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OPTIMUM FEEDING RATES FOR BETTER GROWTH, SURVIVAL, YIELD, AND ECONOMIC RETURN OF MONO-SEX NILE TILAPIA (*OREOCHROMIS NILOTICUS*) FROM RIVERINE CAGES

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Abstract

Sustainable tilapia production in cages and its higher economic efficiency depends on optimal feeding strategies. Feed costs in tilapia cage culture account for approximately 60-80% of the total operational expenses. However, studies did not receive much attention on optimizing feeding rates for tilapia culture in floating net cages. This study was conducted to evaluate the effects of different feeding rates on the growth, survival, productivity, and economics of mono-sex Nile tilapia, *Oreochromis niloticus*, cultured in floating net cages in the Dakatia River system. Three feeding rate treatments (4%, 5%, and 6% of body weight), each in triplicate, were assigned. In total, nine cages (18 m³ each) were installed. Each cage was stocked with 900 mono-sex tilapia fingerlings (50 fingerlings/m^3) with a mean initial weight of 20.76 ± 0.80 g. After the 4-month culture period, mean final weight, weight gain, specific growth rate, production, and gross return of tilapia were significantly ($p < 0.05$) higher in the 5% and 6% feeding treatments than in the 4% feeding treatment. In contrast, feed conversion ratio, net return, and benefit-cost ratio were significantly ($p < 0.05$) better in the 4% feeding treatment compared with the 5% and 6% feeding treatments. However, tilapia survival was not significantly affected ($p > 0.05$) in any feeding rate treatments. During the first, second, and third months of culture, tilapia growth in the 5% and 6% feeding treatments did not differ significantly ($p > 0.05$); however, both treatments showed significantly higher growth ($p < 0.05$) compared to the 4% feeding treatment. At the fourth month, tilapia growth was significantly higher ($p < 0.05$) in the 4% feeding treatment compared to the 5% and 6% feeding treatments. Based on this experiment, a feeding rate of 5% of body weight is recommended for the first three months, followed by a reduction to 4% of body weight in the fourth month for commercial tilapia cage culture. The application of these optimal feeding rates in riverine tilapia cage culture can enhance productivity and feed efficiency, leading to higher economic returns for small- to medium-scale commercial farmers.

Key words: Cage culture, riverine aquaculture, Tilapia, GIFT, optimal feeding regime, Grow-out production, sustainable fisheries

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Introduction

Nile tilapia, *Oreochromis niloticus* is considered as a one of the most auspicious aquaculture candidates, which has contributed 9% to total global aquaculture production (FAO, 2022). Bangladesh has secured 3rd and 4th position among Asian and world tilapia production, respectively (DoF, 2020; Kunda *et al.,* 2021). It is an excellent aquaculture candidate and being cultured across the country using different culture systems like, earthen ponds setting for monoculture and polyculture, integrated culture in rice fields and floating net cages in the rivers and lakes (Kunda *et al.,* 2021; Naser and Khatun, 2006, 2007). The annual production of tilapia exceeded 0.42 million tonnes in 2022-23, of which 5,254 tonnes were produced through cage culture (DoF, 2023). It is one of the most preferred fish in Bangladesh due to its lower price compared to other farmed fish, making it a popular choice for people with lower incomes (Rahman and Islam, 2020; Uddin *et al.,* 2019). However, it can be an imperative culture species in floating net cage system in various seasonal and permanent inland waterbodies in Bangladesh because of having a plenty of cultivable inland waterbodies with an area of 4707622 hectares (DoF, 2023; Islam *et al.,* 2023).

The cage culture has long history in Bangladesh, the first attempt has taken more than 50 years ago at Chandpur Fisheries Research Station (Now Riverine station of Bangladesh Fisheries Research Institute) in 1970's; currently, this technology is considered as a profitable business of tilapia production using open waterbodies (Ali *et al.,* 2019; Hossain *et al.,* 2017; Khatun *et al.,* 2010; Shamsuddin *et al.,* 2022). Commercial floating net cage farming of tilapia has contributed in enhancing income generation, employment opportunities, livelihoods, nutrition and food security; it can be considered a vital option in adapting to climate change in Bangladesh (Rahman *et al.,* 2021).

