

# Effects of Varying Levels of *Moringa oleifera* on Growth Performance and Nutrient Utilization of *Clarias gariepinus* Post-Fingerlings

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## Abstract

The study examined the Growth performance and Nutrient utilization of *Clarias gariepinus* post- fingerlings fed varying levels of *Moringa oleifera* leaf meal diets for a period of 8 weeks from July 31<sup>st</sup> to 25<sup>th</sup> September, 2015. *Moringa oleifera* leaf meal substituted fish meal at 0% (Control), 10%, 15%, 20%, 25% in the five different diets. *Clarias gariepinus* post-fingerlings (Mean weight (4.19±1.06g) were randomly distributed into 10 plastic bowls at 12 fish / bowl in duplicate treatments and were fed twice daily; in the morning and evening for 8 weeks. The Mean Weight Gain (MWG), Specific Growth Rate (SGR), Feed Conversion Ratio (FCR), Protein Efficiency Ratio (PER) were calculated.

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The highest Mean Weight gain (MWG) of 5.58g was recorded in the Fishes fed 15% *M. oleifera* leaf meal and the lowest Mean Weight Gain of 3.79g was recorded in the Fishes fed 25% *M. oleifera* leaf meal. The Highest Standard Length increase of 2.67g was recorded in 15% *M. oleifera* leaf meal fed fish and the lowest value of 1.99g was recorded in the fishes fed 20% *M. oleifera* leaf meal. The results obtained in the experiment showed that fishes fed with the control diet did not show statistical significant difference ( $p > 0.05$ ) from fishes fed with 10% and 15% *M. oleifera* leaf meal diets in mean weight gain (MWG), specific growth rate (SGR) and feed conversion ratio (FCR). Fish condition Factor (K) obtained in control experiment was 0.94 while it was 1.1 in Fish fed with 15% *M. oleifera* Leaf meal diet. The Fish were in good condition during the experiment. The present study showed that *M. oleifera* leaf meal has good potential for use as fish meal substitute in *C. gariepinus* diet up to 15% level without compromising growth.

**Keywords:** Alternate Protein source; *Clarias gariepinus*; Fish feed ingredient; Fish meal; *Moringa oleifera*.

## 1. Introduction

The failure of aquaculture to meet the challenge of closing the widening gap between fish supply and demand in Nigeria, results from a number of factors including lack of quality feeds. Compost cribs and occasional animal droppings are usually the main feed input in ponds. These, however, can only promote limited growth and further growth is restricted by insufficiency of nutrients from primary production [1]. Further growth is only possible through provision of supplementary feed to sustain the increased demand for nutrients.

The high cost and fluctuating quality as well as the uncertain availability of fish meal have led to the need to identify alternative protein sources for fish feed formulation. Therefore, in order to attain more economically, sustainable, environmentally friendly and viable production, research interest has been directed towards the evaluation and use of non-conventional sources of plant protein. Researchers of aquaculture industries aim at exploring alternative, cheaper protein sources for use as fish meal replacers in aqua feeds. The decrease in global production of fish meal clearly demonstrates that the sustainability of this industry will depend on the sustained supply of plant proteins for aqua feeds. Currently fish farmers use cereal bran, kitchen leftovers and green leaves as fish feed.

According to [2], poor financial circumstances of the farmers within Sub-Saharan Africa are one of the main constraints impeding aquaculture development. Often feed is the most expensive operating cost item accounting for over 50% of costs in semi-intensive aquaculture [3] and up to 70% in intensive aquaculture [4]. Lack of quality feed is such an issue that nutrition research was given highest overall priority in the synthesis of national reviews and indicative action plans for sub-Saharan African aquaculture [5].

Instability in the fishmeal supply has led to sharp increases in price beyond the reach of many resource-poor fish farmers. Moreover, there are ethical concerns about feeding fish to non-piscivorous fish [6]. Also, there are social concerns over feeding farmed fish with wild fish which could be used directly for human consumption [7,8]. This somewhat contradicts the anticipated role of aquaculture in food security and augmenting dwindling supplies from natural stocks particularly in nutritionally deficient areas of the world

