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Comparative investigation of African Catfish (*Clarias gariepinus*) growth performance on four distinct commercially produced diets

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Abstract

In this study, 180 juveniles *Clarias gariepinus* fish were raised for twelve-week period, and the growth performance of four different commercial fish feeds; Coppens, Vital, Topfeed, and Bluecrown were examined. A thorough one-way analysis of variance (ANOVA) was performed on the data for each parameter at a significance level of 5%., significant variations in growth performance among the feed treatments were observed. Coppens emerges as the top-performing feed, showcasing the highest weight gain at an average of 78.43±0.02g, specific growth rate (SGR) with a mean value of 2.40±0.00, and impressive survival rates of 91.11%±2.22. In stark contrast, Vital feed records comparatively less favourable growth performance, characterized by a weight gain of 60.42±0.02g, SGR of 2.15±0.00, and survival rates of 86.67%±3.85. The feeds' proximate analysis confirmed that there are notable nutritional differences. Coppens notably excels in crude protein content at 48.50%±1.02, marking a noteworthy difference among the feeds. This investigation emphasizes the essential role of selecting high-quality, nutritionally balanced feeds in optimizing the growth and development of aquaculture. The research findings highlight substantial differences in growth performance and feed quality among commercial feeds, emphasizing the critical importance of feed choice in aquaculture production.

Keywords: Aquaculture, *Clarias gariepinus*, commercial fish feeds, growth performance.

1. Introduction

In a time of unrelenting rise in population worldwide, there is an increased need for premium animal protein, exerting unprecedented pressure on our food production systems [1]. This pressing demand underscores the critical imperative to bolster aquaculture production, a necessity brought about by the alarming decline in capture fisheries, primarily due to factors like overfishing, aquatic habitat degradation, and pollution [2]. Amid this context, the role of fish, as a vital source of animal protein, takes center stage. Fish has become an essential component of diets worldwide, nowhere more evident than in Nigeria, where it stands as a primary source of animal protein. Beyond its status as a staple food, fish is a rich reservoir of crucial nutrients, boasting Thiamine, Riboflavin, Vitamins A and D, Phosphorus, Calcium, and Iron [3]. Furthermore, its high content of polyunsaturated fatty acids aligns perfectly with the high carbohydrate diets commonly consumed by low-income groups in Nigeria [4].

The burgeoning fish farming industry in Nigeria holds the promise of making a substantial impact on the economy and satisfying the growing population's need for protein-rich sustenance [5]. Within the practice of catfish cultivation, *Clarias gariepinus*, a member of the Claridae family, claims its place as one of the most frequently cultivated fish species in Nigeria. Feed, a pivotal component in extensive and semi-intensive sustainable aquaculture systems, significantly contributes to the recurrent production costs, typically accounting for 40-60% [6]. The formulation of balanced commercial diets is the ambition of fish nutritionists, aiming to promote not only optimal fish growth but also overall health [7]. The importance of high-quality feed and appropriate feeding frequencies cannot be overstated, as they hold the keys to maximizing diet utilization that leads to accelerated growth and enhanced feed efficiency [8, 9].

On the flip side, poor-quality fish feed can result in nutrient leaching, leading to higher feed conversion ratios, increased input costs, and deterioration of water quality [10]. Therefore, standardizing the quality of commercial feed has become an imperative for attaining optimal production. Despite significant growth in fish farming within Nigeria over the past decade [11], aquaculture in the country remains in the developmental stage, grappling with the challenge of meeting the demands of the ever-expanding population [12]. It is within this complex backdrop that the issue of providing affordable and high-quality fish feed takes center stage. Thus, the goal of this study is to assess the performance in terms of growth of four different commercial fish feeds for *Clarias gariepinus*, subsequently aiming to maximize fish production in the aquaculture industry.

