
**E-ISSN: 2347-5129**
**P-ISSN: 2394-0506**
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2021; 9(3): 63-67

www.fisheriesjournal.com
Received: 28-03-2021
Accepted: 30-04-2021

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# Effect of alternate feeding of normal and low protein diet on the growth performance and biochemical composition of *Clarias gariepinus* (Burchell, 1822) fingerlings

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**DOI:** https://doi.org/10.22271/fish.2021.v9.i3a.2489

**Abstract**
A 56-day feeding trial was conducted with *Clarias gariepinus* fingerlings to evaluate the effects of alternate mixed feeding schedules of normal and low protein diets on growth and feed utilization. Two experimental diets with crude protein levels of 45% (Diet A – normal protein) and 35% (Diet B – low protein) were prepared using locally available feed ingredients. Four different feeding schedules were implemented: Diet A throughout (T1), 1-day Diet A followed by 1-day Diet B (T2), 2-days Diet A followed by 1-day Diet B (T3), and 1-dayDietA followed by 2-days Diet B (T4). The fish were fed 5% of their body weight twice daily throughout the experiment. The results showed no significant difference in the growth and feed utilization parameters except for the protein efficiency ratio. T4 recorded the highest value for weight gain, specific growth rate, feed and protein efficiency ratio. Similarly, T4 recorded the best feed conversion ratio. Hence, the study showed that alternate feeding of normal and low protein diets has no negative effect on fish growth performance with a possibility of reducing feed cost.

**Keywords:** alternate feeding, growth performance, biochemical composition, *Clarias gariepinus*

## 1. Introduction
Fisheries is an important food production subsector providing almost 20 percent of the world's protein supply. However, trends have shown that capture fishery biomasses have continued to decline and that in 2011, 61.3% were fully utilized and could no longer be harvested at a biologically sustainable level (FAO, 2014) [10]. Aquaculture production is expected to increase fish supply and close the ever-widening gap between supply and demand of fish. Despite aquaculture being the most rapidly expanding sector of animal production worldwide in recent decades, it is faced with several challenges. One of the major problems faced by this rapidly growing aquaculture is the high cost and availability of fish feed. In aquaculture, feed accounts for over 50 percent of the production cost (Sehgal and Toor, 1991; Rana *et al.*, 2009) [22, 21].
Fish need protein, the most expensive component in fish feeds, for maintenance and development, and the amount of protein required for these functions varies by species and culture environment. Aquaculture practice requires knowledge of fish protein demands during rapid growth periods in order to maximize feed conversion and consumption, save money, and reduce protein load in the aquatic environment (Abdel-Tawwab *et al.*, 2010) [1].
The main fish cultured in Nigeria is the African catfish, *Clarias gariepinus*, which is a good source of protein and other nutrients for human health. It can be found all over the country, is eaten by most tribes, is immune to harsh environmental conditions, has a high market value, is tasty, and can be kept alive for days during marketing. However, according to Ahmad and Ibrahim (2016) [2], catfish culture has faced numerous challenges among which is the availability of low-cost, high-quality feed, as the price of imported fish feed has risen due to the country's current economic situation.
Though, fish meal replacement studies (Emre *et al.*, 2008; Osho *et al.*, 2019; Babalola *et al.*, 2019) [9, 19, 4] have generally been the main emphasis for reducing feed costs in aquaculture. De Silva (1985) [6] reported that the implementation of varying feed management practices can significantly reduce feed costs in semi-intensive, small-scale aquaculture practices, which may

