Agrosearch (2013) 13 No.1: 1 -15 Http://dx.doi.org/10.4314/agrosh.v13i1.1

AN EVALUATION OF NUTRITIONAL QUALITY AND HAEMATOLOGICAL PARAMETERS OF MORINGA (*Moringa oleifera*) Lam LEAVES IN THE DIET OF AFRICAN CATFISH (*Clarias gariepinus*)

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ABSTRACT

This study was carried out to evaluate the effects of dietary levels of Moringa oleifera leaves on the growth performance and haematological parameters of Clarias gariepinus juveniles. 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 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.

The Fish fed with M. oleifera showed increase in the haematological values of Packed Cell Volume (PCV), (27.38±3.06), Haemoglobin, (HGB), (8.33 ±1.01), Red blood cell, (RBC), (2.48±0.21) and white blood cell, (WBC), (220.56±9.75) compared to the values of fish fed control diet with PCV (13.87±9.40), HGB (5.03±2.70), RBC (1.25±0.85) and WBC (149.60±64.28). The white blood cell (WBC) shows no significant difference (P>0.05) among the fish in tanks T_1, T_2, T_3, and T_4 (25%, 50%, 75% and 100% inclusion of M. oleifera respectively) but they were significantly different (P<0.05) from the fish in the tank T_0 (control tank).There was reduction in the haematological values of the fish fed M.oleifera diet with Mean cell haemoglobin concentration, (MCHC), (28.90±6.62) and the Mean Corpuscular Haemoglobin, (MCH) (32.64±7.32) compared to the values of fish fed the control diet with MCHC (39.24±13.98) and MCH (44.00±17.12). It was concluded that using M.oleifera leaves as feed for Clarias gariepinus enhances the growth of the fish and has no negative impact on the health status of the fish. Therefore partial replacement of feed with M.oleifera should be encouraged.

Keywords: Bio indicator, Heamatology, *Moringa oleifera*, *Clarias gariepinus*

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

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). 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

COLLECTION OF FISH SPECIMENS

One hundred and fifty healthy juveniles of African Catfish, *Clarias gariepinus* were purchased from Aro Fish Farm in Idimu area of Alimosho Local Government Area of Lagos State, Nigeria. The fishes were transported in an open 25L container to the Marine Research Laboratory of the University of Lagos in clean fresh water.

LABORATORY PROCEDURE

The fishes were acclimatized for 14 days. After 14 days of acclimatization, the average body weight of 10 juveniles of *C. gariepinus* was 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 which took place every day.

COLLECTION OF MORINGA LEAVES

Large quantities of fresh leaves of *M. oleifera* were obtained from International Institute of Tropical Agriculture, Ojoo Ibadan, Nigeria. The leaves were dried in an environment with little or no sunlight touching the leaves so as not to destroy the leaves or get them rotten. On drying, the leaves were transferred into a local mortal and ground using pestle. The ground Moringa leaves were poured into a sieve and the fine powder was extracted. The powder was kept in a dry case for later used in feed formulation. Part of the *Moringaoleifera* leaves powder was taken to the Nigerian Institute for Medical Research (NIMR) Laboratory for proximate analysis.

FEED SOURCE

The fish feed was purchased from Tanimowo Ventures, a feed mill at Idimu, Lagos State. The Moringa leaves powder were 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 SET-UP

15 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. The tanks were labelled T_0, T_1, T_2, T_3 and T_4 each having triplicates. The tanks labelled 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_1: Formulated feed (Control)

Tank T_2: 4.1g Inclusion of *M. oleifera* in fish diet.

Tank T_3: 8.2g Inclusion of *M. oleifera* in fish diet.

Tank T_4: 12.3g Inclusion of *M. oleifera* in fish diet.

Tank T_5: 16.39g Inclusion of *M. oleifera* in fish diet.