Several studies have shown that vegetable protein sources have high potentials for supplying fish with required protein needed for their maximum productivity (Nwana and his colleagues 2008). Some of the plant protein sources that have been investigated in an attempt to find substitutes for fish meal in the diets of fishes include; Leucaena, *Leucaena leucocephala* [10, 11], Sesbania, *Sesbania sesban*, [12], Sweet potato, *Ipomoea batata* [13], Mulberry, *Morus* sp [14], alfalfa, *Medicago sativa* [15], Acacia, *Acacia auriculiformis* [16], Papaya, *Carica papaya* [17] Water hyacinth, *Eichornia crassipes* [18], Duckweed, *Lemna polyrhiza* [19] Duck lettuce, *Ottelia alismoides*, Water snowflake, *Nymphoides indicum* [20] and Peanut, *Arachis hypogaea* [21]. In most of these studies the leaf meals could only replace < 25% of fishmeal protein.

Recently, researchers have increasingly been paying attention to Moringa (*M. oleifera* Lam). Moringa is an indigenous plant found growing wild in Northern India and Pakistan. It was introduced into South- East Asia during the early eras, and now cultivated throughout the tropics. In many places, it is also found more or less

naturalized. It holds a considerable potential for becoming an ingredient for animal and fish because of its high nutritional quality that is comparable to other feed protein source [22, 23, 24]. *Moringa. oleifera* is the best known species of Moringaceae family, having an impressive range of medicinal uses with high nutritional value throughout the world [25]. Reference [26] Revealed that *C. gariepinus* infected with bacteria (*Aeromonas* spp.) can be effectively treated with *M. oleifera* leaf extract at 50% concentration without adverse effect.

Dried powdered leaves have shown promising results to feed fishes [27] Several authors have worked on the use of Moringa leaf meal (MLF) to substitute fish meal at different percentages. These include [27] 30 % substitution in Nile Tilapia, [28] worked on the nutrition quality and haematological parameters of *M. oleifera* leaves in the diet of African Catfish *C. gariepinus* juveniles at varying levels: 0g, 4.1g, 8.2g, 12.3g, and 16.39g and reported that 4.1g inclusion of *M. oleifera* had the best weight gain, Specific Growth Rate, Protein Efficiency Ratio and the highest percentage weight gain; [29] reported that *M. oleifera* meal could be substituted with fish meal up to 10% level in *C. gariepinus* and that the diet did not have any adverse effect in the blood and serum enzyme. Similar observation were reported by many workers on *C. gariepinus* substitution; [30] 12.5% substitution [23,24], 8% substitutions, in Nile tilapia *Oreochromis niloticus*. However higher inclusion levels of *M. oleifera* led to a significant reduction in performance due mainly to high level of anti –nutritional factors (ANFs) particularly Saponins and to a lesser extent tannin, phytic acid and hydrogen cyanide (HCN).[32] showed that significant amount of saponin from Moringa leaves can be removed through solvent extraction and aqueous extraction respectively. And that using solvent extracted Moringa leaf meal, the inclusion level could be tripled (33%) to replace up to 30% of fish meal without significantly affecting performance of Nile Tilapia. High cost of fish feed has caused a lot of problems in aquaculture sector, which has actually hindered aquaculture development in Nigeria. Expensive feeds has actually reduced the profitability of fish farming thereby limiting the expansion of farms and reducing the yield in terms of quantity and quality [33]. Finding alternative protein sources to replace fishmeal in fish feed is important if the growth of the aquaculture industry is to be sustained [7]. This has brought about the search for local protein feedstuffs that are cheap and high in quality as alternative protein feed for *Clarias gariepinus* quality. *Moringa oleifera* (leaves in particular) have shown a great potential for animal feeding but this approach is underexploited.

The objectives of this study therefore are to:

- Evaluate *Clarias gariepinus*' performance in terms of growth rate and feed conversion ratio when fed on mature *Moringa oleifera* leaf meal as a protein supplement
- To determine the best level of replacement of Fish meal with *Moringa oleifera* as a cheaper source of protein to maximize profits of aqua culturists for feeding fishes.

## 2. Materials and Methods.

### 2.1 Experimental Site

The research was conducted in the Animal House at the Department of Zoology and Environmental Biology, Ekiti State University, Ado Ekiti, Nigeria in 10 plastic bowls for a period of 8 weeks from July 31<sup>st</sup> to 25<sup>th</sup> September, 2015.

