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Growth comparison of common and grass carp cultivated in earthen ponds

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Abstract :The current experiment was conducted in earthen ponds at Agricultural Research Station belong to Aquaculture Unit- Agriculture College at Basrah University, Al-Hartha District about 16 km northern-east of Basrah Governorate (30º65`64.6"N, 47º 74`79.5"E) from 17th Feb. to 10th June 2021. Six small earthen ponds (600 m^2) were used to investigate the differences of growth criteria for common and grass carp [250 grass carp (T1); 125 grass carp+ 125 common carp (T2); 250 common carp (T3)]. Fishes were fed daily 3% of fish weight 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%, soya meal 5% and vitamins-minerals premix 2%). Total length and weight of fishes were measured at the beginning and at the end of the experiment, while subsamples of fishes were weighed periodically and daily food changed after each weighing. Daily feed was divided into three meals, the first given early on the morning, the second at mid-day and the third given at afternoon. Results of current experiment revealed that common carp have good growth criteria compared with grass carp. The best growth criteria recorded by common carp reared with grass carp (T2), where final weight was 898.8 g, weight increment was 663.2 g, daily growth rate was 5.92 g/day and specific growth rate was1.07 %/day. length-weight relationship for the treatments after the end of the experiment illustrated positive allometric pattern of growth for common carp and negative allometric growth pattern for grass carp. The results show little differences in the value of relative and Fulton's condition factors between before and after the experiment, while there were big difference in the values of modified condition factor before and after the experiment for common carp related to differences in the value of the slope (b).

Keywords: common carp, grass carp, earthen ponds

1. INTRODUCTION

Hasan *et al*. (2007) pointed that recent country reviews of FAO support the fact that fish ponds characteristics make it very suitable to produce cultivated fishes in an inexpensive integrated way. Grass carp, *Ctenopharyngodon idella* in the past was belonging to the family Cyprinidae and according to the recent phylogenetic studies it was belonging to Xenocypridinae family (Tan & Armbruster, 2018). Common carp, *Cyprinus carpio* consider as one of the most common species that generates an important part of the fish production in

inland freshwater rearing systems. Both species were introduced to inland waters for different regions around the world (Kırkağaç & Demir, 2006; Vilizzi *et al*., 2015; Khan *et al*., 2016). Cudmore & Mandrak (2004) stated that grass carp is a native fish to northwestern China and southeastern Russia, and it has been introduced into many countries for the purpose of vegetation control, while Durborow *et al*. (2007) pointed that this fish is normally used in rearing ponds to consume unwanted aquatic vegetation and filamentous algae. The report of FAO (2020) referred to grass carp in 2018 as most widely cultivated and commercially important freshwater fish species in the world, followed by silver carp, *Hypophthalmichthys molitrix,* and Nile tilapia, *Oreochromis niloticus* and the fourth important cultivated species was common carp. In Iraq, the main aquaculture rearing systems were ponds and floating cages, common carp production per hectare is much lower than other countries around the world with nearly nil grass carp production. This may be related to the absence of correct understanding on the scientific fish culture and management practices.

Grass carp is a herbivorous fish feeds on certain aquatic plants, while in early life it feed on zooplankton, but under culture conditions, can accept artificial pelleted feed, while it is prefer soft plants. Grass carp fingerling consume insect larvae and other invertebrates and even small numbers of fish fry, but juveniles in hatcheries fed on commercial pelleted diets and continue to consume pelleted diets throughout their lives (Masser, 2002). 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. Badilles *et al*. (1996) pointed that the most important factors affected the growth of cultivated fish were stocking rate and availability of natural food. Bolorunduro (2002) stated that the natural food in earthen fish ponds provides all fish feeding requirements and the added feed supplements the natural food. Woynarovich *et al.* (2010) stated that using of supplementary feeding depends upon fish species and fish size in addition to quality and quantity of natural food, and this will be affected on important feed conversion rate.