The Key driving factors influencing tilapia production in floating net cages include optimal fish size, stocking density, feed quality and protein content, feeding regime, and feeding frequency. These factors are essential for ensuring production efficiency, economic viability, sustainable management, and the successful adoption of cage culture technology at the community level. In Bangladesh, some of these factors have already been optimized through previous studies. The stocking density 50-60 tilapia m^{-3} were found for the better production and higher economic return for grow-out production of commercial tilapia culture (Hossain *et al.,* 2023; Hossain *et al.,* 2022; Kunda *et al.,* 2021). The feeding rates ranging from 5-3% of body weight (Hossain *et al.,* 2023; Hossain *et al.,* 2022), and 8-4% of body weight (Kunda *et al.,* 2021) have been applied in their studies. Therefore, optimization of the feeding rate is essential to ensure sustainable

tilapia production and higher economic returns from commercial riverine cage culture systems in Bangladesh.

Nile tilapia (*O. niloticus*), is an omnivorous species that naturally consumes a wide range of food items, including macrophytes, phytoplankton, zooplankton, periphyton, insects, nematodes, and detritus under wild conditions (Temesgen *et al.,* 2022). In pond and other closed aquaculture systems, natural food availability can be enhanced through organic and inorganic fertilization, which may reduce feed costs by up to 50% (Bhujel, 2019; Salger *et al.,* 2020; Stickney, 2017). However, in cage culture systems, natural food and periphyton production are limited due to restricted surface area and the absence of suitable substrates, and fertilization practices similar to pond systems cannot be applied (Bhujel, 2019; Huchette *et al.,* 2000; Huchette and Beveridge, 2003). Sustainable tilapia production and their better economic return can be achieved through optimization of suitable feeding rates.

Consequently, tilapia production and profitability in riverine cage culture largely depend on high-quality pelleted feeds, which account for approximately 60-80% of the total production cost (Bhujel, 2019; Brande *et al.,* 2023). In this context, optimizing feeding rate is critical for achieving sustainable production and improving economic returns in commercial cage culture systems. However, limited information is available on the optimization of feeding rates for tilapia cultured in floating net cages, particularly in Bangladesh. Therefore, this study was conducted to evaluate the effects of different feeding rates (4%, 5%, and 6% of body weight) on the growth performance, survival, production, and economic returns of Nile tilapia reared in floating net cages in Dakatia riverine system. The findings of this study are expected to provide practical guidance for improving tilapia production and may be disseminated among commercial cage farmers to support sustainable livelihoods, enhance income generation, and contribute to climate change adaptation.

Materials and Methods

Floating net cage setting, animal source and acclimation, and experimental protocol: To determine a suitable feeding rate for Nile tilapia grow-out production in floating cages, an experiment was conducted in the Dakatia River (23.2081° N, 90.6632° E) at Raghunathpur, Chandpur, Bangladesh. A total of ten floating net cages were installed for the study. Each cage had dimensions of 3 m in length, 3 m in width, and 2 m in depth, providing a total culture volume of 18 m^3 (Hossain *et al.,* 2023). The water depth at the cage installation site was > 5 m.

In total, approximately 10,000 mono-sex *O. niloticus* fingerlings were acquired from the nursery ponds of Bangladesh Fisheries Research Institute (BFRI), Riverine Station, Chandpur. Each cage was stocked with 900 healthy and active fingerlings. Prior to the experiment, the fingerlings were acclimatized to the cage environment for one week. During the acclimatization period, dead and morbid tilapia fingerlings were replaced with healthy stocks from the additional cage. The fingerlings were fed with tilapia commercial pellet feed (Spectra Hexa Feeds Limited) containing 30% crude protein and 5% fat two times (09:00 and 16:00 h) in a day to apparent satiation.

