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Performance characteristics of *Clarias gariepinus* fingerlings fed *I. batata* leaf inclusion meals

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Abstract

This study aimed to evaluate the performance characteristics of *Clarias gariepinus* fed *Ipomeoa batatas* leaf inclusion meals. Fresh *I. batatas* leaves were harvested and prepared for analysis by standard methods. Feeds were formulated using the Pearson's square standard method. A total of two hundred and seventy (270) fingerlings were used in the study and grouped into six (6) groups of forty-five (45) each and administered feeds as follows: Group 1-(control 1-Coppens feed), Group 2-(control 2-ARAC feed), Group 3-(10% *I. batatas* leaf), Group 4- (20% *I. batatas* leaf), Group 5-(30% *I. batatas* leaf) and Group 6- (100% *I. batatas* leaf). The fishes were administered the respective diets *ad libitum* for a period of 90 days. Physicochemical parameters of the water were determined using LaMotte Fresh Water Aquaculture Test Kit (USA), lengths and weights of the fingerlings were measured using a graduated ruler and electronic weighing balance respectively. Proximate composition was by standard methods while performance characteristics were obtained by calculation. Proximate composition of the formulated fish feeds showed the following ranges: protein (35.16±0.23% to 43.75±0.30%), lipid (6.18±0.60% to 11.93±0.13%), moisture (6.04±2.13% to 9.33±0.82), ash (5.39±0.36% to 9.44±0.12%), NFE (19.41±0.87% to 34.23±0.40%) and fibre (2.15±0.76% to 7.98±0.14%). Proximate content of *I. batatas* leaf was as follows: crude protein (16.60±2.13%), crude fat (0.16±0.00%), moisture (40.62±3.16%), ash (11.92±0.54%), crude fibre (12.28±1.22%) and carbohydrate (18.42±2.17%). Proximate composition of the experimental feeds showed the following ranges: protein (35.16±0.23 to 43.75±0.30%), lipid (6.18±0.60 to 11.93±0.13%), moisture (6.04±2.13 to 9.33±0.82%), ash (5.39±0.36 to 9.44±0.12%), NFE (19.41±0.87 to 34.23±0.40%) and fibre (2.15±0.76 to 7.98±0.14%). Physicochemical parameters (pH, temperature, dissolved oxygen, ammonia, nitrite and total hardness) of the water used for the study were within acceptable limits for fish survival and optimal growth. Performance indices (feed conversion ratio, protein efficiency ratio, specific growth rate, nitrogen metabolism) were very good for all groups of fish. Condition factor (K) of the fish was better at 10% concentration than the ARAC control group while survival rate of 94% at 10% concentration was the best among the formulated feeds. The results support the potential use of Ipomoea batatas leaves as a nutritious and sustainable feed ingredient, promoting efficient growth and improved overall health in *C. gariepinus* farming.

Keywords: *Clarias gariepinus*; *Ipomeoa batatas; p*roximate; fingerlings; physicochemical;

Introduction

Aquaculture, the farming of aquatic organisms, has become an increasingly important sector in global food production. The sustainability of aquaculture relies on the responsible sourcing and formulation of feed. Recent research has focused on reducing the dependence on wild-caught fishmeal and fish oil in aquafeeds by exploring alternative protein and lipid sources, such as plant-based ingredients, microbial-derived proteins, and insect meal (Rawles *et al*., 2021). These alternative feed ingredients not only help to alleviate pressure on marine resources but also contribute to improved feed efficiency and reduced environmental impacts.

