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Growth parameters of common carp *Cyprinus carpio* cultivated in semi-closed system

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Abstract: Growth parameters of common carp *Cyprinus carpio* were investigated in 13 plastic tanks (550 cm diameter and 130 cm depth) of semi-closed system at Abu Al-Khaseeb District, Basrah from 27 October to 17 December, 2016. Number of fishes in every tank was 1300 with an average initial weight 101.9 g. Fishes were fed at a ratio of 5% on sinking pelleted food manufactured in Basrah University factory with 25% protein ratio. Results of current study exhibited highest final weight (381.1 g) achieved by fishes reared in tank number 1 and lowest (326.3 g) in tank number 2. Average fish weight increments for 13 tanks were 248.2 g, with highest weight increment (266.5 g) achieved by fishes reared in tanks 6 and 11, while lowest (222.3 g) achieved by fishes reared in tank number 7. Result also appeared average daily growth of 4.87 g/day, with highest (5.22 g/day) achieved by fishes reared in tanks 6 and 11 and lowest (4.36 g/day) achieved by fishes reared in tank number 7. Average specific growth rate for 13 tanks was 2.44 %/day, with highest (3.10 %/day) achieved by fishes reared in tank number 3 and lowest (1.99 %/day) achieved in tank number 1. Average food conversion rate (FCR) for 13 tanks was 2.12, with highest (2.55) achieved by fishes reared in tanks number 1 and lowest (1.74) achieved by fishes reared in tank number 3.

Keywords: Semi-closed system, Common carp, Growth, FCR.

Introduction

Aquaculture is pursued in a variety of open, semi-closed and closed systems that target a wealth of markets with a primary purpose that parallels to terrestrial agriculture, which aims towards increasing the amount of food available for human consumption (Avault, 1996; Black, 2001; Bridger and Costa-Pierce, 2003). Aquaculture has been practiced for centuries, but its effects and importance have expanded dramatically over the last few decades as the amount of fishes harvested by traditional capture fisheries stagnated, while the demand increased (United States

Department of Agriculture, 2000; FAO, 2001; Tomasso, 2002).

Where water supply is limited in any place, intensive culture can be carried on by recirculating the water in a closed systems, and the high capital investment demanded by these systems of culture generally can be justified only when sites for more extensive systems are no longer available, and when the productivity is commensurate with high production costs, and when the products can demand high market prices (Pillay and Dill, 1979). There are several types of culture system available, some can be used for purposes of cultivation of a variety of species, though a few have been developed specifically for one organism or more related organisms, and once anyone have seen an example of any particular type of systems, it will be immediately recognized others of the same type (Stickney, 2005). New cultivation systems such as floating cage culture and closed systems will open the door for more people to try aquaculture investments (Parker, 2012).

There are always readily apparent differences in designs, and some culturists are so dedicated to their particular design that they are protective about showing outsiders what they have, because they afraid that their opinions will be stolen, but in many instances, most culturists are happy to discuss their opinions and share their techniques and designs for equipment with their peers (Stickney, 2005). Many of the lagoons and ponds used for extensive cultivation of fry in semi-intensive units, and some time the semi-intensive rearing systems are typically plastic bag systems floating in lagoons, or huge concrete tanks on land built up in conjunction with lagoons (Moksness *et al*., 2004).

Recent designs of semi-closed systems employ one or more by-pass treatment units, such as for denitrification, oxygenation, ozonization etc., and in principle, such recirculation should make it economically feasible to cultivate warm-water species in temperate climates by reducing the cost of water heating (Pillay and Kutty, 2005).

Regardless of the type of system used, uneaten food and fecal material should be daily removed from the culture chambers and no alternate food sources should be available. Additionally, water quality parameters must be maintained within the suitable ranges for the species being tested, and maintaining well-characterized and suitable water quality parameters is critical to the design of any rearing designs (Stickney, 2000). Therefore, water quality parameters should be monitored biweekly for ammonia, nitrite, and nitrate, and daily for dissolved oxygen, temperature and salinity.

