Paper ISSN 0189-0514
Online ISSN 1427-4410
J. Anim. Prod. Res. (2020) 34(2):105-118

National Animal Production Research Institute
Ahmadu Bello University
P.M.B 1096, Shika-Zaria,
Kaduna State, Nigeria.
Email:japr@napri.gov.ng Url:journals.napri.gov.ng

GROWTH PERFORMANCE OF AFRICAN CATFISH (*Clariasgariepinus*) JUVENILES FED WITH DIET OF DIFFERENT PROTEIN LEVELS

[1]Yunusa, A., [2]Yusuf. A., [1]Buba, W., [2]Muhammed, F. O. and [2]Salaudeen, M. M.
[1]National Agricultural Extension and Research Liaison Services (NAERLS) Ahmadu Bello University, Zaria, Nigeria.
[2]Department of Fisheries and Aquaculture, Prince Abubakar Audu University, Anyigba. Kogi State, Nigeria
Corresponding Author: ayunusa153@yahoo.com +2348032505232

ABSTRACT

A study was carried out in the Department of Fisheries and Aquaculture hatchery, Faculty of Agriculture, Prince Abubakar Audu University, Anyigba, Kogi State to determine the effect of different protein level diets on the growth performance of the African catfish *(Clariasgariepinus*) juveniles. Four experimental diets with various crude protein levels 25, 35, 45 and 55% were formulated using trial and error method. One hundred and eighty juveniles of African catfish of initial weight of 8.75g were distributed in twelve circular plastic containers: each container stocked with ten fishes fed with the four formulated diets for six weeks and each treatment replicated thrice. The result showed that the fish fed with highest protein (55%) level had the highest final weight (18.24 g) and weight gain (1.94g), while the fish fed with lowest protein (25%) level had the lowest final weight (13.55g) and weight gain (1.29g) The specific growth rate, protein efficiency ratio and food conversion ratio were recorded as 0.62 ± 0.24, 0.79 ± 0.03, and 5.08 ± 0.35respectively. The result showed an increase in growth indices with increase in dietary protein levels. Most of the growth indices such as mean weight gain (MWG) specific growth rate, (SGR), mean daily weight gain (MDW) and food conversion ratio (FCR), were higher (P>0.05) in juveniles fed with 55% crude protein. Higher dietary protein level was observed to give higher growth rate in this study and it is therefore recommended that juveniles of the African catfish are ought to be fed with higher protein level (55%) diet for optimum production.

Key words: *Growth Performance, African catfish, Protein level.*

INTRODUCTION

Nigeria is endowed with an estimated surface area of 12.5m ha of fresh water, dams, lakes, reservoirs and ponds which are capable of producing 105 metric tons of fish annually (Omitoyin, 2007). The estimated population of Nigeria is over 200 million while FAO (2014), estimated the annual fish demand in Nigeria as 1.5 million metric tons with an existing demand deficit of 1.0 million metric tons. The human demand for food fish rose from the consumption level of about 90 million metric tons to about 150 metric tons in the year 2016. This made the share of aquaculture in the total world food fish production to increase from 29% to 40% at the year 2016 (Aduku and Bolorunduro, 2016). To sustain such high rates of increase in aquaculture production, a matching increase of global levels of aqua-feed production is required (FAO, 2010).

One of the major factors militating against fish farming in Nigeria has been lack of adequate feed that are formulated to meet the nutrient requirements of cultivable fish species (Olaniyi, *et al.*, 2009). As such fishes do not attain market size at the right age (Gabriel *et al.*,

2007). Feed is one of the most critical factors to be considered for aquaculture (Kumar *et al.,* 2018). Lack of good quality feed for economic production adversely affects growth rates, disease manifestation and total harvest of fish. In fact, the growth of fish mainly depends on the dietary protein content. Dietary protein, not only provides energy and essential amino acids maintaining normal life but also affects physiological metabolism and immune function of fish (Zhao *et al.,* 2015). Nutritionists give priority to protein since it is the single ingredient needed in largest quantity for growth and development (Helfrich and Craig, 2002). Increase in dietary protein has often been associated with higher growth rates in many species. However, there is a protein level beyond which further growth is not supported and may even decrease (Yang *et al.,* 2014). While according to Ranjan *et al.* (2018), insufficient or excess protein levels in the diet is undesirable in the early development of fish.