Many field and laboratory studies were done in Iraq on common carp, in contrast, limited field studies were conducted on grass carp in Iraq (Al-Seyab, 1996; Saleh *et al*., 2008; Taher, 2020a), while most studies were focused on laboratory experiments (Al-Dubakel *et al*., 2011; Jaafar & Ahmed, 2011; Al-Shkakrchy & Ahemed, 2013; Talal, 2013; Al-Maliky, 2017; Taher, 2017; Sayed-Lafi *et al.,* 2018; Taher, 2020b; Al-Dubakel *et al*., 2020; Abdullah *et al.*, 2020). The present study aims to compare the growth of common carp and grass carp cultivated in earthen ponds with the growth of both fishes cultivated together.

2. MATERIALS AND METHODS

The current experiment was conducted in earthen ponds at Agricultural Research Station belong to Aquaculture Unit- Agriculture College at Basrah University, Al-Hartha District about 16 km northern-east of Basrah Governorate (30º65`64.6"N, 47º 74`79.5"E) from 17th Feb. to 10th June 2021. Feeding experiment begin after eight days of fish acclimation. Six small earthen ponds (600 m^2) were used for current experiment to investigate the differences of growth criteria for common and grass carp [250 grass carp in pond 1 and 2 (T1); 125 grass carp+ 125 common carp in pond 3 and 4(T2); 250 common carp in pond 5 and 6 (T3)]. Average grass carp weigh for T1 was 202.2 g, average grass weight for T2 was 272.4 g and average common carp weigh for T2 was 235.6, while average common carp weigh for T3 was 178.7 g.

Fishes were fed daily 3% of fish weight 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%, soya meal 5% and vitamins-minerals premix 2%). Total length and weight of fishes were measured at the beginning and at the end of the experiment, while subsamples of fishes were weighed periodically and daily food changed after each weighing. Daily feed was divided into three meals, the first given early on the morning, the second at mid-day and the third given at afternoon.

Temperature, pH and salinity of the water of ponds were measured at each sampling period. Throughout this period, six 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 fishes at the beginning and at 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 the carps 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 & Braga (2005):

$Kb = 100\ w/L^b$

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

Kn = W/ ^w

Where W= the actual total weight of the fish in g, ^w= the expected weight from length-weight equation formula. Statistical software SPSS IBM (23) and Excel 2013 were used for analyzing the data.

3. RESULTS

Table (1) show the measurement of average fish weight with stranded deviation during the experiment for the three treatments. Water temperature ranged from 17 ^{0}C during Feb. to 28 ^{0}C during June, pH ranged between 7.8-8.1 and salinity between 3.14-4.21 ppt. Table (2) appear the growth criteria of the three treatments in the experiment. The highest average final weight (898.8 g) achieved by common carp in T2, while the lowest (265.6 g) achieved by grass carp in T1. Statistical analysis for FW showed significant differences ($P\leq0.05$) between the three treatments. The highest average weight increment (663.2 g) was achieved by common carp in T2, followed with 420.6 g achieved by common carp in T3, while the lowest average weight increment (63.4 g) was achieved by grass carp in T1. Statistical analysis for WI showed significant differences ($P\leq0.05$) between common carp in T2 and T3 and also between common and grass carp, while there were no significant differences ($P>0.05$) between the grass carp. Common carp in T2 recorded the highest average daily growth rate (5.92 g/day) followed by common carp in T3 that recorded 3.70 g/day, while the lowest (0.57 g/day) was recorded by grass carp in T1. Statistical analysis for DGR showed significant differences ($P\leq0.05$) between common carp in T2 and T3 and also

between common and grass carp, while there were no significant differences (P>0.05) between the grass carp. The highest average specific growth rate (1.07 %/day) was recorded by common carp in T2, while the lowest (0.23 %/day) recorded by grass carp in T1. Statistical analysis for SGR showed significant differences (P≤0.05) between common carp and grass carp, while there were no significant differences (P>0.05) between common carp in T2 and T3, and also between grass carp in T1 and T2. Average feed conversion rates recorded were 10.95, 8.58, 2.24 and 2.46 for T1, T2 grass, T2 common and T3 respectively. Statistical analysis for FCR showed significant differences (P≤0.05) between grass carp and common carp, while there were no significant differences (P>0.05) between grass carp in T1 and T2, and also between common carp in T2 and T3. Average mortality ratio recorded were 1.2, 2.4, 1.6 and 7.0% for T1, T2 grass, T2 common and T3 respectively. Statistical analysis for MR showed no significant differences (P>0.05) between the three treatments.

