GROWTH PERFORMANCE OF *Clarias gariepinus* (TEUGELS, 1986) JUVENILES FED RAW AND TOASTED SESAME (*Sesamum radiatum* LINN.) SEEDS MEAL AT VARYING DIETARY PROTEIN LEVELS

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R. Umar[1]*, M. A. Suleiman[2], C. Bamaiyi[2] and M. A. Haruna[3]
[1]National Agricultural Extension & Research Liaison Services, Ahmadu Bello University, Zaria, Nigeria
[2]Department of Biological Sciences Bello University, Zaria, Nigeria
[3]Federal University University Dutse, Jagawa State, Nigeria
*Corresponding author: aquafingers@gmail.com

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Abstract: Growth performance of *Clarias gariepinus)* Juveniles fed raw and toasted Sesame (*Sesamum radiatum* Linn.) seeds meal at varying dietary protein levels was investigated. The Proximate analyses of both raw and toasted Sesame seed were determined using standard procedures of AOAC. The determined parameters were analysed statistically using analysis of variance (ANOVA). The means of results were compared for significant difference at ($p \leq 0.05$). The result indicated that the raw and toasted Sesame seed had mean value of 20.70 and 25.20% crude protein, 6.00 and 10.90% crude fibre, 5.35 and 4.80% Ash, 11.80 and 8.10% carbohydrate, 2.15 and 1.50% moisture content, respectively. The result indicated that fish fed with the 35% toasted diet (Diet E) had the best growth performance, with a Mean Body Weight Gain of 3.125 g, Mean Standard Length (1.212), SGR (0.00224), FE (0.00830), NPU (40.361), PER (0.186), GFCE (69.797), and Survival Rate of 98.000%. The crude protein content of the carcass fish was significantly high ($p \leq 0.05$) in diet E. Sesame seeds have been found to be a good alternative source of protein in fish feed formulations, especially when toasted and added at the 35% crude protein levels for *Clarias gariepinus*.

Keywords: *Clarias gariepinus*, diets, feed, survival and growth, *Sesamum radiatum*

Introduction

Aquaculture is the rearing of aquatic animals like fish, shrimps, oysters, prawns, etc in an enclosed natural or artificial water body bodies. It is aimed at improving the nutritional as well as the economic standards of man through boosting the provision of high quality animal protein as well as an opportunity to generate income Otubusin (1998).

In the Nigerian experience, aquaculture practices are still in the extensive and semi-intensive levels (Adikwu, 1999), and recently intensive re-circulatory system (Bolorunduro, 2006). In aquaculture, nutrition to a great extent relies on natural pond water and productivity and the use of various feed supplements (with the use of complete diets only in re-circulatory production systems hence production is in the low to the medium ranges).

The efficient production and growth of fish in the culture system depend on feeding the fish at levels not exceeding their dietary requirements (Ayinla, 1991). The scope for improving the aquaculture nutritional practices in Nigeria is very wide with new developments of integrated cultures arising and paving way for challenging researches on aquaculture nutrition to meet up with the new developments.

When fish are removed from their natural environment to an artificial one, enough food must be supplied in order to enable them grow. The limiting factor in fish production is water quality, but more limiting is the nutrient requirement. Fish feed account for about 70% of aquaculture operations (Eyo, 1995). Protein represents the most expensive component in fish feed and protein sources like fish meal are often the major reasons for the high cost of the feed. Some known animal and plant feedstuff are known to be good sources of protein in fish feed formulation. However, they are in competition with human consumption needs and in formulating other animal feeds (Banyighi *et al.,* 2001). It has therefore become imperative to search for alternative unconventional feedstuff that is not in direct competition with humans and other animal needs.

The demand for fish is now very high. In Nigeria people are now trying to engage in raising fish both in homestead and farms. One such species of fish generating interest in the people is the catfish. The fish is highly relished in Nigeria because of its fast growth, nutritional value and high taste value (Oladosu *et al.,* 1994). The demand for catfish has apparently risen dramatically in recent years but its supply has not kept with the pace. This is apparent with the price increase of the fish.

