THE EVALUATED PROXIMATE PROFILES OF *MORINGA OLEIFERA* PLANT PARTS AND THE UTILIZATION OF *MORINGA OLEIFERA* SEED MEAL BASED DIETS ON GROWTH RESPONSE OF THE AFRICAN CATFISH

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Abstract: The examination of the nutritional value of wild plant materials has garnered interest since they possess a noteworthy quantity of vital elements that may be utilized for human intake as well as in the creation of animal diets. This work evaluated the proximate profiles of *Moringa oleifera* plant parts and the utilization *Moringa oleifera* seed meal based diets on growth response of the African catfish, *Clarias gariepinus* juvenile. Five experimental diets containing 40% crude protein were formulated in which moringa seed cake protein replaced soybeans meal at levels of 0% (control), 5%, 10%, 15% and 20%. The only sources of protein in the control diet were soybean meal and fish meal. African catfish (*Clarias gariepinus*) juveniles stocked at 20 fishes/50litres of bowl were fed two times daily (i.e. morning and evening) at 6% of their body weight in duplicates for three months. Mean Weight Gain, Specific Growth Rate, Protein Efficiency Ratio, Mean Feed Intake, Feed Conversion Ratio and Profit indices and water parameters were determined using standard methods. The results demonstrated that the moringa seed has the highest crude protein and the fish fed 15% inclusion level of moringa seed meal has the highest specific growth rate and highest mean weight gain.

Keywords: *Moringa oleifera*, *Clarias gariepinus*, fish feed, dietary supplement, performance indices, fish nutrition.

Introduction

One of the key challenges limiting profitability in aquaculture systems is the rising cost of feed due to the rising cost of fishmeal, which is utilized as the primary source of protein (Gasco, *et al*., 2018). Finding alternate sources of protein for aquaculture diets is therefore necessary and finding substitute protein sources for use in fish feed formulations has become necessary because of the high cost and erratic quality of imported fish meal (Ssepuuya, *et al*., 2019). The examination of the nutritional content of wild plant materials has garnered interest recently since they contain a sizable number of vital elements that may be utilized to make animal feed as well as for human use (Gatlin III, *et al*., 2007). The assessment and utilization of non-conventional protein sources, especially those derived from plant products including seeds, leaves, roots, and other agricultural byproducts, have drawn study interest in an effort to achieve a more ecologically and economically sustainable production (Milião, *et al.*, 2022). Large-scale research on the agronomic characteristics of moringa, a tropical plant with a great potential for producing fresh green matter, has been conducted during the past ten years (Aslam, *et al.*, 2020). The plant known as the "drumstick tree," *Moringa oleifera*, is a member of the Moringaceae family and grows quickly. It is very important to the food and pharmaceutical industries economically. It has been observed that this plant's whole body is a fantastic source of natural antioxidants and is high in protein, vitamin C, calcium, and potassium (Santos, *et al.*, 2012) and increase the shelf life of foods high in fat because they include a variety of antioxidant compounds, including carotenoids, flavonoids, phenolics, and ascorbic acid. (Ali, *et al.*, 2015). The high oleic acid content of moringa seeds is thought to be one among the components causing the Mediterranean diet's health-promoting benefits. (Kashyap, *et al.*, 2022). Many people use *Moringa oleifera* plant parts to treat cardiovascular diseases and other related illnesses like malnutrition because the leaves, roots, gum, flowers, and infusion of seeds contain chemical constituents called nitrite, mustard oil glycosides, and thio-carbonate glycosides, that are believed to be responsible for the tree's diuretic, lipid-lowering, antiulcer, hepatoprotective, and cardiovascular-protective qualities (Alegbeleye, 2018). Moringa seed is recommended for use as animal feed due to its high protein, fat, and sulfur-containing amino acid contents, as well as its relative absence of anti-nutritional components. It has minerals, proteins, fiber, lipids, and vitamins A, B, and C as well as amino acids (Valdivié-Navarro, *et al.*, 2020). Therefore, this study investigates the proximate profile of *Moringa oleifera* plant parts and the growth performance of *Clarias gariepinus* fed varied degrees of *Moringa oleifera* seed meal based diets.

