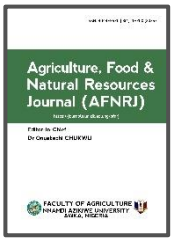
Agr. Foo. Nat. Res. J. Volume 4, Issue 2, Page 186 - 190

e-ISSN: 1597-7153 | p-ISSN: 3043-5420

Agriculture, Food and Natural Resources Journal

The Official Journal of the Faculty of Agriculture, Nnamdi Azikiwe University, Awka, Nigeria

Journal homepage: https://journals.unizik.edu.ng/afnrj



Original Article

Growth performance of *Clarias gariepinus* juvenile fed diets containing soaked date palm seed meal

OPEN ACCESS

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DOI: https://www.doi.org/10.5281/zenodo.17219712

Editor: *Dr Onyekachi Chukwu, Nnamdi Azikiwe University, NIGERIA*

Received: *June 30, 2025*
Accepted: *August 18, 2025*
Available online: *September 30, 2025*

Peer-review: *Externally peer-reviewed*

Conflict of Interest: *The authors have no conflicts of interest to declare*

Financial Disclosure: *The authors declared that this study has received no financial support.*

A B S T R A C T

A feeding trial was conducted to investigate the effect of soaked date palm seed meal (Dactylus phoenix) on the growth performance and digestibility of Clarias gariepinus. A total of one hundred and fifty juvenile specimens of catfish (Clarias gariepinus), exhibiting an average weight of 13.94 ± 1.96 (mean ± SD), were allocated to individual plastic bowls (33 liters). Four iso-nitrogenous diets comprising 40% crude protein were formulated, wherein maize was substituted by soaked date palm seed meal at replacement levels of 0% (Diet 1), 25% (Diet 2), 50% (Diet 3), 75% (Diet 4), and 100% (Diet 5). The juveniles were administered a feeding regimen of 5% of their body weight daily over a duration of 42 days. At the conclusion of the experiment, it was determined that the inclusion of Soaked Date Palm Seed Meal (SPSM) was most advantageous as an energy supplement when incorporated at a 50% replacement level. The recorded values for Weight Gain, Specific Growth Rate (SGR), Feed Conversion Ratio (FCR), and Protein Production Value (PPV) were 35.60 g, 2.25% per day, 2.58, and 0.56, respectively, which were observed to be maximal in the fish receiving Diet 3. The final weights of the fish did not exhibit significant differences (P>0.05) across the various diet groups. Furthermore, there was no statistically significant difference (P>0.05) in FCR among the dietary treatments. Based on these findings, it is recommended that a 50% inclusion of Soaked date palm seed in the diet is optimal for juvenile Clarias gariepinus, without compromising growth rates or adversely affecting digestibility parameters.

K E Y W O R D S : *Aquaculture, Catfish, Date palm, Digestion alternative feed, Feed conversion ratio*

INTRODUCTION

Aquaculture is acknowledged as a rapidly expanding sector within Nigeria's food industry. The development of aquaculture farming has resulted in increased fish stocking densities. Feed plays a crucial role in fish nutrition and management, as it contributes to the reduction of fish diseases and enhances productivity, thereby improving overall profitability (Prakash *et al.*, 2023). To meet rising global demand and compensate for the decline in wild fish populations, aquaculture production should be expanded and intensified to increase the availability of food fish. (Prakash *et al.*, 2023). In the last several decades, aquaculture has experienced substantial growth in response to the surging global demand for fish as a primary protein source (Claude *et al.*, 2022). This phenomenon can be attributed to the fact that production levels from capture fisheries have approached their maximal potential, with a noticeable reduction in catch volumes occurring daily (Rahim & Hastutu, 2023). According to the FAO (2017), it is evident that fish supplies derived from capture fisheries will be insufficient to satisfy the escalating global appetite for aquatic food products.

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Nonetheless, the rising prohibitive costs associated with this commodity have created an imperative to explore alternative sources of energy. Recently, the FAO (2017) has documented significant shortages in cereal production, presenting a critical challenge in numerous nations, including Nigeria.

The incorporation of cereal products, particularly maize, in aquaculture feeds is becoming increasingly indefensible from an economic perspective (Pratik *et al.*, 2023), owing to the continually rising costs associated with such ingredients. Consequently, there exists a pressing necessity to explore alternative energy sources that are more cost-effective in replacing high-priced cereals within the formulation of fish feeds. The specific problem addressed by this research is the need for a cost-effective and sustainable replacement for maize in fish feed. This study proposes using soaked date palm seed meal (DPSM), a readily available agricultural byproduct, as a viable alternative. Raw date palm seeds contain high levels of fiber and anti-nutritional factors like tannins and phytic acid, which limit their use in fish feed by hindering nutrient absorption. By improving digestibility, soaked DPSM can provide a valuable energy source, supporting the growth and overall health of the fish. Its use also contributes to a more circular economy by repurposing agricultural waste, aligning with sustainable aquaculture practices.

