E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2020; 8(1): 20-24

www.fisheriesjournal.com
Received: 12-11-2019
Accepted: 16-12-2019

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A comparison of the growth of the Nile tilapia (*Oreochromis niloticus*, Linnaeus, 1758) fingerlings fed blue crown® and Skretting®

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Abstract
A comparison of the growth of the Nile tilapia (*Oreochromis niloticus*) fingerlings fed with Blue crown® and Skretting® commercial feeds was studied for a period of 8 weeks. A total of sixty fingerlings of *Oreochromis niloticus* were used. The treatments showed significant difference ($p< 0.05$) in terms of the mean final weights of 5.23±0.01 to 5.32±0.01 for Blue crown® and Skretting® respectively and gain in total length by the fish with values ranging from 0.93±0.03 to 1.13±0.03 for Blue crown® and Skretting®. The SGR, GR, MFTL, MFSL, FCE and FCR showed no significant difference ($p>0.05$) between the two feeds. Some water quality parameters assessed during the experiment indicated that only the dissolved oxygen was significantly different between the two treatments ($p< 0.05$) with values ranging from 4.44±0.04 (Blue crown®) to 4.58±0.04 (Skretting®). Since the growth of the fingerlings in both feed treatments did not differ when compared, it is inferred that the two feeds can be used in the culture of this species of fish.

Keywords: Blue crown®, skretting®, *Oreochromis niloticus*, fish feed

1. Introduction
Every living organism requires food for growth, reproduction and maintenance of tissues. To sustain fish under culture, supplementation diet should be provided to complement natural feeds supply (Karapan, 2002) [8]. Feed is one of the major inputs in aquaculture production particularly in Africa and other developing countries of the world (Gabriel *et al.*, 2007) [5].
Due to the increasing population in Nigeria, aquaculture production has become increasingly dependent on alternative nutrient sources for farmed fish (Ojutiku, 2008) [11]. Fish growth and survival rate depend on the kind of feed, feeding frequency, feed intake and the fish's ability to absorb the nutrients. Live feeds such as Artemia, rotifers, copepods, cladocerans have been employed with successful outcomes in feeding fry of *O. niloticus.* Although Artemia nauplii and decapsulated cysts have long been used successfully in starter feeds of most fish fry, their increasing cost is a major constraint to most fish farmers especially in Nigeria. Substitution of commercial compounded diets for live feed is essential for lowering production cost while sustaining production of quality fish (Bai *et al.*, 2001) [1]. Good quality feed and optimum feeding frequency may provide maximum utilization of diets and thus, fast growth of the fingerlings. Feeding constitutes a major factor in intensive rearing of finfishes and their fry. This is because the growth of fish depends strongly on the quality of feeds provided (Solomon and Okomoda 2012) [14]. A well prepared and carefully formulated fish feed plays a significant role in fish culture (Ukagha, 2003) [16]. It ensures better growth and maintains better health status of farmed fish. However, the unavailability and affordability of adequate commercial fish feed have significantly affected the development of aquaculture in many parts of the world (Tiamiyu *et al.*, 2014) [15]. This experiment is designed to compare the growth of *O. niloticus* fingerlings fed Blue crown® and Skretting® feeds.

2. Materials and Methods
2.1 Experimental site
The experiment was carried out at the Department of Fisheries and Aquaculture hatchery unit, University of Agriculture, Makurdi, Benue state for 56 days.

2.2 Experimental setup
Oreochromis niloticus fingerlings numbering sixty were obtained from the research fish farm of the Federal University of Agriculture, Makurdi. Tanks of approximately 50 liters capacity were washed and filled with 25 liters of water. The fingerlings were acclimatized in the tanks for 48 hours before the experiment.

2.3 Experimental feeds
Blue crown® (Olam group of companies, Nigeria) and Skretting® (Nutreco group of companies, Netherlands), were purchased from Jay Brown Ventures feed shop at High level, Makurdi.