Sesame seed is produced in large quantity by peasant farmers in the savanna region of northern Nigeria. The seed is mainly used for oil production and its direct consumption is low. Not much work has been carried out on its incorporation in animal feed production. Sesame seed meal has been reported to have high methionine content. The lipid content also contains high linoleic acid. This may give diets formulated with levels of the seed a good nutritive value and high floatation property because of the oil content (Eyo *et al.,* 2003). The objective of the study was to determine the response of *Clariasgariepinus* to diet formulated with sesame seeds at various inclusion levels and processing methods.

Materials and Methods

Source of fish

One hundred and fifty juvenile *Clariasgariepinus* of unknown parental stock were obtained from the Department of Biological Sciences, Ahmadu Bello University (ABU), Zaria fishpond and brought to the Hydrobiology laboratory of the department in buckets filled with the pond water. They were then transferred to a bathtub which contains dechlorinated water and left for a period of one week to acclimatize. During this period, they were fed with commercial diet at 5% total body weight. Water quality parameter such as pH, Dissolved Oxygen (D.O) and temperature were monitored.

Stocking and weighing of fish

After the period of acclimatization, fish were then selected at random and weighed individually using an Electronic Mettler sensitive top loading balance (Swiss made) and recorded as initial weight and stocked.

Six aquaria glass tanks with dimension 60 x 30 x 30 cm were thoroughly washed and set up for the experiment. The aquaria were filled with 35 litres of dechlorinated water and labeled A, B, C, D, E, and F, respectively. Six aquaria were each stocked with ten (10) *Clariasgariepinus* juveniles in a complete randomized design and were triplicated. The water in each aquarium was changed every other day to remove the faeces and the leftover feed. The total and standard lengths were also measured and recorded using a measuring board calibrated in centimeters. The weighing and length measurements of the fish were taken bi- weekly throughout the period of the experiment.

Feed formulation and processing

The sesame seeds were obtained from Sabon-gari market, Zaria, brought to the Department of Biological Sciences, Ahmadu Bello University, Zaria.

Feedstuff used in the experiments were blood meal, fish meal (Clupeid) and sesame seed as the protein concentrates; yellow maize as the basal feed; gari as the binder; bone meal, vitamin Premix and common salt. The proximate analysis and anti-nutritional content of sesame seed were determined both in the raw and locally toasted forms, following the AOAC (1990) method.

The blood meal was obtained as finely ground particles. The clupeid fish were sun dried and milled to fine particles. Part of the sesame seeds were toasted in an open pan and another part were left raw.

The yellow maize was first parboiled and dried. All the ingredients were milled to form fine powder. The bone meal was used already milled to fine particles. Six diets of varying protein levels were formulated. The diets contain 35% control feed, 35% raw sesame, 20% toasted sesame, 30% toasted sesame, 35% toasted sesame and 40% toasted sesame.

The percentage inclusion of each ingredient was calculated using the Pearson Square Method. They were then weighed with an Electrical Mettler sensitive top loading balance separately. Each diet was first mixed dry and later with just enough warm water to obtain a homogenous paste. The paste was then pelleted with a locally fabricated instrument and sun dried for forty-eight hours.

Proximate analysis

The method described by AOAC (1990) was adopted. A clean crucible was dried to a constant weight in an air oven at 110^0c, cooled in a desiccator and weighed (W_1). 2 g of finely ground sample was accurately weighed into the previously labeled crucible and re weighed (W_2). The crucible containing the sample was dried in an oven to a constant weight (W_3). The percentage moisture content was calculated as follows:

$$\% \, moisture\, content = \frac{W_2 - W_3}{W_2 - W_1} \, x \, 100$$

$$\% \, dry\, matter = \frac{W_3 - W_1}{W_2 - W_1} \, x \, 100$$

Also in the determination of Crude fibre, Crude protein and crude fits the method of AOAC (1990) was adopted. The carbohydrate was calculated by deference. The results were used in the various diets formulations.

The experimental fish were fed 5% of their total body weight daily with their respective experimental diets. The feeding was done twice daily in the morning between 7.00 and 8.00am and in the evening between 5.00 – 6.00pm. The quantity of the daily ratio was adjusted after every two weeks based on fish weight gain.