The objective of this study was to assess the impact of replacing maize with varying proportions of date seed meal on the growth performance of juvenile *Clarias gariepinus*.

MATERIALS AND METHOD

Study Area

Lake Kainji was established through the construction of a dam on the Niger River at Kainji Island. The dam's closure occurred on the 2nd of August, 1968, resulting in the formation of a reservoir with a maximum-sustained surface area of 1,120 square kilometers. The lake extends over a length of 137 kilometers and possesses a width of 24 kilometers. Kainji Lake is situated within the Guinea savannah vegetation zone of north-western Nigeria (Ogundana et al., 2020). The experimental study was conducted within the engineering section of the Agricultural Technology Department at the Federal College of Freshwater Fisheries Technology, located in New Bussa, Niger State.

Source of Date Palm

The Date palm was procured from the Monday market in New Bussa and subsequently transported to the Engineering section of the food processing unit within the Department of Agricultural Technology for further processing.

Processing of Date Palm

The date palm seeds were soaked for 24hours. It's done to soften the hard outer shell and, more importantly, to reduce anti-nutritional factors (ANFs) like tannins. 24 hours was chosen to maximize the reduction of these compounds without causing fermentation. The seeds were sun-dried for 3-5 days at an average ambient temperature of 35∘C.

Experimental Fish

One hundred and fifty juveniles of *Clarias gariepinus* fish of initial average of 13.94 g was obtain from Fisheries Technology Department hatchery unit of Federal college of freshwater fisheries technology, New Bussa, Niger State. The *Clarias gariepinus* juveniles where the fish were distributed equally into 5 experimental treatments, which were triplicated. ten African catfish juveniles were housed in rectangular fish holding facilities (Neoplastics), while the water quality parameters were monitored bi-weekly. A 50 % water change was conducted every three days and the fish were fed twice daily 8:00 am in the morning and 5:00pm.

Experimental Design

The experimental design consisted of five treatments, each replicated three times, utilizing a diet formulated from practical ingredients with varying inclusions of soaked date palm seed meal replacing yellow maize (YM) at 0%, 25%, 50%, 75%, and 100% by weight. This was conducted in a completely randomized design (CRD) as per Steel Tonic (1990). The fish subjects were provided with the experimental diet in 35-liter cylindrical plastic bowls equipped with aerators.

Table 1 shown the experimental isonitrogenous Diet Formulation Five (5) (40% crude protein diet were formulated as follows;

Treatment 1- 100% YM+0% SDPSM; Treatment 2-75% YM + 25% SPSM; Treatment 3- 50% YM +50% SPSM; Treatment 4-25% YM +75% SPSM; Treatment 5-0% YM+100% SPSM.

Growth Parameters

The growth of fish and the efficiency of feed utilization were assessed weekly and at the conclusion of the experiment, as outlined by Balogun *et al.*, 2016.

$$\text{Percentage of weight gain} = \frac{(Mean\ final - mean\ initial\ weight)}{Mean\ initial\ weight} \quad (1)$$

Growth weight gain (%) = Mean final weight – mean initial weight (2)

$$\text{Growth rate per fish per day (g/day)} = \frac{Mean\ final - mean\ initial\ weight}{Culture\ period\ in\ days} \quad (3)$$

$$\text{Specific growth rate (SGR)} = \frac{(in(wf) - in(wi)}{Culture\ period\ 1} \times 100 \quad (4)$$

$$\text{Feed conversion ratio (FCR)} = \frac{Total\ feed\ consumed}{weight\ gain} \quad (5)$$

$$\text{Total fish production (kg/m}^3\text{)} = \frac{Final\ weight(g)\ x\ survival\ rate}{1000g} \quad (6)$$

$$\text{Survival rate (\%)} = \frac{Final\ number\ of\ fish}{Initial\ number\ of\ fish} \times 100 \quad (7)$$

Table 1: Experimental Diet of Catfish *Clarias gariepinus* Juvenile

Feed Ingredient	Diet 1 (0%) SDPSM	Diet 2 (25%) SDPSM	Diet 3 (50%) SDPSM	Diet 4 (75%) SDPSM	Diet 5 (100%) SDPSM
SDPSM	0	4.00	8.00	12.00	16.00
Yellow maize	16.00	12.00	8.00	4.00	4.00
Fish meal	24.00	24.00	24.00	24.00	24.00
Soya beans	24.00	24.00	24.00	24.00	24.00
Groundnut cake (GNC)	24.00	24.00	24.00	24.00	24.00
Vitamin premix	3.00	3.00	3.00	3.00	3.00
Vegetable oil	3.00	3.00	3.00	3.00	3.00
Bone meal	1.50	1.50	1.50	1.50	1.50
Methionine	1.50	1.50	1.50	1.50	1.50
Lysine	1.50	1.50	1.50	1.50	1.50
Vitamin C	1.00	1.00	1.00	1.00	1.00
Salt	0.50	0.50	0.50	0.50	0.50
Total	100	100	100	100	100

