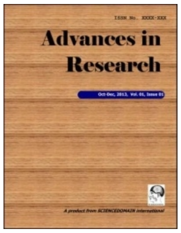

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Moringa oleifera (Lam) as a Protein Supplement in *Clarias gariepinus* Diet

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Author's contribution

This whole work was carried out by the author AAA.

Original Research Article

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ABSTRACT

This experiment was carried out to investigate chemical properties of *Moringa oleifera* and the effects of dietary levels of *Moringa oleifera* leaves on the growth performance and feed utilization for *Clarias gariepinus* fry. The study was carried out in aquarium tanks, for a period of 8 weeks, in the months of April-May, 2013, at the Aquaculture Centre of the Ekiti State University, Ado Ekiti, Nigeria. Biochemical analyses of samples were performed, at the Animal Science and Central Science Laboratories of Obafemi Awolowo University, Ile Ife. The trial diets were fed to triplicate groups (n=30) of *C. gariepinus* fry (average weight of 2.0g ±0.1). Fish samples were collected and individual weight and length were measured, biweekly. The MWG, FWG and FCR of the fish fed diets M0, M5, M10 were not significantly different (P>0.05) from one another, while these were significantly different *(P=.05)* from the performance of the fish fed M20 and M30 diets. The DWG and SGR of the Moringa meal-based diets were not significantly different (p>0.05) from any of the dietary treatments. The results indicate that *Moringa oleifera* leaf meal can be used to replace up to 10% of the fish meal in *C. gariepinus* fry diet, without adverse effects on survival and growth performance. Whereas, the higher replacing levels in diets significantly (p<0.05) reduced the growth and feed utilization parameters.

Keywords: Fish quality; anti-nutritional factors; growth; feed; moringa; Clarias gariepinus.

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1. INTRODUCTION

Fish farming continues to make substantial contributions to Nigeria's animal protein requirements. Due to the over exploitation of the capture fisheries, the hope of the Nigerian fisheries is in aquaculture development. Production from aquaculture is increasing and supplied between 2.3 – 23% of total domestic fish production between the year 2000-2010.

The African catfish (*Clarias gariepinus*) remains the most cultured species in Nigeria and is appreciated by consumers for the quality of its meat. The African catfish is an excellent species for aquaculture, as it is omnivorous, grows fast, and tolerates relatively poor water quality [1]. The fish is mostly cultured in earthen ponds. However, it can be cultured in other systems, such as tanks and hapas. With the recent breakthrough in its culture and management, a good number of entrepreneurs have picked up interest in its commercial culture, while numerous citizens culture it in homestead ponds, at their backyards, sometimes in polyculture with tilapia (*Oreochromis niloticus*). Live-catfish market is now a common site in many cities and towns, all over Nigeria. The product is mostly smoked and the fresh one is used in making 'pepper soup', which is a delicacy in many metropolitan restaurants.

Inspite of the above progress, the success story of aquaculture in Nigeria is still largely dependent on imported extruded feed using the limited foreign exchange of the state. Feed inputs thus constitute up to 40%-60% of the total farming cost. This scenario is unacceptable, as it reduces the profit margin of the farmer. Hence, various researches are on-going, especially in the area of feed development. The main focus in fish feed research is to replace or substitute the often imported, expensive fish meal component, with readily available, cheaper, alternative source of protein.

A number of crop materials are being investigated for their potential to supplement or even replace fish meal [2,3,4]. *Moringa oleifera* (Fig. 1) (family Moringaceae) has been identified to hold the potential to make contributions to fish culture.

Fig. 1. Young moringa shoot

Moringa oleifera is a highly valued plant, distributed in many countries of the tropics and subtropics. It is a non-leguminous tree with a high crude protein in the leaves (251g/kg DM) and negligible content of tannins and other anti-nutritional factors [5]. It has an impressive range of medicinal uses with high nutritional value. Different parts of this plant contain a profile of important minerals, and are a good source of protein, vitamins, -carotene, amino acids and various phenolics. Every part of moringa tree is said to have beneficial properties that can serve humanity. Nutritional analysis indicates that Moringa leaves contain a wealth of essential, disease preventing nutrients. They even contain all of the essential amino acids, such as methionine, cystine, tryptophan [5], as required by aquatic animals [6]. This is unusual for a plant source. Based on a number of reports on the nutritional/medicinal values of moringa, it is being promoted as a “healthful” food, used traditionally to combat a number of common ailments. Since the dried leaves are concentrated, they contain higher amounts of many of the nutrients, except Vitamin C. Leaves and pods of Moringa therefore, offers an alternative source of protein to fish.

