Effects of frequency of feeding on Nile tilapia (*Oreochromis niloticus*) growth in a closed system

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Abstract

This study aims to assess the influence of feeding frequency on growth, feed conversion efficiency, and survival rate of Nile tilapia (Oreochromis niloticus). The experiment involved 80 fish of comparable size, and the average weight was 5.78 g. Each of the eight 45-liter tanks contained ten fish. The experiment includes two replicates for each feed frequency. The fish were categorized into four categories based on their feeding frequency: once daily (A), twice daily (B), thrice daily (C), and four times daily (D). The fish were fed at a daily rate of 3% of their body weight. The highest weight gain 12.52 g, relative growth rate 214.57%, specific growth rate 2.605 g/day%, and feed conversion rate 2.06 were observed in Treatment C, which was provided three times daily. Moreover, all these values varied significantly from the other treatments, and the analysis of variance indicated substantial differences ($p < 0.05$). According to the results of the present study, Nile tilapia growth in aquaculture systems is facilitated by an increase in feeding frequency; this study indicates that feeding fish thrice daily may enhance their growth and feed conversion efficiency; hence, farmers should use this practice. The study revealed that feeding frequency is essential for enhancing production in aquaculture, as regulating feeding intervals can result in improved growth rates of Nile tilapia.

Keywords: Feeding frequency, Growth Performance, Nile Tilapia , Survival Rate .

Introduction

Increasing global temperatures, declining fish stocks, and population growth have increased animal protein demand (Mavraganis *et al.*, 2020). There has been a growing emphasis on aquaculture development as a viable source of fish production. Aquaculture is a natural process that can enhance productivity (Daet, 2019; Hassan *et al.*, 2021). Feeding systems that prevent under or over-feeding, which affects growth, efficiency and water quality, are critical in reducing costs (Hassan *et al.*, 2021). Feed management in intensive and semi-intensive fish biomass production units involves feeding regimes that may differ with the stage, feed type, feeding frequency, feed intake, and rate of nutrient

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absorption. Feeding schedules are critical in managing fish biomass in intensively and semi-intensively cultivated aquaculture systems. The primary factors are feed type, frequency, intake, and nutrient absorption at various life stages. This is a problem for fish farmers as they struggle to find the right balance between feeding the fish as fast as they can grow (Dwyer *et al*., 2002; Gokcek *et al*., 2008). Feed expenses account for 60% of the total costs in intensive farming systems (Bhuiyan *et al*., 2018), and may account for 70% (NRC, 2011).

Therefore, determining how feeding times or frequency affects feed management, nutrient utilization, and growth rates is crucial. Feeding fish at varying times in aquaculture impacts their growth, feed conversion ratio, survival, meat composition, and water quality (Aydin *et al*., 2011; Lee and Pham, 2010). One of the most important ways that the appropriate feeding frequency can assist in lowering feed costs (Davies *et al*., 2006). Feeding fish in aquaculture plays a role in determining their growth rate and efficiency in converting feed into body mass while also affecting their chances of survival and the overall quality of their flesh and the environment they inhabit (Aydin *et al*., 2011; Lee and Pham 2010).

In Aquaculture, the management of feed for cultured freshwater fish is seen as a significant issue, as feeding frequency affects nutrient utilization rates, and growth depends not just on feed composition (Silva *et al*., 2020). Factors influencing feeding frequency and their correlation with growth and feed conversion efficiency include fish age or size, dietary protein and carbohydrate composition, stocking density, feed quality, feeding schedule, feeding behavior, digestive tract length, gastric emptying time, and stomach capacity (Guo *et al*., 2018; Aderolu *et al*., 2017; Okomoda *et al*., 2019).

Several studies on the effect of feeding frequency on fish growth indicate differences in results between fish species (Guo *et al*., 2018). Daudpota *et al*. (2016) showed that the highest growth was recorded for juvenile Nile tilapia O. niloticus fed four times a day, and Azrita *et al*. (2020) indicated that the highest growth was recorded for giant goramy Osphronemus goramy fed three times a day. The sex-reversed tilapia *O. niloticus* fed twice a day achieved the highest growth, which was confirmed by (Thongprajukaew *et al*., 2017).

Common carp Cyprinus carpio achieved the highest growth when fed three times a day, which was recorded by Al-Hamadany *et al*. (2009), while Ul Hassan *et al*. (2021) indicated that the best growth was in Asian sea bass Lates calcarifer fed three times a day. Although some work has been done on the feeding patterns of Nile tilapia, data regarding feeding frequency for this species in Iraqi waters are scarce. Because of this paucity of information, the present study was carried out to investigate the influence of feeding frequency on the growth and feed efficiency of juvenile Nile tilapia for 60 days.