Fish feed plays a crucial role in aquaculture, ensuring the growth, health, and productivity of farmed fish. Recent studies have focused on exploring alternative feed ingredients for fish feeds, aiming to reduce dependence on marine resources and enhance feed sustainability. Various plant-based protein sources, such as soybean meal, canola meal, and pea protein concentrate, have been investigated as viable alternatives to fishmeal (Tacon *et al*., 2020). In addition, microorganisms, such as bacteria and yeast, are being explored as potential feed ingredients due to their high protein content and nutritional value (Yúfera *et al*., 2021). The formulation of fish feeds has also evolved, employing a combination of ingredients to meet the specific nutritional requirements of different fish species and life stages. Understanding the nutritional requirements of farmed fish is essential for formulating balanced and efficient feeds. Recent research has focused on optimizing the protein-to-energy ratios, lipid content, and amino acid profiles of fish feeds to support growth, feed utilization, and overall fish health (Glencross *et al*., 2021). The use of advanced techniques, such as molecular biology and metabolomics, has provided valuable insights into the nutrient utilization and metabolic pathways in fish, contributing to improved feed formulations. Feed additives play a crucial role in enhancing feed performance and fish health. Recent studies have explored the use of functional additives, such as probiotics, prebiotics, and immunostimulants, to improve feed efficiency, disease resistance, and gut health in farmed fish (Dawood *et al*., 2022). Additionally, natural additives derived from plant extracts, seaweeds, and herbs have shown potential in promoting growth, disease prevention, and stress tolerance in fish (Yan *et al*., 2021). The development of sustainable and environmentally friendly additives is a focus area for future feed innovation.

Clarias gariepinus is a member of the *Clariidae* family and is native to freshwater habitats in Africa (Moehl *et al*., 2016). It has a robust body structure, with an elongated shape and a streamlined head and exhibits sexual dimorphism, with males typically displaying a larger body size and the presence of specialized breeding tubercles (Ng *et al*., 2001). *C. gariepinus* has a broad ecological tolerance, allowing it to colonize diverse habitats, including rivers, lakes, swamps, and man-made reservoirs. The natural distribution of *C. gariepinus* spans across many African countries, including Nigeria, Egypt, Sudan, Zambia, and South Africa (Eyo *et al*., 2013). However, due to its adaptability and commercial value, it has been introduced to other regions, such as Asia, Europe, and the Americas. This widespread distribution reflects its ability to thrive in varying climatic and environmental conditions. *C. gariepinus* is considered an opportunistic and omnivorous feeder, displaying a versatile diet. In its natural habitat, it consumes a wide range of food sources, including insects, crustaceans, small fish, plant matter, and detritus (Okwundu *et al*., 2018). This adaptability in feeding habits enables *C. gariepinus* to exploit various food resources in different environments.

C. gariepinus

Ipomoea batatas (sweet potato), has gained attention as a potential feed ingredient in fish feed formulation. *I. batatas* is a rich source of carbohydrates, fiber, vitamins, and minerals and studies have revealed its nutritional composition, including high starch content, moderate protein levels, and a variety of essential micronutrients (Oduro *et al*., 2018). The presence of bioactive compounds, such as antioxidants and phytochemicals, also contributes to the nutritional value of *I. batatas.* Several studies have investigated the inclusion of *I. batatas* in fish diets and its effects on growth performance. Osman *et al*., (2021) reported that *I. batatas*-based diets have shown positive effects on growth, feed utilization, and body composition of tilapia (*Oreochromis spp*.). The presence of essential nutrients, along with the bioactive compounds, may contribute to improved fish growth and overall health. *I. batatas* has been reported to possess anti-inflammatory, anticancer, immunomodulatory, antidiabetic, anti-microbial, cardiovascular and antioxidant properties (Ayeleso *et al.* 2016; Elgabry, *et al.* 2023). Several studies have demonstrated the positive effects of incorporating *I. batatas* in fish diets on the immune response and disease resistance. In Nile tilapia (*Oreochromis niloticus*), supplementation with *I. batatas* extracts enhanced immune parameters and resistance against bacterial infections (Jayasankar *et al*., 2020). These findings suggest the potential of *I. batatas* to improve fish health and disease resistance. The use of *I. batatas* in fish feeds holds potential sustainability benefits in that it is a widely available and inexpensive crop, making it a promising alternative to conventional feed ingredients. This study therefore aimed to investigate the performance characteristics of *C. gariepinus* fingerlings fed *I. batatas* leaf inclusion diets.