be better suited for small-scale practices in the tropics. Based on the observations on the daily variation in apparent dry matter and protein digestibility of feed in the Asian chromid, *Etroplus suratensis* (De Silva and Perera, 1983) [7] and *Oreochromis niloticus* (De Silva and Perera, 1984) [8], De Silva (1985) [6] proposed the concept of "mixed feeding schedules" and postulated that the application of this feeding schedules where a high-protein diet was alternated with a low-protein diet could result in improved nutrient utilization. The effectiveness of mixed feeding schedules in reducing feed costs and improving nutrient utilization has been demonstrated in several fish species such as Indian carps, *Catla catla* and *Labeo rohita* (Nandeesha *et al.*, 1993, 1994; Kumar *et al.*, 2013) [14, 16, 13]; common carp, *Cyprinus carpio* (Srikanth *et al*., 1989; Nandeesha *et al*., 1995, 2002) [23, 15, 17]; Nile tilapia, *Oreochromis niloticus* (Patel and Yakupitiyage, 2003) [20]; sutchi catfish, *Pangasius hypophthalmus*; and silver carp, *Hypophthalmichthys molitrix* (Ali *et al*., 2005) [3]. However, limited research work has been done on the applicability of mixed feeding schedules in African catfish, *Clarias gariepinus*. Hence, this study aimed to determine the growth performance and nutrient utilization of *Clarias gariepinus* juveniles fed with an alternate presentation of a normal and low protein diets.

## 2. Materials and Methods

### 2.1 Experimental site

The experiment was conducted at the Hatchery and Grow-out unit of Fisheries Technology Department, Lagos State Polytechnic, Ikorodu.

### 2.2 Experimental diet

Two experimental diets with crude protein levels of 45% (Diet A – normal protein) and 35% (Diet B – low protein) were formulated. In preparing the experimental diet, ingredients such as fish meal, maize, soya bean meal, groundnut cake (GNC), Dicalcium phosphate (DCP), premix, lysine, methionine, and salt were used as shown in Table 1. These ingredients were purchased from a commercial feed mill at Sabo Market, Ikorodu. The feed ingredients were ground in a hammer mill, mixed, and pelletized before being sun-dried and packaged in airtight polythene bags and then transported to the experimental site.

**Table 1:** Percentage Ingredients and Proximate Composition of the Experimental Diets

| Ingredients (%) | Diet A (45%CP) | Diet B (35% CP) |
|---|---|---|
| Fish meal (72% CP) | 35 | 20 |
| Maize | 20 | 37 |
| Soya bean meal | 20 | 19 |
| GNC | 20 | 19 |
| DCP | 2.5 | 2.5 |
| Premix | 1.0 | 1.0 |
| Lysine | 0.5 | 0.5 |
| Methionine | 0.5 | 0.5 |
| Salt | 0.5 | 0.5 |

### 2.3 Experimental fish

Fingerlings of African catfish (*Clarias gariepinus*) were procured from the fish farm estate, Ikorodu, Lagos State. Fish were transported in a black 50 L container half-filled with water to the hatchery unit of Fisheries Technology Department, Lagos State Polytechnic, Ikorodu, Lagos. The fish were acclimatized at the experimental site for 14 days. During this period, the fish were fed a commercial diet (Blue crown). At the end of the acclimatization period, fish were starved for 24 hours before the commencement of the experiment to enable the fish to empty their guts.

### 2.4 Experimental design and setup

A total of twelve (12) rectangular plastic tanks (67.5x48x37.5cm$^3$) were used for the experiments. The tanks were divided into four (4) experimental groups (in triplicate). After acclimatization, the fish were sorted into uniform size and randomly allotted into the plastic tanks. One hundred and twenty fingerlings were randomly distributed into the four experimental groups with each of three replicates. Ten fishes with initial body weight ranging from 12.48g-12.65g were stocked in each plastic tank. The experiment was conducted for 56 days. The total volume of water in the plastic tanks was maintained at 100 L throughout the experimental period and the water in each tank was changed every two days.

### 2.5 Feeding schedule

The fish were fed 5% of their body weight twice daily, morning (09:00 – 09:30am) and evening (04:00 - 4:30 pm) throughout the experiment. The four experimental groups based on feeding schedule were T1 (fed Diet-A throughout), T2 (fed Diet-A 1 day / Diet-B 1 day alternately), T3 (Diet-A 2 days / Diet-B 1 day alternately), and T4 (Diet-A 1 day / Diet-B 2 days alternately). Bodyweight measurements of fish per experimental tank were taken weekly and rations adjusted according to fish weight gain.

### 2.6 Growth and nutrient utilization study

At the end of the feeding trial, the weight gain record computed every week was used to compute the following growth and nutrient utilization parameters.