### 2.2 *Moringa oleifera* leaf processing

Fresh *Moringa* leaves (Fig. 1) (*M. oleifera* Lam) were collected from a Garden in Ado-Ekiti, Ekiti State, Nigeria. The leaves were soaked in water for 3 days to reduce the anti-nutritional factors present in the leaves and dried in the sun for a day. A complete drying process takes 72hrs and yields 1kg of flour from 10kg of fresh material. Thereafter, the leaves were milled into fine powder and analyzed for proximate composition according to [34]. The parameters of importance were Crude Protein, Crude Fat, Crude fibre, Moisture Content, Total ash and Nitrogen free Extract.

### 2.3 Fish diet formulation and processing

Six different diets were formulated using Pearson's method of fish feed formulation to contain 35% Crude Protein. The other fish feed ingredients were purchased from Metro vet feed ventures Ado-Ekiti, Ekiti State. The *Moringa oleifera* Leaf Meal (MLM) were



**Figure 1:** *Moringa* Leaves with Flowers.

Source: FloralPix (2006)

incorporated into each of the diet at 0% (Control), 10%, 15%, 20%, and 25% to replace equal weight of fish meal as shown in Table 1.

Prior to processing, the feed ingredients were milled individually to fine powder by using a milling machine, then individually weighed and properly mixed together with adequate water added to ensure smooth pelleting. The strands were cut into short pieces and sun dried to reduce moisture [35]

**Table 1:** Percentage Composition (%) of the Experimental diets

Ingredients	A(Control)	B	C	D	E
MLM	0.00	2.37	3.36	4.75	5.96
Fishmeal	23.74	21.37	20.18	18.99	17.80
Soybean(Toasted)	23.74	23.74	23.74	23.74	23.74
Maize	22.76	22.76	22.76	22.76	22.76
Rice bran	26.26	26.26	26.26	26.26	26.26
Lysine	0.5	0.5	0.5	0.5	0.5
Methionine	0.5	0.5	0.5	0.5	0.5
Vit. C	0.5	0.5	0.5	0.5	0.5
Salt	1.0	1.0	1.0	1.0	1.0
Veg. Oil	1.0	1.0	1.0	1.0	1.0
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>

MLM, Moringa Leaf Meal

#### 2.4 Experimental Design and Feeding Trials

One hundred and twenty African Catfish fingerlings (*Clarias gariepinus*) of average weight ( $4.19 \pm 1.06$ g) and average Length (7.28cm) were purchased from Adebayo farms, Ibadan, Nigeria. The fish were allowed to acclimatize for two weeks and were fed on commercial diet. Prior to the commencement of the experiment, all fish were starved for 24hours to eliminate variation in weight due to residue food in the gut and at the same time to increase the appetite of the fish.

The fish initial weight ranged from 2.2-7.0g. Mean weight of 4.3g were weighed with a weighing balance model Shanghai Jingtian J72101N. The initial mean Standard length (7.4cm) and initial mean total length (8.3cm) were measured with graduated ruler and recorded.

The ten plastic bowls were randomly allocated to 5 treatment diets (A, B, C, D & E Treatment A contained 0% *Moringa oleifera* leaf meal and treatment B, C, D and E contained 10%, 15%, 20% and 25% *M. oleifera* leaf

meal respectively) in duplicates and fish were randomly distributed into the bowls at a stocking density of 12 fingerlings per bowl.

Feedings were generally carried out twice daily: morning and Evening at 5% of their body weight for 8weeks and feed quantity was adjusted in accordance to their body weight. Water was completely replaced every three days. Subsequently, Total weight and Standard Length measurements were taken biweekly.

**2.5 Determination of fish growth and performance**

The Growth parameters were calculated following the method described by [36]

❖ Protein Efficiency Ratio (PER)

$$PER = \frac{\text{Net weight gain (g)}}{\text{Crude protein fed}} \quad (1)$$

❖ Specific Growth Rate(SGR)

$$SGR = \frac{\text{Log (Wt}_2) - \text{Log (Wt}_1)}{t_2 - t_1} \times \frac{100}{1} \quad (2)$$

where

Log (Wt<sub>1</sub>) = Natural Log of the weight of the animal at the initial stage (t<sub>1</sub>)

Log (Wt<sub>2</sub>) = Natural Log of the weight of the animal at the final stage (t<sub>2</sub>)

t<sub>2</sub>-t<sub>1</sub> = Time taken

❖ Feed Conversion Ratio (FCR)

$$FCR = \frac{\text{Mass of food consumed Dry}}{\text{Increase in mass of animal produced wet}} \times \frac{100}{1} \quad (3)$$