Materials and methods

Materials

Fresh *I. batatas* leaves were harvested from Aluu community in Ikwerre L.G.A. of Rivers State, Nigeria in April 2020 and identified at the Department of plant science and biotechnology herbarium, University of Port Harcourt by Mr. Ekeke (reference number: UPH/V/1332). All chemicals and reagents used were of analytical standard.

Methods

Experimental Design: Two hundred and seventy (270) fingerlings were grouped into six (6) groups of forty-five (45) each and administered feeds as follow: Group 1 (control 1)-(Coppens feed), Group 2-(control 2) (ARAC feed), Group 3-(10% *I. batatas* leaf inclusion diet), Group 4-(20% *I. batatas* leaf inclusion diet), Group 5-(30% *I. batatas* leaf inclusion diet) and Group 6-(100% *I. batatas* leaf inclusion diet). The fishes were administered the respective diets *ad libitum* for a period of 90 days and all analysis was carried out in triplicates to minimize error.
Method of Feed Composition: The composition of the feeds used in the study where formulated based on the skeleton formula (table 1) and the percentage composition of the various ingredients were calculated using the Pearson's square and substituted into each formulation.

Table 1: The Skeleton Formula

Ingredients	Percentage
Wheat bran	?
Soya bean meal	?
Fishmeal	?
Palm oil	5
Garri	5
Premix	0.25
Methionine	0.15
Vitamin C	0.1
Total	**= 100%**

N/B: Ingredients 1-3 were the protein component of the feed making up the 45% protein requirement of the feed. Also, the proportion of the 1st 3 protein ingredients is (100 – 10.5) % = 89.5%.

The Pearson's square: The feeds were formulated using the Pearson square method (fig. 1) and the percentage of the various ingredients calculated suing formula.

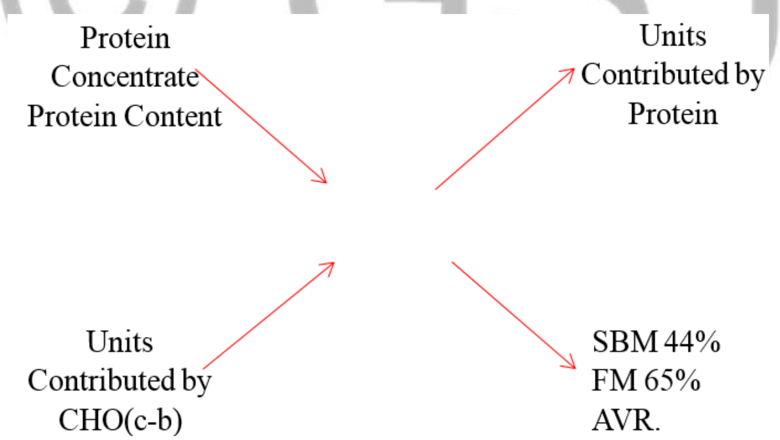

Fig. 1: Pearson's square

Total units contributed by CHO and protein concentrates = (c-b) + (c-a)

The following formulas were applied in the calculation of the percentage of each unit:

$$\% \, CHO = \frac{c-b}{(c-b)+(c-a)} \times 89.5$$

$$\% \, Protein \, Concentrate = \frac{c - a}{(c - b) + (c - a)} \times 89.5$$

Where 89.5 is the proportion of the 3 protein-containing ingredients that go into the square.

Table 2: Formulation of test feeds

Ingredients	ARAC (control)	*I. batatas* leaf inclusion feeds 10%	20%	30%	100%
I. batatas leaf	0	3.9845	7.969	11.9535	39.845
Wheat bran	9.81	9.81	9.81	9.81	9.81
Soyabean meal	39.845	35.8605	31.876	27.8915	39.845
Fishmeal	39.845	39.845	39.845	39.845	0
Palm oil	5	5	5	5	5
Garri	5	5	5	5	5
Premix	0.25	0.25	0.25	0.25	0.25
Methionine	0.15	0.15	0.15	0.15	0.15
Vitamin C	0.1	0.1	0.1	0.1	0.1

N/B: 15kg of each feed was produced based on the percentages shown above

Proximate analysis of *I. batatas* leaves and compounded fish feed

Proximate composition of samples (moisture, ash, lipid, crude fiber and crude protein) were determined by standard procedures (AOAC, 2000).