There were three feeding rates treatments, corresponding to 4%, 5%, and 6% of fish body weight per day, with completely randomize design with triplicate for a period of 120-days. The initial mean weight of mono-sex tilapia fingerlings was 20.76±0.80 g. A stocking density of 50 fish m^3 was employed, following the recommended stocking density for commercial tilapia cage culture in riverine systems (Hossain *et al.,* 2023; Hossain *et al.,* 2022). The tilapias were fed a commercial floating pellet diet twice daily between 10:00-10:30 h and 16:00-16:30 h throughout the experimental period. The daily feed ration was adjusted at 30-day intervals based on the average body weight of the fish. For this purpose, 50 tilapia were randomly sampled monthly from each cage and individually weighed to estimate growth performance and determine subsequent feed requirements. The cage nets were cleaned at 30-day intervals throughout the study period to maintain adequate water exchange and minimize biofouling.

Final sampling and growth performance parameters: At the end of this study, the tilapia were harvested and counted to determine the survival. In total, ≥ 150 tilapia were taken for body weight measurements from each cage. Fish survival, final weight, weight gain, specific growth rate, production and feed conversion ratio were estimated using the following formulas.

Survival rate (%) = (Number of tilapia harvested / Number of tilapia stocked) × 100

Weight gain (g) = Final weight of tilapia - Initial weight of tilapia

Specific growth rate (SGR) (% / day) = $[(\ln W_2 - \ln W_1)]/ t \times 100$, where W_2 = final weight of tilapia, W_1 = initial weight of tilapia, and t = culture days

Feed conversion ratio (FCR) = Total feed intake (g) / Total gain (g)

Gross production (kg) = Number of tilapia harvest × Mean final weight of tilapia

Net production (kg) = Number of tilapia harvested × (Mean final weight of tilapia - Initial weight of tilapia).

Economic analysis: An economic analysis was performed to calculate the cost-effectiveness of sex reversed *O. niloticus* grow-out phase in floating net cage culture in the riverine system for this experiment. The cost-benefit analysis was used the expenses of cage materials, fingerlings, feed, nursery phase, transportation and labour wage for each treatment of this study. These were estimated using the following equation (Asaduzzaman *et al.,* 2009; Hosain *et al.,* 2024).

$$R = Pbi \cdot Bi - (Pxj \cdot Xj + TFC)$$

where R = net return, Pb_i = unit price of ith products (U.S. dollars per kilogram or number), B_i = quantity of ith products sold (U.S. dollars per kilogram), Pxj = unit price of jth inputs, X_j = quantity of jth inputs, i = 1, 2, 3, … n, and TFC = fixed costs.

Benefit-cost ratio (BCR) = total net return/total input cost.

Profit (USD) = Total income - total expenditure.

Water quality parameters: The physicochemical features of each cage water measured at every 14th day in each month between 08:30 and 11:00 hours. Water depth beside each cage was measured with a marked bamboo stick. Water transparency was determined using a Secchi dise. Water pH was measured with a HANNA pH meter (Model HI 8424, Italy). The dissolved oxygen level of each cage water was estimated using Lutron DO meter (Model DO 5509, Singapore). Free carbon dioxide, ammonia-N, nitrite-N, total alkalinity and total hardness of each cage water were determined using HACH water quality testing kit (Model FF-2, USA).

Statistical analysis: Statistical analysis was done using SPSS version 25. Prior to analysis, data were checked for normality and homogeneity of variances using Levine's test. Water quality, tilapia growth, production and economics of the experiment was subjected to One-way analysis of variance (ANOVA). Pearson correlation coefficients were used for the inter-relationship of water quality parameters. When significant differences were detected ($p < 0.05$), Tukey's multiple comparison test was used for post hoc comparison of the mean among different treatment groups.

