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Effect of feeding ratio on the growth of common carp cultivated in earthen ponds

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Abstract

The current experiment was conducted in earthen ponds at the Agricultural Research Station belonging to the Aquaculture Unit- Agriculture College at Basrah University, Al-Hartha District about 16 km northern-east of Basrah Governorate (30°39`20.264"N, 47° 44`51.533"E) from 25th July to 23rd October 2021. The feeding experiment begin after ten days of fish acclimation. Six small earthen ponds (600 m²) were used for the current experiment to investigate the differences in growth criteria for 200 individuals of common carp fed (2 T1, 3 T2 and 4 T3) % of total fish weight. Fishes were fed daily on commercial pellets manufactured by Agricultural Consultant Office belonging to Agriculture College. The total length and weight of fish were measured at the beginning and the end of the experiment, while subsamples of fish were weighed periodically and daily food changed after each weighing. Initial fish weights were 530.0± 132.7, 513.4±118.3 and 477.3±122.5 for T1, T2 and T3 respectively. Daily feed was divided into three meals, the first given early in the morning, the second at mid-day and the third given in the afternoon. Results of current experiments showed a high growth rate (FW= 1341.4 g, WI= 873.0 g, DGR=9.59 g/day and SGR=1.16 %/day) for fish fed on 4% feeding ratio compared with the two feeding ratios. Feed conversion rates were 2.46, 4.01 and 3.28 for T1, T2 and T3 respectively. Statistical analysis showed that there were no significant differences (P>0.05) between values of b with value 3 (Isometric pattern of growth) of common carp before and after the experiment. Statistical analysis of three models for condition factor proved that there were significant differences (P≤0.05) between the values before the experiment with values after the experiment, while there were no significant differences (P>0.05) after the experiment between different condition factors for common carp reared on different feeding ratio.

Key words: Feeding rate, final weight, daily growth rate, feed conversion rate.

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Introduction

It has been pointed according to the recent country reviews of FAO that fish ponds characteristics make it very suitable to produce cultivated fish in an integrated way (Hasan *et al*., 2007). It has been considered that the common carp, *Cyprinus carpio* was one of the most common species that generates an important part of the fish production in inland freshwater rearing systems. Common carp and grass carp, *Ctenopharyngodon idella* were introduced to inland waters in different regions around the world (Kırkağaç and Demir, 2006; Vilizzi *et al*., 2015; Khan *et al*., 2016). Common carp was the fourth most important freshwater cultivated species around the world in 2018 after grass carp, silver carp, *Hypophthalmichthys molitrix,* and Nile tilapia, *Oreochromis niloticus* (FAO, 2022). In Iraq, the main aquaculture rearing systems were ponds and floating cages, and the only commercially cultivated species is common carp, therefore many field and laboratory studies were conducted on this fish.

Common carp is very much favored for cultivation in ponds alone or in combination with other fishes, because of its excellent growth rate and omnivorous habit. Gyalog *et al*. (2017) revealed that common carp farming had a key role in the Blue Revolution at a global level and it was introduced into many countries around the world, in addition to Asia, Europe, Australia and North America.

Badilles *et al*. (1996) pointed out that the stocking rate and availability of natural food were most important factors that affected fish growth in earthen ponds. The added fish feed in earthen ponds supplements the natural food that provides all fish feeding requirements (Bolorunduro, 2002). Woynarovich *et al*. (2010) stated that supplementary feeding depends upon fish species and fish size in addition to the amount and kinds of available natural food, and this will be affected on important feed conversion rate.

The feeding ratio was an important tool in the fish culture industry and it depends on many factors such as fish species, fish size, stocking density, rearing system and environmental factors especially water temperature.

Woynarovich et al. (2010) stated that using and consuming of supplementary feeds depends upon fish species and size in addition to the quantity and quality of available natural food that effect on feeding conversion rate. One of the most important problems in fish culture was the

really feed quantity needed by cultivated fishes, so little or excessive feeds lead to many economic and environmental problems. The present study aims to determine the proper feeding ratio for common carp cult-ivated in the earthen pond that give better growth and low production cost.