❖ Mean Weight gain (MWG)

$$MWG = (W.\text{sub.2}) - (W.\text{sub.1})$$

(W. sub.2) = Initial weight (g) of Fish

(W. sub.1) = Final Weight (g) of Fish

Condition factor (K)

$$K = \frac{100W}{L^3} \quad (4)$$

W = Final mean body weight (g)

L = Mean Standard Length (cm)

Survival Rate (SR) (%)

$$SR = \frac{\text{Initial number of fish Stocked} - \text{Mortality}}{\text{Initial Number of Fish}} \times \frac{100}{1} \quad (5)$$

## 2.6 Water quality parameters

The water quality parameters measured were temperature, pH and Dissolved Oxygen concentration. Temperature was measured using mercury in glass thermometer, and pH was measured with a Digital pH meter (model S358236HANNA) and Dissolved Oxygen by Oxygen meter.

## 2.7 Data Analysis

The Proximate analyses of the Moringa meal, experimental diets and the fish carcass before and after the feeding trials were carried out by the method of [34]. Data generated were subjected to Analysis of Variance (ANOVA) using the Generalized Linear Model (GLM) Approach and the Least Square Design for the post hoc comparing the P value to the Standard with  $\alpha = 0.05$ . Standard errors of means were also determined at 95% Confidence limit using SAS 9.2 Package

## 3. Result

Water quality parameters measured were within tolerable ranges. Temperature has mean value of 25.4<sup>0c</sup>, pH 6.05 and Dissolved Oxygen was 6.4ppm. Table 1 shows the percentage composition of the formulated experimental diets. The biochemical composition and Mineral content of Processed MLM are shown in Tables 2 and 3. *Moringa oleifera* leaf meal had a Crude Protein value of 26.94%, Crude Lipid 5.39%, Crude fibre 4.38%, total ash 3.36% and 51.08% for Nitrogen Free Extract. Table 4 shows the Proximate Composition of the experimental Diets. Treatment A contained 0% *Moringa oleifera* leaf meal and treatment B, C, D and E contained 10%, 15%, 20% and 25% *M. oleifera* leaf meal respectively. The Crude Protein content of the diet ranged between 31.23 and 33.16%, Crude Lipid 12.20 and 13.92% and Crude fibre 9.86 and 12.01%, Moisture Content 8.45 and 9.70%. Table 5 shows the Proximate Composition of the Fish Carcass before and after the Feeding Trial with Crude Protein, Crude Fibre, Crude Lipid, Total Ash, Moisture Content and Carbohydrate as Parameters of Importance. The Highest Crude Protein value of 72.5% is obtained in the Fish carcass before feeding trial commenced. The Highest Moisture content of 11.53% is obtained in the 15% Moringa fed fish.

The Highest Crude Lipid Value of 10.13% is obtained in Fish fed 20% Moringa, 12.15% the Highest value of Ash was obtained from fish fed 25% Moringa.

**Table 2:** Proximate Composition of *Moringa oleifera* Leaf Meal.

Nutrient	Percentage Composition (%)
Moisture Content	8.85
Crude Protein	26.94
Crude Lipid	5.39
Crude Fibre	4.38
Total ash	3.36
NFE	51.08
Energy value (Kcal/100Kg)	1948.6

**Table 3:** Mineral Content (mg/ 100g) of the Moringa leaf used in Formulating the *Clarias gariepinus* diets

Mineral	Content
Calcium	0.22%
Phosphorus	0.03ppm

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

### 3.1 Survival, Feed utilization and Growth Performance

#### 3.1.1 Survival

In the Course of the feeding Trial, 20% of *Moringa oleifera* Leaf meal had the lowest Survival Rate of 83.33% while 0%, 10%, 15% had the highest Survival Value recorded of 95.84%

**Table 4:** Proximate Composition (%) of the experimental Diets.

Proximate Components	A Control	B	C	D	E
Crude Protein (%)	32.75	32.72	33.16	31.23	31.33
Moisture Content (%)	9.70	8.80	9.46	9.52	8.45
Crude Fibre (%)	11.68	9.86	10.03	11.06	12.01
Ash (%)	12.77	8.48	10.49	11.96	11.95
Crude Lipid (%)	13.92	13.20	12.62	12.20	12.66
Energy value	19.18	26.95	24.26	24.04	23.62