In Nigeria, there is awareness creation campaign as to the value of this leaf and people have started to eat it and grow it in backyards. Because information is scanty on the utilization of Moringa leaves as feed supplement for fish, the present study investigated the effect of various levels of *Moringa oleifera* supplementation, on the growth and nutrient utilization of the cherished *Clarias gariepinus* fish, for a period of eight weeks.

2. MATERIALS AND METHODS

2.1 Experimental Site

The study was carried out at the Ekiti State University, Ado Ekiti, Nigeria, Aquaculture Research Centre (Science Laboratory Technology campus, Ifaki Ekiti).

2.2 Procurement of Materials

2.2.1 Feedstuff

Fresh moringa leaves were harvested from Obafemi Awolowo University staff quarters, Ile Ife, Nigeria. The leaves were air-dried indoors, milled into powdery form with a hammer mill, and stored in opaque, well-sealed plastic containers, in a deep freezer till ready for use. Other feedstuffs (Danish fishmeal, yellow maize meal, brewery waste, Bio-mix, table salt and vegetable oil) were purchased from MetroVet Ventures, Ado Ekiti.

2.2.2 Fish

Four hundred and fifty, post fingerling (2.0±1g) *Clarias gariepinus*, were collected from Adebayo farms at Emure Ekiti, Nigeria and transported to the laboratory. The fish was acclimatized and fed the same commercial diet (Durante fish feed) for a period of two weeks, after which they were randomly distributed (n=30) into plastic aquarium tanks (60cm x 30cm x 30cm) at the Aquaculture Centre. The fish was raised in a flow-through system, with adequate water supply/aeration.

2.3 Feed Formulation

The necessary milling of the feedstuff was done and the ingredients were manually mixed together in proportions determined by Pearson's square method [7]. To compound five approximately, iso-nitrogenous (35% crude protein) diets, 5%, 10%, 20%, 30% moringa meal was used to replace fishmeal respectively and the diets were tagged M5, M10, M20, M30 respectively (Table 2). There was no moringa meal (0%) added to the control diet (M0). The main source of lipid in these diets is the vegetable oil. The mixed feed ingredients were pelleted, to a particulate size of 2mm, by a Hobart A120 pelleting machine (Hobart Manufacturing Ltd., London England). The air-dried product was packed into plastic containers and refrigerated until ready for use. The chemical composition of the various diets formulated are presented in Table 3.

2.4 Experimental Design and Feeding Trials

Each of the trial diet was fed to triplicate groups of the fish, at 4% of their body weight, twice a day, between 8.00-9.00a.m and 6.00-7.00p.m, for 8 weeks. A metric-graduated fish measuring-board was used to measure the standard lengths of the fish (in cm) and a Mettler top-loading balance was used to take the weights (in gram). Before acclimation, the lengths and weights of ten fish samples from the whole stock were taken as baseline data. This exercise, using three samples from each replicate, was repeated every fourteen days. Total cleaning and water renewal was done bi-weekly. From the length-weight data and the quantity of feed consumed, the growth performance and nutrient utilization data were generated by using the formulae used by [8].

2.5 Data Analysis

The physico-chemical parameters (temperature, dissolved oxygen, conductivity and pH) of the test media were monitored before and during the test period, using standard methods of [9]. The proximate analyses (moisture content, crude protein, ether, ash and fibre) and mineral content (calcium, magnesium, copper, iron and phosphorous) of the moringa meal, were carried out by the method of [10] at the Animal Science and Central Science Laboratories of Obafemi Awolowo University, Ile Ife.