Feed is a significant factor in increasing the productivity and profitability of aquaculture. Feed determines the viability of fish farming as it account between 60 and 62% of the total cost of production (Bolorunduro, 2016). It is expedient to know the actual nutritional requirement of catfish under varying culture conditions so that suitable diets can be formulated to maximize their growth, reproduction and maintenance of good health (Ozigbo *et al.,* 2014). Thus, Production of *C.gariepinus* can be economical only when its qualitative and quantitative feed requirements are known.

Also, protein requirement is given high priority in any nutritional study since it is the largest quantity for growth and development and also because it is the most expensive ingredient in the diet. Hence there is need to formulate fish feeds carefully to ensure that the protein fraction does not exceed the optimum level required by the fish in order to minimize wastage.

Clariasgariepenus a member of the catfish family called *Clariidae,* is a fresh water air-breathing aquaculture specie. It is one of the most important fish species currently being cultured both within and outside its natural range of tropical and subtropical environments (Adewolu *et al.,* 2008). The Clariid exhibit many qualities which make them suitable for culture; these include fast growth rate, high resistance to disease, tolerance to adverse environmental conditions, ability to feed on wide range of feed and capacity to withstand low pH and oxygen (Osborne *et al.,* 2019). It also has high feed efficiency and utilization. Nutritional Requirements of *Clariasgariepinus* showed that the species is euryphagic, it feeds predominantly on fish. Its propensity toward a carnivorous feeding habit suggests that *C. gariepinus* has a relatively high dietary protein requirement, in the order of 40–50 percent of crude protein on a dry weight basis (FAO, 2010).

Fagbenro and Davies (2013) reported that Clarias species has a high propensity to consume a wide variety of supplementary feeds thereby making it possible to combine a variety of conventional and non-conventional ingredients for formulating its diet. From a farming perspective, euryphagy holds the benefit that a wide variety of feed ingredients of animal and plant origin may be considered in formulating feeds that will satisfy the fish's dietary requirements (FAO, 2010).

Fingerlings of *Clariasgariepinus* have a high protein demand of around 45-50% and a high lipid requirement of 9% (Aduku and Bolorunduro, 2016). The carbohydrate content can be as high as 25-35% of the diet. A minimum level of 0.5 – 1 % n-fatty acids has been recommended. *Clariasgariepinus* fingerlings grow better if at least 10% of the total lipid consists of fish oil (Lim and Lee, 2009). It is recommended that minimum level is incorporated into the fingerling's feeds (Mugendi *et al.,* 2010). This shows that *Clariasgariepinus* fingerlings are capable of

digesting carbohydrates from early stage and this goes throughout the life of the fish span.

The nutrient requirement of *Clarias*gariepinus during the juvenile growth stage is from 40-43% crude protein (CP), 10-12% dietary lipid and between 15- 32 % for carbohydrates. Optimum digestible energy is between 14-16 kj/g and the protein to energy ratio is optimal between 26- 29 mg/kj of digestible energy (Prabu *et al*., 20017). Both plant and animal proteins are well digested and can be used at varying degrees to replace fish meal. It would appear that the average permissible carbohydrate level is around 27% and that cannot utilize dietary carbohydrate levels above 26 %. Sogbeson and Ugwumba (2006) found that dietary carbohydrate levels of between 26 – 32 % had significant protein sparing effect, advocating the greater use of carbohydrate in the diet formulation of juveniles of *Clariasgariepinus.* Adult fish require lesser amount of protein however the amino acid which make up that protein need to be available in certain ratios. Maintenance diets may contain as little as 25 to 35% crude protein (Francis-Floyd, 2004) and food for grow-outs often approach or exceed 40% crude protein.

The fish growth rate is maintained in different dietary protein content. Generally, the catfish growth rate increases with increasing dietary protein content until growth rate cease, indicating that the limit of response has occurred (Bolorunduro, 2016). The aim of this work is to determine the appropriate dietary protein level for the production of the African catfish.

MATERIALS AND METHODS

The study was carried out at the Department of Fisheries and Aquaculture hatchery, Faculty of Agriculture, Prince Abubakar Audu University, Anyigba, Kogi State, lies between Latitude 7° 28' 51.39" N and Longitude 7° 11' 14.86" E, within guinea savannah middle belt zones of Nigeria. The distribution of trees, grasses and other things in the area is determined by factors such as; fire, demographic pressure, patterns of cultivation, clearing and relief. Trees found in Anyigba do adapt to dry conditions (deciduous) and they shed their leaves in the dry season to control evapotranspiration (Ifatimehin *et al*., 2012).