2.4 Experimental procedure
The experiment was conducted in six tanks under two treatments. Ten fingerlings were stocked in each tank and fed the respective diets twice daily at 8:00am and 4:00pm at 3% body weight. Uneaten feed was removed from the water surface an hour after feeding using a hand net and faecal debris was siphoned from each tank at 9:00am and 5:00pm daily. The water was changed weekly from the tanks and replaced with clean water. The standard and total lengths of the fingerlings were measured using a mathematical meter rule by placing the fish on a wooden board and measuring the snout to the beginning of the caudal peduncle for the standard length, then the snout to the end of the caudal peduncle for the total length. The weight of the fish in each treatment and their respective replicates were measured using a Metlar electronic weighing scale (model MT 2000). The measurements were done weekly.

2.5 Determination of Growth of *O. niloticus* fingerlings
The growth of the fingerlings was determined using the average length and weight of the fingerlings in each diet treatment. These were then used to determine the growth rate, specific growth rate and other parameters which pertain to feeding.

2.6 Proximate Composition of the Diets
The experimental diets were analyzed using methods of AOAC (2000) for crude protein, crude lipid, moisture content, crude fiber and ash content.

2.7 Crude protein
The Kjeldahl method was used in the determination of crude protein. Two grams of each of the diets were weighed and wrapped in a filter paper together with ¼ of mercury tablet and placed into a flask. Then 10ml of concentrated H_2SO_4 acid was poured into the De211p Dalton digester and left to cool overnight. This was followed by adding 130ml of water and 13ml of caustic soda to each of the labelled flasks. The solution formed was introduced into an electric distiller and fumes of ammonia from each of the bottles was allowed to bubble into the beaker containing some concentrated H_2SO_4 acid with two drops of methyl orange as indicator. The solution obtained from the distillation was cooled and then titrated with NaOH. The end point of the titration was recorded. To obtain the crude protein, the nitrogen value was multiplied by 6.26. The value of the protein was then expressed by: Volume of acid molarity 1000.0146.25

Where Molarity = 0.0025100

2.8 Crude lipid
The crude lipid determination of the diets was carried out by using the solvent extraction, sox Tec extractor otherwise known as Soxhlet method. This was achieved by weighing and wrapping of the samples in a filter paper and introduced into weighed flasks, each containing 80ml petroleum ether. This was then introduced into the Soxhlet extractor to extract the fat content for 18-20 ^{0}C. After the ether had become clear, the wrapped samples were then removed from the flasks and the petroleum ether recovered. The flasks containing the extracted oil were weighed. The fat content is extracted as follows: Weight of flask and fat - weight of flask ÷ Weight of the flask and sample - weight of flask.

2.9 Moisture content
The procedure involved that the entire crucible was dried at 800 ^{0}C for 30 minutes in a Gallen camp Sanyo electric oven and cooled in desiccators. Afterwards, the crucible was weighed on a Metlar electronic weighing balance. A known Weight (10g) of each diet was taken and placed into crucibles. The samples were transferred to an electric oven already graduated to 120 ^{0}C for 24 hours, after which the crucibles with samples were cooled in desiccators, weighed and introduced into the oven until constant weight was obtained. The moisture content was calculated using the following expression:

% Moisture = Loss of water due to drying ÷ sample weight × 100.

2.10 Crude fiber
The samples were weighed (2g each) and put into conical flasks to which 40ml of NH_2SO_4 was added and then boiled for one minute. The contents were then re-heated for 20 minutes with distilled water, then filtered through close-textured linen fitted over a Buchner funnel and washed with boiling distilled water. The residues that were obtained were transferred to flasks containing NaOH and then boiled for one minute. This process was repeated and at the end was washed twice with 95% alcohol, dried overnight at 100^{0}C, cooled and then weighed. This was accomplished with a shing at 600^{0}C for three hours to burn all organic matter, cooled and weighed to measure weight loss during ignition. The crude fiber was obtained using:

$$\% \text{ CF} = \frac{W_2 - W_3}{W_1} 100$$

Where
% CF = percentage crude fiber
W= Weight of sample
W2= Weight of dried sample
W3= Weight of sample after ashing