Materials and Methods

The current experiment was conducted in earthen ponds at the Agricultural Research Station belonging to the Aquaculture Unit- Agriculture College at Basrah University, Al-Hartha District about 16 km northern-east of Basrah Governorate (30°39`20.264" N, 47° 44`51.533" E) from 25th July to 23rd October 2021. The feeding experiment begin after ten days of fish acclimation. Six small earthen ponds (600 m^2) were used for current experiment to investigate the differences of growth criteria for 200 individuals of common carp fed 2, 3 and 4 % of total fish weight. The average fish weight for T1 (2%) was 530.0 g, for T2 (3%) was 513.4 g and for T3 (4%) was 477.3 g.

Fishes were fed daily on commercial pellets manufactured by Agricultural Consultant Office belonging to Agriculture College using different ingredients ((Fishmeal 25%, wheat flour 28%, wheat bran 25%, barley 15%, soybean meal 5% and vitamins-minerals premix 2%). The total length and weight of fish were measured at the beginning and the end of the experiment, while subsamples of fish were weighed periodically and daily food changed after each weighing. Daily feed was divided into three meals, the first given early in the morning, the second at mid-day and the third given in the afternoon.

Temperature, pH and salinity of the water of ponds were measured at each sampling period. Throughout this period, five sampling data were collected to calculate the following equations:

Weight increments (WI, g) = FW – IW

Daily growth rate (DGR, g/day) = FW – IW / days

Specific growth rate (SGR, %/day) = 100 * [(ln FW) - (ln IW)] / days

Where: FW = Final fish weight (g); IW = Initial fish weight (g)

Length-weight relationship and condition factor were calculated for fish at the beginning and the end of the experiment for each treatment. The following equation was used to calculate the length-weight relationship:

$W = aL^b$ (Pauly, 1983).

Where W= weight of fish in g, L= Length of fish in cm, a = describe the rate of change in weight with length (intercept), and b = weight at unit length (slope). The condition factors (K) of common carp were estimated using the following equations:

1- Fulton's condition factor, the value of K was calculated according to Froese (2006):

$K3 = 100\ w/L^3$

2- Modified condition factor (Ricker, 1975) was estimated following Gomiero and Braga (2005):

$Kb = 100\ w/L^b$

3- Relative condition factor 'Kn' (Le Cren, 1951) was estimated following Sheikh *et al.* (2017):

$Kn = W/\ \hat{}w$

Where W= the actual total weight of the fish in g, ^w= the expected weight from length-weight equation formula. The results of the current experiment were conducted with a completely randomized design, and the differences between the means were tested by analysis of variance (ANOVA). The significant differences were tested by LSD test at 0.5% probability level by SPSS program Ver. 26.

Results

Table (1) shows the measurement of average fish weight with stranded deviation during the experiment for the three treatments. Water temperature ranged from 22 ^oC during October to 30 ^oC during August, pH ranged between 7.8-8.0 and salinity between 3.11-4.22 PSU. Table (2) display the growth criteria of the three treatments in the experiment. The highest average final weight (1341.4 g) achieved by common carp in T3, while the lowest (1048.2 g) was achieved by common carp in T2. Statistical analysis for FW showed significant differences ($P \leq 0.05$) between T3 with T1 and T2, while there were no significant differences ($P > 0.05$) between T1 and T2. The highest average weight increment (873.0 g) was achieved by common carp in T3, followed by 534.8 g achieved by common carp in T2, while the lowest

average weight increment (522.9) was achieved by common carp in T1. Statistical analysis for WI showed

Table 1: Measurements of average fish weight during the experiment with environmental parameters.

Date	Average Fish Weight (g) ±SD						Temp. (°C)	pH	Sal. (PSU)
	T1P1	T1P2	T2P3	T2P4	T3P5	T3P6			
25/7/2021	519.2 ±128.1	540.9 ±133.7	548.1 ±122.8	478.7 ±110.9	434.0 ±120.9	502.7 ±133.8	29	8.0	3.89
23/8	542.0 ±144.7	713.0 ±187.6	695.0 ±138.9	657.0 ±167.8	632.5 ±167.5	676.8 ±156.8	30	7.9	4.22
13/9	600.0 ±198.7	750.0 ±201.6	850.0 ±177.6	800.5 ±188.9	794.3 ±200.9	825.6 ±234.8	28	7.9	4.14
4/10	835.3 ±233.8	1012.0 ±222.0	1037.5 ±210.8	1008.9 ±296.7	1140.0 ±333.6	1197.4 ±321.9	25	7.9	3.34
23/10	1044.9 ±301.6	1061.0 ±254.9	1054.9 ±230.0	1076.1 ±363.0	1352.3 ±421.9	1330.4 ±403.7	22	7.8	3.11

Table 2: Growth criteria of fishes reared on three different feeding ratios.