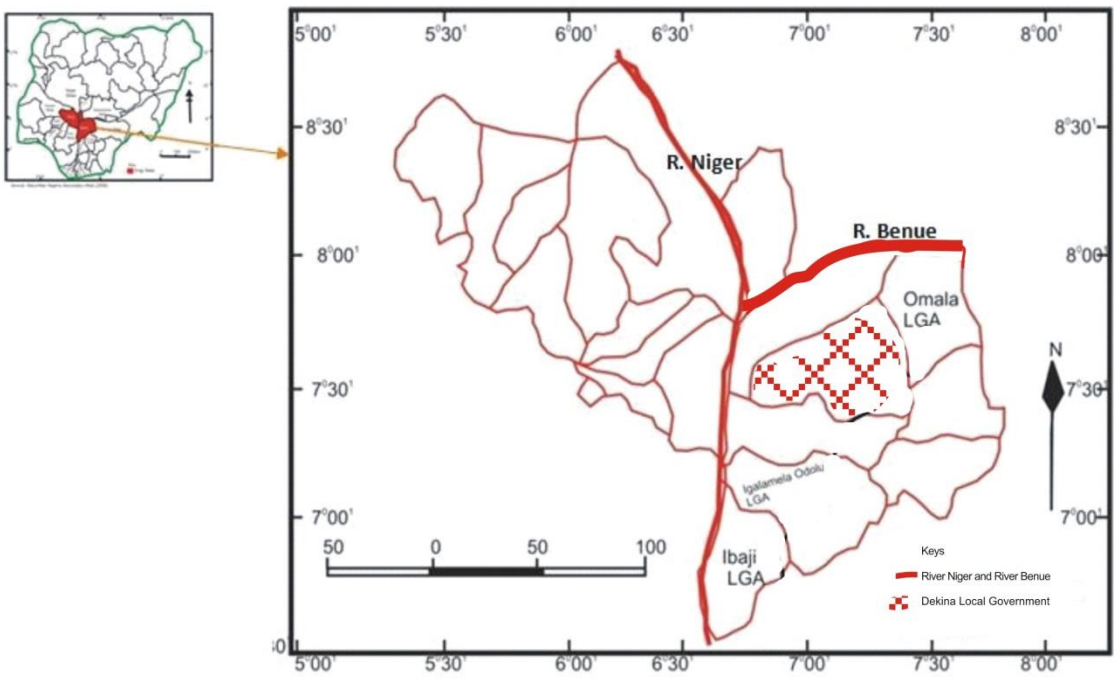

Fig.1: Map of Nigeria showing Kogi state and Dekina Local Government Area. Source: Department of Geography and Environmental Science, Prince AbubakarAudu University, Anyigba.

Collection of Fish

A total number of one hundred and twenty (120) *Clariasgariepinus* juveniles were used for the experiment. The fish were obtained from Success fish farm, Kubwa at Abuja. The fish were transported in a fifty litres (50) half-filled plastic Jerry can with water very early in the morning between 7.00am-10.00am to the Department of Fisheries and Aquaculture hatchery, Faculty of Agriculture, Anyigba, Kogi State. This was done to take advantage of the early morning low temperature after which they were immediately transferred into 4m x5m x1.3m tank dimension for a period of one week (acclimatization period).

Experimental Diet

A total of four diets were formulated with different crude protein level of 25%, 35%, 45%, and 55% crude protein (CP) levels respectively. Feedstuff used in formulating the diets included fish meal, soybean, groundnut cake, maize (yellow), premix, bone meal, salt, and vegetable oil. The experimental diet was formulated using trial and error method. The ingredients were then grinded and weighed out for each diet according to proportion into a clean basin. The grinded ingredients were hand mixed thoroughly to ensure homogeneity of the mixture and pelleted thereafter into 4mm size pellets. The pelleted feeds were sun dried for a day to constant weight.

Experimental Procedure

The juveniles were acclimatized in a 4m x5m x1.3m tank dimension for two weeks, and were given control diet in order to boost their appetite and stabilize them, they fish were physically examined to see if they were in good condition and also to observe any mortality, incidence of shooters or jumpers and to select uniform size to be cultured in the trial tanks. The juveniles were then starved for a day in other to empty their guts and prepare them for the experimental diet. The fish were fed at 3% of their body

weight and feeding was done manually by simply dropping the feed into the basins. The faecal materials were siphoned and the water replaced every day. The fish was stocked randomly in twelve 12 circular plastic basins (40 litres capacity and filled with 30 litres of water) at a stocking rate of 10 fish per basin. The twelve (12) tanks were assigned to four (4) treatments (different levels of CP) at a rate of one treatment per plastic basin with three (3) replicates per treatment. The fish in the various treatment groups were weighed at the beginning of the experiment and weekly for a period of six weeks using digital weighing scale. The quantity of feed was adjusted based on the body weight of the fish in each basin throughout the experiment. Water quality parameters was determined and maintained throughout the experiment.

