nigeria), T2 (Blue crown), T3 (Aqua boom) and T4 (Coppens).

Water Quality Parameters Determination

Water quality parameters were determined before the acute toxicity test using multifunction water testing kit (Model no. EZ-9909-SP). Parameters such as pH and Dissolved oxygen, Electrical Conductivity, water temperature and Total Dissolved Solids were determined as described by Manufacturer.

Growth Performance Determination

Effect of the fish feed and their growth performance were assessed monthly to evaluate the mean monthly weight gain (MWG), percentage survival rate (%SR) and specific growth rate (SGR) as adopted by Olaniyi *et al*. (2013). Mean weight gain (MWG) of individual fish in each treatment was estimated by subtracting the initial mean weight from the final mean weight at the end of the exposure period using the following formula:

$$MWG = W_2 - W_1$$

Where: W_2: final mean weight of fish at four months; W_1: initial mean weight of fish at the onset

Percentage Survival Rate (%SR) was calculated from the following relationship:

$$\% SR \; \frac{initial\ number\ of\ fishes - mortality \times 100}{initial\ number\ of\ fishes\ stocked}$$

The specific growth rate was determined as follows:

$$SGR = \frac{\log\ (W_2 - \log W_1)\ \times 100}{period\ under\ study\ (days)}$$

Biochemical Analysis

Blood sample for biochemical investigation was collected for the experimental by piecing caudal vein using plain sample container without anticoagulant. Plasma was obtained from the whole blood by the centrifugation at 5000rpm for 15min. the aspartate amino transferase (AST), Alkaline phosphate (ALP) and Alanine amino transferase (ALT), activities was determined at Biochemistry Laboratory, Bayero University, Kano. Using Randox kits.

Statistical Analyses

The data for physicochemical parameters were subjected to one way analysis of variance (ANOVA) to determine differences between sites and where differences existed LSD at 0.05% was used to separate the means. All analysis were carried out using SPSS version 20.0 software.

RESULTS AND DISCUSSION

RESULTS

Table 1 shows the physicochemical parameters' mean and range before and after treatment. Prior exposure values for DO, TDS, pH, EC, turbidity, and temperature varied from 4.42 to 5.78, 263-284 mg/L, 6.70 to 7.50, 273-324µS/cm, 22-34 NTU, and 28.5-31.7°C. Additionally, following a 96-hour exposure period, the following values were recorded: DO, TDS, pH, EC, turbidity, and temperature: 3.40-5.24 mg/L, 297-344 mg/L, 8.52-9.54, 283-297µS/cm, 25-41NTU, and 33.1-34.6°C, respectively.

Table 1: Physicochemical Parameters of Water Before and After the Treatment

Parameters	Before Range	Mean	After Range	Mean	FAO (2020)
DO (mg/L)	5.42-5.78	5.90±0.13	5.40-5.24	5.81±0.10	5.0-9.0mg/L
TDS (mg/L)	263-285	278±2.17	297-344	314±4.10	<500mg/L
pH	6.70-7.50	6.80±0.71	8.52-9.54	8.93±0.51	6.0-9.0
E.C (µS/cm)	273-324	289±3.01	283-297	286±1.78	<1000µS/cm
Turbidity (NTU)	12-34	16.8±1.13	12-41	13.8±0.19	<25 NTU
Water temperature (°C)	28.5-31.8	29.4±0.31	33.1-34.6	34.0±0.54	<40°Cmg/L

The *C. gariepinus*'s total weight (WT) and total length (LT) ranged from 197.8 ±3.61 to 286.8± 4.11g and 21.6 ± 1.01 to 27.6± 0.06 cm, respectively. During the analysis, average weight and length for T3 were 156.6 ± 2.17 and 21.6 ± 1.01 cm, respectively. The average weight and total length of the T2 under examination were 19.7± 0.71g and 27.6± 0.06 cm, respectively (Table 2).

