International Academic Research Consortium Journals (IARCJ)
International Journal of Agricultural Science and Technology
ISSN: 2360-9888. Volume 11, Number 2
Pages 9-16 (August, 2023)
DOI: 427251452781122
www.arcnjournals.org

Determinations of Nutritional Quality and Dietary Effect of *Moringa oleifera* Lam. Leaves on a Diet of Catfish (*Clarias gariepinus*)

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Abstract: *The study was conducted at livestock and fish farm of Umaru Ali shinkafi polytechnic, Sokoto located in Wamakko local government area of Sokoto state, to determine the nutritional quality and dietary effect of Moringa oleifera Lam. Leaves on a Diet of Catfish (Clarias gariepinus). Five hundred and fifty healthy juveniles of African Catfish, Clarias gariepinus was collected from Lagos State, Nigeria. Five treatments were used and 10 Clarias gariepinus juveniles with mean weight (19.00±0.50g) per tank each in triplicate. The five treatment tanks were fed with five isonitrogenous diets containing 40% crude protein with varying inclusion of Moringa oleifera (control diet with 0% Moringa oleifera, 4.1g Moringa oleifera inclusion, 8.2g Moringa oleifera inclusion, 12.3g Moringa oleifera inclusion and 16.39g Moringa oleifera inclusion). The fishes were fed twice daily for an experimental period of 12 weeks. The fish in tank T_2 (4.1g inclusion of Moringa oleifera) had the best weight gain with 2 range 27.67±0.60. The specific growth rate was highest in fish in tank T_2 (0.96±0.01). The fish fed 4.1g M.oleifera inclusion had the best feed conversion ratio (1.36±0.03). The highest feed intake (15.11±0.00) was found in fish fed with 4.1g M. oleifera inclusion. The protein efficiency ratio was higher in fish fed with 4.1g M. oleifera with range 1.83±0.04. Percentage weight gain was higher in fish fed 4.1g M. oleifera with range 142.00±3.06. There was no significant difference in the growth performance of all the treatment. No mortality was recorded in all experimental tanks.*

Keywords: *Nutritional Quality, Dietary, Catfish, Moringa Oleifera, Clarias Gariepinus, Weight Gain.*

INTRODUCTION

Fish and fishery products remain a cheap and major source of animal protein contributing 40% of the total animal protein intake of Nigerians, particularly for the majority of our populace (FDF, 1990). Fish has the highest level of easily metabolisable high quality protein, fats, vitamins, calcium, iron and essential amino acids when compared to other sources of animal protein such as poultry and beef (Ayoola, 2010). Since the last decade, fish production from captured fisheries which accounts for over 80% of the total domestic supply in the country has been declining. This is largely due to over exploitation and water pollution arising from poor or lack of effective management of our country's water resources leading to the depletion of natural fish stocks. Similarly, livestock which provides the major alternative source of animal protein to the people is almost collapsing due to natural disasters such as desert encroachment, feed scarcity and render pest and drought devastations of the traditional grazing reserves. According to Ayoola (2010), the demand for fish in Nigeria is increasing at the rate of 2.99% annually with 3.9% increase in population growth. Nigerians are high fish consumers with a total current annual fish demand of about 2.50million metric tonnes.

The total domestic fish production in 2008 was 579,500 tonnes, with fish demand currently estimated at 1.80 million metric tonnes, the fish demand and supply gap are currently over 1 million metric tonnes (while the fish seed demand and supply deficit are put at over 500million fingerlings). With increasing gap between fish supply and demand in Nigeria, Nigeria has embarked on fish importation in order to meet up for the deficit in supply as less than 50% of the total annual fish consumed by Nigerians are produced locally. Over the years the import bill has been very high with an average of 70 billion naira spent annually on fish importation in Nigeria in the past 10 years (Ayoola, 2010). With the production from captured fisheries (natural water bodies- lakes, dam, rivers, creeks, etc.) being fully exploited based on the fact that the landing from this fishery sub-sector has been on the decline over the years, fish culture therefore remains the most viable option of mass production of fish in Nigeria (Ayoola, 2010). Data on domestic fish production in the country show that it ranges between 0.26 and 0.48 million tonnes per annum (FDF, 1990). Production value is less than 30% of the projected demand; hence the need for increased production to bridge this gap. Fish production from aquaculture is seen as the only means to bridge the widening gap between domestic fish supply from depleting return from captured fisheries and demand. The growth of aquaculture in Nigeria now is largely being boosted by a steady rise in catfish culture. Since the culture of

