EVALUATION OF THE IMPACT OFFEED TYPES ON REPRODUCTIVE PERFORMANCE AND GROWTH OF *Clarias gariepinus*UNDER DIFFERENT CULTURE SYSTEMS

Abstract

The study evaluated the impact of farm-made and commercial feed types on reproductive performance and growth of *Clarias gariepinus*under different culture systems (tarpaulin, concrete, metal and earthen pond). The research was conducted for 56 weeks in a newly constructed 1m^3 (4ftby4ft by4ft) stocked with 20 juveniles each and it was established that fecundity wassignificantly different (*P*<0.05), with the highest value (320,366.67 ± 14359.01eggs) obtained in fish fed Commercial feed C in Concrete tank C and the lowest value in theEarthen pond fed farm-made feed (153,533.33 ± 6053.1900 eggs).The results obtained in this study showed fertilisationwas significantly different, with the highest value in Metal tank B fed Commercial feed B (83.52 ± 0.76 %), whereas earthen pond A fed farm-made feed recorded the lowest value (63.73 ± 2.27 %). The growth rate showed that the Highest mean weight gain of 3824.23±373.69was recorded in Con B and the lowest of 2035.57±252.04 in Tarp A. The highest specific growth rate of 2.85±0.19was in fish fed commercial feed C in Meta tank C and the lowest of 2.45±0.11 in fish fed farm-made feed in Tarp A.Growth parameters including length gain (cm), weight gain (g), specific growth rate (%/day), and percentage weight gain (%), were significantly better (*P*<0.05) in fish fed commercial feed B in the concrete tank although fish fed farm made feed and commercial feed A in other tanks showed some impressive competition. Therefore, feeding fish with commercial feed C in concrete pond C and metal tank B with Commercial feed Bis recommended for better reproductive performance while the use of commercial feed B in Concrete pondis recommended forfish growth although fish fed farm-made feed and commercial feed A in other tanks showed some impressive competition.

Keywords: Growth parameters, Clarias gariepinus, commercial feed,

Introduction

Despite the outrageous increase in the number of people yearly with the production rate of fish, Nigeria, similar to most third world countries, is not able to meet her animal protein requirement, which is traceable to our fish production, which has fallen below expectations. Many fish hatcheries in Nigeria are functional at low capacity; producing only a total sum of 30 million fingerlings per year, although the total existing capacity could easily be 1 billion fingerlings per year. Based on a 1992 United Nations Development Project (UNDP)-assisted baseline study, the total annual fingerling requirement for Nigeria was 250,000 million, while domestic production stood at 7.2 million (Akoachere*et al.*, 2002).

The reproductive performance, growth and nutritional factors of fish are determined by the quality and quantity of dietary protein in its meal. A balanced diet in fish contains all the essential nutrients in the appropriate quantities, with energy forming the majority, while protein constitutes the most expensive item in the formulated feed (Annune and Oniye, 1993). Nutritionists prioritiseprotein since it is the single ingredient needed in the largest quantity for growth and development (Lovell, 1981). Thus, in formulating fish feed, consideration is given to the protein requirements of *Clarias gariepinus,* the protein constituents and the amino acid profile of the feedstuffs to be incorporated into the feed. One of the major expenses in any fish culture operations is the cost of feeds for the fish, and the profitability of many fish farm operations is always tied to the cost of feed, as documented in NRAC Fact Sheet 1994. One of the factors militating against fish farming in Nigeria has been the lack of adequate feedformulated to meet the nutrient requirements of culturable fish species (Olarinde, 2005; Olaniyi, 2009a).Omitoyin (2007) reported that many fish farmers in Nigeria depend on imported quality fish feeds,which are usually expensive. An estimated 4,000 tons of quality fish feeds are imported into the country each year (AIFP, 2004). Utilisationof such commercially formulated feeds increases the cost of production, thereby reducing the profit margin of fish farmers. This ultimately translates to a high cost of fish production and represents a high proportion (50-80%) of the variable cost of production (Helfrich and Craig, 2002).

Knowledge of the effects of broodstock nutrition on egg production and quality is important because good broodstock feeding leads to successful spawning and good growth and health of the progeny (Adewumi *et al.*, 2005). There is a need to establish the effect of feed quality and feeding level on the reproductive performance of catfish broodstocks. Few studies have included the reproductive performance of catfish broodstock as a selection criterion (Prinsloo *et al.*, 1990; Legendre *et al.*, 1992; Grobler *et al.*, 1992).

