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Effect of Dietary Inclusion Levels of *Alternanthera brasiliana* Leaf Meal on Mineral Composition of *Clarias gariepinus* Fingerlings

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ABSTRACT

The nutritional value of feeding *Clarias gariepinus* fingerlings with various levels of *Alternanthera brasiliana* leaf meal was evaluated for 56 days. Five diets of 40% crude protein were formulated with different levels of *A. brasiliana* at 0.0, 5.0, 10.0, 15.0 and 20.0g/100g inclusion denoted as (ABI- AB5). Two hundred and twenty-five (225) *C. gariepinus* fingerlings with mean weight of 9.08 ± 0.10 g were randomly selected and distributed into 15 glass tanks at the rate of 15 fish per tank representing five treatments and three replicates. The results revealed that significant differences ($P < 0.05$) were observed in all the mineral composition. Fish fed diets containing the plant additives showed higher mineral values than the control group. Calcium, sodium, potassium, and iron increased across most supplemented treatments, while magnesium was highest in fish fed 0.5g/100 g inclusion level. Water quality parameters remained within suitable ranges throughout the experimental period. The result indicates that low dietary inclusion of *A. brasiliana* leaf meal may improve mineral retention in *C. gariepinus* fingerlings and could serve as a useful plant supplement in fish feed formulation.

Keywords: *Alternanthera brasiliana*; mineral composition; *Clarias gariepinus*

Introduction

Fish farming has continued to expand in Nigeria due to the increased demand for affordable animal protein (Kaleem and Sabi, 2021). Among the culture fish species, *Clarias gariepinus* is widely accepted by farmers because it grows rapidly, tolerates varying environmental condition and performs well under intensive culture systems (Akinrotimi *et al.*, 2011).

However, despite these advantages, the high cost of feed remains a major challenge to profitable catfish production (Fadri *et al.*, 2016). In most fish farming operations, feed takes up the largest portion of production costs, mainly because of the reliance on fishmeal and other expensive feed ingredients (Hardy and Tacon, 2002). The limited availability and rising cost of these conventional protein sources has encouraged researchers to investigate the use of locally available plant materials as supplements or partial feed replacements in aquaculture diets. Medicinal plants

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are receiving attention in aquaculture because some contain useful minerals, bioactive compounds and natural antioxidants that may improve fish health and nutrient utilisation (Salam *et al.*, 2021). *Alternanthera brasiliana* is a tropical plant commonly found in many parts of Nigeria and has been associated with several medicinal properties (Gomes *et al.*, 2019). It has long been used in traditional medicine and has also been explored in livestock feeding studies (Ogbole *et al.*, 2017). Previous studies have examined its phytochemical composition and use in livestock nutrition as reported by (Adeyemi *et al.*, 2018), but information on its application in fish feeding is still limited. Most available studies on plant additives in aquaculture focus mainly on growth performance and survival, while fewer studies have considered their effect on mineral deposition in fish tissues. Minerals such as calcium, iron, sodium, and potassium are important for normal growth, skeletal formation and osmoregulation in fish. Therefore, this study evaluated the effect of dietary inclusion of *A. brasiliana* leaf meal on the mineral composition of *Clarias gariepinus* fingerlings.

Materials and Methods

Experimental Site

The study was conducted at the Fisheries and Aquaculture Technology Laboratory, Federal University of Technology, Akure, Nigeria, over a period of 56 days.

Plant Material

Fresh leaves of *A. brasiliana* were harvested from the vicinity of the School of Agriculture Annex, Federal University of Technology, Akure. Identification and authentication were performed by a botanist in the Department of Biochemistry. After collection, the

leaves were washed, and air-dried under ambient laboratory conditions to preserve heat-sensitive nutrients. The dried leaves were milled into fine powder using an electric grinder (Model ES 242) and stored in airtight containers at 4 °C prior to feed formulation.

Experimental Fish and Acclimation

Apparently healthy *Clarias gariepinus* fingerlings were obtained from the university fish farm and acclimated for seven days under laboratory conditions. During acclimation, fish were fed a commercial diet containing 40% crude protein twice daily at 08:00–09:00 h and 16:00–17:00 h until apparent satiation.

Diet Formulation and Composition

Five experimental diets were formulated to be isonitrogenous, containing graded inclusion levels of *A. brasiliana* leaf meal (0.0–2.0 g/100 g). Other ingredients were kept constant to ensure that variations in fish response were attributable only to the test ingredient (Table 1).