Growth Criteria	T1 (2% FR)		T2 (3% FR)		T3 (4% FR)	
	P1	P2	P3	P4	P5	P6
FW	1044.9	1061.0	1020.3	1076.1	1352.3	1330.4
Average	**1052.9a**		**1048.2a**		**1341.4b**	
WI (g)	525.7	520.1	472.2	597.4	918.3	827.7
Average	**522.9a**		**534.8a**		**873.0b**	
DGR (g/day)	5.75	5.71	5.19	6.56	10.09	9.09
Average	**5.73a**		**5.87a**		**9.59b**	
SGR (%/day)	0.77	0.74	0.68	0.89	1.25	1.07
Average	**0.75a**		**0.78a**		**1.16b**	
FCR	2.22	2.69	4.60	3.41	3.04	3.51
Average	**2.46a**		**4.01a**		**3.28a**	

Different letters in one row are significantly different (P≤0.05).

significant differences (P≤0.05) between T3 with T1 and T2, while there were no significant differences (P>0.05) between T1 and T2.

Common carp in T3 recorded the highest average daily growth rate (9.59 g/day) followed by common carp in T1 which recorded 5.87 g/day, while the lowest (5.73 g/day) was recorded in T2. Statistical analysis for DGR showed significant differences (P≤0.05) between T3 with T1 and T2, while there were no significant differences (P>0.05) between T1 and T2. The highest average specific growth rate (1.16 %/day) was recorded by common carp in T3, while the lowest (0.75 %/day) was recorded in T1. Statistical analysis for SGR showed significant differences (P≤0.05) between T3 with T1 and T2, while there were no significant differences (P>0.05) between T1 and T2. Average feed conversion rates recorded were 2.46, 4.01 and 3.28 for T1, T2 and T3 respectively. Statistical analysis for FCR showed no significant differences (P>0.05) between common carp in the three treatments.

Table (3) showed data on the length and weight of common carp before and after the experiment. Average length increases were 6.7, 6.0 and 8.9 cm for T1, T2 and T3 respectively. Maximum length (50.5 cm) and maximum weight were reached by T3. Weight ranges at the end of the experiment were 654-1820, 620-1930 and 650-2500 g for T1, T2 and T3 respectively. Figure (1) pointed out the length-weight relationship of common carp before the experiment. There was an isometric pattern of growth (b= 3.0231) for the common carp before the experiment. Figure (2) pointed out the length-weight relationship for the treatments after the end of the experiment with a positive allometric pattern of growth for common carp (b= 3.0333, 3.1573 and 3.5854 for T1, T2 and T3 respectively).

Table (4) illustrates the parameters of the length weight-relationship for common carp before and after the experiment. Statistical analysis showed that there were no significant differences (P>0.05) between values of b with value 3 (Isometric pattern of growth) of common carp before and after the experiment.

Table (5) show three models of condition factors for common carp before and after the experiment. The values of Kb were 1.2249 before the experiment and 1.3931, 1.3512 and 1.4182 for T1, T2 and T3 after the experiment respectively. The values of Kn were 1.0894 before the

experiment and 1.0022, 0.9720 and 1.0203 for T1, T2 and T3 after the experiment respectively. The values of K3 were 1.3290 before the experiment and 1.5764, 1.5280 and 1.607 for T1, T2 and T3 after the experiment respectively. Statistical analysis of three models for condition factor proved that there were significant differences ($P \leq 0.05$) between the values before the experiment with values after the experiment, while there were no significant differences ($P > 0.05$) after the experiment between different condition factors for common carp reared on different feeding ratio.

Table 3: Data on the length and weight of common carp before and after the experiment.