**Table 5:** Proximate Composition (%) of *Clarias gariepinus* carcass fed *Moringa oleifera* based diet subjected to ANOVA

Proximate Composition (%)	Initial	A Control	B	C	D	E
Moisture Content	11.33 <sup>b</sup> ±0.1	11.49 <sup>a</sup> ±0.2	11.48 <sup>a</sup> ±0.7	11.53 <sup>a</sup> ±0.4	11.49 <sup>a</sup> ±0.1	11.35 <sup>b</sup> ±0.01
Crude Lipid	2.05 <sup>c</sup> ±0.04	7.23 <sup>b</sup> ±0.09	8.38 <sup>ab</sup> ±0.4	10.1 <sup>a</sup> ±0.4	10.13 <sup>a</sup> ±0.9	8.92 <sup>ab</sup> ±1.15
Crude Protein	72.5 <sup>a</sup> ±0.01	64.06 <sup>b</sup> ±1.1	61.49 <sup>b</sup> ±1.74	61.82 <sup>b</sup> ±1.5	61.17 <sup>b</sup> ±0.35	63.76 <sup>b</sup> ±2.24
Crude Fibre	0.00	0.00	0.00	0.00	0.00	0.00
Total Ash	10.61 <sup>a</sup> ±0.01	10.64 <sup>a</sup> ±0.4	11.65 <sup>a</sup> ±1.39	11.41 <sup>a</sup> ±0	10.9 <sup>a</sup> ±1.61	12.15 <sup>a</sup> ±0.15
Carbohydrate	3.58 <sup>b</sup> ±0.01	6.60 <sup>a</sup> ±1.08	7.01 <sup>a</sup> ±0.05	5.14 <sup>a</sup> ±1.61	6.33 <sup>a</sup> ±1.46	3.88 <sup>b</sup> ±1.19

Note: Figures on the same row having the same superscript are not significantly different (p>0.05)

**Table 6:** Growth Response, Nutrient utilization and survival parameters of *Clarias gariepinus* post-fingerlings fed varying levels of *Moringa oleifera* leaf meal diet subjected to ANOVA

Parameters	A (Control)	B	C	D	E
Initial Mean weight(g)	4.77 <sup>a</sup> ±1.0	4.47 <sup>a</sup> ±0.14	4.17 <sup>a</sup> ±1.0	3.35 <sup>a</sup> ±0.0	4.19 <sup>a</sup> ±2.2
Mean Final Weight (g)	9.55 <sup>a</sup> ±3.0	8.57 <sup>a</sup> ±0.05	9.75 <sup>a</sup> ±0.5	8.29 <sup>a</sup> ±0.4	7.97 <sup>a</sup> ±0.8
Mean Weight gain (g)	4.79 <sup>a</sup> ±2.2	4.10 <sup>a</sup> ±0.6	5.58 <sup>a</sup> ±1.4	4.92 <sup>a</sup> ±0.4	3.79 <sup>a</sup> ±1.4
Mean Daily Weight Gain (g)	0.09 <sup>a</sup> ±0.04	0.08 <sup>a</sup> ±0.0	0.1 <sup>a</sup> ±0.0	0.09 <sup>a</sup> ±0.0	0.07 <sup>a</sup> ±0.0
Initial Mean Standard L.(cm)	7.59 <sup>a</sup> ±0.4	6.9 <sup>a</sup> ±0.04	7.1 <sup>a</sup> ±0.5	7.44 <sup>a</sup> ±0.5	7.35 <sup>a</sup> ±1.5
Mean Final Standard Length	10.0 <sup>a</sup> ±0.8	9.52 <sup>a</sup> ±0.3	9.77 <sup>a</sup> ±0.3	9.42 <sup>a</sup> ±0.1	9.57 <sup>a</sup> ±0.8
Mean Standard Length Gain(cm)	2.42 <sup>a</sup> ±0.4	2.62 <sup>a</sup> ±0.3	2.67 <sup>a</sup> ±0.8	1.99 <sup>a</sup> ±0.4	2.22 <sup>a</sup> ±0.7
Initial Mean Total Length(cm)	8.48 <sup>a</sup> ±0.6	8.42 <sup>a</sup> ±1.3	7.88 <sup>a</sup> ±0.6	8.39 <sup>a</sup> ±0.5	8.17 <sup>a</sup> ±1.6
Final Mean Total Length(cm)	10.87 <sup>a</sup> ±0.8	10.62 <sup>a</sup> ±0.1	10.8 <sup>a</sup> ±0.2	10.5 <sup>a</sup> ±0.1	10.5 <sup>a</sup> ±0.8
Mean Total Length gain(cm)	2.39 <sup>a</sup> ±0.16	2.21 <sup>a</sup> ±1.2	2.92 <sup>a</sup> ±0.9	2.12 <sup>a</sup> ±0.3	2.34 <sup>a</sup> ±0.8
Feed Intake (g)/ Fish	18.41 <sup>a</sup> ±8.6	17.5 <sup>a</sup> ±0.4	16.38 <sup>a</sup> ±5.0	16.52 <sup>a</sup> ±0.4	17.71 <sup>a</sup> ±7.0
Specific Growth Rate (SGR)	0.50 <sup>a</sup> ±0.1	0.50 <sup>a</sup> ±0.1	0.70 <sup>a</sup> ±0.2	0.70 <sup>a</sup> ±0.0	0.60 <sup>a</sup> ±0.4
Food Conversion Ratio (FCR)	3.8 <sup>a</sup> ±0.00	4.3 <sup>a</sup> ±0.6	3.2 <sup>a</sup> ±1.7	3.4 <sup>a</sup> ±0.2	5.4 <sup>a</sup> ±3.8
Protein Efficiency Ratio (PER)	0.8 <sup>a</sup> ±0.00	0.7 <sup>a</sup> ±0.1	1.1 <sup>a</sup> ±0.6	1.0 <sup>a</sup> ±0.1	0.8 <sup>a</sup> ±0.5
Condition(k) Factor	0.94 <sup>a</sup> ±0.1	1.0 <sup>a</sup> ±0.0	1.1 <sup>a</sup> ±0.0	1.0 <sup>a</sup> ±0.0	0.9 <sup>a</sup> ±0.1
Survival Rate (SR)%	95.84%	95.84%	95.84%	83.33%	91.67%

