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Growth Performance and Nutrient Utilization of African Catfish (Clarias gariepinus) Fingerlings Fed Solid-State Fermented Cassava Peels as Partial Replacement for Fishmeal

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Abstract
The cassava fermentation process enhances nutritional value by increasing protein content and detoxifying harmful and anti-nutritional chemicals in cassava peels. The most difficult issue facing aquaculture is the high cost of feed, and the most costly component in fish feed composition is fishmeal. This study investigated growth performance and nutrient utilization of African Catfish (Clarias gariepinus) fingerlings fed solid state fermented cassava peels as partial replacement for fishmeal. Three hundred and sixty (360) C. gariepinus fingerlings were stocked at 15 fish per plastic tank. Six iso-nitrogenous diets were formulated with an inclusion level of FCP 10%, FCP 20%, FCP 30%, FCP 40%, FCP 50% and control diet with 0% FCP substitution. Fish were fed at 3% of their weekly body weight twice at 9.00am and 5pm daily for 12 weeks. Twelve-weeks feeding trial was conducted using completely randomized design to determine the physico-chemical parameters, investigate the proximate composition, the growth performance and the nutrient utilization of African catfish. The feeding schedules showed significant differences (p>0.05) on the body composition. The result for the growth and feed utilization parameter showed that FCP 30% had the highest value while the control FCP (0%) had the least value. Diets of cassava peels fermented with palm wine yeast as fish meal substitute is therefore a cost-effective practical alternative to commercial fishmeal in the diet of Clarias gariepinus when used as a meal at the 30% inclusion level. FCP at 30% inclusion level is therefore recommended as a fishmeal substitute in the diet of C. gariepinus fingerlings.

Keywords: Growth Performance, Nutrient Utilization, Clarias gariepinus, Cassava Peels, Weight

Introduction

In order to meet the demands of global food and nutrition security and manage the problems of food scarcity and malnutrition, aquaculture is an essential sector of the food production industry. Everyone agrees that overfishing, climate change, pollution, and inadequate fisheries resource management make it impossible for wild harvests to meet the growing global demand for aquatic products (FAO, 2022; Maulu et al., 2021). According to FAO (2014), the output of aquaculture food has increased over the past ten years, with the proportion of overall fish production from aquaculture increasing from roughly 50 million tonnes to almost 67 million tonnes. As a result, rapid growth comes at the expense of sustainability, the difficulty of preventing disease, accelerating growth rates, creating more effective feed, improving larval rearing, and, finally, creating a food product that satisfies safety and nutritional requirements (Coyne, 2015).

African catfish are incredibly high in protein and vital amino acids, which the body needs for rapid growth and development. Omega-3 fatty acids are abundant in fish, which also has a very low cholesterol concentration. Due to the high nutritious value of fish, demand is rising quickly without corresponding increases in output (Ozigbo et al., 2014). Farmers need to take notice of this serious shortage of supplies as the population grows in order to avoid the very low protein intake of the typical Nigerian. Additionally, it has been reported that 60–70% of the entire recurring costs of production are supplied by fish feed, making it practically impossible for fish farmers to manage (Onu et al., 2021). The absence of traditional fish feed and the high cost of ingredients as a result of competition with humans and industries may be the cause of this. Examining alternate food sources is crucial to enhancing aquaculture productivity because the majority of traditional animal feed ingredients are becoming scarce and more expensive (Onu et al., 2021).

According to Bob-Manuel, (2017) in Nigeria, aquaculture has come a very long way since its introduction because is really playing an important role in meeting the fish needs of the country. Aquaculture is also one of the areas in which the fisheries potential of Nigeria could be enhanced. The high cost of feed is the most challenging problem in the development and expansion of aquaculture. The profitability of the fish farming enterprise depends on fish feed. Eyiwunmi et al., (2018) also reported that presently, there is considerable decline in fish production from the capture fisheries, while in the culture fisheries; the production level is on the raise with approximately 100% raise. Fish is nutritive, delicious and acceptable with characteristic source of essential mineral, vitamins, fats/oils and amino acid.

As a result, protein used in diet formulas and locality availability is currently being replaced with alternatives. This is done with the goal of maintaining ideal growth while lowering production costs without sacrificing fish health (Okomoda et al., 2017; Howlader et al., 2023). Fishmeal, the conventional protein source in fish meals, is becoming more and more expensive, and environmental concerns are driving the need for protein substitution in aquaculture. Finding sustainable substitutes is essential to the aquaculture sector's long-term survival. In this sense, using agro-industrial byproducts is a good substitute. The addition to aqua diet has the potential to significantly lower production costs (Reguengo et al., 2022), therefore converting waste to wealth (Ezeoke & Nwoye, 2022).

According to a review by Idowu et al., (2018), fish meal is the primary component of many fish species' commercially produced diets. Fish meal prices have increased significantly due to the rapid expansion of fish farming, and they may continue to climb as long as demand continues to rise. Many academics and fish farmers are looking into alternative protein sources of excellent nutritional quality that are ideally more affordable and widely available than fishmeal due to the lack of availability of fishmeal and its probable high cost. This will decrease the cost of production and create a high quality product suitable for any small or large-scale fish production system. The aim of this research was to investigate the effect of growth performance and nutrient utilization of African Catfish fingerlings fed solid state fermented cassava peels as partial replacement for fishmeal. The objectives of this study includes to evaluate the growth performance of the experimental diets and evaluate nutrient utilization parameters of the experiment diets.

Materials And Methods

experimental site

The Hydrobiology and Fisheries experimental facility at Ignatius Ajuru University of Education in Rumuolumeni, Rivers State, served as the venue for the experiment. Over the course of twelve weeks (84 days; 9th September, 2024 to 25th November, 2024), the fingerlings were fed, stockpiled, measured, and weighed using the appropriate equipment and techniques.

Experimental Units

The research was carried out in twenty-four (24) outdoor plastic tanks of the same size and measurement, with the dimensions, 48cm length, 30cm width and 36cm depth. The tanks were properly washed and sun-dried for three days to eliminate any competitive parasites. The water level was filled to ¾ (three quarters) of the tank height. Open net was used to cover the top of the pond (tank) to prevent predator attack.

Sample Collection

Collection Of Cassava Peels And Palm Wine Yeast

Cassava peels of *Manihot esculenta* were collected from farmers at Umuolobo Abara Etche, Rivers state. The fresh cassava peels were abandoned as farm waste and at house back yards. They were put in sack bags and later transferred into well covered 100 liters plastic basin. Palm wine yeast was obtained from palm wine seller located at 1st Car wash, Omusele Umunwei Igwruta, Rivers state. The palm wine yeast was collected with a 10-liter plastic container.

