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Economic Performance of *Clarias gariepinus* Juveniles Fed Separately with Factory and Farm-Made Diets

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Authors' contributions

This work was carried out in collaboration among all authors. Authors APJ and EMA designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors ROA and EAI managed the analyses of the study. Author CBN managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Economic performance of using Coppens (commercial fish feed) and locally formulated feeds for *Clarias gariepinus* culture was studied. Forty juveniles averaging a total length of 9.15 ± 0.17cm and weight of 20.00 ± 2.58g were used and fed twice daily at 3% of their body weight. The weight gain (WG), growth rate (GR) and specific growth rate (SGR) varied significantly (p<0.05), while mean growth rate (MGR) varied insignificantly between treatment groups (p>0.05). Water parameters were at the required level. Cost of experimental feed per kilogram was highest in Coppens (₦733.33 ($2.156853)/kg) but lowest for chicken offal based diet (COBD) (₦267.00 ($0.785294)/kg). Feed consumption was higher for Coppens group (41650.00g ± 315.34) but lowest for COBD group

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(38276.00g ± 432.97). Cost of feeding (FC) was lower for COBD group (₦ 10219.69 ($30.057912) ±115.60) but higher in shrimp based diet (SBD) group (₦ 30,543.19 ($89.832912) ± 231.25). The ICA was higher in fish fed Coppens (₦ 1933.33 ($5.686265) ± 0.00) but lower for COBD group (₦1467.00 ($4.314706) ± 0.00). The NPV was higher in fish fed Coppens (₦ 440998.26 ($1297.053706) ±11636.93), but lower in COBD group (₦ 132916.16 ($390.929882) ± 3297.24). The PI was highest in Coppens group (₦14.44 ($0.042471) ± 0.35) but lowest in COBD group (₦ 13.01 ($0.038265) ± 0.43). The GP was higher in Coppens group (₦439064.93 ($1291.367441) ± 11636.93) but lower in COBD group (₦131449.16 ($386.615176) ± 3297.24). The IC was higher in Coppens group (₦228.10 ($0.670882) ± 6.02) but lower in COBD group (₦90.61 ($0.266500) ± 2.25). The BCR was higher in fish fed coppens (1.78±0.04) but lowest in COBD group (0.71±0.01). Feed consumed, FC, ICA, NPV, PI, GP and IC varied significantly (p<0.05), while BCR varied insignificantly (p>0.05) between treatment group. The SBD and COBD were as effective as Coppens in terms of growth performance and economic benefits. More researches should be carried out on the use of locally formulated feeds in aquaculture.

Keywords: Economic performance; productivity; Clarias gariepinus; coppens; chicken offal and shrimp based diet.

1. INTRODUCTION

Fish has been an essential means of income and a source of food to numerous people who depend on it in countries that are still developing. With respect to Africa for instance, an estimated 5% of the populace, depends entirely or partly on the fisheries sector for a living [1]. Culture fish needs high quality and nutritionally balanced diet in order to grow fast and attain a good market size within the shortest duration of time. For this reason, indigenous production of feeds is required for the commencement, enhancement and sustainability of fish farming. Fishmeal has been the most used source of protein incorporated in fish diets, despite the fact that fish supply is not increasing globally [2,3,4].

In Indonesia, the production of large quantities of fish meal is still not feasible because trash fish is consumed by humans; consequently, most fishmeal used in aquaculture feeds must be imported [5,6,7]. The development and sustenance of subsistent fish farming depend chiefly on the utilisation of traditionally available ingredients to minimise the outrageous feeding cost [8]. It is economically more beneficial if shrimp head waste usually discharged into environments in Nigeria are harnessed into fish feed [9]. The use of locally formulated feeds has not contributed much to aquaculture development in Africa, as a result, more research has been suggested on how best plant and animal materials can be utilised as fish feed [10].

About 60% of the overall cost of producing fish in Africa comes from fish feed [11], which to a large extent accounts for the viability and profitability of the fish farming venture. Expansion of aquaculture in Nigeria and indeed in Africa has led to the massive importation of feeds from the European Countries. In Nigeria, it has been estimated that about 4000 tonnes of good quality feed for fish have commercially imported into the country annually [12]. This has contributed to increasing the overall cost of production of fish which in turn translates to the high cost of marketable fish, invariably making it too costly for the generality of the poor people living in Sub-saharan Africa [13]. The study was aimed at comparing the economic benefits of using chicken offals based diet (COBD) and shrimp based diet (SBD) as an alternative to coppens (fish commercial feeds) in *Clarias gariepinus* production.