2. Materials and methods

2.1 Test feeds and experimental organisms

The investigation was executed at the Department of Fisheries and Aquaculture, Federal Polytechnic, Ado Ekiti, located in Ekiti State, Nigeria. A total of 180 Clarias gariepinus post-fingerlings, each initially weighing 5.5 ± 0.00g, were acquired from Afe Babalola University and Farms (ABUAD) in Ado Ekiti, Ekiti State. They were transported to the experimental site in open plastic containers covered with nylon nets and allowed to acclimate for a period of 14 days before the commencement of the study. The four standard commercial feeds used in the research; Coppens, Vital, Topfeed, and Bluecrown, each with a particle size of 2 mm, were sourced from Sojnik Feed Depot, a local commercial feed supplier in Ado Ekiti.

2.2 Experimental design

The study lasted for a period of twelve weeks and involved 180 *Clarias gariepinus* specimens. They were distributed randomly, with fifteen fish assigned to each treatment group (T1 representing Coppens, T2 for Vital feed, T3 for Topfeed, and T4 for Bluecrown) and this was replicated three times. Rectangular plastic tanks measuring 0.50 x 0.38 x 30 meters were utilized for the research. To ensure consistency in the trial conditions, the test subjects underwent a 24-hour fasting period prior to the initiation of the experiment. During the study, the fish were feed twice, corresponding to 5% of their individual body weights. To maintain optimal water quality, routine waste removal was carried out daily, and the water was replenished every three days from a borehole source. It is important to note that the experimental design followed a completely randomized arrangement.

2.3 Growth variables

Initial and final body weights and lengths of the fish were recorded weekly to monitor weight gain and length increase. Various growth parameters were calculated, including weight gain (WG), mortality rate, survival percentage, specific growth rate (SGR), and feed conversion ratio using the following formula given by [13]:

a. Mean weight gain (g):

$$MWG = W_2 - W_1 \quad (1)$$

Where, W_1 = fish initial mean weight and W_2 = fish final mean weight

b. Specific growth rate (SGR):

$$SGR = \frac{\log_e W_f - \log_e W_i}{T} \times 100 \quad (2)$$

Where, W_f the experiment's final average weight at the end of the study, W_i = the experiment's initial average weight at the end of the study, Loge = Natural Logarithm's base and T = number of experiment days.

c. Feed Conversion Ratio (FCR):

$$FCR = \frac{Feed\ intake\ (g)}{Fish\ weight\ gain(g)} \quad (3)$$

d. Survival rate (%):

$$SR = \frac{Total\ Fish\ (Harvested\ nimber)}{Total\ number\ of\ fish\ stocked} \times 100 \quad (4)$$

2.4 Proximate analysis of experimental diets

The validated proximate analysis approach described in the work of [14] guidelines was used for the nutritional analysis of the various conventional commercially available feeds. This approach was adopted to ensure the precise determination of components such as moisture, crude protein, ether extract, fiber, and ash in the feeds.

2.5 Water quality assessment

Water quality parameters were rigorously monitored throughout the study, with measurements taken on a weekly basis at 08:00 hour. Temperature was measured using a mercury-in-glass thermometer, providing readings in degrees Celsius (°C). Waters pH level was determined using a handheld pH meter (Milwaukee pH 600 Tester Kit), ensuring accuracy in the assessments. Additionally, the presence of Dissolved Oxygen (DO) in the water was quantified using a portable Dissolved Oxygen meter (Milwaukee MW 600), enabling precise measurements.

2.6 Statistical analysis

Data collected were statistically analysed to determine variations in parameters measured during the research. In order to determine whether there were any significant differences ($P < 0.05$) between the data. One-way analysis of variance (ANOVA) was used. To further investigate distinctions within means, Duncan's multiple range was conducted. Statistical analysis was performed using Statistical Package for Social Sciences (SPSS), version 21.

3. Results and discussions

3.1 Results

3.1.1 Proximate composition of experimental diets

Table 3.1 shows the proximate analysis of the several commercial feeds used in this investigation. To evaluate the nutritional value of these diets, their proximate composition was examined. The results reveal that Coppens (T1) exhibited the highest crude protein content with a mean value of 48.50 ± 1.02, surpassing the other treatments: T3 (Topfeed) with 47.30 ± 0.29, T4 (Bluecrown) with 43.30 ± 1.00; T2 (Vital Feed) having the least figure of 45.60 ± 0.29. T1 recorded the greatest value at 12.50 ± 0.58, followed by T3 (8.00 ± 0.12), T4 (5.20 ± 0.10), and T2 (1.50 ± 0.58). The mean values for ether extract also show the same trend. Regarding crude fiber, T2 had the greatest mean value (3.00 ± 0.12), and

