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Effects of Alien Organisms on Growth of Common Carp, *Cyprinus carpio* Cultivated in Earthen Ponds

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Abstract: The experiment was carried out at Basrah University's Agricultural Research Station- Aquaculture Unit- Agriculture College in six earthen ponds (600 m3). The study including of alien organisms effect on growth of common carp Cyprinus carpio. Using an agricultural shadow as a filtering fabric was put in inlets pipes (T1), while T2 without filters. Fishes was daily feeding by a commercial sinking pellets produced by Agriculture College's Agricultural Consultant Office, With a ratio of 3% from fishes weight. Fish weight and total length were measured at the start and finish of the experiment. Fish subsamples were weighed on a regular basis, and daily feed was modified following each weighing. At the end of the experiment the alien organism in all ponds were collected, classified and weighed individually except shrimp. The current experiment's results showed that there were notable differences ($P \leq 0.0.5$) in final weigh, increment, daily growth rate and feed conversion rate between fishes reared in ponds with and without filter. These differences may be related to differences in numbers and weighs of alien organisms in these ponds (97 individuals of six fish species in ponds without filter comparing with two individuals of one fish species in ponds with filter, and also 16314 g of shrimp in ponds without filter comparing with 440 g in ponds with filter). From the results of the current experiment, it can be concluded that culturist must use filters in inlet pipes of their ponds to prevent or reduced the entering of alien organisms to these ponds.

تأثير الاحياء الغريبة في نمو اسماك الكارب الشائع *Cyprinus carpio* المستزرعة في الاحواض الارضية

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المستخلص: اجريت الدراسة الحالية في ستة احواض ارضية (600 متر مكعب) تابعة لوحدة الاستزراع المائي في محطة البحوث الزراعية في الهارثة التابعة لكلية الزراعة - جامعة البصرة، لغرض فحص تأثير الاحياء الغريبة (غير المستهدفة في الاستزراع) على نمو اسماك الكارب الشائع، *Cyprinus carpio*. وضع المرشح المصنوع من شبكة الظلة الزراعية في مدخل المياه لثلاثة احواض (المعاملة الاولى) وتركت الثلاثة احواض اخرى من غير مرشح (المعاملة الثانية). غذيت الاسماك يوميا بنسبة تغذية قدرها 3% من الوزن الحي للأسماك باستعمال حبيبات علفية مركزة غاطسة مصنعة في معمل الاعلاف التابع للمكتب الاستشاري الزراعي لكلية

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الزراعة. تم قياس طول الاسماك الكلي ووزنها في بداية التجربة وفي نهايتها، بينما قيست اوزان الاسماك بشكل دوري وعدل الغذاء اليومي بعد كل قياس. في نهاية التجربة تم جمع كل الاحياء الغريبة في الاحواض ثم صنفت ووزنت افرادها ماعدا الروبيان الذي استخرج وزنه الكلي. اشارت نتائج الدراسة الحالية بوجود اختلافات معنوية ($P \leq 0.0.5$) في الوزن النهائي والزيادة الوزنية ومعدل النمو اليومي ومعدل التحويل الغذائي بين الاسماك المستزرعة بالأحواض المزودة بمرشح والاحواض الخالية منه. ربما تعود هذه النتائج الى الاختلافات في اعداد واوزان الكائنات الغريبة التي وجدت في الاحواض (97 سمكة تعود الى ستة انواع في الاحواض الغير مجهزة بمرشح مقارنة بسمكتين تعود لنوع واحد في الاحواض المجهزة بمرشح، اضافة الى 16314 غم من الروبيان في الاحواض ذات المرشح مقارنة بـ 440 غم من الروبيان في الاحواض الحاوية على مرشح). الاستنتاج العام من نتائج التجربة الحالية هو ضرورة استخدام مستزرعي الاسماك مرشحات في مدخل مياه الاستزراع لمنع او تقليل الاحياء الغريبة من الدخول الى احواض الاستزراع.

الكلمات المفتاحية: الاحياء الغريبة، معدل النمو اليومي، المرشحات، الوزن النهائي.