Experimental Fish

Three hundred and sixty (360) *C. gariepinus* fingerlings with initial weight of 1.35g each was procured from a private fish farm (Oke-Pros fish farm) in Umuolobo Abara Etche, Rivers state. Nigeria and transported in 50 liters open plastic containers, half-filled with water to the experimental site within 45-50 minutes of collection. This was done in the early hours of the morning to avoid stress on the fingerlings. The fish were distributed into 24 outdoor tanks, 15 fish per tank and allowed to acclimatize in the experimental tank for 2 days. During the period of acclimatization, the fishes were feed coppens fish meal.

Water Source

The water used for the studies was obtained from borehole located in the university premises. The water was directly supplied into the experimental tanks through the taps connected direct from borehole tank in the experimental unit.

Experimental Design

Complete randomized design was used in this research which consists of six (6) treatments and four (4) replicates, making a total of twenty-four (24) experimental units. All the tanks were arranged in four rows and kept in a wooden frame to facilitate better observation and accessibility. This can be expressed mathematically as;
Treatment = Six (6) pelleted feeds/diets
Replicates = Four (4) plastic tanks
Therefore, units = 6 x 4 = 24 experimental units.

Physicochemical Parameters For Growth Of *Clarias Gariepinus* Fingerlings

Physicochemical parameter of water temperature was measured using mercury in bulb thermometer calibrated from 0 – 100^{o}C which was immersed 5cm deep on the water surface. Water pH was using Jenway pH meter and Dissolved oxygen was determined using dissolve oxygen meter.

Processing Of Cassava Peels Fermented With Palm Wine Yeast

The cassava peels were washed and grounded into smaller pieces with the aid of grinding machine. Then it was placed in a bowel and weighed at 30kg and it was preserved in a refrigerator. Weekly 5kg of grinded cassava peels, 1.5 liters of palm wine yeast and 0.5g of methionine was added together and mixed appropriately. The cassava peels was transferred in flat trays and placed into the incubator for fermentation for a period of 7 days at 30^{o}C.
The oven dried fermented cassava peels were grounded into powered form and stored in an air tight container. Proximate composition of the fermented and unfermented cassava peels was carried out according to (AOAC, 2017). The grounded cassava peels serve as the substrate while the palm wine is the innoculum in the solid-state fermentation.

Formulation Of Experimental Feed

Six Iso-nitrogenous diets were formulated to yield crude protein. The energy and carbohydrate source included was fermented with yeast to replace fish meal at varying levels of inclusion such as 0%, 10%, 20%, 30%, 40% and 50%. The negative control diet was prepared at 0% inclusion level of fermented cassava peels. Other feed ingredients that were used in the diet formulation were procured from a reliable sales outlet at Modern agro enterprise no.2 Rumuodomaya, Port Harcourt. The feed composition includes; bone meal (BM), Iodized salt, palm oil (PO), garri (binder), soyabean, wheat bran (WB), fish meal (FM) and vitamin premix (VP) were also bought at Modern agro enterprise no.2 Rumuodomaya, Port Harcourt. The oven dried fermented cassava peels, soyabeans (SB) and wheat bran (WB) were crushed using grinding machine into fine particles. All feed ingredients were measured accurately in its varying proportions and mixed properly with warm water to pellet using 2mm mesh size for easy uptake and absorption of *C. gariepinus* fingerlings and the formulated diets were labeled appropriately and sun-dried to avoid denatured protein content of the feed. Trial and error method was used at 3.0k/ca/l/g respectively. The feed was analyzed for its proximate composition. The formulation of prepared diets was carried out in a way that fish meal was substituted in the diets at varying level of inclusion namely: Treatment 1 serves as the control diet only fish meal with no inclusion of FCP (FCP 0%) while treatment 2,3,4,5,6 constitute of fish meal substituted with FCP at 10%, 20%, 30%, 40% and 50% respectively

Where, Treatments 1- 6 represent different diets and FCP represent fermented cassava peel.

composition (g/100g dry matter) of the experimental diets fed to *Clarias gariepinus* fingerlings during the period of study

Table 1: Ingredients composition of the experimental diets (g/100g/dry basis)

Ingredients	Control	FCP 10%	FCP 20%	FCP 30%	FCP 40%	FCP 50%
Wheat bran	27.00	27.00	27.00	27.00	27.00	27.00
Yellow maize	19.00	19.00	19.00	19.00	19.00	19.00
Soya beans Cake	18.00	18.00	18.00	18.00	18.00	18.00
Fish meal	28.00	23.00	18.00	13.00	8.00	3.00
Fermented Cassava Peels	-	5.00	10.00	15.00	20.00	25.00
Bone meal	1.00	1.00	1.00	1.00	1.00	1.00
Palm oil	2.50	2.50	2.50	2.50	2.50	2.50
Salt	1.00	1.00	1.00	1.00	1.00	1.00
Binder (white garri)	1.00	1.00	1.00	1.00	1.00	1.00
Mineral premix	1.00	1.00	1.00	1.00	1.00	1.00
Vitamin premix	1.00	1.00	1.00	1.00	1.00	1.00
Methionine	0.50	0.50	0.50	0.50	0.50	0.50
Total	100	100	100	100	100	100

Key:
FCP 10% - FCP 50% = Cassava peels treatment substituted with fishmeal at 10%, 20%, 30%, 40%, and 50%.

Experimental Feeding Trials

Four (4) plastic experimental tanks were used for each replicate of feed treatments and the fish were fed twice daily at 8.00 - 9.00am and 4.00 – 5.00pm on the bases of 3% of their body weight in two rations for 84days. The rations were adjusted every week and quantity of fish feed was subjected to adjustment depending on its total body weight on weekly basis. The new weights of the fingerlings for each treatment and replicates were determined. After that, the water was replaced with fresh dechlorinated water. The amount of feed fed by fish was recorded for subsequent calculation of Daily Feed Intake (DFI), Protein Intake (PI), Mean Weight Gain (MWG)g, Percentage Weight Gain (PWG)%, Nitrogen Metabolism (NM), Feed Conversion Ratio (FCR), and Protein Efficiency Ratio (PER).

Growth Parameters Of The *Clarias Gariepinus* Fed Experimental Diet

The growth performance was determined in terms of the initial and final weekly measurement of the fish weight (g), percentage weight gain (%) and specific growth rate (SGR).

