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VOLUNTARY FEED INTAKE AND GROWTH RESPONSE OF *Clarias gariepinus* FINGERLINGS TO *ad libitum*

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ABSTRACT

The research was carried out to evaluate the establishment of ad libitum by weight in the nutrition of Clarias gariepinus fingerlings. Ninety (90) fingerlings were procured from a commercial Fish Farm and used for the study in a completely randomized design. C. gariepinus fingerlings were stocked at ten fish per square meter density for 3 different feeds (Aller aqua as T1, Coppensas T2 and Skretting as T3) and each treatment replicated thrice and fed ad-libitum for 56 days. The result showed that protein efficiency ratio differed significantly at 42 days feeding while average weight gain and average final weight varied significantly at 56 days after feeding. Average final weight gain (AWG) of Skretting (79.87±0.12g), Coppens feed (47.19±0.13) and Aller aqua feed (75.81±3.28); feed conversion ratio of Skretting feed (1.19±0.11) followed by Aller aqua (1.14±0.14) and Coppens (1.05±0.14); survival rate (ranging from 80.00±1.00 to 86.67±0.88); weight gain range of 232.00±32.63g (Coppens) to 362.00±57.41 (Aller aqua.) Skretting recorded better growth performances at 42 and 56 days. The result showed that Skretting and Aller aqua feeds are best for rearing fingerling at ad-libitum feeding regime. However there is need to investigate the originality of the brand of Coppens feed used.

Key words: *Voluntary feed intake, ad libitum, Clarias gariepinus*

INTRODUCTION

African Catfish constitute an excellent food fish of high commercial value. The advantage of *Clariasgariepinus* as an Aquaculture candidate cultured in many parts of the world is in its ability to withstand adverse environmental conditions, utilize atmospheric oxygen and effectively convert different feedstuff to flesh (Okomoda, 2018). It is very important to sustainability of aquaculture industry in Nigeria (Owodeinde and Ndimele, 2011). Catfish (*C. gariepinus*) is one of the most important groups of farmed fishes in the world; it commands a very good commercial value in Nigeria markets (Ayinla, 2003). It has the potential to grow and develop on a wide range of both artificial and natural feed. It has a very high yield potential, tolerance to low oxygen and has the capacity to grow fast in both intensive and extensive culture system according to Anene *et al*., 2012. Cat fish produces thousands of

eggs in a breeding period; withstand both handling and environmental stress (Ochokwu, *et al*., 2019). Ochokwu, *et al*., (2019) also reported its ability to withstand disease, tranquility and many other adverse conditions that can kill some species of fish. Catfish are very popular to fish farmers and consumers in Nigeria.

The response of fish to feeding and its utilization of feed can be greatly influenced by its stage of biological development as well as the timing of feeding per day (Quaglino*et al*., 1988). Feed management in terms of optimization (feeding rate and frequency) has become a crucial area of study in the culture of many aquaculture species (Priestly *et al*., 2006; Tiamiyu *et al*., 2018). A proper feeding practice involves providing a cost-effective foodstuff at the right time(s), in the proper amounts, and in the proper form for the optimal growth of the fish. Both over and underfeeding can be detrimental to the production of fish. The former may cause a marked deterioration in water quality (decrease dissolved oxygen and increase ammonia content), reduced growth/food utilization, and increase susceptibility to infections (due to increased susceptibility to infectious disease by stress through poor water quality) (Schnaittacher*et al*., 2005). Underfeeding on the other hand has a direct impact on production time because fishes are partially starved in this process (Küçük*et al*., 2013; Oh and VenmathiMaran, 2015). Hence, by identifying the optimum feeding regimes, farmers can successfully optimize production time, maximize feed utilization, improve the rearing environment (water qualities) and facilitates the production of even sized fish (Silva *et al*., 2007; Oh and VenmathiMaran, 2015). These regimes may differ for different species, size/age, feed composition, and rearing environment (Xie *et al*., 2011).

