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Growth Performance of *Clarias gariepinus* (Burchell, 1822) Fed Processed *Moringa oleifera* (LAM.) Seed Meal

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ABSTRACT

Inflating price and uncertain availability of fishmeal entailed the need to focus on utilization of cheaper plant protein source ingredients. Growth performance of *Clarias gariepinus* fed processed *Moringa* seed was evaluated for the period of eight weeks. The *Moringa* seeds were taken to Biology Department, Kaduna State University for identification and authentication. The seeds were soaked in water for 24hours, rinsed and boiled at 100^{o}C for 15minutes, air dried, toasted for another 5minutes and pulverised to obtain *Moringa oliefera* seed meal (MOSM) used to replace fishmeal at 0%, 5%, 10%, 15%, 20%, 25% inclusion levels. Six diets and a commercial feed (control) were used in the experiment labelled T1,T2,T3,T4,T5,T6 and T7. Mixed sexes *Clarias gariepinus* fingerlings of average weight of 5.23±0.06 were used . Twenty one rubber tanks (25liter capacity) were used at the stocking density of 10 fish per tank with three replications. Fish fed 5% and 10% inclusions of MOSM recorded the highest weight of 28.8±0.08 and 28.6±0.08 respectively showing no significant difference between the controls (0% inclusion and the commercial feed) and the experimental diets at p-value (<0.05). The study shows that processed MOSM can be included in Catfish diet at the inclusion level of up to 25%.

Keywords: fishmeal, Moringa, fingerlings and *Clarias gariepinus.*

1.0 INTRODUCTION

Food insecurity and malnutrition have been the major problem of the developing countries, including Nigeria. Any approach to help fights this problem will go a long way in pushing the wheel of development in our country. Plant protein products are gaining increased interest as ingredients in food systems throughout many parts of the world, and the success of utilizing plant proteins as additives depends greatly upon the favourable characteristics that they impart to food. Plants proteins are now regarded as versatile functional ingredients or as biologically active components more than as essential nutrients in the developed countries (Adebowale *et al.*, 2005).

For commercial culture of fish, the formulation of low-cost balanced diet using locally available agro-industry byproducts is needed. Recently fish meal has become the most expensive protein ingredient in aquaculture feeds. Many studies have shown considerable success in partially replacing fishmeal with soybean meal and other soybean products in diet for various fish species. For the improvement of fisheries and to achieve maximum yields from resources of fresh water, it is necessary to provide artificial feed, by which fish grows rapidly and attains maximum weight in shortest possible time. Replacement of fish meal with cheaper ingredients of plant origin in fish feed is necessary because of rising cost and uncertain availability. Increased use of plant protein supplements in fish feed can reduce the cost of fish meal. Since farming aquatic animals is broadly adopted and improved, it has caused a problem of high priced feed as well as insufficient nutrition. A significant proportion of fish meal possesses a broad range of amino acids, and hence high-priced. There has been an attempt to replace fish meal with soybean meal which possesses good quality of essential amino acids (EAA). As a result, soybean meal and other plant products, both imported and locally made, are utilized with the hope to help decrease the costs, but as it turns out, it is also quite expensive. Aquaculturists are therefore, looking for a cheaper plant protein source raw material to decrease the cost of fishmeal

and other animal source protein ingredients, but it might not be as preferable as fish meal or soybean meal. This new material should be produced locally, inexpensive and provide high nutrition. Certain plant materials offer the most promising alternative aqua feed ingredients and in fact locally produced materials have already been used in different part of the world (Hernadez *et al.,* 2007).

1.2 Statement of Research Problem

Considerable emphasis has been focused on the utilization of conventional plant protein sources due to inflating price of fish meal, as such, the plant protein like *Moringa*, a potential animal and fish feed ingredients possesses anti-nutrients in its extracts which could adversely affect the growth performance of catfish. (Ekelemu *et al.*, 2000). Fishmeal is important and major source of animal protein in the diets of fish, livestock and poultry. Although it is a major component, its high price and anti-nutritional contents are the main constraints in feed formulation. and when used in formulation of feed, it led to an increase in the cost of feed and a corresponding rise in fish production (Ekelemu *et al.*, 2000).