Analysis of water quality parameters in the experimental tanks: The temperature was measured using a mercury-in-glass thermometer. The physicochemical parameters of the water in the experimental tanks were determined using LaMotte Fresh Water Aquaculture Test Kit (USA) following the instructions on the kit leaflets. Each test had a specific code as follows- pH (Code 3633-01), Dissolved oxygen (DO) (Code 3633-05,), Ammonia-nitrogen (NH_3-N) (Code 3633-05., Nitrite-nitrogen (Code 3633-05) and total hardness (Code 0633-05, USA).

Determination of growth parameters of fish: The lengths of the fingerlings were measured using a graduated ruler and weighed using an electronic weighing balance (Kerro, India). To determine the average and percent weight gain, the fish were weighed at the beginning and end of study after starvation. Growth performance of fingerlings was evaluated using standard formulae (NRC, 1993).

$$\text{Weight gain } \% = \frac{(\text{Final weight} - \text{Initial weight})}{\text{Initial wieght}} \times 100$$

$$\text{FCR} = \frac{\text{Total dry feed intake (g)}}{\text{Weight gain}}$$

$$\text{Specific growth rate } \%/\text{day} = \frac{(\text{In. final wt. of fish} - \text{In. initial wt of fish})}{\text{Trial day}} \times 100$$

$$\text{Food Specific growth rate } (\%/\text{day}) = \frac{(\text{In. final wt. of fish} - \text{In. initial wt of fish})}{\text{Trial day}} \times 100$$

$$\text{Protein efficiency ratio} = \frac{\text{weight gain (g)}}{\text{Protein intake (g)}}$$

$$\text{Nitrogen metabolism (NM)} = \frac{(\text{b} - \text{a}) \times 0.54 \times \text{h}}{2}$$

Where a and b=initial and final weights of fish, h =experimental period in days and 0.54=experimental constant

$$\text{Condition factor (K)} = \frac{100\text{W}}{l^3}$$

Where W=average weight of fish at various stages and l=average standard length of fish at various stages.

Statistical analysis

Data were expressed as means and standard deviations. The data was subjected to analysis of variance (ANOVA) using SPSS (version 21) and significant differences determined at $p<0.05$.

Results and discussion

Aquaculture plays a crucial role in meeting the increasing demand for seafood while striving for sustainability and resource conservation. The conventional feed sources used in aquaculture, such as fishmeal and soybean meal, are facing challenges in terms of cost, availability, and environmental impact. As a result, there is growing interest in exploring alternative feed ingredients, including leaves from various plant sources. Leaves from different plant species, such as *Moringa oleifera*, *Azolla pinnata*, and *Ipomoea batatas*, have been investigated for their nutritional composition. These leaf meals are known to be rich in proteins, essential amino acids, vitamins, minerals, and dietary fiber, making them suitable candidates as alternative feed ingredients (Leng, 2017). Leaf meals often contain a balanced nutrient profile that can meet the dietary requirements of various cultured fish species. Studies on the inclusion of leaf meals in fish feed have shown promising results regarding growth performance and feed utilization efficiency. *I. batatas* leaves have gained attention due to their nutritional composition, cost-effectiveness, and potential as a viable feed ingredient for fish. Studies have shown that *I. batatas* leaves are very nutritious and have good potential to serve as a valuable dietary supplement for fish (Xu *et al*., 2018; Silva *et al*., 2020). The protein content of fish feed is a critical factor in promoting growth and development. Studies have shown that the inclusion of *I. batatas* leaves in fish feed can significantly increase the protein content. A study by Nguyen *et al*. (2020) observed that the protein content in Asian sea bass (*Lates calcarifer*) feed increased from 30% to 36% when supplemented with 10% *I. batatas* leaf meal. Similarly, Olaoye *et al*. (2022) reported an increase in protein content from 25% to 31% when Nile tilapia (*Oreochromis niloticus*) feed was supplemented with 15% *I. batatas* leaf meal. Lipids play a crucial role in providing energy and essential fatty acids for fish growth and overall health. The lipid content of fish feed can be influenced by the inclusion of *I. batatas* leaves. Togun *et al*. (2019) found that the lipid content in Nile tilapia (*Oreochromis niloticus*) feed increased from 8% to 12% when supplemented with 10% *I. batatas* leaf meal. However, in another study by Fernandez *et al*. (2019), no significant change in lipid content was observed in Asian sea bass feed supplemented with 5% *I. batatas* leaf meal. Carbohydrates serve as an energy source in fish diets thus the inclusion of *I. batatas* leaves in fish feed can influence the carbohydrate content. Silva *et al*. (2020) reported an increase in carbohydrate content from 35% to 42% when Asian sea bass feed was supplemented with 20% *I. batatas* leaf meal. In contrast, Xu *et al*. (2018) found that the carbohydrate content remained relatively constant in Nile tilapia (*Oreochromis niloticus*) feed supplemented with 10% *I. batatas* leaf meal. Ash content in fish feed reflects the mineral composition, including essential elements like calcium and phosphorus. The inclusion of *I. batatas* leaves in fish feed can influence the ash content. Nguyen *et al*. (2021) reported a significant increase in ash content from 10% to 15% in Asian sea bass feed supplemented with 5% *I. batatas* leaf meal. Similar finding shave been reported in the current study.