Mean Weight Gain (MWG)

The weekly weights measurement recorded was used to compute the growth parameters. The following indices are;
Mean Weight Gain (MWG) = $(W_2 - W_1)$ g
Where:
W_1=Initial Mean Weight (g)
W_2=Final Mean Weight (g) (Brown, 1957)

Percentage Weight Gain (PWG) %

The percentage weight gain was calculated from the relationship between weight gain and mean fish weight;

$$PWG = \frac{\text{Mean Weight Gain}}{\text{Mean of fish Weight}} \times 100$$

(Brown, 1957)

Specific Growth Rate (SGR)

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$$SGR = \frac{\log_c W_1 - \log_c W_2}{T_2 - T_1} \times 100$$

Where, W_2 = final weight of fish (Brown, 1957)

W_1= initial weight of fish

T_2 = final time

T_1 = initial time

Log c = Natural log base c

Nutrient Utilization Parameters Of *C. Gariepinus* Fingerlings Fed Experimental Diet

The weekly wet weight gain and protein gain was used to compute the nutrient utilization parameter of *C. gariepinus* fingerlings fed with the experimental diet during the experimental period to determine the net protein utilization, feed conversion ratio, gross feed conversion efficiency and nitrogen metabolism of the fish.

Net Protein Utilization (NPU)

$$NPU = \frac{\text{Protein gain}}{\text{Protein consumed}} \times 100$$ (Dabrowski & Kozak, 1979)

Where;

Protein gained = final total body protein – initial total body protein

and Protein consumed = $\frac{\text{protein in the feed (\%)} \times \text{protein gained}}{100}$

Feed Conversion Ratio (FCR)

The feed conversion ratio (FCR) was expressed as the proportion of dry feed fed per unit live weight gain of fish.

$$FCR = \frac{\text{Feed intake (g)}}{\text{Wet weight gain (g)}}$$ (Boonyaratpalin, 1989)

Protein Efficiency Ratio (PER)

This is the efficiency with which the fish utilizes dietary protein and is defined by the equation.

$$PER = \frac{\text{wet weight gain by fish (g)}}{\text{Weight of crude protein fed}}$$ (EIFAC 1980)

Nitrogen Metabolism (Nm)

$$Nm = \frac{(0.549)(b-a)h}{2}$$ (Castell & Tiews, 1980)

Where;

a = initial weight of fish

b = final weight of fish

h = experimental period in days

0.549 = experimental content

Proximate Analysis Of Experimental Feed And Fish Carcass

At the end of the experimental feeding trials the formulated diets were analyzed to determine the nutrient composition of the feed. Five (5) fish from the stock were randomly selected and oven dried at 60^{o}C after which they were crushed to fine particles and placed in a specimen bottle for initial carcass analysis of the fish. Also, at the end of the experiment, five (5) fish were selected randomly across each of the experimental units and properly labeled for final carcass analysis to determine the protein, moisture, ash, carbohydrate (NFE), lipid and crude fibre.

Determination Of Crude Protein

The crude protein analysis was done using Kejal method with block design plus steam distillation to find the percentage Nitrogen content which is calculated by;

$$\%\ \text{Nitrogen Content} = \frac{(\text{ml of standard acid} - \text{ml of blank}) \times \text{N of Acid} \times 1.4007}{\text{Weight of samples in grams}}$$

Nitrogen is finally converted to crude protein by multiplying by 6.25.

determination of moisture content

Moisture content was determined by weighing the samples in a porcelain crucible.

$$\% \text{ moisture content} = \frac{\text{weight of moisture obtained (gm)}}{\text{weight of sample (gm)}} \times 100$$

Determination Of Ash Content

Ash content was determined following the method of A.O.A.C. (2000).

$$\% \text{ Ash content} = \frac{\text{weight of ash obtained (gm)}}{\text{weight of sample (gm)}} \times 100$$

Determination Of Fibre

The crude fibre was calculated by difference. This was done by subtracting the sums of protein, carbohydrate, lipid and ash from a 100.

Determination of Crude Fat/Lipid

Crude fat/lipid was done using Soxhlet method. 2ml of ethanol at 45% and 10ml of HCL which grade 2g of sample in a test tube and boiled for 30mins. The test tube content was cooled to room temperature and poured into separating funnel. Then 25ml of diethyl ether and 25ml of 25ml of petroleum ether were added to the test tube and it was shook for 1min. manually the upper portion of the solvent was poured into a fat cup. 15ml of diethyl ether of petroleum ether was added to the test tube and it was shaken for 1min. The upper portion of the solvent was poured into a fat cup and placed on a sand bath at 30Oc for 45mins and insert in an extraction thimble.

$$\% \text{ fat} = \frac{\text{weight of fat/lipid obtained (gm)}}{\text{weight of sample (gm)}} \times 100$$

(A.O.A.C. , 2017)

Statistical analysis

The growth and nutrient utilization data obtained from the study was collated, analyzed and presented in tables and graphs using SPSS statistics software version 25 for windows. Data was first tested for normality (Kolmogrov - Smimov test). When the conditions were satisfied, mean standard deviation and analysis of variance (ANOVA) was employed to reveal significant differences in measured variables among control and experimental groups ($CT_O - CT_E$) in proximate analysis of experimental diets, growth performance and nutrient utilization parameters, physicochemical parameters while Duncan's Multiple Range post Hoc Test of multiple comparison was used to reveal which treatment was significantly different $p<0.05$.

Results

growth performance and nutrient utilization parameters of the experimental diet

Table 1 showed that the highest weight gain was recorded by the fish fed with diet FCP 30 (6.35g) followed by those fed with diet FCP 50 (5.90g), while least in those fed with diet Control (4.64g). Figure 1 showed that the highest percentage weight gain was recorded by the fish fed with diet FCP 30 (353.02) followed by those fed with diet FCP 50 (331.11), while least in those fed with diet Control (282.57). Figure 2 showed that the highest specific growth rate was recorded by the fish fed with diet FCP 30 (209.43 g%/day) followed by those fed with diet FCP 50 (203.45 g% day), while least in those fed with diet Control (183.45 g%/day). The analysis of variance results revealed that there was a significant difference between the weight gain, percentage weight gain and specific growth rate of *C. gariepinus* fingerlings fed with the six experimental diets at $p<0.05$.

nutrient utilization parameters of the experimental diet

Table 2 showed that the highest feed intake was recorded by the fish fed with diet FCP 30 (15.07) followed by those fed with diet FCP 10 (13.37), while least in those fed with diet Control (9.93). Figure 3 showed that the highest feed conversion ratio was recorded by the fish fed with diet FCP 30 (2.33) followed by those fed with diet FCP 20 (2.29), while least in those fed with diet Control (2.11). Figure 4 shows that the highest gross feed conversion ratio was recorded by the fish fed with the control diet (47.50) followed by those fed with diet FCP 50 (45.71), while least in those fed with diet FCP 30 (42.86). Figure 5 showed that the highest protein consumed was recorded by the fish fed

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with the FCP 30 (47.50) followed by those fed with diet FCP 50 (2.68), while least in those fed with the control diet (1.05). The analysis of variance results revealed that there was a significant difference between the feed conversion ratio, gross feed conversion ratio and protein consumed by *C. gariepinus* fingerlings fed with the six experimental diets at p<0.05.