2. MATERIALS AND METHODS

2.1 Study Area

This research (fish culture) took place at Andem and Sons Fish Farm Limited, located in Calabar South Local Government Area, Calabar, Cross River State, Nigeria. It is geographically located between longitude 8^{o} 19’ 41.657’’E and latitude 4^{o} 56’ 2.651’’ N. The processes of the feed formulation were all carried out at Aqua Marvels Farms in Calabar. The two fish farms were 800 meters from each other. The farm is also a designated centre (Nigeria Markets II) used by the United State Agency for International Development (USAID) for Wet Field Demonstration on improved Aquacultural Practices, established in 2014.

2.2 Collection, Preservation and Preparation of Chicken Offal and Shrimp Waste

Chicken offal used in this study were purchased from Watt Market and Mr. Runyi broiler slaughter farm at the Cross River State Water Board premises, Calabar, Cross River State.

The freshly collected offal was thoroughly and carefully washed in water to remove the faeces from it as much as possible before weighing it. The Chicken offal was then par boiled for about 30 minutes [13]. It was allowed to cool, before sun drying. Shrimp waste was obtained from Calabar beach market in a dry form, then packed in a bargo super sack bag and kept in a dry place until when needed.

2.3 Diet Ingredient

Coppens feed produced by Coppens International in Netherlands is made up of good standard ingredients like calcium, methionine, copper sulphate (CuSo4), marine fish meal, phosphorus, lysine, selenium refined fish oil and several grains. The pellet sizes of coppens feed used were 2mm (42% crude protein), 4mm (44% crude protein) and 6mm (45% crude protein) respectively.

Experimental diets were composed of Soyabean meal (SBM), Chicken offal (CO), Shrimp meal (SHM), Wheat offal (WO), Cassava starch, vitamin premix, bone ash/calcium, Sodium chloride (NaCl), kings vegetable oil, lysine, methionine.

2.4 Diet Formulation

Shrimp based diet (SBD) and chicken offal based diet (COBD) were formulated for this experiment, adopting Pearson square system to arrive at a crude protein level of 42%. Various ingredients of feed were ground and amalgamated properly in accordance with their percentages by weighing to the nearest grams. After which the feed was pelletised into 2mm, 4mm and 6mm using a Hand Cranker machine into small sizes and oven dried for 30 minutes. Soon after drying was over, the feed was allowed to get cold, before they were packed in bags and stored in a dry place. The component and proportion of the diet formulated are shown below in Table 1.

2.5 Fish Stocking and Experimental Procedures

Prior to the commencement of the experiment, the tanks were treated with 20ppm common salt solution (sodium chloride, NaCl) for the complete extermination of micro-organisms which can pose a threat to *C. gariepinus* juveniles. Water was then filled and allowed for two weeks, before flushing out. The tanks were refilled with water before the introduction of fish juveniles.

Table 1. The component and proportion of shrimp based diet and chicken offal based diet

Ingredients	Diet B		Diet C	
	Amount in g	**(%)**	**Amount in g**	**(%)**
Chicken offal (CO)	---	---	370	37
Shrimps meal (SHM)	360	36	---	---
Soybeans meal (SBM)	360	36	370	37
Yellow maize (YM)	120	12	110	11
Wheat offal (WO)	120	12	110	11
Methionine	2.5	0.25	2.5	0.25
Lysine	2.5	0.25	2.5	0.25
Bone ash/calcium	5	0.5	5	0.5
Vitamin premix	15	1.25	15	1.25
Sodium chloride (NaCl)	5	0.5	5	0.5
Cassava Starch	5	0.5	5	0.5
Palm oil	5	0.5	5	0.5
Total	**1000g**	**99.75**	**1000g**	**99.75**

Diet B= Shrimp-based diet (SBD), Diet C = Chicken Offal-based diet (COBD)

Borehole water (groundwater) was introduced into the experimental tanks through an electrical pump. Three hundred and sixty juveniles of *C. gariepinus* were obtained from the University of Calabar Fish Farm Hatchery complex, Institute of Oceanography, Calabar, and transported to Andem and Sons fish farm in 50 liter water storage tank, where they were allowed to acclimate to the new environmental conditions for about 2 weeks. During this period of acclimation, they were fed twice a day between 7:00 and 8:00am and 6:00 and 7:00pm at 3% of their body weight. Before stocking, the initial length and weight of each fish sample was accurately measured using a measuring board (to the nearest centimeters) and electronic weighing balance Metlar mt-5000D version (to the nearest grams) respectively. Forty juveniles of *C. gariepinus* with average total length of 9.15±0.17cm and average weight of 20.00 ± 2.58g were stocked per treatment group. This research work was undertaken for 22 weeks (i.e June-November, 2016). Nine concrete tanks, each measuring 3.5 x 1.7 x 1.5m^3 were used and labelled A_1, A_2, A_3, B_1, B_2, B_3 and C_1, C_2, C_3. The culture water was completely changed every 48 hours and refilled immediately, to maintain good water quality throughout the experiment.

