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EFFICACY of *Moringa oleifera* LEAF MEAL ON THE GROWTH PERFORMANCE OF *Clarias gariepinus* (AFRICAN CATFISH)

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ABSTRACT

Partial replacement of fish meal by *Moringa* leaf meal was conducted in 56 days at the Biological garden of Federal University of Kashere. Four diets(40% crude protein) including the control (Diet A), Diet B, Diet C and Diet D with an inclusion level of 0%, 10%, 20% and 30% respectively based on fish meal were formulated and tested on *Clarias gariepinus*. These diets were tested on duplicates of 10 fishes of initial weight of 2.4g±0.07 per bowl. The result obtained showed that there is no significant difference (p>0.05) in final weight gain of fishes fed the control diet (Diet A) and 30% replacement (Diet D). But there was significant difference in control diet and diet B and C. The highest mean weight gain 6.07±0.28g was recorded in fishes fed the control diet while the lowest 2.28±0.21g was recorded in 10% inclusion level. The highest final mean length 10.00±0.12 cm was obtained from fishes fed the control diet while the lowest 8.09±0.20cm was obtained from fishes fed 10% inclusion level. The carcass composition was recorded with the highest protein value of 48.31% recorded in Diet D and the lowest 32.28% in Diet A. This study showed that *Moringa oleifera* leaves can replace 30% of the fish meal component for African catfish without any adverse effects on growth. However, more study should be done in finding methods for inactivating the antinutritional factors for inclusion of *Moringa* leaves in the diet of African catfish at higher levels.

Keywords: Growth performance, Nutrient utilization, *Moringa oleifera*; *Clarias gariepinus* (Catfish)

INTRODUCTION

Healthy food is a major requirement for all living organisms including fish for growth, reproduction and body maintenance (Adebayo *et al*., 2020). 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. Aquaculture production in Africa has been on a steady increase growing more rapidly in Sub-Saharan countries than the rest of Africa (FAO, 2012). In fish culture systems, the importance of feed cannot be over emphasized, since feed is the most expensive input in terms of cost in fish production. Nutritional requirement of fish is necessary in order to formulate an economical and nutritionally balanced diet for the fish (Solomon *et al.* 2012). To sustain fish under culture, supplementary diet must be provided to complement natural feeds supply (Karapan, 2002).

Fish culture is one of the fastest growing sectors of the world's animal production with an annual increase of about 10% (FAO, 2012). To sustain such high rates of increase in production, a matching increase in fish feed production is imperative. 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 (Idowu *et al*., 2017). 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. The inclusion of plant protein sources in the ration of fish requires investigation on limiting factors in the plant ingredients such as high crude fibre content and anti-nutritional factors as earlier investigations on some plants have shown that their excessive inclusion in the feed may result in slower growth rates and general poor performance of cultured fish species (Francis *et al*., 2001; Alegbeleye *et al*., 2001; Nwanna *et al*., 2008; Dienye and Olumuji, 2014).

One plant receiving a lot of attention as a possible replacement of fish meal is *Moringa oleifera.* This is a fast-growing plant and it is widely available in the tropics and subtropics and it has several economically important uses for industry and medicine (Richter *et al*., 2003). The leaves are rich in proteins, vitamins, fatty acids and minerals (Moyo *et al*., 2011). It has been nicknamed as a 'wonder plant'. Various studies have been conducted to replace fish meal with *Moringa* leaf meal in diets of mainly *Oreochromis niloticus*, *Clarias gariepinus* and other species with varying results (Madalla *et al*., 2013; Olaniyi *et al*., 2013; Hlophe and Moyo, 2014; Ncha *et al*., 2015; Mehdi *et al*., 2016). However, most studies have shown depressed growth on fish species fed with diets containing *Moringa oleifera* leaf meal.

The aim of this research work is to determine the growth performance of *Clarias gariepinus* fed on mature *Moringa oleifera* leaf meal as a protein supplement.

MATERIALS AND METHODS

Sampling of Experimental Fishes

One hundred fingerlings of *Clarias gariepinus* were bought from AA farms, Dadinkowa in Gombe town. They were transported from Dadin kowa to Biological Garden of the Federal University of Kashere in a plastic jerrican of 25 liters. The fish samples were later acclimatized for one week.