This study aimed to evaluate the impact of various feeding management techniques to determine the optimal feeding regime for Nile tilapia (*Oreochromis niloticus*). The aim was to optimize feed conversion efficiency and growth to reduce feed supply.

Materials And Methods

1 - Experimental Fish

Nile tilapia (*O. niloticus*) was brought to the laboratory from the Marine Science Centre fish farm at the University of Basrah, Iraq and provided a balanced diet of fish meals, soybean meal, barley, white flour, yellow corn, vitamins and minerals. The components and ratios of experimental food are shown in Table (1), along with the actual chemical composition. The chemical composition of the experiment feed is displayed in (Figure 1). The mixture was ground, sifted, and then heat-treated. After it cooled, the vitamin and mineral mixture was added to it, and the dough was formed into 2 mm discs using a meat grinder (Al-Dubakel *et al.*, 2014). The manufactured standard feed was analyzed to estimate (moisture, protein, fat and ash) based on the methods mentioned in (A.O.A.C., 2006), while carbohydrates were calculated mathematically (Al-Aswad, 2000).

2 -Feeding experiment

The feeding experiment was conducted in plastic tanks measuring (40×70×60) cm with a capacity of 45 -liters equipped with a ventilation system. The fish were acclimatised to the experimental conditions for 7 days before feeding, and the tanks were sterilised with a 200 Part per million (ppm) sodium hypochlorite solution for one hour. The fish received a standard diet including 30% protein, given at 3% of their body weight daily for 60 days, with feeding quantities modified every 15 days according to weight changes. Each tank housed ten fish, with two replicates for each of the four treatments, which were randomly assigned to 80 fish at the start of the experiment. As shown in Table (2), fish were fed once (A), twice (B), thrice (C), and four times (D) daily. Water tank conditions, including temperature (ºC), dissolved oxygen (mg/L), pH, and salinity (g/L), were monitored weekly using a YSI 556 MPS. Different growth and feed parameters were calculated following Sveier *et al.* (2000) as: Total weight gain (g) = final weight − initial weight
Feed conversion ratio = dry food consumption (g) / weight gain (g)

Relative growth rate (%) = [(final weight - initial weight) / Initial weight] × 100

Specific growth rate (%/day) = [ln (final weight)−ln (initial weight)] / Period (days) × 100

Survival rate (%) = (final fish number / initially fish number) × 100.

Table (1): Proportions and components of raw materials of the feed used during the experimental period.

Components	Percentage (%)
Fish meal	30
Soybean Powder	25
Yellow Corn Powder	15
Wheat	18
Barley	10
Vitamins & Minerals	2

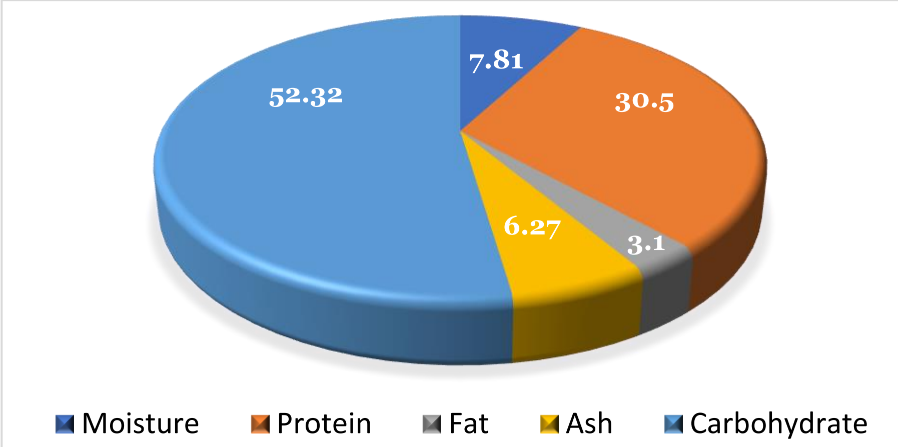

Figure (1): The actual chemical composition of the experimental feed.

Table (2): Number of feeding times and their time in different transactions during the feeding period.

Treatment	Number of Feeding	Time
A	1	9
B	2	9, 10.30
C	3	9, 10.31, 12.0
D	4	9, 10.30, 12.0, 13.30

3-Statistical analysis

The study utilized a completely randomized design (CRD), employing statistical software (SPSS, 2000) and the methodology of Al-Rawi and Khalaf Allah (2000) to assess the significance of differences at a probability level of ($P< 0.05$).

