THE EFFECT OF PARTIAL REPLACEMENT FOR FISH MEAL WITH FEATHER MEAL IN THE GROWTH PERFORMANCE OF CATFISH (*Clarias gariepinus*)

[1] GANA, E.S, [2] OMOBOSOLA, V.B and [3] AGBO, N.O
[1 & 2] *Faculty of Agriculture, University of Abuja*
[3] *National Open University of Nigeria*
Email: sundefian@yahoo.com **GSM:** 08060662972

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ABSTRACT

The research studied the effect of partial replacement for fish meal with feather meal in the growth performance of catfish,A total number of seventy-five (75) fingerlings divided into five treatments of varying inclusion levels of 0%,25%,50%, 75% and 100% respectively were used to partially replace fish meal with feather meal with the objectives to determine the proximate analysis, growth performance and water quality in which the fingerlings thrive, for the proximate analysis, moisture content, crude protein, ash content, lipid content and crude fiber content were investigated, also for growth performance, parameter investigated were specific growth rate, feed conversion ratio, percentage weight gain and survival rate, on the other hand, water quality parameters measured were , temperature, Dissolved oxygen, $P_{H,}$ nitrite and nitrate, values for crude Protein ranges between (40.58 – 45.92%), fats (1.39 – 1.74%), crude fibre (1.93 – 1.97%), moisture (87.94 – 89.11%), ash (10.48 – 13.72%) and energy (2474.07 – 2499.97Kcal/kg), All the parameters measured were significantly different among the treatments ($p<0.05$), Growth performance of catfish (Clarias gariepinus) fed different inclusion of feather meal show Initial body weight, final body weight, body weight gain, initial body length, final body length, increasing body length, specific growth rate, feed conversion ratio values range between 2.40 – 2.37g, 18.80 – 6.90g, 16.40 – 4.53g, 9.44 – 9.33cm, 16.43 – 9.53cm, 6.99 – 0.27cm, 29.29 – 8.10 and 8.78 – 14.50 respectively. All the parameters were significantly different among the treatments. ($p<0.05$), Physic-chemical analysis of African catfish fed with different inclusion level of feather meal show pH, temperature alkalinity, dissolved oxygen nitrate and nitrite values ranges between 6.83 – 7.11, 27.40 – 27.57^{0}C, 76.92 – 89.04Mg/l, 7.83 – 10.10mg/l, 4.23 – 1.22mg/l, 1.19 – 0.06mg/l respectively, all the parameters were significantly ($p<0.05$) influenced by the dietary inclusion of feather meal,the high body weight gain in T1 and T2 could also be attributed to the 25% and 50% inclusion level of feather meal in the experimental diet, In terms of growth performance, feed conversion ratio serves as a chief indicator for growth performance, result shows that T1 and T2 has the best replacement level, as inclusion level of feather meal increases there was also a proportional increase in parameters (protein, fat, fibre, ash, moisture) taken, Furthermore, as the level of inclusion increases all the water parameter determined also increased with a detrimental consequence, thus, there was incremental mortality noticed suggesting increase in feather meal can proportionally affect the survival rate of the fingerlings, the study shows that 25%to 50% replacement of fish meals with feather meal is ideal for optimum growth and nutrient utilization of the fish. Substituting fish meal with feather meals in the feed of Clarias gariepinus would indirectly reduce the feed production cost as feather meal has been shown to be a convenient economically viable, protein- rich feed ingredient and as unconventional source of feeding Clarias gariepinus

Keywords: *Clarias gariepinus*, feather meal, Fish meal and growth performance

INTRODUCTION

According to Amienghene (2005), the African cat fish (*Clarias gariepinus*) is a widely recognized and easily accessible fish in Nigeria. It inhibits various fresh water bodies in and around communities in different form, including sun dried preparation and pepper soup and for example, Different Nigeria tribes have distinct local names for the cat fish (*Clarias gariepinus*) as follow the hausa people call It "kusadabaki or Tarwada" the Yoruba called it "Aro" and the igbo call it "Okpo and Gbari people call it Gyaddah (Lamai, 2011).

