Moringa oleifera AS FEED ADDITIVE IN *Clarias gariepinus* CULTURE: AN ORGANIC WATER QUALITY MANAGEMENT TECHNIQUE TO BOOST FISH PRODUCTION

***EKELEMU[1] J. K., D. A. AKPOTOR[1], O. J. ERIEGHA[2] and O. PEACE MUNU-KOMI**
[1]*Department of Fisheries and Aquaculture, Delta State University, Abraka.*
[2]*Department of Fisheries and Aquaculture, Nigeria Maritime University, Okerenkoko.*
*corresponding author: **ekelemujerimoth@gmail**.com, +2348036792753

ABSTRACT
The study aimed at evaluating effect of using Moringa oleifera leaf to boost fish production and manage water quality was conducted in 12 weeks. One hundred and eighty Clarias gariepinus juveniles average weight (37.80g) and length (10.96cm) used for the study were distributed in fifteens into 12 tarpaulin tanks of 1m x1m x 1m and grouped into four treatments in triplicates (T_{1A-C} to T_{4A-C}). They were fed with commercial feed, (Blue crown), to which were added M. oleifera leaf meal (MLM) at the rate of 0g, 5g, 10g and 15g/kg of feed to give different treatment diets ($T_1 – T_4$). T_1 was the control. The MLM was bound to the feed using starch. Data collected were analysed by ANOVA and Duncan Multiple Range Test (DMRT) used to separate means where there was significant difference ($p<0.05$). Fish were sampled fortnightly for length and weight measurement, and water samples taken to test for pH, dissolved oxygen, ammonia and temperature. Results showed that addition of 15g of M. oleifera leaf meal per kg of feed increased weight significantly ($P<0.05$) and resulted in reduced ammonia production. Thus use of M. oleifera at 15g/kg of feed is recommend in ponds to help improve water quality through suppressing pollution by ammonia, and consequently improving fish production.

Keywords: Moringa leaf meal (MLM), Appetite, Weight gain, Juveniles, Ammonia.

INTRODUCTION

Nigeria with a population of over 200 million people (NBS, 2022) is among the largest fish consumers in the world. Annual Fish demand in Nigeria totals 3.6 Million tons whereas production from Aquaculture, Artisanal and Industrial sectors is about 1.1 Million tons leaving 2.5 Million tons deficit (FMARD, 2022). The gap notwithstanding, fish still constitutes a significant part of diet for households as a survey by the World fish centre in 2019 recorded that 92 percent of households consume fish weekly, a clear indication of the affinity of Nigerian people for fish (Subasinghe *et al*., 2021). To improve on availability of fish towards mitigating the gap, aquaculture development has been encouraged in recent years (Oboh, 2022).

The most widely farmed fish specie in Nigeria is *Clarias gariepinus*. This is so as most fish culturist find its production more convenient and profitable for its hardiness, fast growth rate, ability to effectively convert feed into flesh and withstand adverse environmental conditions (Okomoda *et al*, 2019).

Efforts to develop reference diets for farmed fish in Nigeria using agro-industrial by-products from animal and crop processing industries have been steady (Adams and Christiana, 2020; Irabor *et al*., 2022). *Moringa oleifera* is a plant used as nonconventional feed additive in aquaculture and livestock production for its high mineral, vitamin and essential phytochemicals content. Methionine, cysteine, tryptophan and lysine are essential amino acids found in moringa leaf (Makkar and Becker, 1996) and in comparison, the essential amino acids composition of raw moringa leaf and soybean shows an identical pattern (Foidl *et al*., 2001). There is an abundant amount of these essential amino acids in the leaf that can be used as animal feed (Gabriel, 2019). Its leaf extracts are used to treat malnutrition and augment breast milk in lactating mothers. It is also used antioxidant, anticancer, anti-inflammatory, anti-diabetic and antimicrobial agent. *M. oleifera* seed, a natural coagulant is extensively used in water treatment (Jafer *et al*, 2019). The study therefore aimed at evaluating the growth response of *C. gariepinus* juveniles fed dietary Moringa leaf meal as an additive.