Table 1: Weekly Weight Gain of *C. gariepinus* fed with fermented cassava peel and diets

Weeks	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	Net Gain(g)
FCP 0	$1.64^{ab}\pm0.04$	$1.78^{a}\pm0.06$	$1.91^{a}\pm0.05$	$2.54^{a}\pm0.08$	$3.10^{a}\pm0.05$	$3.92^{a}\pm0.05$	$4.34^{a}\pm0.05$	$4.64^{a}\pm0.06$	$5.04^{a}\pm0.06$	$5.34^{a}\pm0.06$	$5.83^{a}\pm0.05$	$6.28^{a}\pm0.11$	$4.64^{b}\pm0.07$
FCP 10	$1.78^{c}\pm0.03$	$2.04^{c}\pm0.05$	$2.53^{d}\pm0.05$	$3.02^{c}\pm0.03$	$4.66^{c}\pm0.05$	$5.01^{c}\pm0.05$	$5.54^{d}\pm0.08$	$5.96^{a}\pm0.05$	$6.32^{d}\pm0.06$	$6.70^{d}\pm0.06$	$7.19^{d}\pm0.04$	$7.63^{c}\pm0.08$	$5.85^{d}\pm0.05$
FCP 20	$1.57^{a}\pm0.04$	$1.88^{b}\pm0.05$	$2.13^{b}\pm0.07$	$2.78^{b}\pm0.12$	$3.83^{b}\pm0.05$	$4.13^{b}\pm0.07$	$4.55^{b}\pm0.08$	$5.10^{b}\pm0.5$	$5.21^{b}\pm0.06$	$5.75^{c}\pm0.21$	$6.25^{c}\pm0.16$	$6.69^{b}\pm0.15$	$5.11^{c}\pm0.12$
FCP 30	$1.80^{c}\pm0.05$	$2.50^{d}\pm0.07$	$2.94^{e}\pm0.05$	$3.43^{d}\pm0.04$	$5.27^{e}\pm0.04$	$5.49^{d}\pm0.08$	$5.99^{e}\pm0.05$	$6.36^{d}\pm0.05$	$6.79^{e}\pm0.08$	$7.17^{e}\pm0.06$	$7.66^{e}\pm0.05$	$8.14^{d}\pm0.19$	$6.35^{e}\pm0.14$
FCP 40	$1.67^{b}\pm0.06$	$1.84^{a}\pm0.04$	$2.08^{b}\pm0.06$	$2.75^{b}\pm0.04$	$3.82^{c}\pm0.07$	$3.91^{a}\pm0.06$	$4.39^{a}\pm0.08$	$4.66^{a}\pm0.05$	$5.11^{ab}\pm0.09$	$5.56^{b}\pm0.05$	$6.05^{b}\pm0.16$	$6.57^{b}\pm0.17$	$4.90^{b}\pm0.12$
FCP 50	$1.78^{c}\pm0.06$	$2.02^{c}\pm0.04$	$2.43^{c}\pm0.06$	$2.96^{c}\pm0.05$	$4.57^{c}\pm0.06$	$4.96^{c}\pm0.07$	$5.42^{c}\pm0.11$	$5.75^{c}\pm0.05$	$6.18^{c}\pm0.09$	$6.60^{d}\pm0.08$	$7.15^{d}\pm0.04$	$7.67^{c}\pm0.09$	$5.90^{d}\pm0.03$

Columns sharing similar superscripts are not significantly different at P>0.05

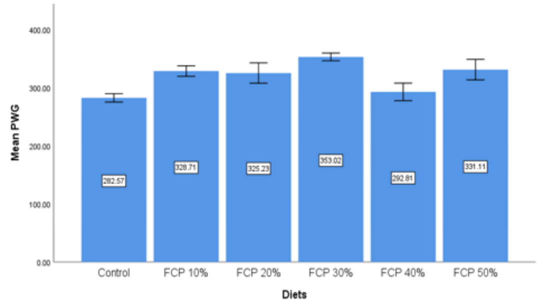

Figure 1: Percentage Weight Gain of *C. gariepinus* fingerlings fed with the control and fermented cassava peel diets.

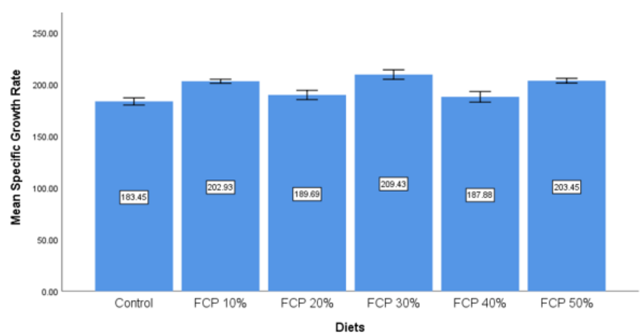

Figure 2: Specific growth rate of *C. gariepinus* fingerlings fed with control and fermented cassava peel diets

Table 2: Feed intake of *C. gariepinus* fingerlings fed with control and fermented cassava peel diets

