

## **Influence of feeding frequency and feeding time on growth performance and feed utilisation of African catfish (*Clarias gariepinus* Burchell 1822) fingerlings**

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### **Abstract**

*Feeds and feeding constitute the main cost in intensive aquaculture and effective fish feeding is a major determinant of success. There is limited information on the most appropriate feeding time and the combination of feeding frequency and time that can ensure the best productivity in the culture of African catfish. This research was therefore carried out to examine the influence of feeding frequency and feeding time on the growth performance and feed utilisation of African catfish (*Clarias gariepinus*) fingerlings was reared for 42 days. Fingerlings of *C. gariepinus* with initial weight  $9.0 \pm 0.5$  g were randomly distributed at 10 fish per tank into 12 tanks for the four treatments in triplicates. The treatments were; T1 (fish fed once a day in the morning), T2 (fish fed once a day in the evening), T3 (fish fed twice a day: morning and evening), and T4 (fish fed three times a day: morning, afternoon and evening). The selected water quality parameters including temperature, pH and dissolved oxygen were examined once daily, while the fish was weighed once in a week for the six weeks for evaluation of growth and feed utilisation. At the end of the six weeks, three fish from each tanks were measured for weight and length, and were dissected for the removal of the visceral for evaluation of the Viscero-somatic and hepato-somatic indices. All the selected water quality parameters were not different significantly among the treatments. The fish fed three times a day showed superior growth performance over other frequencies, the fish fed in the evening had better performance than fish fed in the morning alone. It is safe to conclude that feeding African catfish fingerlings three times a day is the optimal feeding frequency. Feeding time could also influence performance of the fish.*

**Keywords:** African catfish, feeding frequency, feeding time, feed utilization

## **Influence de la fréquence d'alimentation et du temps d'alimentation sur les performances de croissance et l'utilisation de l'alimentation des alevins de poisson-chat africain (*Clarias gariepinus* Burchell 1822)**



### **Résumé**

*Les aliments et l'alimentation constituent le principal coût de l'aquaculture intensive et l'alimentation efficace des poissons est un déterminant majeur du succès. Il existe peu d'informations sur le moment d'alimentation le plus approprié et la combinaison de la fréquence et du temps d'alimentation qui peuvent assurer la meilleure productivité dans l'élevage du poisson-chat africain. Cette recherche a donc été menée pour examiner l'influence de la fréquence d'alimentation et du temps d'alimentation sur les performances de croissance et l'utilisation de l'alimentation des alevins de poisson-chat africain (*Clarias gariepinus*) élevés pendant 42 jours. Des alevins de *C. gariepinus* d'un poids initial de  $9,0 \pm 0,5$  g ont été distribués au hasard à raison de 10 poissons par réservoir dans 12 réservoirs pour les quatre traitements en triple exemplaire. Les traitements étaient : T1 (poissons nourris une fois par jour le matin), T2 (poissons nourris une fois par jour le soir), T3 (poissons nourris deux fois par jour : matin et soir) et T4 (poissons nourris trois fois par jour*

: matin, après-midi et soir). Les paramètres de qualité de l'eau sélectionnés, notamment la température, le pH et l'oxygène dissous, ont été examinés une fois par jour, tandis que le poisson a été pesé une fois par semaine pendant les six semaines pour évaluer la croissance et l'utilisation des aliments. À la fin des six semaines, trois poissons de chaque réservoir ont été mesurés pour le poids et la longueur, et ont été disséqués pour l'élimination des viscères pour l'évaluation des indices viscéro-somatiques et hépato-somatiques. Tous les paramètres de qualité de l'eau sélectionnés n'étaient pas significativement différents entre les traitements. Les poissons nourris trois fois par jour ont montré des performances de croissance supérieures par rapport aux autres fréquences, les poissons nourris le soir avaient de meilleures performances que les poissons nourris le matin seul. Il est prudent de conclure que l'alimentation des alevins de poisson-chat africain trois fois par jour est la fréquence d'alimentation optimale. Le temps d'alimentation pourrait également influencer les performances des poissons.

