



Research Article

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A Comparative Study of the Growth Performance and Food Utilisation of the African Catfish (*Clarias gariepinus*) Fed Unical Aqua Feed and Coppens Commercial Feed

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Abstract

Growth performance of African catfish, *Clarias gariepinus* fed Unical Aqua feed was carried out as a comparative study with Coppens commercial feed for six months in concrete tanks. Triplicate group of 50 post fingerlings with a mean bulk weight of 0.50 ± 0.02 kg were stocked in three circular concrete tanks, area 16.63m^2 labelled A₁, A₂, A₃, B₁, B₂ and B₃. Fish in units A₁, A₂ and A₃ were fed Coppens feed while fish in units B₁, B₂ and B₃ were fed Unical Aqua feed twice daily at 3% of their body weights. Growth performance indices showed that weight gain (kg), growth rate (GR), specific growth rate (SGR) and mean growth rate (MGR) of *C. gariepinus* fed Unical feed was significantly different ($P < 0.05$) from fish fed Coppens feed. Food utilisation indices showed that fish fed Coppens feed consumed significantly ($P < 0.05$) more feed (66.69 ± 5.09 kg) than fish fed Unical feed (48.84 ± 5.07) whereas food conversion ratio (FCR) was not significantly different ($P > 0.05$). Proximate analysis of the dry matter of the two experimental feeds showed that moisture content, fat content, crude fibre content, ash content, carbohydrate and Caloric value (C/V) were significantly different ($P < 0.05$) while crude protein content was not significantly different ($p > 0.05$). Physicochemical parameters including water temperature ($^{\circ}\text{C}$), pH, dissolved oxygen (mg/L) and ammonia (mg/L) were controlled within the acceptable range for fresh water fish culture. Based on these findings, it was concluded that Unical Aqua feed has competed favourably with Coppens feed in growth performance and food utilisation of *C. gariepinus*. Unical Aqua feed is recommended on the basis of affordability as a substitute for Coppens commercial feed for *C. gariepinus* production.

Keywords: Growth performance; Food utilisation; *Clarias gariepinus*; Unical Aqua feed; Coppens feed

Introduction

The African catfish, *Clarias gariepinus*, belonging to the family Clariidae is one of the most highly desired freshwater food fish and cultivar species in Nigeria due to its ability to tolerate a wide range of environmental conditions and high stocking densities under culture

conditions and relative fast growth [1,2]. Fish culture is a good source of income and employment for hundreds of millions of people around the world. Aquaculture is the fastest-growing animal-food-producing sector, now accounting for almost half of total food fish supply [3].

Fish feed technology is one of the least developed sectors in Nigeria and other developing countries of the world [4]. Coppens commercial feed is an imported floating feed which engulfs 40–60% of operating cost in intensive fish culture in Nigeria [5,6]. Agokei et al. [7] compared five different juvenile *C. gariepinus* feeds including Coppens and concluded that feed with macronutrient combinations of 45% CP, 12% crude fat, crude fiber, 1.5%, Ash 9.5% promoted better growth rates in *C. gariepinus* juveniles as compared with other combinations.

The growth of the fish culture industry in Nigeria has been partly hampered by the high cost of imported feeds. In an effort to address feed availability and cost, the Education Thrust Fund (ETF) donated a multi-million naira feed mill to the University of Calabar fish farm. The objective of this study was to determine and compare the growth performance and food utilisation of *C. gariepinus* fed Unical Aqua feed with fish fed Coppens Commercial feed.

Materials and Methods

Study area

This research work was carried out in the Institute of Oceanography Fish Farm Hatchery complex, University of Calabar which is geographically located within the historic peninsula between the Calabar River and the Great Kwa River with elevation of 41 meters above sea level. This area has Latitude of $04^{\circ}55.9'\text{N}$ and longitude $08^{\circ}26'\text{E}$ respectively with a total surface area of three hectares (3Ha).