The major item in recurrent cost in production is feed. This item cost alone has progressively taken the large share of the cost of production, so the total feed cost account for over 60% percent or total production cost. The pre-requiste for successful fish farming is the availability of suitable artificial formulated feed from locally available nutritional requirement of the fish culture (Adebayo and Faphunda, 2005).

Locally produced feed reduces the cost production and hence cheaper means of meeting the protein requirement to improve food security and reduced the level of poverty and locally available feed stuff in developing countries, this inexpesive and locally available feedstuff are to be identified. The search for alternative protein source is to be focused on by-product and material which are not suitable for direct human consumption the proportion or protein in fish is higher than those of other culture animal, this makes fish meal very exorbitant (Ali, 2008)

Feather meal is one of the poultry by- product which contain high protein content (80-85 percent) and commercially available with some chemical treatment, it can be a good source of the sulphur-containing amino acid (Bertsch 1980 and coello 2005), feather meal is relatively low in essential amino acid, including lysine, methionine and histidine (Hertrampf and piedad-pascual 2000) which are required for fish growth and health. Besides, the cost of feather meal is approximately two thirds less than the costs of other animal proteins in the market and it is readily available from many sources (Bishop *et al.,* 1995).

The feed industry is faced with enormous challenges not only regarding the availability of feed ingredient but also the ability to produce high quality product in a cost-effective manner (Chauynarong *et al.,*2009). Increased competition for available conventional feed and scarcity of food has led to the need for research into the use of unconventional feedstuff with no competition with man, that could meet the nutritional need of livestock and possibly substitute more expensive protein (groundnut cake and soy beans) and energy source (maize) in future (Onyimonony and onukwufor,2003).

Objective of this research

The overall aim of the research is to evaluate effect of partial replacement of fish meal with feather meal in the growth performance of catfish (*Clarias gariepinus*).

The specific objectives of the study are:

a. Access the growth of (*Clarias gariepinus)* feed with feather meal using the following indices:

percentage weight gain, feed conversion ratio, mean growth rate, specific growth rate and survival ratio

b. Evaluate the physio chemical parameter of water

c. Access the Proximate analysis of the feed ingredient

Materials and methods

An indoor system of fish farming was applied in order to assess the efficacy of feather meal in the diet of African catfish *(clarias gariepinus*) so as to determine the growth performance, water parameters using the necessary materials needed such as ruler (calibrated in cm), thermometer, PH meter, weighing balance and indoor tanks.

Experimental site and duration of the study

The experiment was carried out at the fishery

unit in university of Abuja, permanent site faculty of Agriculture, federal capital territory (F.C.T) Abuja. The project lasted for 8 weeks.

Materials and preparation of experimental test

The catfish (*Clarias gariepinus*) was cultured in 5 indoor tanks with one control which were 5 treatments with 3 replicate each.

Data collection

Seventy-Five (75) fingerlings catfish (*clarias gariepinus*) were obtained from a reputable fish farm in kuje, Abuja. The ages of the fingerlings were 4 weeks; the weight and length were recorded. *Clarias gariepinus* were acclimatized for a period of 5 - 7 days to adapt to the new environment. The 75 fingerlings were reared in an indoor tank and their growth weight were observed and analyzed by random selection. The fish were fed for a period of 8 weeks at the rate of 5% of their body weight per day, shared between morning(7am-8am) and evening (5pm-6pm), while the water of all the treatments was changed manually at the end of each week. The quantity of feed given was calculated thus;

$$\text{Quantity of feed (g)} = \text{total weight of fish} \times \frac{5}{100}$$

Length and weight measurements of the juveniles were taken at the start of the experiment using a meter rule and a sensitive weighing balance. And at weekly intervals, the fish in each tank were weighed and the average length and weight of the fishes in each tank were measured. Water pH and temperature records were taken on a daily basis with a pH meter and laboratory mercury thermometer (0^{o}-100^{0}c) respectively. Daily mortalities of fish in the tanks were recorded as described by (Agbon, 2012).