T3 followed second next with (2.40 ± 0.17), while T1 had the lowest value at 1.50 ± 0.06. In terms of moisture content, T3 recorded the highest mean value at 7.90 ± 0.17, followed closely by T4 at 7.80 ± 0.23, T2 at 7.70 ± 0.23, and T1 at 7.30 ± 0.23, which had the lowest moisture content. The results of the proximate analysis demonstrated notable variations (P<0.05) in the macronutrient content of the various feeds, emphasizing the dietary variances across the four treatments. These findings are critical for understanding the nutritional value of the feeds in the context of *Clarias gariepinus* farming.

Table 3.1: Proximate composition of experimental feeds

Parameters	T1	T2	T3	T4
Moisture content	7.30±0.23^{a}	7.70±0.23^{a}	7.90±0.17^{a}	7.80±0.23^{a}
Crude protein content	48.50±1.02^{a}	45.60±0.29^{b}	47.30±0.29^{ab}	43.30±1.00^{a}
Ether Extract content	12.50±0.58^{a}	1.50±0.58^{c}	8.00±0.12^{b}	5.20±0.10^{a}
Ash content	9.00±0.32^{a}	8.00±0.12^{b}	7.50±0.12^{b}	8.00±0.22^{a}
Crude fibre content	1.50±0.06^{c}	3.00±0.12^{a}	2.40±0.17^{b}	3.50±0.07^{a}
Nitrogen free extract	21.20±0.71^{c}	34.20±0.21^{a}	25.23±1.29^{b}	32.30±0.28^{b}

Means ± S. E with different superscripts are significantly different at $p \leq 0.05$.

3.1.2 Growth performance of Clarias gariepinus post fingerlings fed different commercial standard feeds.

The investigation looked at how effectively African catfish post-fingerlings grew and utilized nutrients when fed several commercial standard diets. Four different feed treatments (T1, T2, T3, and T4) were investigated with a predetermined significance level of $p \leq 0.05$ for the comprehensive assessment of multiple parameters and the result presented in Table 3.2.

Notably, concerning final weight, T1 demonstrated the highest weight measurement at 83.94 ± 0.02, while T2 displayed the lowest final weight at 65.94 ± 0.02. Similarly, the pattern persisted for weight gain, with T1 yielding the highest increase at 78.43 ± 0.02, and T2 recording the least gain at 60.42 ± 0.02.

Feed intake also showed significant differences, with T1 having the highest feed intake (110.17±2.76), while T2 had the lowest (91.06±4.05). Furthermore, there was a considerable difference in the feed conversion ratio (FCR) with T3 having the lowest FCR (1.38±0.09), indicating more efficient feed utilization, whereas T1 had the highest FCR (1.40±0.03).

Specific growth rate (SGR) varied among the treatments, with T1 showing the highest SGR (2.40±0.00) and T2 having the lowest (2.15±0.00). Survival rates were generally high across all treatments, with T1 and T3 having the highest survival rates (91.11±2.22), and T2 having the lowest (86.67±3.85).

Table 3.2: *Clarias gariepinus* post-fingerling growth performance on several commercial standard diets.

Parameters	T1	T2	T3	T4
Initial Weight	5.51±0.00^{d}	5.52±0.00^{a}	5.50±0.00^{c}	5.51±0.00^{b}
Final Weight	83.94±0.02^{d}	65.94±0.02^{a}	78.98±0.03^{c}	69.22±0.02^{b}
Weight Gain	78.43±0.02^{d}	60.42±0.02^{a}	73.48±0.02^{c}	63.71±0.02^{b}
Feed Intake	110.17±2.76^{b}	91.06±4.05^{a}	101.63±6.82^{ab}	96.50±2.35^{ab}
FCR	1.40±0.03^{a}	1.51±0.07^{a}	1.38±0.09^{a}	1.51±0.37^{a}
SGR	2.40±0.00^{d}	2.15±0.00^{a}	2.34±0.00^{c}	2.21±0.00^{b}
Survival (%)	91.11±2.22^{a}	86.67±3.85^{a}	91.11±5.88^{a}	88.89±2.22^{a}

Means ± S. E with different superscripts are significantly different at $p \leq 0.05$.