**Mots-clés :** poisson-chat africain, fréquence d'alimentation, heure d'alimentation, utilisation de l'alimentation

## **Introduction**

The cultivation of fish and other aquatic organisms is becoming increasingly important as one of the fastest-growing agro-industrial activities in the world. Nigeria is one of the top aquaculture producers in Africa and there are still numerous opportunities for increase large-scale production (Dauda *et al.*, 2018). Several researchers have reported constraints to production in the industry, nonetheless, the prospects can be achieved by expanding aquaculture production zones, improving management practices of production systems and enhancing product quality. This may eventually lead to increased job creation, regular income and investment (Amosu *et al.*, 2017).

Aquaculture development in Nigeria is faced with some problems amongst which are water quality and quantity, high cost of feed, diseases infestation, inadequate capital, among others (Dauda *et al.*, 2015). Successful management of fish farm requires an understanding of the above stated constraints and ability to twist them in favour of fish production.

Feeds and feeding constitute the main costs in intensified aquaculture (Dasuki *et al.*, 2014). Over 60% of operational cost in aquaculture has been linked to feed and

feeding practices, hence, the needs to be deliberately interested in feeding management in fish farms. Rational feed management can significantly decrease these costs and improve the profitability of fish farming (Silva *et al.*, 2007; Tacon and Metian, 2008). Overfeeding and leftover food may disrupt the water quality and inadequate food supply may also have direct impact on the production, including stunted growth, increased aggression and cannibalism (Muntaziana *et al.*, 2016).

The quantity of the daily feed intake, frequency and timing of the feedings and presentation of the predetermined ration are the major factors of feed management strategies, influencing the growth and feed conversion (Abdel-Aziz *et al.*, 2021). Optimal feeding frequency may vary depending on species, age, size, environmental factors, husbandry and feed quality.

African catfish is another species of fish cultured globally and it remains a very important cultured fish to the continent of Africa. It is the second most cultured fish in Africa after Nile tilapia, and Nigeria being the global highest producer of the fish (Dauda *et al.*, 2018). According to Aderolu *et al.* (2010) success of African catfish culture both the fingerlings and the juveniles depends on effective feeding

frequency. Although, several researchers have reported influence of feeding frequency on the performance of African catfish (Aderolu *et al.*, 2010; Hossain *et al.*, 2002; Okomoda *et al.*, 2019), there is still limited information on the feeding time or a combination of feeding frequency and time. This study was therefore carried out to examine the effect of feeding frequency and feeding time on growth performance and feed utilisation of African catfish (*Clarias gariepinus*) fingerlings reared in a stagnant renewal system.

### **Materials and methods**

#### ***Study area and material source and experimental animal***

The experiment was carried out in the Department of Fisheries and Aquaculture, Federal University Dutsin-Ma Katsina State, Nigeria. The rearing of the fish was done using rectangular shape plastic tanks of 44cm x 29cm x 25cm with working capacity of 20L of water. Borehole water was used for all the treatments. One hundred and twenty pieces of *Clarias gariepinus* fingerlings of about  $9.0 \pm 0.5$ g body weight were obtained from a fish farm in Kano town, Kano State and transported down to Dutsin-Ma in plastic kegs with the top opened. The experimental animals were acclimatised for five days and fed twice daily with commercial feed having 42% crude protein.

#### ***Experimental design and procedure***

The design used was a complete randomized design (CRD) comprising of four treatments, each treatment having three replicates. Treatment 1 was fed once a day, only in the morning, treatment 2 was fed once a day only in the evening, treatment 3 was fed twice a day, morning and evening while treatment 4 was fed three times a day, morning, afternoon and evening. Each tank was filled with 20 L of water and stocked randomly with 10 fish each. All the fish stocked were fed to apparent satiation with a commercial

extruded pellets of 2mm size and 42% crude protein in line with their treatments. The fish were sampled and weight was recorded every week till the experiment ended after 42 days.

#### ***Water quality analysis***

The selected water quality parameters sampling were carried out on weekly basis in each tank. The temperature was measured in situ using a mercury-in-glass thermometer. pH was measured using pH meter while the dissolved oxygen was examined using reagent methods as described by Dauda and Akinwale (2014).