Fingerlings production and availability of quality fish feeds have been the bane of fish farming developmentin Nigeria for the past four decades and stressed the need for increased production of fingerlings to meet theever rising fish demand (Jimoh*et al.*,2010; Adebayo and Popoola, 2018).Reproduction techniques are one of the factors that affect the performance ofany fish farm or hatchery as it can either be natural or artificial. The output of the natural propagation in fish is very low and cannot meetthe protein requirement of its consumers (FAO, 2016)

The continuous increase in the prices of fish feed is a critical issue that requires farmers to develop intense capacity for the production of farm-made feed and to enable them to increase fish feed production as stated by Francis et al., (2001) due to the high operational cost that accounts for 60-80% of the variable cost of fish production (Olamola, 1990).The growth and reproductive performance of *Clarias gariepinus* is an important factor that requires a nutritionally well-balanced diet with an optimal feeding level in a suitable culture environment. For a successful culture operation, there must be a balance between rapid fish growth and reproductive development through proper stocking density, optimum feeding with a well-balanced diet, good water quality management and knowledge of the effects of nutrition on egg production and quality. Therefore, fish production has taken into account the different fish nutrition diets for efficient growth and reproductive performance in different culture systems.

Methodology

The set-up is a completely randomiseddesign comprised of three experimental feeds in four newly constructed culture systems (tarpulin, concrete, metal and earthen pond) with triplicates. The duration of fish culture lasted for a period of fifty-six (56) weeks and involved the culture of *C. gariepinus*juveniles in fish grow-out tanks in three replicates per treatment, giving a total of 36 tanks with each tank measuring 1m^3 (4ft ×4ft × 4ft).

The table below shows the position and layout of the experimental design:

Table 1: Experimental Design Layout

S/no	Culture Systems	Farm Made feed (42% C.P)	Commercial Feed B (42% C.P)	Commercial Feed C (42% C.P)
1	Tarpulin Pond	TAR-A1, TAR-A2, TAR-A3	TAR-B1, TAR-B2, TAR-B3	TAR-C1, TAR-C2, TAR-C3
2	Concrete Pond	CON-A1, CON-A2,	CON-B1, CON-B2,	CON-C1, CON-C2,

		CON-A3	CON-B3	CON-C3
3	Metal Tank Pond	MET-A1, MET-A2, MET-A3	MET-B1, MET-B2, MET-B3	MET-C1, MET-C2, MET-C3
4	Earthen Pond (Control)	EAR-A1 EAR-A2, EAR-A3,	EAR-B1, EAR-B2, EAR-B3	EAR-C1 EAR-C2, EAR-C3

Each experimental unit was stocked with 20 fingerlings, and the fish were fed with farm-made feed, commercial feed B, and commercial feed C to satiation at 09:00 am and 06:00 pm daily for 56 weeks.

The experimental fish were fed 42% crude protein diet and the experimental feed composition is presented in Table 2. The diet for all the AF system was formulated using nationally and environmentally available ingredients such as poultry meal (25%), fish meal (22%), soya bean meal (22%), maise(15%), cassava (13%), fish oil (0.8%), poultry oil (0.7%), micro ingredients (1.5%) .

The diet for all the BF system was formulated using available ingredients such as meat and bone meal (15%), poultry-by-products (15%), hydrolysed feather meal (10%), soya bean meal (10%), fish meal (10%), cassava meal (15%), corn fine grain (12%), wheat flour (10%), calcium (1.50%), phosphorous (1.10%) and sodium (0.4%).

The diet for all the CF system had the following locally formulated ingredients; poultry meal (22%), soybean meal (20%), fish meal (18%), hydrolysedfeather meal (14%), maise(15%), wheat flour (9%), and micro ingredients (2%).