Closed, semi-closed, and open culture systems typically employ relatively small culture chambers compared with earthen ponds. Typical culture chambers are circular tanks, linear raceways and silos (tall circular raceways). Material used for construction of culture chambers can vary widely, depending on some factors such as the preference of the culturist, the availability of materials, the cost and in some cases the cultivated species (Stickney, 2000). Since a major source of organisms causing different diseases for fishes is the water flowing into the rearing units, semi-closed or recirculating systems offer significant advantages over open systems such as ponds and cages, because, it is possible to treat the incoming water to prevent or reduce the pathogens that enter the system and caused the risk (Le François *et al*., 2010).

Recirculation system is a rapidly growing segment of the aquaculture industry, but for the most part it is still widely unused or unproven, and some people in this sector have found that they can reuse far more water than ever thought possible and still obtain respectable production (Stickney, 2000). In Iraq, closed systems projects are still at the beginning, while most of these projects were failed and some of them were altered to semi-closed systems. The aim of this study is to find some information about growth and food conversion of common carp (*Cyprinus carpio*) cultivated in semi-closed systems.

Materials and Methods

The current study was conducted in 13 plastic tanks (550 cm diameter and 130 cm depth) at Abu Al-Khaseeb District, Basrah (Fig. 1). These tanks were constructed as a semi-closed system with continuously changing water by pumping the clean water from a small canal and outlet the drainage water by gravity, in addition to air pumping for all tanks.

The present study was directed with common carp of average weight 101.9 g from 27 October to 17 December, 2016. Number of fishes in every tank was 1300. Fishes were fed on sinking pelleted food manufactured in Basrah University Factory with 25% protein ratio. Feeding ratio was 5% which was divided to three meals daily. Some environmental factors (water temperature, salinity and pH) were measured using digital YSI (m102866k13). Sampled fishes were weighed nearly every ten days and daily food was changed according to new weights.

Growth parameters measured were weight gain (WG), daily growth rate (DGR), specific growth rate (SGR) and food conversion rate (FCR) according to the following equations:

WG= $W_2 - W_1$, where w_2 was the final weight and w_1 was the initial weight.

DGR= $(W_2 - W_1)/(t_2 - t_1)$, where t_2 was the time at final weight and t_1 was the time at initial weight.

SGR= $\{(\ln W_2 - \ln W_1) / (t_2 - t_1)\} / 100$

FCR= (DF × number of days)/ $(W_2 - W_1)$ × fish number, where DF was daily food.

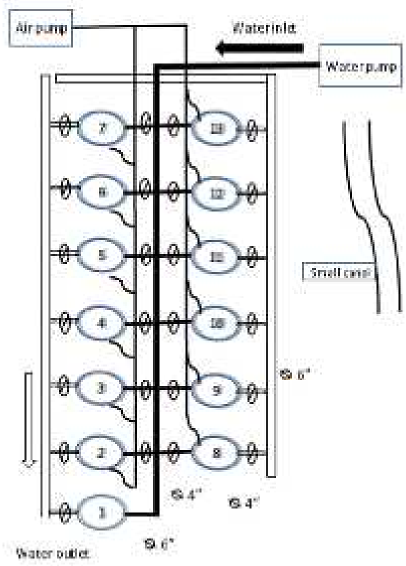

Fig. (1): Diagram of fish culture system.

Results

Table (1) revealed the values of environmental factors (water temperature, salinity and pH) during the experiment. Water temperature in all tanks ranged between 20-28^{o}C, salinity ranged between 1.4-1.7 PSU, while pH ranged between 7.4-7.6. No mortalities were occurred for common carp cultivated in all tanks during experiment time.

Table (2) showed average fish weights for fishes cultivated in the tanks during experiment. The highest average weight (381.1 g) was achieved by fishes reared in tank number 1, while the lowest (326.3 g) was achieved by fishes reared in tank number 2. Average initial weight for fishes cultivated in all tanks was 101.9 g, while average final weight was 350.1 g, so the average weight

Table (1): Average of environmental factors (water temperature, salinity and pH) during the experiment.