The fish were sampled bi-weekly to determine their growth (mean body weight) and survival (mortality). The rations were adjusted once in 2 weeks, to correspond with the new body weight using the weighing balance. The sampling exercises were carried out between 7-8am to minimise heat stress. The dissolved oxygen (DO), hydrogen ion concentration (pH), temperature and ammonia (NH_3) were monitored throughout the experiment duration. The DO and pH were measured using Jenway meters model 3050, England for DO in milligram per litre (mg/L) and model 9070 for pH. Mercury-in-glass thermometer was used to monitor water temperature (degrees celsius). Ice preserved collected water was analysed for Ammonia (NH_3) using spectrophotometer in mg/L.

2.6 Proximate Compositions of the Experimental Diets

The proximate examination for the 3 experimental diet was carried-out in Faculty of Agriculture Central Laboratory, University of Calabar.

Determination of moisture level:

The samples were weighed first (Initial weight), and then dried in electric oven at 105°C for 24–30 hours to obtain a constant weight. The moisture content was calculated according to the formula of [14] as follows:

$$\text{Moisture\%} = \frac{\text{Initial weight} - \text{dry weight X 100}}{\text{Initial weight}}$$

Crude fat or ether extract:

The crude fat of ether extract was determined according to the formular of [14]:

$$\text{\% Ether Extract} = \frac{weight\ of\ extract}{weight\ of\ sample}\ x\ 100$$

Ash content:

The calculation of percentage ash content followed the formula of [14] shown below:

$$\text{\% Ash content} = \frac{wt\ of\ ash}{wt\ of\ sample}\ x\ 100$$

Crude fibre:

Crude fibre was calculated according to the formular of [14]:

% Crude fibre = $W_2 – W_1/W_2$ x 100

Where

W_1 = Initial weight
W_2 = Weight of crude fibre and ash concent

Crude protein estimation:

The Kjeldahl method for estimation of nitrogen was applied. Nitrogen content was then converted to protein percentage by multiplying 6.25 according to [14] as follows:

Protein % = (Va – V_b) x N x 14 x 100 x 6.25)/1000 x Wt

Where:

Va = volume of HCL used in titration.
Vb = volume of sodium hydroxide of known normality used in back titration.
14 = conversion factor of ammonium sulfate to nitrogen.
6.25 = conversion factor of nitrogen to protein.
Wt = weight of diet

2.7 Evaluation of Growth Performance

All growth performance parameters were calculated following the method stated by De Silva and Anderson [15] as follows:

Weight gain (g): This is given as final weight (W_2) – initial weight (W_1)

Length gain (cm): This is given as final length (L_2) – initial length (L_1)

Growth Rate (GR): This is evaluated as final weight (W_2) – initial weight (W_1) / Number of days

Specific growth rate (SGR): This was evaluated as the percentage of weight gain per day

SGR= Ln weight (W_2) final – Ln weight (W_1) initial/(Number of days) 100 OR written as:

$100(LnW_2-LnW_1)/(T_2-T_1)$

Where:

W_2 = Weight (final) at end of time T_2
W_1 = Weight (initial) at beginning of time T_1
Ln = natural base of logarithm

Mean growth rate (MGR):

This was calculated as average weight gain in million grams per day.

M.G.R = $[1000 (W_2 – W_1)]/ [0.5 (W_2 + W_1) t]$ g/day

Where;

W_2 = Final weight (g)
W_1 = initial weight (g)
t = Duration of experiment in days

Percentage weight gain (PWG): This was calculated as follows;

$PWG = 100(W_2-W_1)/W_2$

Where

W_2 = weight (final)
W_1 = weight (initial)

2.8 Economic Evaluation

The economic evaluations of production of *Clarias gariepinus* using coppens, shrimp based diet and chicken offals based diet was carried-out according to [16].

Investment cost analysis (ICA): This was calculated as follows;

ICA = Cost of feeding + cost of fingerlings stocked

Net production value (NPV): This was calculated as follows;

NPV = Mean weight gain of fish (g) x total survival x cost per kg

Gross profit (GP): This was calculated as follows;

GP = NPV – ICA

Profit index (PI): This was calculated as follows;

$$PI = \frac{\text{NPV+Initial investment}}{\text{Initial investment}}$$

Incidence of cost (IC): This was calculated as follows;

$$IC = \frac{\text{Cost of feeding}}{\text{weight of fish produced (g)}}$$

Benefit cost ratio (BCR): This was calculated as follows;

$$BCR = \frac{\text{NPV}}{\text{ICA}}$$

2.9 Data Analysis

Data obtained were subjected to descriptive analysis (mean and standard deviation). One way analysis of variance (ANOVA) was also used to test for the significance of differences among growth performances and economic indices of the dietary treatments. One way ANOVA was also used to test for the significance of differences in proximate compositions among the 3 dietary treatments using Version 20 of predictive Analytical Software (PASW) and Microsoft Excel 2013. All ANOVA analysis were carried out at 0.05 level of significance and their relevant degree of freedom.