Note: Figures on the same row having the same superscript are not significantly different (p>0.05)

#### 4.12 Feed Utilization and Growth Performance

The results for the feed utilization and Growth parameters are presented in Table 6. Fishes fed the control diet gained 4.79g, fishes fed 10%, 15%, 20%, 25% *M. oleifera* leaf meal gained 4.10g, 5.58g, 4.92g and 3.79g respectively.

The highest **Mean Weight gain (MWG)** of 5.58g was recorded in the Fishes fed 15% *M. oleifera* leaf meal and the lowest Mean Weight Gain of 3.79g was recorded in the Fishes fed 25% *M. oleifera* leaf meal.

There was no Statistical difference ( $p>0.05$ ) between the fishes fed 0% *M. oleifera* leaf meal and those fed 15% *M. oleifera* leaf meal.

The Highest **Mean Daily Weight Gain (MDWG)** of 0.1g was recorded in the Fishes fed 15% *M. oleifera* leaf meal and the lowest value of 0.07 was recorded in fishes fed 25% *M. oleifera* leaf meal Fig .

There was no statistical significant difference ( $p>0.05$ ) between fish fed 0% and 15% *M. oleifera* leaf meal diet. Fig. 3 shows the weekly average Length recorded for *Clarias gariepinus* fed with different formulated diets.

The Highest **Standard Length increase** of 2.67g was recorded in 15% *M. oleifera* leaf meal fed fish and the lowest value of 1.99g was recorded in the fishes fed 20% *M. oleifera* leaf meal. There was no statistical significant difference ( $p>0.05$ ) between Lengths recorded in all the diets.