Previous studies on *C.gariepinus* fingerlings showed that growth and survival were significantly increased when the fish were fed twice daily, (Marimuthu *et al*., 2010) however, larvae growth were not affected by feeding either three or six time per day (Kaiser *et al*., 1995). Hence, there is a need to ascertain optimum feeding requirement for different species as well as for different stages of development of different fishes. More so, the determination of the right feeding requirement for the *C. gariepinus* could further help reduce cannibalism which is responsible for a significant portion of the mortality observed during the rearing of this fish (Olufeagba and Okomoda, 2016). Studies on *C. gariepinus* fry and fingerlings have shown that feeding frequencies can

affect growth; survival and social interactions and when *ad-libitum* feeding are employed, waste and increased production is inevitable if not properly regulated (Hossain *et al*., (2001); Marimuthu *et al*., 2010). In the same light, body composition such as protein and fats have been shown to significantly increased with increasing feeding frequency and best in *ad-libitum* feeding in species like Jade Perch (*Scortum barcoo*) and striped snakehead (*Channa striatus*), (Al-Khafaji *et al*., 2017 and Muntaziana *et al*. 2017). The current study, is therefore, designed to establish the voluntary feed intake by fish when fed *ad-libitum,*to investigate if *ad-libitum* varies with type of feed and to assess the time variation of *ad-libitum* in fish production.

MATERIALS AND METHODS

Experimental Area

The experiment was carried out in Teaching and Research Farm Department of Fisheries and Aquaculture Ebonyi State University, Abakaliki. Ebonyi state is located on latitude 6º 18' 58" (6º 18' 97) North of the Equator and longitude 8º 7' 0" (8º 7' 1) E and an altitude of 123m. It has an average annual rain fall of about 1613.8mm to 2136.27mm with maximum temperature of 27º to 30^0C. The rainy season run from April through October, while the dry season commences November and ends in March. The driest months of the year are January and February when the relative humidity drops to 13% (Diagi and Weli, 2017).

Collection and Acclimation of Experimental Fish

Ninety (90) fingerlings of *C. gariepinus* fingerlings were procured from ChiboyFish Farm, in Ebonyi State, Nigeria. The fish was transported in plastic troughs (50 cm diameter × 30 cm deep) to teaching and research fish farm of Department of Fisheries and Aquaculture, Ebonyi State University. The fingerlings were acclimatized for 2 days (48hours) in 10 m^2 concrete pond.

Experimental Design

Water was sourced from the experimental site. The experiment was laid out in a completely randomized design. Ten (10)*C. gariepinus* fingerlings were stocked per pond for 3 different feeds that were used. The experimental diet was assigned randomly to the tanks and each group of fish was fed at ad- for 56 days. Every week, all the fish were batch-weighed to determine the growth performance.

The three commercial feeds (Aller aqua, Coppens and Skretting) were sourced from

the Margaret Umahi International Market, Abakalkiki. The quantity to be given to the fish will always be weighed before and the remnants also collected and weighed when the fingerlings have fed to their satisfaction.

Weight Measurement

The initial body weight of each set of fish was measured using sensitive weighing balance before stocking and subsequently bulk weighing of the fish in each tank was done at two weeks interval. The length measurementwas carried out to the nearest centimeters using a measuring board graduated in centimeters. The total weight was measured in grams using Ohaus electric weighing balance of 500 capacity.