MATERIALS AND METHODS

Experimental site

The trial was embarked on for 12 weeks using twelve 1.0 m^3 tarpaulin tanks in static renewal culture system at the research farm of the Department of Fisheries and Aquaculture, Delta State University.

Experimental diet

Commercial feed (Blue crown) containing 45% CP to which *M. oleifera* leaf meal was added

was used for the study. Fresh moringa leaves were harvested around the University, dried at room temperature and ground.

Four treatment diets were formulated by adding 0g, 5g, 10g and15g of moringa leaf meal to a kilogram of the feed respectively, and starch used as the binder to form four diets T_1, T_2, T_3 and T_4. T_1 without moringa leaf meal was the control diet.

Experimental fish

180 *C. gariepinus* juveniles were sourced from a reputable source and acclimated for one week before the diets were administered.

Experimental procedure

The average weight (37.80g) and total length (10.96cm) of experimental fish samples were measured and randomly distributed in fifteens into 12 tarpaulin tanks of dimension 1m x 1m x 1m. The tanks containing fish were then grouped in threes to give four treatments in triplicates ($T_{1A-C,}$ $T_{2A-C,}$ T_{3A-C} and $T_{4\ A-C}$) giving a completely randomized design (CRD) experimental setup. The fishes were fed to satiation twice daily at 8:00 and 16:00 hours.

Water quality was monitored by taking samples once every forthnight. Fish samples were also collected fortnightly to determine growth response. Other parameters determined include feed intake, feed conversion ratio (FCR) and survival for every treatment according to the following formulae:

Apparent feed intake = $Quantity\ of\ feed\ fed\ during\ the\ experiment$

Weight gain (WG) = $Final\ weight\ (g) - Initial\ weight\ (g)$

Net weight gain = $Average\ final\ weight\ (g) - Average\ initial\ weight\ (g)$

Percentage Weight gain = $\frac{\text{Final Weight(g)} - \text{Initial weight(g) x 100}}{\text{Initial body weight (g)}}$

Feed conversion ratio = $\frac{\text{Feed given (g)}}{\text{Weight gain (g)}}$

Survival rate = $\frac{\text{Number of fish harvested x 100}}{\text{Number of fish stocked}}$

Statistical analysis

Data obtained were analysed by ANOVA ($p<0.05$) and mean differences separated by Duncan Multiple Range Test (DMRT). Statistical package SPSS version 23 was used in performing all computations.

RESULTS

Table 1 shows feed intake by the different treatment groups. Results (Table 1) shows that feed intake was more in the *M. oleifera* included diets.

Table 1: Feed intake of *C. gariepinus* juveniles fed graded levels of *M. oleifera* leaf meal

Week / feed intake (g)	T_1	T_2	T_3	T_4
2	170	175	175	175
4	210	315	315	315
6	305	425	427	420
8	505	620	605	590
10	614	649	644	629
12	650	700	715	717

The weekly gain in length of *C. gariepinus* juveniles fed *M. oleifera* leaf meal is shown in table 2. The one way ANOVA of the data (table 2) showed that moringa leaf meal as additive have no significant effect ($p>0.05$) on the body length of *C. gariepinus* juveniles at 4th, 6th and 8th week of the feeding trial. *C. gariepinus* juveniles receiving 10% (T_3) moringa leaf inclusion recorded highest body length for week 4 (17.85 cm) and week 6 (23.06 cm) relative to other treatments, although not significant. While the control (T_1) recorded least (17.31 cm). Body length at 10th and 12th week however were significant ($p<0.05$). At week 10 T_3 recorded highest for body length (27.45cm), T_4 (25.96cm), T_2 (25.69) and T_1 (23.58). 10% inclusion (T_3) recorded highest body length (29.56cm) while the control (T_1) was least (25.07cm) at the 12th week.

Table 2: Cumulative increase in length of *C. gariepinus* juveniles on *M. oleifera* diet.