Table 2: Experimental feed composition

Ingredients	Feed A	Feed B	Feed C

Poultry meal	25	-	22
Meat and bone meal	-	15	-
Poultry byproduct	-	15	-
Fishmeal	22	10	18
Hydrolysedfeather meal	-	10	14
Soybean meal	22	10	20
Maise	15	12	15
Wheat flour	-	10	9
Cassava meal	13	15	-
Fish oil	0.8	-	-
Poultry oil	0.8	-	-
Micro ingredients	1.5	-	2
Calcium	-	1.5	-
Phosphorus	-	1.1	-
Sodium	-	0.4	-

Each experimental unit was stocked with 20 fingerlings, and the fish were fed with farm-made feed, commercial feed B, and commercial feed C to satiation at 09:00 am and 06:00 pm daily for 56 weeks. The feed production technology used was outlined as follows: weighing of ingredients, milling of ingredients, mixing of ingredients, pelletising, cooling, collection and storage.

After fifty-six weeks of the feeding trial, selected female *Clarias gariepinus* from each treatment were induced to spawn with Ovulin (0.5 mg/kg body weight) in the hatchery. Spawning substrates made from cut nylon mosquito nets will be spread inside the hatching troughs previously filled with properly aerated clean water to a depth of 10 cm for the purpose of incubation. Fertilisedeggs obtained by mixing stripped eggs and spermatozoa from Ovulin-induced broodfish were immediately spread thinly on the substrate for between 24-36 hours for incubation and hatching. The fry, weaned on Artemia for 10 days, will be subsequently fed ad libitum three times daily with milled dry prawns (*Parapenaeopsis atlantica*) irrespective of the additional natural planktonic population available to the fry (Adewumi *et al*., 2005). The assessment of fertility and hatchability commenced after stripping of the induced female broodstock, where the eggs were weighed. The males were sacrificed to obtain the gonads that house the milt. The mixture of eggs and milt was stirred gently for approximately 1-2 minutes to allow contact and adequate fertilisation. Within a few minutes after fertilisation, the eggs absorbed water and could become sticky, so the eggs were distributed in netting suspended in the hatching trough (50 cm x 35 cm x30 cm). The incubated eggs were monitored, and the temperature was maintained between 260°C and 27°C for incubation between 23 and 25 hours. The percentage (%) fertility and hatchability were determined subjectively after 12–15 hours of fertilisationby identifying the healthy developing eggs that were transparent green brownish in colour, while the dead eggs were also estimated:

Total no. of fertilisedeggs

% Hatchability = (Total no. of fertilisedeggs - Total no. of unfertilisedeggs) X 100%

% Fertility = (No. of fertilisedeggs/No. of Extruded eggs) X 100%

This was done by allowing the newly hatched larvae of all the treatments and that of the control to live on the remains of their yolk sacs for the first 2 days (Heicht*et al.*, 1979) after hatching out of the eggs and thereafter carefully removed from the hatching troughs and were fed with Artemia on a regular basis (i.e., twice per day).

Fecundity

Eggs from each gravid fish were removed by cutting-open the abdomen with a pair of scissors. Eggs were washed in distilled water and weighed on an electronic weighing balance to the nearest 0.1 g. The eggs were fixed in Gilson fluid in sample bottles for 48 hours before estimation. Fecundity was estimated by multiplying the weight of the egg mass by 700 (Viveen*et al.*, 1985).

The percentage number of eggs stripped from each fish, the percentage number of eggs fertilisedand the number of eggs hatched were computed according to the method described by Ayinla (1988) as follows:

(a) Number of eggs stripped = weight (g) of fish before stripping-weight of fish after stripping × 66.6

(b) Percentage of eggs fertilized=

Number of eggs incubated – Number of opaque/ Total number of eggs incubated × 100

(c) Percentage eggs hatched= number of whitish broken eggs × 100 / Number of eggs fertilised

Growth parameters

Growth performance was evaluated for each treatment as follows:

Mean weight gain

Mean weight gain (MWG) = W2-W1 (Okoye *et al.*, 2001)

where

W1 is the initial body weight of fish (g) and

W2 is the final body weight of fish (g).

Percentage weight gain

Percentage weight gain (PWG), % = Wt-Wo × 100/Wo (Adewolu*et al.*, 2008)

whereWt = final weight (g) at the end of the experiment and

Wo = fish weight (g) at the start of the experiment.

Specific growth rate

Specific growth rate (SGR), %day $^{-1}$ = lnW2 - lnW1 × 100/T2-T1 (Brown, 1957)

where:

W2 = final weight of fish,

W1 = initial weight of fish (g),

T2 and T1 = mean of end of growth period and at time 0 in days and

ln = natural logarithm.