Experimental Design and Management

A completely randomized design was used. After acclimation, 225 fingerlings were weighed and randomly allocated into 15 glass tanks (70 L capacity; 70 × 45 × 45 cm). Each treatment consisted of three replicates, with 15 fish per tank. Fish were fed twice daily at 08:00–09:00 h and 16:00–17:00 h to apparent satiation throughout the 56-day trial. Fish were fed twice daily to apparent satiation for 56 days. Uneaten feed was removed, and partial water exchange was carried out regularly. Water quality parameters, including temperature, dissolved oxygen, and pH, were monitored twice weekly using standard aquaculture meters. All parameters remained within suitable

Table 1: Gross Composition of the Experimental Diets (g/100 g)

Ingredients	AB1 (0.0)	AB2 (0.5)	AB3 (1.0)	AB4 (1.5)	AB5 (2.0)
Fish meal	25.4	25.4	25.4	25.4	25.4
Soybean meal	28.2	28.2	28.2	28.2	28.2
Groundnut cake	23.5	23.5	23.5	23.5	23.5
Yellow maize	13.1	13.1	13.1	13.1	13.1
Vitamin-Mineral mix	2.30	2.30	2.30	2.30	2.30
Vegetable oil	5.00	5.00	5.00	5.00	5.00
Methionine	0.30	0.30	0.30	0.30	0.30
Lysine	0.20	0.20	0.20	0.20	0.20
Starch	2.00	2.00	2.00	2.00	2.00
<i>A. brasiliana</i> leaf meal (g/100 g)	0.00	0.5	1.0	1.5	2.0

ranges for catfish culture. Proximate composition of plant material and experimental diets was determined according to AOAC (1990), while. mineral analysis was carried out using an Atomic Absorption Spectrophotometer as described by (AOAC, 2016).

Data Analysis

Data collected were analyzed using a Statistical Package for Social Science (SPSS) Version 23. Test among the treatments were done using One-way Analysis of Variance (ANOVA). Duncan’s New Multiple Range Test was used to separate differences among the means at a significance level of 0.05.

Results

The proximate composition of *A. brasiliana* leaf meal used for this study showed that the nitrogen-free extract was the most abundant component at 68.24%, while fiber had the lowest proportion at 4.55% (Table 2).

Table 2: Proximate composition of *A. brasiliana* leaf

Parameters (%)	Values
Moisture	8.94
Fat	3.56
Protein	7.98
Fibre	4.55
Ash	6.73
Nitrogen Free Extract	68.24

Diet Composition

Table 3 presents slight variations in the nutrient composition of the experimental diets. The diets were successfully formulated to be isonitrogenous, with crude protein values ranging from 39.64% to 40.03%. Minor differences were observed in the fibre and ash contents of the diets, as fibre content increased with increasing inclusion levels of *A. brasiliana* leaf meal in the diets.

Table 3: Proximate Composition of the Experimental Diets

Parameters (%)	AB1 (0.0)	AB2 (0.5)	AB3 (1.0)	AB4 (1.5)	AB5 (2.0)
Moisture	9.34	9.50	9.77	8.82	9.94
Ash	7.52	7.41	7.23	7.35	7.26
Lipids	9.46	9.78	9.69	9.98	9.73
Fibre	2.91	3.13	3.18	3.22	3.25
Crude Protein	39.64	39.85	40.03	39.86	39.80
Nitrogen Free Extract	31.13	30.33	30.10	30.77	30.02

Water Quality Parameters

The water quality parameters measured during the 56-days feeding trial showed the following variations: Dissolved oxygen levels were consistent across all

treatments, ranging from 7.55 to 7.60 mg/L. The water temperature ranged from 27.09°C to 27.15°C, which falls within the optimal temperature range for *Clarias gariepinus*. pH values ranged from 6.63 to 6.70 (Table 4).

Table 4: Water Quality Parameters

Treatments	Dissolved oxygen (mg/L)	Temperature (°C)	pH
AB1 (0.0)	6.63±0.12 ^a	27.15±0.04 ^a	7.58±0.06 ^a
AB2 (0.5)	6.67±0.25 ^a	27.08±0.11 ^a	7.55±0.03 ^a
AB3 (1.0)	6.70±0.13 ^a	27.13±0.01 ^a	7.60±0.01 ^a
AB4 (1.5)	6.65±0.11 ^a	27.09±0.02 ^a	7.56±0.01 ^a
AB5 (2.0)	6.63±0.13 ^a	27.12±0.09 ^a	7.59±0.07 ^a

Mineral Composition of Experimental Fish

Table 5 shows the mineral composition of the experimental fish. Those fed diets supplemented

with *A. brasiliiana* generally had higher mineral levels compared to the control group. Calcium, sodium, potassium, and iron all increased as the level of dietary inclusion increased, while magnesium reached its best level at a moderate inclusion rate (0.5g/100 g).