According to Makkar and Becker (1996), *M. oleifera* can be used in the diet of fish which in turn reduce overdependence on fish meal. Therefore, there is need to focus on utilization of this less expensive and readily available resources to replace fish meal without reducing the nutritional quality of the feed. The presence of saponin, tannin and phenol in moringa seeds entails the need for application of some technological treatments which can bring an improvement by destroying these anti-nutritional factors.

African catfish (Clarias *gariepinus)* is a typical air-breathing catfish with a scaleless, bony elongated body with long dorsal and anal fins, and a helmet like head. Colour varies dorsally from dark to light brown and is often mottled with shades of olive and grey while the underside is a pale cream to white. It can grow very large with a maximum reported length of 170 cm and weight of 60 kg (Hecht, 2013). The *Clarias gariepinus* is however, an omnivore that grows fast, and tolerates relatively poor water.

The aim of this research is to evaluate the growth performance of catfish fed processed *M. oleifera* seed meal for eight weeks.

2.0 MATERIALS AND METHODS

2.1 Study Area

Biological Garden of Kaduna State University, Kaduna, Nigeria was used for conducting this research. It is located on Latitude of 10.568° North and a Longitude of 7.452° East. It has an elevation of 619 meters (2031 feet) and an average annual temperature of 25.2˚C (77.3˚F) (Aliyu, 2020).

2.2 Source of *Moringa oleifera* Seeds

Ten kilograms (10Kg) of *M. oleifera* seeds were sourced from Unguwan Shanu market within Kaduna metropolis, and taken to Biological Sciences Department, Kaduna State University for identification and authentication. Specimen number kasu/bsh/754 was assigned and sample was deposited (Aliyu, 2020).

2.3 Experimental fish

Two hundred and ten (210) mixed sexes of *Clarias gariepinus* fingerlings with average weight and length of 5g and 6cm respectively were sourced from a Farm (Admix Nigerian Venture) Unguwan Rimi Kaduna and transported in 25liter capacity Jerry-can to experimental area. The fish were allowed to acclimatized and fed with 2mm “Blue Grown” foreign feed for two weeks before the commencement of the research. The fish were starved 24hours to the commencement of the experiment (Mamoon, 2016).

2.4 Preparation and Processing of *Moringa oleifera* Seed Meal

The seeds of *M. oleifera* were sorted out manually before soaking in water for 24 hours, rinsed till free from the foamy water and boiled at 100^{o}C for 15minutes. The seeds were air dried, toasted for 5minutes and ground with mortar and pestle to obtain *M. oliefera* seed meal (MOSM). (Chikwendu *et al.*,2014).

2.5 Feed formulation of the experimental diet

The feed was formulated using Pearson’s Square Method to mix the feed ingredients using Maize as energy source, groundnut cake and fish meal as protein source, Moringa Seeds for fish meal

replacement at 5%, 10%, 15% 20% and 25% graded levels, premix, wheat offal, Rice brand Methionine, Lysine and water were also added to mix the feed. The mixed feed ingredients were pelleted to a size of 3mm using a local machine at Uyama Agro Nigeria Limited, Station Roundabout, Kaduna. These feeds were subjected to proximate analyses (Bhilave *et al.,* 2016).

2.6 Experimental Design

The experiment consists of six treatments with each representing 0, 5, 10, 15 20 and 25 per cent inclusion levels of *M. oleifera* seed meal to replace fishmeal in diet T1,T 2,T 3,T 4,T5 and T6 that were formulated. Each of these treatments were replicated thrice. The controls (0% inclusion of MOSM and commercial feed) have no inclusion of *M. oleifera* seed meal. 21 tanks (25liters capacity) were used at the stocking density of 10 fish per tank. Feeding was at 5% body weight, and took place twice a day, in the morning around 9:00am, and evening around 6:00pm. The water was changed every 24hours in order to avoid stressing the fish throughout the period of the research which lasted for eight weeks.

2.7 Growth performance

Weight and length of experimental fish were taken using weighing balance and metre rule respectively once in every two weeks to determine the specific growth rate (SGR), total feed intake (TFI) and total weight gain (TWG) (Hussein, 2016).

2.7.1 Performance evaluation

During the experiment, fish performance was based on productivity indices on growth performance and nutrient utilization efficiencies as described by (Hussein, 2016):

2.7.2 Total feed intake (TFI)

Total feed intake was estimated by summing the weekly feed intakes during the period of the experiment.