TABLE 1: PERCENTAGE COMPOSITION OF EXPERIMENTAL FEED

Ingredients	Percentage inclusion level of *M. oleifera* in 100kg feed				
	T_1	T_2	T_3	T_4	T_5
CP	40.10	40.25	40.44	40.34	40.60
Moringa	0	4.1	8.2	12.3	16.39
Maize	16.39	12.3	8.2	4.1	0
Fishmeal	32.61	32.61	32.61	32.61	32.61
Groundnut cake	32.61	32.61	32.61	32.61	32.61
Indomie	16.39	16.39	16.39	16.39	16.39
Vitamin premix	0.5	0.5	0.5	0.5	0.5
Mineral premix	1.5	1.5	1.5	1.5	1.5
Total	100	100	100	100	100

FEEDING OF FISH

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

DETERMINATION OF WATER PARAMETERS

The water pH was measured with a Phillip meter (model pH-009 111), with glass electrode. The electrodes were standardized using buffer solution and washed with distilled water. It was thereafter washed with the sample water to be tested, dipped into the water and pH was read on scale.

Dissolved Oxygen (DO) was measured with DO meter (MODEL EUTECH DO 600), water temperature was determined by simple mercury in glass thermometer, calibrated in centigrade (^{o}C). It was immersed into the plastic tank for about five minutes and the level of the mercury was read on the graduated glass tube.

WEIGHT MEASUREMENT

The mean standard weight of the fish in each tank was determined at the beginning of the experiment and at every week. The weight of all the fish in each tank was measured using weighing scale (OHAUS MODEL Cs 5000, CAPACITY 5000x2g) and mean value was calculated.

GROWTH AND NUTRIENT UTILIZATION PARAMETERS

The following indices were used to determine the biological evaluation of growth performance and nutrient utilization of the experimental fish.

WEIGHT GAIN

The weight gained was calculated using the formula below.

Final weight (g) - Initial weight (g)

SPECIFIC GROWTH RATE (SGR)

This is the percentage rate of change in the logarithmic body weight. It was computed according to Hopkins (1992). The SGR was calculated using the formula below.

$$SGR = \frac{Log_e W_f - Log_e W_i}{\text{Times (in days)}} \times 100$$

Where W_f is final body weight and

W_i is the initial body weight.

FOOD CONVERSION RATIO (FCR)
This is the amount of unit weight of food that specimens were able to convert to unitmuscle. It was determined by the formula below;

$$FCR = \frac{\text{Feed intake (g)}}{\text{Total weight gain (g)}}$$

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.

$$PER = \frac{\text{Mean weight gain (g)}}{\text{Protein intake}}$$

PROTEIN INTAKE (P.I)
Protein intake was calculated using the formula below.

PI = Feed intake X Percentage (%) Protein in diet

PERCENTAGE WEIGHT GAIN
This was calculated using the formula below

$$PWG = \frac{\text{Final weight Initial weight}}{\text{Initial weight}} \times 100$$

EXTRACTION OF BLOOD FROM FISH
The fishes were taken out individually using a small hand net and were placed belly upward on a table. Blood samples of about 2 milliliters were collected from the caudal peduncle (Stoskopf, 1993) with the aid of a 2cm3 plastic syringe and the blood was dispensed into ethylene diamine tetra-acetic acid (EDTA) anticoagulant bottle for haematological studies. The use of plastic syringe is a necessary precaution with fish blood because contact with glass result in decreased coagulation time. Haematological studies were done using Sysmex Hematology Systems, Coagulation Systems. Packed cell volume (haematocrit), haemoglobin (Hb) concentration, Red blood cells (RBC), White blood cells (WBC), Mean corpuscular haemoglobin (MCH) and Mean cell volume (MCV) were all analysed using the analyzing machine (Sysmex Hematology Systems, Coagulation Systems).

PROXIMATE ANALYSIS
It involves an assay for all the constituents of a sample apart from the major food constituents. Each fish sample was dried in the oven and ground into fine particles and homogenized. Samples for the different analyses were then taken from the homogenized material. Triplicate determinations were carried out on each group.