Treatments	Length range (cm)	Weight range (g)	Mean length (cm)	Mean Weight (g)
Before experiment	26.6-39.4	216-805	34.3	504.0
After experiment				
T1(2% FR)	33.0-47.0	654-1820	41.0	1053.0
T2 (3% FR)	32.5-49.0	620-1930	40.3	1056.5
T3 (4% FR)	34.4-50.5	650-2500	43.2	1341.4

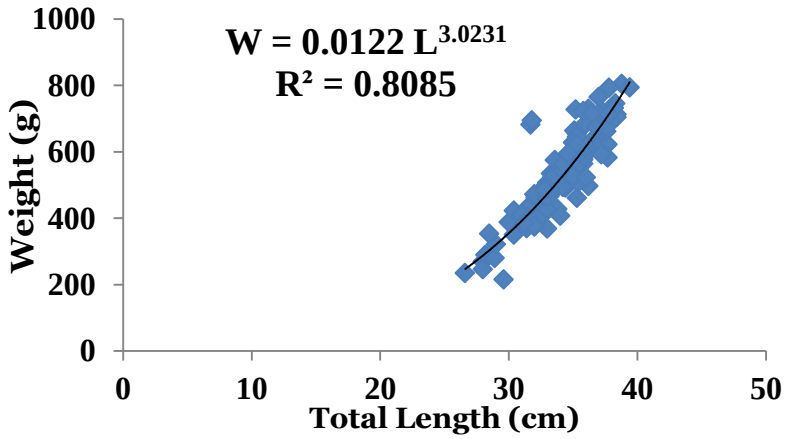

Figure 1: Length-weight relationship for common carp at the beginning of the experiment.

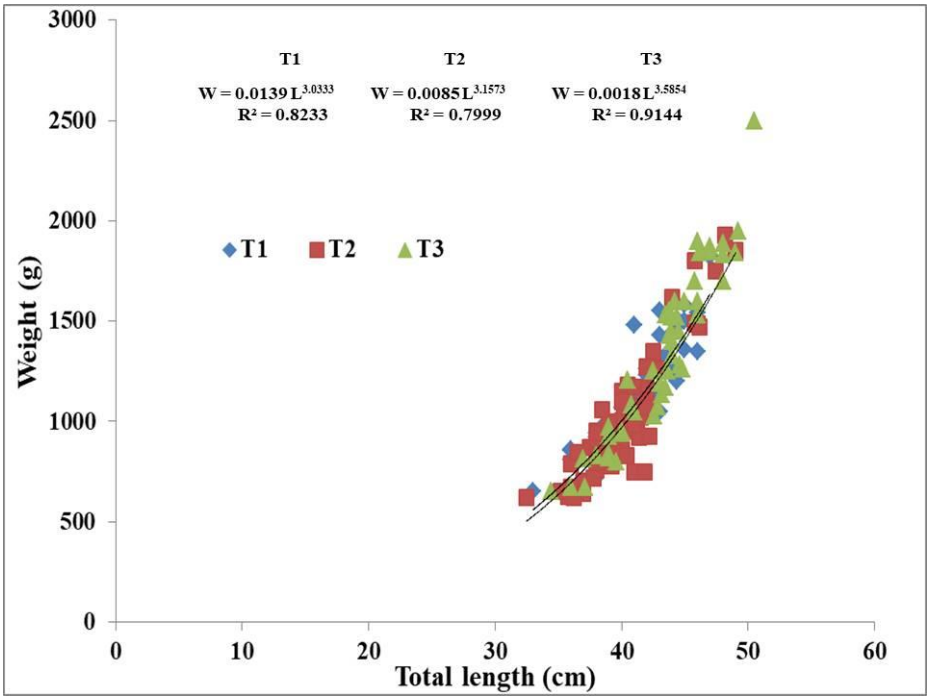

Figure 2: Length-weight relationship for three treatments of common carp at the end of the experiment.

Table 4: Equation parameters of length-weight for common carp before and after the experiment.

Treatments	**a**	**b**	**R2**	**t value (calculated)**	**Significance of t**
Before experiment	0.0122	3.0231	0.8085	0.0018	0.4994
After experiment					
T1 (2% FR)	0.0139	3.0333	0.8233	0.0030	0.4990
T2 (3% FR)	0.0085	3.1573	0.7999	0.0050	0.4984
T3 (4% FR)	0.0018	3.5853	0.9144	0.0136	0.4957

Table 5: Condition factors of common carp before and after the experiment.