Results and Discussion

Growth performance and economic analysis: During the first, second, and third months of culture, mean weight and weight gain of tilapia in the 5% and 6% feeding treatments did not differ significantly ($p > 0.05$) (Fig. 1a, b). However, both treatments showed significantly higher final weight and weight gain ($p < 0.05$) compared to the 4% feeding

treatment (Fig. 1a, b). For specific growth rate (SGR), it did not differ significantly ($p > 0.05$) between the 5% and 6% feeding treatments during the first two months of culture; nevertheless, both treatments showed significantly higher SGR ($p < 0.05$) than the 4% feeding treatment (Fig. 1c). In the third month, SGR did not differ significantly ($p > 0.05$) among the three feeding treatments. At the fourth month of culture, mean weight, weight gain, and SGR of tilapia were significantly higher ($p < 0.05$) in the 4% feeding treatment compared to the 5% and 6% feeding treatments (Figure 1a,b,c). The findings of the present study indicate that juvenile tilapia utilized feed more efficiently during the three months of culture, whereas feed utilization efficiency appeared to decline in the later stages of growth. Similar trends have been reported for GIFT tilapia (Huang *et al.,* 2015; Liu *et al.,* 2018), African catfish (*Clarias gariepinus*) (Marimuthu *et al.,* 2011), and Asian sea bass (*Lates calcarifer*) (Ul Hassan *et al.,* 2021) cultured under closed aquaculture systems. Therefore, the findings of the present study suggest that a feeding rate of 5% body weight could be more suitable during the first three months of the culture period; thereafter, the feeding rate could be reduced to 4% of total body weight in the fourth month to achieve economically efficient commercial riverine cage culture of Nile tilapia.

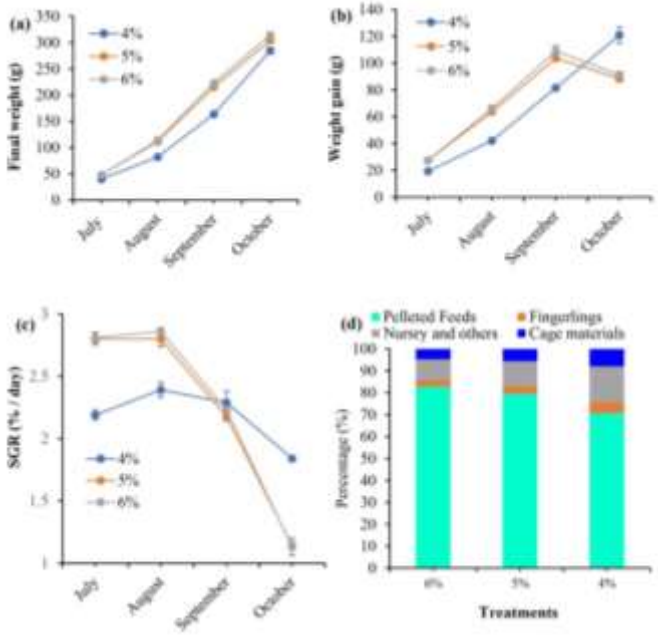


Fig. 1. Monthly mean (± SE) final weight (g) (a), weight gain (g) (b), specific growth rate (SGR; % / day) (c), and the overall composition (%) of different expenses groups include pelleted feeds, fingerlings, cages materials, nursery and other cost varying in three different feeding rate treatments of *Oreochromis niloticus* cultured in cages, Dakatia River, Chandpur, Bangladesh during 120 days culture period.

After the 4-month culture period, the significantly ($p < 0.05$) higher mean final weight, weight gain, SGR and production of tilapia observed in the 5% and 6% feeding treatments compared with the 4% feeding treatment indicate that higher feeding rates facilitated improved tilapia growth and production (Table 1). Similar trends have frequently been reported in tilapia aquaculture systems and were comprehensively reviewed by Abd El-Hack *et al.* (2022). However, higher feeding rates in tilapia cage culture may not be economically feasible due to reduced feed utilization efficiency. In the present study, feed conversion ratio (FCR) was significantly ($p < 0.05$) better in the 4% feeding treatment compared with the 5% and 6% treatments (Table 1), indicating more efficient feed utilization at the lower feeding rate. In contrast, tilapia survival was not significantly affected ($p > 0.05$) by the different feeding rates (Table 1), suggesting that feeding rate did not influence fish survival in the riverine cage culture conditions. In the

Table 1. The survival, growth performance and an economic analysis of culturing mono-sex *Oreochromis niloticus* at three different fixed feeding rate treatments of cage culture in the Dakatia River, Chandpur, Bangladesh after 120 days.