Water quality is a crucial factor in successful fish farming as it directly impacts the health, growth, and overall well-being of fish. Monitoring physicochemical parameters is essential to ensure that the aquatic environment is suitable for fish survival and growth. Temperature influences the metabolic rate, feeding behavior, and reproductive activities of fish. Different fish species have specific temperature ranges in which they thrive hence temperature fluctuations beyond the preferred range can lead to stress, reduced growth, and increased susceptibility to diseases (Huner, 2005). Dissolved oxygen is vital for fish survival as it is essential for aerobic respiration. Low dissolved oxygen levels can result from overstocking, excessive organic matter, or algal blooms and insufficient oxygen can lead to fish mortality, especially in intensive fish farming systems (Noga, 2010). The optimal dissolved oxygen levels vary between species, but generally, levels above 5 mg/L are considered suitable for most fish. The pH level of water indicates its acidity or alkalinity and affects the physiological processes of fish. Fish species have specific pH tolerance ranges, and deviations from their preferred range can cause stress and affect nutrient absorption. Most freshwater fish prefer a pH range of 6.5 to 8.0, but some species may have more specific requirements (Boyd, 2019). Regular monitoring of pH levels and appropriate corrective measures are necessary to maintain a stable and suitable environment for fish. Ammonia is produced by fish excretion and decaying organic matter. High ammonia levels are toxic to fish, as they can damage gills and impair the fish's ability to excrete waste. In fish farming, ammmonia levels should be kept below 0.02 mg/L to avoid adverse effects on fish health and growth (Timmons *et al*., 2002). Proper water exchange, filtration, and nitrification processes are essential for managing ammonia levels. Nitrite and nitrate are intermediate and end products of the nitrification process in the nitrogen cycle. Elevated nitrite levels are toxic to fish, causing methemoglobinemia or "brown blood disease," which reduces oxygen-carrying capacity (Rakocy *et al*., 2006). The quality of water in this study was within acceptable levels.