Results

Figure (2) shows some environmental parameters observed during the tests. The average water temperature was 24.3 °C, with a dissolved oxygen concentration of 6.41 mg/L, salinity of 0.75 g/L, and pH of 7.3. Figure (3) illustrates the initial and final weights of Nile tilapia (*O. niloticus*). Statistical analysis indicated no significant ($P>0.05$) in average initial weights among the four treatments (A, B, C, and D), which were 5.78, 5.74, 5.83, and 5.74 g, respectively. However, the final weights showed significant differences ($p<0.05$), with averages of 10.99, 13.26, 18.35, and 15.45g, respectively. The study indicated that daily feeding frequency markedly affected the growth performance of Nile tilapia, including total weight gain, relative growth, specific growth, and feed conversion rate (Figures 4–7). Statistical analysis ($p<0.05$) indicated that fish fed thrice daily (C) exceeded those fed once (A), twice (B), or four times (D) daily. Treatment C achieved the highest final weight (18.35 g), total weight gain (12.52 g), relative growth (214.57%), specific growth rate (2.605 g/day%), and feed conversion ratio (2.06), with no impact on survival rates (Figure 8).

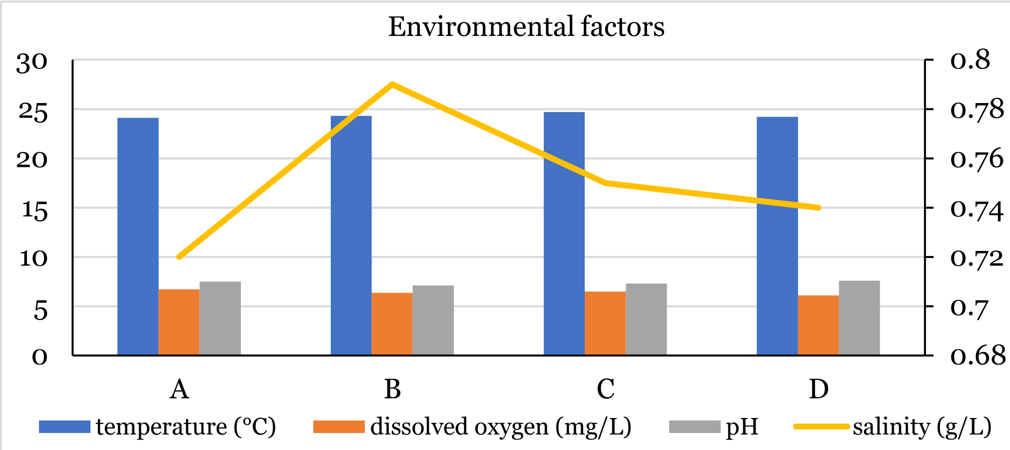

Figure (2): Environmental factors of the experimental water tank.

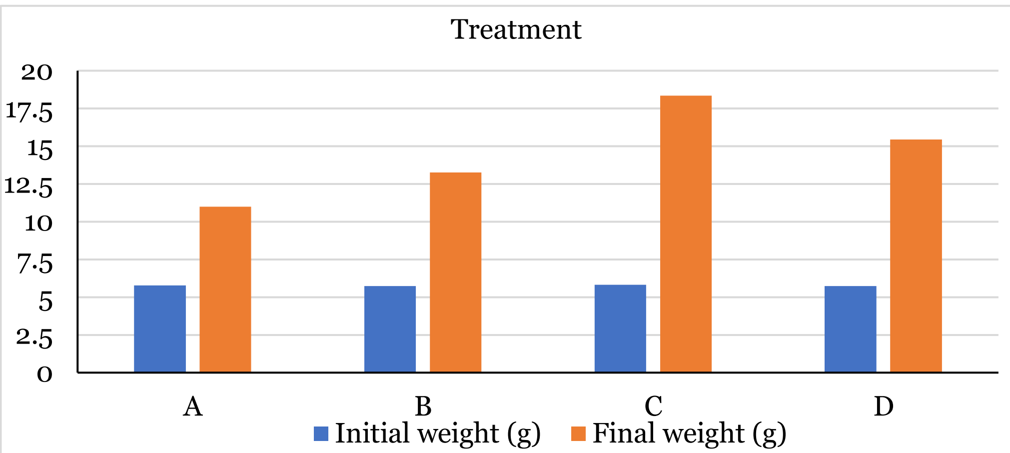

Figure 3: Experimental fish weight rates at beginning and the end.