Variables	Feeding regime treatments		
	4%	5%	6%
Initial weight (g)	20.76 ± 0.80	20.76 ± 0.80	20.76 ± 0.80
Final weight (g)	284.64 ± 5.85^{b}	303.93 ± 2.79^{a}	314.46 ± 2.86^{a}
Weight gain (g)	263.88 ± 5.85^{b}	283.16 ± 2.79^{a}	293.70 ± 2.86^{a}
SGR (% / day)	2.18 ± 0.01^{b}	2.23 ± 0.008^{a}	2.26 ± 0.007^{a}
FCR	1.31 ± 0.02^{a}	1.88 ± 0.02^{b}	2.24 ± 0.02^{c}
Survival (%)	96.66 ± 0.66^{a}	97.22 ± 0.44^{a}	97.0 ± 0.57^{a}
Gross production (kg/cage)	247.62 ± 4.93^{b}	265.96 ± 3.75^{a}	274.53 ± 3.46^{a}
Gross production (kg/m^3)	13.75 ± 0.27^{b}	14.77 ± 0.20^{a}	15.25 ± 0.19^{a}
Net production (kg/cage)	229.56± 4.92^{b}	247.79± 3.67^{ab}	256.41± 3.38^{a}
Net production (kg/m^3)	12.75 ± 0.27^{b}	13.76 ± 0.20^{a}	14.25 ± 0.18^{a}
Economic analysis			
Gross cost (USD/cage)	198.74 ± 0.0	284.91 ± 0.0	337.13 ± 0.0
Gross return (USD/cage)	385.02 ± 5.38^{b}	410.47 ± 0.35^{a}	422.79 ± 1.83^{a}
Net return (USD/cage)	186.28 ± 5.38^{a}	125.55 ± 0.35^{b}	85.65 ± 1.83^{c}
BCR	1.93 ± 0.02^{a}	1.44 ± 0.001^{b}	1.25 ± 0.005^{c}

Different superscripted letters in each row indicate significant differences ($p < 0.05$). SGR= Specific growth rate; FCR= Feed conversion ratio; BCR= Benefit cost ratio. $1 USD = ৳75.45 (Saturday 1 October 2011)

present study, Nile tilapia reached marketable sizes of 284.64 g, 303.93 g, and 314.46 g in the 4%, 5%, and 6% feeding treatments, respectively. These harvest sizes are comparable with those reported for cage-cultured tilapia in several countries, including

Brazil, Ethiopia, Ghana, Kenya, and Bangladesh (Garcia *et al.,* 2016; Gibtan *et al.,* 2008; Musa *et al.,* 2022; Ofori *et al.,* 2010; Shamsuddin *et al.,* 2022).

Significantly higher gross returns were recorded in the 5% and 6% body weight feeding groups compared with the 4% body weight feeding group (Table 1). However, fish fed at the 4% body weight group, showed reduced feed cost, suggesting that this feeding level optimized feed utilization and lowered production expenses (Table 1). These findings indicate that optimal feeding promotes efficient feed utilization, which in turn improves FCR and enhances economic returns. Similar observations have been reported by Ng and Romano (2013), Bhujel (2019) and Abd El-Hack *et al.* (2022). In addition, the 4% feeding rate showed lower feed cost, resulting in the most efficient economic performance among the treatments. The cost composition analysis further supports this pattern, as feed cost constituted the major operational expense across all treatments, accounting for 82.72, 79.55 and 70.69% of total expenditure in the 6, 5 and 4% feeding groups, respectively (Fig. 1d). The reduced proportion of feed cost at the 4% feeding rate explains the improved economic efficiency observed in this treatment, where feed costs were 12% and 9% lower than those in the 6% and 5% groups, respectively. Among all cost components, fingerling cost contributed the least to total expenditure across all treatments (Fig. 1d).