Date	Water Temperature (^{0}c)	Salinity (PSU)	pH
27/10/2016	28	1.7	7.6
6/11/2016	28	1.5	7.4
16/11/2016	27	1.5	7.5
27/11/2016	25	1.5	7.5
7/12/2016	22	1.4	7.5
17/12/2016	20	1.4	7.4

increments was 248.2 g. Fig. (2) exhibited weight increments of fishes cultivated in all tanks during the experiment. Average fish weight increments for all tanks was 248.2±13.1 g, with highest weight increment (266.5 g) achieved by fishes reared in tanks 6 and 11, while lowest (222.3 g) achieved by fishes reared in tank 7.

Fig. (3) exhibited daily growth rate of fishes cultivated in all tanks during the experiment. Average daily growth rate for these tanks was 4.87±0.26 g/day, with highest daily growth rate (5.22 g/day) was achieved by fishes reared in tanks 6 and 11, while lowest rate (4.36 g/day) was achieved by fishes reared in tank 7.

Table (2): Average of fish weights during the experiment.

Tank Number	Average of fish weights (g) at different dates					
	27/10/2016	**6/11/2016**	**16/11/2016**	**27/11/2016**	**7/12/2016**	**17/12/2016**
T_1	137.8	185.9	241.8	300.3	348.8	381.1
T_2	83.2	132.6	180.7	235.3	288.6	326.3
T_3	67.6	127.0	180.7	230.1	287.3	328.9
T_4	96.2	144.3	192.4	248.3	306	344.5
T_5	97.5	146.9	196.3	245.7	289.9	339.3
T_6	102.7	154.7	211.9	266.5	328.9	369.2
T_7	106.6	153.3	200.2	247	293.2	328.9
T_8	105.3	154.7	209.3	260	317.2	352.3
T_9	105.3	157.3	213.2	269.1	318.5	357.5
T_{10}	126.1	180.7	215.8	263.9	317.2	354.9
T_{11}	97.5	153.4	209.3	262.2	310.7	364.0
T_{12}	98.8	154.7	202.8	252.2	305.5	349.7
T_{13}	100.1	149.5	218.4	266.5	321.1	354.9
Average Weights (g)± SD	**101.9±10.3**	**153.5±16.1**	**205.6±16.4**	**257.5±17.8**	**310.2±17.9**	**350.1±16.4**

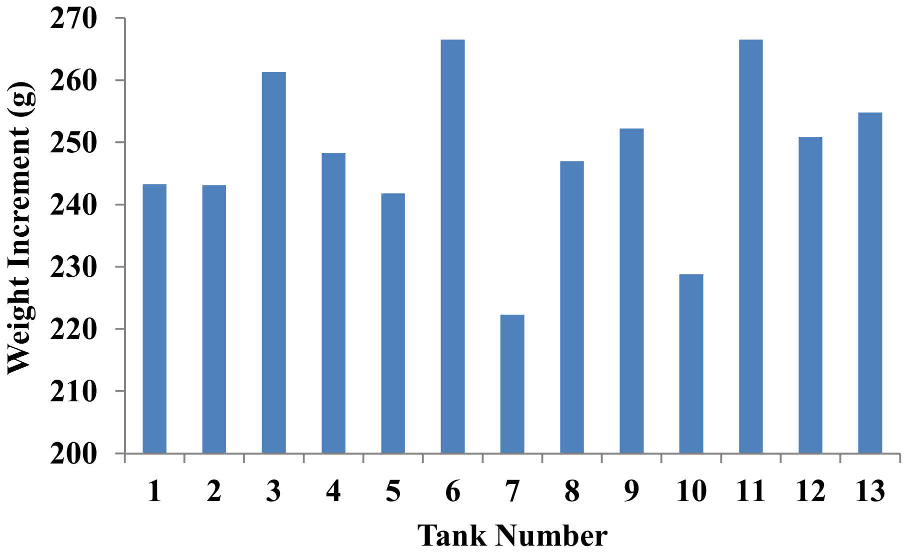

Fig. (2): Weight increments for fishes cultivated in all tanks.