DETERMINATION OF MOISTURE

The moisture content of each fish sample was determined using the oven drying method following the method of AOAC (1994).

STATISTICAL ANALYSIS

Analysis of variance (ANOVA) was carried out to test significance of the treatments on the fish growth rate pattern within the study period and level of significance was determined using the Duncan Multiple Range Test (DMRT).

RESULTS

WATER QUALITY PARAMETERS

The water quality parameters were measured in all the experimental tanks. The results are given in Table 2.

PROXIMATE COMPOSITION OF *Moringa oleifera* LEAVES

The proximate composition of *Moringa oleifera* leaves is shown in Table 3. The percentage crude protein of *Moringa oleifera* is 25%, the percentage ash, crude fibre, moisture and ether extract were 5.9%, 13.06%, 12.76% and 6.7% respectively.

PROXIMATE COMPOSITION OF CARCASS OF *C. gariepinus* FED WITH *M. oleifera*

Table 4 shows the proximate composition of *C. gariepinus* fed *M. oleifera.* The crude protein was highest in carcass fed with 4.1g *M. oleifera* (T_2) while it was lowest in carcass fed with 8.2g *M. oleifera* (T_3). Lipid was highest in carcass fed with 50% *M. oleifera* (T_2)while it was lowest in tank fed with 12.3g M*. oleifera* (T_3). Ash content was highest in carcass fed with 16.39g inclusion of *M. oleifera* (T_4) while lowest in carcass fed with 4.1g (T_1) *M. oleifera. M*oisture was highest in 16.39g *M. oleifera* inclusion (T_4) and lowest in 12.3g (T_3) *M. oleifera* inclusion. NFE composition was highest in carcass fed 75% *M. oleifera,* but lowest in carcass fed 8.2g M*. oleifera* inclusion in diet.

TABLE 2: WATER QUALITY PARAMETERS OF THE EXPERIMENTAL TANKS

Parameters	Range	Mean and Standard deviation
pH	6.5-7.2	6.88±0.27
Dissolved Oxygen (DO)	6.5-6.8mg/L	6.7±0.10
Temperature	26-30^{0}C	28±1.38

TABLE 3: PROXIMATE COMPOSITION OF *Moringa oleifera* LEAVES

Parameters	Composition (%)
Crude protein	25.0
Ash	5.9
Crude fibre	13.06
Moisture	12.76
Ether extract	6.7
NFE	36.58

TABLE 4: PROXIMATE ANALYSIS OF CARCASS OF *C. gariepinus* FED WITH *M. Oleifera.*

Parameters	T_0	T_1	T_2	T_3	T_4
Protein	66.5	66.6	66.8	66.2	66.3
Lipid	9.5	9.4	9.8	9.1	9.3
Ash	4.3	4.2	4.4	4.6	4.8
Moisture	7.3	7.6	7.3	7.2	7.8
NFE	12.4	12.2	11.7	12.9	11.8

GROWTH PARAMETERS AND NUTRIENTS UTILIZATION OF *C. gariepinus*

The growth parameters and nutrients utilization of *C. gariepinus* fed with *M.oleifera* at different levels of inclusion are shown in Table 6. 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 gain 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 thatwere 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 fed 8.2g *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 they 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 6: GROWTH PARAMETERS AND NUTRIENTS UTILIZATION OF *C. Gariepinus*.

Parameters	T_0	T_1	T_2	T_3	T_4
Initial mean 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]
Final mean 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]	19.17±1.92[a]	19.00±1.26[a]
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[c]
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[c]	101.50±12.29[ab]	97.33±5.36[a]
Survival	100	100	100	100	100

[1]Pooled standard error; Mean in the same row with the superscript are not significantly different from each other, P (>0.05).