Condition factor (K)

Condition factor (K) = 100 W/l3 (Bagenal, 1978)

where W is the total weight (g) and

l is the total length (cm) of fish.

Survival rate

Survival of fish (S) = Ni x 100/No (Alatise and Otubusin, 2006)

where No is the number of fish at the start of the experiment and

Ni is the number of fish alive at the end of the experiment.

Measurement of water quality parameters

Careful monitoring of water parameters was performed every two weeks in the entire pond by measuring the pH, temperature, and dissolved oxygen. Water temperature, pHand dissolved oxygen were monitoredusing a mercury-in-bulb thermometer, digital pH meter, and MicroprocessorOximeter®, respectively (Nlewadim*et al.*, 2010).

Proximate analysis of farm-made and commercial feeds

Proximate analysis was carried out on the farm-made and commercial feeds in the university of Uyo biochemistry laboratory following the methods of AOAC, (1995 and 2005). The indices that were analysedwere moisture content, crude protein, crude lipid, crude fibre, percentage ash, carbohydrate and energy.

Data Analysis

Data obtained were subjected to analysis of variance (ANOVA) at 0.05% level of significance and means were separated using the Duncan multiple range test.

Results and Discussions

In this study, the proximate composition of all the experimental feed showed that all theproximate indices, including crude protein, crude fibre ash, moisture, crude fatand nitrogen-free extract, were within the range recommended for the optimal growth performance of *C. gariepinus*. The proximate analysis of the commercial feeds and farm-made feed used in this study agrees with that of Agokei*et al.* (2011), Ekanem *et al.* (2012), and Ayuba and Iorkol (2012) reported for commercial feed such as Coppens feed.The results of the present study indicated that *C. gariepinus*responded positively to all the experimental diets, as was seen in their reproductive performance.

The results of this study agree with the findings of other authors, including Ekanem *et al.* (2013), who found that the fecundity of *C. gariepinus*can be significantly affected by feed. In this study, fecundity was significantly different, with the highest value (320,366.67 ± 14359.01eggs) obtained in fish fed Commercial feed C in Concrete tank C, followed by fish fed Commercial feed B in Concrete tank B (319,200.00 ± 13,213.76 eggs), fish fed Commercial feed B in Tarpaulin tank B (292,366.67 ± 4988.09 eggs) and the lowest value in theEarthen pond fed farm-made feed (153,533.33 ± 6053.1900 eggs). According to Shim *et al.* (1989), diet composition affects the fecundity of fish. The significant difference (*P*<0.05) observed in this study for the fecundity of fish fed the three experimental diets in different fish housing facilities could be attributed to the differences in the quality of the three diets. Proximate analysis of the three experimental feeds showed that the nutrient composition of the commercial feed C, including crude protein level, crude fibre, ash, moisture, crude fat and nitrogen-free extract, was slightly different than that of the commercial feed B and farm-made feeds. Therefore, thedifference in fecundity observed in this study may not be attributed to the amount of food utilisedbut rather, to the quality of the feeds. The variation in fecundity observed in this study could be attributed to the different housing facilities used in rearing the experimental fish. This agrees with the findings of Ekanem *et al*. (2013), who reported a higher fecundity in *C. gariepinus*fed Coppens commercial feed in earthen ponds than in *C. gariepinus*fed Coppens commercial feed in concrete tanks.

The results obtained in this study showed fertilisationwas significantly different, with highest value in Metal tank B fed Commercial feed B (83.52 ± 0.76 %), followed by Earthen pond B fed Commercial feed B (82.38 ± 1.56 %), followed by Concrete tank B fed Commercial feed B (81.39 ±3.03%), followed by Tarpaulin tank B fed Commercial feed B (81.39 ± 0.66%) whereas earthen pond A fed farm-made feed recorded the lowest value (63.73 ± 2.27 %).

