



EFFECTS OF FISH WEIGHT AND WATER TEMPERATURE ON FEED INTAKE OF GRASS CARP, *CTENOPHARYNGODON* *IDELLA* (CUVIER AND VALENCIENNES, 1884)

MAJID M. TAHER

Aquaculture Unit, College of Agriculture, University of Basrah

Email: maj61ae@yahoo.co

ABSTRACT

The current experiment was conducted in the Fish Laboratory of Aquaculture Unit- College of Agriculture-University of Basra to investigate the effects of fish weight and water temperature on feed intake of grass carp, *Ctenopharyngodon idella* (Cuvier and Valenciennes, 1884). Five water temperatures (10, 15, 20, 25 and 30) °C and two fish weight (average weight 55 and 400 g) were investigated. Results of the current experiment showed that the highest daily consumed feed for large fishes was (9.44, 12.32, 17.76, 37.04 and 35.92) g, while the lowest daily consumed feed for small fishes was (3.68, 6.88, 4.64, 7.60 and 6.56) g in the temperature degrees, 10, 15, 20, 25, and 30 °C respectively. The average consumed feed and daily feeding rate by small fishes showed significant differences ($P \leq 0.05$) between water temperature 10 °C with 25 and 30 °C, while there were no significant differences ($P > 0.05$) between water temperature 10, 15 with 20 °C, and between 15, 20, 25 with 30 °C. The average consumed feed for large fishes showed significant differences ($P \leq 0.05$) between water temperature 10 and 15 °C with water temperature 30 °C, while there were no significant differences ($P > 0.05$) between water temperature 20 °C with other four temperatures. Statistical analysis of average daily feeding rate for large fishes showed significant differences ($P \leq 0.05$) between water temperature 10 °C with 25 and 30 °C, while there were no significant differences ($P > 0.05$) between other temperatures. It can be concluded from these results that water temperature affected the daily feeding rate too much comparing with the low effect of fish size.

Keywords: Aquaria, Water temperature, Daily consumed feed, Daily feeding rate.

INTRODUCTION

Grass carp *Ctenopharyngodon idella* (Cuvier and Valenciennes, 1884) is a native fish species related to the large rivers of eastern Asia and has been introduced since 1945 to many countries around the world mainly for culture and aquatic vegetation control (Pfeiffer and Lovell, 1990; Kırkağaç and Demir, 2006). Cudmore & Mandrak (2004) stated that grass carp has been deliberately introduced into many countries for vegetation control, and they pointed that it was altering habitat and compete with other herbivorous species, thus can impact water quality, aquatic flora and fauna, and wildlife species. Grass carp are used in warm water ponds to consume unwanted aquatic plants, aquatic vegetation and filamentous algae (Durborow *et al.*, 2007), and they feed exclusively on aquatic plants and eat 2–3 times their weight each day (Bozkurt *et al.*, 2017).

Grass carp is a herbivorous fish that naturally feeds on aquatic plants, while at early life (larvae, fry, and juveniles) it feed on phytoplankton and zooplankton, but in culture conditions, it can well accept different artificial feeds. Fingerlings of grass carp consume insect larvae, other

invertebrates and even small numbers of fish fry, and it is also fed on commercial pelleted diets under culture conditions, so fish culturists often complain that grass carp consume pelleted diets rather than aquatic plants (Masser, 2002).

Tan & Armbruster (2018) stated that grass carp considered as belonging to the family Xenocypridinae instead of Cyprinidae according to recent phylogenetic studies. FAO (2018) pointed out that grass carp was the most widely cultivated and commercially important freshwater fish species in the world (comprise 11% of world production).

Most studies in Iraq on grass carp deal with laboratory experiments with little field studies. Al- Seyab (1996) studied the efficiency of grass carp control for aquatic plants in drainage systems. Saleh *et al.* (2008) studied the culture of grass carp in Fadak fish farm-Basrah. Jaafar & Ahmed (2011) investigated the effect of salt stress on osmoregulation and energy consumption in grass carp. Al-Dubakel *et al.* (2011) studied growth parameters and the implication of grass carp larvae reared in recirculation system. Al-Shkakrchy & Ahemed (2013) tested the duckweed *Lemna* spp. as a potential food for grass and

common carp. Talal (2013) investigated the effects of the polluted and non-polluted aquatic environment on cultivated grass carp. Taher (2017) conducted four laboratory experiments on the grass carp, and Al-Dubakel *et al.* (2020) pointed out the results of partial replacement of fish meal by *Azolla filiculoides* meal in grass carp feed. Current experiment aimed to investigate the effects of fish size and water temperature on feed intake of grass carp cultivated in laboratory aquaria.