Introduction:

The total aquaculture Fish production represents for about 46% of global fish production in 2018, thus it needs to increase by at least five times to meet demand over the next 20 years (FAO, 2020). It must be initiate new production systems with high fish density such as recirculating aquaculture systems to face these increasing demands. Martins *et al*., 2010 mentioned that the expansion of traditional fish culture projects such as earthen ponds lead to deteriorate water quality and then reducing the capacity of these projects. The most common species that contributes significantly to inland freshwater fish production around the world was common carp, *Cyprinus carpio.* This species was nearly the alone cultivated species in Iraq which cultured in ponds and cages. Iraq produces far less common carp per hectare than other nations in the world because of uncorrected understanding of scientific fish cultivation and management techniques FAO (2022) stated that in 2020, common carp ranked as the fourth most significant freshwater cultivated fish worldwide after grass carp, *Ctenophayngon idella*, silver carp, *Hypophthalmichthys molitrix,* and Nile tilapia, *Oreochromis niloticus* (FAO, 2022).

Availability of natural food sources and stocking rates were the two main elements influencing the growth and productivity of farmed fish (Badilles *et al*., 1996; Hassan & Mahmoud, 2011; Roy *et al*., 2018). Determining the optimal fish densities for various cultivated species, as well as for the same species raised in various systems, is difficult, yet it's necessary to enhance fish health and financial gain.

Weimin & Diana (2009) explained that the preservation of native species is a significant concern for a number of Asian nations, as the introduction of foreign species is viewed with suspicion. The main effects of alien species were predation, competition, hybridization with native species that disrupt the processes and functions of ecosystems (Walsh *et al*., 2012). De Silva *et al*. (2007) recorded many reasons for the number of freshwater fish species that became extinct, endangered or becoming rare, and one of these reasons, was the introduction of alien species. So, the rerearches dealing with the impacts of alien species is very important to develop solutions for conservation problems (Richardson & Ricciardi, 2013). Introduction of alien species was done for improved aquaculture yield and biological control, but these species had the ability to alter ecosystem through many functions such as predation, hybridization, introduction of parasites, competition and alteration of existing food webs (Wellcome, 1988; Ogutu-Ohwayo & Hecky, 1991; FAO, 2004).

Freire & Prodocimo (2019) pointed out that the deleterious effect on the native fauna caused by Nile tilapia has been extensively reported worldwide, while Okun *et al.* (2008) stated that this fish made many changes for the native community structure and also reducing the abundance of planktonic micro crustaceans, lowering water transparency and increasing the abundance of microalgae. Mozambique tilapia, *Oreochromis mossambicus* is also known as invasive species that cause many environmental and ecological problems around the world (Canonico *et al.*, 2005). Casal (2006) reported 159 fish species introduced in philipines for aquaculture (18%), ornamental (77%), mosquito control (4%) and 1% for fisheris purpose, but 24% of these species recorded in natural environments. In Europe countries there were 1200 alien species and 11% of them are invasive, causing significant environmental, economic and social damage (FAO, 2015). It is well known that alien species considered invasive only if it had adverse impacts on environment, economy and human health. The objective of the current study to evaluate the impact of alien organisms on the growth of common carps cultivated in earthen ponds by using filter made from agricultural shadow.

Materials and Methods:

The experiment was carried out at the Aquaculture Unit of the Agriculture College at Basrah University's Agricultural Research Station, which located in 16 kilometers northeast of the Basrah Governorate in the Al-Hartha District. (30o39`20.264"N, 47o 44`51.533"E). Six earthen ponds (600 m3) were used from 24th February to 23th July 2021. Filters made from agricultural shadow was put in inlets pipes of pond 1, 2 and 3 (T1), while inlets pipes of pond 3, 4 and 5 without filters (T2). Twenty five individuals of common carp were put in each pond with initial average fish weigh range of 111.1- 140.0 g.

Fish were fed daily with commercial sinking pellets made with a variety of ingredients (fish meal 25%, wheat flour 28%, barley 15%, soy meal 5%, and vitamins-minerals premix 2%), by the Agriculture College's Agricultural Consultant Office. Feeding level 3% of fish weight was used. Fish weight and length were measured at the start and finish of the experiment. Fish samples were weighed on a regular basis in order to alter the daily feed schedule, which consisted of three meals: an early morning meal, a midday meal, and an afternoon meal. At the end of the experiment the alien organism in all ponds were collected, classified and weighed individually except shrimp.