Moringa oleifera leaf processing

Fresh *Moringa* leaves were collected from a Garden in Karu, Nasarawa State, Nigeria. The leaves were air dried under the shade for 3 days. Thereafter, the leaves were milled into fine powder using mortar and pestle then analyzed for proximate composition. The parameters checked were Crude Protein, Crude fibre, Moisture Content and Total ash.

Formulation and Processing of Experimental Diets

Four different diets were formulated using Pearson's method of fish feed formulation to contain 40% Crude Protein. The other fish feed ingredients were purchased from a market in Karu, Nasarawa state .The *Moringa oleifera* Leaf Meal were incorporated into each of the diet at 0% (Control), 10%, 20%, and 30% to replace equal weight of fish meal.

Prior to processing, the feed ingredients were milled individually to fine powder by using a mortar and pestle, then individually weighed and properly mixed together with starch added to ensure smooth pelleting. The strands were cut into short pieces and sun dried to reduce moisture and then subjected to analysis for chemical composition following AOAC (2000) prior to the commencement of the feeding.

Feeding Trials

Prior to the commencement of the experiment, all fishes 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 (Idowu *et al*., 2017). Experimental fishes were weighed with a weighing balance (SF-490). The initial mean Standard length and initial mean total length were measured with graduated ruler and recorded (Idowu *et al*., 2017).

The eight plastic bowls were randomly allocated to 4 treatment diets (A, B, C,& D). Treatment A contained 0% *Moringa oleifera* leaf meal and treatment B, C, and D contained 10%, 20% and 30% *M. oleifera* leaf meal respectively in duplicates and fish were randomly distributed into the bowls at a stocking density of 10 fingerlings per bowl.

Feeding was typically done twice a day: in the morning and in the evening for 8 weeks at 5% of their body weight, with feed quantity being modified in accordance to their body weight. Every three days, the entire water supply was changed. Following the measurements of standard length and total weight which were obtained every week.

Biological Evaluation

The feed utilization and growth parameters such as: Mean weight gain (MWG), feed conversion ratio (FCR), protein efficiency ratio (PER), survival and relative growth rate (RGR) were evaluated using the collected growth data. The growth parameters were computed using the following formulae reported in Kolawole and Ugwumba (2018) as follows**:**

i. Mean weight gain = final weight of fish (W2) – initial weight (W1).

ii. $$\text{Protein efficiency ratio (PER)} = \frac{\text{fish weight gain (g)}}{\text{Protein consumed (g)}}$$

iii. $$\text{Feed conversion ratio (FCR)} = \frac{\text{weight of feed (g)}}{\text{Fish weight gain (g)}}$$

iv. $$\text{Survival rate (SR) (\%)} = \frac{\text{Initial number of fish stocked – Mortality}}{\text{initial number of fish}} \times 100$$

Proximate Analysis

Proximate analysis was done in Biochemistry lab of Gombe State University. Standard methods described in AOAC (2005) were used to analyse the proximate composition of the plants for crude protein, crude fiber and moisture content using standard procedure.

Data Analysis

The Proximate analyses of the *Moringa* meal, experimental diets and the fish carcass before and after the feeding trials were carried out. Data generated were subjected to Analysis of Variance (ANOVA) and the Least Square Design for the post hoc was used to compare the P value at 95% Confidence limit using Statistical Package for the Social Sciences (SPSS) Version 26.

RESULTS

Proximate Composition of *Moringa oleifera* Leaf Meal

The result of the proximate analysis of the *M. oleifera* leaf meal is shown in Table 1. *M. oleifera* leaf meal had a crude protein level of 19.94%, crude fibre 15.68% and total ash of 5.46%.

Table 1: Proximate composition of *Moringa* leaf meal (%)

Nutrients	Composition (%)
Crude protein	19.94±0.29
Crude fiber	15.68±0.17
Moisture content	0.20±0.05
Ash	5.46±0.11
NFE	34.58±0.24

NFE, Nitrogen free extract; Values are mean±Standard Error of Mean (SEM)

Proximate Composition of the Formulated Diet

The proximate composition of experimental diets fed to *C. gariepinus* fingerlings are presented in Table 2. Moisture content of the experimental diets ranged between 0.65% to 0.81%. The ash content ranged between 5.81% to 7.67%). Protein content was within the formulated 40% CP diets, and ranged between 36.44% to 47.14%. Crude fibre value ranges from 09%) to13.35%.