Weight gain (g) = Final weight – Initial weight

Feed fed = Total feed adminstered

Survival and Mortality

The survival and mortality of fish in each treatment was monitored by counting the mortalities on a daily basis

$$\% \text{ Survival} = \frac{\text{Number of stocked fingerlings}}{\text{Total number of fingerlings after 56 days}} \times 100$$

Specific Growth Rate (SGR)

This is the mean percentage increase in body weight per day over a given time interval (22). In this study the time interval was 14 weeks.

$$\text{SGR} = \frac{\text{Ln weight at the time of observation} - \text{Ln initial weight}}{\text{Duration of experiment in days}} \times 100$$

Where Ln = natural log

Feed Conversion Ratio (FCR)

The efficiency of a feed is normally measured by the amount necessary to produce a unit weight of fish. This is called the feed conversion ratio.

$$\text{FCR} = \frac{\text{Total dry feed consumed (g)}}{\text{Total Wet weight gain (g)}}$$

Protein Efficiency Ratio (PER)

This is the efficiency with which the fish utilizes dietary protein and is defined by the equation.

$$\text{PER} = \frac{\text{wet weight gain by fish (g)}}{\text{Weight of crude protein fed}}$$

Statistical Analysis

Data collected was analyzed statistically using the Generalized Linear Model (GLM) procedure of SAS (Statistical Analysis System) version 8, 1999 as reported by Tame*et.al* (2013); Means was separated using FLSD (0.05).

RESULTS AND DISCUSSION

Growth Parameters and Feed Utilization of fish fed *ad-libitum* after 14 days

The growth and feed utilization parameters measured within the span of 14 days is presented in Table 1 below. The result in table 1 showed all the parameters assessed did not differ (P>0.05) significantly among the treatment means. The final weight gain ranged from 113.00±12.50 to 145.67±3.48, with aller aqua feed and Skretting feed recording the highest and lowest weight respectively. The highest average weight of fish after 14 days was recorded by Aller aqua (40.90±7.04), followed by skretting (39.49±7.85) while coppens recorded the lowest average fish weight of 29.09±4.45. The specific growth rate of the three treatments ranged from -4.23±0.11 to -3.96±0.13 with skretting and aller aqua recording the highest and lowest specific growth rate respectively. The feed conversion ratio was in the decreasing order of aller aqua (0.70±0.01)>skretting feed (0.65±0.06) >coppens feed (0.56±0.06). Similarly, the average weight gain of the fishes from the three treatments ranged from 28.68±4.43 (coppens) to 40.53±7.04 (Aller aqua) while skretting recorded AWG of 39.11±7.84. While weight gain (WG) was in increasing order of Coppens (123.17±15.38) <Skretting (109.50±12.50) <aller aqua (142.17±3.48). The quantity of feed fed among the three treatment showed that aller aqua recorded the highest feed fed to the fishes (54.21±14.09) followed by skretting (53.06±12.62) while coppens recorded the lowest feed fed to the fishes after 21 days (33.55±7.37). The PER of the three treatments was in an increasing order of coppen<skretting<Aller aqua (0.68±0.09, 1.07±0.18 and 1.09±0.16 respectively). In the same vein, the voluntary feed intake of the fishes was highest with aller aqua feed followed by skretting and coppens.

Table 1: Growth Parameters and Feed Utilization of fish fed *ad libitum* after 14 days

Parameters	Aller aqua	Coppens	Skretting
Final weight (g)	145.67±0.28	126.67±0.38	113.00±0.20
Average final weight (g)	40.90±0.04	29.09±0.15	39.49±0.15
Specific growth rate	-3.96±0.13	-4.12±0.13	-4.23±0.11
Feed conversion ratio	0.70±0.01	0.56±0.06	0.65±0.06
Average weight gain (g)	40.53±0.04	28.68±0.43	39.11±0.04
Weight gain (g)	142.17±0.18	123.17±0.38	109.50±0.10
Feed fed	54.21±0.09	33.55±0.37	53.06±0.22
Survival rate (%)	93.33±3.33	85.00±0.38	91.67±0.24
Protein efficiency rate	1.09±0.16	0.68±0.09	1.07±0.18
Voluntary feed intake	65.01±0.99	50.89±0.63	59.18±0.02

Means ± standard error, values across rows without statistical indicator (alphabet letters) indicate no significant differences at 0.05.