Temperature, pH, and salinity of the pond water were among the environmental characteristics that were measured. at each weighing of fishes by (Mps556YSI). These sampling during experiment period were used to calculate the following equations:

$$Weight\ increments\ (WI, g) = FW - IW$$

$$Daily\ growth\ rate\ (DGR, g day^{-1}) = FW - IW\ \ day^{-1}$$

$$Specific\ growth\ rate (SGR\% day^{-1}) = 100 * [(ln\ FW) - (ln\ IW)]\ day^{-1}$$

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

Fish length-weight relationships were determined at the start and end of the experiment for each treatment using the following equation:
$W = aL^b$ (Pauly, 1983).

Where W = the fish's weight in grams, L = its length fish in centimeters, a = the weight change rate with length (intercept), and b = the weight of the fish at one unit of length (slope).

The following equations were used to estimate the condition factors (K) before and after the experiment:

1- Fulton's condition factor, K value was calculated using Froese (2006):

2- $K3 = 100\, W/L^3$

2- Estimate the modified condition factor (Ricker, 1975), by used Gomiero and Braga (2005):

$$Kb = 100\, W/L^b$$

3- Relative condition factor 'Kn' (Le Cren, 1951) was assessed by Le Cren (1951):

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

Where:
W= actual total weight of the fish (g).
^w= expected weight which calculated from length-weight equation.

Where W= the actual total weight of the fish in g, ^w= the expected weight from length-weight relationship formula. The current experiment's results were obtained using a completely randomized design, and analysis of variance (ANOVA) was used to test for differences in 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. Fish classification was based on (Coad, 2010).

Results:

The measurements of average fish weight and environmental parameters during the experiment were showed in Table (1). The range of initial average weight was 111.1 g in pond 3 and 140.0 g in pond 5. The temperature of the water ranged from 17 ºC in February to 30 ºC in July, Salinity ranged from 3.14 to 4.23 PSU, and pH was between 7.8 and 8.1. The growth criteria of the six ponds for the two treatments were shown in Table (2). T1 achieved the highest average final weight of 645.0 g, while T2 achieved the lowest weight of 573.2 g. Statistical analysis for WI showed significant differences ($P \leq 0.05$) between T1 and T2. T1 had the highest average weight increment (523.2 g), whereas T2 had the lowest (448.3 g). Statistical analysis for WI showed significant differences ($P \leq 0.05$) between T1 and T2. Fishes in T1 recorded average daily growth rate of 3.49 gday−1, while fishes in T2 recorded 2.99 g day^{-1}. Significant differences ($P \leq 0.05$) between T1 and T2 were found in the DGR statistical analysis. The average specific growth rates recorded were 1.11 and 1.02 % day^{-1} for T1 and T2 respectively. Statistical analysis for SGR showed no significant differences ($P > 0.05$) between the two treatments. Fishes in T1 recorded best average feed conversion rate (2.27) comparing with fishes in T2, where feed conversion rate was 2.89. Statistical analysis for FCR showed significant differences ($P \leq 0.05$)

between T1 and T2. Statistical analysis for fish mortality ratio showed no significant differences (P>0.05) between the two treatments, where it was 1.2% for T1 and 1.1% for T2.

Table 1. The average measurements of fishes weight according to the environment parameters.

Date	Average Fish Weight (g) ±SD						Temp. (ºC)	pH	Sal. (PSU)
	T1P1	T1P2	T1P3	T2P4	T2P5	T2P6			
24/2/2021	128.1 ±38.7	126.1 ±60.2	111.1 ±50.7	111.8 ±37.3	140.0 ±45.7	122.7 ±51.0	17	8.0	3.19
18/3	187.0 ±35.7	150.0 ±89.7	126.1 ±55.6	148.5 ±38.9	176.0 ±55.6	162.5 ±51.9	21	7.8	3.22
8/4	227.0 ±55.8	226.9 ±88.2	230.7 ±88.9	225.0 ±67.5	311.4 ±87.5	222.7 ±69.0	25	7.9	3.14
29/4	279.8 ±84.9	300.7 ±100.8	310.6 ±77.5	287.6 ±99.6	370.9 ±100.5	270.9 ±120.8	26	7.9	3.34
20/5	402.7 ±11.4	303.6 ±130.6	330.5 ±76.4	318.8 ±140.5	375.0 ±100.9	372.5 ±111.1	27	8.0	3.88
17/6	527.5 ±133.2	460.0 ±130.7	395.8 ±120.9	419.4 ±130.4	410.0 ±133.2	397.0 ±165.9	27	8.1	4.01
2/7	600.5 ±165.4	555.8 ±164.3	510.8 ±144.4	490.8 ±166.3	470.7 ±160.7	460.7 ±177.4	29	8.0	4.23
23/7	654.9 ±193.1	654.4 ±192.2	625.6 ±189.6	572.3 ±192.9	563.7 ±173.3	583.5 ±209.6	30	8.0	4.11