After a 90-days feeding period, the mean weight gain of the fish showed the following trend: group 1 (coppens feed)> group 3 (10% *I. batatas* inclusion feed)>group 2 (ARAC)>group 4 (20% *I. batatas* inclusion feed)>group 5 (30% *I. batatas* inclusion feed)>group 6 (*I. batatas* inclusion feed). Specific growth rate (SGR), nitrogen metabolism (NM) and condition factor (K) of the fish was also better at 10% concentration than the ARAC control group indicating better performance when leaf meal is included at that concentration. There were no significant difference in mean weight gain of fishes except in 100% concentration where weight grain was not rapid as other groups. The 100% concentration group has a significant difference ($p<0.05$) mean weight gain from the control groups. There was no significant difference in PER across dietary groups except in group 6 which recorded a significantly different ($p<0.05$) PER compared to control groups. There was no significant difference ($P<0.05$) in nitrogen metabolism in all groups except group 6 which recorded a however value compared to control groups. Fish growth is measured in units of weight and length, and is best described as SGR (Labh, 2020). Several studies have investigated the growth rate of *C. gariepinus* fed diets containing *I. batatas* leaves. Togun *et al*. (2019) conducted a study on African catfish (*C. gariepinus*) and observed that fish fed diets with up to 15% *I. batatas* leaf meal exhibited improved growth rates compared to those fed with traditional diets. Similar findings were reported by Olaoye *et al*. (2022) in a study on *Heterobranchus longifilis,* where the inclusion of 10% *I. batatas* leaf meal led to enhanced growth rates. These studies suggest that the supplementation of fish feed with *I. batatas* leaves positively influences the growth performance of *C. gariepinus*. Feed utilization efficiency is a crucial factor in aquaculture as it directly impacts production costs and environmental sustainability. Studies have investigated the feed utilization efficiency of *C. gariepinus* fed *I. batatas* leaf-supplemented fish feed. Silva *et al*. (2020) reported that juvenile channel catfish (*Ictalurus punctatus*) fed diets containing up to 20% *I. batatas* leaf meal showed improved feed conversion ratios (FCR) compared to the control group. This indicates that the incorporation of *I. batatas* leaves in *C. gariepinus* diets can enhance feed utilization efficiency, potentially leading to cost savings and reduced environmental impact. The findings of this study on percentage weight gain and SGR of fish were similar to the reports of other researchers (El-abd *et al*. 2019; Labh, 2020; Tabassum, *et al*. 2021). The increase in length and weight obtained in this study indicates that the formulated feed was nutritionally adequate to support growth and fish survival.

Condition factor and survival rate are essential indicators of the overall health and well-being of fish in aquaculture. The use of alternative feed ingredients, such as *I. batatas* leaves, has been studied to understand their impact on condition factor and survival rate of *C. gariepinus*. Conditions factor (K) which is the overall wellbeing of the fished in water was not significantly different (p>0.05) in all dietary groups which indicates the fished adopted well to their environment and the food formulated was palatable and well accepted by the fishes while survival rate of fished in all dietary groups recorded above 90% except group 6 which recorded a 78% survival rate. The fishes in this study had a survival rate of 94% at 10% concentration as close to the coppens feed which recorded a 96% survival rate. Studies have examined the condition factor of *C. gariepinus* fed diets containing *I. batatas* leaves. Silva *et al*. (2020) conducted a study on juvenile channel catfish (*Ictalurus punctatus*) and reported that fish fed diets containing up to 20% *I. batatas* leaf meal showed significantly improved condition factors compared to the control group. This suggests that the inclusion of *I. batatas* leaves in *C. gariepinus* diets positively affects their health and overall condition. Survival rate is a critical parameter in aquaculture, as it directly reflects the ability of fish to withstand various stressors and challenges. Nguyen *et al*. (2021) investigated the effects of *I. batatas* leaf meal supplementation on the survival rate of African catfish (Clarias gariepinus) and found that fish fed diets containing 5% *I. batatas* leaf meal showed higher survival rates compared to the control group. The findings of this present study were similar to literature. This indicates that the inclusion of *I. batatas* leaves in *C. gariepinus* diets can improve their resilience and survival, potentially reducing mortality rates in *C. gariepinus* farming systems.