#### ***Evaluation of growth performance and feed utilisation***

Initial body weight of all fish in each treatment was taken and recorded using a sensitive weighing balance. Fish feed intake was recorded daily and growth was monitored every week for 6 weeks. At the end of the experiment, length, weight and number of the fish remaining in each tank was taken and recorded. Nine fish were then sampled from each treatment (i.e. 3 fish per replicate), for individual weight and length. Then, the fish were dissected for removal of the gut to weigh the visceral and the liver for examination of viscerosomatic indices. The growth performance parameters, feed utilisation and body indices parameters were calculated as described by Dauda *et al.* (2017):

Weight gain = Final weight – initial weight  
Percentage weight gain =  $\frac{\text{Weight gain}}{\text{initial weight}} \times 100$

Specific growth rate =  $\frac{(\ln W_2 - \ln W_1)}{\text{number of days for fish culture}} \times 100$

Feed intake = Total daily feed intake for the 42 days of the experiment

Food conversion ratio =  $\frac{\text{Feed intake}}{\text{wet weight gain}}$

Protein efficiency ratio =  $\frac{\text{Weight gain}}{\text{protein intake}}$

Viscerosomatic index =  $\frac{\text{weight of viscera}}{\text{weight of fish}} \times 100$

Hepatosomatic index = (weight of

liver/weight of fish) x 100

Where: Ln is natural logarithm, W is weight, L is length

### Statistical analysis

The data obtained were presented using descriptive statistics mean±standard error. The differences among the treatments for each parameter was tested using one way analysis of variance (ANOVA), after test of homogeneity. Where, a significant difference was observed, Duncan multiple range test was used as follow-up test.

## Results

### Water quality parameters

All the selected water quality parameters were not different significantly among the treatments, although there were slight variations in each of the parameter. Highest pH was observed in treatment 4 while the least was observed in treatment 1. Treatment 4 also had the highest temperature but the least was in treatment 3. In contrary for dissolved oxygen, the highest was observed in the treatment 2 (Table 1).

**Table1: Selected water quality parameters in culture tanks for fish fed at different feeding frequency and time**

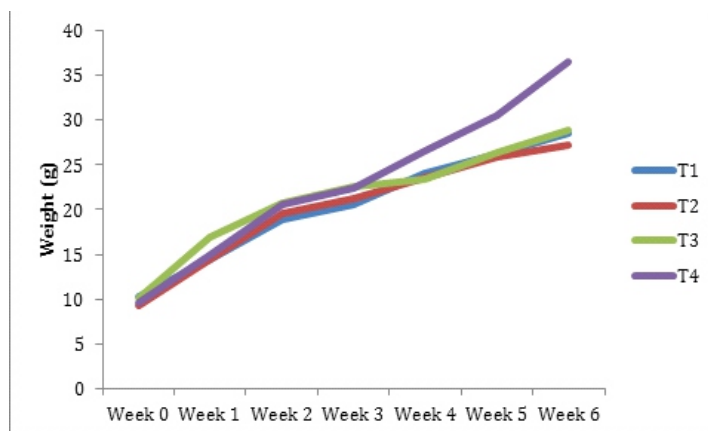
Parameters	Treatment 1	Treatment 2	Treatment 3	Treatment 4
pH	6.21±0.19 <sup>a</sup>	6.35±0.14 <sup>a</sup>	6.34±0.13 <sup>a</sup>	6.46±0.13 <sup>a</sup>
Temperature	25.09±0.57 <sup>a</sup>	25.26±0.59 <sup>a</sup>	24.96±0.71 <sup>a</sup>	25.47±0.74 <sup>a</sup>
Dissolved oxygen	4.83±0.20 <sup>a</sup>	5.00±0.22 <sup>a</sup>	5.00±0.17 <sup>a</sup>	4.85±0.19 <sup>a</sup>

Different letters as superscript in each row indicate significant difference (P<0.05)

### Growth performance

The weight gain, percentage weight gain, daily weight gain and specific growth rate were all higher significantly in the treatment where the fish was fed three times a day, compared to feeding morning and evening or any of morning or evening alone. The least percentage weight gain (180.13±19.7) and specific growth rate (2.39±0.17) was observed in treatment 1,

where the fish was fed once a day in the morning only (Table 2). The weekly increase in weight (Figure 1) showed that the weight were similar among the treatments until week 4, when treatment 4 conspicuously exceeded other treatments. Increase in length and percentage increased in length were also significantly higher in treatment 4 than all other treatments.