FEED AND SUPPLEMENT PREPARATION

Feather meal was obtained from omaga farm, oyo. Other ingredients such as groundnut cake, soybeans meal, fish meal, yellow maize, maize offal was purchased from Gwagwalada market, Abuja and brought to the fishery unit of faculty of agriculture, university of Abuja, for feed formulation.

The feather meal was supplemented into the feed at (0%,25%,50%,75% and 100% respectively); maize, groundnut cake, soy beans and maize offal were collected and homogenized prior to application in treatment 0,1,2,3 and 4 respectively, while there was no percentage of feather meal in the control.

Experimental diet

Five experimental diets were formulated using maize, groundnut cake, fish meal, soya beans meal, feather meal all grind and pellet. Pro-biotic enzymes were added to the feed for easy digestion. The feather meal is mixed with the other ingredients to form five treatments of 0% 25%, 50%, 75% and 100% replacement for fishmeal in the diet, the control (T_o) feed had no inclusion level of feather meal. Below is the composition of the diet used.

Measuring of growth performance

The initial body weight, initial body length and weekly body weight gain, increase in body length of the fish were recorded for analysis.

The parameters are calculated as follow:

1. Specific growth rate

$$\text{Specific growth rate} = \frac{W2 - W1}{T} \times \frac{100}{1}$$

W2= final weight of fish

W1 = initial weight of fish

T1= period of experiment in day

2. Feed conversion ratio

$$\text{Feed conversion ratio (FCR)} = \frac{\textit{Total Feed given (g)}}{\textit{Weight gain (g)}} X \frac{100}{1}$$

3. Percentage weight gain

$$\text{Percentage weight gain} = \frac{\textit{Gain in Weight}}{\textit{Initial Weight}} \; X\,100$$

4. Survival ratio

$$\text{Survival rate} = \frac{\text{Total number of fish at harvest}}{\text{Number of fish stocked}} \times \frac{100}{1}$$

5. Mean growth rate

$$\text{Mean growth rate (MGR)} = \frac{W_2 - W_1}{0.5(W_1+W_2)\,t} \times \frac{100}{1}$$

Where t = period of the experiment in days
W_1 = initial weight
W_2 = final weight

Water quality parameters

Water quality was monitored regularly in all the experiment system to ensure that the water used have optimum required quality for fish culture. The parameters that were measured included dissolved oxygen, PH, conductivity, temperature, nitrate and nitrite.

Dissolved oxygen was determined by winkle methods as described in (Hassan, 2019), water sample were collected weekly and taken to the laboratory for analysis.

The PH was determined from water sample taken to the laboratory using KENTAL pH model 7045/46 according to the method described by (Hassan 2019).

Conductivity of water sample taken to laboratory was measured with conductivity water, using model JENWAY 4010 according to the method described by (Hassan 2019) reading was expressed in N-siemen/ cm.

The temperature was determined daily to the nearest ^{o}C with the aid of mercury in glass thermometer. Griess reaction and cadmium reduction method is used to determine nitate and nitrite level according to the method described by (Griess 1879; cataldo et al., 1975).

Proximate composition

The proximate composition of the feed was carried out using the methods of Association of Analytical Chemist (AOAC, 2006). The parameters analyzed include moisture, protein, ash, fibre and lipid.

Determination of moisture content

The moisture content of the sample was determined by drying the sample in the dark room for 336 hours (14 days). The moisture loss was determined by measurement of water in the sample which was expressed as a percentage of the initial sample weight.

%moisture content=

Determination of Crude Protein Content

$$\frac{\textit{weight of wet sample} - \textit{weight of dry sample}}{\textit{Weight of sample}} \times \frac{\textit{100}}{\textit{1}}$$

0.5- 1.0g of the sample were digested with 20ml of concentrated sulphuric acid and a mercuric digestion table. The digested samples were heated on a mantle until the solution becomes clear. The ammonia in the digested sample was released when reacted with 10ml of 40% sodium hydroxide during distillation which was trapped in 20% boric and mixed with methyl red indicator. 50 - 75ml of distill was collected and titrated against standardized 0.1ml hydrochloric acid. The digest treated the same way was used as blank titre.