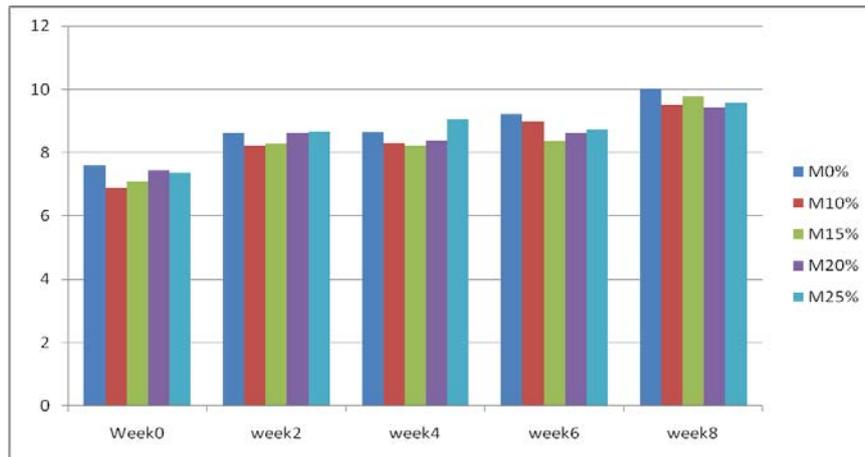
The Highest **Mean Total length** of 2.92g was recorded in the fish fed 15% *M. oleifera* leaf meal and the lowest value of 2.12g was recorded in the fishes fed 20% *M. oleifera* leaf meal Fig. 3. Shows the weekly average Length recorded for *Clarias gariepinus* fed with different formulated diets. From the **feed Intake** data, it is observed that the Fish fed M0 diet consumed more feed than the Fish fed the other diets.

The results for the **Specific Growth Rate (SGR)** showed that Fishes fed with 15% and 20% had the highest value of 0.7 and the lowest value of 0.5 was recorded in fishes fed with 0% *M. oleifera* leaf meal.

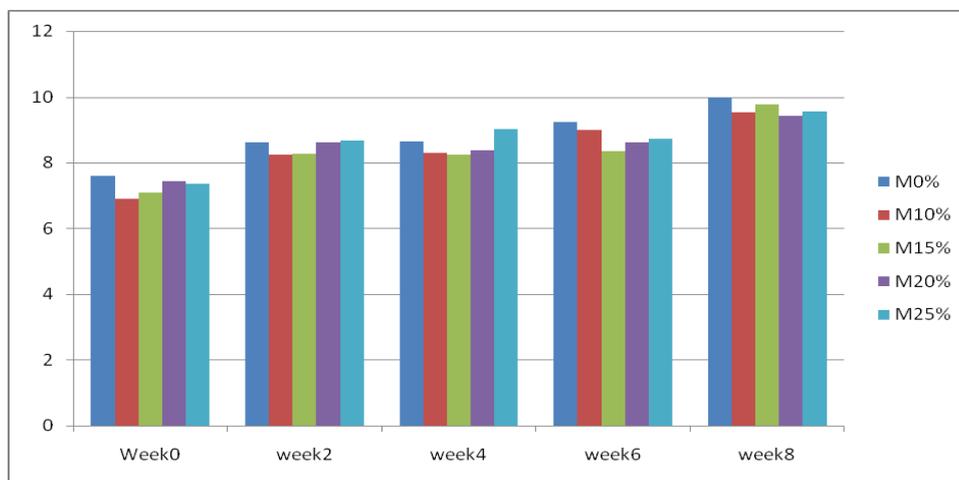
**The Food Conversion Ratio (FCR)** data shows that 25% *M. oleifera* leaf meal fed fishes had the highest value of 5.4 and the lowest value of 3.2 in the 15% *M. oleifera* leaf meal fed fishes.

There was no Significant difference ( $p<0.05$ ) between fishes fed M0 and M15. Fish fed with 0%, 10% and 20% *M. oleifera* leaf meal diet showed better feed conversion ratio (FCR) in all the experimental diets.

The Highest **Protein Efficiency Ratio (PER)** value of 1.1 was recorded in the Fishes fed 15% *M. oleifera* leaf meal and the lowest value of 0.7 from fishes fed 10% *M. oleifera* leaf meal. There was no significant difference ( $p>0.05$ ) between fishes fed M0 and M15. **Fish condition Factor (K)** obtained in control experiment was 0.94 and it was 1.1 in Fish fed with 15% *M. oleifera* Leaf meal diet



**Figure 2:** The weekly average Weight recorded for *Clarias gariepinus* fed with different formulated diets



**Figure 3:** The weekly average Length recorded for *Clarias gariepinus* fed with different formulated diets.

## 4. Discussion and Conclusion

### 4.1 Discussion

This study reveals the possibility of utilising *Moringa oleifera* Leaf Meal to replace Fishmeal in the diets of *Clarias gariepinus*. The potential of a feedstuff such as leaf meal in fish diets can be evaluated on the basis of its proximate chemical composition, which comprises the moisture content, crude protein, crude fibre, crude fat, total ash and nitrogen free extract.