Treatments	Condition factors		
	Modified condition factor Kb= 100 W/ Lb	Relative condition factor Kn= W/ W^	Fulton's condition factor K3= 100 W/ L3
Before experiment	1.2249±0.1467 a	1.0894±0.1303a	1.3290±0.1590a
After experiment			
T1 (2% FR)	1.3931±0.1460b	1.0022±0.1050b	1.5764±0.1651b
T2 (3% FR)	1.3512±0.1658b	0.9720±0.1193b	1.5280±0.1880b
T3 (4% FR)	1.4182±0.1486b	1.0203±0.1069b	1.6077±0.1705b

Different letters in one column are significantly different (P≤0.05).

Discussion

Piska and Naik (2013) stated that the feeding requirements of any reared fish depend on many factors such as species, fish size and other environmental parameters (water temperature, physiological situation, stress). It is well known that the optimum water temperature for the cultivation of common carp ranged between 25-28 ^{o}C. In the current experiment nearly all environmental factors were as optimum for the growth of common carp. Pfeiffer and Lovell (1990) stated that fishes of warm water environments lowering feeding activity when the temperature drops below 26 ^{o}C and also above 30 ^{o}C. Laiz-Carrión *et al.* (2005) stated that osmoregulation metabolism for cultivated fishes increased with increasing the salinity and lead to negative effects on the growth and feed conversion. It is well known that common carp could survive in high salinities but its growth is extremely affected at more than 7 ppt.

Filizadeh *et al.* (2005) recorded many factors (water temperature, salinity, dissolved O_2, fish age and stocking densities) had effects on the growth of grass carp reared in earthen ponds.

It has been stated that the main function of most earthen ponds is fish production which depends on the utilization of the natural production potential of the ecosystem (Petrea *et al.*, 2017). The results of the current experiment revealed important fact for the cultivation of common carp in earthen ponds. This fact about the feeding ratio revealed that common carp of 500 g weight and more need 4% feeding ratio. This fact may be confirmed by the result (5% feeding ratio) of Taher *et al.* (2014) when cultivating common carp in floating cages. Taher *et al.* (2021) found a high growth rate of common carp cultivated with grass carp compared with common carp cultivated alone and concluded that the feeding ratio (3%) seem don't enough for common carp and it consumed the residual feeds of grass carp, therefore they recommended feeding ratio of 4% or 5% for cultivated common carp.

The daily growth rate (9.59 g/day) achieved by common carp fed 4% feeding ratio in the current experiment was higher than DGR recorded by many studies. Taher *et al.* (2021) recorded DGR of 3.72 and 5.92 g/day for common carp reared alone and with grass carp respectively. Taher *et al.* (2014) investigated three feeding ratios (3, 5 and 7% of fish weight) for common carp cultivated in floating cages and found the best results at 5% feeding ratio where DGR is 3.16 g/day. Albahadly *et al.* (2021) recorded DGR range of 3.26-4.73 for graded and ungraded cultivated common carp in floating cages. Taher *et al.* (2018) recorded DGR of 4.87 for common carp cultivated in a semi-closed system. Feed conversion rates recorded in the current experiment were at the limits of FCR recorded by other researchers. Taher *et al.* (2014) recorded an FCR of 2.63 for common carp cultivated in floating cages at 5% feeding ratio. Taher (2020) recorded FCR range of 2.56-7.07 for common carp fed on four imported floating pellets. Taher *et al.* (2018) recorded an FCR of 2.12 for common carp cultivated in a semi-closed system.

It is well known that the length-weight relationship was an important tool for fisheries and fishery management. Results of the current experiment revealed positive allometric pattern growth were b values are 3.0333, 3.1573 and 3.5853 for common carp in T1, T2 and T3 respectively. A negative allometric growth was recorded for common carp cultivated in Mid Hill Region, (Kumar *et al.*, 2014) while Singh *et al.* (2015) recorded a positive allometric growth pattern for common carp reared in Bengal.

In Little Zab River, Northern Iraq, Rashid *et al.* (2018) mentioned a negative allometric growth pattern (b = 2.574) for common carp. Similar results have been found for the common carp population in Gölhisar Lake (Alp and Balık, 2000) and in Lake İznik (Tarkan *et al.* 2006).
Positive allometric growth (b=3.319) was recorded for some populations of common carp in Almus Dam Lake (Karataş *et al.*, 2007), and also the same result in Ömerli Reservoir was recorded by Vilizzi *et al.* (2013). Taher *et al.* (2022) recorded positive allometric patterns for the five treatments investigated inside and outside cages located in an earthen pond. These variations in b value may be attributed to different factors such as environmental conditions, feeding practice, fish size, sex and maturity.