Mean Weight Gain (MWG)

MWG =Mean Final weight (g) – Mean Initial Weight (g)

Relative Growth Rate (RGR)

$$RGR = \frac{\text{Mean Weight Gain (g)}}{\text{Mean Initial Weight (g)}} \times 100$$

SGR = (Log$_e$Mean final weight- Log$_e$ Mean initial weight) x 100

Specific Growth Rate (SGR)

$$SGR = \frac{(\text{Log}_e \text{ Mean final weight- Log}_e \text{ Mean initial weight})}{\text{Number of days}} \times 100$$

Feed Conversion Ratio (FCR)

$$FCR = \frac{\text{Feed intake (g)}}{\text{Mean Weight Gain (g)}}$$

Feed Efficiency Ratio (FER)

$$FER = \frac{\text{Mean Weight Gain (g)}}{\text{Feed intake (g)}} \times 100$$

Protein Efficiency Ratio (PER)

$$PER = \frac{\text{Mean Weight Gain (g)}}{\text{Protein intake (g)}}$$

**2.7 Biochemical analysis**

The biochemical analysis was carried out in the Department of Biochemistry Laboratory, Lagos University Teaching Hospital (LUTH), Idi-Araba, Lagos. Twelve blood samples were collected with the aid of 2ml syringes from the caudal vasculature of the fish, three fish from each treatment group and blood was emptied into ethylene diamine tetra-acetic acid (EDTA) bottle. The biochemical parameters analysed include aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), total protein (TP), albumin (ALB), triglycerides (TG) and cholesterol (CHO) using Cobas 311 and Roche/Hitachi 902 automated chemistry analyser.

**2.8 Statistical analysis**

All values recorded were subjected to one-way analysis of variance (ANOVA) using SPSS 21. The differences between treatments were analyzed with Duncan Multiple range test at p<0.05 significance level.

**3. Results**

**3.1 Growth and nutrient utilization parameters**

The growth and nutrient utilization parameters of the African catfish (*Clarias gariepinus*) juveniles fed low and normal protein diet alternately are shown in Table 2 and they include Initial weight gain (IW), Final weight gain (FW), Mean weight gain (MWG), Relative growth rate (RGR), Specific growth rate (SGR), Feed conversion ratio (FCR), Feed efficiency ratio (FER) and Protein efficiency ratio (PER). All the parameters tested except Protein efficiency ratio (PER) are not significantly different (p<0.05) across the treatments. However, T4 recorded the highest MWG (61.48±5.64), RGR (484.64±3949), SGR (1.37±0.05), FER (85.11±4.15), PER (2.22±0.01$^{b}$) while T2 recorded the lowest MWG (55.77±6.11), RGR (442.33±44.13), SGR (1.31±0.07) and T3 recorded the lowest FER (76.45±9.39 and PER. (1.83±0.23$^{a}$). Also, T4 recorded the lowest FCR (1.18±0.06) followed by T1 (1.22±0.13) and the highest value was recorded in T3 (1.42±0.17).

**Table 2:** Growth and nutrients utilization parameters of *Clarias gariepinus* juvenile fed protein diets alternately

| Parameters | T1 | T2 | T3 | T4 |
|---|---|---|---|---|
| IW | 12.59±0.11 | 12.60±0.15 | 12.47±.23 | 12.68±0.13 |
| FW | 69.34±8.61 | 68.37±6.24 | 68.99±7.07 | 74.17±5.77 |
| MWG | 56.73±8.62 | 55.77±6.11 | 56.52±7.07 | 61.48±5.64 |
| RGR | 450.64±68.94 | 442.33±44.13 | 453.27±56.97 | 484.64±3949 |
| SGR | 1.32±0.09 | 1.31±0.07 | 1.33±0.08 | 1.37±0.05 |
| FCR | 1.22±.013 | 1.24±0.04 | 1.42±0.17 | 1.18±0.06 |
| FER | 82.71±9.11 | 80.54±2.64 | 76.45±9.39 | 85.11±4.15 |
| PER | 1.84±0.20$^{a}$ | 2.01±0.07$^{ab}$ | 1.83±0.23$^{a}$ | 2.22±0.01$^{b}$ |

Value of the same row with different superscript are significantly different (p<0.05) from each other