2.7.3 Total weight gain (TWG)

Total weight gain was obtained as the difference between the initial weight and the final weight gained of the whole experimental fish using the formula below:

T*otal weight gain (TWG) = final weight – initial weight* (Mamoon, 2016).

2.7.4 Total percentage weight gain (TPWG %)

Total percentage weight gain was calculated using the formula below:

TPWG = Total weight gained / Initial weight x 100% (Hussein, 2016)

2.7.5 Specific growth rate

Specific Growth Rate (SGR) was determined using the relationship of the difference in the weight grain of fish within an experimental period. It was obtained using the formula below:

$SGR\ (\%) = Log_e W_2 - Log_e W_1 / T_2 - T1 \times 100$

Where W_2 = final weight of fish, T_2= final day (time), W_1 = initial weight of fish, T_1 = initial day (time) days, Loge = natural log (Hussein, 2016).

2.7.6 Feed conversion ratio

From the feed consumed by each group of fish and weight gained, the feed conversion ratio (FCR) was calculated using the expression adopted by Hussain (2016).

FCR = Feed Intake / Net weight gain.

2.7.7 Protein Efficiency Ratio

Protein Efficiency Ratio (PER) was calculated from the weight gain obtained from the test subject divided by its intake of a particular feed protein during the test period. Hence

PER = Gain in body mass (g)/ Protein intake (g) (AOAC, 2010).

2.8 Data Analysis

Analysis Of Variance (ANOVA) was used to evaluate significant differences among *M. oleifera* seed meal inclusions and the controls. P-value < 0.05 was considered to be significant. Statistical package used was Statistical Analysis System (SAS) version 9.4.

3.0 RESULTS

3.1 Growth performance of the experimental fish fed with *Moringa oleifera* Seed Meal for eight weeks

3.1.1 Initial weight of the Experimental fish

The average initial weight of the experimental fish before the commencement of the experiment ranges from 5.03-5.27gram as shown in table 1. The result of data analysis shows that there was no significant difference at p-value (>0.05) among the experimental treatments, indicating the complete random distribution of individual fish at the start of the experiment (Table 1).

3.1.2 Final weight gain of the Experimental fish

Table 1 shows that the final weight gain of the *Clarias gariepinus* after eight weeks of feeding with graded level of Moringa seed was between 26.3±0.08-28.8±0.08. At p-value >0.05, the least significance difference (LSD) shows that there was no significant difference between the treatment and the controls that produced 26.3±0.08 and 26.5±0.10 (0% inclusion of MOSM and commercial feed respectively).

Table 1: Mean Weight (gram) of Experimental Fish Fed *Moringa oleifera* Seed Meal For Eight Weeks Feeding Trial

Parameter	T1 (0%)	T2 (5%)	T3 (10%)	T4 (15%)	T5 (20%)	T6 (25%)	T7 (com)
W1	5.03±0.06^{e}	5.27±0.06^{e}	5.23±0.06^{e}	5.13±0.06^{e}	5.17±0.12^{e}	5.13±0.06^{e}	5.13±0.06^{e}
W2	8.10±0.10^{d}	8.43±0.15^{d}	8.33±0.15^{d}	8.20±0.10^{d}	8.13±0.06^{d}	8.13±0.06^{d}	8.13±0.06^{d}
W4	12.2±0.15^{c}	13.6±0.15^{c}	13.1±0.06^{c}	12.2±0.10^{c}	12.2±0.06^{c}	12.2±0.06^{c}	12.2±0.06^{c}
W6	19.3±0.10^{b}	21.9±0.06^{b}	21.7±0.10^{b}	19.4±0.10^{b}	19.5±0.06^{b}	19.6±0.10^{b}	19.6±0.05^{b}
W8	26.3±0.08^{a}	28.8±0.08^{a}	28.6±0.08^{a}	26.4±0.06^{a}	26.4±0.05^{a}	26.4±0.08^{a}	26.5±0.10^{a}
p value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Values are given as mean standard deviation. In each column, means with the same letter are not significantly different ($p < 0.05$). keys: W1; initial weight, W2; week 2, W4; week 4, W6; week 6, W8; week 8, T1; treatment 1, T2; treatment 2, T3; treatment 3, T4; treatment 4, T5; treatment 5, T6; treatment 6, T7; treatment7(commercial feed).