Growth Parameter Measured

The growth parameters measured includes initial and final weight, mean weight gain (MWG), percentage mean weight gain (% MWG), feed conversion ratio (FCR), gross feed conversion efficiency (GFCE), specific growth rate (SGR), protein efficiency ratio (PER) and percentage survival rate.

Mean Weight Gain

This was calculated by finding the difference between the initial mean weight and final mean weight of the experimental fish (Falayi, 2009).

Mean weight gain = final mean weight – initial mean weight.

Percent Mean Weight Gain

This was calculated from the relationship between the mean weight gain of the fish expressed as a percentage of the initial mean weight (Falayi, 2009).

$$\text{Percentage mean weight gain} = \frac{\text{MWG} \times 100}{\text{IMW}}$$

Where, MWG = mean weight gain (g)

IMW = initial mean weight (g).

Feed Conversion Ratio (FCR)

This was expressed as the relationship between the average feed intake by each treatment and the mean weight gain. (Falayi, 2009).

$$\textbf{FCR} = \frac{\text{AFI}}{\text{MWG}}$$

Where, AFI = Average feed intake,

MWG = Mean weight gain

Specific Growth Rate (SGR)

The specific growth rate was calculated as described by Aderolu and Sogbesan (2010) as follows:

$$\textbf{SGR (\%)} = \frac{[(\text{Log}_e W2 - \text{Log}_e W1) \times 100]}{T}$$

Where W2 = final weight of fish,

W1 = initial weight of fish,

T = Experimental period of days,

Log_e= Natural logarithm to base 10

Protein Efficiency Ratio (PER)

This is the efficiency with which the fish utilizes dietary protein and is defined by the equation given by Osborne *et al.* (2019).

PER = weight gain (g) / protein fed.

$$\text{Where protein fed} = \frac{\% \text{ protein in the diet} \times \text{total weight of diet consumed}}{100}$$

Survival Rate (SR)

$$\textbf{SR} (\%) = \frac{\text{Ni} \times 100}{\overline{\text{No}}}$$

Where,

Ni = number of fish alive at end

No= number of fish alive at beginning of experiment

Statistical Analysis

All data collected from the study were subjected to 1-way analysis of variance (ANOVA). The significant difference between the means was determined by least significant difference (LSD) using the SPSS version 20 (2011) statistical software package.

RESULTS

The composition of experimental diets using trial and error method in the formulation is shown in table 1 below.

Table 1: Composition of experimental diet at different protein (CP) level

Ingredients	Diet1 25% CP	Diet2 35% CP	Diet3 45% CP	Diet4 55% CP
Fish meal	150	510	900	1560
Soybean meal	300	630	900	690
Maize	1800	1140	540	450
GNC	600	570	510	150
Bone meal	30	30	30	30
Premix	30	30	30	30
Lysine	15	15	15	15
Methionine	15	15	15	15
Vegetable oil	30	30	30	30
Salt	30	30	30	30

Growth Performance of *Clariasgariepinus*

Selected parameters are used to study the growth performance of the juveniles in response to feed with different protein level. The results of growth performance of *Clariasgariepinus* juveniles in terms of both final weight and mean weight gain are shown in Table 2 and Table 3, respectively.

Mean Initial Weight

The mean initial weight for the treatments is 8.74 g. The value of the mean initial weight per fish fed with the treatment diet range from 8.66-8.83g (Table 2) for the fish fed with 25%, 35%, 45%, and 55% crude protein inclusion level.

Mean Weekly and Final Weight

The result of the weekly weight recorded for the fish reveals that at week one, the fish have initial weight values that ranges from 8.66 and 8.79(g). Meanwhile for the subsequent weeks the fish have weight values that range from 8.84 and 10.19g for the second week, 9.52 and 11.50g for the third week, 10.13 and 12.62g for

the fourth week, 10.97 and 14.36g for the fifth week. The values of final weight per fish range from 12.26-16.3g for fish fed with the different crude protein level shown in Table 2.