Clarias gariepinus was initiated in Western Nigeria in 1973, the procedure has been widely practised throughout Nigeria, thus leading to increase of farm-raised catfishes from the 80's to date (FAO, 2003). The favoured catfish species in Nigeria aquaculture include: *Clarias gariepinus, Heterobranchus bidorsalis, Heterobranchus hybrid* (Heteroclarias) and *Chrysichthys nigrodigitatus*. Fish feed is a high protein feed supplement which can be mixed with other ingredients to produce a balanced diet for fish. Feed and feeding of catfishes in ponds are very important. Various efforts have been made to establish the crude protein and amino acid requirements of *Clarias gariepinus*. Ayinla (1988) recommended 35% and 40% crude protein for raising table size and brood stock Agrosearch (2013) 13 No.1 3 respectively. Fish feed constitutes over 60% of the operating cost of aquaculture (Nwanna, 2002). Yang et al. (2002) similarly described that fish feed accounts for 50% or more of the total production cost. In order to formulate and compound aqua feeds that will meet the nutrient requirements of the catfish at affordable cost, several conventional and non-conventional animal by-products and plant residues have been tested to substitute or replace fishmeal. Aquaculture production in the developing countries is greatly constrained by undersupply, scarcity and high cost of conventional quality fish feeds (Fagbenro and Arowosegbe, 1991).

Similarly, livestock which provides the major alternative source of animal protein to the people is almost collapsing due to natural disasters such as desert encroachment, feed scarcity and render pest and drought devastations of the traditional grazing reserves. According to Ayoola (2010), the demand for fish in Nigeria is increasing at the rate of 2.99% annually with 3.9% increase in population growth. Nigerians are high fish consumers with a total current annual fish demand of about 2.50million metric tonnes. The ever growing cost and uncertainties about the quality and availability of some of the fish feed ingredients have compelled many aquaculture nutritionists to use readily available plant protein source materials (such as *Moringa oleifera*) as an alternative protein source (Lim and Dominy, 1989). The development of formulated feeds that can satisfy the nutritional requirement of the fish is considered to be one of the major tasks in aquaculture. Much research is geared towards the development of least cost feeds to rear fish as cost effectively as possible. The high cost of feed is a major factor against the rapid growth of aquaculture in developing countries. There is therefore the need for alternative. It may be feasible to replace expensive conventional fish feedstuffs with cheaper alternatives in order to reduce the cost of feed. Plants, therefore becoming the preferred sources of protein for these fish species.

There have been a number of efforts in the past decades to test the suitability of a number of plant-derived protein sources for various, popular aquaculture species. Most of these plants require environmental and soil conditions and energy subsidies that restrict the scope for increasing their production (George *et al.,* 1993). *Moringa oleifera* Lam is the most widely cultivated species of the

genus *Moringa*, which is the only genus in the family of *Moringaceae*. It is also called 'horse-radish' tree (it is so called because of the taste of a condiment prepared from the roots) or 'drumstick' tree (arising from the shape of the pods). It is an exceptionally nutritious vegetable tree with a variety of potential uses. There are no studies so far which report utilisation of *Moringa* leaves or seed meal as fish feed ingredients. *Moringa* plant parts have the potential to be a supplier of macro and micronutrients in a fish feed derived from a mixture of plant products (George *et al.,* 1993). The objective of this study therefore is to determine the effects of dietary levels of *Moringa oleifera* leaves at the expense of maize on performance and haematological parameters of *Clarias gariepinus*.