RESULTS AND DISCUSSION

Results

Growth performance of the African catfish *Clarias gariepinus*, fed varying quantities of feed containing soaked date palm seed meal (SDPSM) for a 42 days' period is presented Table 2 and the summary of mean growth parameter of *Clarias gariepinus* juvenile fed with soaked date seed meal in Table 3. Biological indices were subjected to One-way ANOVA using SPSS version 20.0. (International Business Machines, New York, USA). Duncan multiple range tests were used to assess the differences among individual means. Fish fed with SDPM at 50 % inclusion level gave the best growth performance which was significantly higher than those fed on fish meal without the date seed meal (0 % SDPSM). The fish fed 100 % SDPSM (Diet 5) resulted in the non-significant trend in the growth performance. There were significant differences ($P < 0.05$) in the initial body weight (IBW), final body weight (FBW), mean weight gain, feed conversion ratio (FCR), specific growth rate (SGR), mortality, initial condition factor and final condition factor. The highest weight gain and SGR were found in fish fed Diet 3 (50 % SDPSM), the highest and least FCR was recorded in fish fed on Diet 1 (0 % SDPSM) and Diet 2 (25 % SDPSM) respectively. The least weight gain and SGR were observed in fish fed Diet 5 (100 % SDPSM).

Table 2: Statistical analysis of variance of growth parameter

Treatment					
Parameter	1	2	3	4	5
Mean initial weight	39.44±0.23	39.32±0.15	39.38±0.38	39.62±0.65	39.87±0.14
Mean final weight	49.12±0.15	52.70±0.16	53.95±0.21	53.15±0.04	46.79±2.61
Feed intake	4.56±0.26	4.702±0.0	4.72±0.6	4.70±0.02	4.59±0.10
Weight gain	9.66±4.97	13.38±0.07	14.59±0.17	13.50±0.04	6.96±2.47
Food conversion ratio	0.85±0.40	0.35±0.00	0.54±038	0.39±0.07	0.71±0.20
% weight gain	24.59±12.70	34.02±0.23	37.05±0.08	34.07±0.85	16.69±4.85
SGR	22.65±11.50	28.18±6.78	34.68±0.53	32.14±0.20	16.49±8.70
Daily growth rate	0.23±0.12	0.32±0.00	0.35±0.00	0.32±0.00	0.16±0.06
Survival rate	3.33±11.55	100±0.00	96.67±5.78	83.33±15.28	83.33±5.78

Table 3: Summary of mean growth parameter of *Clarias gariepinus* juvenile fed with fed with soaked date seed meal

Treatment	Weight gain	Food conversion ratio	Specific growth rate	Survival rate
1	9.66±4.97c	0.86±0.49a	23.43±12.04ab	03.34±11.54a
2	13.38±0.07ab	0.36±0.00a	28.17±6.77ab	100±0.00a
3	14.60±0.16a	0.54±0.38a	34.67±0.52a	96.67±5.78a
4	14.49±0.05ab	0.39±0.08a	32.15±0.20a	83.33±15.28a
5	7.58±2.37c	0.81±0.20a	16.48±8.72b	83.33±5.78a

^{abc} *Means values in the same column with different superscript differ significantly at $P < 0.05$*

Discussion

The inclusion of date palm seed meal in the diets of *Clarias gariepinus* significantly affected growth and nutrient utilization ($P<0.05$). Growth performance and nutrient utilization indices generally decreased as the level of date palm seed meal increased in the diets. However, a key finding was the lack of a significant difference in growth and nutrient utilization between the control diet (0% date palm seed meal) and the diet where date palm seed meal replaced maize at 50%. This indicates that maize can be replaced with date palm seed meal up to this level without compromising the growth performance of *Clarias gariepinus* juveniles.

Similar to the present study, which evaluates date palm seed meal as a maize substitute, other research has explored using alternative, starch-rich agricultural byproducts. For instance, studies on mirror carp and rainbow trout have shown they can effectively utilize high levels of cassava, a carbohydrate source with a similar nutritional role to date palm seed meal. These findings provide a useful precedent, suggesting that the successful replacement of maize with alternative energy sources is feasible in other aquaculture systems (Dulmini *et al*., 2021).

The high initial growth rate observed in *Clarias gariepinus* during the first few weeks of the study may be attributed to an initial period of starvation or acclimatization. This phenomenon, where fish become more metabolically active after being introduced to a new feed source, is consistent with observations by Adegbesan *et al.* (2018), who also recorded an increase in growth in juvenile *Heterotis niloticus* after a delay in feed distribution.