Table 2: Weekly Mean weight recorded for fish fed with different protein level

Weeks	25%	35%	45%	55%
0	8.66^{d}	8.70^{c}	8.83^{a}	8.79^{b}
1	8.84^{a}	9.13^{a}	9.50^{a}	10.19^{a}
2	9.52^{b}	10.10^{b}	10.72^{a}	11.50^{a}
3	10.13^{b}	10.82^{b}	11.69^{ab}	12.62^{a}
4	10.97^{b}	11.84^{b}	13.08^{a}	14.36^{a}
5	12.26^{c}	12.87^{c}	14.64^{b}	16.3^{a}
6	13.55^{c}	13.90^{c}	16.20^{b}	18.24^{a}

*Means with different superscript letters within a row are significantly different ($P < 0.05$)

Mean Weight Gain

The mean weight gain for the fishes at week two are 0.18, 0.43, 0.67 and 1.4(g) for 25, 35, 45 and 55% Crude Protein level, respectively. The value of the mean weight gain increased weekly (Table 3) and it was recorded at week three to range from 0.68 and 1.31g ; week four is between 0.61 and 1.12g; week 5 is between 0.84 and 1.74g lastly at week six as 1.29, 1.03, 1.56 and 1.94g for 25, 35, 45 and 55% CP level, respectively.

The final weight gain (WG) increased as dietary protein level increased. Diet containing 55% CP results in greatest increase in body weight gain (7.4g) and percent weight gain (82.3%) of fish as shown in Table 4. Performance thereafter reduces as dietary protein increases from 55-45% (5.8 g and 65%). The least increases in weight of 3.5 g and 88.68% are observed in fish fed with 25% CP diet.

Table 3: **Weekly Mean weight gain recorded for fish fed with different protein level**

	Treatments			
Weeks	**25% CP**	**35% CP**	**45% CP**	**55% CP**
1	0.16^{d}	0.40^{c}	0.65^{b}	1.2^{a}
2	0.18^{d}	0.43^{c}	0.67^{b}	1.4^{a}
3	0.68^{c}	0.97^{b}	1.22^{a}	1.31^{a}
4	0.61^{b}	0.72^{b}	0.97^{a}	1.12^{a}
5	0.84^{c}	1.02^{b}	1.39^{b}	1.74^{a}
6	1.29^{b}	1.03^{b}	1.56^{a}	1.94^{a}

Means with different superscript letters within a row are significantly different ($P < 0.05$).

Growth Performance of *Clariasgariepinus*

Selected parameters are used to study the growth performance of the juveniles in response to feed with different protein level. Specific growth rate, percentage mean weight gain, protein efficiency ratio, feed conversion ratio and percentage survival rate of the juveniles are presented in Table 4. There is no significant difference ($P>0.05$) observed in the initial mean body weights of the juveniles (Table 4). Differences are observed in the values of the final mean body weights observed, with fish fed diet of 25% and 35% CP inclusion level recording the lowest final mean body weights which are significantly different ($P<0.05$) from the other diets (Table 4).

Protein Efficiency Ratio

The protein efficiency ratio ranges from 0.75 to 0.85 for 25 % CP, 0.63 to 0.69 for 35% CP, 0.61 to 0.75 for 45 % CP and 0.66 to 0.77 for 55% CP levels (Table 4). The protein Efficiency Ratio (PER) values indicates that fish diet with 35% CP level have the lowest value of PER (0.66). Meanwhile, the highest PER value is obtained from diet with 25% CP (0.79) as shown in Table 4.

Feed Conversion Ratio

The value of feed conversion rate (FCR) was observed to range from 4.67 and 5.33 for 25% CP, 4.0 and 4.42 for 35% CP, 2.95 and 3.66 for 45% CP and lastly from 2.33 and 2.72 for 55% CP level (Table 4). The FCR value is observed to be highest in feed diet with 25% crude protein level and is statistically similar to feed diet with 35% CP inclusion level (Table 4). Fish diet with 55% CP levels observed has the least value of FCR and is statistically similar to diet with 45% CP ($P>0.05$).

Specific Growth Rate

The specific growth rate (SGR) value ranges steadily from 0.34 to 0.38 for 25% CP, 0.39 to 0.42 for 35% CP, 0.47 to 0.55 for 45% CP and 0.58 to 0.66% for 55% CP level (Table 4). The mean value for 55%CP diet is highest with SGR value of 0.62% (Table 4). However, the values for 25% and 35% CP are the lowest with SGR values of 0.36 and 0.41

%, respectively and are both not significantly different (P>0.05) (Table4).

Percentage Survival Rate

There is a high survival rate in all the experimental treatments with fish fed diet containing 35% and 45% CP having a mean 100% survival rate while diet containing 25% and 55 CP having 95 % and 96% CP survival rate, respectively as observed in Table 4.

Table 4: Growth Performance of *Clariasgariepinus* juveniles fed with different protein level diets

Means with different superscript letters along the rows are significantly different (P < 0.05).