Data generated were subjected to one way analysis of variance (ANOVA), according to Duncan's Multiple Range Descriptive Test [11], with mean at a significant level of P=.05. Standard errors of means were also determined at 95% confidence limit using SPSS 13.0 package.

3. RESULTS AND DISCUSSION

3.1 Nutritional Chemistry of Moringa Leaf

The nutrient composition of the moringa leaf and the experimental diets are as given in Tables 1 and 2.

Table 1. Proximate composition (g/100g) of the moringa leaf used in formulating the *C. gariepinus* diets

Nutritional Analysis	Proximate Composition (g/100g)
Crude protein	23.5
Moisture	3.5
Fiber	7.9
Ash	8.3
Crude lipid	2.9
NFE	57.8
Energy value (Kcal/100kg)	1349.2

Table 2. Mineral content (mg/100g) of the moringa leaf used in formulating the *C. gariepinus* diets

Mineral	Content
Calcium	1.93%
Magnessium	0.41%
Phosphorous	33.10 ppm
Manganese	80.55 ppm
Copper	6.13 ppm
Iron	109.75 ppm
Sodium	189.22 ppm
Zinc	59.12 ppm

ppm = parts per million (1mg/kg = 1ppm)

Table 3. Proximate composition (g/100g) of the experimental diets fed to *C. gariepinus*

Diets Feedstuff	M0	M5	M10	M20	M30
Fishmeal	30.5	22.9	15.3	7.6	-
Moringa meal	-	7.6	14.2	22.9	30.5
Fixed ingredients*	69.5	69.5	69.5	69.5	69.5
Proximate	**Composition**				
Crude Protein	39.8	39.6	39.2	39.0	39.4
Ether extract	15.2	5.6	4.8	3.6	1.8
Moisture	9.9	10.0	9.8	9.6	10.2
Crude fibre	5.2	7.7	8.2	11.0	13.3
Ash	9.9	8.5	7.6	7.6	6.6
NFE**	20.0	28.6	30.4	29.2	28.7
Energy (kcal/g)	4.1	3.7	3.7	3.7	3.9

**Fixed ingredients: brewery waste, 34.7%; yellow maize 32.8%; salt 0.5%; vegetable oil, 0.5% and Biomix, 0.5%. [a]Biomix from Bio-organics production contains Vitamins A,D,E,K,B1,B2, Niacin, Vitamins B6,B12; Pantothenic Acid, Folic Acid, Biotin. Choline Chloride, Manganese, Iron, Zinc, Copper, Iodine, Cobalt and Selenium.*

*** NFE = Nitrogen-free Extract = 100 – (Crude protein + Crude fibre + Lipid content + Moisture content + Ash)*

The moringa leaf meal was stored in opaque, well-sealed plastic containers to prevent sunlight from destroying the vitamin A because it is estimated that only 20-40% of vitamin A content will be retained, if leaves are dried under direct sunlight, while 50-70% will be retained in leaves, if stored in this manner [12].

This work corroborates earlier studies which have shown that, *Moringa oleifera* is nutritionally rich and is a promising protein source for inclusion in fish diets [5,13,14]. It was observed in this work, that the nutritional constituent of this moringa meal differs from the biochemical analysis report of some earlier workers. For example, the crude protein value reported by [15] was higher (27.4%) than the value obtained in this study (23.5%). [16] also reported much higher (30.6%) crude protein in *Moringa oleifera* leaves. The crude fibre, fat and ash contents reported by them were also slightly higher than the values obtained in this study. These differences may not be unconnected with variations in the geographical locations, stage of maturity of the plants used, environmental factors, post-harvest handling and different means of processing which may all influence the nutritional and functional qualities of moringa.

Nutritional constraints of most crop residues are low content of nitrogen (N), poor digestion and low intake, such that productive performance of tropical animals is often low. It has been recognized that feed intake and utilization efficiency of crop residues are influenced by the rate of rumen fermentation (ruminants) and the balance of nutrients absorbed in the intestines [17]. Improvement in the nutritive value, removal of nutritional limitations to rumen fermentation, and a balanced supply of nutrients to host animals would result in an improvement in animal productivity.