Hatchability was significantly highest ($p < 0.05$) in Metal tank B fed Commercial feed B (58.34 ± 0.54 %), followed by Earthen pond B fed Commercial feed B (57.74 ± 0.65 %), followed by Concrete tank B fed Commercial feed B (56.79 ± 2.18 %) with lowest hatchability obtained in (18 %), and Earthen pond A fed farm-made feed (43.86 ± 1.65 %). These findings imply that one of the factors that could be responsible for the variation infertilisationand hatchability rate in *C. gariepinus*is the diet composition. Farm-made feed may not have contained all the micro and macronutrients present in the commercial feeds used in this study, resulting in the lowest fertilisationrate and hatchability in this study. According to Wadunde*et al.* (2014), dietary protein content affects the reproductive performance of *C. gariepinus*, and the higher the protein levels in the diet, the better the hatchability (Sotolu, 2010). In this study, the proximate composition of the three feeds showed that crude protein, crude fibre, ash, moisture, crude fatand nitrogen-free extract were within the range recommended for the optimal growth and good health of *C. gariepinus*. Additionally, the proximate composition of the three feeds agrees with that of Agokei*et al.* (2011), and Ayuba and Iorkol (2012) reported for commercial feed such as Coppens feed. Interestingly, Earthen pond A fed farm-made feed with the lowest hatchability (43.86 ±1.65 %) had the lowestfertilisationrate (63.73 ± 2.27 %), implying that thefertilisationrate is a major determinant of egg hatchability. Water quality parameters are very crucial factors that influence the reproductive performance of fish, but in this study, all the important water quality parameters measured were within the recommended range for the culture of freshwater fishes (Boyd, 1979).

This implies thatthe results obtained for the reproductive performance of fish in all the treatments were not influenced by water quality parameters.

The results of the present study indicated that *C. gariepinus*responded positively to all the experimental diets, as was seen in their biweekly length and weight increment, growth performance and survival. Although all the experimental fish fed the experimental diets responded positively, some treatments were found to give better growth performance than others. Length gain (cm) was significantly higher (P<0.05) in Concrete tank B fed with commercial feed B (70.33 ± 0.89 cm), followed by Metal tank C fed with Commercial feed C (68.60 ± 1.40 cm), followed by Tarpaulin Tank B fed with Commercial feed B (66.67 ± 1.76 cm), followed by Tarpaulin tank C fed with Commercial feed C (64.63 ± 4.87 cm), and the lowest value was obtained in Earthen pond A fed with farm-made feed (51.87 ± 4.54 cm). Weight gain was significantly highest (P<0.05) in Concrete B fed with Commercial feed B (3824.23 ± 373.69 g), followed by Metal tank C fed with Commercial feed C (3824.23 ± 373.69 g), followed by Metal tank B fed with Commercial feed B (3144.03 ± 347.42 g), and the lowest value was obtained in Tarpaulin tank A fed with farm-made feed (2035.57 ± 252.04 g). According to Glencross *et al.* (2007), fish growth performance depends on the feedstuffs and their percentage in the formulated feed. Comparing and contrasting these findings across all the experimental units, fish fed commercial feed gave the overall best growth performance, which indicates that commercial feeds wholly meet the nutritional requirements of *C. gariepinus.* This could be attributed to the quality of ingredients used in the production of those feeds, as the major protein ingredients are from marine ingredients, which remain crucial feedstuffs in the aquaculture feed industries.

Specific growth rate and mean growth rate obtained for all the experimental units were not significantly different (P<0.05) in this study, with the highest value (2.85 ± 0.19 %/day) obtained in metal tank C fed commercial feed C and the lowest value in Earthen pond A fed farm-made feed (2.45 ± 0.11 %/day). In this study, the differences obtained across the experimental treatments cannot be attributed to the feeding frequency because all the experimental fish in the different experimental units were subjected to the same feeding frequency twice daily. However, the fishes were fed to satiation, which resulted in fishes in some experimental units consuming more feed than others, which resulted in fishes consuming more feed growing better than those consuming less.

The percentage survival (%) of fish in all the experimental units did not vary significantly (P>0.05), indicating that the different experimental feeds did influence fish survival. The low mortalities recorded in this study may be due to the cannibalistic nature of *C. gariepinus*since only the skulls of dead fish were removed from tanks during the process of water replacement.

In this study, water quality parameters such as pH, water temperature, dissolved oxygen and ammonia were within the range recommended for optimal growth and survival offreshwater fishes (Boyd, 1979; Goos and Richter, 1996). There was no significant difference (*P*>0.05) in any of the water quality parameters measured in the experimental tanks. This means that the growth performance of *C. gariepinus*fed different experimental feeds in the different tanks was not influenced by the water quality parameters of the fish culture tanks. Differences in the level of dissolved oxygen in the experimental units could be tracedto the slight differences observed in temperatureamong the boreholes, which implies that a slight change inwater temperature could trigger a significant change inthe level of dissolved oxygen in water (Uka and Okoro, 2022).