3. RESULTS

3.1 Proximate Compositions of the Experimental Diets

The summary of the mean proximate compositions of the experimental diets is shown in Table 2. Mean proximate analysis of the dry matter (mg/100g) of the 3 experimental diets showed that crude protein content was highest (40.61 ± 0.13%) in diet A (Coppens), followed by diet C, chicken offal based diet (COBD) with 38.15 ± 0.16% and least (37.00 ± 0.32%) in diet B, shrimp-based diet (SBD). Mean ether extract was highest in diet A (11.71 ± 0.10%), followed by diet C (10.00 ± 0.30%) and least in diet B (6.70 ± 0.12%). Mean crude fibre was highest in diet A (7.43 ± 0.01%), followed by diet B (5.13 ± 0.13%), and least in diet C (4.30 ± 0.33%).

Mean ash content was maximum in diet A (9.10 ± 0.12 %), followed by diet B (6.67 ± 0.33 %), and least was observed in diet C (5.00 ± 0.00%). Mean moisture content was highest in diet B (17.37 ± 0.31%), followed by diet C (14.84 ± 0.14 %) and least in diet A (8.50 ± 0.21%). Mean nitrogen-free extract (NFE) was greater in diet C (27.76 ± 0.56%), followed by diet B (27.13 ± 0.23%) and least in diet A (22.68 ± 0.13%).

Statistically, there was a significant difference between the nutritional composition in coppens, shrimp based diet and chicken offal based diet at $p<0.05$.

3.2 Water Quality

The summary of the mean water quality of culture water in the tank with fish fed 3 diets is shown in table 3. For the fish group fed Diet A, the temperature of the water ranged from 27.27 – 32.83°C, with a mean and standard deviation of 29.975 ± 0.291°C, while pH ranged from 6.87 – 7.40, with a mean and standard deviation of 7.082 ± 0.144. The dissolved oxygen (DO) ranged from 3.33 – 5.33 mg/L, with a mean and standard deviation of 4.648 ± 0.603 mg/L, while the ammonia level ranged from 0.00 – 0.17 mg/L, with a mean and standard deviation of 0.133 ± 0.048 mg/L (Table 3).

For the fish group fed Diet B, the temperature of the water ranged from 27.33 – 33.46 °C, with a mean and standard deviation of 30.099 ± 0.380 °C, while pH ranged from 6.91 – 7.19, with a mean and standard deviation of 7.085 ± 0.088. The dissolved oxygen (DO) ranged from 3.37 – 5.34 mg/L, with a mean and standard deviation of 4.188 ± 1.370 mg/L, while the ammonia level ranged from 0.00 – 0.20 mg/L, with a mean and standard deviation of 0.130 ± 0.052 mg/L (Table 3).

For fish fed Diet C, the temperature of the water ranged from 27.30 – 33.10°C, with a mean and standard deviation of 30.111 ± 0.278°C, while pH ranged from 6.93 – 7.27, with a mean and standard deviation of 7.089 ± 0.119. The dissolved oxygen (DO) ranged from 3.76 – 5.34 mg/L, with a mean and standard deviation of 4.574 ± 0.559 mg/L, while the ammonia level ranged from 0.00 – 0.17 mg/L, with a mean and standard deviation of 0.126 ± 0.045 mg/L (Table 3).

Statistically, the temperature, pH, DO and ammonia levels varied insignificantly between the culture water with fish fed the 3 diets at $p>0.05$ (Table 3).

3.3 Growth Performance of Fish Fed Experimental Diets

The summary of the growth performance of fish fed the 3 different diets are shown in Table 4. Growth performance of juveniles (*C. gariepinus)* that were administered the 3 test diets was evaluated using indices including; weight gain (g), growth rate (g/day), specific growth rate (%/day) and mean growth rate (g/day). Weight gain (g) was highest in fish fed diet A (Coppens), having 17969.33±506.61g, followed by 15825.33±202.42 g for fish fed diet B and 15137.33 ± 108.25 g for fish fed diet C. The Growth rate (GR) was equally highest in juveniles fed with Coppens (111.62 ± 3.29 g/day), followed by 97.69±1.31 g/day for fish fed diet B, and least in fish fed with diet C with 93.23±0.70 g/day (Table 4).