Experimental design

This research lasted for six months and was carried out in the Hatchery complex of the Institute of Oceanography, University of Calabar where 3 ETF circular concrete tanks of area 16.63m^2 were used. The three tanks were divided into two equal parts with hard wood covered with tapeline, each giving a total of six experimental units. The six units were labelled A₁, A₂, A₃, B₁, B₂ and B₃ to aid triplication of the experiment. Water volume in each unit was (8.32m^3) . A total of 300 post fingerlings of *C. gariepinus* of mean weight (bulk) 0.50 ± 0.00 kg (10 g for each post fingerling) were collected from the University of Calabar fish farm and stocked in each of the six experimental units (50 in each unit). The stocked fish were acclimated for seven days prior to the start of the feeding trial. During the acclimation period the fish were fed twice daily to satiation. At the start of feeding trial, the acclimated fish were starved for 24 hours, after which the average initial wet body weight of the fish in each experimental unit was measured using a METTLAR MT-5000D electronic balance to the nearest gram (Eyo and Ekanem 2011). Fish in units A₁, A₂ and A₃ were fed with Coppens feed while fish in units B₁, B₂ and B₃ were fed Unical Aqua feed. Feeding was carried out twice daily (9:00 am and 4:00 pm) at 3% of their body weight. Measurement of the fish body weight in each experimental unit was repeated on monthly basis. Physicochemical parameters like dissolved oxygen

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(DO), pH, ammonia and temperature were measured once weekly. Figure 1 shows the schematic representation of the experimental outlay.

Coppens feed composition, characteristics and collection

Coppens feed (42%cp) is composed of high quality ingredients such as marine fish meal, calcium, phosphorus, lysine, methionine, copper sulphate (CuSO₄), selenium refined fish oil and several grains. The combination of these ingredients makes the feed extremely attractive for freshwater fish and also for the promotion of fast growth. Three sizes of Coppens feed (2 mm, 4 mm and 6 mm) were purchased from a fish feed store in Calabar, Nigeria.

Formulation, composition and preparation of Unical Aqua feed

Unical Aqua feed was formulated using pearson square method to 42% crude protein level. Unical Aqua feed is composed of industrial fish meal (IFM), corn powder, and groundnut cake (GNC), soybean meal (SBM), bone meal, lysine, methionine, molasis, wheat flour, vitamin premix and sodium chloride (NaCl) as shown in table 1.

Unical Aqua feed production technology: Unical Aqua feed was produced following the steps outlined below

- i) Weighing of ingredients
- ii) Milling of ingredients
- iii) Mixing of ingredients
- iv) Pelletizing
- v) Cooling
- vi) Collection and storage

- i) **Weighing of ingredients:** Ingredients were weighed in grams as calculated using an electronic scale (Figure 2)
- ii) **Milling of ingredients:** This was carried out in the hammer mill unit of the feed mill (Figure 3). This unit mills ingredient that are classified into two categories i.e. grain-like ingredients such as groundnut, maize, millet, soybean etc and non-powdered ingredients such as wheat offal, rice bran, palm kernel cake etc. The ingredients were poured into the screw feeder bucket where it is screwed into the hammer mill for milling. The cyclone transfers the crushed feed ingredients through the oxbow pipe to Bin 1 where it enters the mixer.
- iii) **Mixing of ingredients:** This was carried out in the mixer unit of the feed mill (Figure 4). The main function of the mixer is

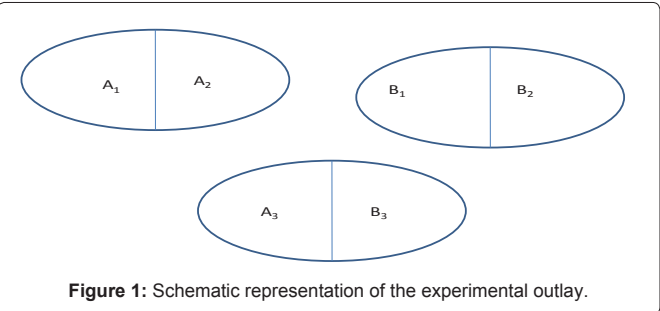


Figure 1: Schematic representation of the experimental outlay.

Table 1: Unical Feed composition in grams per kilograms.

Ingredients	Composition in grams
Industrial fishmeal (IFM)	244.4
Groundnut meal (GNM)	244.4
Soybean meal (SBM)	244.4
Corn meal	206.8
Vitamin premix	10
Bone ash	5
Sodium chloride (NaCl)	5
Lysine	5
Wheat flour	10
Palm oil	10
Molasis	20
Methionine	5
Total	1000g



Figure 2: Sensitive weighing balance used for weighing feed ingredients.