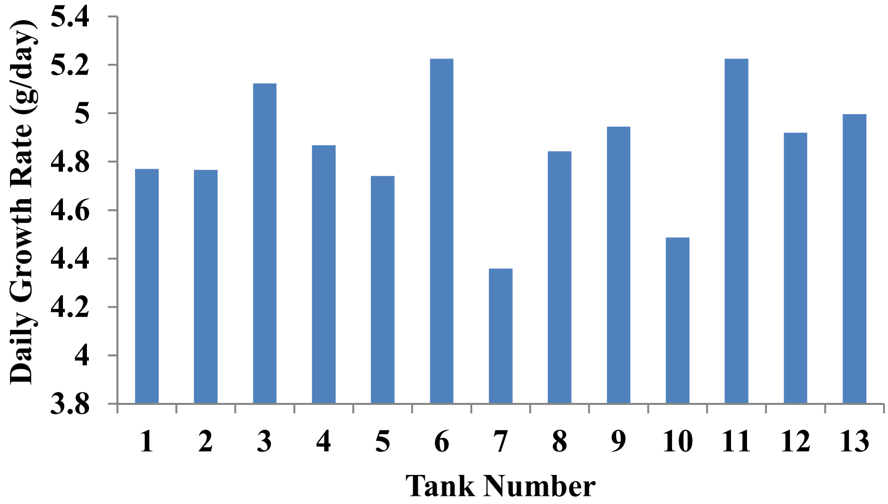

Fig. (3): Daily growth rate for fishes cultivated in all tanks.

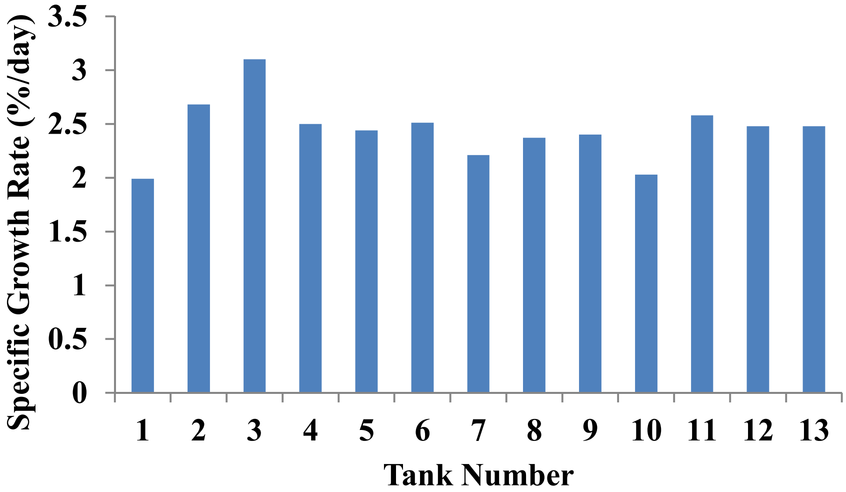

Fig. (4): Specific growth rate for fishes cultivated in all tanks.