Diets	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	Mean feed intake
Control	$5.02^{b}\pm0.02$	$5.17^{a}\pm0.01$	$5.52^{a}\pm0.02$	$6.92^{a}\pm0.01$	$8.63^{a}\pm0.03$	$11.06^{b}\pm0.04$	$11.45^{a}\pm0.03$	$11.76^{a}\pm0.04$	$12.26^{a}\pm0.04$	$12.45^{a}\pm0.04$	$13.04^{a}\pm0.03$	$13.65^{a}\pm0.03$	$9.93^{a}\pm3.11$
FCP 10%	$5.45^{d}\pm0.04$	$6.02^{d}\pm0.02$	$7.45^{e}\pm0.03$	$8.82^{e}\pm0.02$	$13.51^{e}\pm0.01$	$14.02^{d}\pm0.01$	$15.43^{f}\pm0.02$	$16.25^{e}\pm0.03$	$16.73^{e}\pm0.04$	$17.12^{d}\pm0.02$	$18.04^{e}\pm0.04$	$18.26^{d}\pm0.04$	$13.37^{cd}\pm4.56$
FCP 20%	$4.82^{a}\pm0.02$	$5.62^{c}\pm0.01$	$6.34^{c}\pm0.03$	$8.22^{c}\pm0.01$	$11.52^{c}\pm0.02$	$12.12^{c}\pm0.01$	$12.63^{c}\pm0.02$	$13.73^{c}\pm0.02$	$14.62^{c}\pm0.03$	$15.44^{c}\pm0.03$	$16.73^{c}\pm0.03$	$17.59^{c}\pm0.08$	$11.86^{bc}\pm4.18$
FCP 30%	$5.49^{d}\pm0.06$	$7.30^{f}\pm0.02$	$8.82^{f}\pm0.01$	$10.36^{f}\pm0.04$	$15.72^{f}\pm0.02$	$14.82^{f}\pm0.02$	$17.34^{f}\pm0.03$	$18.17^{f}\pm0.05$	$18.64^{f}\pm0.03$	$19.36^{f}\pm0.04$	$20.35^{f}\pm0.04$	$21.03^{f}\pm0.02$	$15.07^{f}\pm5.15$
FCP 40%	$5.04^{b}\pm0.03$	$5.55^{b}\pm0.03$	$6.17^{c}\pm0.05$	$8.02^{b}\pm0.02$	$11.02^{b}\pm0.01$	$10.91^{a}\pm0.02$	$11.96^{b}\pm0.04$	$12.56^{b}\pm0.04$	$13.13^{b}\pm0.03$	$13.86^{b}\pm0.04$	$14.85^{b}\pm0.04$	$16.05^{d}\pm0.04$	$10.97^{ab}\pm3.54$
FCP 50%	$5.35^{c}\pm0.04$	$6.12^{e}\pm0.01$	$7.15^{d}\pm0.04$	$8.36^{d}\pm0.04$	$13.23^{d}\pm0.02$	$14.14^{e}\pm0.03$	$15.03^{d}\pm0.02$	$15.55^{d}\pm0.04$	$16.35^{d}\pm0.04$	$17.07^{d}\pm0.07$	$17.86^{d}\pm0.04$	$18.32^{d}\pm0.02$	$13.15^{c}\pm4.55$

Columns sharing similar superscripts are not significantly different at P>0.05

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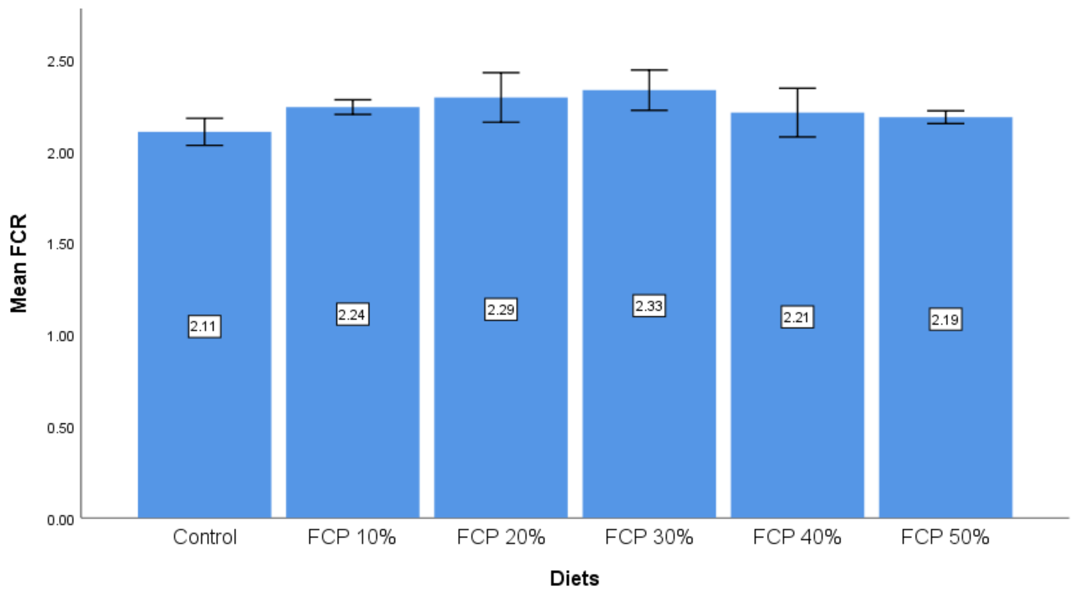

Figure 3: Feed conversion ratio of *C. gariepinus* fingerlings fed with control and fermented cassava peel diets.

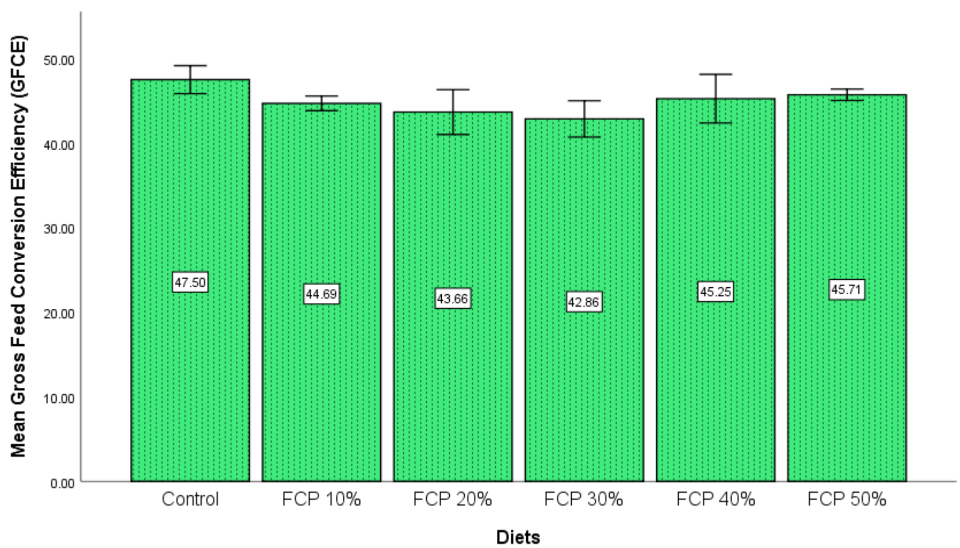

Figure 4: Gross Feed conversion ratio of *C. gariepinus* fingerlings fed with control and fermented cassava peel diets