[1] mean initial weight [2] mean final weight [3] mean weight gain [4] percentage mean weight gain [5] protein efficiency ratio [6] feed conversion ratio [7] specific growth rates [8] percentage survival rate

Growth index	Crude protein level			
	25% (D1)	**35% (D2)**	**45%(D3)**	**55%(D4)**
IMW[1](g)	8.66 ± 0.18	8.68 ± 0.17	8.83 ± 0.14	8.8 ± 0.09
FMW[2] (g)	12.26 ± 0.24^{c}	12.87 ± 0.23^{c}	14.64 ± 0.38^{b}	16.3 ± 0.1^{a}
MWG[3] (g)	3.5 ± 0.23^{c}	4.2 ± 0.18^{c}	5.8 ± 0.3^{b}	7.4 ± 0.23^{a}
MWG[4] (%)	41.5 ± 1.7^{c}	48.5 ± 1.3^{c}	65 ± 4.2^{b}	82 ± 1.3^{a}
PER[5]	0.79 ± 0.03^{a}	0.66 ± 0.03^{b}	0.69 ± 0.07^{ab}	0.71 ± 0.05^{ab}
FCR[6]	5.08 ± 0.35^{a}	4.33 ± 0.2^{a}	3.21 ± 0.38^{b}	2.36 ± 0.20^{b}
SGR[7]	0.36 ± 0.01^{c}	0.41 ± 0.01^{c}	0.52 ± 0.23^{b}	0.62 ± 0.24^{a}
SR[8] (%)	95	100	100	96

DISCUSSION

After feeding the fishes with the different diet treatments (25%, 35%, 45% and 55% CP), the values of the initial mean weight range from 8.66 to 8.80g while there is a progressive increase in the final weight of the fishes with increasing crude protein level in the feeds. Feed with 55% CP level recorded highest mean final weight and the highest weight gain. The higher weight observed here can be attributed to adequate consumption and utilization of the feed by the fish.

Weight gain is an important index in measuring fish responses to experimental diets and it is also a reliable indicator of growth (Balogun *et al.*, 2004). The growth performance of fish fed with the experiment diets clearly shows that 55% CP inclusion level with observed 82.3% weight gain is better statistically (P>0.05) than the rest. This

could be attributed to better digestibility and utilization of the nutrients in the feed to produce good weight gain. There is no significant different (P>0.05) in diets with 25% and 35% CP inclusion level and they have the least weight gain. This finding is similar to the growth pattern of juveniles with inadequate protein in their diets as observed in various fish species like hybrid catfish (*Heterobranchusbidorsalis*x *Clariasanguillaris*) (Diyaware *et al*., 2009) and *Clariasgariepinus* (Farhat and Khan, 2011).

Thus, increasing protein level in diets can lead to improved fish production, as consistent intake of protein is required, since it is continually used by the fish to build new proteins. However, inadequate protein levels in the diets results in a reduction of growth and loss of weight of the fishes.

The Protein Efficiency Ratio (PER) indicates the weight gained per crude protein consumed by the fish. Excess protein beyond the required level needed by the fish will be excreted as nitrogenous wastes in form of ammonia through the gills (Lovell, 1981). This suggests that a higher PER value indicates a better utilization of the crude protein consumed. In this study, feed with 25 % CP level is preferred in terms of PER due to its high mean value while diet with 35% CP level which is observed to be lowest in terms of PER. Fish fed with diet containing 45% and 55% CP levels has PER values of 0.69 and 0.7, respectively, which are not statistically (P > 0.05) different from fish fed with diet having 35% CP and 25% CP level.

Values for feed conversion rate FCR obtained in this study appeared to decrease with increase in protein level within the range of 25-55% CP. The higher FCR for 25 and 35% CP diets indicates that food utilization becomes less efficient and apparently fish did not consume the amount of protein needed for optimum growth (Anguas-Vélez *et al.,* 2000). The result of this finding agrees with the findings of Reginald and Odite (2014) on *Clariasgariepinus* fingerlings and also with the findings of Mouhamadou (2013) which reported that the best FCR were obtained at 45% protein level with *Florida pompano.*

Specific growth rate (SGR) values for this study are low and the low values observed for the fish can be attributed to its developmental phase, since the value of SGR decreases as fish increases in size (Aderolu and Sogbesan 2010). The best SGR obtained in this study (0.62%/d) with dietary protein 55% is far from 5.5% reported by Reginald and Odite (2014) (50% CP) for fish of the same species, although smaller in sizes than the fish in this study.