3.1.3 Average initial length of the Experimental fish

The average initial length of the experimental fish was between 5.77±0.25-6.23±0.06. Table 2 shows that there was no significant difference (p<0.05) among the treatments indicating complete random distribution of the individual fish in each of the treatments (Table 2).

3.1.4 Final length of the Experimental fish

Analysis of variance indicates that the final length of the experimental fish after eight weeks of feeding with *M. oleifera* seed meal (MOSM) was between 17.4±0.06-18.6±0.10 throughout the treatments. The least significant difference shows that there was no significant difference at p-value (p<0.05) (Table 2).

Table 2: Mean Length (cm) of Experimental Fish Fed *Moringa oleifera* Seed Meal For Eight Weeks Feeding Trial

Parameter	T1 (0%)	T2 (5%)	T3 (10%)	T4 (15%)	T5 (20%)	T6 (25%)	T7 (com)
W1	5.77±0.25^{e}	6.23±0.06^{e}	6.23±0.06^{e}	6.10±0.00^{e}	6.10±0.10^{e}	6.07±0.06^{e}	6.07±0.06^{e}
W2	9.10±0.10^{d}	9.53±0.06^{d}	9.33±0.06^{d}	8.80±0.52d	9.13±0.06^{d}	9.13±0.06^{d}	9.13±0.06^{d}
W4	12.7±0.06^{c}	12.9±0.00^{c}	12.8±0.06^{c}	12.5±0.00^{c}	12.5±0.06^{c}	12.6±0.06^{c}	12.6±0.06^{c}
W6	15.4±0.00^{b}	15.8±0.06^{b}	15.8±0.06^{b}	15.5±0.10^{b}	15.5±0.06^{b}	15.6±0.12^{b}	15.6±0.06^{b}
W8	17.5±0.10^{a}	18.6±0.10^{a}	18.5±0.06^{a}	17.4±0.06^{a}	17.5±0.06^{a}	17.5±0.10^{a}	17.5±0.10^{a}
p value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Values are given as mean standard deviation. In each column, means with the same letter are not significantly different ($p < 0.05$). keys: W1; initial length, W2; week 2, W4; week 4, W6; week 6, W8; week 8, T1; treatment 1, T2; treatment 2, T3; treatment 3, T4; treatment 4, T5; treatment.

3.1.5 Survival rate of fish

The survival rate of the fish fed the experimental diets throughout the experimental period ranged from 80-100 with the highest obtained in T3, T4 and T7, followed by T1, T5, and T6. The least was observed in T2. No significant difference between the fishes fed the commercial feed with that of the experimental diets (Table 3).

3.1.6 Specific Growth Rate

The highest specific growth rate of the Experimental fish fed the experimental diets is 3.03±0.02[a]/fish/day obtained from Treatment 2 and 3, followed by 2.92±0.01/fish/day obtained in treatment 1, 4, 6, 7. This result shows that there is no significant difference at (p>0.05) between the fishes fed the commercial feed with that of the experimental diets (Table 3).

3.2 Nutrient utilization parameters

Treatment 5 (20%) produced the best result for the Feed Conversion Ratio (FCR) of 98.1, it was followed by Treatment 4 (15%) which yielded 97.9. The least value was observed in Treatment 2 and 3 (88.2). However, result of analysis of variance shows that the feed conversion ratio of the treatments was not significantly different with that of the commercial feed. (Table 3)

Treatments 2 (5%) and 3 (10%) gave the highest value of 1.04 and 1.03 respectively for the Percentage Efficiency Ratio (PER), which was followed by Treatment 7 (commercial feed) that produced 1.02. Lowest value was obtained in the other treatment but does not show any significant difference (Table 3).

Table 3: Growth Performance, Survival, And Feed Utilization Parameters Of The Experimental Fish Fed Experimental Diets For Eight Weeks Feeding Trial