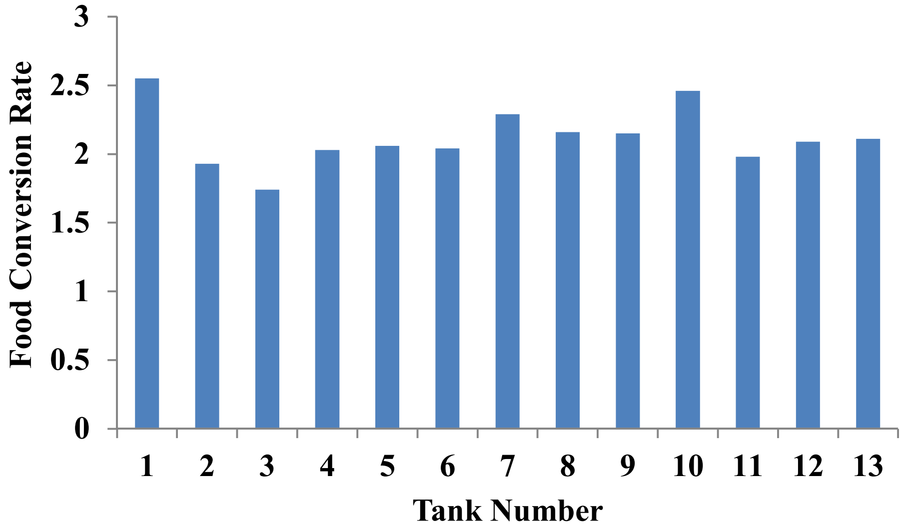

Fig. (5): Food conversion rate for fishes cultivated in all tanks.

Fig. (4) exhibited specific growth rate of fishes cultivated in thirteen tanks during the experiment. Average specific growth rate for these tanks was 2.44±0.28%/day, with highest daily specific rate (3.10%/day) achieved by fishes reared in tank number 3, while lowest (1.99 %/day) achieved by fishes reared in tank number 1. Fig. (5) exhibited food conversion rate of fishes cultivated in these tanks during the experiment. Average food conversion rate for these tanks was 2.12 ±0.21, with highest food conversion rate (2.55) was achieved by fishes reared in tank number 1, while lowest (1.74) was achieved by fishes reared in tank number 3.

Discussion

Water quality conditions must be maintained within the suitable ranges for cultivated species and maintaining well-characterized and suitable water quality parameters is critical to the design of any experiment. Therefore, some water quality parameters should be monitored daily (Stickney, 2000). The results showed that environmental factors measured during this experiment were suitable for fish health and growth.

The current experiment showed average weight increment of 248.2 g during 52 days. Taher *et al.* (2014) recorded weight increment of 186.8 g for common carp cultivated in floating cages on 5% feeding ratio.

The present experiment showed average daily growth rate of 4.87 g/day during experiment. Daily growth rate of current experiment was better than daily growth rate (1.07, 3.16 and 2.78 g/day) recorded by Taher *et al.* (2014) when used three feeding ratios (3, 5 and 7, respectively). Manomaitis and Cremer (2004) recorded daily growth rate of 2.71 g/day for common carp fed on floating pelleted feed of 32% protein level, while Bisht *et al.* (2012) recorded 1.9 g/day when added *Bacillus subtilis* bacteria as probiotic to the diet of fingerlings of common carp.

The present investigation also showed average specific growth rate of 2.44%/day during the experiment. Specific growth rate recorded in the current experiment was better than specific growth rate (0.70, 1.85 and 1.71%/day) recorded by Taher *et al.* (2014) when they used three feeding ratios (3, 5 and 7, respectively). Common carp cultivated in fish breeding project in the Agriculture and

Forestry College, Dohuk University in Summel city, showed specific growth rates of 0.71, 0.87 and 0.76%/day when fed on three diets of different protein ratios (25, 30 and 35%, respectively) according to Al-Jader and Al-Sulevany (2012).

The present experiment revealed an average food conversion rate of 2.12. Taher *et al.* (2014) recorded food conversion rate of 2.63 for common carp cultivated in floating cages on 5% feeding ratio. Costa-Pierce and Hadikusumah (1990) exhibited a food conversion rate of 2.13-2.15 for common carp (initial weight 90 g) reared in Saguling Reservoir, Indonesia. Pucher *et al*. (2012) recorded food conversion rate of 1.2-1.5 when replaced fishmeal with earthworm meal in the diet. Piska and Naik (2013) reported 2.0 as food conversion rate for common carp reared in floating cages of Hyderabad, India.

Conclusions

It can be concluded from the current study that culturists in Iraq can use the semi-closed systems for producing common carp. These projects don't need large places and can produce large amounts of fishes in small tanks.

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