Week / length (cm)	T_1	T_2	T_3	T_4	SEM
Initial average length	10.96	10.96	10.96	10.96	-
2	14.97	15.30	15.32	15.28	0.25
4	17.31	17.67	17.85	17.62	0.27
6	21.99	22.44	23.06	21.82	0.30
8	23.16	23.18	24.47	24.70	0.32
10	23.58^c	25.69^b	27.45^a	25.96^b	0.42
12	25.07^b	29.35^a	29.56^a	28.67^a	0.43

Different letters as superscript across the rows indicate signifant difference

Weekly weight gain of *C. gariepinus* juveniles fed Moringa leaf meal as additive (Table 3) shows that moringa leaf intake has positive effect on body weight. There was significant difference between the control and treatments ($P<0.05$). T_4 had the highest gain in weight, while T_1 was the least

.

Table 3: Weekly weight gain (g) of *C. gariepinus* juveniles fed *M. oleifera* leaf meal.

Week / weight gain (g)	T_1	T_2	T_3	T_4	SEM
Initial mean wt.	37.80	37.80	37.80	37.80	-
2	113.33^c	133.33^a	120.00^b	120.00^b	4.19
4	200.00^b	213.33^a	213.33^a	206.66^b	3.19
6	253.33^b	266.67^a	266.67^a	266.66^a	3.33
8	266.69^b	293.33^a	293.33^a	286.66^a	6.30
10	313.33^c	333.33^b	333.33^b	340.00^a	0.42
12	329.07^c	380.35^b	380.66^b	390.56^a	1.04

Different letters as superscript across the rows indicate signifant difference

The summary of growth performance of *C. gariepinus* fed Moringa leaf meal can be seen in table 4, the means of the various treatment varied significantly ($p<0.05$) for final weight, final length, weight gain, percentage weight gain and survival rate. The groups receiving 5, 10 and 15% moringa inclusion had higher values for all measured growth parameters than the control except survival. Treatments receiving 5, 10 and 15% inclusion were statistically similar for final weight and length.

Treatment 4 (T_4) performed best for weight gain (352.76g) and percentage weight gain (933.22%). The control recorded lowest for all measured growth parameters except for survival rate (100%). Treatment three (T_3) had better values for final length (32.90cm). Although no statistical difference was observed for FCR across the treatments, the control had a better value (1.66) followed by T_4 (1.77) and T_3 with the highest value. The results also showed marked differences in mean values of *C. gariepinu*s juveniles receiving varied levels of inclusion for survival. T_1 and T_3 had 100% survival while T_2 and T_4 recorded 86.6% survival.

Table 4: Growth performance of *C. gariepinus* juveniles as affected by varied levels of moringa leaf meal.

Parameters	T_1	T_2	T_3	T_4	SEM
Initial mean weight (g)	37.80	37.80	37.80	37.80	-
Final mean weight (g)	329.07^b	380.35^a	380.66^a	390.56^a	1.04
Mean weight gain (g)	291.27^b	342.55^a	342.86^a	352.76^a	4.57
Final length (cm)	29.13^b	31.73^a	32.90^a	32.80^a	0.85
% weight gain	770.55	906.21	907.03	933.22	4.57
FCR	1.66	1.78	1.79	1.77	0.10
Survival rate	100	86.60	100	86.60	0.04

Different letters as superscript across the rows indicate signifant difference

Results from Table 5, shows that *M.oleifera* had no noticeable effect (P>0.05) on pH, dissolved oxygen and temperature in the different treatment tanks. However its effect on ammonia NH_3 was significant (P< 0.05), where values were found to decrease as inclusion rises.

Table 5: Summary of water quality in the culture tanks

Water quality parameters	T_1	T_2	T_3	T_4	SEM
pH	7.02	7.04	7.07	7.18	0.05
DO (mg/l)	5.90	6.07	5.90	6.05	0.08
NH_3 (mg/l)	0.09	0.07	0.06	0.05	0.00
Temperature (^oC)	29.00	29.35	28.51	28.57	0.13

DISCUSSION

The use of plant material like *M. oleifera* in fish feed will help in improving the nutritional quality. The plant has also been used to maintain good health condition of fishes.