%crude protein=

$$\frac{\textit{Sample tire - blank tire}}{\textit{Weight of sample}} \times 0.1 \times 0.014 \times 6.25 \times \frac{100}{1}$$

Determination of ash content

This is the measurement of total inorganic matter by incineration. 2g of sample X $\frac{100}{1}$

Weighted with a W1 crucible and incineration in muffed furnace at 600oc for 12 hours. At the completion of ashing, samples were cooled in a desiccators. Weight of the crucible after incineration W2 represent the ash expressed as a percentage of the original weight.

%Ash=

Determination of lipid content

$$\frac{W1 - W2}{Weight\ of\ sample} \quad X \quad \frac{100}{1}$$

The method of solvent extraction, using Soxhlet extractor was used. 1.2g of sample was weighed into a filter paper thimble, corked with Colton wool as W1 and put into the extracting chamber. The chamber was filled with (40-60b.pt) petroleum ether to overflow into a receiving flask, thereby flushing the thimble once in a while. The extractor was then filled to about two-third its volume with the setup into the water source that was continuously running through the condenser. Extraction was carried out for minimum of 6hours until it becomes colorless, an indication that the crude lipid content has been completely extracted from the extractor's chamber. Extracted sample in the filter paper thimble was removed, oven dried, cooled in the dessicators and overweighed (W2). Percentage of crude lipid was calculated as follows:

$$\%Crude\ Lipid = \frac{W1\text{-}W2}{Weight\ of\ sample} \times \frac{100}{1}$$

Determination of crude fibre

The method of solvent extraction using solvent extractor was used. 1.2g of sample were weighted into a filter paper thimble and corked with cotton wool as W1 and put into the extracting chamber. They were filled with (40 - 60) petroleum either to overflow into a receiving flask, thereby flushing the thimble once in a while the extractor was then filled to about two - third its volume, with the setup into water source that was continuously running of six hours until it become colorless an indication that the crude lipid content has been completely extracted from the extractors chamber. Extracted in the filter paper thimble was removed, oven dried, cooled in a desiccator and reweighed (W2) percentage of crude lipid content was calculated as;

$$\%\ Ether\ extract = \frac{W1\text{-}W2}{Weight\ of\ sample} \times \frac{100}{1}$$

Statistical analysis

The statistical tool used was Statistical Package for Social Science (SPSS) where the mean was separated by Duncan multiple tests.

Experimental design

EPLICATES	**T0**	**T1**	**T2**	**T3**	**T4**
1	T_0r_1	T_1r_1	T_2r_1	T_3r_1	T_4r_1
2	T_0r_2	T_1r_2	T_2r_2	T_3r_2	T_4r_2
3	T_0r_3	T_1r_3	T_2r_3	T_3r_3	T_4r_3

RESULTS

Table 1: COMPOSITION OF THE EXPERIMENTAL DIET (KG/100KG)

Treatment	T0%	T1%	T2%	T3%	T4%
Maize offal	10	10	10	10	10
Yellow maize	25	25	25	25	25
Groundnut cake	23.4	23.4	23.4	23.4	23.4
Soya beans meal	23.3	23.3	23.3	23.3	23.3
Fish meal	16	11	6	1	-
Feather meal	-	5	10	15	16
Probiotic Enzymes	2	2	2	2	2
Salt	0.3	0.3	0.3	0.3	0.3
TOTAL	100	100	100	100	100

Treatment 0 = 0% feather meal
Treatment 1 = 25% feather meal
Treatment 2 = 50% feather meal
Treatment 3 = 75% feather meal
Treatment 4 = 100% feather meal

Table 1, show the feed formulation that was used in this research, the different types ingredients include yellow maize, soya bean meal, maize offal, fish meal feather meal, groundnut cake, probiotics enzymes and different proportions. The values of both fish meal and feather meal were
the variables of interest in this research which had an inclusion increase of twenty five percent

Nutritional value of feather meal

Table 2. Nutrient composition of Feather meal

Parameters	%
Dry matter	90%
Crude protein	82%
Digestibility	75 % min
Fat	6%
Ash	4%
Crude fibre	0.60%
Available lysine	1.80%
Methionine + cysteine	4.90%
TMEn	3.07Kcal/g (12.8MJ/Kg)

Source: Soni *et al.* (2017).