Specific growth rate (SGR) observed was highest in juveniles fed Coppens with 2.02 ± 0.02 %/day, followed by 1.94±0.01 %/day for fish fed with diet B, and least in *C. gariepinus* fed with diet C with 1.91±0.01 %/day. Mean growth rate was highest in fish fed with diet A (Coppens) with 11.88 ± 0.29 g/day, followed by 11.74±0.15 g/day for fish fed with diet B, and least in fish fed with diet C with 11.69±0.09 g/day (Table 4).

Statistically, the weight gain, growth rate and specific growth rate varied significantly between the fish group fed with the 3 diets at $p<0.05$, while the mean growth rate did not vary significantly between the fish group fed with the 3 diets at $p>0.05$ (Table 4).

3.4 Economic Evaluations of *Clarias gariepinus* Fed with the Experimental Diets

The summary of the economic evaluations of *C. gariepinus* fed experimental diets is shown in Table 5 and 6. Cost of experimental feed per kg was highest in diet A (Coppens) with ₦733.33/kg ($2.156853/kg), followed by diet B (SBD) with ₦426.50/kg ($1.254412/kg) and least in diet C (COBD) with ₦267.00/kg ($0.785294) (Table 5).

Food consumed by all the fishes per treatment group was highest in fish administered Coppens (diet A) with a mean value of 41650.00g ± 315.34, followed by fish fed with diet B SBD (39034.24g ± 86.34) and then COBD (diet C) as the least with 38276.00g ± 432.97. Cost of feeding (FC) the fishes per treatment was lowest in fish fed with diet C having a mean value of ₦10,219.69±115.60 ($30.057912), followed by diet B with ₦16648.10±36.83 ($48.965) and then fish fed with diet A with ₦30,543.19±231.25 ($89.832912). Cost of fish (juveniles) was ₦ 2000.00 ($5.882353) for each treatment. Investment cost analysis (ICA) for each treatment group was highest in fish fed with coppens (₦ 1933.33 ($5.686265) ± 0.00), followed by fish fed with diet B (₦ 1626.50 ($4.783824) ±0.00) and then diet C with ₦1467.00±0.00 ($4.314706). Net production value (NPV) per treatment group was also highest in fish fed with coppen with ₦ 440998.26±11636.93 ($1297.053706), followed by diet B with ₦ 220346.39±4595.46 ($648.077618), and then diet C with ₦ 132916.16±3297.24 ($390.929882). Profit index (PI) per treatment group was highest in fish fed with diet A (₦14.44 ($0.042471) ± 0.35), followed by the fish group fed with diet B (₦ 13.24 ($0.038941) ± 2.83) and then the group fed with diet C as the least (₦ 13.01 ($0.038265) ± 0.43). Gross profit (GP) was highest in fish fed with diet A (₦439064.93 ($1291.367441) ± 11636.93), followed by the treatment group fed with diet B (₦218,719.89 ($643.293794) ± 4595.46) and then fish fed with diet C as the least (₦131,449.16 ($386.615176) ± 3297.24). Incidence of cost (r) per treatment group was higher in fish fed diet A with ₦228.10±6.02 ($0.670882) followed by fish fed with diet B (₦135.48 ($0.398471) ± 2.83) and fish fed with diet C (₦90.61 ($0.266500) ± 2.25). Benefit cost ratio (BCR) per treatment group was highest in fish fed with diet A (1.78±0.04), followed by fish fed with diet B (1.11±0.02) and then fish fed diet C (0.71±0.01). Statistically, the feed consumed, FC, ICA, NPV, PI, GP and IC varied significantly ($p<0.05$), while BCR varied insignificantly ($p>0.05$) between treatment groups (Table 6).

Table 2. Mean proximate composition of the experimental diets

Indices	Diet A (Control) (Coppens)	Diet B (SBD)	Diet C (COBD)
Crude Protein (%)	40.61 ± 0.13^a	37.00 ± 0.32^b	38.15 ± 0.16^c
Ether Extract (%)	11.71 ± 0.10^a	6.70 ± 0.12^b	10.00 ± 0.30^c
Crude Fibre (%)	7.43 ± 0.01^a	5.13 ± 0.13^b	4.30 ± 0.33^c
Ash (%)	9.10 ± 0.12^a	6.67 ± 0.33^b	5.00 ± 0.00^c
Moisture (%)	8.50 ± 0.21^a	17.37 ± 0.3^b	14.84 ± 0.14^c
NFE (%)	22.68 ± 0.13^a	27.13 ± 0.23^b	27.76 ± 0.56^c

**SBD = Shrimp-based diet, COBD = Chicken Offal-based diet, NFE = Nitrogen Free Extract*
Values are in mean ± standard deviation
Values with different superscript are significantly different at p<0.05