2.11 Ash content
Samples of each diet was placed in labelled crucibles which were previously dried and weighed. The crucibles containing the samples were then introduced into Galle Kamp Hot spot furnace set at 4500 ^{0}C for 24 hours. The samples were left in the furnace to ash, cooled in the desiccator and weighed. The ash content was calculated as: % Ash = Weight of sample after ashing / Sample weight × 100

2.12 Monitoring of water quality parameters
The water quality parameter assessed each week were Total Dissolved Solids (using a TDS meter by Hanna™), Temperature (using a thermometer by Hanna™), Electrical Conductivity (using an EC meter by Hanna™), pH (using a pH meter by Hanna™) and Dissolved Oxygen (using a Model JFS DO analyzer). This was done daily by immersing the respective instrument onto the water sample from each diet treatment to ensure that the culture medium was conducive for the fish.

2.13 Statistical analysis
The means for the length and weight of the test fish for the period of the experiment were subjected to a student t-test. Means from water quality assessment were subjected to Analysis of Variance (ANOVA) using the SPSS software version 2001. All tests were carried out at 5% level of significance.

3. Results
3.1 Growth of *O. niloticus* fingerlings analyze
The growth of the fingerlings from Table 1 shows that there was significant difference in the values of the mean final weight and the mean total length gained with values ranging from 5.23±0.01 (Diet 1) to 5.32±0.01 (Diet 2) and 0.93±0.03 (Diet 1) to 1.13±0.03 (Diet 2) respectively. There was no significant difference in the values of the specific growth rate, growth rate, mean standard length gain, protein efficiency ratio, feed conversion efficiency, feed conversion ratio.

3.2 Analysis of Blue Crown® and Skretting® fed to Oreochromis *niloticus* fingerlings
The values of the crude protein, crude fiber, crude fat, moisture and NFE of the two feed treatments from the proximate analysis presented had significant differences ($p< 0.05$) in the pooled variance of each feed, having varying standard deviations.

3.3 Analyzed mean water quality parameters
The values of the temperature, pH, TDS and electrical conductivity had no significant difference in the pooled variance. The dissolved oxygen had a significant difference ($p>0.05$) between the diets with values ranging from 4.44 (Blue crown) to 4.58 (Skretting), having standard deviations of ± 0.04 each.

Table 1: Growth Performance of *Oreochromis niloticus* fingerlings fed Blue Crown® and Skretting®.

Treatments	Blue Crown®	Skretting®	P-value
MIW	4.37±0.03	4.43±0.03	0.230
MFW	5.23±0.01	5.32±0.01	0.002*
MWG	0.86±0.02	0.89±0.03	0.565
MITL	6.03±0.03	6.00±0.06	0.374
MFTL	6.97±0.07	7.13±0.03	0.089
MTLG	0.93±0.03	1.13±0.03	0.013*
MISL	5.43±0.03	5.43±0.03	1.000
MFSL	6.33±0.13	6.50±0.10	0.374
MSLG	0.90±0.10	1.07±0.12	0.346
GR	0.015±0.00	0.016±0.00	0.519
SGR	0.323±0.01	0.327±0.01	0.845
FCE	6.50±0.22	6.60±0.22	0.755
FCR	15.42±0.51	15.18±0.52	0.764
PER	0.019±0.00	0.020±0.00	0.205
%Survival	93.33±3.33	93.33±3.33	1.000

*Mean values are significantly different ($P< 0.05$)

Keys
MIW=Mean initial weight, MFW=mean final weight, MWG=weight gain, MITL=Mean initial Total length, MFTL=Mean final Total length, MTLG=Mean Total length gain, MISL=Mean initial Standard length, MFSL=Mean final Standard length, MSLG=Mean Standard length gain GR=growth rate. SGR=specific growth rate, PER= protein efficiency ratio.

Table 2: Proximate analysis of Blue Crown® and Skretting® fed to *Oreochromis niloticus* fingerlings.