3.2 Survival, Feed Utilization and Growth Performance

3.2.1 Survival

In the course of feeding with the experimental diets, there was no mortality recorded. This is an indication that moringa and all of the test ingredients were non-toxic and the water quality parameters were adequate (Table 4).

Table 4. Water quality parameters (mean ± SE) of the culture facility measured during the experimental period

Treatment	Water Temperature (ºC)	pH	Disolved Oxygen concentration (mg l^{-l})	Conductivity (µs/cm)
Initial	26.0±1	7.0±1	5.3±0.7	79.1±2
M0	26.9±0.5	7.2±0.6	5.6±1	80.3±4
M5	26.6±0.2	7.7±1	5.8±0.8	81.4±2
M10	27.4±0.1	7.6±2	5.7±0.6	80.2±4
M20	26.7±0.5	7.4±0.4	5.4±0.6	77.7±2
M30	26.9±0.6	7.4±0.3	4.9±1	80.4±3

3.2.2 Nutrient Utilization and Growth Performance

All the diets with moringa had more crude fibre content than the control diet. Increase in the moringa meal content of the test diets is accompanied by poor growth in the fish fed with the diets (Fig. 2 and Table 5). In the first two weeks of feeding, there was no apparent difference in the growth of fish fed any of the diets. However, by the fourth week the fish fed diet M20 and M30 have started lagging behind. This differential growth became glaringly displayed by the 6^{th} and 8^{th} week of feeding. From the illustration in chart 2 and Table 5, it can be concluded that there was no significant difference (P>.05) in the overall growth performance of the fish fed diets, in which fishmeal was replaced with up to 10% moringa meal.

Table 5. Growth performance and nutrient utilization of *C. gariepinus* fed *Moringa oleifera* diets

Diet Parameters	M0	M5	M10	M20	M30
Initial weight (g)	2.1[a]	2.0[a]	2.0[a]	2.0[a]	2.0[a]
Final weight (g)	8.8[a]	8.5[a]	7.2[a]	4.5[b]	4.6[b]
Mean weight gain (g)	6.8[a]	5.7[a]	5.6[a]	2.5[b]	2.6[b]
% Mean Wt Gain	323.0	285.0	280.0	125.0	130.0
Daily Weight gain (g)	0.1[a]	0.1[a]	0.1[a]	0.1[a]	0.1[a]
Specific growth rate (SGR)	1.0[a]	0.8[a]	0.8[a]	0.7[a]	0.7[a]
Food Conversion ratio (FCR)	2.8[a]	3.1[a]	3.2[a]	5.1[b]	6.9[c]
Total Feed intake (g)	22.2[a]	21.0[a]	18.5[a]	14.0[b]	14.1[b]
% Survival	99.0[a]	100.0[a]	100.0a	98.0[a]	100.0[a]

Means with the same superscripts in the same row are not significantly different at P>0.05