Table (3) showed data on length and weight of grass and common carp before and after the experiment. Average length increased recorded were 4.1, 4.2, 14.6 and 11.3 cm for T1, T2 grass, T2 common and T3 respectively. Figure (1) pointed out the length-weight relationship for grass and common carp before the experiment. There was an isometric pattern of growth (b= 3.0029) for the common carp in T2, while there were a negative allometric pattern of growth for grass carp in T1(b= 2.9073) and T2 (b= 2.5626), and also for common carp in T3 (b= 2.7358). Figure (2) pointed out the length-weight relationship for the treatments after the end of the experiment with positive allometric pattern of growth for common carp and negative allometric growth pattern for grass carp. Table (4) illustrate the parameters of the length weight-relationship for grass and 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 grass and common carp before and after the experiment.

Table (5) show three models of condition factors for grass and common carp at the beginning and the end of the experiment. The results show little differences in the value of K3 and Kn between before and after the experiment, while there were big difference in the values of Kb before and after experiment for common carp related to differences in the value of b. Statistical analysis proved that there were significant differences (P≤0.05) in modified condition factor (Kb) between common and grass carp and also between common carp in T2 and T3, while there were no significant differences (P>0.05) between grass carp in T1 and T2. There were no significant differences (P>0.05) in relative condition factor (Kn) between grass and

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

Date	Average weigh (g) ±standard deviation								**Environmental Factors**		
	T1P1	T1P2	T2P3		T2P4		T3P5	T3P6	Temp. (°C)	pH	Sal. (ppt)
			Grass	Common	Grass	Common					
24/2/2021	179.8 ±77.7	224.6 ±103.3	264.4 ±86.4	235.5 ±105.0	280.5 ±68.7	235.7 ±132.7	214.7 ±95.2	142.7 ±124.8	17	8.1	3.19
18/3	213.2	240.8 ±100.	300.0	365.9 ±130.7	290.9	350.0 ±177.7	258.8 ±110.	289.7 ±157.	22	7.8	3.34

	±75.7	0	±77.7		±77.5		7	7			
8/4	240.8 ±77.7	264.1 ±106.7	315.6 ±79.9	505.8 ±220.6	310.7 ±79.7	547.1 ±223.6	313.8 ±186.3	385.5 ±177.7	25	7.9	3.14
29/4	244.6 ±78.1	270.9 ±110.9	330.6 ±77.4	570.8 ±280.6	340.6 ±85.7	625.4 ±277.4	390.6 ±200.6	455.6 ±175.3	26	7.9	3.34
20/5	248.7 ±77.3	275.6 ±112.6	364.7 ±77.2	780.0 ±350.7	360.8 ±90.5	897.8 ±324.7	498.9 ±220.0	567.9 ±180.8	27	7.8	3.98
16/6	251.1 ±84.2	280.2 ±118.9	364.8 ±78.5	887.5 ±394.6	384.8 ±93.2	910.2 ±365.5	568 ±249.6	630.7 ±198.8	28	8.0	4.21

Table (2) Growth criteria of different treatments in the experiment.