Figure 3: Hammer mill used for milling of feed ingredients.

to mix all the feed ingredients homogenously. The crushed feed ingredients in Bin 1 enters the mixer and also ingredients in powdered form like lysine, NaCl, vitamin premix etc are poured in the screw for mixer where it is screwed into the mixer to be mixed homogenously with other ingredients. When the feed is homogenously mixed and is ready for pelletizing, the control panel will produce an alarm signal indicating that it is ready for pelletizing.

- iv) **Pelletizing:** This helps in producing feed of different sizes depending on the age, size and species of fish to be fed and is carried out in the pelletizing unit of the feed mill (Figure 5). The alarm signal from the control indicates that the mixed feed ingredient is ready for pelletizing. The mixed feed ingredients

will leave the mixer through the bucket elevator to Bin 2 where it is discharged gradually into the inverter before it is discharged into the conditioner. In the conditioner, steam is released from the steam boiler (Figure 6) to steam-cook the feed. After conditioning, the feed enters the screw feeder 2 which feeds the di-ring for pelletizing. The di-ring (Figure 7) determines the size of the feed produced. Its size ranges from 2 mm, 4 mm, 6 mm and 8 mm. Feed sizes produced were 2 mm, 4 mm and 6 mm respectively.

- v) **Cooling:** This is achieved using the cooler (Figure 8). The hot pelletized feed leaves the pelletizer into the bucket elevator 2 through the airlock into the counter flow cooler. In this unit, the extraction fan absorbs all the heat in the system and discharges it outside the feed mill.
- vi) **Collection and storage:** After cooling for about 10 minutes, the cooled pelletized feed is released into the vibrating filter where fine particles in the new feed is filtered and discharged into sacs. The feed is later sundried (Figure 9) to reduce the moisture content preventing the growth of mould and thereafter stored in a cool and dry place.

Proximate analysis of Unical aqua feed and Coppens feed

Proximate analysis of the dry matter of Unical Aqua feed and Coppens feed was performed according to A.O.A.C. [8], in the Department of Biochemistry, University of Calabar.

Growth performance and food utilization indices

This was calculated according to Eyo and Ekanem [9] as follows:



Figure 4: Mixer unit which is used in mixing feed ingredients homogeneously.



Figure 5: Pelletizer used in pelletizing feed to various sizes (2 mm, 4 mm, 6 mm and 8 mm).



Figure 6: Steam boiler unit which produces steam for feed production.



Figure 7: Di-rings used in the pelletizer for pelletizing feed to sizes ranging from 2 mm, 4 mm, 6 mm and 8 mm.



Figure 8: Cooler and feed collection unit where freshly pelleted feed is cooled and collected.



Figure 9: Sun-drying of Unical Aqua feed.

Weight gain (g) is given as final weight (W_2)–initial weight (W_1)
Growth rate (GR) is given as final weight (W_2)–initial weight (W_1)
/No. of days

Where, W_2 =final weight and W_1 =initial weight

Specific Growth Rate (SGR) is given as shown below:

$SGR = \frac{\ln \text{ final weight } (w_2) - \ln \text{ initial weight } (w_1)}{(\text{Number of days}) 100}$

Where, Ln is base of natural logarithm

Mean growth rate (MGR) is given as shown below:

$$M.G.R = [(W_2 - W_1) / 0.5(W_2 + W_1)t] \times 1000$$

Where, t=experimental period in days

Food Consumed (g) is given as $3\% \times \text{body weight} \times \text{No. of days}$
Food Conversion Ratio (FCR) is given as: Feed consumed (g)/Weight gain (g)

Statistical analysis

Data obtained from the growth performance indices and food utilisation indices of fish fed Unical Aqua feed and Coppens feed were subjected to T-test analysis for significant difference using Predictive Analytical Software (PASW) for statistical analysis (version 18.0). Effects with a probability of ($P < 0.05$) were considered significant.

Statement of hypothesis: 1. Null hypothesis (H_0): There is no significant difference in growth performance and food utilization of *C. gariepinus* fed Unical Aqua feed and Coppens commercial feed.

2. Alternative hypothesis (H_1): There is significant difference in growth performance and feed utilization of *C. gariepinus* fish fed Unical Aqua feed and Coppens commercial feed.