Table 3: Proximate composition of control and compounded fish feeds

Parameter	**Control feeds**		**Compounded feeds (% *I. batatas* leaf inclusion)**			
	Coppens	**ARAC**	**10%**	**20%**	**30%**	**100%**
Protein	43.75 ± 0.30^{b}	43.32 ± 1.57^{b}	42.55 ± 0.41^{b}	35.16 ± 0.23^{a}	39.32 ± 0.15^{a}	37.86 ± 0.52^{a}
Lipid	11.93 ± 0.13	6.75 ± 0.36^{a}	6.88 ± 2.02^{a}	7.02 ± 0.47^{b}	6.18 ± 0.60^{b}	8.23 ± 1.40^{b}
Moisture	8.1 ± 0.27	7.16 ± 2.15^{a}	7.25 ± 0.29^{a}	9.33 ± 0.82^{b}	7.19 ± 0.31^{a}	6.04 ± 2.13^{b}
Ash	9.44 ± 0.12	6.29 ± 0.34^{a}	5.39 ± 0.36^{b}	6.28 ± 0.38^{b}	8.77 ± 0.01^{a}	7.99 ± 0.53^{b}
NFE	19.41 ± 0.87	29.33 ± 0.60^{a}	30.08 ± 0.70^{b}	34.23 ± 0.40^{b}	31.48 ± 0.30^{b}	33.72 ± 0.65^{b}
Fibre	7.42 ± 0.62	2.15 ± 0.76^{a}	7.85 ± 1.27^{b}	7.98 ± 0.14^{b}	7.06 ± 0.53^{b}	6.16 ± 0.22^{b}

NFE-Nitrogen Free Extract; ARAC-African regional Aquaculture centre; Values are presented as mean ± standard deviation (n=3); Values with different superscript letters in same row differ significantly (p<0.05)

Table 4: Physicochemical properties of water in the experimental tanks

Parameters	**Tank**

	1	2	3	4	5	6
pH	6.69 ± 0.01^c	6.70 ± 0.02^c	6.68±0.01^c	6.69 ±0.01^c	6.68±0.01^c	6.69±0.02^c
Temperature(°C)	27.27±0.01^c	27.28±0.01^c	27.28±0.02^c	27.27±0.01^c	27.29±0.02^c	27.28±0.01^c
Dissolved Oxygen (mg/l)	6.62±0.02^c	6.71±0.01^c	6.59±0.02^c	6.63±0.02^c	6.59±0.01^c	6.54±0.01^c
Ammonia(mg/l)	0.11±0.01^c	0.10±0.01^c	0.11±0.02^c	0.12±0.01^c	0.10±0.01^c	0.10±0.02^c
Nitrite(mg/l)	0.28±0.01^c	0.29±0.01^c	0.28±0.01^c	0.29±0.01^c	0.29±0.01^c	0.29±0.01^c
Total Hardness(mg/l)	43.47±0.02^c	43.47±0.01^c	43.47±0.02^c	43.46±0.01^c	43.46±0.01^c	43.47±0.02^c

Values are presented as mean ± standard deviation (n=3); Values with different superscript letters in same row differ significantly (p<0.05)

Table 5: Weight gain and specific growth rate

Group (% inclusion)	Length (cm) Initial	Length (cm) Final	Weight (g) Initial	Weight (g) Final	Weight gain(g)	Weight gain (%)	SGR (%)
1(Coppens)	15.30 ±0.75	37.60 ±0.17	67.10 ±0.11	473.10 ±5.66	266.07 ±143.69	356.19 ±218.36	2.98 ±0.04
2(ARAC)	15.88 ±0.59	34.87 ±0.55^a	67.12 ±0.56^c	432.10 ±10.50^a	245.18 ±133.06^a	343.43 ±212.30	2.22 ±0.08^a
3(10%)	15.44 ±0.10^c	34.00 ±0.68^a	66.45 ±0.96^c	461.08 ±9.88	248.27 ±136.98^a	345.51 ±231.17	2.23 ±0.16^a
4(20%)	15.20 ±0.86^c	33.97 ±0.77^a	67.15 ±0.88^c	404.12 ±0.55^a	222.60 ±112.44^a	316.48 ±281.94^a	2.26 ±0.09^a
5(30%)	15.60 ±0.12^c	30.23 ±0.56$^{a, b}$	66.40 ±0.90^c	397.02 ±11.04$^{a, b,}$	215.07 ±126.16^a	303.12 ±268.80^a	2.13 ±0.13^a
6(100%)	15.42 ±0.90^c	28.01 ±0.03$^{a, b}$	67.33 ±0.60^c	282.78± 8.67$^{a, b}$	190.05 ±110.56$^{a, b}$	261.50 ±230.10^a	1.65 ±0.17$^{a, b}$