Table 5: Mineral Composition of Experimental Fish

Parameters g/100 g	AB1 (0.0)	AB2 (0.5)	AB3 (1.0)	AB4 (1.5)	AB5 (2.0)
Calcium	2.25±0.08 ^a	3.17±0.04 ^b	3.46±0.02 ^c	3.14±0.29 ^b	3.86±0.07 ^d
Sodium	4.44±0.01 ^a	5.97±0.06 ^b	5.92±0.00 ^b	5.62±0.01 ^b	6.04±0.05 ^c
Magnesium	0.67±0.03 ^a	1.09±0.02 ^c	0.69±0.06 ^a	0.77±0.02 ^b	0.80±0.01 ^b
Potassium	1.29±0.01 ^a	2.71±0.08 ^b	2.65±0.03 ^b	2.54±0.01 ^b	2.84±0.09 ^b
Iron	4.73±0.32 ^a	6.45±0.02 ^b	6.53±0.04 ^b	6.32±0.15 ^b	6.59±0.02 ^b

Mean in the same row with different letter are significantly different at P<0.05.

Discussion

Proximate Composition of *A. brasiliiana* Leaf Meal

The proximate composition of *A. brasiliiana* leaf meal showed that the plant contains moderate nutrient levels and appreciable ash content, indicating the presence of minerals that may contribute to fish nutrition. The crude protein content of *A. brasiliiana* recorded in this study was higher than 4.30 reported by Iwuoha (2022). These variations may be due to factors such as seed maturity, geographical location and environmental conditions.

Proximate Composition of the Experimental Diets

The experimental diets were formulated to contain similar protein levels which helped reduce the influence of protein variation among treatments. The observed protein content in the fish diet ranged from 39.64 to 40.03%. Rashid *et al.* (2024) reported that the dietary protein requirements of warm water fish have been estimated to vary from 20 to 40%. Therefore, protein content of the test diets used in this study were within the suitable range for *C. gariepinus* culture.

Water Quality Parameters

Water quality remained fairly stable throughout the feeding period. These physicochemical parameters were within the recommended ranges for most freshwater fish species, including *C. gariepinus*, ensuring optimal growth and survival. Since there were no differences among treatments, the changes observed in fish mineral composition were more likely related to the dietary treatments than to environmental conditions. These findings align with those reported

by (Idowu *et al.* 2019) for *C. gariepinus* in controlled aquaculture setting.

Mineral Composition of Experimental Fish

Fish fed diets containing *A. brasiliiana* leaf meal generally showed higher mineral values than fish fed the control diet. Calcium concentration increased progressively across the supplemented diets, with the highest values recorded in fish fed 2.0g/ 100 g. This may indicate improved mineral deposition in fish tissues following dietary supplementation. Similar study was reported by (Lewis *et al.*, 2020). Iron levels also increased in treated groups, suggesting that the leaf meal contributed additional mineral elements that become available to the fish during digestion which compared favorably with that reported by (Clark *et al.*, 2020). Sodium and potassium values were higher in most supplemented treatments compared to the control group. Their increase may indicate improved electrolytes balance in fish receiving the plant supplemented diets. These findings align with those reported by (Miller *et al.*, 2021) on mineral requirements and electrolyte balance in intensive fish culture. Magnesium content showed a slightly different trend from the other minerals. The highest value was recorded in fish fed 2.0g/100 g, after which the concentration declined slightly in subsequent treatments. This result may suggest that moderate inclusion of the leaf meal favours mineral utilisation better than excessive inclusions levels.

Conclusion

Dietary inclusion of *Alternanthera brasiliiana* leaf meal positively influences the mineral composition of *Clarias gariepinus* fingerlings, particularly for calcium, iron, sodium, and potassium. A low inclusion

level (0.5 g/100 g) produced the most favourable outcomes, indicating improved nutrient utilization at minimal supplementation levels. Higher inclusion levels did not enhance performance and may reduce nutrient efficiency. The findings support the use of *A. brasiliensis* as a low-cost functional feed additive in catfish culture when included at optimal dietary levels.

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