Results

Mean proximate analysis of the dry matter of Unical Aqua feed and Coppens feed (mg/100 g)

Mean proximate analysis (Table 2) of the dry matter (mg/100 g) of Unical and Coppens feed shows that moisture content was higher in Unical feed (13.53 ± 0.15) than Coppens (10.02 ± 0.02). Mean crude protein content was also higher in Unical feed (13.30 ± 0.23) than Coppens (11.67 ± 0.15). Mean fat content also followed the same trend with Unical feed showing a higher value (19.03 ± 0.02) than Coppens feed (12.02 ± 0.03). Mean crude fibre content was higher in Coppens feed (1.43 ± 0.21) than Unical feed (0.6 ± 0.1). Mean ash content was higher in Coppens feed (15.27 ± 0.21) than Unical feed (12.4 ± 0.2). Mean carbohydrate content was higher in Coppens feed (49.58 ± 0.29) than Unical feed (41.14 ± 0.27). Mean caloric value (C/V) was also higher in Unical feed (388.97 ± 0.59) than Coppens feed (353.21 ± 1.51).

Mean growth performance indices *C. gariepinus* fed Unical Aqua feed and Coppens feed

Indices used to evaluate the growth performance (Table 3) of *C. gariepinus* fed Unical feed and Coppens feed were weight gain (kg), growth rate (GR), specific growth rate (SGR) and mean growth rate (MGR). The weight gain was higher in fish fed Coppens feed (25.37 ± 0.99 kg) than fish fed Unical feed (19.60 ± 1.67 kg). Growth rate (GR) was also higher in fish fed Coppens feed (139.38 ± 5.42 g/day) than

Table 3: Mean growth performance and food utilisation indices of *C. gariepinus* fed Unical and Coppens feed.

	Unical Feed	Coppens Feed
Mean initial weight (kg)	0.5 ± 0.02	0.50 ± 0.01
Mean final weight (kg)	20.10 ± 1.67	25.87 ± 0.99
Mean weight gain (kg)	19.60 ± 1.67^a	25.37 ± 0.99^b
Growth rate (g/day)	107.69 ± 9.22^a	139.38 ± 5.42^b
Mean SGR(%/day)	2.03 ± 0.06^a	2.18 ± 0.03^b
Mean MGR(mg/day)	10.45 ± 0.06^a	10.57 ± 0.02^b
Food consumed (kg)	48.84 ± 5.07^a	66.69 ± 5.09^b
Food conversion ratio (FCR)	2.43 ± 0.05^a	2.57 ± 0.09^a

Mean with the same superscript are not significantly different ($P > 0.05$).

fish fed Unical feed (107.69 ± 9.22 g/day). Specific growth rate (SGR) was also higher in fish fed Coppens feed ($2.18 \pm 0.03\%/day$) than fish fed Unical feed ($2.03 \pm 0.06\%/day$). Mean growth rate (MGR) followed the same trend with fish fed Coppens feed showing higher value (10.57 ± 0.02 mg/day) than fish fed Unical feed (10.45 ± 0.06 mg/day).

Mean food utilisation indices of *C. gariepinus* fed Unical Aqua feed and Coppens feed

Mean food utilisation indices (Table 3) evaluated includes food consumed and food conversion ratio (FCR). Fish fed Coppens feed consumed more food (66.69 ± 5.09 kg) than fish fed Unical feed (48.84 ± 5.07). Fish fed Unical Aqua feed had a better food conversion ratio (2.43 ± 0.05) than fish fed Coppens feed (2.57 ± 0.09).

Water quality parameter

Water quality (Table 4) analysis showed that in experimental units fed Unical Aqua feed, mean pH ranged between 6.54 ± 0.03 in week 0 to 7.31 ± 0.08 in week 16 while in experimental units fed Coppens feed, mean pH ranged between 6.87 ± 0.07 in week 0 to 7.24 ± 0.17 in week 6. Mean dissolved oxygen ranged between 4.83 ± 0.35 mg/L in week 18 to 5.87 ± 0.23 mg/L in week 6 in experimental units fed Unical feed while in experimental units fed Coppens feed, dissolved oxygen ranged between 4.97 ± 0.21 mg/L in week 4 and 22 to 5.57 ± 0.11 mg/L in week 6. In experimental units fed Unical feed, mean water temperature ranged between $30.04 \pm 0.44^\circ\text{C}$ in week 4 to $31.30 \pm 0.17^\circ\text{C}$ in week 24 while in experimental units fed Coppens feed, mean water temperature ranged between $29.73 \pm 0.84^\circ\text{C}$ in week 0 to $30.93 \pm 0.49^\circ\text{C}$ in week 24. Mean ammonia level ranged between 0.00 ± 0.00 mg/L in week 8 to 0.53 ± 0.12 mg/L in week 14 in experimental units fed Unical feed while in experimental units fed Coppens feed, mean ammonia level ranged between 0.00 ± 0.0 mg/L in week 14, 16, 20 and 22 to 0.37 ± 0.06 mg/L in week 6.