Overall, marketable sizes of tilapia (284.64 to 314.46 g) were obtained across all three feeding treatments, starting from an initial mean stocking weight of 20.76 g. The results clearly indicate that an optimal feeding strategy can support sustainable feeding management in riverine cage-based tilapia grow-out culture. Based on the present findings, a feeding rate of 5% body weight is recommended during the first three months of culture, followed by a reduction to 4% in the fourth month to ensure efficient and cost-effective commercial production in riverine cage culture system.

Water quality parameters: In this study, overall physico-chemical parameters of cage water, water depth, current velocity, transparency, temperature, pH, dissolved oxygen, free CO_2, total alkalinity and total hardness were not different ($p > 0.05$) among three feeding rates treatments (Table 2). In case of monthly fluctuation of these water quality parameters, water depth in three feeding rate treatments were slightly increased in each month from June to September then these decreased again in October (Fig. 2a). While the current velocities were gradually increased in each month from to June to October (Fig. 2b). However, water transparency, water temperature, pH and dissolved oxygen values were similar during the study period (Fig. 2c,d,e,f). The higher values of free CO_2 were recorded in June and July than August, September and October (Fig. 3a). On contrary, the

higher values of total hardness were found in October than those of June, July, August and September (Fig. 3b). Significantly ($p< 0.05$) a higher peak of total alkalinity was shown in 5% body weight of feeding treatments in October than other two treatments (Table 2 and Fig. 3c). Ammonia-N and nitrite-N were not found during the study period in the three feeding rate treatments (Table 2).

Table 2. Overall water quality parameters (mean ± SE) of cage water in the three different feeding rate treatments of mono-sex *Oreochromis niloticus* cultured in the Dakatia River, Chandpur, Bangladesh during 120 days.

Variables	Feeding regime treatments		
	4%	5%	6%
Depth of water (m)	5.26 ± 0.08[a]	5.27 ± 0.07[a]	5.32 ± 0.08[a]
Current velocity (cm/sec)	30.60 ± 1.02[a]	30.66 ± 1.04[a]	31.33 ± 1.05[a]
Water transparency (cm)	41.53 ± 0.56[a]	41.60 ± 0.60[a]	41.80 ± 0.65[a]
Water temperature (°C)	32.24 ± 0.12[a]	32.25 ± 0.08[a]	32.36 ± 0.09[a]
pH	7.47 ± 0.03[a]	7.47 ± 0.03[a]	7.48 ± 0.04[a]
Dissolved oxygen (mg/)	5.0 ± 0.12[a]	5.02 ± 0.11[a]	5.17 ± 0.09[a]
Free CO_2 (mg/l)	7.11 ± 0.24[a]	6.88 ± 0.22[a]	6.88 ± 0.20[a]
Total alkalinity (mg/l)	45.97 ± 0.67[a]	47.35 ± 0.84[a]	46.49 ± 0.82[a]
Total hardness (mg/l)	60.85 ± 1.54[a]	61.32 ± 2.24[a]	62.64 ± 1.44[a]
Ammonia-N (mg/l)	ND	ND	ND
Nitrite-N (mg/l)	ND	ND	ND

ND: not detected. Within rows, similar letter indicates no differences ($p > 0.05$).

Water depth and water current velocity exhibited a positive correlation ($r = 0.668$; $p < 0.01$) (Table 3). Dissolved oxygen had the negative correlation with water depth ($r = - 0.446$; $p < 0.01$) and water current velocity ($r = - 0.344$; $p < 0.05$) (Table 3). Free CO_2 showed the negative correlation with water depth ($r = - 0.556$; $p < 0.01$) and water current velocity ($r = - 0.539$; $p < 0.01$) (Table 3). On the other hand, this also had the positive correlation with pH ($r = 0.612$; $p < 0.01$) and dissolved oxygen ($r = 0.453$; $p < 0.01$) (Table 3). Total hardness showed strong positive correlation with water current velocity ($r = 0.599$; $p < 0.01$) (Table 3).