**3.2 Biochemical parameters**

The result of the biochemical parameters tested [aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), total protein (TP), albumin (ALB), triglycerides (TG) and cholesterol (CHO)] is shown in Table 3. All the parameters tested except for ALP were not significantly different (p<0.05) across the treatments. For AST, ALT and ALP the highest value was recorded in T3 (1550.07±261.85, 306.50±61.06 and 23.43±4.79 respectively) while the lowest value was recorded in T1 (1171.27±133.67, 254.50±42.55 and 6.83±3.83 respectively). The value for TP and CHO were highest in T4 (34.43±5.26 and 3.61±0.41 respectively) and lowest in T2 (28.00±2.66 and 3.26±0.75 respectively).

**Table 3:** Biochemical parameter of *Clarias gariepinus* Juvenile fed low and normal protein diet alternately

| Parameters | T1 | T2 | T3 | T4 |
|---|---|---|---|---|
| AST | 1171.27±133.67 | 1263.03±393.62 | 1550.07±261.89 | 1350.00±465.48 |
| ALT | 254.50±42.55 | 264.37±87.82 | 306.50±61.06 | 280.40±79.53 |
| ALP | 6.83±3.83$^{a}$ | 15.00±6.45$^{ab}$ | 23.43±4.79$^{b}$ | 11.67±10.01$^{ab}$ |
| TP | 31.13±3.69 | 28.00±2.66 | 30.80±6.15 | 34.43±5.26 |
| ALB | 13.93±1.40 | 12.83±0.19 | 13.07±1.79 | 13.80±1.13 |
| TG | 1.97±0.19 | 1.86±0.32 | 1.89±0.59 | 1.93±0.21 |
| CHO | 3.49±0.54 | 3.26±0.75 | 3.53±0.43 | 3.61±0.41 |

Value on same row with different superscript are significantly different (p<0.05) from each other

**4. Discussion**

The result of this study showed that the growth and nutrient utilization parameters were not affected by the alternate feeding of normal and low protein diets. T4 showed a slightly better but similar result to the control (T1) but not significantly different from the results of other treatments used in this study. The result of the growth performance and nutrient utilization parameters for this study is similar to the findings of De Silva (1985) [6] and Ali *et al.* (2005) [3]. The result of De Silva (1985) [6] showed that the overall performance and carcass composition of young *Oreochromis niloticus* were comparable or even better when maintained on certain alternate high/low protein dietary schedules than those continually maintained on a high protein diet, while the result of Ali *et al.* (2005) [3] revealed that the mixed feeding schedule of low protein alternated with a high protein resulted in the best growth, feed utilization, and production compared with feeding catfish and silver carp with a high protein continuously. This agrees with the findings of Oishi *et al.* (2010) which stated that excess protein does not support an additional increase in growth performance, but rather results in economic losses and deterioration of water quality. De Silva (1985) [6] also reported that presentation of alternate high/low content protein diets probably influences the growth performance independently of the mean amount of dietary protein given to the fish.

In this study, fish fed the alternate protein diets and the control (normal protein diet) showed no negative effect on total protein, albumin, triglyceride, cholesterol, aspartate aminotransferase and alanine aminotransferase. These results are similar to the findings of Kumar *et al.* (2013) [13]. However, alkaline phosphatase was significantly higher in fish fed alternate protein. Alkaline phosphatase activity was reported to be an indicator of the intensity of nutrient absorption in enterocytes of fish (Harpaz and Uni, 1999; Gawlicka *et al*., 2000) [12, 11]. The significant increase in the activities of serum alkaline phosphatase may be considered as the response of organism to stressors as reported by Bitiren *et al.* (2004) [5].

## 5. Conclusions and Recommendations

From the results obtained for this study, it can be concluded that the alternate feeding of normal and low protein diets has no negative effect on fish growth performance. This shows that feeding 45% and 35% crude protein diets alternately is as good as feeding a normal protein diet alone, and this will reduce feeding costs in fish farming.

It is known that cost of feeding accounts for about 50% of the cost of production in fish farming, and the common practice among fish farmers areto feed their fish with normally required protein diets daily. From the findings of this study, it is recommended that fish farmers should feed their fish with normal and low protein diets alternately as this will reduce the cost of feeding.

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