Discussion

Fish feed is a major input in fish culture business and has remained a principal constraint to fish farmers in Nigeria and other developing countries because of high cost and availability [4]. Fish like other animals, has a requirement for essential nutrients for growth, reproduction repairs, etc. In the present study, the experimental fish responded positively to Unical feed and Coppens feed as indicated in their growth performance indices (weight gain, length gain, specific growth rate, mean growth rate). Growth performance indices evaluated in the present study showed that weight gain (kg),

Table 2: Mean proximate analysis of the dry matter (mg/100 g) of Unical Aqua feed and Coppens feed.

	Unical Feed	Coppens Feed
Mean moisture content	13.53 ± 0.15^a	10.02 ± 0.02^a
Mean Crude protein content	13.30 ± 0.23^a	11.67 ± 0.15^a
Mean fat content	19.03 ± 0.02^a	12.02 ± 0.03^a
Mean crude fibre content	0.6 ± 0.1^a	1.43 ± 0.21^a
Mean ash content	12.4 ± 0.20^a	15.27 ± 0.21^a
Mean Carbohydrate	41.14 ± 0.27^a	49.58 ± 0.29^a
Mean caloric value (J/g)	388.97 ± 0.59^a	353.21 ± 1.51^a

Mean with the same superscript are not significantly different ($P > 0.05$)

Table 4: Mean water quality parameters.

Weeks	Unical feed				Coppens feed			
	pH	DO (mg/L)	Tempt. (°C)	NH ₃ (mg/L)	pH	DO (mg/L)	Tempt. (°C)	NH ₃ (mg/L)
Week 0	6.54 ± 0.03	5.37 ± 0.21	30.37 ± 0.31	0.30 ± 0.0	6.87 ± 0.07	5.2 ± 0.20	29.73 ± 0.84	0.1 ± 0.17
Week 2	6.79 ± 0.02	5.03 ± 0.06	30.0 ± 0.20	0.23 ± 0.06	6.93 ± 0.09	5.03 ± 0.06	29.93 ± 0.15	0.27 ± 0.06
Week 4	7.02 ± 0.03	5.33 ± 0.12	30.0 ± 0.44	0.30 ± 0.00	6.97 ± 0.02	4.97 ± 0.21	30.23 ± 0.31	0.30 ± 0.00
Week 6	6.98 ± 0.05	5.87 ± 0.23	30.43 ± 0.12	0.30 ± 0.00	7.24 ± 0.17	5.57 ± 0.11	30.17 ± 0.15	0.37 ± 0.06
Week 8	6.99 ± 0.06	5.47 ± 0.16	30.37 ± 0.21	0.00 ± 0.00	7.02 ± 0.06	5.40 ± 0.10	30.20 ± 0.25	0.20 ± 0.17
Week 10	7.31 ± 0.05	5.73 ± 0.12	30.83 ± 0.29	0.30 ± 0.00	7.21 ± 0.06	5.53 ± 0.06	30.57 ± 0.06	0.30 ± 0.00
Week 12	7.25 ± 0.06	5.13 ± 0.16	30.57 ± 0.23	0.30 ± 0.00	7.22 ± 0.08	5.13 ± 0.06	30.23 ± 0.06	0.30 ± 0.00
Week 14	6.98 ± 0.12	5.1 ± 0.35	30.87 ± 0.40	0.53 ± 0.12	7.04 ± 0.06	5.20 ± 0.27	30.53 ± 0.12	0.00 ± 0.00
Week 16	7.31 ± 0.08	5.20 ± 0.17	30.03 ± 0.40	0.30 ± 0.00	7.07 ± 0.13	5.33 ± 0.29	30.23 ± 0.23	0.00 ± 0.00
Week 18	7.29 ± 0.04	4.83 ± 0.35	30.77 ± 0.23	0.23 ± 0.21	7.11 ± 0.12	5.27 ± 0.06	30.17 ± 0.29	0.30 ± 0.00
Week 20	7.09 ± 0.04	5.23 ± 0.06	30.57 ± 0.06	0.50 ± 0.17	7.24 ± 0.17	5.37 ± 0.15	30.30 ± 0.17	0.00 ± 0.00
Week 22	7.14 ± 0.16	5.27 ± 0.06	30.10 ± 0.36	0.3 ± 0.0	6.98 ± 0.03	4.97 ± 0.21	30.43 ± 0.12	0.10 ± 0.17
Week 24	7.30 ± 0.10	5.03 ± 0.06	31.30 ± 0.17	0.30 ± 0.00	7.22 ± 0.18	5.33 ± 0.29	30.93 ± 0.49	0.00 ± 0.00