Processing of Moringa leaves using aqueous extraction of MLM led to reduction of most nutrients most likely due to leaching of soluble nutrients and it also led to the reduction of the Fibre content of *Moringa oleifera* Leaf Meal. This may suggest reason why Moringa of up to 15% replacement of fish meal give positive effect in *C. gariepinus* in the present study

The proximate composition of *M. oleifera* leaf meal in the present investigation revealed that the crude protein

content value of 26.94% reported was lower than 27.57% reported by [37], 29.68% by [38] but higher than 23.56±0.56% reported by [39]. The variation in the nutrient content of the leaves could be attributed to the age of cutting, harvesting, climatic conditions, edaphic factors as well as methods of processing and analysis [39]. Values of crude fibre 4.38%, crude fat 5.39% and total ash 3.36% were reported in this study. These observed values fall within the range obtained by [32]. The similarities in chemical composition with the other study may be an indication that similar processing methods were used. Furthermore, values of chemical composition were comparable with those reported in other leaf meals such as *Leucaena leucocephala*, and *Ipomoea batatas* [40]. This suggests the potential of *M. oleifera* leaf meal as animals feed agree with other leaf meals from nutritional point of view.

The Proximate composition of the feed and carcass showed the different protein composition at varying levels. Other feed sources like fat also contributed to essential fatty acids which are needed for fish growth and survival. *M. oleifera* Leaf Meal was well utilised by fish and this resulted in good fish performance in their weight and length in this study. There was an increase in the Length of fish in all the diets, Diet A (0%) increased from 7.59cm to 10cm, Diet B (10%) increased from 6.9cm to 9.52cm, Diet C (15%) increased from 7.1cm to 9.77cm, diet D(20%) increased from 7.44cm to 9.42cm, Diet E (25%) increased from 7.35cm to 9.57cm, there was no significant difference ( $p>0.05$ ) in the Mean length increase of the fishes fed the different diets.

Also there was an increase in the weight of the fish in all the diets, Diet A (0%) increased from 4.77g to 9.55g, Diet B (10%) increased from 4.47g to 8.57g, Diet C (15%) increased from 4.17g to 9.75g, diet D (20%) increased from 3.35g to 8.29g and Diet E (25%) increased from 4.19g to 7.97g.

The Growth and Nutrient utilization by fish decreased as *M. oleifera* leaf meal increased in the Diets above 15% [27] showed that higher substitution of *M. oleifera* leaf meal with fish meal had an impact on lowering the growth performance because of the presence of anti-nutrients such as phenol, tannins, phylates and saponins. The decrease in growth rate could be due to reduction of level of protein and amino acids in the diets having higher substitution levels, from the optimum level for growth and feed utilization. Similar observations were made by other workers [39, 24]. Reference [41] Reported that solvent – extracted *M. oleifera* leaf meal could replace 30% of fish meal from *Oreochromis niloticus* diets. Reference [42] Also showed that 30% substitution of duckweed, *Spirodela polyrrhiza* with fish meal in the diet of *Oreochromis niloticus* supported growth. These various workers have shown that leaf meal protein at low levels of substitution (less – than 50%) in fish diets were able to support fish growth.

Results obtained in this work seem to have direct link with palatability of the diet which causes reduced feed intake at higher substitution level. Reference [41] Opined that saponins and tannins present in the Moringa extracts are known to have a bitter taste that might have acted as a feed restraint. Avoidance of feed in fish can be caused by the bitter taste of the phenolics binding to saliva mucopolysaccharides, epidermis or chemosensory receptors [43]. Fish condition Factor (K) obtained in this study indicates that fish fed with M15 diet with condition factor of 1.1 and that fed with M0 diet (control) that has condition factor of 0.94 were in good condition.

## 4.2 Conclusion

Fishmeal is the most important fish feed ingredient ironically it is also the most expensive due to its nutrient profile and availability. The *Moringa* plant is one of the cheapest close substitutes being a plant feed stuff, it has a nutrient profile that is close to what is obtainable in fishmeal and it can also be made available in quantity that can support the aquaculture industry.

In conclusion, the results obtained from this study showed that *M. oleifera* leaf meal could be substituted with fish meal up to 15% level in *Clarias gariepinus* diets without any negative effects on the growth and feed efficiency.

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