Experimental diets

Six diets of varying protein levels were formulated, diet A contain 35% crude protein (Copens-a commercial diet) as control feed, diet B contained 35% raw sesame, diets C, D, E and F contained 20, 30, 35 and 40% toasted sesame supplement, respectively.

The percentage inclusion of each ingredient was calculated using the Pearson Square Method. They were then weighed with an Electrical Mettler sensitive top loading balance (Swiss made) separately. Each diet was first mixed dry and later with just enough warm water to obtain a homogenous hard-paste. The paste was then pellated with a locally fabricated instrument and sun dried for forty-eight hours. The feed was collected separately and kept in a dry cupboard separately.

Data analysis

The data collected at the end of the experiment was subjected to Analysis of variance (ANOVA) to find out if there is significant difference ($p \leq 0.05$) between the means. The means were further ranked using Duncan's multiple range tests at the 95% confidence limit. Also the Statistical Package for Social Sciences (SPSS 20.0) software was used in the analysis.

Results and Discussion

Table 1 shows the mean temperature, pH and Dissolved Oxygen recorded bi-weekly throughout the duration of the experiment of eight weeks.

The water temperature in all the aquaria was within the range of 25.50 – 26.80^{o}C. The statistical analysis showed no significant difference (P>0.05) in the water temperature of the experimental aquaria. The pH of the water in the aquaria ranged between 6.8 and 7.0. There was no significant difference (P>0.05) in the pH of water in all the experimental tanks. The Dissolved Oxygen was monitored throughout the period of the experiment and the range was between 6.8 and 7.2 mg/l. There was no significant difference (P>0.05) in the Dissolved Oxygen of the experimental tanks.

Table 1: Mean water quality parameter (eight weeks)

Mean Temperature (^{o}C)	Mean pH	Mean Dissolved Oxygen (mg/l)
25.6^a	6.9^a	7.1^a
25.5^a	7.0^a	7.2^a
26.3^a	7.0^a	6.9^a
26.0^a	6.8^a	7.0^a
25.9^a	6.9^a	7.0^a
26.8^a	7.0^a	6.8^a

Same superscripts in the same column are not significantly different (p<0.05)

Table 2: Proximate composition of raw and toasted sesame seed

S/N	Composition (%)	Raw	Toasted
1	Moisture	2.15^a	1.50^b
2	Ash content	5.35^a	4.80^b
3	Crude lipid	54.00^a	49.50^b
4	Crude protein	20.70^b	25.20^a
5	Crude fibre	6.00^b	10.90^a
6	Carbohydrate	11.80^a	8.10^b

Same superscript on the same row are not significantly different (p<0.05)

Table 2 shows the proximate composition of the experimental seed both in the raw and locally toasted seeds. The moisture content of the raw seed was higher (2.15%) than the toasted (1.50%). The moisture content reduced with toasting of the seed. There was significant difference ($p \leq 0.05$) in the moisture content of the raw and the toasted seed. The ash content of the raw seed was 5.35% while that of the toasted seed was 4.80%. Statistical analysis showed significant difference ($p \leq 0.05$) in the ash content of the raw and the toasted seed. The crude lipid content of the raw seed was higher (54.00%) than the toasted seed (49.50%). There was significant difference ($p \leq 0.05$) between the raw and the processed seed. The crude protein content of the toasted seeds (25.20%) was higher than in the raw (20.70%). There was significant difference ($p \leq 0.05$) between the crude protein content of the raw and toasted seeds.

The crude fibre content of the seed in the raw and toasted form indicated a significant difference ($p \leq 0.05$) with the toasted seed having a higher value (10.90%) than the raw seed (6.00%). The carbohydrate content of the seed was higher in the raw (11.80%) than in the toasted seed (8.10%).