Table 2: Mean Length-Weight Parameters of *C. gariepinus* Fed with Different Feeds

Treatment	T1	T2	T3	T4
Initial mean weight (g)	29.65±0.04	29.71±0.72	28.69±0.85	28.94±0.03
Final mean weight (g)	867±2.10	945±1.77	888±4.16	986±7.82
Mean Weight Gain (g)	822±3.16	913.24±0.78	797.31±1.0	867.06±1.21
Condition Factor (K)	2.13	1.89	1.76	1.85
Survival rate (%)	80	70	60	53
Specific Growth Rate (SGR)	0.78	0.61	0.52	0.46
Initial mean length (cm)	15.01±0.01	13.67±1.05	14.5±0.03	15.02±0.10
Final mean length (cm)	41.7±1.56.	38.6±3.12	37±2.89	36.6±1.71

Biochemical Parameters of the Experimental fish fed with different fish feed

The mean liver AST of the experimental fish when exposed to the varying treatment (Table 3). Lowest activity was obtained in the T1 (34.60 ±1.19U/L) and the highest of (58.37±1.03U/L) was obtained among T3. The AST activity between T1 and treatments differed significantly (P<0.05). The activity ALT had the highest activity of (48.09±1.02U/L) among T4 while the lowest was recorded among T1 (38.67±1.51 U/L) and the mean values differed significantly between the treatments (P<0.05).The serum ALP activity had its highest value T4(37.91±1.10 U/L), followed by T3 (36.09±0.60U/L) and T2 (35.67±1.02U/l) against the lowest value from T1 31.78±1.50U/l. The mean values obtained differed significantly (P<0.05).

Table 3: Mean Concentrations of Biochemical Parameters of Experimental Fish Fed with Different Fish feeds

Group/parameters	AST (U/L)	ALT (U/L)	ALP (U/L)
T1	34.60 ±1.19[a]	38.67±1.51 [a]	31.78±1.50[b]
T2	48.49±0.92[b]	46.87 ±1.09[a]	35.67±1.02[a]
T3	58.37±1.03[a]	45.51±2.41[a]	36.09±0.60[b]
T4	42.74±0.86[a]	48.09±1.02[a]	37.91±2.10[a]

Note: values are means and SD, means with the same superscript in a column are not significantly different (P>0.05).

Table 4 displays the findings for the four treatment groups' average proximal makeup. The mean ± standard deviation (mean ± S.D.) was used to express all results. According to treatment variation, T1 had the highest mean protein content (66.08±0.41%), whereas T4 had the lowest (55.70±0.45%). There was a statistically significant difference in the proportion of protein between the treatments ($p<0.05$). According to the moisture content, T4 had the highest value at 14.66 ± 0.27%, while T1 had the lowest at 9.50 ± 0.14%. The ash content varied significantly, with T3 recording the highest value at 8.76% and T1 the lowest at 4.78. According to the lipid percentage, T2 had the lowest value at 8.20% and T3 had the highest at 14.06%.T4 contained the highest percentage of carbohydrates (10.57%), whereas T3 had the lowest percentage (6.51%).

Table 4: Proximate Composition of the Experimental Fish species

Treatment	*T1*	*T2*	*T3*	*T4*
Proteins	66.08 ± 0.41^{b}	63.50 ± 0.39^{a}	57.00 ± 2.03^{a}	55.70 ± 0.45^{b}
Moisture	9.50 ± 0.14^{b}	11.50 ± 0.06^{b}	13.67 ± 0.13^{a}	14.66 ± 0.27^{a}
Ash	4.78 ± 0.69^{a}	7.66 ± 0.01^{b}	8.76 ± 0.22^{a}	8.50 ± 0.04^{a}
Lipid	12.25 ± 0.07^{a}	8.20 ± 0.02^{b}	14.06 ± 0.03^{a}	10.57 ± 0.14^{a}
Carbohydrates	7.39 ± 0.77^{a}	9.140 ± 0.13^{a}	6.51 ± 0.38^{a}	10.57 ± 1.73^{a}

Mean values with different superscripts in a row are significantly different ($P<0.05$)

Discussion

Comparison of the growth parameters and water physicochemical conditions of African catfish with four commercial fish feeds revealed that, the effects of the feeds on the fish and the water physico-chemical conditions during the culture period varied. As demonstrated by, this is to be expected given the variations in the nutrient contents of the fish's diets. The mean concentration of dissolved oxygen (DO) in T3, T4, and T1 varied significantly. However, the fluctuation were within FAO (2020) recommended limit of 5.0 mg/L. The respiration and breakdown processes that try to balance the test fish's chemical and biotic oxidation might be the cause of the variance in DO.