Table 2: show the nutrient composition of feather meal, worthy of note, is the value of crude protein, this value of 82% is similar to crude protein value obtainable in fish meal that ranges from 60-80%. Furthermore, values of both lysine and methionine were appreciable

Table 3: Growth performance of catfish fed with different inclusion level of feather meal

Parameters	T0	T1	T2	T3	T4	SEM±
Initial body weight(g)	2.40^{a}	2.30^{a}	2.27^{a}	2.30^{a}	2.37^{a}	0.03
Final body weight(g)	18.80^{d}	12.40^{c}	10.63^{b}	7.70^{a}	6.90^{a}	1.14
Body weight gain(g)	16.40^{e}	10.10^{d}	8.37^{c}	5.40^{a}	4.53^{a}	1.13
Initial body length(cm)	9.44^{b}	9.09^{a}	8.70^{a}	9.15^{a}	9.33^{b}	0.09
Final body length(cm)	16.43^{e}	12.20^{d}	11.37^{c}	10.70^{b}	9.57^{a}	0.63
Increasing body length(cm)	6.99^{a}	3.10^{c}	2.63^{c}	1.55^{b}	0.27^{a}	0.61
Feed conversion ratio	8.78^{a}	10.66^{b}	10.72^{b}	13.49^{c}	14.50^{c}	0.57
Specific growth rate	29.29^{e}	18.03^{d}	14.94^{c}	9.64^{a}	8.10^{a}	2.02
Mean growth rate	14.65^{d}	9.02^{c}	7.47^{b}	3.99^{a}	4.05^{a}	1.05
Survival rate	100.00^{c}	93.33^{bc}	86.67^{bc}	80.00^{ab}	7.33^{a}	3.19
Mortality ratio	0.00^{a}	0.00^{a}	0.33^{a}	1.00^{b}	1.67^{c}	0.19

Means in the same row with different superscripts differ significantly(p<0.05)

T0 = *0% feather meal*, T1 = *25% feather meal*, T2 = *50% feather meal*, T3 = *75% feather meal*, T4 = *100% feather meal*, SEM – *Standard Error Mean*

Growth performance of catfish (*Clarias gariepinus*) fed different inclusion of feather meal is presented in table 3. Initial body weight, final body weight, body weight gain, initial body length, final body length, increasing body length, specific growth rate, feed conversion ratio values range between 2.40 – 2.37g, 18.80 – 6.90g, 16.40 – 4.53g, 9.44 – 9.33cm, 16.43 – 9.53cm, 6.99 – 0.27cm, 29.29 – 8.10 and 8.78 – 14.50 respectively. All the parameters were significantly different among the treatments. (p<0.05)

Table 4: PHYSIO-CHEMICAL ANALYSIS OF JUVENILE CATFISH FED WITH DIFFERENT INCLUSION LEVEL OF FEATHER MEAL

Parameters	T0	T1	T2	T3	T4	SEM±
$_{p}$H	6.83^{a}	7.01^{b}	7.03^{b}	7.07^{c}	7.11^{e}	0.03
Temperature(^{0}C)	27.40^{c}	27.89^{b}	28.77^{c}	27.69^{d}	27.57^{e}	0.13
Alkalinity(mg/l)	76.92^{a}	87.10^{b}	87.11^{c}	86.19^{c}	89.04^{d}	1.14
Nitrate(mg/l)	4.23^{a}	2.82^{b}	1.34^{c}	1.28^{d}	1.22^{e}	0.32
Nitrite(mg/l)	1.19^{a}	0.09^{a}	0.39^{a}	0.08^{a}	0.06^{b}	0.13
Dissolved Oxygen(mg/l)	7.83^{a}	8.66^{b}	9.84^{b}	9.93^{d}	10.10^{e}	0.23