Growth Criteria	Treatments							
	T1		T2				T3	
	P1	P2	P3		P4		P5	P6
			Grass	Common	Grass	Common		
FW	251.1	280.2	364.8	887.5	384.8	910.2	568	630.7
Average	**265.6 a**		**374.8 b**	**898.8 c**	**-**	**-**	**599.3 d**	
WI (g)	71.3	55.6	100.4	652.0	104.3	674.5	353.3	488
Average	**63.4 c**		**102.3 c**	**663.2 a**	**-**	**-**	**420.6 b**	
DGR (g/day)	0.64	0.50	0.90	5.82	0.93	6.02	3.15	4.36
Average	**0.57 c**		**0.91 c**	**5.92 a**	**-**	**-**	**3.70 b**	
SGR (%/day)	0.28	0.18	0.26	1.06	0.25	1.08	0.78	1.19
Average	**0.23 b**		**0.25 b**	**1.07 a**	**-**	**-**	**0.98 a**	
FCR	8.95	12.96	8.59	2.19	8.57	2.29	2.73	2.2
Average	**10.95 a**		**8.58 a**	**2.24 b**	**-**	**-**	**2.46 b**	
Mortality%	2.0	0.4	0	0	4.8	3.2	6.8	7.2
Average	**1.2 a**		**2.4 a**	**1.6 a**	**-**	**-**	**7.0 a**	

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

common carp, while there were significant differences (P≤0.05) in Fulton's condition factor (K3) between grass and common carp with no significant differences (P>0.05) between grass carp in T1 and T2 and also between common carp in T2 and T3.

Table (3) Data on length and weight of grass and common carp before and after the experiment.

Treatments	Length range (cm)	Weight range (g)	Mean length (cm)	Mean Weight (g)

Before experiment				
T1	18.6-31.8	75-416	25.4	229.6
T2 Grass	20.8-35.0	126-460	27.3	272.5
T2 Common	16.5-34.5	65-620	24.1	235.6
T3	16.4-33.5	70-590	23.7	232.7
After experiment				
T1	25.1-38.4	130-610	29.5	265.6
T2 Grass	27.2-40.2	250-575	33.1	374.8
T2 Common	33.2-47.5	540-1800	38.7	898.8
T3	27.4-45.0	300-1520	35.0	599.3