Table 3. Mean physicochemical parameters of water in each treatment tank

Water parameters	Tank A (control) (Coppens)	Tank B (SDB)	Tank C (COBD)	FAO limit
Temperature (^oC)	29.975 ± 0.291^a (27.27 – 32.83)	30.099 ± 0.380^a (27.33 – 33.46)	30.111 ± 0.287^a (27.30 – 33.10)	<40
Ph	7.082 ± 0.144^a (6.87 – 7.40)	7.085 ± 0.088^a (6.91 – 7.19)	7.089 ± 0.119^a (6.93 – 7.27)	6 – 9
Dissolved oxygen (mg/L)	4.648 ± 0.603^a (3.33 – 5.33)	4.188 ± 1.370^a (3.37 – 5.34)	4.574 ± 0.559^a (3.76 – 5.34)	>4
Ammonia (NH_3) (mg/L)	0.133 ± 0.048^a (0.00 – 0.17)	0.130 ± 0.052^a (0.00 – 0.20)	0.126 ± 0.045^a (0.00 – 0.17)	<1

**SBD = Shrimp-based diet, COBD = Chicken Offal-based diet*
Values are in mean ± standard deviation
Ranges are in parenthesis ( )
Values with different superscript are significantly different at p<0.05

Table 4. Mean growth performance indices of *C. gariepinus* fed experimental diets

Growth Indices	Diet A (Control)(Coppens)	Diet B (SBD)	Diet C (COBD)
Initial Weight (g)	20.00 ± 2.58	20.00 ± 2.58	20.00 ± 2.58
Final Weight (g)	17989.33 ± 506.61[a]	15845.33 ± 202.42[b]	15157.33 ± 108.25[c]
Weight Gain (g)	17969.33 ± 506.61[a]	15825.33 ± 202.42[b]	15137.33 ± 108.25[c]
Initial Length (cm)	9.15 ± 0.17	9.15 ± 0.17	9.15 ± 0.17
Final Length (cm)	40.85 ± 0.39[a]	39.76 ± 0.10[b]	38.69 ± 0.35[c]
Length gain (cm)	31.70 ± 0.22[a]	30.61 ± 0.21[a]	29.54 ± 0.25[a]
Growth Rate	111.62 ± 3.29[a]	97.69 ± 1.31[b]	93.23 ± 0.70[c]
SGR (%/day)	2.02 ± 0.02[a]	1.94 ± 0.01[b]	1.91 ± 0.01[c]
MGR (g/day)	11.88 ± 0.29[a]	11.74 ± 0.15[a]	11.69 ± 0.09[a]

**SBD = Shrimp-based diet, COBD = Chicken Offal-based diet, SGR= Specific growth rate, MGR= mean growth rate*
Values are in mean ± standard deviation
Values with different superscript are significantly different at p<0.05

Table 5. Cost of experimental feed in Naira per kilogram (₦ /kg)

Ingredients	Feed A (Coppens)		Feed B (SBD)		Feed C (COBD)	
	Amount (g/kg)	**(₦)**	**Amount (g/kg)**	**(₦)**	**Amount (g/kg)**	**(₦)**
Chicken offal (CO)	***		---	---	370	92.5
Shrimps meal (SHM)	***	***	360	252	---	---
Soybeans meal (SBM)	***	***	360	72	370	74
Yellow maize (YM)	***	***	120	18	110	16.5
Wheat offal (WO)	***	***	120	6	110	5.5
Methionine	***	***	2.5	3.5	2.5	3.5
Lysine	***	***	2.5	4	2.5	4
Bone ash/calcium	***	***	5	1	5	1
Vitamin premix	***	***	15	30	15	30
NaCl	***	***	5	5	5	5
Cassava Starch	***	***	5	10	5	10
Palm oil	***	***	5	25	5	25
Total in ₦ /kg		733.33		426.50		267.00

** Coppens was bought @ ₦11,000/15kg bag = ₦ 733.33*
**SBD = Shrimp-based diet, COBD = Chicken Offal-based diet, 1$ (1USD) = ₦ 340*

Table 6. Mean economic indices of *C. gariepinus* production using Coppens feed, SBD and COBD