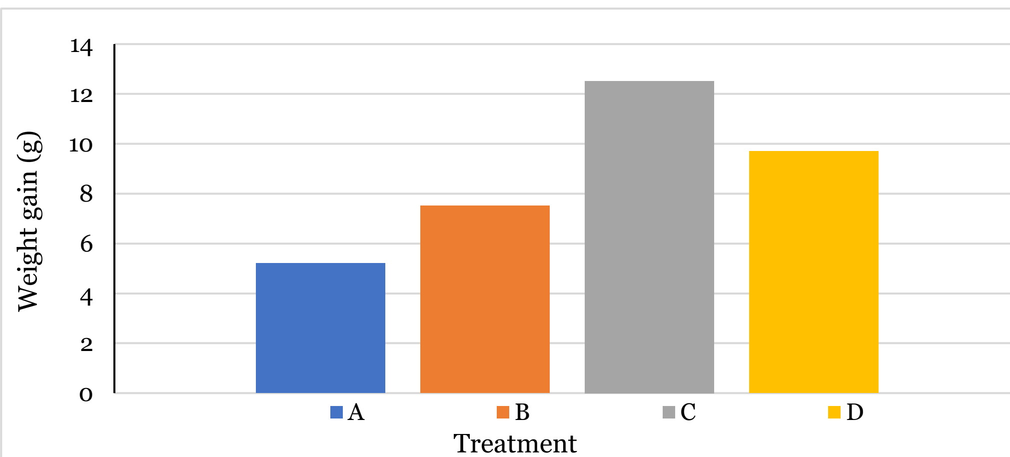

Figure (4): Total weight gain rates of experimental fish.

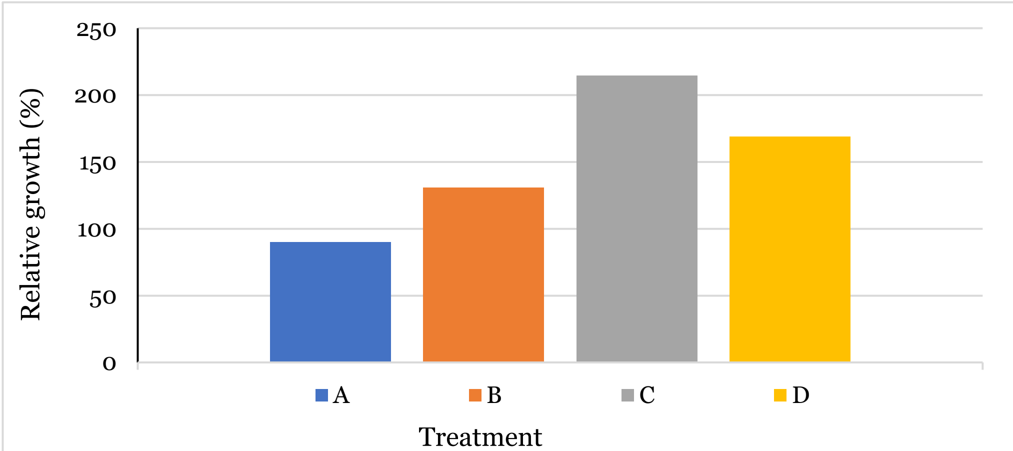

Figure 5: Relative growth rate of the experiment fish.

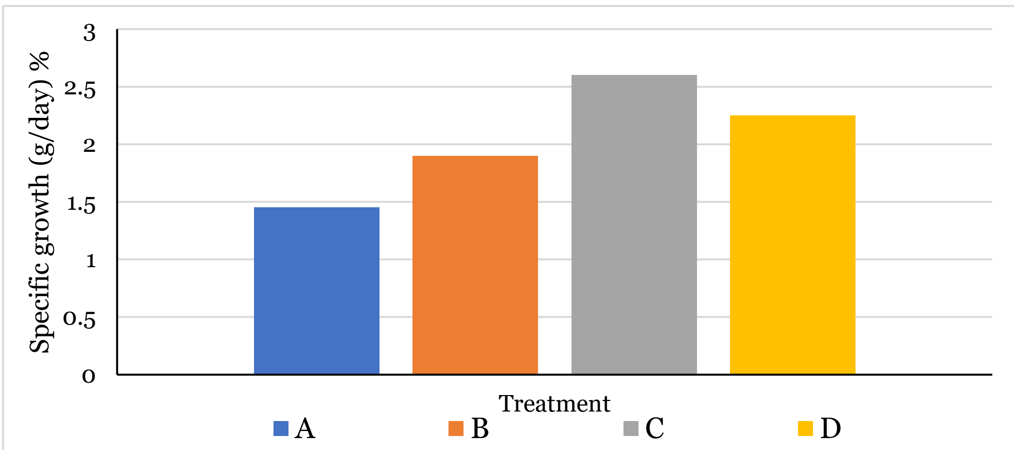

Figure 6: Specific Growth Rate of Experiment Fish.