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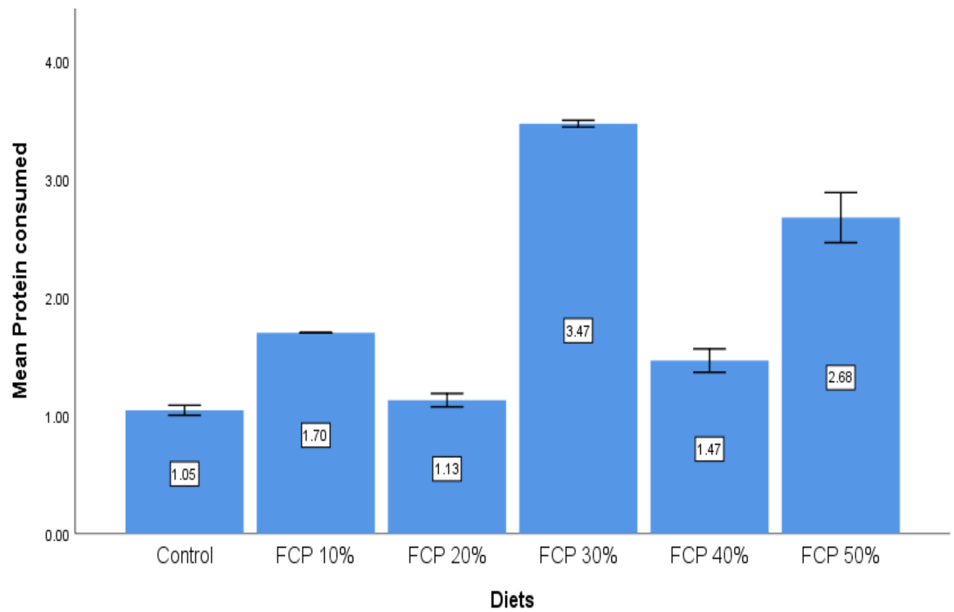

Figure 5: Protein Consumed by *C. gariepinus* fingerlings fed with control and fermented cassava peel diets

Nitrogen Metabolism (Nm)

Figure 6 shows that the highest nitrogen metabolism was recorded by the fish fed with the FCP 30 (146.30) followed by those fed with diet FCP 50 (135.81), while least in those fed with the control diet (106.99). The analysis of variance results revealed that there was a significant difference between the nitrogen metabolism by *C. gariepinus* fingerlings fed with the six experimental diets at $p<0.05$.

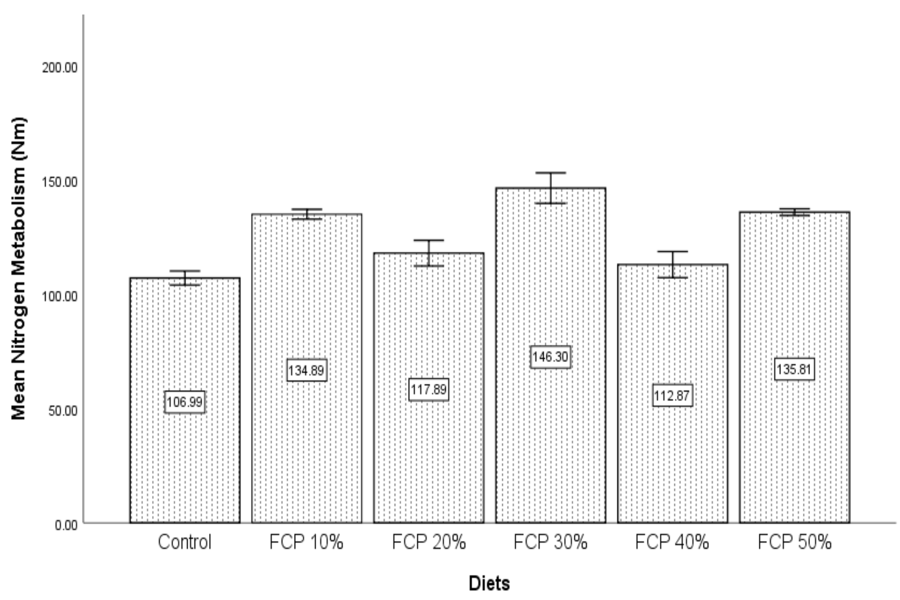

Figure 6: Nitrogen Metabolism in *C. gariepinus* fingerlings fed with control and fermented cassava peel diets

Protein Efficiency Ratio (PER)

Table 5 indicated that the highest protein efficiency ratio was recorded by the fish fed with the FCP 20 (4.52) followed by those fed with the control diet (4.44), while least in those fed with the FCP 30 (1.84). The analysis of variance

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results revealed that there was a significant difference between the protein efficiency ratio of *C. gariepinus* fingerlings fed with the six experimental diets at p<0.05.

Table 3: Protein efficiency ratio of *C. gariepinus* fingerlings fed with control and fermented cassava peel diets

Diets	Mean Protein efficiency ratio ±SD
Control	4.44±0.09
FCP 10	3.45±0.01
FCP 20	4.52±0.12
FCP 30	1.84±0.01
FCP 40	3.35±0.11
FCP 50	2.21±0.09
Total	3.30±1.06

Net Protein Utilization

The result in Figure 7 revealed that the highest net protein utilization was recorded in FCP 10 (632.33) followed by FCP 20 (462.03) while least in the FCP 50 (311.26). There was a significant difference in the net protein utilization of *C. gariepinus* fingerlings fed with control and fermented cassava peel diets.