Conclusion

This study revealed thatthe reproductive performance of fish fed commercial feed in concrete tank C had the highest fecundity, while fish in the metal tank fed commercial feed B had the highest fertilisationrate and hatchability. Growth parameters, including length gain (cm), weight gain (g)., specific growth rate (%/day), and percentage weight gain (%), of fish fed the experimental diets were significantly better in fish fed commercial feed B in the concrete tank, although fish fed farm-made feed and commercial feed C in other tanks showed some impressive competition. The survival rate was above 60 % across the different treatments, even though the highest survival was obtained in fish fed commercial feed B in Tarpaulin tank B.

Table 3. Reproductive performance indices of experimental fishes

	Tarp A	Tarp B	Tarp C	Met A	Met B	Met C	Con A	Con B	Con C	Ear A	Ear B	Ear C
Final weight (g)	2333.33±120.19	2966.67±348-01	2980.00±196.98	2510.00±95.39	3400.00±115.47	2933.33±120.19	2866.67±218.58	3800.00±351.19	3200.00±173.21	2183.33±60.09	2826.67±37.12	2333.33±120.19
Final length (cm)	62.73±3.27	76.17±0.60	74.07±3.98	67.23±1.19	70.63±2.63	74.83±3.44	74.73±2.77	73.76±1.30	73.50±1.33	59.13±3.57	65.97±3.02	695.97±3.04
No. of eggs Stripped	15917.40±1626.37	27816.60±474.58	23243.40±1271.23	14245.80±1797.56	22777.20±2133.63	20801.40±173.39	20091.20±1687.30	46353.60±9205.35	30480.60±1366.16	13963.80±850.58	22377.60±2682.53	15828.60±1378.01
Percentage stripping	10.36±1.47	14.41±1.43	11.83±1.49	9.25±0.43	10.49±0.17	10.79±0.32	11.59±0.85	14.29±2.29	14.37±0..86	10.04±0..12	10.95±0..64	10.16±0..44
Fecundity	167300.00±17093.96 ^{e}	292366.67±4988.09^{b}	242900.00±14453.49 ^{c}	162633.33±10234.79^{e}	249900.00±12548.041 ^{c}	220966.67±4048.182 ^{d}	230066.67±4684.134 ^{c}	319200.00±13213.76 ^{a}	320366.67±14359.01 ^{a}	153533.33±6053.19 ^{f}	217000.00±15657.69 ^{d}	166366.67±14483.59 ^{e}
Fertilization	71.32±1.28^{c}	81.39±0.66 ^{a}	71.42±0.79 ^{c}	71.87±0.42 ^{c}	83.52±0.76^{a}	79.92±1.53 ^{b}	72.77±0.55 ^{c}	81.39±3.03 ^{e}	78.29±0.89 ^{b}	63.73±2.27^{d}	82.83±1.56 ^{e}	75.19±0.79 ^{c}
Hatchability	49.96±0.91 ^{b}	56.89±0.3 ^{a} 9	54.18±0.52 ^{a}	50.28±0.30 ^{a}	58.34±0.54^{a}	55.81±1.05 ^{a}	48.63±2.04 ^{b}	56.79±2.18 ^{a}	54.57±0.65 ^{a}	43.86±1.65^{c}	57.74±1.02 ^{a}	52.52±0.51 ^{b}