The high survival rate recorded in the study could be attributed to the optimum maintenance and management of physico-chemical parameters of the water and also due to the good health condition of the fish. The percentage survival rates show no significant difference (P>0.05) among the fish fed different crude protein diets.

CONCLUSION

The dietary protein level significantly influenced the growth performance of the juveniles. It was also observed that there was progressive increase in weight gain of the fish as the crude protein in the diet increased. The feed conversion rate (FCR) value was higher in feed diet containing lower crude protein level. From the result of this study, it can be concluded that juveniles of African cat fish (*Clariasgariepinus*) should be fed with higher protein level diet to maximize production.

RECOMMENDATION

It is recommended that *Clariasgariepinus*juveniles should be fed diet with diet containing 55% CP.

REFERENCES

Aderolu, A. Z. and Sogbesan, O. A. (2010). Evaluation and Potential of Cocoyam as Carbohydrate Source in Catfish, (*Clariasgariepinus*[Burchell, 1822]) Juvenile Diets.*African Journal of Agriculture Research,* 5 (6): 453 – 457

Adewolu, M. A., Adeniji, C. A. and Adejobi, B. (2008). Feed utilization, growth, and survival of *Clariasgariepinus* (Burchell 1822) fingerlings cultured under different photoperiods. *Aquaculture*, 283: 64–67.

Aduku, A. O. and Bolorunduro, P. I. (2016). Practical Livestock and Fish Feeds Production in the Tropics. Revised Edition, T.W. Press and Publishers.ISBN-2528-20-X.V.V. 3, Keffi/ Lagos Street, Kaduna-Nigeria, 20-34.

Anguas-Vélez, B. H,, Civera-Cerecedo, R., Cadena-Roa, M., Guillaume, J. and Martinez-Diaz, S. F. (2000) *Studies on the Nutrition of Spotted Sand Bass*Paralabraxmaculatofasciatus: Effect of the Dietary Protein Level on Growth and Protein utilization in Juveniles Fed Semi Purified Diets. *Journal of World Aquaculture Society* 31: 580-591.

Balogun, J. K. S., Abdullahi, A. S., Auta, J. and Ogunlade, O. P. (2004). Feed Conversion, Protein Efficiency, Digestibility and Growth Performance of *Oreochromisniloticus* fed *Delinixregia* seed meal. Proceedings of the NationalConference of Fisheries Society of Nigeria (FISON), Lagos, Nigeria. 838 – 842pp.

Bolorunduro, P. I. (2002). Feed Formulation and Feeding Practices in Fish Culture. Extension Bulletin. No. 152. Fisheries Series, No. 8.NAERLS. A.B.U., Zaria. 7p. Bolorunduro, P.I. (2016). Fisheries Extension Service in Nigeria.*Extension Bulletin Fisheries Series* No 5, 30.

Diyaware, M. Y., Modu1, B. M., and Yakubu, U. P. (2009). Effect of different dietary protein levels on growth performance and feed utilization of hybrid catfish (*Heterobranchusbidorsalis*x *Clariasanguillaris*) fry in north-east Nigeria. *African Journal of Biotechnology,* Vol. 8 (16): 3954-3957.

F.A.O. (2014). World Review of Fisheries and Aquaculture, 3 edn, Academic Press, New York, U.S.A. 88-90.

Fagbenro, E. A. and Davies, S. J. (2013). Use of high percentages of soybean protein concentrate as fishmeal substitute in practical diets for African catfish, *Clariasgariepinus* (Burchel 1822): Growth, Feed Utilization and Digestibility. *Journal ofApplied Aquaculture,* 16 (22):233-253.

Falayi, B.A. (2009). Tropical Feedstuffs Comp osition Tables and Some Biological Catalogues in *Fish and Livestock Production (A Guide, in Nutrition Technology).* Matt Printing Press 69, Second West Circular Road Benin City, Edo State Nigeria, 77p.

FAO. (2010). NorthAfricancatfishdocument, 18p.www.fao_fira.com/Africancatfish.

Farhat, G. and Mukhtar, A. K. (2011).Growth, Feed Conversion, and Nutrient Retention Efficiency of African catfish, *Clariasgariepinus*, (Burchell) Fingerling Fed Dietswith Varying Levels of Protein.*Journal of Applied Aquaculture*, 23:304–316pp

Francis, G., Makkar, H.P.S. and Becker, K. (2001).Antinutritional factors present in plant derived alternate fish feed ingredients and their effects in fish. *Aquaculture,* 199:197- 227.