MATERIALS AND METHODS

Study area

Study was conducted in Wamakko Local Government area of Sokoto state. The area is located on the latitude 11^{o} 13' 13^{o} and longitude 3^{o} 5' 7^{o}. The climate is semi- arid and characterized by alternating wet and dry season with a short cool and dry period, which starts in November and end in late February (Hassan and Bode, 1990). Mean annual rainfall in the area is between 625 to 700mm, ambient temperature ranges from 14°C during harmattan period to 36°C during the hot season (SERC, 2004). The natural vegetation of the area is dominated by grasses with sparse trees of about 5 – 9m tall that cover about 30% of the ground (Baba *et al.*, 2009).

Collection of Fish Specimens

Five hundred and fifty healthy juveniles of African Catfish, Clarias gariepinus was collected from Lagos State, Nigeria. The fishes were transported in an open 25L container to the fish farm in Umaru Ali shinkafi polytechnic, Sokoto.

Laboratory Procedure

The fishes were exposed to acclimatized for 14 days. After 14 days of acclimatization, the average body weight of 100 juveniles of C. gariepinus have been measured and transferred into each of the Plastic experimental tanks using a scoop net. Suitable conditions were maintained by cleaning the tanks and constant changing of the water every day.

Collection of Moringa Leaves

Large quantities of fresh leaves of M. oleifera was obtained from the Moringa plantation in the college farm at Umaru Ali shinkafi polytechnic, Sokoto. The leaves were shed dry in an environment with little sunlight touching the leaves so as not to destroy the leaves or get them rotten. After drying, the leaves were transfer into a local mortal and grounded using pestle. The grounded Moringa leaves was poured into a sieve and the fine powder were extracted. The powder was kept in a dry case and later used in feed formulation. Part of the *Moringa oleifera* leaves powder were taken to the Nigerian Institute for Medical Research (NIMR) Laboratory for proximate analysis.

Feed Source

The fish feed was source from Sokoto old market in Sokoto State Nigeria. The Moringa leaves powder are incorporated into the compounded feed mixed with warm water, pelleted and dried.

The feed was pelleted into 2mm pellet size to enable the fish swallow them easily.

Experimental Design

Five plastics tanks containing 2000L was used for the experiment. Each of the tanks were cleaned by washing the tanks properly with soap and water after which the tanks were filled with water for three

to four days to remove the residue of the soap used in washing, then the tank was sterile to kill the germs. Each of the tanks were fill with de-chlorinated tap water. Each tank has been stocked with 100 juveniles of *C. gariepinus*. The water was fill to 3/4 of the volume of each tank (1500 litres). The mean weight gain of the specimen in each of the experimental tanks were obtained at the end of every week. The tanks labelled T_0, T_1, T_2, T_3 and T_4 represent each of the feeding regimes. The tanks labelled 0 1 2 3 4 represent each of the feeding regimes. Table 1 shows the percentage composition of the experimental feed. The experimental feeds were formulated with varying inclusion levels of *Moringa oleifera* at 4.1g,

8.2g, 12.3g and 16.39g.

Tank T_0: Formulated feed (Control)

Tank T_1: 4.1g Inclusion of M. oleifera in fish diet.

Tank T_2: 8.2g Inclusion of M. oleifera in fish diet.

Tank T_3: 12.3g Inclusion of M. oleifera in fish diet.

Tank T_4: 16.39g Inclusion of M. oleifera in fish diet.