**Figure 1: Weekly increase in weight of African catfish fingerlings reared at different feeding frequency and time**

**Table 2: Growth performance of fish fed at different feeding frequency and time**

Parameters	Treatments			
	1	2	3	4
Initial weight	10.33±0.51 <sup>a</sup>	9.34±0.40 <sup>a</sup>	10.02±0.08 <sup>a</sup>	9.62±0.62 <sup>a</sup>
Final weight	28.60±2.17 <sup>a</sup>	27.25±2.51 <sup>a</sup>	28.84±2.18 <sup>a</sup>	36.47±2.86 <sup>a</sup>
Weight gain	18.27±2.01 <sup>a</sup>	17.91±2.28 <sup>a</sup>	18.83±2.13 <sup>a</sup>	26.85±2.42 <sup>b</sup>
PWG	180.13±19.7 <sup>a</sup>	189.89±19.39 <sup>a</sup>	186.80±20.08 <sup>a</sup>	240.47±18.7 <sup>b</sup>
Daily weight gain	0.44±0.05 <sup>a</sup>	0.43±0.05 <sup>a</sup>	0.45±0.05 <sup>a</sup>	0.64±0.06 <sup>b</sup>
SGR	2.39±0.17 <sup>a</sup>	2.48±0.15 <sup>a</sup>	2.44±0.17 <sup>a</sup>	3.15±0.11 <sup>b</sup>
Increase in length	4.88±0.44 <sup>a</sup>	4.66±0.51 <sup>a</sup>	5.28±0.41 <sup>ab</sup>	6.30±0.42 <sup>b</sup>
Percentage	30.49±1.96 <sup>a</sup>	29.36± 2.16 <sup>a</sup>	32.38±1.08 <sup>ab</sup>	36.63± 1.56 <sup>b</sup>

Means along same row with different super script differ significantly (p<0.05). Percentage weight gain (PGW) Specific growth rate (SGR)

**Feed utilisation and survival**

The highest feed intake, 25.71±8.46 g, protein efficiency ratio, 1.98±0.31 and survival 83.33±8.87% were observed in treatment 4, while the highest FCR 1.76±0.69 was observed in the treatment 3. The least FCR, 1.28±0.21 was recorded in treatment 4. However, the difference was not significant among the treatments for any of the parameters. The least survival was

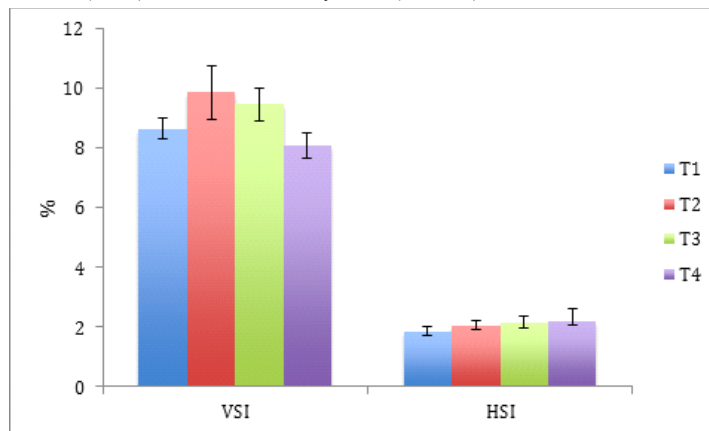
observed in the treatment where the fish was fed once daily in the morning, while the highest was recorded in treatment 4, where the fish was fed three times a day. Although the difference was not significant among the treatments.