Table 3 indicated the proximate composition of experiment diets fed to *Clarias gariepinus* for the duration of 56 days. The moisture content of the experimental diets ranged from 2.0 – 4.30% with Diet C having the highest value (4.30%) followed by Diet D (2.87%), then Diet B (2.14%), Diet A (2.09%) and Diet E (2.04%). Diet F has the lowest value (2.00%). There was significant difference ($P < 0.05$) between the moisture content of Diet C and the other diets. The ash content ranged from 4.91 – 5.89%. Diet C recorded the highest value of ash (5.89%) followed by Diet D (5.47%) and then Diet A (5.35%) and Diets B and E (5.32%). Diet F had the lowest value (4.91%). However, there was no significant difference ($p > 0.05$) in the ash content of the experimental diets. The dry matter content ranges between 91.00 and 98.53% of the diets. Diet D had the highest value (98.53) followed by Diets F, E, A and B with 98.00, 97.96, 97.91 and 97.86 values, respectively. Diet C had the lowest dry matter content (95.70). However, there was no significant difference ($P>0.05$) in the dry matter content of the diets.

The values of the organic matter content ranged from 89.81 – 93.09. Diet F had the highest value (93.09) followed by Diets D (93.06), E (92.64), A (92.56) and B (92.54). Diet C had the lowest value (89.81). There was however no significant difference ($P>0.05$) in the organic matter contents of all the experimental diets.

The crude protein content of the diets ranged from 19.45 – 35.95%. The highest was in Diet F (35.95%) and the lowest was in Diet C (19.45%). In between them are Diets A (33.90%), E (33.75%), B (33.60%) and D (29.55%). There was significant difference ($p \leq 0.05$) in the crude protein content between the control and Diets C and D. This ranged from 50.53% in Diet F to 65.00% in Diet C. Diet D had (56.98%), E (52.05%), B (52.04%) and A (51.99%). There was significant difference ($p \leq 0.05$) in the crude fibre content between Diet C (65.00%) and the other Diets. The crude lipid of the experimental diets ranged from 2.00% (Diet F) to 2.54% (Diet E). This was followed by Diets C (2.35%), D (2.21%), B (2.20%) and A (2.15%). There was however no significant difference ($P>0.05$) in the crude lipid content between the control and the other experimental diets.

The NFE content of the experimental diets was highest in Diet B (4.70%) and lowest in Diet C (3.01%). The other diets had the values of 4.61%, 4.52%, 4.32% and 4.30% for diets F, A, D and E, respectively. There was no significant difference ($P>0.05$) in the NFE content between the control and the other experimental diets.

Table 3: Proximate composition of experimental diets fed to *Clariasgariepinus* juveniles

Composition	Diets					
	Diet A 35% Control	**Diet B 35% Raw**	**Diet C 20% Toasted**	**Diet D 30% Toasted**	**Diet E 35% Toasted**	**Diet F 40% Toasted**
Moisture	2.09^{a}	2.14^{a}	4.30^{b}	2.87^{a}	2.04^{a}	2.00^{a}
Ash content	5.35^{a}	5.32^{a}	5.89^{a}	5.47^{a}	5.32^{a}	4.91^{b}
Dry matter	97.91^{a}	97.86^{a}	95.70^{a}	98.53^{a}	97.96^{a}	98.00^{a}
Organic matter	92.56^{a}	92.54^{a}	89.81^{a}	93.06^{a}	92.64^{a}	93.09^{a}
Crude protein	33.90^{a}	33.60^{a}	19.45^{b}	29.55^{b}	33.75^{a}	35.95^{a}
Crude fibre	51.99^{a}	52.04^{a}	65.00^{b}	56.98^{a}	52.05^{a}	50.53^{a}
Crude lipid	2.15^{a}	2.20^{a}	2.35^{a}	2.21^{a}	2.54^{a}	2.00^{a}
NFE	4.52^{a}	4.70^{a}	3.01^{a}	4.32^{a}	4.30^{a}	4.61^{a}

Same superscript on the same row are not significantly different ($p<0.05$)

Table 4: The survival and growth performance of *Clariasgariepinus* Juveniles fed the experimental diets 56 days