Economic indices	Diet A (Control) (Coppens)	Diet B (SBD)	Diet C (COBD)
Feed consumed (g)	41650.00±315.34[a]	39034.24±86.34[b]	38276.00±432.97[c]
Cost of feed per kilogram (FC)	733.33±0.00[a]	426.50±0.00[b]	267.00±0.00[c]
Investment cost analysis (ICA) (₦)	1933.33±0.00[a]	1626.50±0.00[b]	1467.00±0.00[c]
Net production value (NPV) (₦)	440998.26±11636.93[a]	220346.39±4595.46[b]	132916.16±3297.24[c]
Profit index (PI) (₦)	14.44±0.35[a]	13.24±2.83[b]	13.01±0.43[c]
Gross profit (GP) (₦)	439064.93±11636,93[a]	218719.89±4595.46[b]	131449.16±3297.24[c]
Incidence of cost (IC) (r)	228.10±6.02[a]	135.48±2.83[b]	90.61±2.25[c]
Benefit cost ratio (BCR)	1.78±0.04[a]	1.11±0.02[a]	0.71±0.01[a]

**SBD = Shrimp-based diet, COBD = Chicken Offal-based diet*
Values are in mean ± standard deviation
Values with different superscript are significantly different at p<0.05

4. DISCUSSION

The nutritional composition of the 3 feeds used differed in this study, with Coppens being the best, although all 3 feeds were balanced fish diet. The differences in the nutritional levels of the 3 diets could be due to the difference in the components of the 3 diets. This corroborated with the findings of [17,18], who both purported that, the nutritional constituents of fish diets can vary depending on the part being processed.

The indices of growth examined in this study revealed that weight gain, growth rate (GR) and specific growth rate (SGR) varied between the *C. gariepinus* administered the 3 different diet. Findings observed in the present study was in conformity with [15] report; who stated that feed standard is a matter of how efficient an animal's nutrient requirement is met by that feed. Growth response of fish observed in this study is an indication of the fact that the three experimental diets were nutritionally balanced for normal fish growth. The present study revealed that fish fed diet A grew faster than fish fed diet B, while fish fed diet C had the slowest growth based on the growth parameters studied. This could be attributed to the fact that coppens (diet A) are floatable and with strong fish odour to attract fish, which are attributes lacking in diets B and C. This finding agrees with [19,20] who in their report stated that business feeds like Coppens, Vital, Multifed, and Euro, release stronger odour that is fishy in nature. Agbokei et al. [19] also reported that *C. gariepinus* like most catfish feed mostly using olfactory senses, which makes them more attracted to coppens as a result of its strong fish odour. This reasons could be responsible for coppens feed being more inviting to the fishes than diet B and C. Going by Coppens manufacturer's label, its ingredient differed slightly from that used in formulating diet B and C, although most ingredients and additives were almost the same. However, the 3 feeds were consumed by the fish, albeit at a different rate.

The water quality parameters (pH, DO, NH_3 levels, temperature) varied across the 3 treatment group fed diet A, B and C, although all water quality parameters monitored were normal and they were within tolerable limits for normal growth of *C. gariepinus* [1].

The only way to ensure that catfish production is encouraged is through proper economic evaluation that will bring to light the level of profitability of catfish farming and constraints to production [21]. In the present study, investment and operating cost, including input levels, prices, and yields were mainly based on the current market price of feed and fish in Calabar (South-east Nigeria). The total amount of feed consumed by all the cultured fish group fed diet A was greater than feed consumed by fish fed with diet B and C. In catfish farming, farmers are often faced with several costs to bear in the course of producing fish. The variable cost involved in the production of catfish as articulated by many researchers [22,23,24] and includes: catfish seeds (fingerlings), catfish feed, labour, water, fuel, electricity, transportation and miscellaneous costs.

In these study, catfish seeds (juveniles) and feeds were the only variable cost considered. Cost of feed was lower in fish given diet B and C in comparison with fish fed diet A for 22 weeks. These show that diet B and C are more economical than diet A as justified by a lower investment cost analysis (ICA) of ₦1467.00±0.00 ($4.314706) (diet C), ₦ 1626.50±0.00 ($4.783824) (diet B) compared to ₦ 1933.33±0.00 ($5.686265) (diet A). Profit index (PI) and benefit cost ratio (BCR) were higher in fish fed with diet A than those with diets B and C. Although, the profit index varied slightly between the 3 treatments groups, the use of diet A, B or C was economically beneficial.

The cost of catfish juveniles and feeds alone in this study constituted about 76 - 80% of the financial requirement for catfish production, and this is similar to the findings of [21], who reported that feeds alone constituted about 73.56% in catfish production. This finding implies that in catfish production, feed cost is one of the most important factors that determine productivity and profitability.

5. CONCLUSION

Juveniles of *C. gariepinus* fed Coppens performed better compared to the groups fed SBD and COBD in terms of growth performance, but economically SBD and COBD were better for *C. gariepinus* production within the duration of the study. As a result, formulated feeds should be used more in aquaculture since similar results compared to the use of Coppens could be achieved at a lower cost. More researches should be carried out on the use of different locally formulated feeds in aquaculture, to ensure that catfish productivity and economic evaluation are evenly poised.