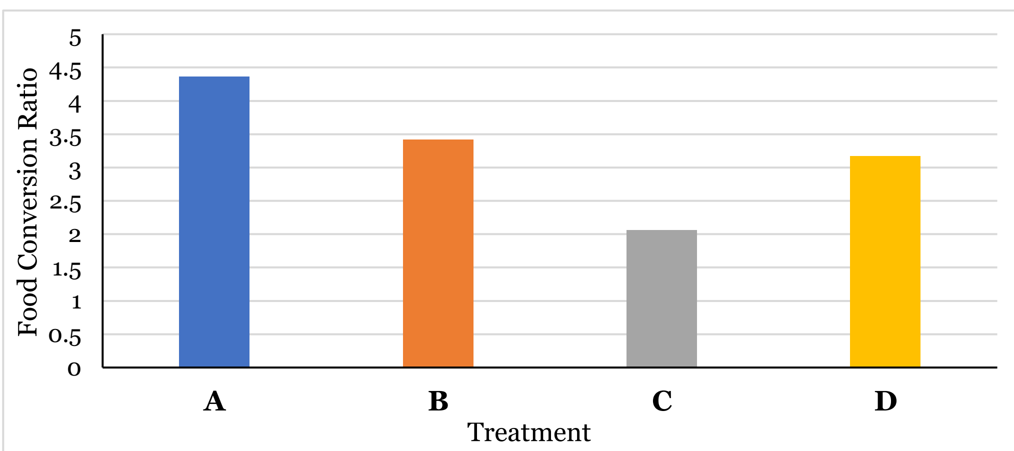

Figure (7): Food conversion ratio of experiment fish.

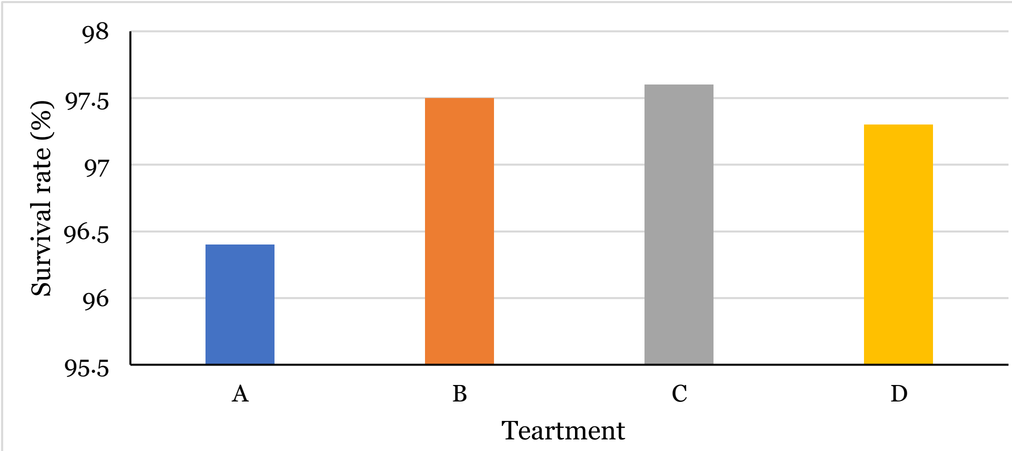

Figure (8): Survival Rate of Experiment Fish.

Discussion

The results indicate that the water quality parameters are appropriate for rearing juvenile Nile tilapia, as Abdel-Hakim *et al.* (2002) and Abdelhamid *et al.* (2002) noted. These values are acceptable for breeding this type of fish, so they do not affect feeding activity. The current study showed that Nile tilapia juveniles fed three times a day achieved the highest growth performance, which is evident from the total weight gain and the best feed conversion rate, as growth and feed conversion rate are affected by nutrition. The results were inconsistent with the study of Daudpota *et al.* (2016) when Nile tilapia was fed four times a day, and the reason may be due to the composition of the feed, the experimental conditions, and the used rearing system and method. Sometimes, high feeding leads to adverse results (Hung *et al.*, 1993) (Ng *et al.*, 2000).

Feeding more than three times a day above the satiation level of the fish leads to feed waste. Moreover, when feeding once or twice a day, the fish showed the lowest growth rate, which was explained by the nutrient requirements for maintenance. A large proportion of the nutrients in the feed were used to maintain life, and only a small proportion of them remained for growth. As a result, the higher growth of Nile tilapia Nile tilapia has better feed conversion, and this is consistent with findings for other fishes such as Mystus nemurus (Ng *et al.*, 2000) and grass carp Ctenopharyngodon idella (Du *et al.*, 2006). Also, in this study, feeding the fish thrice daily produced better relative and specific growth rates, showing that feeding three times is suitable for Nile tilapia growth. All four treatments had high survival rates, indicating adequate environmental conditions and feeding. The feeding frequency varied among the first, second, and fourth treatments, which were provided once, twice, and four times a day, respectively.