Growth Parameters and Feed Utilization of fish fed *ad-libitum* after 28 days

The growth and feed utilization parameters measured within the span of 28 days is presented in Table 2 below. The result revealed that all the parameters assessed were not significantly different among the treatment means, however, Aller aqua feed recorded the highest mean value for most of the evaluated parameters. The final weight of fishes after 28 days showed that Aller aqua recorded the highest final weight followed by Skretting while Coppens recorded the lowest final weight of fishes after 28 days. Similarly the average fish weight was in the decreasing order of aller aqua >Skretting >Coppens. The specific growth rate also followed the same trend with Aller aqua recording the highest SGR followed by Skretting and Coppens. The highest feed conversion ratio was recorded by skretting feed followed by Aller aqua and Coppens. The three treatment recorded good survivability after 28 days in the increasing order of coppens<skretting<aller aqua. The highest feed fed was recorded by aller aqua feed, followed by Skretting feed while Coppens feed recorded the lowest feed fed to the fishes. The protein efficiency rate was highest at Aller aqua and skretting while coppens recorded a PER less than 1. The voluntary feed intake of the three treatment showed that skretting feed recorded the highest VFI followed by Alaquer and Coppens respectively.

Table 2: Growth Parameters and Feed Utilization of fish fed *ad-libitum* after 28 days

Parameters	Aller aqua	Coppens	Skretting
Final weight (g)	204.50±0.18 [a]	153.00±0.18 [b]	166.50±0.14 [c]
Average final weight (g)	49.69±0.22 [a]	34.57±0.02 [b]	48.74±0.31 [a]
Specific growth rate	0.80±0.13 [a]	0.52±0.12 [b]	0.58±0.16 [b]
Average weight gain	49.29±0.21 [a]	34.13±0.08[b]	48.34±0.38 [a]
Feed conversion ratio	0.81±0.09 [a]	0.66±0.09[b]	0.93±0.14 [a]
Survival rate (%)	91.11±0.42 [a]	80.00±0.37[b]	90.00±0.29 [a]
Weight gain (g)	201.00±0.18 [a]	149.50±0.78 [b]	163.00±0.34 [c]
Feed fed	68.95±0.17 [a]	42.49±0.03 [b]	68.35±0.24 [a]
Protein efficiency rate (PER)	1.09±0.16 [a]	0.68±0.09 [b]	1.07±0.19 [a]
Voluntary feed intake (VFI)	76.36±0.33 [a]	61.12±0.39 [b]	87.40±0.17 [a]

Means ± standard error, values across rows without statistical indicator (alphabet letters) indicate no significant differences at 0.05.

Growth Parameters and Feed Utilization of fish fed *ad libitum* after 42 days

The result presented in Table 3 showed the protein efficiency rate (PER) of the feed evaluated were significantly ($P<0.05$) different among each other after 42 days. Aller aqua feed recorded the highest PER and varied significantly ($P<0.05$) from Coppens feed but did not differ significantly from skretting feed. The mean value for Skretting and Coppens were also significantly similar. Outside the PER, all other parameters assessed were not significantly different among the treatment means. Aller aqua feed recorded the highest mean value final weight of fishes after 42 days while Coppens recorded the lowest final weight of fishes after 42 days. Similarly the average fish weight after 42 days was in the decreasing order of Skretting >aller aqua >Coppens. The specific growth rate Aller aqua recording the highest SGR followed by skretting and Coppens. The average weight gain with Coppens recorded the lowest AWG while skretting feed recorded the highest average weight gain a little above Aller aqua. The highest feed conversion ratio was recorded by Skretting feed followed by Aller aqua and Coppens. The three treatment recorded good survivability after 42 days with coppens recording the lowest survival rate while aller aqua and skretting recorded the same survival rate (88.33%). The highest weight was scored by Coppens followed by Aller aqua and lastly Skretting respectively after 42 days. The highest feed fed was recorded by aller aqua feed, followed by skretting feed while coppens feed recorded the lowest feed fed to the fishes. The protein efficiency rate was highest at Aller aqua and skretting while