This study showed that means of the various treatment groups varied (p<0.05) for final weight, final length, weight gain, percentage weight gain and survival rate. Treatments with 5, 10 and 15% moringa inclusion performed better, except for survival rate and FCR. Fish samples in T4 performed better with final mean weight (390.56g), weight gain (352.76g) and percentage weight gain (933.22%) and differed significantly (P<0.05) from other treatments. This is in line with Olaniyi *et al*., (2013) that *M. oleifera* leaf meal may be included in

the diets of *C. geriepinus* at inclusion levels up to 30% but it is better at 15% inclusion level. Dienye and Olumuj (2014) also reported highest weight gain for *C. gariepinus* fed 10% dietary moringa inclusion. Idowu *et al.,* (2017) posited that growth and nutrient utilization by fish decreased as *M. oleifera* leaf increased above 15%. The control recorded lowest for all measured growth parameters except for survival rate (100%). Idowu *et al*., (2017) also showed in their results that final weight gain and average length of *C. gariepinus* were highest at 15% moringa leaf inclusion. Feed conversion ratio was not bettered by moringa leaf inclusion as the control gave the best numerical value. However, the improved weight gain recorded for the moringa fortified diets is associated with increased feed ingestion, an indication that *M. oleifera* stimulates appetite in fish, rather than an improvement in feed efficiency. The observation is supported by the work of Abdel-Tawwab *et al*. (2021) who reported that improved performance in *Oreochromis niloticus* was a direct result of using yucca as feed additive. The fish fed 5% - 15% consumed more feed but may have converted at similar rates with the control.

Findings here is at variance with Bbole *et al*., (2016) who reported minimal weight gain in treatments containing moringa leaf inclusion. This discrepancy may be due to the levels at which the moringa leaf additive were fed to the fishes. A careful look at the this report with a contrary position to the findings of this study revealed that the moringa leaf were included at levels higher than 15% and also were used as a replacement for fishmeal rather than acting as just additive. This could be the major reason for discrepancy among the results, as higher levels of moringa inclusion also have its adverse effect on growth and nutrient utilization.

Ritcher *et al*. (2003) observed that replacement of fish meal with *M. oleifera* leaf at higher level lowers growth performance because of anti-nutrients such as phenol, tannins, phylates and saponins. The decrease in growth rate could have resulted from reduction in protein and amino acids levels in the diets at higher substitution levels.

With respect to water quality, *M. oleifera* suppressed the generation of ammonia as values in treatment T_4 with 15g of *M. oleifera* was lower significantly ($P<0.05$) from others. This is as a result of increased protein metabolism in the fish body, with a possible reduction in ammonia excretion (Santacruz-Reyes and Chien, 2010; Fleck *et al*., 2019). Besides, the bioactive component of moringa which availed it a natural coagulant properties used in water treatment (Jafer *et al*, 2019) can absorb or bind ammonia, reducing pollution.

CONCLUSION

The study established that *M. oleifera* leaf meal as additive to feed at 15g/kg will significantly improve feed intake and growth performance of *C. gariepinus*, and also serve as an organic water quality management technique to reduce ammonia in culture ponds.

REFERENCES

Abdel-Tawwab, M.; Mounes, H.A.; Shady, S.H. and Ahmed, K.M. (2021). Effects of yucca, *Yucca schidigera*, extract and/or yeast, *Saccharomyces cerevisiae*, as water additives on growth, biochemical, and antioxidants/oxidant biomarkers of Nile tilapia, *Oreochromis niloticus*. *Aquaculture , 533, 736122*.

Adams, A., and Christiana, O. F. (2020). Comparative Effect of Local and Foreign Commercial Feeds on the Growth and Survival of African Catfish (*Clarias gariepinus*) Juvenils. *Metropolitan Journal of Environmental & Health Research*, 125.