Diets	**Mean initial body Wt (g)**	**Mean final body wt (g)**	**Mean body wt gain (g)**	**% live wt gain**	**Mean initial standard length (cm)**	**Mean final standard length (cm)**	**Mean standard length gain (cm**	**Specific Growth Rate (SGR)**	**Feed Efficiency (FE)**	**Feed conversion Ratio (FCR)**	**Apparent Net Protein Utilization (NPU)**	**Protein Efficiency Ration (PER)**	**Gross feed conversion Efficiency (GFCE)**	**Survival Rate %**
	X± S.D	**X±S.D**	**X±S.D**	**X± S.D**	**X± S.D**	**X± S.D**	**X± S.D**	**X± S.D**	**X± S.D**	**X± S.D**	**X± S.D**	**X± S.D**	**X± S.D**	**X± S.D**
A **Control**	31.025^{a} ±0.23	31.912^{a} ±0.11	0.887^{b} ±0.40	2.859^{b} ±0.69	14.000^{a} ±0.27	14.363^{b} ±0.15	0.363^{a} ±0.23	0.00090^{b} ±0.31	0.00442^{a} ±0.08	1.685^{a} ±0.43	5.144^{c} ±0.23	1.304^{a} ±0.19	59.347^{b} ±0.55	**96.250^{a} ±0.41**
B 35%Raw	23.812^{ab} ±0.29	25.163^{cd} ±0.09	1.351^{a} ±0.88	5.674^{a} ±0.25	14.062^{a} ±0.31	14.137^{a} ±0.05	0.075^{c} ±0.02	0.00171^{a} ±0.44	0.00601^{a} ±0.23	1.465^{a} ±0.18	9.463^{c} ±0.22	0.273^{b} ±0.63	68.259^{a} ±0.33	**92.250^{ab} ±0.18**
C 20% Toasted	21.913^{b} ± 0.56	22.650^{d} ± 0.48	0.737^{b} ± 0.10	3.363^{b} ± 0.12	13.575^{a} ± 0.21	13.712^{a} ± 0.44	0.137^{b} ± 0.29	0.00103^{a} ± 0.11	0.00482^{a} ± 0.23	1.686^{a} ± 0.08	27.034^{b} ± 0.11	2.478^{a} ± 0.22	59.312^{b} ± 0.42	**89.375^{b} ± 0.31**
D 30% Toasted	25.700^{ab} ± 0.09	26.037^{bcd} ±0.21	0.337^{b} ±0.18	1.311^{b} ± 0.05	14.100^{a} ± 0.11	14.262^{a} ± 0.069	0.162^{b} ±0.31	0.00040^{b} ±0.24	0.00212^{a} ±0.21	1.522^{a} ±0.56	37.161^{a} ±0.38	0.754^{b} ±0.66	65.703^{a} ±0.21	**93.500^{ab} ±0.23**
E 35% Toasted	26.100^{ab} ± 0.15	29.225^{ab} ±0.16	3.125^{a} ± 0.90	11.973^{a} ±0.15	13.425^{a} ± 0.65	14.637^{a} ± 0.41	1.212^{a} ± 0.06	0.0002224^{a} ± 0.19	0.00830^{a} ± 0.21	0.475^{b} ± 0.28	40.361^{a} ± 0.22	0.186^{b} ± 0.33	69.797^{a} ± 1.06	**98.000^{a} ± 0.26**
F 40% Toasted	26.725^{ab} ± 0.19	26.937^{bc} ± 0.13	0.212^{b} ± 0.61	0.793^{b} ± 1.05	14.750^{a} ± 0.14	14.788^{a} ± 0.55	0.038^{c} ±0.02	0.00025^{b} ± 9.87	0.00113^{a} ±0.22	1.735^{a} ±0.44	21.554^{b} ±0.14	0.291^{b} ±0.19	57.637^{b} ±0.08	**96.250^{a} ±0.07**

Main values in column having same superscripts are not significantly different ($P>0.05$)