Changes in the water chemistry caused by respiratory activities occurring in the water containers and the release of carbonic acid from respiration or decomposition, which tends to be alkaline, are reflected in the test water's fluctuating pH. According to the pH range of 7.40 to 9.01, the test water is alkaline, which could have an impact on a variety of physiological processes in the test fish. Since the test water's pH was unaffected by substances that may have made it extremely basic or acidic, it is clear that the pH concentrations falls within the recommended limit of FAO (2020). The findings are consistent with this observation (Adamu *et al.*, 2016). The measured water's mean temperature varied, reflecting variations in the surrounding air temperature. The ecological zone's high levels of solar radiation were accompanied by a comparatively high temperature. Aquatic biota that grow in a wide variety of temperatures may be able to survive in the temperature range discovered in the present study. This is consistent with Ibrahim *et al.* (2024).

Compared to the control group, the test water had a higher electrical conductivity. The test water's high mineralization from the dissolved ions may help to explain this, indicating that more ions and other dissolved elements were ingested by the fish from the test water. The reported electrical conductivity fell within the FAO (2020) recommended limit of 1000 µS/cm. The mean TDS concentrations may have been influenced by the dissolved salts in the water, which therefore changes the experimental fish's metabolic activities. The TDS levels were within the 25NTU FAO (2020) recommended range for surface freshwater bodies. When evaluating the impact of diet on the test fish, growth parameters are crucial. Weight gain (kg), growth rate (GR), specific growth rate (SGR), and mean growth rate (MGR) of *C. gariepinus* fed T2 and T3 were significantly different (P<0.05) from fish fed T1 and T4 in the current investigation on growth performance. Among other reasons, the variance in fish diet may be caused by variations in feed composition, palatability and floating efficiency. The current study's findings concur with those of Paul *et al*. (2013). Ayegba *et al*. (2016) believed that an animal's nutritional needs determine the quality of a diet. The growth performance of fish fed the four experimental diets shows that there was no negligible (P>0.05) variance in the feeds' ability to meet the nutritional needs of *C. gariepinus* in a culture system. In terms of crude protein content, the current study deviates from Paiboon and Kriangsak's (2015). In contrast to Paiboon and Kriangsak (2015), who fed their fish commercial feed (39% CP), the fish in the present study were fed with designed treatment diets (42% CP). Additionally, the results showed that the minerals from the fish meals were bioavailable. A crucial element of fish feed, according to Eyo and Ekanem (2011), is the availability of nutrients in a diet that is efficiently digested.

Fish provided T3, T4 feed reacted to the feed more aggressively than fish fed with T1 and T2 feed, according to the current study. This might be explained by the two experimental diets' dissimilar compositions. While T1 and T2 feed had less of a fishy smell and was designed to sink, T3 and T4 feed had a fishy smell that attracted fish and made it floatable. Given that *C. gariepinus* uses its olfactory receptors during feeding, this observation is consistent with Agokei *et al*. (2011), who found that commercial fish feeds like Vital and Euro produce higher fishy odors. However, the amount of feed that the two feeds consumed at the end of the feeding period differed significantly, and this difference was also represented in the different growth performances that were noted in the present study. The fact that fish often grow isometrically in natural environments with plenty of food sources and few human disruptions may help to explain the discrepancy between the current findings and those of other studies. This is in line with what Ali *et al*. (2015) reported. According to Olaniyi *et al.* (2013), when treatment foods and water quality are properly regulated, isometric fish development can be attained in a controlled experiment.