Coppens recorded a PER less than 1. The voluntary feed intake of the three treatment showed that Skretting feed recorded the highest VFI followed by Aller aqua while Coppens recorded the lowest voluntary feed intake as shown below:

Table 3: Growth Parameters and Feed Utilization of fish fed *ad libitun* after 42 days

Parameters	Aller aqua	Coppens	Skretting
Final weight (g)	283.33±0.42[a]	188.22±0.23[b]	239.22±0.18[c]
Average final weight (g)	60.83±0.04 [a]	40.84±0.15[b]	61.31±0.14 [a]
Specific growth rate	2.56±0.16 [a]	2.20±0.12 [b]	2.37±0.18 [a]
Survival rate (%)	88.33±0.40 [a]	78.33±0.40[b]	88.33±0.40 [a]
Feed conversion ratio	0.96±0.19 [a]	0.89±0.14 [a]	1.12±0.13 [b]
Average weight gain (g)	60.42±0.02 [a]	40.39±0.84 [b]	60.91±0.02 [a]
Weight gain (g)	279.83±0.33 [a]	184.72±0.43 [b]	235.72±0.18 [c]
Feed fed	91.29±0.09 [a]	56.17±0.19 [b]	88.57±71.89 [a]
Protein efficiency rate	6.22±0.97[a]	3.69±0.46[b]	5.24±0.91[ab]
Voluntary feed intake	91.04±1.01 [a]	84.56±1.39 [b]	106.39±1.37 [c]

Means ± standard error, values across rows with statistical indicator (alphabet letters) indicate significant differences at 0.05.

Growth Parameters and Feed Utilization of fish fed *ad libitum*after 56 days

The result presented in Table 4 shows the growth parameters and feed utilization of fish fed *ad-libitum* after 56 days. The result showed that there exists a significant (P<0.05) difference on the effect of three feed types fed to fishes with respect to average final weight. Skretting feed recorded the highest average final weight. This was similar statistically with Aller aqua feed while both feeds differed significantly (P<0.05) from Coppens. Similarly, the average weight gain of the treatments was significantly (P<0.05) different among each other after 56 days. Skretting feed recorded the highest AWG and varied significantly from coppens feed but did not differ significantly from Aller aqua feed. All other parameters assessed were not significantly different among the treatment means. Aller aqua feed recorded the highest mean value final weight of fishes after 56 days followed by Skretting while coppens recorded the lowest final weight of fishes. The highest feed conversion ratio was recorded by Skretting feed followed by Aller aqua and Coppens. The three treatments also recorded good survivability after 56 days with Skretting recorded the same survival rate.

The highest feed fed was recorded by aller aqua feed, followed by Skretting feed while coppens feed recorded the lowest feed fed to the fishes. The protein efficiency rate was highest at Aller aqua followed by Skretting.

The voluntary feed intake of the three treatment showed that skretting feed recorded the highest VFI followed by Aller aqua while Coppens recorded the lowest voluntary feed intake as shown below:

Table 4: Growth Parameters and Feed Utilization of fish fed *ad libitum* after 56 days

Parameters	Aller aqua	Coppens	Skretting
Final weight (g)	365.50±0.22 [a]	235.50±0.12 [b]	351.25±0.32 [a]
Average final weight (g)	75.77±0.27[a]	47.19±0.13[b]	79.87±0.12[a]
Specific growth rate	3.52±0.17 [a]	3.12±0.14 [b]	3.41±0.21 [a b]
Feed conversion ratio	1.14±0.14	1.05±0.14	1.19±0.11
Weight gain (g)	362.00±0.41 [a]	232.00±0.13 [b]	347.75±0.15 [a]
Average weight gain (g)	75.81±0.28[a]	47.21±6.73[b]	79.87±0.02[a]
Feed fed	126.41±0.25 [a]	67.04±0.14 [b]	114.67±0.16 [a]
Protein efficiency rate	8.04±1.27 [a]	4.64±0.65 [b]	7.78±0.38 [a]
Survival rate (%)	80.00±1.00 [a]	80.00±1.00 [a]	86.67±0.88 [a b]
Voluntary feed intake	91.04±0.01 [a]	84.56±0.19 [b]	106.39±0.37 [c]

Means ± standard error, values across rows with statistical indicator (alphabet letters) indicate significant differences at 0.05.