Parameter	T1 (0%)	T2 (5%)	T3 (10%)	T4 (15%)	T5 (20%)	T6 (25%)	T7 (com)
FBG (g)	26.3±0.08[a]	28.8±0.08[a]	28.6±0.08[a]	26.4±0.06[a]	26.4±0.05[a]	26.4±0.08[a]	26.5±0.10[a]
IBW (g)	5.03±0.06[e]	5.27±0.06[e]	5.23±0.06[e]	5.13±0.06[e]	5.17±0.12[e]	5.13±0.06[e]	5.13±0.06[e]
WG (g)	21.3±0.12[c]	23.5±0.12[a]	23.4±0.12[b]	21.3±0.06[c]	21.3±0.05[c]	21.3±0.06[c]	21.3±0.10[c]
PWG (%)	422.6±6.28[b]	446.9±6.32[a]	446.5±6.29[a]	414.3±4.18[b]	411.8±10.1[b]	414.3±4.19[b]	414.9±5.03[b]
SGR (%)	2.95±0.02[b]	3.03±0.02[a]	3.03±0.02[a]	2.92±0.01[b]	2.91±0.04[b]	2.92±0.01[b]	2.92±0.02[b]
FI (g)	2072.5	2072.5	2064.5	2084.6	2092.7	2046.4	2076.5
FCR	97.3	88.2	88.2	97.9	98.2	96.1	97.5
PI	22.2	22.7	22.8	22.6	22.6	22.6	20.9
PER	0.96	1.04	1.03	0.94	0.94	0.94	1.02
Survival (%)	90	90	90	80	100	100	80

Values are given as mean standard deviation. In each column, means with the same letter are not significantly different ($p < 0.05$). Keys: FBW: final body weight; IBW: initial body weight; WG: weight gain; PWG: percentage weight gain; SGR: specific growth rate; FI: feed intake; FCR: feed conversion ratio; PI: protein intake; PER: protein efficiency ratio, FCR=Feed Intake (FI)/Weight Gain (WG), Protein Intake (PI)=FI*percent protein in feed, PER=WG/PI.

4.0 DISCUSSION

The growth performance of the experimental fish fed graded level of *Moringa oleifera* seed meal indicated that, the average initial weight of the fish at the beginning of the experiment shows that there was no significant difference across all the Treatments, and the controls at p-value (<0.05). This also indicated that all the treatments and the controls were given an equal chance to compete in attaining a particular weight gain. While the mean weight gain at the end of the experimental period indicates that fishmeal can be replaced with processed *M. oleifera* seed meal in catfish diet up to 25%. This may be due to processing method applied to the *M. oleifera* seed. This result contradicts Aliyu (2020) who experiment on Effect of inclusion levels of processed *Moringa oleifera* leaf meal on the growth performance of catfish, his finding is however, in contrast with the work of (Gbadamosi and Osungbemiro, 2016) where unprocessed *Moringa oleifera* leaves inclusion was not beyond 10% inclusion level. Their work is also in conformity with the work of Abo-State *et al*. (2014) that conducted a 75-day feeding trial to evaluate the effect of feeding different levels of raw *Moringa oleifera* leaves meal at 0%,8%,10% and 12% on the growth performance, feed utilization and carcass composition of Nile tilapia (*Oreochromis niloticus*) fingerlings diets. They found that raw Moringa leaves meal might be used up to 8% level of dietary protein in Nile tilapia (*Oreochromis niloticus*) fingerlings diets without negative effect on growth performance.

The survival rate of the experimental fish fed *Moringa* seed meal throughout the experimental

period suggested that all diets including the controls were suitable for the fish and met its nutritional requirement which may be due to the technological treatments applied to the *Moringa* seed meal. These findings are similar to (Curiel *et al.*,2016) where 90-100% survival rate was obtained and no significant differences were reported while Gumus and Aydin (2013) reported a 100% survival rate.

The overall Protein Efficiency Ratio (PER) recorded reveals that *Moringa* seed is a good protein source that can replace fishmeal up to 25% inclusion level. This indicates that the soaking, boiling and toasting methods applied to *Moringa* seed revealed positive effect on the nutritional contents. This is consistent with the result obtained by Emre *et al.,* (2003) who worked on mirror carp and reported that there was decrease with increase of Poultry Offal meal. The Feed Conversion Ratio (FCR) obtained is slightly higher than that presented by Adewolu *et al.,* (2010) who worked on *Clarias gariepinus* and reported that there was an increase in feed conversion ratio with increase of Poultry offal meal.

5.0 Conclusion

The soaking, boiling and toasting processing methods applied to the *Moringa* seed have adverse effect on the anti-nutritional factors present in the seed and obtained minimum amount that have no negative effect on the growth performance of Catfish. The processed *Moringa oleifera* seed meal used at different inclusion levels have no adverse effect on the growth performance of *Clarias gariepinus.* The study reveals that the processed *Moringa* seed can therefore, be used up to 25% inclusion level to replace fishmeal in catfish diet.