Table 4: Growth performance indices of experimental fish

Growth indices	Tarp A	Tarp B	TarC	Met A	Met B	Met C	Con A	Con B	Con C	Ear A	Ear B	Ear C
Initial length (cm)	6.73±0.20	7.37±0.52	7.87±0.72	7.80±0.56	8.13±0.35	8.40±0.47	8.30±0.21	7.60±0.40	8.47±0.56	7.60±0.59	7.90±0.35	8.00±0.32
Final length (cm)	61.80±2.89	74.03 ±2.05	76.93±1.56	72.54±5.43	59.74±4.96	69.00±2.83	70.97±2.46	77.93±1.07	72.77±1.52	59.47±3.97	71.00±6.11	72.33±0.88
Length Gain (cm)	55.07±4.89^{b}	66.67±1.76^{e}	69.06±4.87^{d}	64.74±2.30^{d}	51.61±2.72^{a}	60.60±1.40^{d}	62.67±2.49^{d}	70.33±0.89^{d}	64.30±1.51^{d}	51.87±4.54^{a}	63.10±6.05^{d}	64.33±1.15^{d}
Initial weight (g)	7.77±0.15	8.50±0.40	8.93±0.55	8.77±0.38	9.27±0.26	9.27±0.32	8.83±0.19	9.10±0.21	9.43±0.54	8.63±0.41	8.97±0.19	9.20±0.32
Final weight (g)	2043.33±252.08	2973.33±342.60	2980.00±196.97	2593.33±109.74	3153.33±347.43	3380.00±143.64	3273.33±269.09	3833.33±373.73	2930.00±140.12	2440.00±173.49	2973.33±130.42	3030.00±58.59
Mean Weight	2035.57±252.04^{i}	2964.83±342.44^{f}	2970.93±196.43^{f}	2584.57±110.12^{g}	3144.03±347.42^{d}	3370.73±143.83^{b}	3264.50±269.05^{c}	3824.23±373.69^{a}	2920.57±139.72^{f}	2431.37±173.65^{h}	2964.37±130.38^{f}	3020.80±58.89^{e}

Gain (g)												
SGR (%/day)	2.47±0.06^{e}	2.61±0.05^{c}	2.59±0.02^{d}	2.57±0.02^{d}	2.59±0.05^{d}	2.85±0.19^{a}	2.64±0.04^{c}	2.69±0.04^{b}	2.56±0.02^{d}	2.45±0.11^{e}	2.59±0.02^{d}	2.59±0.02^{d}
PWG (%)	99.61±0.04^{a}	99.71±0.03^{a}	99.69±0.01^{a}	99.66±0.03^{a}	99.70±0.04^{a}	99.72±0.02^{a}	99.72±0.02^{a}	99.75±0.02^{a}	99.65±0.02^{a}	99.64±0.04^{a}	99.69±0.01^{a}	99.69±0.02^{a}
Condition factor	0.98±0.13^{b}	0.72±0.0^{d}	0.81±0.14^{c}	1.13±0.18^{a}	0.96±0.12^{b}	0.74±0.04^{d}	0.76±0.06^{d}	1.07±0.03^{a}	0.77±0.07^{d}	1.21±0.19^{a}	0.89±0.22^{c}	0.80±0.03^{c}
Survival	71.66±11.7^{c}	93.33±4.41^{a}	86.67±4.41^{b}	61.67±7.26^{d}	88.33±1.67^{b}	88.33±1.67^{b}	86.67±1.67^{b}	90.00±2.89^{a}	93.33±3.33^{a}	68.33±4.41^{c}	81.67±4.41^{b}	85.00±2.89^{b}

*Means with the same superscript are not significantly different (P>0.05) values represent the mean and the standard error of the triplicate units.

Table 5.Proximate composition of the experimental feed

	Feed A (Farm-made)	Feed B (Commercial Feed B)	Feed C (Commercial Feed C)
Moisture (%)	2.09 ± 0.01^{a}	1.69 ± 0.01^{b}	1.13 ± 0.01
Lipid (%)	6.11 ± 0.01^{c}	8.15 ± 0.03^{a}	7.17 ± 0.01^{b}

Ash (%)	2.65 ± 0.03 [b]	2.42 ± 0.03 [c]	2.76 ± 0.02 [a]
Fibre (%)	1.75 ± 0.03 [b]	1.65 ± 0.03 [c]	1.82 ± 0.01 [a]
Crude Protein (%)	11.01 ± 0.10 [b]	11.68 ± 0.03 [b]	16.61 ± 3.25 [a]
Carbohydrate (%)	72.40 ± 0.09 [a]	74.42 ± 0.05 [a]	73.84 ± 0.08 [a]
Energy (Kcal)	403.40 ± 0.77 [a]	415.61 ± 1.69 [a]	413.75 ± 0.77 [a]

*Means with the same superscript are not significantly different (P>0.05); values represent the mean ± standard error of the triplicate units.

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