Table 4 shows the growth performance of *Clariasgariepinus* fed with the various experimental diets for 8 weeks. The mean body weight gain of the experimental fish ranged between 0.212 – 3.125 g. The weight gain of fish fed with the control diet (Diet A) was 0.887 g. Fish weight gain was highest in Diet E (3.125 g) and lowest in Diet F (0.212 g). There was significant difference ($p\leq0.05$) in the weight gain of fish fed with the experimental diets.
The percentage live weight gain of fish fed with Diet E was highest (11.973%) and lowest in Diet F (0.793%). The control diet recorded a percentage live weight gain of 2.859%. Diet B had 5.674%, Diet C had 3.363% and Diet D (1.311%). There was significant difference ($p\leq0.05$) in the percentage live weight gain of the fish.
This ranged from 0.038 – 1.212 cm. This was highest in Diet E (1.212 cm) and lowest in Diet F (0.038 cm). The control diet had 0.363 cm, Diet B had (0.075 cm), Diet C (0.137 cm) and Diet D (0.162 cm). There was no significant difference ($P>0.05$) in the standard length gain of the experimental fish.
The highest specific growth rate was recorded in Diet E (0.00224) while the lowest was in Diet F (0.00025). The control diet had a SGR of (0.00090), Diet B (0.00171), Diet C (0.00103) and Diet D (0.00040). There was no significant difference ($P>0.05$) in the specific growth rate of the experiment fish.
The fish fed Diet E recorded the highest feed efficiency (0.00830) and diet F had the lowest feed efficiency (0.00113). The control Diet had a feed efficiency of (0.00442), Diet B (0.00601), Diet C (0.00482) and D (0.00212). There was no significant difference ($P>0.05$) in the feed efficiency of the experimental fish.
The feed conversion ratio was lowest in (Diet E 0.475) and highest in (Diet F 1.735). Fish fed with the control Diet had a FCR of 1.685, Diet B (1.465), Diet C (1.686) and Diet D (1.522). There was no significant difference ($P>0.05$) between the Feed Conversion Ratio of fish given the control and the other diets.
TheNet Protein Utilization had 40.361% in Diet E, Diet D had 37.161%, Diet C 27.034%, Diet F 21.554% and Diet B 9.463%. There was a significant difference ($p\leq0.05$) in the Net Protein Utilization of the experimental fish fed with the various experimental diets.
The Protein Efficiency Ratio ranged from 0.186 for fish fed with Diet E (which was the lowest), to 2.478 in Diet C (which was the highest). Fish fed with the control diet recorded a PER of 1.304. Diets D, F and B had 0.754, 0.291 and 0.273, respectively. There was no significant difference ($p\leq0.05$) between Diets A and C, but there was a significant difference ($p\leq0.05$) between Diet C and the other diets.
The GFCE of fish given the experimental diets ranged from 57.637%, in Diet F to 69.797% in Diet E. In between this range was Diet B (68.259%), Diet D (65.703%), Diet A (59.347%) and Diet C (59.312%). Statistical analysis indicated a significant difference ($p\leq0.05$) in the GFCE of fish fed with the other experimental diets as compared to those fed with Diets B, D and E.
The highest survival rate of the fish was recorded in Diet E (98.000%) and the lowest was in Diet C (89.375%). Diets A and F had 96.250% while Diets B and D had 92.250 and 93.500%, respectively. There was significant difference ($p\leq0.05$) in the survival rate of the experimental fish.
The major limiting factor in fish culture is the water quality. The results of the water parameters reported in this work, were within the range of values recommended for the culture of *Clariasgariepinus* as defined for warm water fish species. Boyd (1979) reported that a temperature range of 22 – 27°C, pH range of 6.5 – 9.0 and Dissolved Oxygen range of 6.3 – 9.6 mg/l gives the best growth in cultured tropical fishes. Balogun *et al.* (2004) reported a temperature range of 23 – 27°C, pH 6.3 – 7.8 and Dissolved Oxygen of 6.3– 9.6 mg/l for the optimal growth and development of *Oreochromisniloticus* cultured under aquaria conditions. Since the physicochemical parameters reported in this work were within the recommended values, they were not a limiting factor to the growth performance of *Clariasgariepinus*. The only limiting factor could be the formulated experimental diets.
The moisture content of sesame was 1.50% in toasted and 2.15% raw and was lower than the values reported by Oshodi *et al.* (1999) who reported a range of 3.10 – 4.60%. The difference could be as a result of intra species difference and the toasting of the seeds, which further decreased the moisture content. The low moisture content of the seed indicated that it has a longer shelf life than most cereals. The high moisture content of cereals causes deterioration due to insect and fungal attacks.
The ash content and crude lipid of sesame seed were comparable to those reported by Ozkan and Akgul (1995). They reported a range of 3.67 – 5.39% for the ash content and 52.00 – 61.00% for crude lipid. The carbohydrate content of the seed ranged from 8.10 – 11.80% and was similar to the values reported by Dashak and Fali (1993) who recorded a range of 6.85 – 10.30%. The slight difference in the values could be as a result of reflection of variety, location and environmental influences.
The crude protein content of the seed ranged from 20.70% raw to 25.20% in toasted and these findings were similar to values reported for non – Nigerian sesame seeds (Joshi, 1961). The crude protein increased with toasting of the seed possibly as a result of the destruction of the anti-nutrients of sesame seeds.
The crude protein requirement of *Clariasgariepinus* was within the range reported by Ayinla and Akande (1988) as 31 – 34% for all the diets with the exception of Diet C (19.45%). The crude lipid contents of the experimental diets were lower than those recommended as standard lipid requirement of most tropical fishes which ranged from 8 – 10% (Adikwu, 1987). The growth performance of *Clariasgariepinus* juveniles fed with experimental diets for 56 days showed Diet E (35% Toasted) recording the highest body weight gain which was significantly higher ($p\leq0.05$) than in the control and other diets. Also, fish fed with Diet E had the highest standard length gain.
Balogun *et al.* (2004) reported that weight gain and standard length increase are known to be the most important indices for measuring fish responses to experimental diets and reliable indicators of growth.
The Specific Growth Rate showed a similar pattern with the body weight gain. Diet E recorded the highest Specific Growth Rate that was not significantly different ($p\leq0.05$) to diet B. The Feed Efficiency was also highest in Diet E (35% Toasted). However, it was not significantly different ($p\leq0.05$) from the other diets. The low values of the FE recorded could be as a result of the high fibre content of the experimental diets. *Clarias spp* being a carnivorous fish is not equipped to digest fibre, which is considered to contribute little to its nutrition Eyo, (2003).
The Feed Conversion Ratio is another growth parameter used to measure the gross utilization of food for growth and, according to Adikwu (2003), lower FCR implies efficient feed utilization by fish. Diet E therefore, with the lowest FCR recorded in this work had the best growth.
The Apparent Net Protein Utilization values recorded Diet E with the highest reading that was significantly different ($p\leq 0.05$) from the other diets. The Protein Efficiency Ratio also in Diet E was significantly higher than the other diets. However, Adikwu (2003) reported that the PER is not an accurate measure of growth and protein utilization in fish and other animals because PER implies that weight increase in