Experimental Set-Up

5 plastics tanks (75 x 95 x 70cm) were used for the experiment. Each of the tanks was cleared by washing the tanks properly with soap and water after which the tanks were filled with water for three to four days to remove the residue of the soap used in washing. The water was removed after four days. Each of the tanks was filled with dechlorinated tap water and was stocked with 10 juveniles of C. gariepinus. The water was filled to 2/3 of the volume of each tank (50 litres). The mean weight gain of the specimen in each of the experimental tanks was obtained at the end of every week.

Feeding of Fish

The fishes were fed 2 times a day in equal proportions with their various experimental feeds for a period of 12 weeks. The daily feeding ratio were measured at the beginning of every week using the weighing scale (OHAUS MODEL 5000). Feeding response were monitored and no mortality rate are recorded. The water has been changing every week in order to avoid contamination of the water by the uneaten feed and faeces. **Data Collection**

Data collected involved physical observation of the samples, weight recording before and after feeding, weight increment after feeding fortnightly in twelve weeks' period as described by (Malami *et al.,* 2015).

Statistical analysis

The data obtained were subjected to one-way Analysis of Variance (ANOVA) to determine significant effects of treatments on the fish growth rate pattern within the study period. Mean separation were done using Duncan Multiple Range Test (DMRT) at 5% level of significance in order to test the level of significance of the treatment.

Feed Conversion Ratio (FCR)
This is the amount of unit weight of food that specimens were able to convert to unit muscle.
It was determined by the formula below;
FCR= Feed intake (g)/Total weight gain (g)

Protein Efficiency Ratio (PER)
This was calculated from the relationship between the increments in the weight of fish (i.e. weight gain of fish) and protein consumed. PER = Mean weight gain (g) /Protein intake

Protein Intake (P.I)
Protein intake was calculated using the formula below.
PI = Feed intake X Percentage (%) Protein in diet

Percentage Weight Gain (PWG)
This was calculated using the formula below
PWG = Final weight /Initial weight X 100

RESULTS

Tabe 1: Illustrated the growth parameters and nutrients utilization of *C. gariepinus* fed with *M.oleifera* at different levels of inclusion. The initial weight of the experimental fish was not significantly different ($P>0.05$) from each other. The final weight of the experimental fish in tanks T_0, T_3 and T_4 were not significantly different ($P>0.05$) from each other but they were significantly different ($P<0.05$) from the final weight of the fish in T_1 and T_2. The highest average weight gains of fish (27.67±0.60) was recorded by fish fed with 8.2g inclusion of *Moringa oleifera* diet while the least (19.17±1.92) was recorded by fish fed 12.3g of Moringa. The fish in tanks T_3 and T_4 have average weight gain that were not significantly different ($P>0.05$) from each other but they were significantly different ($p<0.05$) from the fish in tanks T_0, T_1 and T_2. Similar pattern was recorded for the specific growth rate (SGR) of the experimental fish. The highest SGR (0.96±0.01) was recorded for the fish fed 8.2g inclusion of *Moringa oleifera* while the least was recorded by fish fed with 12.3g inclusion of *Moringa oleifera* (0.77±0.07). There was no significant difference ($P>0.05$) between the specific growth rate of the fish in tanks T_3 and T_4 but they were significantly different ($P<0.05$) from the fish in tanks T_0, T_1 and T_2. The percentage weight gain (142.00±3.06) was highest in fish fed 8.2g *Moringa oleifera*. The highest Food Conversion Ratio, (FCR) (1.87±0.13), was recorded by fish fed 16.39g *M. oleifera* inclusion in diet while the lowest and the best FCR (1.36±0.03), was recorded by fish fed8.2g *M. oleifera* in diet. The FCR of the fish were significantly different ($P<0.05$) from each other. There was no significant difference ($P>0.05$) in the PI among the fish in all the tanks. The Protein Efficiency Ratio, (PER) (1.83±0.04) was highest in fish fed 8.2g inclusion of *Moringa oleifera* diet. There was no significant difference ($P>0.05$) in the PER among the fish in tanks T_0, T_3 and T_4 (0%, 12.3g and 16.39g inclusion of *M. oleifera* respectively) but there were significantly different from the fish in tanks T_1 and T_2, (4.1g and 8.2g inclusion of *M. oleifera* respectively). There was no mortality recorded among the fish in all the experimental tanks.