HAEMATOLOGICAL PARAMETERS OF *C. gariepinus* FED WITH *M. oleifera*

The haematological studies for the fish in treatment tanks showed that for white blood cells (WBC), there was no significant difference (P>0.05) among the fish in tanks T_1, T_2, T_3 and T_4 (25%, 50%, 75% and 100% inclusion of *M. oleifera* respectively) but they were significantly different (P<0.05) from the fish in the tank T_0 (control tank). The White Blood Cell Count (WBC) increased from the range of 149.60±22.73 in control to range of 220.56±3.25, in tank T_3 having 75% *M. oleifera* inclusion. For the Red Blood Cells (RBC), there was no significant difference (P>0.05) among the fish in tanks T_1, T_2, T_3 and T_4 (25%, 50%, 75% and 100% inclusion of *M. oleifera* respectively) but they were significantly different (P<0.05) from the fish in the tank T_0 (control tank). The result showed that there was an increase in the RBC count, which range from 1.25±0.28in control tank (0% *M. oleifera*) to range of 2.48±0.07 in tank T_3 (with 75% inclusion of *M. oleifera).* Haemoglobin concentration (HGB) showed that there was no significant difference (P>0.05) among the fish in tanks T_1, T_2, T_3 and T_4 (25%, 50%, 75% and 100% inclusion of *M. oleifera* respectively) but they were significantly different (P<0.05) from the fish in the tank T_0 (control tank). The Haemoglobin concentration (Hb) increased with range from 5.03±0.91 in control tank (T_0) to 8.33±0.34 in T_3 (75% inclusion of *M. oleifera*). Packed Cell Volume (PCV) showed was no significant difference (P>0.05) among the fish in tanks T_1, T_2, T_3 and T_4 (25%, 50%, 75% and 100% inclusion of *M. oleifera* respectively) but they were significantly different (P<0.05) from the fish in the tank T_0 (control tank). The result showed that there was an increase in the PCV with the highest value 27.38±1.02 at 75% inclusion of *M. Oleifera*.

The Mean Cell Volume (MCV) values showed that there was no significant difference (P>0.05) among the fish in the experimental tanks. The Mean Cell Haemoglobin Concentration (MCHC) showed that the fish in the experimental tanks were significantly different (P<0.05) from each other. The highest MCHC (39.24±6.47) was recorded in the control tank while the lowest (28.90±2.44) was recorded in the 50% inclusion *M. oleifera* tank. The Mean Cell Haemoglobin (MCH) showed no significant difference (P>0.05) in fish in the experimental tanks. The highest MCH (44.00±5.28) was recorded in the control tank T_0 while the least (32.64±2.21) was recorded in the 50% inclusion *M. oleifera* tank. Table 7 shows the haematological parameters of *C. gariepinus* fed with *M. Oleifera.*

TABLE 7:HAEMATOLOGICAL PARAMETERS OF *C. gariepinus* FED WITH *M. Oleifera*.

Parameters	T_0	T_1	T_2	T_3	T_4
WBC	149.60±22.73^{b}	209.41±7.73^{a}	214.61±3.53^{a}	220.56±3.25^{a}	205.88±6.43^{a}
RBC	1.25±0.28^{b}	2.25±0.16^{a}	2.08±0.21^{a}	2.48±0.07^{a}	1.99±0.16^{a}
HGB	5.03±0.91^{b}	7.94±0.48^{a}	7.06±0.83^{a}	8.33±0.34^{a}	7.43±0.21^{a}
PCV	13.87±3.13^{b}	25.13±1.43^{a}	23.54±2.42^{a}	27.38±1.02^{a}	22.32±1.82^{a}
MCV	111.39±1.49^{a}	112.53±3.32^{a}	102.17±8.45^{a}	111.08±5.04^{a}	112.68±2.67^{a}
MCHC	39.24±6.47^{a}	31.69±1.00^{ab}	28.90±2.44^{b}	30.51±1.07^{ab}	36.08±5.21^{ab}

[1]Pooled standard error; Mean in the same row with the superscript are not significantly different from each other, P (> 0.05).