Body indices of *Clarias gariepinus* reared at different feeding frequency and feeding time as shown in figure 2, both the viscerosomatic and hepatosomatic indices were similar among the treatments.

**Table 3: Feed utilisation and survival of African catfish fed at different feeding frequency and time**

Parameters	Treatments			
	1	2	3	4
Feed intake (g)	23.93±1.35	23.22±0.92	23.70±3.09	25.71±8.46
FCR	1.51±0.14	1.71±0.63	1.76±0.69	1.28±0.21
PER (%)	1.67±0.15	1.57±0.48	1.61±0.72	1.98±0.31
Survival rate (%)	70.0±10.0	76.67±11.55	76.67±5.77	83.33±8.87

Feed conversion ratio (FCR), Protein efficiency ratio (PER %)



**Figure 2: Viscerosomatic index (VSI) and Hepatosomatic index (HSI) of *Clarias gariepinus* reared at different feeding frequency and time**

## **Discussion**

Water quality parameters have been noted as important factors in successful culture of fish. They can have adverse effect on the growth, stress the stocked fish and increase the chance of disease infestation (Dauda and Akinwole, 2014). All the water quality parameters were within the recommended range for the culture of African catfish (Ajani *et al.*, 2011), except for the pH that was slightly lower. The similarities among the water quality parameters in this experiment, indicated that the feed supplied was well fed and that irrespective of the feeding frequency the water did not deteriorate. According to Priestley *et al.* (2006) both over and under-feeding may have adverse effect on the health of the fish and lead to deterioration in water quality, hence, reduced weight, poor feed utilisation and increased susceptibility to infection. The differences in growth performance in this experiment could be sufficiently linked to the feed administration and not the environment, considering the similarities in water quality parameters. The overall growth performance was best in the treatment 4 where the fish were fed three times a day, while the least performance was observed in the treatment 1 where the fish was fed once daily in the morning. Muntaziana *et al.* (2016) earlier noted that optimal feeding frequency is highly species-specific, and that it is between one to five for most species of fish. Feeding once a day was found optimum for bighead carp, *Aristichthys nobilis* (Carlos, 1988) and Korean rockfish, *Sebastes schlegeli* (Lee *et al.*, 2000). Four times or more daily was reported as optimum for Nile tilapia, *Oreochromis niloticus* (Sanchez and Hayashi, 2001), red-spotted grouper, *Epinephelus akaara* (Kayano *et al.*, 1993) and ayu, *Plecoglossus altivelis* (Cho *et al.*, 2003). The results of this research with highest performance of three times a day for

fingerlings was similar to that of Aderolu *et al.* (2010), who reported three times a day as the optimal feeding frequencies as there was no further significant difference beyond three times for either fingerlings or juveniles. Okomoda *et al.* (2019) also had a similar report for fingerlings, while five times per day was reported for fry. The feed utilisation also follows same pattern, as feed conversion and protein efficiency ratios though not significant were both highest and lowest, respectively in those fed three times a day, which suggest that feeding three times a day may be optimal for improved growth performance, feed utilisation and survival of African catfish fingerlings (Aderolu *et al.*, 2010; Okomoda *et al.*, 2019). While there was no significant difference for any of the growth or feed utilization parameters for either feeding in the morning or evening, the performance was consistently slightly better in the fish fed in the evening. This can be linked to the nocturnal nature of *C. gariepinus* and it is consistent with the findings of Biswas *et al.*, (2010) for striped knifejaw and Hossain *et al.* (2001) for African catfish fingerlings. The results of the body indices showed that none of the feeding frequency or time has negative effect on the fish culture as shown in the HSI and VSI. The results were within the range reported by Dauda *et al.* (2017) for *C. gariepinus* reared with different carbon sources in biofloc system.

## **Conclusion**

The results of the current research further confirmed the reports of previous researches that both feeding time and frequency could influence the growth performance, feed utilisation and survival of fish cultured. Most importantly that, feeding three times a day is the optimal feeding frequency for African catfish fingerlings. While for feeding time, the performance tends towards better for fish fed in the evening than morning.

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