Material and Methodology

Experimental site

The research was conducted at the Wabillahitaofiq Fish Farm, Surulere Area, Eyenkorin, Ilorin, Kwara State, Ilorin, Nigeria.

Preparation and processing of Moringa oleifera seed

A proximate analysis was performed on the plant components (leaves, dry seed cake and flower) in order to known the actual part that has the highest crude protein level at University of Ilorin Chemistry Laboratory. The result (Table 1) shows that moringa dry seed cake contains the highest crude protein level out of the three samples (leaves, dry seed cake and flowers). The seed pods were bought from moringa farm, Ilorin Kwara State, Nigeria. The seed pods were sundried, removed from the pods; white seed remove from the sac, sundried to obtained a constant weight for easy grinding, milled to powder using manual grinder to obtain right particle size and stored in an air tight container until use.

Experimental Procedure

Two hundred (200) *Clarias gariepinus* juveniles were procured from Yesha-yahu fish farm located at Egbejila, Ilorin, Kwara State. They were transported in a well aerated kegs early in the morning (around 7:00 am) to Wabillahitaofiq Fish Farm, Surulere Eyenkorin, Ilorin,

Kwara State. The length and weight of the fish were measured and recorded.

They were acclimatized for 14 days, fed control (0%) diet at the farm and starved for 12 hours to empty their bowel before the commencement of the feeding trial. Twenty juveniles were assigned to ten circular plastic tanks of a capacity of fifty liters, and the treatments were repeated twice. The bowls were covered firmly with mosquito nets at the top to prevent the fishes from jumping out of the bowls. The water used in running the experiment was pump from bore-hole located beside the fish farm. The water of the fish were changed every two days, this was done to get rid of waste products and uneaten food. Water parameters such as pH, Temperature and Dissolved oxygen (DO) were monitored throughout the period of the experiment by constantly changing of the water every two-two days. Ingredients for the experimental diet feed were bought from a reliable feed mill in Ilorin. The ingredients used were soybean cake, maize, wheat offal, fish meal, methionne, Lysine, Vit-mineral premix, fish premix and salt (Table 2). Five experimental diets were formulated by substituting soybean meal with the *Moringa oleifera* seed meal at 0%, 5%, 10%, 15%, and 20% inclusion levels. Diet 1 of 0% inclusion level served as the control and had no *Moringa oleifera* meal. The feed ingredients were weighed in accordance with their calculated weight, well blended and then pelletized in order to replace the dustiness and ensure appropriate acceptance by the fish. The pellets were sun dried for two days to prevent feed degrading and the meals were kept fresh in an airtight container. The diets were isonitrogenous containing 40% crude protein and each diet was assigned to the treatment with two (2) replicates.

Feeding and Management of experimental fish

The experimental fish were fed twice at 8.00 – 9.00hr in the morning and 17.00 – 18.00hr in the evening daily, at 6% body weight in duplicates for 3months in a completely randomized design (CRD), using the experimental plastic bowls (50 litres), the bowls were filled to 4/5 (i.e. 40 litres) of its volume. Fish were not fed on the first day of weighing because of the stress they've undergone and to familiarize them with their new environment. The quantity of feed was adjusted based on the weight attained by the fish for previous fortnight throughout the feeding trial. Fish were sampled weekly for the duration of the experiment using a sensitive weighing scale weigh balance; 20kg x 50g. To ensure the highest quality of the culture medium and the healthiest possible conditions for the fish, the water quality standard was strictly followed. Particulate wastes in the experimental bowls were removed by siphoning them every day before feeding, and the water in each experimental plastic bowl was changed out completely every two to three days. The experimental plastic bowls were washed with a salt solution once a week to disinfect the bowls as recommended by Eriegha and Ekokotu, (2017). The death rate of the dead fish was observed every day, and they were removed, tallied, and documented to ascertain the survival rate (Biu, *et al.*, 2015). The growth parameters, condition factor, survival rate, and nutrient consumption were calculated and analyzed using Hassan *et al.*, 2021 method. The temperature and pH (hydrogen ion concentration) of the water in the rearing environment were measured using a graduated mercury-inglass thermometer every day at 0800 and 1600 hours, respectively, before feeding. A Do meter (EDT Diection) was used to measure dissolved oxygen (DO) as recommended by Huettel and Merikhi, (2020).