Results of the current experiment showed significant differences (P≤0.05) in the three types of condition factors before and after experiments. Singh *et al.* (2015) stated that the relative condition factor (Kn) for common carp reared in Bengal varied from 0.93 to 1.10 in male and from 0.95 to 1.19 in females, while Das *et al.* (2019) found (Kn) more than 1 in both sexes of common carp in the river Ganga, Allahabad. Taher et al. (2021) recorded Kb 0.31 for common carp cultivated with grass carp and 0.98 for common carp cultivated alone, while K3 of 1.47 for common carp cultivated with grass carp and 1.35 for common carp cultivated alone. Al-Dubakel *et al.* (2022) recorded (Kb) between 0.19-0.79 and (Kn) 1.38-1.56 for common carp cultivated in cages (different stocking densities) and earthen ponds.

Conclusion

It was concluded from the results of the experiment that better feeding ratio for common carp cultivated in earthen ponds was 4% of total fish weight from economic and production view. This feeding ratio for initial weight of nearly 500 g and it may be more than this value in young common carp.

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تأثير نسبة التغذية في نمو اسماك الكارب الشائع المستزرعة في الاحواض الارضية

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المستخلص

اجريت الدراسة الحالية في الاحواض الارضية لمحطة البحوث الزراعية في الهارثة والتابعة لوحدة الاستزراع المائي-كلية الزراعة-جامعة البصرة والتي تقع شمال شرق محافظة البصرة (47^{o} 30°65`64.6"N, 74`79.5"E) للفترة من 25 تموز ولغاية 23 اوكتوبر عام 2021. بدأت تجربة التغذية بعد عشرة ايام اقلمة للأسماك في ست احواض مساحة 600 متر مربع (200 سمكة لكل حوض) لفحص الاختلافات في معايير النمو لأسماك الكارب الشائع المغذات على نسبة تغذية 2% (المعاملة الاولى) و 3% (المعاملة الثانية) و 4% (المعاملة الثالثة). غذيت الاسماك يوميا على عليقة حبيبات تجارية مصنعة من قبل معمل اعلاف المكتب الاستشاري الزراعي لكلية الزراعة. قيس كل من الطول الكلي والوزن للأسماك في بداية ونهاية التجربة واخذت عينات دورية لقياس وزن الاسماك وتعديل كمية الغذاء اليومي. الوزن الابتدائي للأسماك $530.0_{\pm 132.7}$ و$513.4_{\pm 118.3}$ و 477.3 $_{\pm 122.5}$للمعاملات الثلاث على التوالي. قسمت كمية الغذاء اليومي الى ثلاث وجبات، تعطى الاولى عند الصباح الباكر والثانية عند منتصف النهار والثالثة عند العصر. اظهرت نتائج الدراسة الحالية معدلات نمو عالية (الوزن النهائي 1341.4 غم، الزيادة الوزنية 873.0 غم، معدل النمو اليومي 9.59 غم/يوم، معدل نمو نوعي 1.16 %/يوم) للمعاملة الثالثة مقارنة مع العاملة الاولى والثانية. سجلت الاسماك معدل تحويل غذائي قدره 2.46 و 4.01 و3.28 للمعاملة الاولى والثانية والثالثة على التوالي. اظهر التحليل الاحصائي للنتائج عدم وجود فروق معنوية ($P>0.05$) بين قيم الانحدار (b) مع القيمة 3 (نموذج النمو المتماثل) لأسماك الكارب الشائع قبل وبعد التجربة، بينما اظهر التحليل الاحصائي وجود فروقات معنوية ($P\leq0.05$) في النماذج الثلاث لمعامل الحالة قبل التجربة وبعدها، في حين لم توجد أي فروقات معنوية ($P>0.05$) في مختلف نماذج معامل الحالة للاسماك المغذاة على نسب تغذية مختلفة.

الكلمات المفتاحية: نسبة التغذية، الوزن النهائي، معدل النمو اليومي، معدل التحويل الغذائي.

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