The amount of feed consumed is a critical component in determining the food conversion ratio (FCR) in fish nutritional research. Given the high cost of feed, the feed conversion ratio (FCR) is a crucial metric for assessing how best to use it (Eyo and Ekanem, 2011). Except for SGR, which did not exhibit a consistent pattern, the results of the current investigation compared favorably with those published by Aiyelari and Adeyeye (2022). This study's findings on growth responses and nutrient consumption were consistent with those of Olapade and Kargbo (2015). Understanding FCR properly enables the farmer to feed the fish until they are satisfied. When fish are fed precisely the right amount of feed, they do not experience stress and produce high-quality flesh that can be consumed by humans (Jamabo *et al*., 2013). The variations in the diet's protein content could be the cause of the discrepancy in growth and nutrient use protein. Overfeeding and underfeeding can have negative effects on fish health, including decreased weight, poor food utilization, heightened susceptibility to infection, and a noticeable decline in water quality (Priestly *et al*., 2008).

The biochemistry and overall health of a fish are influenced by physiological and other related environmental factors. Age, sex, genetic variation, stress during capture, and transportation are some possible causes of these factors (Aiyelari and Adedeyi, 2022). Variations in the experimental fish's serum plasma ALT, AST, and ALP levels during the current investigation, fed with varying fish feed, suggested that the test fish had neither tissue damage or organ failure. In comparison to the original results acquired prior to the trial, all of the fish fed the experimental diets had reduced serum biochemical values. This demonstrated that the study that found a significant increase in blood enzyme activity (ALT, AST, and ALP) as the amount of protein in *Clarias gariepinus* diets rose is consistent with this data. There is a high correlation between the absence of hepatic damage and the activity of these hepatic enzymes (Idowu *et al*., 2013). Either the phospholipids in the hepatocytes' regular membrane or a byproduct of the metabolism of fish feed are to blame for this.

All of the experimental fish's blood levels of vital liver indicators, including AST, ALT, and ALP, increased somewhat with each treatment during the current study. In contrast to other hepatic enzymes, these enzymes' increased activity may be linked to minor hepatic injury, according to Abdullah *et al*. (2017). This could be the result of the fish feed's active ingredient. A mild hepatic damage, myocardial infarction, and cardiovascular illnesses may be linked to an increase in the activity of ALT, AST, and ALP in the exposed fish (Ugwu *et al*., 2013). This is in line with what Adamu and Ahmed (2014) observed. The elevated levels of serum enzymes (ALT, AST, and ALP) were illustrated by Abdullah *et al*. (2017). According to Pierre *et al*. (2017), the presence of non-digestible substances in the feed that prevent the catalytic interconversion of amino acids and α-ketoacids by amino group in ALT may be the cause of the increased liver enzyme activity in the experimental rats exposed to T1 and T2. The change of these enzymes from cytosolic injured hepatic cells into the bloodstream is what causes the increase in these enzyme levels, not an increased rate of biosynthesis (Usman *et al*., 2018).

Conclusion

The findings showed that the average of every physiochemical parameter assessed between treatments was within the FAO (2020) guideline limits. The results of this investigation showed that the experimental fish was in excellent health and that there were no feeding-related issues in the test containers. This study found that the feed brands differed significantly in terms of specific weight gain, specific growth rate, protein efficiency ratio, percentage survival rate, and feed cost per kilogram of weight gain. It is evident from the proximate composition that fish grow more effectively when fed vital meals that are heavy in both protein and fat. The results showed that test fish fed Vita feed had lower feed conversion rates and considerably ($p<0.05$) higher specific growth rates than test fish fed the other treatments. All of the treatments showed high survival rates (>80%). The fish fed Blue Crown feed showed the most weight gain, whereas the fish fed Aquaboom showed the lowest. *Clarias gariepinus* fed Vital feed had the highest specific growth rate, followed by those fed Blue Crown, while those fed Coppens had the lowest. All test fish exhibited unchanged levels of Alanine Amino Transferase (ALT), Alkaline Phosphate (ALP), and Aspartate Amino Transferase (AST). In order to prevent the importation of feeds with dubious nutritional components that could negatively impact local production of *C. gariepinus*, it is advised that the genetic variety of the fish species be taken into account before beginning to formulate their feed.

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