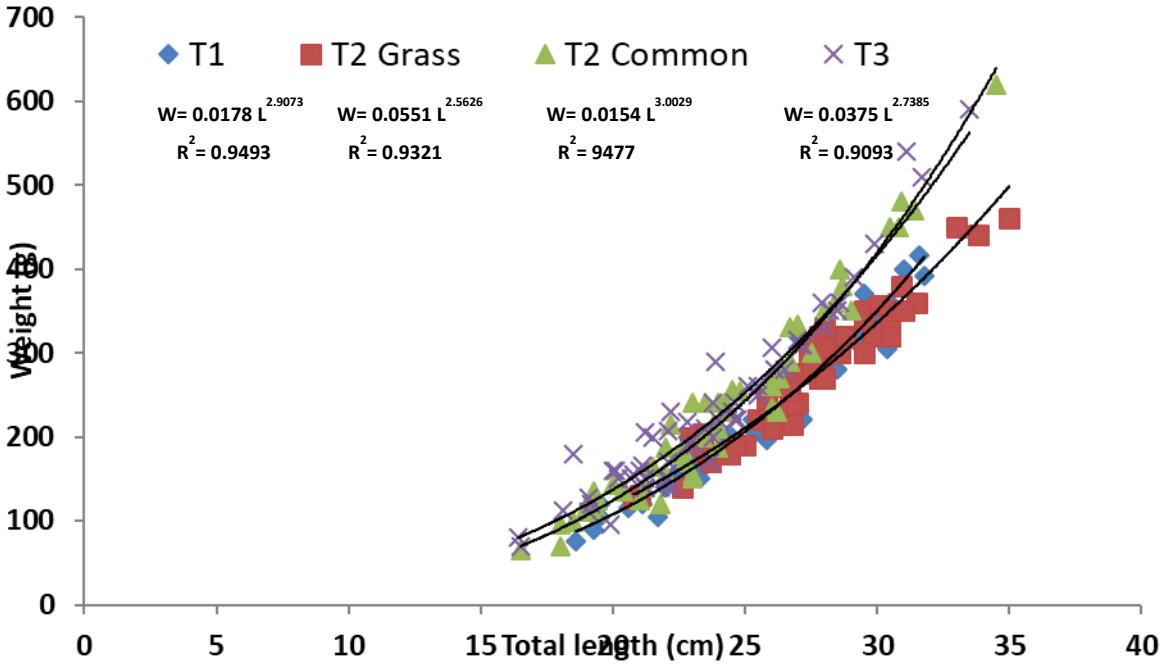

Figure (1) Length-weight relationship for grass and common carp before the experiment.

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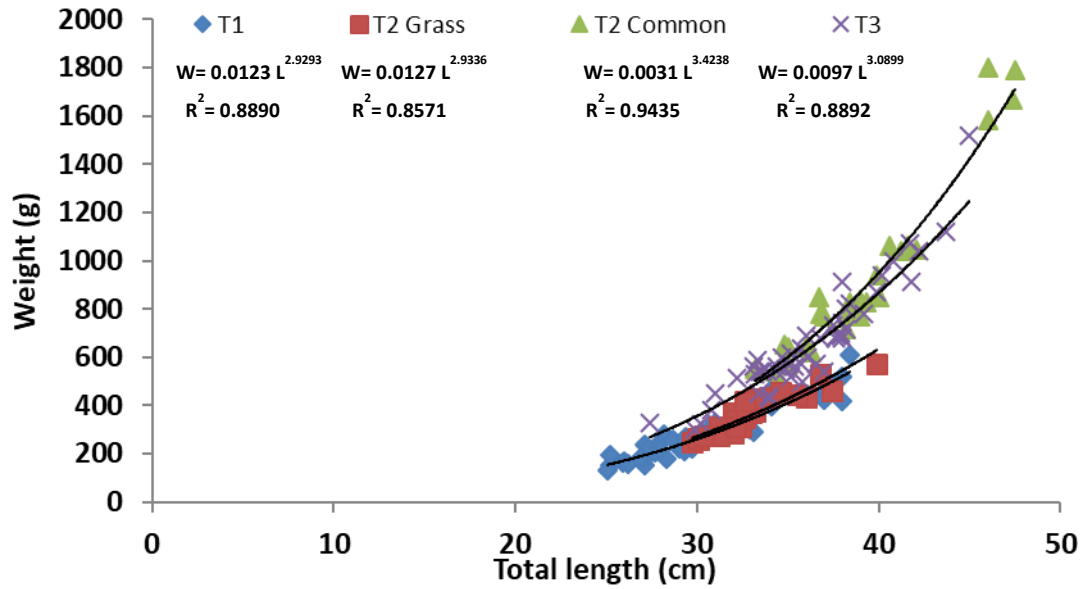

Figure (2) Length-weight relationship for grass and common carp after experiment.

Table (4) Equation parameters of Length-weight relationship for grass and common carp before and after the experiment.

Treatments	a	b	R2	t value (calculated)	Significance of t
Before experiment					
T1	0.0178	2.9073	0.9493	2.705958	0.113
T2 Grass	0.0551	2.5626	0.9321	2.007163	0.147
T2 Common	0.0154	3.0029	0.9477	2.164513	0.138
T3	0.0375	2.7385	0.9093	1.951507	0.151
After experiment					
T1	0.0123	2.9293	0.8571	0.914251	0.264
T2 Grass	0.0127	2.9336	0.8571	0.227709	0.429
T2 Common	0.0031	3.4238	0.9435	0.643879	0.318
T3	0.0097	3.0899	0.8892	2.089181	0.142