Means in the same row with different superscripts differ significantly ($p<0.05$)
T0 = *0% feather meal*, T1 = *25% feather meal*, T2 = *50% feather meal*, T3 = *75% feather meal*, T4 = *100% feather meal*, SEM – *Standard Error Mean.*
Physic-chemical analysis of African catfish fed with different inclusion level of feather meal is presented in table 4, $_{P}$H, temperature, alkalinity, dissolved oxygen nitrate and nitrite values ranges between 6.83 – 7.11, 27.40 – 27.57^{0}C, 76.92 – 89.04Mg/l, 7.83 – 10.10mg/l, 4.23 – 1.22mg/l, 1.19 – 0.06mg/l respectively. All the parameters were significantly ($p<0.05$) influenced by the dietary inclusion of feather meal.

Table 5: PROXIMATE COMPOSITION OF THE EXPERIMENTAL DIET

Parameters	T0	T1	T2	T3	T4	SEM±
Protein(%)	40.58^{a}	43.78^{b}	43.13^{d}	45.74^{d}	45.92^{e}	0.53
Fats(%)	1.39^{a}	1.42^{a}	1.64^{b}	1.72^{c}	1.74^{c}	0.04
Moisture(%)	87.94	89.07^{b}	88.66^{c}	87.40^{a}	89.11^{d}	0.18
Fibre(%)	1.93^{a}	1.75^{a}	1.68^{a}	1.56^{a}	1.97^{a}	0.89
Ash(%)	10.48^{a}	12.15^{b}	12.95^{c}	13.26^{d}	13.72^{e}	0.30
Energy(M/cal)	2474.07^{a}	2494.77^{b}	2498.90^{b}	2496.07^{b}	2499.97^{b}	2.64

Means in the same row with different superscripts differ significantly ($p<0.05$)

T0 = *0% feather meal*, T1 = *25% feather meal*, T2 = *50% feather meal*, T3 = *75% feather meal*, T4 = *100% feather meal*, SEM – *Standard Error Mean.*
Proximate composition of experimental diet is presented in table 5 Protein ranges between (40.58 – 45.92%), fats (1.39 – 1.74%), crude fibre (1.93 – 1.97%), moisture (87.94 – 89.11%), ash (10.48 – 13.72%) and energy (2474.07 – 2499.97Kcal/kg). All the parameters measured were significantly different among the treatments ($p<0.05$)

DISCUSSION

These studies have shown that the replacement of fish meal with feather meal in catfish diet can have negative effect on the growth performance. The growth rate, feed conversion ratio may be compromised when feather meal is increased. The performance record indicates that T3 and T4 had the lowest weight gain and growth depression compared to other treatment ($P<0.05$), this could be attributed to the inadequate supply of essential amino acid and low digestibility due to high inclusion level of feather meal in T3 and T4. According to (Crashaw,2019); (Baker *et al*, 1981) feather meal is a protein source of poor quality because its deficient in amino acid, lysine, methionine, histidine and tryptophan essential in many livestock species and similar to the findings of Hertrampf and pieded-pascual (2000).
The high body weight gain in T1 and T2 could also be attributed to the 25% and 50% inclusion level of feather meal in the experimental diet. It is an indication that the nutritional requirements of the animal are meet. This result is in agreement with the findings of (Mustapha *et al* 2022).
All the water quality parameters measured were significantly different among the treatment. Unlike temperature, dissolved oxygen, the presence of normal level of nitrate usually does not have a direct effect on aquatic insect or fish (Ayinla, 2007). However, excess level of nitrate in water can create condition that makes it

difficult for aquatic insect or fish to survive (Amiengheme, 2005). Nitrate exposure has been shown to adversely affect fish and shellfish growth, water balance, osmoregulation, and causes endocrime disruption (balogun and ologboho, 1989). However, the range of nitrate and nitate (4.23-1.22 mg/l and 1, 19-0.06mg were within the range reported by (Machrels 1985).