Table 2. Growth criteria of the two treatments in the experiment.

Growth Criteria	Treatments					
	T1 (with filter)			T2 (without filter)		
	P1	P2	P3	P4	P5	P6
FW	654.9	654.4	625.6	572.3	563.7	583.5
Average	645.0 a			573.2 b		
WI (g)	526.8	528.3	514.5	460.5	423.7	460.8
Average	523.2 a			448.3 b		
DGR ($gday^{-1}$)	3.51	3.52	3.43	3.07	2.82	3.07
Average	3.49 a			2.99 b		
SGR ($\%day^{-1}$)	1.09	1.09	1.15	1.09	0.93	1.04
Average	1.11 a			1.02 a		
FCR	2.18	2.34	2.28	2.55	3.14	2.98
Average	2.27 a			2.89 b		
Mortality rate (%)	0.4	0	3.2	0.4	0.8	2
Average	1.2 a			1.1 a		

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

Table (3) appears data on length and weight of common carp before and after the experiment. Both the overall length and weight increased in the two treatments. The highest increase (16.1 cm) in total length was achieved by T1, while lowest increase was 15.2 cm achieved by T2. Fig. (1) Pointed out the length-weight relationship for fishes before the experiment. There was a negative allometric pattern of growth (b less than 3) in the two treatments as b values were

2.8495 and 2.9122 for T1 and T2 respectively. Figure (2) illustrate the length-weight relationship for the two treatments after the end of experiment with positive allometric pattern of growth (b more than 3) in the treatments where b values were 3.3041 and 3.1649 for T1 and T2 respectively.

Table 3. Length and weight data of common carp before and after the experiment.

Treatments	Length range (cm)	Weight range (g)	Mean length (cm)	Mean Weight (g)
Before experiment				
T1 (with filter)	13.2-25.0	44.0-266.0	19.3	121.8
T2 (without filter)	13.6-24.6	43.0-242.0	20.0	124.8
After experiment				
T1 (with filter)	26.2-43.4	216.0-1213.0	35.4	645.0
T2 (without filter)	28.0-43.8	247.0-1270.0	35.2	573.2