SGR-Specific Growth Rate (%); ARAC-African regional Aquaculture centre; Values are presented as mean ± standard deviation (n=3); Values with different superscript letters in same row differ significantly (p<0.05)

Table 6: Performance characteristics

Diet group	Feed conversion ratio	Protein efficiency ratio	Nitrogen metabolism
1(Coppens)	1.28±0.70	2.11±0.66	3978.15±3506.67
2(ARAC)	1.18±0.68^c	2.07±0.45	3655.70±3546.88^a
3(10%)	1.19±0.77^c	2.07±0.78	3674.08±3754.84^a
4(20%)	1.16±0.54^c	2.05±0.89	3886.74±3608.77
5(30%)	1.16±0.76^c	1.96±0.66^a	3698.09±3200±3766.67^a
6(100%)	0.88±0.14^{a,}	1.12±0.73$^{a, b}$	2671.05±2004.562.07^a

ARAC-African regional Aquaculture centre; Values are presented as mean ± standard deviation (n=3); Values with different superscript letters in same row differ significantly (p<0.05)

Table 7: Condition factor and survival rate

Group (% inclusion)	Condition factor (g/cm^3)	Survival rate (%)
1(Coppens)	1.01±0.13^c	96.56±5.78^b
2(ARAC)	1.07±0.62^c	93.04±2.79^b
3(10%)	1.07±0.35^c	94.11±7.93^b

4(20%)	1.10±0.04[c]	93.55±3.41[b]
5(30%)	1.23±0.07[c]	91.06±3.88[b]
6(100%)	2.08±0.15[a]	78.76±1.07[a]

ARAC-African regional Aquaculture centre; Values are presented as mean ± standard deviation (n=3); Values with different superscript letters in same row differ significantly (p<0.05)

Conclusion `

In this research article, we investigated the performance characteristics of *C. gariepinus* fingerlings fed fish feed supplemented with *I. batatas* (sweet potato) leaves. The study aimed to evaluate the potential of *I. batatas* leaf meal as an alternative feed ingredient in enhancing the growth and overall performance of the catfish fingerlings. The results of our study demonstrated promising outcomes regarding the performance of *C. gariepinus* fingerlings fed *I. batatas* leaf-supplemented fish feed. The inclusion of *I. batatas* leaf meal positively influenced the growth rate of the fingerlings, as evidenced by a significant improvement in weight gain and specific growth rate (SGR). The observed enhancement in growth parameters indicates the suitability of *I. batatas* leaves as a valuable dietary supplement for young Clarias gariepinus. Moreover, the feed utilization efficiency of the fingerlings improved when supplemented with *I. batatas* leaf meal, as reflected by favorable feed conversion ratios (FCR). This finding suggests that the inclusion of this alternative feed ingredient can lead to improved nutrient utilization and reduced feed wastage, potentially contributing to cost-effective and sustainable aquaculture practices. Beyond growth performance, our study also evaluated the health and condition of the *C. gariepinus* fingerlings. We observed a positive impact on the condition factor, indicating overall good health and well-being of the fish fed *I. batatas* leaf-supplemented fish feed. Additionally, the survival rate of the fingerlings was significantly higher compared to the control group, signifying the resilience and adaptability of the fish to the experimental diet. Overall, the results of this study provide valuable insights into the potential benefits of *I. batatas* leaf meal as a supplementary feed ingredient for *C. gariepinus* fingerlings in aquaculture. The improved growth performance, feed utilization efficiency, and health indicators observed in the fingerlings fed with *I. batatas* leaf-supplemented fish feed suggest the viability of incorporating this alternative feed ingredient into commercial catfish diets.

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