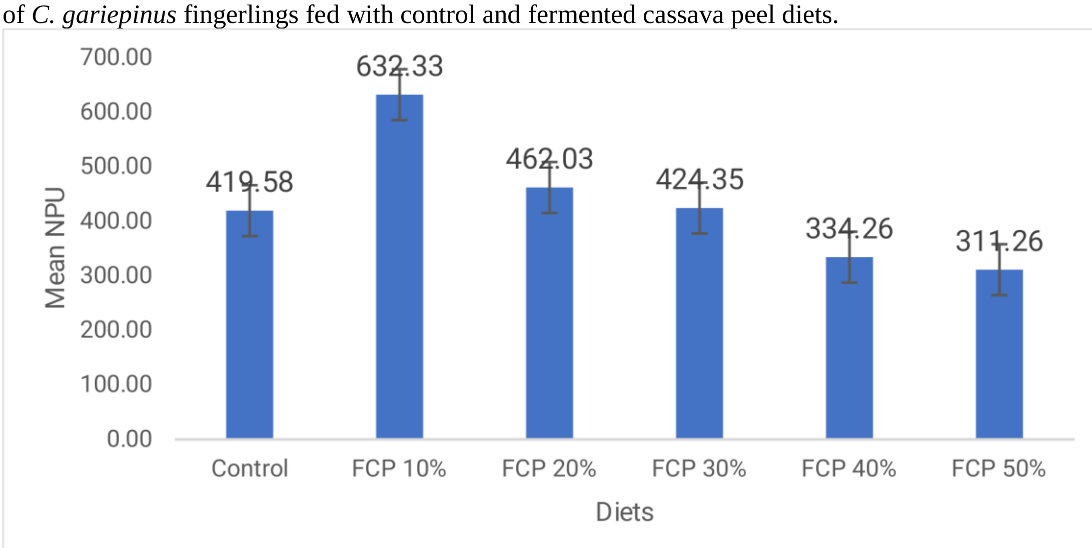

Figure 7: Net Protein Utilization of *C. gariepinus* fingerlings fed with control and fermented cassava peel diet

Discussion

The growth performance revealed that the fishes fed with the experimental diets were able to convert the nutrients absorbed into flesh and *C. gariepinus* in all the experimental treatments accepted the feed which showed an increase in final mean weight when compared to the initial mean weight. Also, the fish were able to convert feed protein into extra muscles and tissues. The result showed that the highest weight gain was recorded by the fish fed with diet FCP 30 (6.35g) followed by those fed with diet FCP 50 (5.90g), while least in those fed with diet FCP 0 (4.64g). This may be that the fish used the available protein in the diet effectively than others which lead to growth of *C. gariepinus* fingerlings. This is comparable to the findings of Idowu et al., (2019), who found that the fish's ability to convert feed protein into additional muscle was demonstrated by the rise in weight gain observed in all treatments. The weight rise seen in this study is consistent with that of Olaniyi et al., (2015), who found that feeding *C. gariepinus* a diet containing *M. oleifera* leaf meal boosted weight gain over that of the control diet. The nutritional advantages inherent in processed fermented cassava peel meal (FCPM) may be the cause of the enhanced performance observed in this study. The Specific growth rate (SGR) showed that the significant highest specific growth rate was recorded by the fish fed with diet FCP 30 (209.43 g%/day) followed by those fed with diet FCP 50 (203.45 g% day), while least in those fed with diet Control (183.45 g%/day). This result is similar to the finding of Bob-Manuel (2017) who also observed a significant difference between the specific growth rate of *C. gariepinus* fingerlings fed with the experimental diets at $p<0.05$. The result of this study is different from the finding of Oyelere et al., (2016) who fed varying levels of *Albizia lebbeck* (Benth) leaf meal.

The protein intake value of *C. gariepinus* fingerlings fed fermented cassava peels with FCP 0% varied in each experimental diet. Diet FCP at 30% inclusions gave the highest value and this can be due to the acceptability and palatability of the protein level in the experimental diets. The results from this study are not similar with Abdullahi (2015), who stated that increased feed intake at 20% inclusion causes higher growth than that of 30% inclusion of *P. phasedlides* seed due to reduced palatability of the diet uptake by *C. gariepinus* juveniles. This work is also dissimilar with the research done by Bob-Manuel and Edoghotu (2017) which showed that the growth and nutrient utilization parameter indicated that Mean Weight Gain is highest for D_1 (1.27) and lowest for D_5 (0.56) and the trend is $D_1 > D_3 > D_4 > D_2$ D_1. There was a gradual decrease in feed conversion efficiency among the inclusion varying inclusion levels of the treatments except a slight increase in diet FCP at 30% inclusion level. This is different from the work of Odo et al., (2016) who reported the lower feed conversion ratio indicated better utilization of the *Clarias gariepinus* fed dietary levels of processed cassava leaves. Also, Olapade & Conteh (2019) reported that control diet at (0%) inclusion of *Anisophylleal aurina* seed meal gave the best MWG, protein intake and feed intake in the growth performance of *C. gariepinus*.

The result from the nutrient utilization parameters showed that the highest FCR was recorded by the fish fed with the FCP 30 (2.33) followed by FCP 20 (2.29) while the least in those fed with the FCP 0 (2.11). Also, the NPU, Nm recorded FCP 30 as the highest while the least in those feed with FCP 0%.The result showed that the highest protein efficiency ratio was recorded by the fish fed with the FCP 20 (4.52) followed by those fed with the FCP 0 diet (4.44), while least in those fed with the FCP 30 (1.84). Rasaq et al., (2018) reported the highest PER value at 40% inclusion level of replacing fermented *Mucuna prurience* in growth of catfish. The result of this nutrient utilization is comparable with the work of Bob-Manuel (2013) who reported that *O. niloticus* fingerlings could accommodate higher levels of yeast SCP substitution up to 80 % substation level without adverse effect on nutrient utilization.

Conclusion

This study revealed that fish meal substituted at diet FCP 50% showed a high crude protein value, followed by fish meal substituted at diet FCP 40%. In terms of growth performance and nutrient utilization parameters of *C. gariepinus* fed with experimental diets at FCP 50 substitution, *C. gariepinus* showed a decrease in growth due to palatability of the feed. Then, fish meal substitute at FCP 30% showed the highest mean growth and nutrient utilization parameters.

Recommendation

From the findings of this research on growth performance and nutrient utilization of African catfish (*Clarias gariepinus*) fingerlings fed solid state fermented cassava peels as partial replacement for fishmeal, the following recommendation was made to enhance the sustainable management and long-term productivity of aquaculture in Nigeria: The environmental impact of using cassava peels as a fish feed ingredient, considering the possible means for reducing reliance on fishmeal and promoting sustainable aquaculture practices should be assessed.

References

AOAC. (2000). *Official methods of analysis* (16th ed.). Association of Official Analytical Chemists, Arlington, VA, USA.