Table (5) Condition factors of grass and 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			
T1	$1.79_{\pm 0.17}$	$1.00_{\pm 0.10}$	$1.32_{\pm 0.13}$
T2 Grass	$5.53_{\pm 0.43}$	$1.00_{\pm 0.08}$	$1.31_{\pm 0.12}$
T2 Common	$1.55_{\pm 0.17}$	$1.01_{\pm 0.11}$	$1.56_{\pm 0.18}$
T3	$3.79_{\pm 0.54}$	$1.01_{\pm 0.14}$	$1.66_{\pm 0.26}$
After experiment			
T1	$1.24\ a_{\pm 0.15}$	$1.01a_{\pm 0.12}$	$0.97\ b_{\pm 0.12}$
T2 Grass	$1.27\ a_{\pm 0.11}$	$1.00\ a_{\pm 0.09}$	$1.01\ b_{\pm 0.09}$

T2 Common	0.31 $b_{\pm 0.03}$	1.01 $a_{\pm 0.08}$	1.47 $a_{\pm 0.14}$
T3	0.98 $c_{\pm 0.10}$	1.01 $a_{\pm 0.10}$	1.35 $a_{\pm 0.14}$

Different letters in one column is significantly different ($P \leq 0.05$).

4. DISCUSSION

Piska & Naik (2013) stated that there were many factors affected the feeding requirements of reared fishes such as species, fish size and other environmental parameters (water temperature, physiological situation, stress). Depending on the observation of many researchers around the world, the optimum water temperature for cultivation grass and common carp ranged between 25-28 ^{0}C. In current experiment nearly all environmental factors were as optimum for the growth of grass and common carp. Feeding activity of warm water fishes decreased when the temperature drops below 26 ^{o}C and also when increased to more than 30 ^{o}C (Pfeiffer & Lovell, 1990). Masser (2002) recorded optimum temperature for grass carp between 21-30 ^{o}C. Laiz-Carrión *et al*. (2005) stated that the metabolism for osmoregulation increased with salinity increasing leading to negative effects on the growth and feed conversion of cultivated fishes. Crivelli (1981) recorded common carps in brackish water marshes (salinity about 14 ppt) in southern France, while Barus *et al.* (2001) stated that common carps found in coastal areas of the Caspian and Aral seas, as well as in the estuaries of large Ukrainian and Russian rivers. It is well known that common carps could survive in high salinities but at more than 7 ppt the growth is extremely affected. Mangat & Hundal (2014) illustrate that common carp showed high appetitive behavior for feed between 0 to 6 ppt salinities.

Petrea *et al.* (2017) stated that in most earthen ponds the main function is the production of fishes depending on utilization of the natural production potential of the ecosystem. Many factors had effects on the growth of grass carp reared in earthen ponds such as water temperature, salinity, dissolved O_2, fish age and stocking densities (Filizadeh *et al*., 2005). Results of current experiment revealed many facts for cultivation grass and common carp in earthen ponds. The first fact was the slow growth (DGR, 0.57 and 0.91 g/day) and high feed conversion rate (10.59 and 8.58) for grass carp cultivated alone or with common carp respectively. This fact may attributed to herbivorous feeding habits of this fish, so it prefer soft plants rather than fish pelleted. The second obvious fact was high growth rate of common carp cultivated with grass carp comparing with common carp cultivated alone (FW, 898.8 g compare with 599.3 g, WI, 663.2 g compare with 420.6 g and DGR, 5.92 g/day compare with 3.70 g/day). This fact may be related to un preferring pelleted feed by grass carp, so common carp consume the residual pelleted feed. From previous results and facts it can be concluded that feeding ratio (3%) used in current experiment don't enough for common carp. For this reason feeding ratio of 4% or 5% is recommended for cultivated common carp. Taher *et al*. (2014) investigated three feeding ratio (3, 5 and 7% of fish weight) for common carp cultivated in floating cages and found best results at 5% feeding ratio (WI of 186.8 g, DGR of 3.16 g/day, SGR of 1.85 %/day and FCR of 2.63). Taher (2020a) found growth criteria (WI= 142.7g, DGR= 1.24 g/day, SGR= 1.00 %/day, FCR=3.91) for grass carp cultivated at the same ponds and at the same fish density. Taher (2020b) recorded growth criteria for common carp (WI of 484.5-411.4, DGR of 4.07-8.21 g/day, FCR of 2.56-7.07) when investigated four imported floating pellets. The value of FCR for grass carp in the current experiment is too high and not encouraging from an economical point of view. Many researchers recorded better FCR for grass carp such as Cremer *et al*.