This variation was reflected in the feed conversion rates, with the third treatment exhibiting the lowest rates. The feed conversion ratios of Nile tilapia in this study were 4.36, 3.42, 2.06, and 3.17 in the first to fourth feeding regime, while Thongprajukaew *et* *al*. (2017) working on sex-reversed Nile tilapia (*O. niloticus*) revealed the ratios to be 1.07-1.5. The difference in feed conversion ratios can be explained by the size of the fish and the water temperature, as noted by Priestley *et al*. (2006). The feed conversion ratio measures how feeds are converted into body weight in fish; a lower ratio indicates higher efficiency. Sung Yong and Venmathi (2015) studied rock bream (*Oplegnathus fasciatus*), finding no changes in FCR when they adjusted the feeding frequency. Costa Bomfim and colleagues (2014) found that changing the feeding frequency for cobia (*Rachycentron canadum*) showed no impact on the feed conversion ratio (FCR). Busti *et al*. (2020) also found that the feed conversion ratio of seabream (*Sparus aurata*) did not differ significantly across different feeding schedules. In contrast, our research revealed a disparity in feed conversion ratios among the four feeding frequencies examined.

Conclusion

This study showed that feeding Nile tilapia three times a day leads to growth rates and efficient feed conversion in controlled environments, making it the preferred feeding schedule to follow. Additionally, the efficacy of feeding frequencies and the feeding habits of fish during studies are influenced by variables such as water temperature, dissolved oxygen concentration, and salinity in the water. The improvement of fish feeding practices requires an assessment of the impact of water temperature and fish size on growth, as well as the frequency of feeding on feed conversion efficiency. Additionally, it is essential to assess the energy and protein composition of the fish's food and to maintain water quality.

References:

Abdelhamid, A. M.; khalil, F. F.; El-Barbary, M. I.; Zaki, V. H. and Hussein, H. S. (2002). Feeding Nile tilapia on Biogen to detoxify aflatoxin diets. Proc. Con. Animal, Fish Prod. Mansoura, 24- 25 Sep., pp: 207-230.

Abdel-Hakim, N. F.; Bakeer, M. N. and Soltan, M. A. (2002). Water Environment for Fish Culture. Deposition No. 4774.

Aderolu, A. Z.; Lawal, M. O.; Eziefula, P. N. and Ahaiwe, E. E. (2017). Feeding frequency and feeding regime in catfish: effects on nutrient utilization, growth, biochemical and haematological parameters. J. Agri. Sci., 62: 395–410.

Al-Aswad, M. B. (2000). Meat Science and Technology, Ministry of Higher Education and Scientific Research, Dar Al-Kutub Foundation for Printing and Publishing, University of Mosul. 139 pp.

Al-Dubakel, A. Y.; Al-Hamadany, Q. H. and Jabir, A. A. (2014). The relationship between the diet flavor and feeding sequence on the growth of common carp (*Cyprinus carpio* L.) fingerlings. Basrah J. Agric. Sci., (Special Issue) 26(2):130-142.

Al-Hamadany, Q. H.; Shihab, H. A.; Mahdi, A. A.; Yesser, A.T. and Mankhi, J. R. (2009). Effect of daily feeding frequency and feed conversion on juvenile common carp *Cyprinus carpio* L. Basrah Journal of Veterinary Research, 8 (2): 70-77.

Al-Rawi, K. M. and Khalaf Allah, A. M. (2000). Design and Analysis of Agricultural Experiments, Dar Al-Kutub for Printing and Publishing, University of Mosul, 488 pp.

AOAC. (2006). Association of Official Analytical Chemists Official Methods of analysis, 15th ed., Washington, DC., USA.

Aydin, I.; Küçük, E.; Sahin, T. and Kolotog lu, L. (2011). The effect of feeding frequency and feeding rate on growth performance juvenile black sea turbot (*Psetta maxima*). J. Fish. Sci. com. 5, 35–42. https://doi: 10.3153/jfscom.2011004.

Azrita, A.; Syandri, H. and Adnestasia, L. (2020). Feed Conversion Ratio of Gurami Sago (*Osphronemus Goramy*) Fingerlings in A Recirculating Aquaculture Pond System. The 8th International and National Seminar on Fisheries and Marine Science. Earth and Environmental Science, 430: 1-7. DOI 10.1088/1755-1315/430/1/012029.