AOAC. (2017). *Official methods of analysis*. Association of Official Analytical Chemists.

Abdullahi, G. T. (2015). *Growth response and feed utilization of Clarias gariepinus juveniles fed graded levels of boiled Pueraria phaseoloides (tropical kudzu) seed meal* (M.Sc. thesis). Ahmadu Bello University, Zaria, Nigeria.

Bob-Manuel, F. G. (2013). An assessment of increased levels of yeast single-cell protein (SCP) diets on the growth, feed utilization, and condition factor of Tilapia (*Oreochromis niloticus*) fingerlings. *Journal of Aquatic Science, 28*(2), 159–167.

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Bob-Manuel, F. G., & Edoghotu, J. A. (2017). Wheat bran-grown brewers yeast (*Saccharomyces cerevisiae*) as feed for *Clarias gariepinus* fingerlings: Carcass analysis and growth performance. *Journal of Natural Science Research, 7*(2), 75–80.

Bob-Manuel, F. G. (2017). Effect of fermented wheat bran on the African mud catfish *Clarias gariepinus* fingerlings. *Continental Journal of Agricultural Science, 11*(1), 18–30.

Boonyaratpalin, M. (1989). Methodologies for vitamin requirements studies. In S. S. De Silver (Ed.), *Fish nutrition research in Asia: Proceedings of the Third Asia Fish Nutrition Network Meeting* (pp. 58–67). Asian Fisheries Society.

Brown, M. F. (1957). Experimental studies on growth. In M. F. Brown (Ed.), *Fish physiology,* 1 (1), 361–400.

Castel, J. D., & Tiews, K. (1980). Report of the EIFAC, IUNS, and ICES working group on the standardization of methodology in fish nutrition research. *EIFAC Technical Paper, 36*.

Coyne, V. E. (2015). Proteomics: Applications and advances. In S. K. Kim (Ed.), *Springer handbook of marine biotechnology*. Springer Publisher.

Dabrowski, K. R., & Kozak, B. (1979). The use of fish meal and soybean meal as a protein source in the diet of grass carp fry. *Aquaculture Journal, 18*, 73–107.

Eyiwunmi, F. A., Augustine, O., & Ovie, W. K. (2018). The hematological parameters of catfish (*Clarias gariepinus*) fed fish feeds with replaced premix using Moringa leaf meal (MLM). *Madridge Journal of Aquaculture Resource Development, 2*(1), 35–39.

Ezeoke, F. C., & Nwoye, I. I. (2022). Organoleptic properties, carcass characteristics, and internal organ profile of finisher broilers fed sundried cassava peel meal blended with palm oil sludge. *International Journal of Agricultural Environmental Resources, 8*(6), 853–863.

Food and Agriculture Organization (FAO). (2014). *Sustainable fisheries and aquaculture for food security and nutrition: A report by the high-level panel of experts on food security and nutrition.*

Food and Agriculture Organization (FAO). (2022). *The state of world fisheries and aquaculture 2022: Towards blue transformation.* https://doi.org/10.4060/cc0461en

Howlader, S., Sumi, K. R., Sarkar, S., Billah, S. M., Ali, M. L., Howlader, J., & Shahjahan, M. (2023). Effects of dietary replacement of fishmeal by soybean meal on growth, feed utilization, and health condition of stinging catfish, *Heteropneustesfossilis*. *Saudi Journal of Biological Sciences, 30*(3).

Idowu, E. O., Odeyemi, D. F., & Araeko, O. H. (2018). Nutrient utilization and growth performance of *Clarias gariepinus* fingerlings fed graded levels of dietary protein. *International Journal of Advanced Scientific and Technical Research, 8*(3), 1–12.

Maulu, S., Hasimuna, O. J., Haambiya, L. H., Monde, C., Musuka, C. G., Makorwa, T. H., Munganga, B. P., Phiri, K. J., & Nsekanabo, J. D. (2021). Climate change effects on aquaculture production: Sustainability implications, mitigation, and adaptations. *Frontiers in Sustainable Food Systems, 5*, 609097.

Odo, G. E., Agwu, J. E., Nweze, N. O., Clement, S., Alfreda, N. O., Onyishi, G., Nzekwe, U., Ajuziogu, G., Ikegbunam, C., Nelson, O. I., Ezea, O. C., Osayi, E., Onyeke, C., & Eneje, V. (2016). Growth performance and nutrient utilization of *Clarias gariepinus* fed with different dietary levels of processed cassava leaves. *African Journal of Biotechnology, 15*(24), 1184–1192.

Okomoda, V. T., Tiamiyu, L. O., & Wase, G. (2017). Effects of tank background colour on growth performance and feed utilization of African catfish *Clarias gariepinus* (Burchell, 1822) fingerlings. *Croatian Journal of Fisheries, 75*(1), 5–11.

Olaniyi, A. O., Mercy, G., & Nenibarini, Z. (2015). Estimation of length-weight relationship and proximate composition of catfish (*Clarias gariepinus*) from two different culture facilities. *Turkish Journal of Agriculture-Food Science and Technology, 3*(7), 566–570.

Onu, E. O., Ossai, N. I., Nworga, C. C., & Onyimonyi, A. E. (2021). Growth performance and haematological indices of African catfish (*Clarias gariepinus* Burchell, 1822) fed graded levels of processed *Jatropha curcas* leaf meals in the Southeastern Zone of Nigeria. *IOSR Journal of Agriculture and Veterinary Science, 14*(1), 27–37.

Oyelere, E. A., Balogun, J. K., & Abubakar, B. Y. (2016). Growth and nutrient utilization of African catfish (*Clarias gariepinus*) fed varying levels of *Albizia lebbeck* (*Benthi*) leaf meal. *Agricultural Research Journal, 16*(1), 15–24.

Ozigbo, E., Anyadike, C., Adegbite, O., & Kolawole, P. (2014). Review of aquaculture production and management in Nigeria. *American Journal of Experimental Agriculture, 4*(10), 1137–1151.

Rasaq, I., Bolorunduro, P. I., & Adakole, J. A. (2018). Effect of dietary inclusion of fermented *Mucuna pruriens* leaf meal on growth and feed utilization of *Clarias gariepinus* fingerlings. *Asian Journal of Fisheries and Aquatic Research, 1*(4), 1–8.

Reguengo, L. M., Salgaco, M. K., Sivieri, K., & Junior, M. R. M. (2022). Agro-industrial by-products: Valuable sources of bioactive compounds. *Food Research International, 152*, 110871.