Table 2: Proximate composition of experimental diets (%)

Proximate components	Diet A (0%)	Diet B (10%)	Diet C (20%)	Diet D (30%)
Crude Protein (%)	36.44 ±0.11	40.60±0.04	43.30±0.06	47.14±0.58
Crude Fiber (%)	13.35±0.08	11.09±0.11	10.10±0.20	9.44±0.01
Moisture Content(%)	0.81±0.01	0.72±0.08	0.69±0.15	0.65±0.01
Ash (%)	5.81±0.06	6.15±0.25	7.04±0.04	7.67±0.02
NFE	36.15±0.28	32.13±0.03	29.45±0.07	24.29±0.60

NFE, Nitrogen free extract; Values are mean±Standard Error of Mean (SEM)

Growth Performance of Experimental Fish

Figure 1 showed the mean weekly weight of *Clarias gariepinus* fingerlings fed with different percentage of *Moringa oleifera*. At the commencement of the feeding regimes, initial mean weights were taken to be 4.6, 3.1, 3.5 and 3.9 for Diet A, Diet B, Diet C and Diet D respectively. The greatest final weight (8.42±0.09) was achieved by the fishes in treatment Diet A (control), followed by fishes in Diet D (30%) and the least final weight (4.48±0.25) was recorded with fishes fed Diet B(10%). There is significant different ($P<0.05$) in all the inclusion level. Figure 2 showed the mean weekly length gain of experimental fishes fed with different percentage of *Moringa oleifera*. The highest final length (10.0±0.12) was recorded in Diet A (Control) followed by Diet D (30%), the least final length (8.09±0.2) was recorded in Diet B (10%).