Chemical Analysis of the Test Diet

The proximate composition of *Moringa oleifera* plant parts were conducted for dry matter (DM), carbohydrate, crude protein (CP), crude fiber (CF), ash, and energy content using Ibiene, *et al.,* (2021) method.

Data Collection

The following parameters were measured: feed intake, average daily weight gain, and weight gain. Each of these parameters was assessed every two weeks. Characteristics of performance were assessed according to the method of Freetly, *et al*, (2020) as follows:

i. Feed intake (FI) = 6% body weight of fish × No. of fish/treatment /tank

iii. Relative Growth rate (RGR) (%) = $\frac{W_2 - W_1}{W_1} \times 100$

Where, W_1 = initial average weight (g) at the beginning of experiment

W_2 = final average weight (g) at the end of experiment

iv. Percent Weight Gain (PWG) = $\frac{Final\ weight\ (g)\ x\ Initial\ weight\ (g)}{Initial\ weight\ (g)}$

v. Percent Length Increase (PLI) (%) = $\frac{Final\ length\ (mm) - Initial\ length\ (mm)\ x\ 100}{Initial\ length\ (mm)}$

vi. Specific Growth rate (SGR) (%) = $\frac{Log_e W_f - Log_e W_i \times 100}{Time\ (days)}$

Where,

Log_e =Natural logarithm

Wi = initial weight (g) of fish at the beginning of experiment.

Wf = final weight (g) of fish at the end of the experiment.

vii. Feed Conversion Ratio (FCR) = $\frac{Dry\ weight\ of\ feed\ fed\ (g)}{Fish\ weight\ gain\ (g)}$

viii. Protein Efficiency Ratio (PER) = $\frac{Wet\ body\ weight\ gain\ (g)}{Crude\ protein\ fed}$

ix. Percent Survival Rate S(%) = $\frac{N_i}{N_o} \times 100$

Where, N_o =number of fry stocked at the beginning of the experiment.

N_i =number of fry alive at the end of the experiment.

x. Mortality rate = 100 − Survival rate (%)

xi. Performance Index (PI) = $\frac{SR \times W2 - W1}{Rearing\ duration\ in\ days}$

Where,

SR is the survival rate,

W_2 is the final mean weight and

W_1 is the initial mean weight

xii. Digestibility = $\frac{(intake - excreted)\ x\ 100}{intake}$

xiii. Condition factor (K) = $\frac{\frac{100W}{L^2}}{}$

Where,

W= weight of fish (g)

L= total length of fish (cm).

Statistical Analysis

One Way Analysis of Variance (ANOVA) was performed on the obtained data using the statistical software for social science (SPSS 20.0 version). The Duncan Multiple Range Test (DMRT) was used to ascertain the degree of significance of the means from each treatment.

Results and Discussion

The feed study (Table 3) of *C. gariepinus* fed varying percentages of inclusion level of *moringa oleifera* seed meal in place of soybean meal for three months demonstrated that the inclusion level of experimental diets had a substantial impact on the growth responses. Diet D, which includes 15% of *moringa oleifera* seed meal, had the greatest specific growth rate (SGR) (0.386%) while diet C (10% inclusion) and diet E (20% inclusion) of *moringa oleifera* seed meal had the same SGR (0.297%). The RGR of diet D shows significant difference ($p<0.05$) to all other diets. It was found that the fish given diet D acquired the most mean weight of 35.63g, whereas the fish fed diet E gained the least mean weight of 19g. Although the fish given diet D had the greatest death rate. The fish with the best survival rate (100%) were those given diet E.