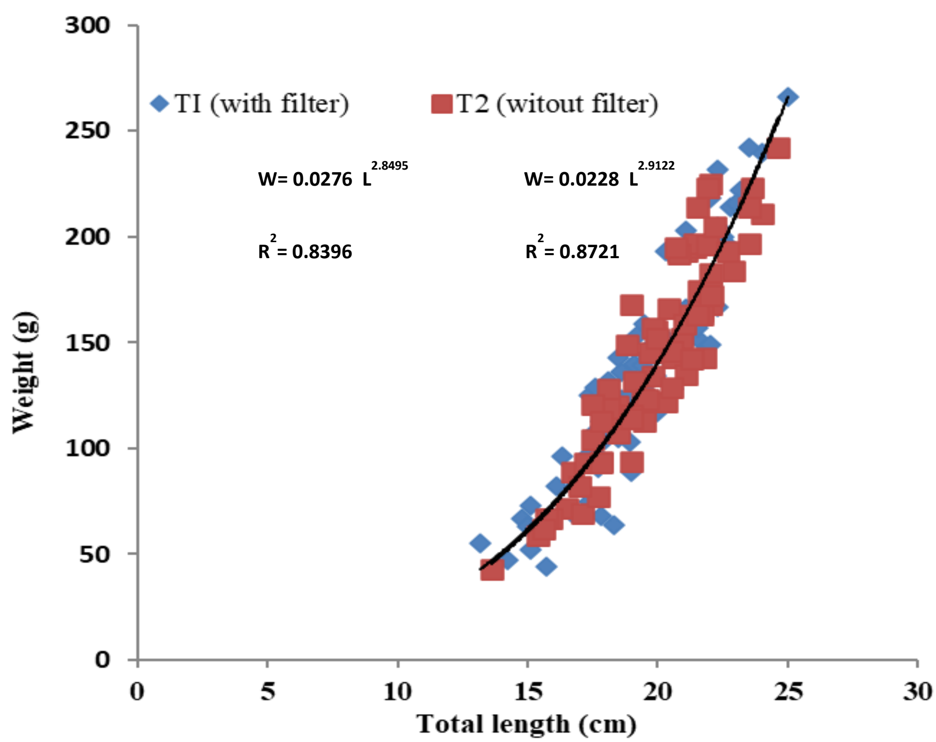

Figure 1. Length-weight relationship for the two treatments of common carp before the experiment.

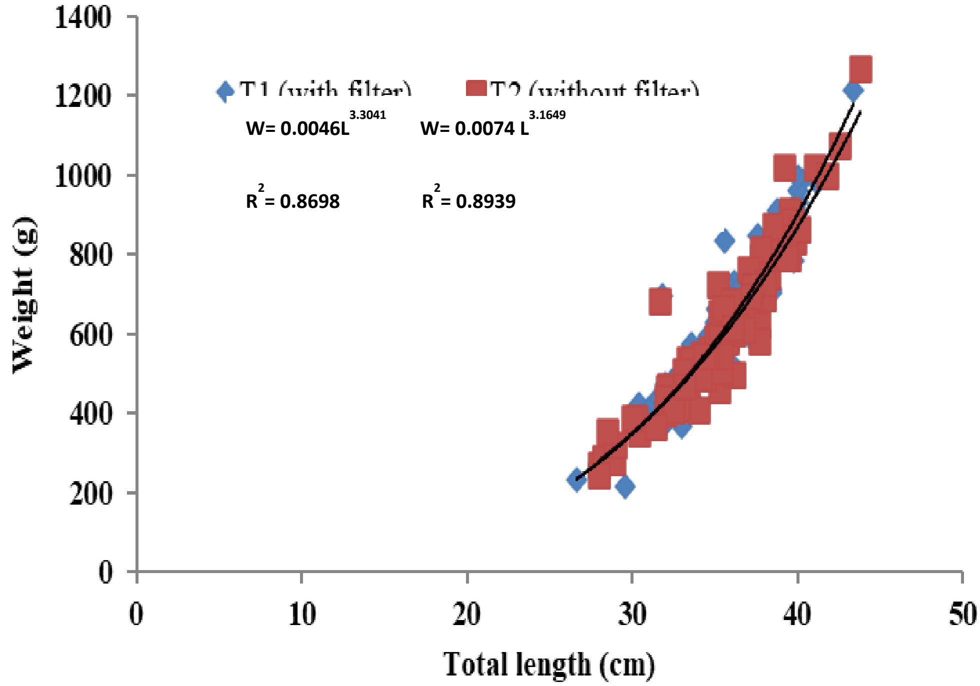

Figure 2. Length-weight relationship for the two treatments of common carp after experiment.

Table (4) displays the common carp's length-weight relationship's parameters before and after the experiment. Statistical analysis revealed the values of b with value 3 (Isometric pattern of growth) for common carp before and after the experiment for the two treatments did not differ significantly (P>0.05). Table (5) show condition factors for common carp at the beginning and the end of the experiment. Results appeared decreasing in modified condition factor (Kb) after the experiment from 2.7988 to 0.4623 in T1 and from 2.2974 to 0.4540 in T2. Statistical analysis of the results showed there were no significant differences (P>0.05) in the three models of condition factors after the experiment.

Table 4. Values parameters of Length-weight for common carp before and after experiment.