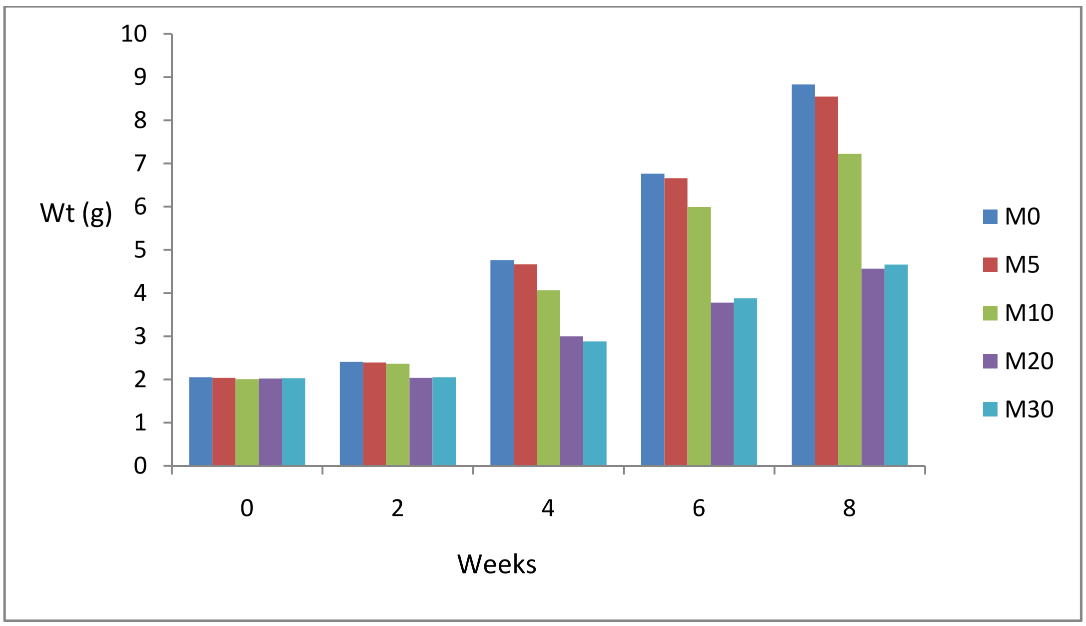

Fig. 2. The weekly average growth recorded for *C. gariepinus* fed with different formulated diets

From Table 5, it can be observed that there was no significant difference (P=.05) in the growth rate, specific growth rate and in the mean weight gain for all the treatments. This observation might, probably, change if the experiment was taken beyond 8weeks.

From the total feed intake data, it is observed that the fish fed M0 diet consumed more feed than the fish fed the other diets. However, as the quantity of the moringa meal increased, less feed was consumed. This observation is an indicator of the level of acceptability and palatability of the various diets. Diet with 100% fishmeal, as the protein source, was more acceptable and probably more palatable than the other diets. This fishmeal-based diet acceptability, as indicated by the total quantity of feed intake, was however, not significantly different (P=.05) from those treatments with up to 10% moringa meal replacement.

Poor feed conversion ratio (less efficiency) was obtained generally in this study especially with the moringa meal-based diets. Poor feed conversion ratio would lead to poor growth. Similar poor feed conversion ratios were reported by [18,19] when various plant protein-based diets were fed to tilapia and carp fingerlings, This observation could partly be due to low feed intake by the fish. The high fibre content of the plant-based diets could also be responsible for this poor feed conversion ratio. High fibre content in diets causes dilution of the nutrients, reduces digestibility, resulting in growth depression, as the diets become inconsistent.

[20] reported that fibre creates bulkiness of feed in the gut, reduces feed consumption of animals and creates regular bowel movement. Fibre depresses utilization of feed energy and essential nutrients. This energy deficit would in turn affect other biological parameters, as well as nutrient retention and thus weight loss. Thus the average final weight per fish and the average daily weight gain were all significantly different (*P=.05*) as shown in Table 3. The highest average final weight per fish (8.8g) was recorded under the control treatment M0 (fishmeal-based diet). This was followed closely by treatment M5 (8.6g) and M10 (7.2g) while treatment M20 and M30 had significantly low (*P=.05*) final weight (4.56g and 4.66g) respectively. The average daily weight gain and the specific growth rate were not significantly different (*P>.05*) in all the dietary treatments.

These observations agree with the findings of many authors [21,22,13,5,14] who reported that moringa is nutritionally rich and can be included in fish diet at low levels. [12] reported that moringa leaf extracts exhibited anti-microbial activity including inhibition of the growth of S*taphylococcus aureus* strains, isolated from food and animal intestines and that moringa added to fodder could be a potential bio-ceutical agent to substitute for antibiotics in livestock production. The results of thIs work showed that, up to 10% of fishmeal could be replaced by *Moringa oleifera* meal, without significant reduction in growth and feed utilization in *C. gariepinus*. This also agrees with the observations of [13], who used *M. oleifera* in feeding *O. niloticus*.

4. CONCLUSION

The products from the moringa hold considerable potential for becoming animal and fish feed ingredients, because of their high nutritional quality and low anti-nutritional factors. This work has indicated that fishmeal, in the diet of *C. gariepinus*, can be efficiently replaced with up to 10% moringa meal, for good growth and nutrient utilization, comparable with the fishmeal-based diet.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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