REFERENCES

Abo-State, H. Y., Hammouda, H. Y., El-Nadi, A. and AboZaid, H. (2014). Evaluation of Feeding Raw Moringa (*Moringa oleifera* Lam.) *Leaves Meal in Nile Tilapia Fingerlings (Oreochromis niloticus)* Diets. Global Veterinaria 13 (1): 105-111.

Adebowale, Y. A., Adeyemi, I. A, Oshodi, A. A.(2005). Functional and physicochemical properties of flours of six Mucuna species. Afr. J. Biotech;4(12):1461-1468.

Adewolu, M. A., Nafisat B. I, Sunday M. M. (2010) Evaluation of an Animal Protein Mixture as a Replacement for Fishmeal in Practical Diets for Fingerlings of Clarias Gariepinus (Burchell, 1822) The Israeli Journal of Aquaculture -Bamidgeh 62(4), 2010, 237- 244

Aliyu, U. (2020). Effect of inclusion levels of processed Moringa oleifera leaf meal on the growth performance of catfish, clarias gariepenus p :38-44.

AOAC (2010) Association of Official Analytical Chemists Official Methods of Analysis. (15th ed.) Arlington, VA, USA.

Bhilave, M. P., Bhosale, S. V. and Nadaf, S. B. (2016). Formulation of fish feed using ingredients from soyabean, radish, maize and beet International Journal of Fisheries and Aquatic Studies 2016; 4(5): 78-81

Chikwendu, J. N., Igbatim, A. C. and Obizoba, I. C. (2014) Chemical Composition of Processed Cowpea Tender Leaves and Husks International Journal of Scientific and Research Publications, Volume 4, Issue 5, May 2014 1 ISSN 2250-3153

Curiel, F. B., Griselda, P. G., Correa-Reyes, E., D. and María, T. V. (2016).Total and partial fishmeal substitution by poultry byproduct meal (petfood grade) and enrichment with acid fish silage in aquafeeds for juveniles of rainbow trout Oncorhynchus mykiss Latin American Journal of Aquatic Research 44(2): 327-335.

Ekelemu, J. K., Inoni, O. E, Ojeifo, I. M. (2000). Financial Analysis of Integrated Fish-Rice Farming Systems. Proceedings of 5th Annual Conference of Animal Science Association of Nigeria. Port-Harcourt, Nigeria, 2000, 263-265.

Emre, Y., Sevgili, H. and Dilier, I. (2003). Replacing fish meal with poultry by-product meal in practical diets for mirror carp (Cyprinus carpio) fingerlings. Turkey Journal of Fisheries Aquaculture 3:81-85.

Gbadamosi, O. K. and Osungbemiro, N. R. (2016). Growth and nutritional performance

of African catfish, *Clarias gariepinus* (Burchell, 1822) fed varying inclusion levels of dietary *Moringa oleifera* leaf meal. *Livestock Research for Rural Development. Volume 28, Article #204.* Retrieved March 17, 2018, from http://www.lrrd.org/lrrd28/11/gbad28204.html

Gumus E. and Baki, A. (2013). Effect of poultry by product meal on the growth performance and fatty acid composition of carp (Cyprinus carpio) fry. Turkish Journal of Fisheries and Aquactic Sciences 13:827-834

Hernandez, M. D., Martinez, F. J., Jover, M. and Garcia, B. (2007). Effects of partial replacement of fish meal by soybean meal in sharpsnout seabream (Diplodus puntazzo) diet. Aquaculture 263: 159-167

Hussein, E. E. S. M., (2016). Effect of moringa leaves meal as a feed additive on the performance of Nile tilapia, Oreochromis niloticus, International Journal of Aquaculture, 7(1): 1-8 (doi: 10.5376/ija.2017.07.0001).

Makkar, H. P. S. and Becker, K. (1996). Nutritional value and antinutritional components of whole and ethanol extracted Moringa oleifera leaves. Animal Feed Science and Technology. 63, 211-228.

Mamoon, M. (2016). Growth performance of African catfish (Clarias gariepinus) fingerlings fed on graded poultry offal meal M.Sc. Thesis, Department of Biological Sciences, Kaduna State University , Kaduna State, Nigeria. Pp18-57.