DISCUSSION

Aquaculture development has been considered a very rich source of valued protein diet to ever growing human population. Nigerian aquaculture industry is currently faced with the problem of inadequate supply and prohibitive cost of quality fish feeds. 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. The use of *Moringa oleifera* as a substitute for maize is being investigated.

The values of the water parameters used for this study are within the acceptable ranges recommended for aquatic life survival and this agrees with Chapman (2000) who reported that the optimum growth of African catfish, *Clarias gariepinus*, requires 28-30^{o}C, 6.5-9.0 pH and not less than 5mg/L dissolved oxygen in the rearing water. The potential of a feedstuff such as leaf meal in fish diets can be evaluated mainly on the basis of its proximate chemical composition, particularly the, crude protein content. The proximate composition shows that *Moringa oleifera* has 25% crude protein which is higher than that of maize. This value was higher and does not agree with

Makkar and Becker (1997c) who observed 23% CP in the leaves. The difference might be attributed to differences in environmental conditions such as soil types, harvesting time and processing methods. All the experimental diets were accepted by *Clarias gariepinus juveniles*, indicating that the levels of incorporations of *M. oleifera* leaf meal did not affect the palatability of the diets. It helped in the survival of the fish. This might be attributed to the processing technique which involved proper drying and grinding of the Moringa leaves into fine powder and thoroughly mixing it with formulated feed and also adding the right amount of warm water to help incorporate the Moringa powder into the feed thereby increasing its palatability in *Clarias gariepinus. This agrees with Makkar and Becker, (1997c) who worked on Moringa and stated that Moringa oleifera has low levels of antinutrients and thus, indicate their high nutritional quality.* Better growth and nutrient utilization were achieved at low levels (4.1g and 8.2g) of inclusion of *Moringa oleifera* in diet, this does not agree with Amisah, (2009) who stated that, *Leucaena leucocephala* leaf meal in the diets of *Oreochromis niloticus* at 12.5% inclusion did not affect growth, however, at high levels of inclusion, 25% or more, the growth of *Oreochromis niloticus* was diversely affected.

No mortalities occurred throughout the period and, therefore, the meal did not have any deleterious effects on the fish.

There was increase in the values of the White Blood Cell (WBC), Red Blood Cell (RBC), Haemoglobin Concentration (HGB) and Packed Cell Volume (PCV) of *Clarias gariepinus* fed *Moringa oleifera* diet compared with those fish fed with control diet (0% *Moringa oleifera*). This is not in agreement with Ayoola (2011) who recorded slight decrease in the values of haematological parameters of the *Clarias gariepinus* fed with poultry hatchery waste compared to those fed with compounded feed (control).

The increase that was observed in the haematological parameters of fish fed with *Moringa oleifera* inclusion in the diet is in agreement with the findings of Joshi *et al*. (2002b) who stated that survival of fish can be correlated with increase in antibody production which helps in the survival and recovery.

The increase in WBC may be due to increase in leucopolesis as a means of combating stressor in the body system of the fish, similar findings were recorded by Gabriel *et al*. (2004) in *Clarias gariepinus* under confinement due to acclimated for 7 days. These changes in white blood cell have been reported to play important roles in the assessment of the state of health of *C. gariepinus* (Ezeri, 2001; Gabriel *et al.,* 2004).

The increase in the red blood cell and heamoglobin concentration may be attributed to the increase in the size of the fish as a result of growth in the fish. This is in agreement with Das (1965) who reported that both the haemoglobin contents and Erythrocyte counts (red blood cell) tend to increase with length and age of the fish. The increase in haemoglobin concentration could also be as a result of increase in the activity of the fish, *Clarias gariepinus* are naturally active. This agrees with Eisler (1965) who suggested that there was a correlation between haemoglobin concentration and activity of fish. The more active fishes tend to have high haemoglobin values than the more sedentary ones.

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 yellow maize 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 powderin *Clarias gariepinus* diets.

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