(2002) who recorded 1.74, Essa *et al*. (2004) who recorded an FCR of 3.83, Cremer *et al*. (2004) recorded FCR values of 1.74 and finally Taher (2020a) pointed out that FCR for grass carp cultivated in earthen ponds at three stocking densities were 3.91, 5.06 and 4.19.

The length-weight relationship may differ for the same species in the population due to many factors and it was an important tool for fishery management. Results of the current experiment revealed that the growth pattern of grass carp and common carp reared alone were nearly isometric (b values were 2.9293, 2.9336 and 3.0899 for grass carp in T1, T2 and common carp in T3 respectively), while common carp reared with grass carp revealed positive allometric pattern of growth were b value was 3.4238. This result may be attributed to the same reasons mentioned above for growth rate. Negative allometric growth was found for grass carp in Balkhu live fish Market of Kathmandu, Nepal (Chitrakar and Parajuli, 2017). Jones *et al*. (2017) recorded b value of 3.0116 for grass carp caught from the Great Lakes basin, while Khalid and Naeem (2017) recorded 2.97 as b value for farmed grass carp from Muzaffar Garh, Southern Punjab, Pakistan. Shukla and Mishra (2017) found a very high value (4.018) of b for grass carp in Ranitalab pond. In Tudakul Reservoir of Uzbekistan Sobirov *et al*. (2019) recorded a 2.9205 as b value for grass carp. Taher (2020a) stated that the slope (b) for the length-weight relationship of grass carp cultivated in earthen ponds decreased with increasing stocking density and reached 2.8140 in high density (750 fish in 600 m^2). Kumar *et al*. (2014) pointed out that a negative allometric growth was recorded for common carp cultivated at Mid Hill Region, while a positive allometric growth pattern was recorded by Singh *et al*. (2015) for common carp reared in Bengal. Rashid *et al*. (2018) mentioned a negative allometric growth pattern (b = 2.574) for common carp stocks from Little Zab River, Northern Iraq. Similar results have been found for the common carp population of different locations around the world such as Lake İznik (Tarkan *et al.* 2006) and Gölhisar Lake (Alp and Balık, 2000). Karataş *et al*. (2007) recorded positive allometric growth (b=3.319) for some populations of common carp in Almus Dam Lake, and also Vilizzi *et al*. (2013) recorded the same result in Ömerli Reservoir. Taher *et al.* (2022) recorded positive allometric patterns for the five treatments investigated inside and outside cages located in 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 nearly the same relative condition factor (kn) for the two species after the experiment, while there were differences in the two other kinds of condition factor. The value (0.31) for modified condition factor (Kb) of common carp reared with grass carp may be related to the high value (3.4238) for b. Chitrakar and Parajuli (2017) recorded 1.18-1.85 as values of condition factor (K) for grass carp and 1.01-1.08 as relative condition factor (Kn) according to the season. Taher (2020a) recorded modified condition factor (Kb= 1.28-2.72), relative condition factor (Kn=1.00-1.02) and Fulton's condition factor (Kn= 1.17-1.20) for grass carp cultivated in earthen ponds at three different stocking densities. Singh *et al*. (2015) recorded relative condition factor (Kn) varied from 0.93 to 1.10 in male and 0.95 to 1.19 in female for common carp reared in Bengal. Das *et al*. (2019) studied length weight relationship of common carp in the river Ganga, Allahabad, and found (Kn) more than 1 in both sexes. Taher *et al.* (2022) recorded (Kb) between 0.19-0.79 and (Kn) 1.38-1.56 for common carp.

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