ETHICAL CONSIDERATION

The authors ensured that all the ethical and other basic principles underlying behaviour and advancing welfare for the use of animals in research, including handling, relevant laws and regulations were considered before proceeding with the research. Permission was also received from the relevant bodies for the use of fish for this experiment.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. FAO. Food for all poor. Issued on the occasion of the World Food Summit in Rome. FAO Rome. 1996;64.
2. Rumsey G. What is the future of fish meal use? Feed Int. 1994;15:10-16.
3. Barlow S. Fish meal-supply limits demand. Feed Tech. 1997;1(1):34-35.
4. Shepherd T. Rendered products in aquaculture feeds. Int. Aqua. Feed. 1998;4:13-17.
5. Nikijuluw VPH. Analisis kibijakan pengembangan industry tepeun ikan di Indonesia. Pusat penelitian social ekonomi pertanian. Badan penelitian dan pengembagan pertanian. 1998;43.
6. Sukadi FM, Proseno O and Irianto EH. Dukungan keberhasilan gema proteina 2001. Warta. pen. Per. Indon. 1999;2:2-8.
7. Usman R, Samuel L, Kamaruddin N, Tauki A. Replacement of fishmeal with poultry offal meal in diets for humpback grouper (*Cromileptes altivelis*) grow-out. Indon. Aquac. Journ. 2006;1:45-52.
8. Edwards P, Allan GL. Feed and feeding for inland aquaculture in Mekong region countries. ACIAR Technology. 2004;56:1-37.
9. Balogun AM, Akegbejo SY. Waste yield, proximate and mineral composition of shrimp resources of Nigeria's coastal waters. Bio. Tech. 1992;40:157-161.
10. Hetch T. Consideration on African aquaculture. J. of World Aqua. 2000;31: 12-19.
11. Jamu DM, Ayinla OA. Potentials for the development of aquaculture In Africa. Naga, World Fish center Quarterly Available:http://www.worldfishcenter.org/Nagana. Accessed January 22, 2015. 2003: 447.
12. AIFP. Inventory of feed producers in Nigeria. Published by Aquaculture and Inland Fisheries Project. Annex II of The National Special Program for Food Security with the Agriculture Development program in all states and FCT Abuja. Nigeria. 2004;1-8.
13. Gabriel UU, Akinrotimi OA, Bekibele DO, Onunkwo DN, Anyanwu PE. Locally produced fish feed, potentials for aquaculture development in sub-saharan. Afri. J. of Agric. Res. 2007;297:287-295.
14. AOAC. Official methods of analysis of the association of official analytical chemists. 17th. edn. Gaithersburg, MD. USA, AOAC International. 2000;168.
15. De Silva SS, Anderson TA. Fish nutrition in aquaculture. London, Ghapman and Hall. 1995: 319.
16. Faturoti EO, Lawal LA. Performance of supplementary feeding and organic manuring on the production of *Oreochromis nilotocus*. J. of Sci. 1986;1: 25–32.
17. Dale N, Fancher B, Zumbado M, Villacres A. Metabolizable energy content of poultry offal meal. J. of App. Pou. Res. 1993;2:40-42.
18. Watson H. Poultry meal vs poultry-by-product meal. Dogs in Canada Magazine. 2006;2:9-13.
19. Agbokei EO, Oparah CA, Apapa U. Growth of *Clarias gariepinus* juveniles fed five commercial feed. Cont. J. of Fisheries and Aqua. Sci. 2011;5(3):1-5.
20. Ekanem AP, Eyo VO, Austin IO, Udeme IE, Paul JU. A comparative study of the growth performance and food utilisation of the African Catfish (*Clarias gariepinus*) Fed Unical Aqua Feed and Coppens Commercial Feed. J. of Mar. Bio. and Ocea. 2012;1:2-7.
21. Ugwumba COA, Chukwuji CO. The economics of catfish production in Anambra State, Nigeria: A profit fuction approach. J. of Agric. Soc. of Sci. 2010;6: 105-109.
22. Ugwumba COA. The economics of homestead concrete fish pond in Anambra State, Nigeria. Afri. J. of Fisheries and Aqua. 2005;4:28-32.

23. Ocmer R. Raising and production of Catfish (Hito).
Available:http://www.mixph.com/2006/06/raising-and-production of Catfish hito-html. (Accessed 2nd May, 2012. 2006: 15)
24. Phonekhampheng O. On farm feed resource for Catfish (*Clarias gariepinus*) Production in Laos. Retrieved from http://dissepsilon. Slu.se/archive/00001915/01. General Discussion, Accessed 2nd May, 2012. 2006: 8.

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