Treatments	Crude protein	Crude fat/oil	Moisture	NFE	ASH
Skretting®	$44.20±0.00^b$	$14.15±0.00^b$	$5.33±0.01^b$	$6.32±0.01^a$	$13.03±0.00^a$
Blue crown®	$45.01±0.00^a$	$12.01±0.00^a$	$7.89±0.00^a$	$8.03±0.01^b$	$5.82±0.01^b$
p-value	0.00	0.00	0.00	0.00	0.00

Means in the same columns with superscripts are significantly different at 5% level of significance

Table 3: The mean water quality of the test media containing *Oreochromis niloticus* fingerlings fed Blue Crown® and Skretting®

Parameters	pH	Temp (^{0}C)	TDS (ppm)	EC (µS)	DO (mg/L)
Diet 1	7.88±0.07	27.02±0.07	55.38±1.96	110.75±3.87	4.44±0.04
Diet 2	7.79±0.06	27.15±0.05	55.38±1.96	109.12±3.32	4.58±0.04
P-Value	0.405	0.132	0.775	0.755	0.035*

*Means in the same column are significantly different ($P< 0.05$)

Key
pH= $-\text{Log}_{10}$ $[H^+]$, Temp= temperature, TDS= Total Dissolved Solids, EC= Electrical Conductivity, DO= Dissolved Oxygen.

Weekly weight of *O. niloticus* fingerlings for eight weeks
The weekly weight of the fingerlings was more in the fingerlings fed with Diet 2 (Skretting®) and slightly less in the fingerlings fed with Diet 1 (Blue crown®).

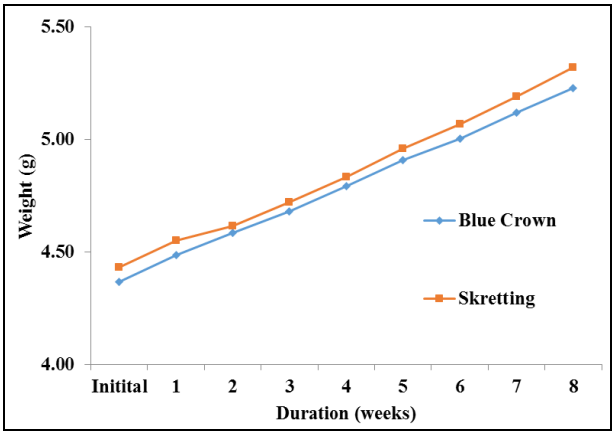

Fig 1: Weekly weight of *Oreochromis niloticus* fingerlings fed Blue crown® and Skretting® for 8 weeks.

3.4 The weekly total length of *O. niloticus* fingerlings for eight weeks

The total length of the fingerlings fed Diet 2 (Skretting®) was slightly more than the fingerlings fed with Diet 1 (Blue crown®). The increase in the total length of the fingerlings was similar between weeks 1 – 4 and slightly different between weeks 4 – 8.

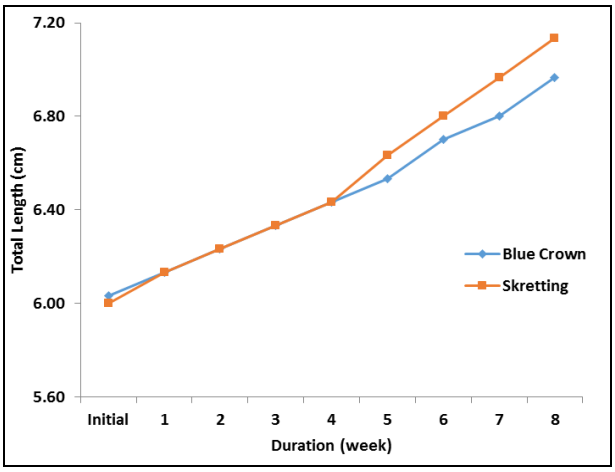

Fig 2: Weekly Total Length of *Oreochromis niloticus* fingerlings fed Blue crown® and Skretting® for 8 weeks

3.5 Weekly standard length of *O. niloticus* fingerlings for eight weeks

The weekly standard length observed in the two treatments and their respective replicates were similar as shown in figure 3 below.