Bhuiyan, M. R. R.; Zamal, H.; Billah, M. M.; Bhuyan, M. S.; Asif, A. A. and Rahman, M. H. (2018). Proximate composition of fish feed ingredients available in Shibpur Upazila, Narsingdi district, Bangladesh, Journal of Entomology and Zoology Studies, vol. 6, pp.1345–1353.

Busti, S.; Bonaldo, A.; Dondi, F.; Cavallini, D.; Yúfera, M.; Gilannejad, N.; Moyano, F. J.; Gatta, P. P. and Parma, L. (2020). Effects of different feeding frequencies on growth, feed utilisation, digestive enzyme activities and plasma biochemistry of gilthead sea bream (*Sparus aurata*) fed with different fishmeal and fish oil dietary levels. Aquaculture, 529:735616. https://doi.org/10.1016/j.aquaculture.2020.735616.

Costa-Bomfim, C. N.; Pessoa, W. V. N.; Oliveira, R. L. M.; Farias, J. L.; Domingues, E. C.; Hamilton, S. and Cavalli, R.O. (2014). The effect of feeding frequency on growth performance of juvenile cobia, *Rachycentron canadum* (Linnaeus, 1766). Journal of Applied Ichthyology. 30:135–139. https://doi.org/10.1111/jai.12339

Daet, I. (2019). Study on culture of sea bass (*Lates calcarifer*) inhapa-in-pond environment. Earth Environ. Sci. 230, 1755–11315.

Daudpota, A. M.; Abbas, G.; Kalhoro, I. B.; Shah, S. S. A.; Kalhoro, H.; Rehman, M. H. and Ghaffar, A. (2016). Effect of Feeding Frequency on Growth Performance, Feed Utilization and Body Composition of Juvenile Nile Tilapia, *Oreochromis niloticus* (L.) Reared in Low Salinity Water. Pakistan Journal of Zoology, 48(1): 171-177.

Davies, O. A.; Inko-Tariah, M. B. and Amachree, D. (2006). Growth response and survival of Heterobranchus longifilis fingerlings fed at different feeding frequencies. Afr. J. Biotechnol., 5: 778-787.

Du, Z.Y.; Liu, Y.J.; Tian, L.X.; He, J.G.; Cao, J.M. and Liang, G.Y. (2006). The influence of feeding rate on growth, feed efficiency and body composition of juvenile grass carp (*Ctenopharyngodon idella*). Aquacult. Int., 14: 247–257.

Dwyer, K. S.; Brown, J. A.; Parrish, C. and Lall, S. P. (2002). Feeding frequency affects food consumption, feeding pattern and growth of juvenile yellowtail flounder (*Limanda ferruginea*). Aquacul- ture, 213 (1–4): 279–292. https://doi.org/10.1016/S0044-8486(02)00224-7

Hassan, H. U.; Gabol, K.; Wattoo, J.; Chatta, A. M.; Ali, Q. M.; Mahmood, K.; Hussain, M.; Abro, N. A.; Attaullah, M.; Rahman, S. U.; Rashid, A.; Rahman, M. A. and Hossain, M. Y. (2021). First Pacific White shrimp, *Litopenaeus vannamei* (Boone, 1931) culture in Pakistan: evaluation of optimum salinity level for the growth performance and survival in the hypo saline and hyper saline condition under pond ecosystem. The J. Anim. Plant Sci. 31 (5), 1018–7081. https://doi.org/10.36899/JAPS.2021.5.0351

Hung, S.S.O.; Conte, F.S. and Hallen, E.F. (1993). Effects of feeding rates on growth, body composition and nutrient metabolism in striped bass (*Morone saxatilis*) fingerlings. Aquaculture, 112: 349–361.

Gokcek, C. K.; Mazlum, Y. and Akyurt, I. (2008). Effects of feeding frequency on the growth and survival of Himri barbell and *Barbus luteus* fry under laboratory conditions. Pak. J. Nutr., 7(1): 66-69.