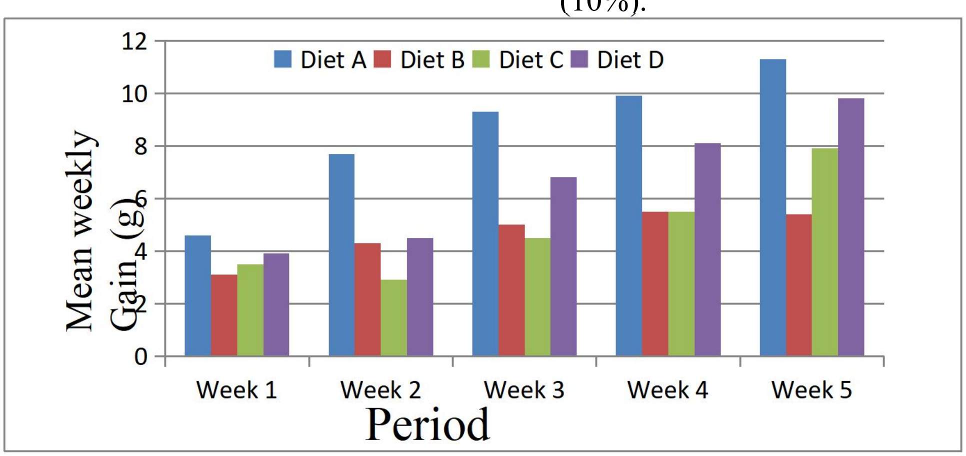

Figure 1: Mean weekly weight gain of experimental fishes

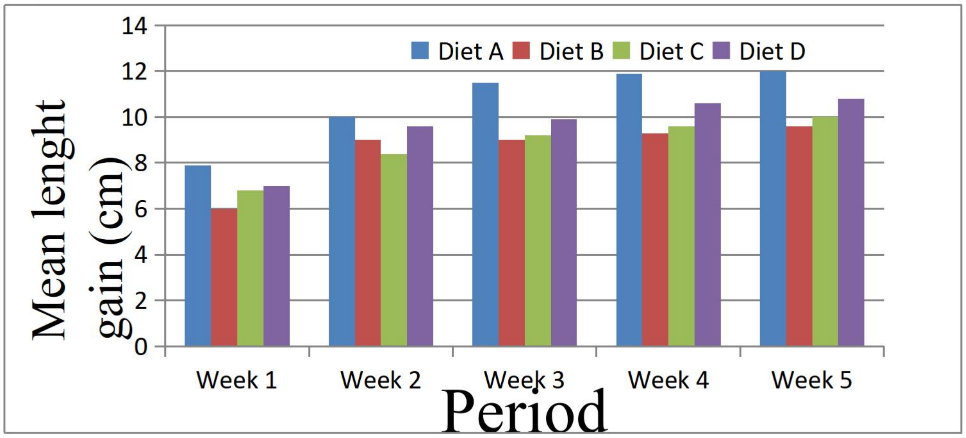

Figure 2: Mean weekly length gain of experimental fish

Nutrient Utilization of Experimental Fish Fed With Different Experimental Diets

The result obtained for the growth response, nutrient utilization and survival parameters of fish fed with *M. oleifera* based diet are shown in Table 3. The fish fed 10% *M. oleifera* leaf meal diet gained 2.41 g, while the fish fed control diet gained 06.06 g. The values obtained for the fish fed control diet and other diets of *M. olifera* leaf meal were significantly different (P < 0.05).. There was significant difference (P < 0.05) in the feed conversion ratio (FCR) in the fish fed control diet, 10, 20% and 30% *M. oleifera* leaf meal diets. The highest value of 0.17 recorded for protein efficiency ratio (PER) was observed in fish fed diet containing 0% *M. oleifera* leaf meal and lowest value of 0.05 was recorded in fish fed diet containing 10% and 20% *M. oleifera* leaf meal. Survival rate (SR) was highest in fish fed with 0% *M. oleifera* leaf meal based diet. Fish growth exhibited significant inverse correlation with increase in *M. oleifera* leaf meal in the diets formulated.

Table 3: Growth responses, Nutrient utilization and Survival parameters of *Clarias gariepinus*

Parameters	Diet A (0%)	Diet B (10%)	Diet C (20%)	Diet D (30%)
Initial mean weight(g)	2.35±0.07[a]	2.20±0.28[a]	1.50±0.21[a]	2.20±0.28[a]
Final mean weight(g)	8.42±0.09[a]	4.48±0.25[b]	4.69±0.23[b]	6.72±0.15[a]
Mean weight gained	6.07±0.28[a]	2.28±0.21[b]	3.19±0.11[b]	4.52±0.28[a]
Initial length(cm)	6.23±0.13[a]	6.12±0.02[a]	6.11±0.01[a]	6.15±0.14[a]
Final mean length	10.00±0.12[a]	8.09±0.20[a]	8.43±0.42[a]	9.31±0.16[a]
Feed conversion ratio	8.59±0.12[a]	9.70±0.80[b]	7.28±0.70[d]	8.19±0.01[c]
Protein Efficiency ratio	0.17±0.02[a]	0,05±0.14[b]	0.05±0.01[b]	0.9±0.05[c]
Survival rate(%)	70	56	55	60

Values in each row (mean ± SD) having different superscripts are significantly different (P< 0.05)

Carcass Composition of Experimental Fish Before and After Feeding Trial

The initial and final whole body composition of experimental fish is presented in Table 4. Moisture content was not significantly different (P>0.05) in all treatments. Compared to the initial value which was 1.15±0.02, it was observed that fish fed diet D had the highest crude protein (48.31±0.03) which was followed by fish fed diet C (42.59±0.25) while the lowest value was observed in fish fed diet A(38.53±0.07). Ash content was significantly different in all treatments (P>0.05) with value which ranged 5.51±0.07 in diet C to 4.42±0.07 in diet A which is higher than the initial value before feeding trial.

Table 4: Proximate composition of fish carcass before and after experiment(%)

Proximate composition (%)	Initial	Diet A (0% MLM)	Diet B (10% MLM)	Diet C(20% MLM)	Diet D(30% MLM)
Crude protein	32.28±0.30a	38.53±0.07	41.20±0.11	42.590.25	48.31±0.03
Crude fiber	6.59±0.04	7.07±0.02	6.46±0.03	6.13±0.01	5.93±0.03
Moisture	1.15±0.02[a]	0.22±0.02[a]	0.21±0.03[a]	0.17±0.05[a]	0.21±0.01[a]
Ash	3.30±0.01[d]	4.42±0.07[b]	4.68±0.02[c]	5.51±0.07[a]	5.42±0.05[a]
NFE	53.05±0.36	43.40±0.12	40.87±0.11	38.31±0.14	33.09±0.05

NFE=Nitrogen Free Extract,Values are mean±Standard Error of Mean(SEM)