The pH level recorded in this study falls within the high survival range reported by Bhatnugar and Garg (2000); Bhatnugar and Sing (2010), the PH value were significantly different among the treatment.

Temperature significantly affects the growth, feed utilization, and metabolic rate of *Clarias gariepinus*. Generally, this species thrives within a temperature range of 25-30°C, with optimal growth observed around 28-30°C (Fagbenro, 2000). Deviations from the preferred temperature range may result in reduced growth rates and feed conversion efficiency.

The alkalinity level of the water agrees with the report of Isyagi *et al* (2009) who reported that an alkalinity range of 75 – 200mg/l is ideal for aquaculture. Alkaline water reduces water hardness and makes a pond habitable for fish. According to Kumar (2004), oxygen level in water should be between the ranges of 3 – 10mg/l, value less than 3mg/l could lead to a serious mortality in ponds.

Fish diet containing 25% crude protein of feather meal has proved to be suitable for optimal growth and performance of *Clarias gariepinus.* The results showed a comparable weight gain, growth performance and feed efficiency to the control diet. Low mortality and suitable water quality showed that feather –containing diet did not pollute the water media. There was no significant p>0.005) difference between feather-substituted diet at 25% and 50% and the control diets. The result depicted that supplementing the fish diet with a small amount of feather meal can effectively promote the growth of *Clarias gariepinus*. This result is similar or agrees with the findings of Mustapha *et al* (2022).

CONCLUSION

In terms of growth performance, feed conversion ratio serves as a chief indicator for growth performance, result shows that T1 and T2 has the best replacement level. As inclusion level of feather meal increases there was also a proportional increase in parameters (protein, fat, fibre, ash, moisture) taken. Furthermore, as level of inclusion increases all the water parameter determined also increases with a detrimental consequence. Thus, there was incremental mortality noticed suggesting increase in feather meal can proportionally affect the survival rate of the fingerlings

The study shows that 25%to 50% replacement of fish meals with feather meal is ideal for optimum growth and nutrient utilization of the fish. Substituting fish meal with feather meals in the feed of *Clarias gariepinus* would indirectly reduce the feed production cost as feather meal has been shown to be a convenient economically viable, protein- rich feed ingredient and as unconventional source of feeding *Clarias gariepinus*.

RECOMMENDATION

In terms of the growth performance indices, it was observed that 2% of probiotics enzymes was added across board in respective of the graded levels of the feather meal concerned. Thus T0(control) that did not contain any feather meal had a higher values when compared to other graded levels, therefore the recommendation here is that, considering the fibrous nature of feather meal, higher values of proboitics enzymes should added to degrade the fibre content of the feather meal as against only the 2% used

Secondly, proximate analysis parameters that were measurement in this research show a progression as the level of inclusion increases, therefore it can be recommended here that higher levels of inclusion above what was used here(In this research) can still be tolerated.

Lastly, values above the graded level used in this research could have a deterimental effect on the physio- chemical paremeters used. Meanig that 75% and 100% adversely affect the survival of fish

Based on the study on the inclusion level of feather meal to the diet of catfish (*clarias gariepinus)* juvenile, 25% and 50% feather meal in the diet is hereby recommended because there was low feed conversion ratio, showing that 25% and 50% consume less and gained much.

There is need for government intervention by encouraging the farmers to practices cheaper means of feed production using feather meal as a case study. This will be done by organizing workshop, seminars and awareness campaign to sensitize and popularize the use of feather meal as an ingredient in the formulation of fish feed among the farmers for easy adoption, it will make the farmer to practice cheaper means compared to the conventional feed.

Therefore, the utilization of unconventional feedstuff such as feather meal should be put into practice.

REFERENCES

Adebayo, O.T. and faphunda, O.O. (2005). An overview of the Nigeria animal feed industry and dietary substitution of feed stuff for farmed fish in Nigeria.