Fish feed is among the most critically important factors influencing the ability of cultured fish to grow profitably in a fish farm (Ereiegha, 2017). According to Marimuthu*et al*. (2010) feeding frequency and type can strongly affect the ingestion of feed and nutrient absorption hence influencing the growth performance of fish. The present study showed variations in the parameters assessed with respect to the three commercial feed sources. However, there were no significant differences on all the parameters (Final weight (g), Average final weight (g), Specific growth rate, Feed conversion ratio, Average weight gain (g), Weight gain (g), Feed fed, Survival rate (%), Protein efficiency rate, Voluntary feed intake) evaluated at 14 and 28 days for the three feed sources but protein efficiency rate (PER) was statistically ($P<0.05$) different after 42 days while average final weight and average weight gain were significant after 56 days of feeding the fishes.

At all stage of evaluation (14, 28, 48 and 56 days) the result shows that Aller aqua feed recorded the highest mean values for most parameters followed by Skretting feed while coppens feed recorded the lowest values.

Skretting feed showed the best FCR at 28, 42 and 56 days bud did not vary from Aller aqua and Coppens. Feed conversion ratio (FCR) is a measure of how well a flock converts feed intake (feed usage) into weight gain. It is also the ability of the livestock to turn feed mass to body mass. Adeyemo *et al*. (2017) reported that comparison of feed conversion ratio among treatment groups may be of little significance unless the feeds involved are of similar quality and suitability. According Sawhney and Gandotra (2010) food conversion efficiencies in fish increased with increasing protein in the diet, hence the study suggest that coppens feed have lower protein in the diet having recorded low FCR. (Houlihan *et al*., 2001) opined that feed conversion ratios vary among fish species, sizes and activity levels of fish, environmental parameters and the culture system used. The result showed that Skretting feed expressed better survival rate followed by Aller aqua and coppens. The different survival rates recorded might be due to the culture medium created by feed dissolution (Otubusin, 2000) as well the quality of feed. The survival rate recorded was however lesser than that reported by Osofero *et al*. (2007) who recorded high survival rates ranging from 98.5–99.5% in cage culture system.

The final weight, average final weight (AFW), weight gain, and average weight gain (AWG) all differed among the feed types. The result showed that both Aller aqua and coppens significantly recorded higher average weight gain and average final weight when compared to coppens. Aller aqua recorded earlier high AFW and AWG till 28 days but was overtaken by skretting feed for the remaining duration (42 and 56 days). This could be as a result of feed quality which enhanced the conversion efficiency. According to De Silva and Anderson (1995), the quality of a feed is a function of how well that feed meets the nutrient requirement of a fish. The differences in growth performance amongst treatments could be attributed to the differences in the nutritional composition of the feed used (Mustapha *et al*., 2014). The low weight gain for fishes fed with coppens could be due to high level of fiber content in feed which slows the growth of *C. gariepinus*. (Agbabiaka *et al*., 2013). Agokei *et al*. (2011) reported a significant highest growth performance of *C. gariepinus* juveniles in the diet that contained < 2% fiber content. Growth performances is proportional to quality feed intake. The fishes placed on Coppens feed recorded slow feed intake when compared to other feed source. This could be as a

result of low palatability, poor texture, aroma and other acceptability factor of the feed (Rishabh *et al*., 2017). The result was not in consonant with the work of Wokeh *et al*., 2021 who reported that the growth performance of African catfish (*Clarias gariepinus*) fed different standard feeds revealed that fish fed with Coppens performed better in growth response than Multifeed and Vital feeds. This performance in growth was because of crude protein content as shown in the proximate analysis result.

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