growth rate (GR), specific growth rate (SGR) and mean growth rate (MGR) of *C. gariepinus* fed Unical Aqua feed was significantly different ($P < 0.05$) from fish fed coppens feed. Results obtained in the present study agree with De Silva et al. [10] who opined that the quality of a feed is a function of how well that feed meets the nutrient requirement of an animal. The growth performance of fish fed the two experimental diets is an indication that the two feeds have met the nutritional requirements of *C. gariepinus* in a culture system without any insignificant ($P > 0.05$) variation between them. The results have also indicated bio-availability of nutrients from the two fish diets. According to [9,11], availability of nutrients in a diet that is effectively digested is a key component of fish feed.

In the present study, it was observed that fish fed Coppens feed responded more aggressively to the feed than fish fed Unical Aqua feed during the experiment. This could be attributed to the differences in composition of the two experimental diets. Coppens feed has a more fishy odour that makes it very inviting to fish and also its floatable nature, whereas, Unical Aqua feed has less fishy odour and it was made to sink. This observation agrees with Agokei et al. [7] who reported that commercial fish feeds such as Coppens, Multifeed, Vital and Euro, emits stronger fishy odours and considering the fact that *C. gariepinus* makes use of the olfactory senses during feeding. However, there was significant difference ($P < 0.05$) in the amount of feed consumed at the end of the feeding time between the two feeds which also reflected in their varying growth performances as observed in this study.

In fish nutritional studies, the amount of feed consumed is a crucial factor for calculating food conversion ratio (FCR). Since feed is expensive, feed conversion ratio (FCR) is an important parameter for the determination of effective use of feed [9]. The proper understanding of FCR help the farmer to feed the fish to satiation, and when fish are fed exactly the quantity of feed required, they are not stressed and they provide high quality meat for human consumption [12-17].

In the present study, fish fed Coppens feed consumed significantly ($P < 0.05$) more feed (66.69 ± 5.09 kg) than fish fed Unical feed (48.84 ± 5.07). According to Ekanem et al. [18] growth and feed conversion ration of a fish is remarkable tool to compute the acceptability of artificial feed. However, FCR of fish fed Unical feed was non-significantly different ($P > 0.05$) from fish fed coppens feed although, fish fed Unical feed had a better food conversion ratio (2.43 ± 0.05) when compared to fish fed Coppens feed (2.57 ± 0.09).

Results from the growth performance also indicated that fish fed the two experimental feed were optimally fed. According to Dwyer et al. [19] both over-and under-feeding may also affect the specific growth rates and the efficiency of feed conversion. According to Priestly et al. [20] over-and under-feeding can be detrimental to the health of the fish and may cause a marked deterioration in water quality, reduced weight, poor food utilization, and increased susceptibility to infection. According to Ng et al. [21] overfeeding disrupts the water quality leading to low dissolved oxygen levels, increased biological oxygen demand, and increased bacterial loads. In the present study, physicochemical parameters of water (temperature, pH and dissolved oxygen and ammonia) were within the acceptable range for fish growth and health [22,23].

Summary and Conclusion

The present study has shown significant difference ($P < 0.05$) in growth performance and food consumed between fish fed Coppens commercial feed and Unical Aqua feed. The implication of the result is that Unical Aqua feed can be used for raising *C. gariepinus* in a culture system instead of Coppens without comprising their growth performances. Unical Aqua Feed is more cost effective for fish farmers than Coppens which is two times more expensive. Moreover, coppens is an imported fish feed while Unical feed is an indigenous feed utilizing locally available materials. Unical Aqua feed is recommended for *C. gariepinus* production on the basis of affordability without compromising their growth performances.

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