Treatments	a	b	r2	t value (calculated)	Significance of t
Before experiment					
T1	0.0276	2.8495	0.8396	3.1661	0.9738
T2	0.0228	2.9122	0.8721	2.9152	0.1052
After experiment					
T1	0.0046	3.3041	0.8698	1.4056	0.1968
T2	0.0074	3.1649	0.8939	0.2391	0.4253

Table 5. Models of condition factors for 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	2.7988 a±0.4398	1.0141 a±0.1593	1.7951 a±0.2873
T2	2.2974 b±0.3042	1.0076 a±0.1334	1.7672 a±0.2348
After experiment			
T1	0.4623 c±0.0599	1.0051 a±0.1214	1.3670 b±0.1653
T2	0.4540 c±0.0517	0.9860 a±0.1125	1.3386 b±0.1507

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

Table (6) shows alien organisms found in the six ponds after the end of experiment. Six fish species {Redbelly tilapia (Coptodon zillii), sailfin molly (Poecilia latipinna), abu mullet (Planiliza abu), crucian carp (Carassius uratus), dusky frillgoby (Bathygobius fuscus) and congaturi halfbeak (Hyporhamphus limbatus)}were founds in adition to native shrimp (Metapenaeus affinis). Numbers and weight of fishes and shrimp differ greatly from ponds with filters (T1) comparing with ponds without filter (T2). Largest number (42) of alien fishes found in pond 4 with higest (320.9 g) fish individual weight represented by redbelly tilapia. Highest shrimp weight (6722 g) was found in pond 5, while there were no shrimp and no alien fish in pond 2. It has pointed from the results that only two individuals of alien fishes found in T1 comparing with 97 individuals in T2.

Table 6. Numbers and weight ranges of alien organisms found in the ponds at the end of the experiment.

Treat.	Alien organisms												
	Coptodon zillii		*Poecilia latipinna*		*Planiliza abu*		*Carassius uratus*		*Bathygobius fuscus*		*Hyporhamphus limbatus*		*Metapenaeus affinis*
	No	WR (g)	No	WR (g)	No	WR (g)	No	WR (g)	No	WR (g)	No	WR (g)	W (g)
T1P1	-	-	-	-	1	14.1	-	-	-	-	-	-	320
T1P2	-	-	-	-	-	-	-	-	-	-	-	-	-
T1P3	-	-	-	-	1	5.3	-	-	-	-	-	-	120
T2P4	16	15.2-320.9	1	7.3	5	10.0-32.4	-	-	20	1.9-3.2	-	-	5038
T2P5	10	0.6-210.7	4	4.2-7.6	12	6.3-11.7	1	110	12	2.0-19.6	-	-	6722
T2P6	15	28.6-110.8	-	-	-	-	-	-	-	-	1	2.4	4556

Discussion:

Cultivated fish were impacted by water temperature, dissolved oxygen, salinity, pH, and ammonia content (Stickney, 2000; Piska & Naik, 2013). As is known from that the optimal range of water temperature for common carp ranged between 20 and 30 °C in tropical and subtropical areas, many researches although recorded temperature range between 25 and 28 °C for common carp in ponds (Bhatnagar & Devi, 2013; Mocanu *et al.*, 2015 a,b; Oprea *et al.*, 2015). In the present experiment water temperature, pH and salinity were as optimum environmental factors for growth of common carp. Laiz-Carrión *et al.* (2005) stated that More than 7 PSU of salinity in the water increases osmoregulation metabolism, which in turn has detrimental effects on fish growth and feed conversion.

The experiment's results showed that there were significant changes (P<0.0.5) in final weigh, weight increment, daily growth rate and feed conversion rate between fishes reared with and without filter, while there were no differences (P>0.05) in specific growth rate and mortality ratio. These differences may be related to defenses in numbers and weighs of alien organisms in these ponds (97 individuals of six fish species in ponds without filter comparing with two individuals of one fish species in ponds with filter, and also 16314 g of shrimp in ponds without filter comparing with 440 g in ponds with filter).

The six fish species founds in ponds without filter, the Red belly tilapia was the most dangerous on fish farms followed by sail fin molly. The reason of that these two species are highly efficient reproductive strategy, simple food requirements and their ability to live in a variety of conditions.

Negative impacts of tilapia species were documented very well by many researchers (Englund, 2000; Costa-Pierce, 2003; Casal, 2006; Vitule *et al.*, 2009). Canonico *et al.* (2005) pointed out that tilapia species are highly invasive and exist under feral environmental conditions in which they have been introduced.

Many fish farms in Iraq (especially in Basrah) were failed because of tilapia fishes that have inexpensive prices (about 500 Iraqi dinar for one kg compared with 4000-5000 dinars for common carp). Small tilapia fishes also enter to floating cages in Basrah and became bigger to compete with common carp on feeds (Personal observation).