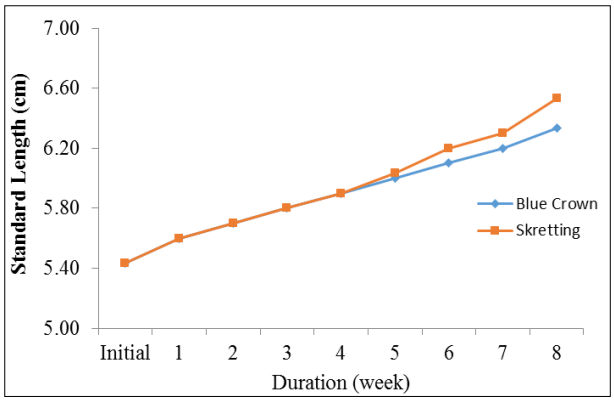

Fig 3: Weekly Standard Length of *Oreochromis niloticus* fed Blue crown® and Skretting® for 8 weeks.

4. Discussion

4.1 Growth of *Oreochromis niloticus* fingerlings and feed analysis

From the specific growth rates and growth rates of the *Oreochromis niloticus* fingerlings fed with Blue crown® and Skretting® feeds, results show that the growth parameters did not vary significantly ($p>0.05$) in both feed treatments. However, fingerlings fed with Diet 2 slightly had more weight at the end of the experiment as indicated by the value of the mean final weight gained (5.32±0.01). The similarity in the weight gained by the fingerlings in the two diet treatments with values of 5.23±0.01 to 5.32±0.01 agrees with the report by Glencross *et al.*, (2007) [6], who stated that the growth of fish depends on the ingredients and its percentage in the formulated feed as seen in the result of the experiment. The values of the crude protein content of the feeds indicated by the manufacturer were similar to the values obtained from the proximate analysis of the feed and were higher in Blue crown feed and lower in Skretting feed. Ash contains many kinds of minerals that carry an important role in body structuring, tissue repair etc. for each organism including calcium, phosphorus, magnesium, iron, zinc and so on (Juan *et al.*, 2016) [7]. It was revealed from the analysis of nutritive values of the feeds that the two brands contained high ash content.

4.2 Water quality parameters assessed

The mean temperature levels recorded from the culture tanks in the course of this study were within the appropriate range according Boyd and Lichotkoter (1979) [2] who stated that temperatures ranging from 25.0 to 32.0 °C is suitable for fish growth. Temperatures between 20 and 36 °C have been reported by various researchers as being suitable for tilapia culture. According to Kausar and Salim (2006), for instance, the preferred temperature range for optimum tilapia growth in ponds is between 25 and 27 °C. FAO (2011) [4] reported the preferred temperature ranges of between 31 and 36 °C, while Ngugi *et al.*, (2007) [9] gave a range of between 20 and35 °C as ideal for tilapia culture. The mean dissolved oxygen concentrations in the two treatments were found to vary from 4.44±0.04 to 4.58±0.04 (Diet 1 to Diet 2) which were within the recommended range according to Riche and Garling (2003) [12], who stated that the preferred Dissolved oxygen for optimum growth of tilapia is above 5 mg/L. On the lower limit however, Ross (2002) [13] noted that DO concentration of 3 mg/L should be the minimum for optimum growth of tilapia. The mean values of pH in the two treatments varied from7.88±0.07 (Diet 1) to 7.79±0.06 (Diet 2) which were also within the acceptable range according to Lichotkoter (1979) [2] who reported that pH range between 6. 5-9. 0 was suitable for fish growth. Monitoring water quality parameters in culture systems is important as they affect the physiological processes of fish such as feeding, visibility and respiration (Da, 2012) [3]. Feed and faecal wastes may lead to water deterioration resulting in significant changes in ecosystem structure and functioning (Da, 2012) [3]. The negative impact of low water quality is very prevalent in the culture of *O. niloticus* which explains why constant monitoring is necessary.

5. Conclusion

In conclusion, the findings from the present study show that *O. niloticus* fingerlings utilized both Blue crown® and Skretting® feeds for growth. The similar growth patterns of the fingerlings in both treatments infers that the two feed types are useful in the culture of this species of fish.

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