DISCUSSION

Use of plant based sources in the production of aqua-feed has been an acceptable development for the development of the aquaculture industry over decades (Adebayo et al., 2020). Recent studies have revealed that substantial use of vegetable oils as energy sources in fish diets have yielded positive growth response in fish (Babalola and Adebayo 2007; Aderolu and Akinremi 2009; Adebayo *et al*., 2020). 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. The proximate composition of *M. oleifera* leaf meal in the present investigation revealed that the crude protein content was 19.94%, crude fibre 15.68%, and total ash 5.46%. These values are in contrast with the values obtained from Dienye and Olumuji (2014) and Idowu *et al*., (2017). The disparities in chemical composition with the other study could be an indication that environmental factors such as season, geographical location, stage of maturity, method of harvesting, climatic conditions, edaphic factors as well as methods of processing and analysis play a role in determining nutritive value of *M. oleifera* leaf meal. This study has confirmed that the *M. oleifera* leaves have the potential to partly replace fish meal and greatly reduce expenditure on fish meal, without reducing growth and nutritional performances of the African catfish.

The proximate composition of the experimental diets showed that the crude protein increased as the percentage of the *M. oleifera* is increased. This result is in contrast with the work of Adebayo *et al*., (2020); Dienye and Olumiji (2014) and Idowu *et al*., (2017) which recorded a decrease in crude protein values as the percentage of *M. oleifera* is increased. However, there is decrease in crude fibre values as the *M. oleifera* percentage is increased in this study which is as well in contrast with the work of Dienye and Olumiji (2014).

The growth and nutrient utilization by fish decreased as *M. oleifera* leaf meal increased in the diets. The higher growth of fish observed in the control group compared to experimental fish feeding on *Moringa* diet is similar to the findings of Dienye and Olumiji (2014) and Idowu *et al*., (2017) This observation supports the findings of previous studies by Ritcher et al. (2003). This could be attributed to some anti-nutritional factors such as phenolics, saponin and phytic acids in the *Moringa* leaves as reported by Richter *et al*. (2003).

In the feeding trials, growth parameters like weight gain,lenght gain and survival in Diet B and C were significantly lower than the control ($P < 0.05$), whereas there was no significant difference in Diet A and D. The Feed Conversion Ratio (FCR) in Diet C were significantly different from the control, however there was no significant difference between Diet D and the control. The fish in the control Diet A, Diet C and D fed better during the entire period of the experiment than in other treatments. Diet B had the highest mortality rate. The findings contradict the works of most research such as Dienye and Olumuji (2014) and Adebayo *et al*., (2020) which discovered a decrease in growth parameters in higher inclusion of *Moringa* leaf meal in *Clarias gariepinus*, Nsofor *et al*.,(2012) which establish the best growth response was obtained in fish fed 20% *Moringa oleifera* leaf inclusion.

This variation may be due to the low crude protein content in the *Moringa* leaf used in this research. Bello and Nzeh (2013) found that *Clarias gariepinus* fed with 0%, 10%, 20%, 30%, 40% and 50% MOLM diet showed best FCR in 10% based diet which is in line with this research. They argued that inclusion of MLM at higher levels in the fish feed resulted in a decrease in FCR. On the other hand, Afaung *et al*., (2003) reported that MLM could be replaced up to 30% of fish meal without any negative effect on growth performance which is in line with the result of this research.

The proximate composition of the experimental diets and carcass showed there was an upward trend in the moisture and ash content of fishes with increasing *Moringa* inclusion at the end of the study, however crude protein content was slightly different in all experimental groups. Although slight increase was recorded in the final proximate composition of fish over the initial in the study except the moisture, the moisture contents of fish at the end of the study were lower than the initial moisture content.

CONCLUSION

This current study intensifies on *Moringa* leaf meal as a non-conventional feed ingredient possessing many attractive attributes backing the results of this study, where 30 % replacement of fish meal with *Moringa* leaf meal in the diet of *C. gariepinus* supported good growth and nutritional performance of fish. However, more work should be done in finding methods for inactivating the antinutritional factors for inclusion of *Moringa* leaves in practical diet for African catfish at higher levels. The leaves of *Moringa oleifera* have the potential to make considerable contributions to the healthy growth of the African catfish. It also holds the potential to partially replace fishmeal in a feeding regimen and, thereby, reduce feed cost to the fish farmer, whose most important production cost comes from feed. This study has demonstrated that *Moringa oleifera* leaf meal could be included up to 30% level in *Clarias gariepinus* diets and therefore, suggests it as the optimum requirement for catfish growth performance.

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