The growth pattern revealed that *Clarias gariepinus* performed in diet Treatment 3 than all other diets. It has been documented that 50% replacement of maize with cassava meal in broiler diet showed no depression in growth or unfavorable feed conversion ratio (Abu *et al*., 2021) and that the best growth performance was recorded in layers fed 10% cassava meal. Ishiyaku *et al.,* (2021) reported a replacement level of 50% cassava meal for maize without a depressing growth in *Clarias gariepinus*. In the present study the best growth performance and nutrient utilization was recorded in fish fed 50% level of whole Date seed meal. This is unlike in broiler that had the best growth performance at 25%, root meal inclusion respectively levels (Kutte, *et al*., 2024).

The experimental diets have indication of the variation in the feed utilization. The reports of Monica *et al.,* (2018) for Atlantic salmon (*Salmon salar*) are at variance (that is contrary) to the report of this study. The acceptance of Soaked Date palm seed Meal by *Clarias gariepinus* indicate that replacement of maize with Date seed meal could be more profitable to fish farmer as maize is more expensive and Date seed which was regarded as a waste is of great use. Ability of an organism to convert nutrients especially protein will positively influence its growth performance. This was justified by the best protein efficiency ratio and growth performance in 50% whole date seed meal inclusion diets lower feed conversion ratio indicates better utilization of the feed by the fish. According to Bikila *et al.,* (2024) feed conversion ratios between 1.2-1.8 for fish fed carefully prepared diets, and the results from the present study falls within this range. Also, Aires *et al.,* (2019) observed that Protein Efficiency Ratio (PER) is a measure of how well the protein sources in a diet could provide the essential amino acid requirement of the fish fed. Furthermore, this index has been associated with fat deposition in fish muscle. The high survival rates recorded in this study Indicate that feeding *C. gariepinus* with date seed meal does not lead to mortality of the fish. The observed water quality parameters were due to constant water change of the culture system. The close range in the average temperate recorded during the experimental period was probably due to the fact that all the treatments were indoors. Bulbul *et al.,* (2022) dissolved oxygen, DO level of between 4-8mg/liter in the pond and do values observed during the experimental period fall within these values. The values of physic-chemical parameters observed in the pond were within the range recommended for *Clarias gariepinus*.

The digestibility of date palm meal (DPM) in Clarias gariepinus (African catfish) diets is enhanced by a fermentation process that reduces anti-nutritional factors like those that inhibit Vitamin B complex. This improved digestibility is crucial for maximizing the nutritional value of DPM when used as a feed ingredient in aquaculture. In essence, the fermentation of date palm meal is a crucial step in utilizing it as a sustainable and cost-effective feed ingredient in aquaculture, as it enhances the digestibility of the nutrients and minimizes the negative impact of anti-nutritional factors (Akeem & Faturoti, (2008). A diet could also be poorly utilized by fish even at high consumption rate probably be due to the presence of certain 34 ant nutritional factors. The relatively and effective digestibility of the experimental diets with inclusions of soaked Date seed meal at treatment 3 level may be due to the detoxication of certain ant nutritional factors such as Anti- Vitamin B Complex factors by fermentation procedures as reported by Authur *et al.,* (2021). This result may also be explained by the observation of Vasantha & Umme (2024) who reported possibility of positive effects of combining starch energy sources in fish diets.

CONCLUSION AND RECOMMENDATIONS

Date palm seed meal has the potential to contribute significantly to the growth performance of African catfish. It can also partially substitute carbohydrate sources in fish diets, potentially reducing feed costs for farmers. This study demonstrated that date seed meal can be included up to a 50% level in the diet of *Clarias gariepinus* without negative effects on growth. The most effective inclusion level was found in the diet containing 50% soaked date seed meal (SDPSM). Thus, partial replacement of carbohydrate sources with SDPSM at this level is beneficial.

Future studies are recommended under earthen pond and recirculating aquaculture system (RAS) conditions to evaluate performance under natural environments. The use of 50 %

SDPSM inclusion level in diet of *Clarias gariepinus* juvenile is recommended.

Acknowledgements

The authors acknowledge the academic staff of the Department of Agricultural Technology, federal College of freshwater Fisheries Technology, New Bussa, Niger State for providing constructive criticism, which improved the quality of the study.

Authors' Contributions

OSO conceptualized the study. OPO & TEO designed the experiment, collected data, performed data analysis, and wrote the first draft of the manuscript. TWO & OAS performed literature searches and reviewed the first draft of the manuscript. All authors read and approved the final draft of the manuscript.

Ethical Statement

This study adhered to ethical research standards, ensuring responsible data use, informed community participation, non-invasive environmental practices, transparency and adhering to the Animal handling protocols.

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