Bbole I., C. Mumba, N. Mupenda, and A.S. Kefi (2016). Analysis of growth performance and haematological parameters of *Oreochromis niloticus* fed on a varying diet of *Moringa oleifera* Lam. leaf meal as an additive protein source. *International Journal of Fisheries and Aquaculture, 8 (11). pp 105-111*

Dienye, H. E. and Olumuj, O. K. (2014). Growth performance and haematological response of African mud catfish *Clarias gariepinus* fed dietary levels of *Moringa oleifera* leaf meal. *Net Journal of Agricultural Science. 2(2): 79 - 88*

Federal Ministry of Agriculture and Rural Development (2022). https://fmard.gov.ng/fg-targets-3-6-million-tons-of-fisheries-annually-to-boost-local-production-income-generation-others/.

Fleck, J.D.; Betti, A.H.; da Silva, F.P.; Troian, E.A.; Olivaro, C.; Ferreira, F. and Verza, S.G. (2019). Saponins from *Quillaja saponaria* and *Quillaja brasiliensis*: Particular chemical characteristics and biological activities. *Molecules, 24, 171*.

Foild, N., Makkar, H.P.S. and Becker, K. (2001). The Potential of *Moringa oleifera* for Agricultural and Industrial Uses. In: Fuglie, L.J., Ed., The Miracle Tree: The Multiple Attributes of Moringa, *CTA, Wageningen, CWS, Dakar, 45-76, 177.*

Gabriel, N. N. (2019). Review on the progress in the role of herbal extracts in tilapia culture. *Cogent Food & Agriculture*, *5*(1), 619-651.

Idowua Eunice, Adejoke Adewumib, James Osoc , Josephine Edward, and Grace Obaronbie (2017). Effects of Varying Levels of *Moringa oleifera* on Growth Performance and Nutrient Utilization of *Clarias gariepinus* Post-Fingerlings. *American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS) (2017) Volume 32, No 1, pp 79-95*

Irabor, A. E., Obakanurhie, O., Nwachi, F. O., Ekokotu, P. A., Ekelemu, J. K., Awhefeada, O. K., and Adagha, O. (2022). Duckweed (*Lemna minor*) meal as partial replacement for fish meal in catfish (*Clarias gariepinus*) juvenile diets. *Bone, 1(1): 1- 00*.

Jafer, A. S., Hassan, A. A., and Naeem, Z. T. (2019). A study on the potential of moringa seeds in adsorption of organic content from water collected from oilfield refinery. *Pakistan Journal of Biotechnology, 16* (1), 27-33.

Makkar H.P.S. and Becker K. (1996): Nutritional value and antinutritional components of whole and ethanol extracted *Moringa oleifera* leaves. Animal *Feed Science and Technology, 63, 211-228 https://doi.org/10.1016/S0377-8401(96)01023-1*.

National Bureau of Statistics (2022). Nigeria Multidimensional Poverty Index (2022). https://nigerianstat.gov.ng/elibrary/read/1241254.

Oboh, A. (2022). Diversification of farmed fish species: A means to increase aquaculture production in Nigeria. *Reviews in Aquaculture, 14(4), 2089-2098.*

Okomoda, V. T., Aminem, W., Hassan, A., and Martins, C. O. (2019). Effects of feeding frequency on fry and fingerlings of African catfish *Clarias gariepinus*. *Aquaculture, 511,* 734232.

Olaniyi C.O., N.O.Ajani and M.N. Adetomi (2013). Growth performance and Nutrient utilization of *Clarias gariepinus* fed *Moringa oleifera* Leaf meal. *Journal of Natural Sciences Research; 3(8), pp 2224-3186, 2013.*

Ritcher,N., Siddhuuraju, A. and Becker K. (2003): Evaluation of nutritional quality of moringa (*Moringa oleifera*) leaves as alternative protein source for Tilapia (*Oreochromis niloticus* L). *Aquaculture Res; 217, 599- 611*

Santacruz-Reyes, R.A. and Chien, Y.-H. (2010). Ammonia reduction in seawater by *Yucca schidigera* extract: Efficacy analysis and empirical modelling. *Aquac. Res. 2010, 41, 1221–1228.*

World Fish Centre (2023). https://worldfishcenter.org/where-we-work/africa/nigeria. *Retrieved 17th April, 2023*.