Many growth parameters recorded in present experiment were differing from the parameters of other experiments. DGR of current experiment ranged between 2.99-3.49 g day^{-1}, SGR ranged between 1.02-1.11 % day^{-1} and FCR between 2.27-2.89. Al-Jader & Al-Sulevany (2012) recorded SGR of 0.71, 0.87 and 0.76 %/day when common carp fed on three distinct diets with a varying protein ratio 25, 30 and 35%, respectively. Taher *et al.* (2014) found that for common carp fed at 5% feeding level in floating cages, the DGR was 3.16, the SGR was 1.85 % day^{-1}, and the FCR was 2.63. During a period of 90 days, the mirror carp (*C. carpio*) recorded SGRs of 4.95 and 4.80 percent day^{-1} at two densities (Hossain *et al.*, 2014). Taher *et al.* (2018) reported that common carp reared in a semi-closed environment for 52 days had an FCR of 2.12 and an SGR of 2.44 percent day^{-1}.

Taher (2020) investigated four imported floating pellets and found that the DGR was 4.07-8.21 g day^{-1}, with an FCR of 2.56-7.07. Albahadly *et al.* (2021) noted that ungraded common carp cultivated in floating cages had a DGR of 2.35 g/day and an SGR of 0.23 % day^{-1}. The variations in initial weights and cultivation system between the current study's results and those of other studies could be the cause of these differences. Taher *et al.* (2021) pointed for common carp reared with grass carp or alone DGR of 5.92 and 3.70 g day^{-1}, SGR of 1.07 and 0.98 % day^{-1}, and FCR of 2.24 and 2.46, respectively. Al-Dubakel *et al.* (2022) reported that for common carp grown in and outside of cages in earthen ponds, the DGR range was 3.41-4.33 g day^{-1}, SGR 0.88-1.00 % day^{-1}, and FCR 2.67-2.77.

The length-weight relationship may differ according to species and also for the same species in the population as a result of a variety of circumstances, such as feeding and reproduction, and it is regarded as a crucial tool for managing fisheries. The length-weight relationship's slope (b) value varied depending on a number of variables, including seasonality, disease, parasites, environmental factors, and geographic location. (Bagenal & Tesch, 1978). Between the values of b with value 3 (Isometric pattern of growth) of common carp in the current experiment before and after the experiment for the two treatments, there were no significant differences (P>0.05), while there were an increasing from 2.8495 to 3.3041 for T1 and from 2.9122 to 3.1649 for T2. In Gölhisar Lake, Alp & Balik (2000) observed negative allometric growth (b= 2.8740) for common carp.

Tarkan *et al.* (2006) recorded b of 2.8300 for common carp in Lake İznik. The same results for common carp raised in various pond environments have been discovered (Kadhar *et al.*, 2014) and for common carp from the Taqtaq Region in northern Iraq's lower Zab River (Rashid *et al.*, 2018). There were positive allometric growths (b=3.319) for certain common carp populations in Almus Dam Lake and Ömerli Reservoir (b=3.140) (Karataş *et al.*, 2007; Vilizzi *et al.*, 2013).

In earthen ponds, Taher *et al.* (2021) reported b values of 3.4238 for common carp cultivated with grass carp and 3.0899 for common carp cultivated alone. Al-Dubakel *et al.* (2022) recorded b value range 3.1702-3.5704 when common carp are cultivated in and out of cages at earthen ponds.

The low value of modified condition factor (Kb) in current experiment perhaps connected to the high value of b. Taher *et al.* (2021) recorded 0.31, 1.01 and 1.47 as Kb, Kn and K3 respectively regarding common carp reared with grass carp and 0.98, 1.01 and 1.35 when cultivated alone in earthen ponds.

Al-Dubakel *et al.* (2022) recorded condition factors ranges as 0.19-0.79, 0.99-1.05 and 1.38-1.56 of Kb, Kn and K3 respectively for common carp cultivated in and outside cages at earthen ponds.

Conclusion:

According to the current experiment's results it can be concluded revealed the growth criteria and feed conversion ratio of common carp raised in earthen ponds were affected by foreign fish and shrimp. For this reason it is recommended for fish culturist to use filters in inlets pipes to prevent these organisms from entering to their rearing ponds.

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