Gabriel, U. U., Akinrotimi, O. A., Bekibebe, D. O. and Anyanwu, P.E. (2007). Locally produced fish feed: Potentials for aquaculture development in sub-Saharan

Africa. *Africa Journal of Agriculture Research*, 2(2):287-295.

Helfrich, L. A. and Craig, S. (2002). *Understanding Fish Nutrition, Feeds and Feeding*.Virginia Cooperative Extension Service Publication. Retrieved November 3, 2019, from: http://www.ext.vt.edu/pubs/fishries/420-256/420-256.html

Ifatimehin, O. O., Odogbo, E. V. and Falola, O.O. (2012). An Analysis of the Spatial Distribution of Plasmodium sporozoites and Effects of Climatic correlates on Malaria Infection in Anyigba Town, Nigeria. *Journal of Natural and Applied Sciences. 3(2): 93-104.*

Kumar, S., Sahu, N. P. and Ranjan, A. (2018). Feeding de-oiled rice bran (DORB) to Rohu, Labeorohita : effect of varying dietary protein and lipid level on growth, body composition, and insulin like growth factor (IGF) expression. *Aquaculture* 4 (9 2): 5 9 – 66.

Lovell, R. T. (1989). *Nutrition and Feeding of Fish*. New York: Van Nostrand Reinhold, Chapman and Hall.

Mouhamadou Amadou, L. Y. (2014). Effect of Dietary Protein Level on Growth and Body Composition of Juveniles Nile Perch (*Latesniloticus*, Linnaeus 1758) *Journal of Biology and Life Science*ISSN 2157-6076 2014, Vol. 5, No. 1

Mugendi, I.B., Njagi, E.N.M., Kuria, E.N., Mwasoru, M.A., Miereithi, J.G. and Apostolides, Z. (2010). Effects of processing technique on the nutritional composition and anti-nutrient content of mucuna been (*Mucunapruriens* L.). *African Journal of Food Science*, 4 (4):156-166.

Olaniyi, C.O., Biniomote, T. and Gbadamosi, M. (2009).*Growth Performance and Nutrient Utilization of Clariasgariepnus fed processed Mucuna seed meal*. In: Proceeding 34 Annual Conference, Nigerian Society for Animal Production, pp. 222-225.

Omitoyin, B. O. (2007). Plasma biochemical changes in *Clariasgariepinus* (Burchell, 1822) fed poultry litter. *Asian Journal of Animal Science*,5(1):48-52.

Osborne, T. B., Mendel, L. B. and Ferry, E. L. (1919). A method for expressing numerically the growth-promoting Value of Olili, H.K. and Krogdahl A. (1994) Soybean trypsin inhibitors in diets for Atlantic Salmon (*SalmoSalar L.*): Effects on 60 nutrient digestibility and trypsin in pyloric proteins *Journal of Biochemistry*, **37**: 223 – 229pp.

Ozigbo, E., Anyadike, C., Adegbite, O. S. and Kolawole, P. (2014). Review of aquaculture production and management in Nigeria. *American Journal of Experimental Agriculture*, 4(10): 1137 – 1151.

Prabu, E., Felix, S., Felix, N., Ahilan, B. and Ruby, P. (2017). An overview on significance of fish nutrition in aquaculture industry. *International Journal of Fisheries and Aquatic Studies*, 5(6): 349-355.

Ranjan, A., Sahu, N. P., Deo, A. D. (2018). Comparative growth performance, in vivo digestibility and enzyme activities of Labeorohita fed with DORB based formulated diet and commercial carp feed. *Turk J Fish Aquaculture Sci* 18:1025–1036.

Reginald, I. K. and Odite, B. (2014). Effect of Varying Dietary Protein Levels on Growth and Nutrient Utilization of African Catfish. *Clariasgariepinus* Fingerlings. *Journal of Experimental Biology and Agricultural Sciences*, February, Volume – 2(1).

Sogbesan, O. A., Ugwumba, A. A. A. and Madu, C. T. (2006). Nutritive potential and utilization of garden snail (Limicolariaaurota) meat in the diet of *Clariasgariepinus* fingerlings. *African Journal of Biotechnology,*5(20):1999-2003.

Yang, S. D., Liou, C. H., and Liu, F. G. (2014). Effects of dietary protein level on growth performance, carcass composition and ammonia excretion in juvenile silver perch (*Bidyanusbidyanus*). *Aquaculure*, 213: 363–372.

Zhao, J., Wen, X., Li, S., Zhu, D. and Li, Y. (2015). Effects of dietary lipid levels on growth, feed utilization, body composition and antioxidants of juvenile mud crab Scylla paramamosain (Estampador). *Aquaculture* 435:200–206.