The sustainability of tilapia cage culture is largely dependent on maintaining optimal water quality conditions, appropriate stocking density, and effective feed and feeding strategies (David *et al.,* 2018; Fialho *et al.,* 2021; Moura *et al.,* 2016; Musa *et al.,* 2022). Floating net-cages installed in river systems facilitate continuous water exchange through the mesh structure, helping to maintain suitable water quality conditions for tilapia. As a result, riverine cage culture often achieves higher production compared to earthen pond

systems (Moyo and Rapatsa, 2021). For instance, in the present study, water quality parameters such as water temperature, depth and current velocity; pH; dissolved oxygen; total hardness and alkalinity; ammonia-N and nitrite-N at the River Dakatia, Chandpur were within the suitable level for tilapia culture (Abd El-Hack *et al.,* 2022; Anusuya Devi *et al.,* 2017). The maintenance of these favorable environmental conditions are likely contributed to enhanced growth performance, higher production, and excellent survival rates of tilapia (96.66 to 97.22%) in the riverine cage culture system.

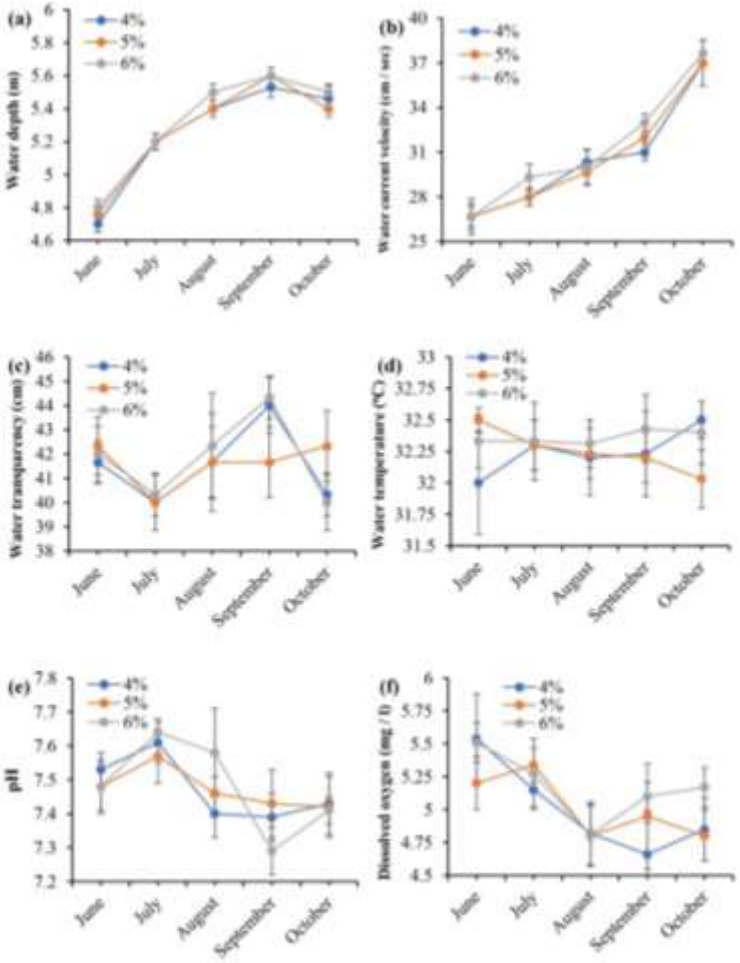


Fig. 2. Monthly mean (± SE) water depth (m) (a), water current velocity (cm/sec) (b), water transparency (cm) (c), water temperature (ºC) (d), pH (e), dissolved oxygen (mg/l) (f) in three different feeding rates treatments when culturing *Oreochromis niloticus* in the Dakatia River, Chandpur, Bangladesh during June to October 2011.