3.1.3 Water quality parameters assessed

Physicochemical parameters of the different treatment groups were assessed and are presented in Table 3. According to the results, there were differences in the mean temperature of the water between the treatments. T3 (Topfeed) had the greatest mean temperature, 24.82 ± 0.15°C, followed by T4 (Bluecrown), 24.73 ± 0.25°C, T2 (Vital Feed), 24.65 ± 0.13°C, and T1 (Coppens), which had the lowest mean temperature. Regarding Dissolved Oxygen levels, T3 recorded the highest mean value (4.73 ± 0.46 mg/L), followed by T4 (4.55 ± 0.42 mg/L), T1 (4.52 ± 0.60 mg/L), and T2 with the lT1 (7.53 ± 0.18), T2 (7.39 ± 0.14), T3 (7.53 ± 0.33), and T4 (7.38 ± 0.15). It is important to note that no statistically significant differences (P > 0.05) were observed in any of the monitored physicochemical parameters of the water throughout the experiment. These results provide valuable insights into the environmental conditions of the experimental setups.

Table 3.3: Water Quality Parameters Assessed during the experimental period

Parameters	T1	T2	T3	T4
Temperature (° C)	24.59±0.39[a]	24.65± 0.13[a]	24.82±0.15[a]	24.73±0.25[a]
Dissolved oxygen (Mg/L)	4.52±0.60[a]	4.51±0.45[a]	4.73±0.46[a]	4.55±0.42[a]
pH	7.53±0.18[a]	7.39±0.14[a]	7.53±0.33[a]	7.38±0.15[a]

Means ± S. E with different superscripts are significantly different at $p \leq 0.05$.

3.2 Discussions

Fish nutrition plays a crucial role in aquaculture, directly influencing the growth and survival rates of fish species [15]. Parameters such as growth metrics, survival rates, and mortality serve as valuable indicators for evaluating the influence of dietary inputs on fish populations and their overall health and productivity [16].

T1 (Coppens) consistently outperformed other feeds in terms of final weight, weight gain, and specific growth rate. This observation aligns with [17] findings, where Coppens demonstrated superior growth and economic benefits. The effective growth observed in fish fed with Coppens fish feed suggests that the feed possesses a well-balanced nutrient composition, as evident from the feed's proximate analysis. Additionally, the notable growth is indicative of high digestibility and efficient nutrient utilization by the fish. The survival rates across all treatments were generally high, consistent with a broader trend observed [13], highlighting the resilience of *Clarias gariepinus* under various feed conditions.

The study also evaluated the physicochemical parameters of the water in which the fish were cultured, including temperature, dissolved oxygen (DO), and pH. These parameters are crucial for the well-being and growth of aquatic organisms, including African catfish. The results showed that the pH and temperature ranges were suitable for catfish production in a cultivated environment [18]. These conditions are essential for the health and development of the fish. However, according to the study, dissolved oxygen (DO) concentrations generally remained low and below the 5 mg/L threshold, which is appropriate for fish development. These low DO levels might have contributed to the recorded mortality during the experimental trial [10]. The low DO concentration can be attributed to the closed environment in which the experiment was conducted, limiting the exchange of atmospheric air.

4. Conclusions

This study sheds light on the critical factors influencing the growth performance and feed utilization of African catfish post-fingerlings when subjected to different commercial standard feeds. The findings emphasize the remarkable influence of feed type on growth parameters, with Coppens exhibiting superior results in weight gain, and SGR compared to other feeds assessed which could be associated with its high nutritional. While the study identified suitable temperature and pH ranges, it highlighted suboptimal dissolved oxygen levels that may have contributed to observed mortalities during the trial. The significance of selecting high-quality, nutritionally balanced feeds in fostering optimal growth and development in African catfish within aquaculture settings is evident. Therefore, to improve African catfish production in aquaculture, feeds with high nutritional content should be selected and also identify cost-effective and efficient feed options for catfish farming.

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