Agbon, A.O, omoniyi, I.T. And Teko, A.A. (2012). Acute toxicity of tobacco (Nicotiana tobaccum) leaf dust on oreochromis niloticus and haematological change resulting from sub- lethal expose. Journal of aquatic science, 17(1), 5-8.

Ajayi, H.I and Iyayi, E.A. (2014). ILEAL nutrient digestibility and performance in broiler chicken feed graded level of feather meal. Ibadan jounal of agricultural research. 10: Pp78-88.

Ali, A, AL-Ogally, S.M. (2008). Effect of feeding different protein to energy (PIE) ration on the growth performance and body composition of Oreochromis niloticus fingerlings applied ichthyol. 24: 31-37

Amienghene, p. (2005). The Importance of fish in human nutrition. A paper delivered at a fish culture forum, Federal Department of fish farmers, Abuja. Pp21

AOAC, (2006). Official method of analysis, 18th edn. N Horinitz, N (Ed), Association of Official Analytical Chemists, Washington, D, USA, pp:109

Ayinla O.A (2007): Analysis of feeds and fertilizer for sustainable Development in Nigeria. NIOMR Technical paper No. 83,13p

Baker, D.H, Blitenthal, R.C.; Boebel, F.P.; czarneckil, G.L, Southern, L.L, Willis, G.M., (1981) Bertsh, A and Coello. N. (2005). A biotechnological process for treatment and recycling poultry feathers as a feed ingredient bioresources technology. 98: 1703-1708.

Bhatnagar, A and Garg, S.K (2000), causative factor of fish mortality in still water fish pond under sub- tropical condition, Aquaculture, 1I (2), PP91-96.

Bhatnagar, A. singh, G (2010), culture fisheriers in village pond: a multi-location study in 68.

biochemical and molecular characterization. Applied Biochemical Biotechnology, 162, 329-344

Bishop, C.D; Angus, R.A and watts S.A (1995). The use of feather meal as a replacement of fish meal in the diet of Oreochromis niloticus fry. Bioresour. Technol. 54: 291-295.

Cataldo, D. A., Schrader, L. E., & Youngs, V.L. (1975). Analysis by digestion and colorimetric assay of total nitrogen in plant tissues high in nitrate. Crop science, 15(6), 825-827.

Chauynarong, N; Elangovans, A.V and Iji, P.A. (2009). The potential of cassava product in diets for poultry word poultry Sci.J 65(1): 23-26.

Crawshaw, R., 2019. Co-product feeds in Europe: Animal feeds derived from industrial processing. Lulu. Com

Eyo, A.A (2001). Fish processing technology in the topics. A publication of national institute of fresh water fisheries research (NIFFR) new bussaunigeria. Pp 10-19.

Fagbenro, O. A. (2000). Temperature preference, tolerance and oxygen consumption of African catfish, Clarias gariepinus (Burchell 1822) fingerlings. Aquaculture Research, 31(2), 127-133.

Hertrampf, J.W and Piedad. F.P. (2000). Handbook on ingredient for aquaculture feeds. Kluwer academics publishers, London. Pp 573.

Isyagi, N., Atukinda, G., Aliguma, L., SSE bisubi, M., John, W., Kubiriza, G. Ans mbulameri, E. 2009b assessment of national aquaculture policies and programme in uganda SARNISSA EC FP7 PP. (Avaliable at: www. Sarnissa.org).

Kumar, S.S. (2004). Management of super intensive farming of Africa catfish simple guideline for enhance profit. *A publication of technical service division, animal care service KONSUCT (Nig) LTDP.* 1-8.

Lamai, S.L inangural lecture series 22. 17th November (2011). Federal university of technology minna pp. 1-60

Machiels M.A.M. And Henken, A. M. (1985). Growth rate, feed utilization and energy metabolization of the African catfish, Clarias gariepinus (Burchell, 1822), as affected by dietary protein and energy content, aquaculture, 44:271-284.