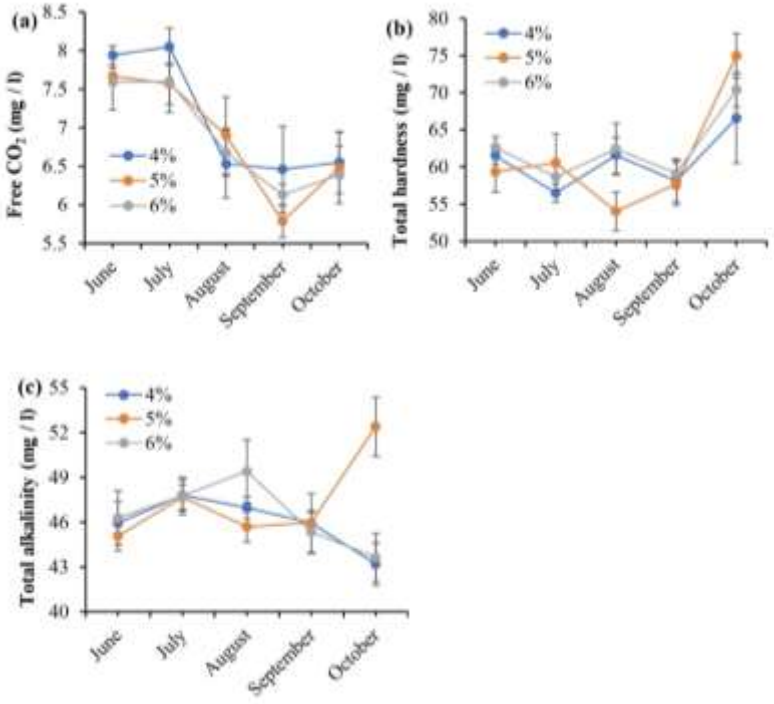


Fig. 3. Monthly mean (± SE) free CO_2 (mg/l) (a), total alkalinity (mg/l) (b) and total hardness (mg/l) (c) in three different feeding rates treatments when culturing *Oreochromis niloticus* in the Dakatia River, Chandpur, Bangladesh during June to October 2011.

Table 3. Correlation matrix of water quality parameters in the cage water of three different fixed feeding rate treatments evaluated for mono-sex *Oreochromis niloticus* cultured in the Dakatia River, Chandpur, Bangladesh during June to October 2011.

	WD	WCV	WT	WTE	pH	DO	CO_2	TA	TH
WD	1								
WCV	0.668**	1							
WT	-0.014	-0.129	1						
WTE	0.013	0.086	-0.097	1					
pH	-0.287	-0.292	-0.216	-0.004	1				
DO	-0.466**	-0.344*	0.001	-0.155	0.265	1			
CO_2	-0.656**	-0.539**	-0.246	0.145	0.612**	0.453**	1		
TA	0.058	-0.063	0.055	-0.235	0.258	-0.108	0.058	1	
TH	0.150	0.599**	-0.141	-0.002	-0.155	-0.120	-0.231	0.222	1

**Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

WD: water depth; WCV: Water current velocity; WT: water transparency; WTE: water temperature; DO: dissolved oxygen; CO_2: carbon di-oxide; TA: total alkalinity; TH: total hardness.

Conclusion

The present study demonstrated that higher feeding rates (5% and 6% of body weight) enhanced significantly the growth performance of Nile tilapia; however, these treatments did not improve feed conversion ratio (FCR) or economic efficiency. In contrast, the lower feeding rate (4% of body weight) resulted significantly better FCR, net return, and benefit-cost ratio. The findings also revealed that growth performance did not differ significantly between the 5% and 6% feeding treatments during the first three months of culture, although both treatments produced significantly higher growth than the 4% feeding treatment. However, during the fourth month, fish reared under the 4% feeding treatment exhibited significantly better growth performance than those under the 5% and 6% feeding treatments.

This study clearly demonstrate that the feeding rates should be adjusted according to the culture period in riverine net-cage tilapia farming. Based on the present findings, a feeding rate of 5% of body weight is recommended during the first three months of culture, followed by a reduction to 4% of body weight in the fourth month to achieve economically efficient commercial tilapia cage culture. Adoption of this feeding strategy may improve feed utilization, enhance production efficiency, and increase economic returns for small- to medium-scale tilapia farmers in river based cage culture system.

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