Guo, Z.; Cui, J.; Li, M.; Liu, H.; Zhang, M.; Meng, F.; Shi, G.; Wang, R.; He, X. and Zhao, Y. (2018). Effect of feeding frequency on growth performance, antioxidant status, immune response and resistance to hypoxia stress challenge on juvenile Dolly varden char (*Salvelinus malma*). Aquacult., 486, 197–201. https://doi.org/10.1016/j.aquaculture.2017.12.031

Lee, S. M. and Pham, M. A. (2010). Effects of feeding frequency and feed type on the growth, feed utilization and body composition of juvenile olive flounder, (*Paralichthys olivaceus*). Aquacult. Res. 41:166–171. https://doi.org/10.1111/j.1365-2109.2010.02491.x

Mavraganis, T.; Onstantina, C. C.; Kolygas, M.; Vidalis, K. and Nathanailides, (2020). Environmental issues of Aquaculture development. Egypt. J. Aquat. Biol. Fish. 24, 441–450. DOI: 10.21608/ejabf.2020.85857

Ng, W.K.; Lu, K.S.; Hashim, R. and Ali, A. (2000). Effects of feeding rate on growth feed utilization and body composition of a tropical bagridae catfish. Aquacult. Int., 8: 19–29.

NRC (2011). Nutrient Requirements of Fish and Shrimp, National Academies Press, Washington, DC, USA, 392p. https://doi.org/10.17226/13039.

Okomoda, V. T.; Aminem, W.; Hassan, A. and Martins, C. O. (2019). Effects of feeding frequency on fry and fingerlings of African cat fish (*Clarias gariepinus*). Aquacult., 511, 1–6. https://doi.org/10.1016/j.aquaculture.2019.734232.

Priestley, S. M.; Stevenson, A. E. and Alexander, L. G. (2006). The influence of feeding frequency on growth and body condition of common Goldfish, Carassius auratus. American Society for Nutrition. J. Nutr. 136: 19795- 19815.

Silva, E. C.; Sterzelecki, F. C.; Musialak, L. A.; Sugai, j. k.; Castro, j. j. p.; Pedrotti, F. S.; Magnotti, C.; Cipriano, F. S. and Cerqueira, V. R. (2020). Effect of feeding frequency on growth performance, blood metabolites, proximate composition and digestive enzymes of Lebranche mullet (*Mugil liza*) juveniles. Aquaculture Research, vol. 51, pp. 1162–1169. https://doi.org/10.1111/are.14466

Spss (2000). SPSS for windows base system user's guide, release 10.0 Chicago, USA.
Sung-Yong, O. and Venmathi, M.B.A. (2015). Feeding frequency influences growth, feed consumption and body composition of juvenile rock bream (*Oplegnathus fasciatus*). Aquaculture International 23(1):175–184.
Sveier, H.; Raae, A. J. and Lied, E. (2000). Growth and protein turnover in Atlantic salmon (*Samosalar L.*), the effect of dietary protein level and protein particle size.Aquaculture, Vol.185,pp.101-120.2000.
Thongprajukaew, K.; Kovitvadhi, S.; Kovitvadhi, U. and Prepramec, P. (2017). Effects of feeding frequency on growth performance and digestive enzyme activity of sex reversed Nile tilapia (*Oreochromis niloticus*). Agri. Natur. Resour. 51, 292–298. https://doi.org/10.1016/j.anres.2017.04.005
Ul Hassan, H.; Ali, Q. M.; Khan, W.; Masood, Z.; Abdel-Aziz, M. F. A.; Ali Shah, M. I.; Gabol, K.; Wattoo, J.; Chatta, A. M.; Kamal, M.; Zulfiqar, T. and Hossain, M. d. Y. (2021). Effect of feeding frequency as a rearing system on biological performance, survival, body chemical composition and economic efficiency of Asian seabass *Lates calcarifer* (Bloch, 1790) reared under controlled environmental conditions. Saudi J. of Bio. Sci., 28(12): 7360–7366.

تأثير تكرار التغذية على نمو أسماك البلطي النيلي (*Oreochromis niloticus*) في النظام المغلق

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المستخلص

تهدف هذه الدراسة الى تقييم تأثير تكرار التغذية على النمو وكفاءة التحويل الغذائي ومعدل البقاء لأسماك البلطي النيلي (*Oreochromis niloticu*). تضمنت التجربة 80 سمكة، جميعها بحجم مماثل ومعدل وزنها 5.78 غم. استخدمت ثمانية احواض سعة 45 لترا وكل حوض احتوى على عشر أسماك وبواقع مكررين لكل معاملة تغذية. تم توزيع الأسماك إلى أربع فئات بناء على تكرار تغذيتها: مرة يوميا (A)، مرتين يوميا (B)، ثلاث مرات يوميا (C)، وأربع مرات يوميا (D). تم تغذية الأسماك بمعدل يومي قدره 3٪ من وزن الجسم. لوحظت أعلى زيادة في الوزن (12.52) غم ومعدل النمو النسبي (214.57) % ومعدل النمو النوعي (2.605).

الكلمات المفتاحية: تكرار التغذية، أداء النمو، البلطي النيلي، معدل البقاء .