The study's experimental diets' crude protein content fell within *C. gariepinus*'s range of required protein (Table 1). This study indicated that *moringa oleifera* seeds have a high crude protein content and this is similar to the report of Compaoré *et al*., (2011), Olagbemide, *et al*., (2014), Igwilo *et al.*(2017) and Chatepa & Mbewe, (2018) , who stated that *moringa oleifera* seeds are an excellent source of crude fiber, proteins, and lipids; however, this is not the same as what was reported by Olugbemi *et al.*, 2010; Abbas, *et al.*, 2018 that *moringa oleifera* leaves has high crude protein. This might have to do with differences in the plant's maturation stage, geographical distribution, post-harvest handling, ambient conditions, and processing methods, all of which can affect the nutritional value of moringa plant sections.

In this present study, physiochemical parameters of water (temperature of 24-26^{o}C, pH of 6.8-7.5) were within the acceptable range for fish growth and health (Olatayo, 2014). Afia, *et al.*, (2020) reported that the growth and food conversion ratio (FCR) of a fish is a remarkable tool to compute the acceptability of artificial feed. The lower FCR was recorded in diet D than all other diets. According to Elvy, *et al.*, (2022), the lower the FCR, the more efficient is the fish at converting feed into new tissue. This shows that fish fed with diet D were able to convert their feed efficiently to new tissues. When the fish are fed precisely the right amount of feed, they are not stressed and produce high-quality meat for human consumption. A solid grasp of FCR aids the farmer in feeding to satiation (Katsika, *et al*, 2021). Diet D containing 15% moringa shows the highest weight gain (Fig 3), suggesting that fish farmers could use the diet to feed *C. gariepinus* to obtain a better growth response.

This result revealed the proximate values of *moringa oleifera* leave, flower and seed meal. *moringa oleifera* seed meal may take the place of any dietary protein source, including soybeans in the diet of *C. gariepinus*, since *C. gariepinus* juveniles were able to withstand up to 15% substitution of MSM for soybean meal without experiencing any adverse effects on their ability to develop. Thus, *moringa oleifera* seed meal at 15% inclusion level in the diet of *C. gariepinus* juveniles is both safe and advantageous for the fish.

Table 1: Proximate analysis of moringa samples

Parameters	Moringa Dry Leaf	Moringa dry flower	Moringa dry seed
Moisture contents %	6.5 ± 0.015^{a}	5.9 ± 0.015^{b}	9.8 ± 0.021^{a}
Ash contents %	5.7 ± 0.021^{a}	4.6 ± 0.015^{b}	4.0 ± 0.020^{c}
Crude protein contents %	28 ± 0.015^{a}	24 ± 0.026^{b}	36 ± 0.010^{c}
Crude fibre content %	5.3 ± 0.031^{a}	4.4 ± 0.015^{b}	2.8 ± 0.078^{c}
Fat & Oil content %	3.7 ± 0.020^{a}	16 ± 0.015^{b}	39 ± 0.015^{c}
Carbohydrate content %	51 ± 0.038^{a}	45 ± 0.015^{b}	8.8 ± 0.097^{c}

Table 2: Gross composition of experimental diets with moringa seed cake inclusion

Ingredients	Diets (% inclusion Level of *Moringa oleifera* seed meal)				
	A (0%)	B (5%)	C (10%)	D (15%)	E (20%)
Fish meal (68%CP)	39.17	39.17	39.17	39.17	39.17
Soybean meal (40%CP)	21.09	18.07	15.02	11.94	8.9
Maize (10%CP)	23.84	23.84	23.84	23.84	23.84
Wheat Offal (16%CP)	15.89	15.89	15.89	15.89	15.89
Methionine	0.05	0.05	0.05	0.05	0.05
Lysine	0.05	0.05	0.05	0.05	0.05
Vitamin-mineral premix	0.05	0.05	0.05	0.05	0.05
Salt	0.05	0.05	0.05	0.05	0.05
Inclusion levels of moringa seed cake (%).	0.00	3.02	6.07	9.15	12.19
Total	100	100	100	100	100
Calculated Crude Protein	40%	40%	40%	40%	40%

Table 3: Feed evaluation of *c. Gariepinus* fed with different percentage of moringa seed meal inclusion