fish and other animals is mainly due to growth, and growth is defined strictly as increase in total body protein. However fat and water accumulation may result in weight increase in animals. The high level of growth indices recorded in Diet B (35% raw) could therefore be as a result of accumulation of water and oil. Eyo (1990) also reported the effect of temperature on the amino acids and anti-nutrient contents of soyabeans. Toasting the seeds at higher temperatures than the recommended values of 121 – 130°C denatures the essential amino acids especially lysine, hence rendering the proteins in soyabeans useless at high temperature. However at lower temperature, the anti-nutrients were still active.

Gross Feed Conversion Efficiency recorded in this work had Diet E having the highest value that was not significantly different ($p \leq 0.05$) from Diets B and D but differs significantly ($p \leq 0.05$) from Diets A, C and F.

The survival rate was high with very little mortality, implied that the juvenile *Clarias spp* were able to overcome the hazards of the feeding trials and tolerated the anti-nutrients present in their various diets. Diet E (35% toasted) inclusion recorded the highest survival rate.

Conclusion and Recommendations

The result obtained from this work indicated that sesame seed has the potentials of competing with other conventional sources of plant protein in the diet of *Clariasgariepinus*. Based on the growth indices recorded (i.e. MWG, MLG, SGR, FE, ANPU, as well as low FER), it can be concluded that fish fed Diet E (35% toasted) had the best growth performance.

Based on the findings of this experiment the following are recommended:

(a) Alternative fish protein source like sesame could be good source of diet in fish feed.
(b) Other processing methodologies such as parboiling and fermenting can be employed to find a better protein levels in feed formulations.
(c) Further studies in the inclusion of sesame seeds in fish feed involving other culturable fish species should be carried out.

Conflict of Interest

Authors declare that there is no conflict of interest reported in this work.

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