Table 1: Growth Parameters and Nutrients Utilization of *Clarias gariepinus*.

Parameters	Treatments				
	T_0	T_1	T_2	T_3	T_4
Initial weight	19.33±0.17[a]	19.87±1.33[a]	19.50±0.00[a]	19.00±0.50[a]	19.50±0.29[a]
Finalmean weight	39.83±1.30[a]	44.67±1.45[b]	47.17±0.60[b]	38.17±1.59[a]	38.50±1.50[a]
Average weight gain	20.5±1.44[ab]	24.80±1.47[bc]	27.67±0.60[c]	27.67±0.60[a]	19.00±1.26[c]
SGR	0.80±0.04[a]	0.92±0.01[a]	0.96±0.01[a]	0.77±0.07[a]	0.75±0.03[a]
FCR	1.63±0.12[abc]	1.45±0.89[ab]	1.36±0.03[a]	1.83±0.20[bc]	1.87±0.13[a]
FI	13.24±0.00[a]	14.24±0.00[a]	15.11±0.00[a]	13.88±0.00[a]	13.64±0.00[a]
PER	1.55±0.11[ab]	1.74±0.11[b]	1.83±0.04[b]	1.38±0.14[a]	1.39±0.09[a]
PWG	106.10±8.30[ab]	125.00±7.64[bc]	142.00±3.06[a]	101.50±12.29[ab]	97.33±5.36[a]
Survival	100	100	100	100	100

*Means in column with different superscript are significant different (P<0.05).

DISCUSSION

Nigerian aquaculture industry is currently faced with the problem of inadequate supply and prohibitive cost of quality fish feeds. The highest average weight gains of fish (27.67±0.60) was recorded by fish fed with 8.2g inclusion of *Moringa oleifera* diet while the least (19.17±1.92) was recorded by fish fed 12.3g Moringa. The fish in tanks T_3 and T_4 have average weight gain that were not significantly different (P>0.05) from each other but they were significantly different (p<0.05) from the fish in tanks T_0, T_1 and T_2. This is in conformity with investigation made by Yang et al. (2002) whose reported that Moringa *oleifera* can be used as a substitute for maize. Fagbenro and Adeparusi, (2003) and Omitoyin (2005) reported increasing attempt to develop practical diets for farmed fish in Nigeria. A number of plants are continued to be investigated for their potential in supplementing or even replacing some of these fish feed ingredients. investigated. Yang et al. (2002) similarly described that fish feed accounts for 50% or more of the total production cost. In order to formulate and compound aqua feeds that will meet the

nutrient requirements of the catfish at affordable cost, several conventional and non-conventional animal by-products and plant residues have been tested to substitute or replace fishmeal. Aquaculture production in the developing countries is greatly constrained by undersupply, scarcity and high cost of conventional quality fish feeds (Fagbenro and Arowosegbe, 199).

CONCLUSION

In conclusion, *M. oleifera* leaves have the potential to make considerable contributions to growth of the African catfish. *M.oleifera* leaves can be used to partially replace maize and other supplemented feeds in the diet of *Clarias gariepinus* thereby reducing feeding cost. This study has demonstrated that *M. oleifera* leaves could be included in the diet of *Clarias gariepinus* without any negative effects on the growth but for effective nutrients utilization, it is advisable to include *M. oleifera* at moderate concentrations such as 8.2g level of inclusion. *M. oleifera* leaves are locally available in the tropics and can be obtained throughout the year. It costs little of nothing to collect *M. oleifera* leaves from the wild. It is therefore economical to partly include *M. oleifera* leaves powdering *Clarias gariepinus* diets.

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