PARAMETERS	0%	5%	10%	15%	20%
Specific growth rate	0.277	0.277	0.297	0.386	0.297
Survival rate	85	85	90	80	100
Mean weight gain	21.73	21.76	21.15	35.63	19
Mean initial weight gain	20	20	20	20	20
Mean final weight gain	41.76	41.76	41.11	55.63	37
Average daily weight gain	0.24	0.24	0.235	0.396	0.211
Relative growth rate	108.8	108.8	105.6	178.15	85
Feed conversion ratio	6.97	6.97	6.35	4.41	6.35

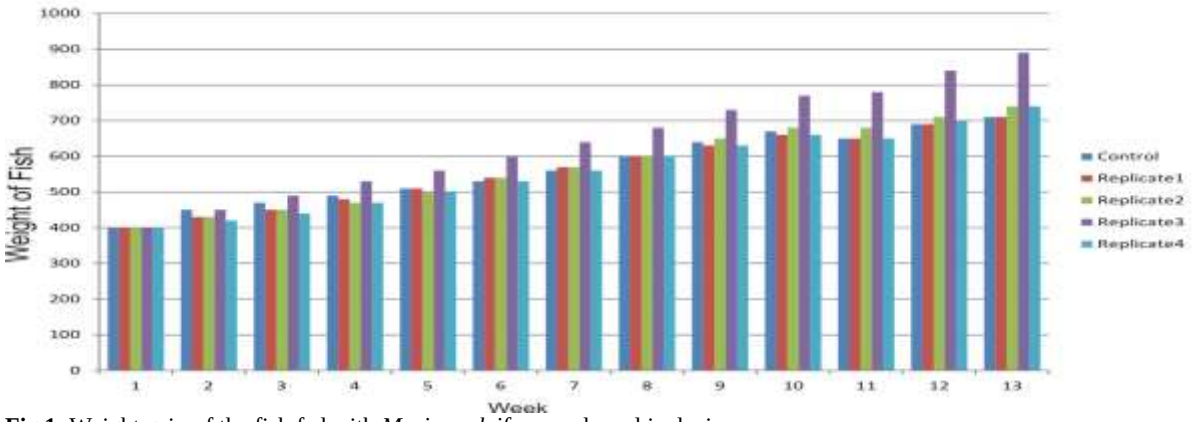

Fig 1: Weight gain of the fish fed with *Moringaoleifera* seed meal inclusion

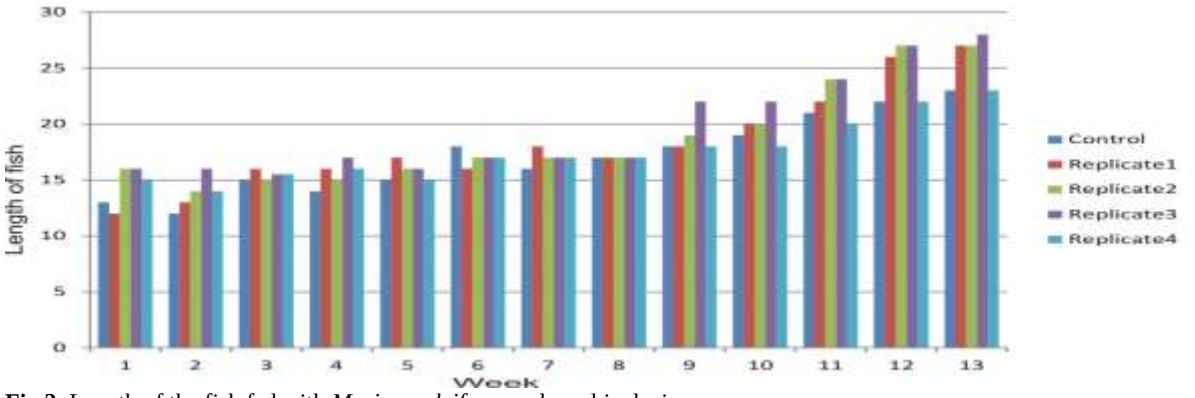

Fig 2: Length of the fish fed with *Moringa oleifera* seed meal inclusion

Conclusion

The results demonstrated that the *moringa oleifera* seed has the highest crude protein and the fish fed 15% inclusion level of *moringa oleifera* seed meal. It also provided an alternative for soybeans in fish and other animals' feeds, enabling food sustainability in animal husbandry.

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