MATERIALS AND METHODS

The current experiment was conducted in Fish Laboratory of Aquaculture Unit-Agriculture College-Basrah University. The grass carp in current experiment fed Arapco floating pellets (32% protein) in five water temperatures (10, 15, 20, 25 and 30) °C with two fish weight i.e., 55 g (five fish in each aquarium) and 400 g (two fish in each aquarium) average weight. The size of aquarium was 60 cm length, 30 cm width, and 40 cm height. There were two replicates for each treatment and repeated for two days interval. Grass carp brought from earthen ponds of Aquaculture Unit located in Al-Hartha Station for Agricultural Researches, North Basrah.

The fishes were acclimatized for one week in laboratory aquaria before the beginning of the experiment. Aquaria provided with air pumps and automatic heaters to control water temperature. Feeds were given daily at 8 o'clock morning and residual floating pellets were collected after three hours in Petri dishes and dried before weighing.

Consumed diet for three hours calculated by the difference between added and residual feeds, then transformed into the ratio of consumption. Daily feeding rates calculated according to following equation:

$$\text{DFR} = \frac{\text{Daily consumed feed}}{\text{Total fish weight}}$$

Data from the experiment were tested by analysis of variance (ANOVA) to determine the difference between the means and the significant differences were tested by the LSD test at 0.05 probability level by SPSS Ver. 22.

RESULTS

Table (1) shows diet consumed in three hours with temperature 10 °C of two fish weights for two consecutive days. The highest ratio of consumed diets concerning to total fish weight (0.23%) was recorded by small fishes, while the lowest ratio of consuming (0.10%) was recorded by

large fishes. Table (2) reveals diet consumed in three hours with temperature 15 °C of two fish weights for two sequent days. The highest ratio of consumed diets concerning to total fish weight (0.39%) was recorded by small fishes, while the lowest ratio of consuming (0.18%) was recorded by large fishes. In 20 °C temperature the highest ratio (0.50%) of consumed diets and the lowest (0.15%) was recorded by small fishes (Table 3), while in 25 °C temperature the highest ratio (0.76%) of consumed diets was recorded by small fishes and lowest ratio (0.20%) was recorded by large fishes (Table 4). Finally at a temperature of 30 °C small fishes were recorded the highest ratio (0.73%) of consumed diets and large fishes recorded the lowest ratio (0.19%) (Table 5).

Table (6) shows daily consumed diet for grass carp at different temperatures. The highest daily consumed diet for large fishes were (9.44, 12.32, 17.76, 37.04 and 35.92) g for temperatures of (10, 15, 20, 25 and 30) °C respectively, while the lowest daily consumed diet for small fishes were (3.68, 6.88, 4.64,

7.60 and 6.56) g for temperatures of (10, 15, 20, 25 and 30) °C respectively.

Table (7) shows average daily consumed diet and average daily feeding rate for small grass carp in different water temperatures. Statically analysis of average consumed feed and daily feeding rate appears significant differences ($P \leq 0.05$) between water temperature 10 °C with 25 and 30 °C, while there were no significant differences ($P > 0.05$) between water temperature 10, 15 and 20 °C, and between 15, 20, 25 with 30 °C.

Table (8) points average daily consumed diet and average daily feeding rate for large grass carp in different water temperatures. Statistical analysis of average consumed feed shows significant differences ($P \leq 0.05$) between water temperature 10 and 15 °C with water temperature 30 °C, while there were no significant differences ($P > 0.05$) between water temperature 20 °C with other four temperatures. Statistical analysis of average daily feeding rate showed significant differences ($P \leq 0.05$) between water temperature 10 °C with 25 and 30 °C, while there were no significant differences ($P > 0.05$) between other temperatures.

Table (1) Diet consumed in three hours with a temperature of 10 °C.

Date	Average fish weight (g)	Aquarium No.	Added diet (g)	Residual diet after 3 hours (g)	Consumed diet (g)	Consumed diet (%)	Consumed diet % (% from fish weight)
10-2-2020	55	1	4.00	3.52	0.48	12.00	0.12
	55	2	4.00	3.54	0.46	11.50	0.12
	400	3	7.00	5.88	1.12	16.00	0.14
	400	4	7.00	5.82	1.18	16.86	0.15
11-2-2020	55	1	4.00	3.12	0.88	22.00	0.23
	55	2	4.00	3.19	0.81	20.25	0.21
	400	3	7.00	6.19	0.81	11.57	0.10
	400	4	7.00	5.98	1.02	14.57	0.13

Table (2) Diet consumed in three hours with a temperature of 15 °C.

Date	Average fish weight (g)	Aquarium No.	Added diet (g)	Residual diet after 3 hours (g)	Consumed diet (g)	Consumed diet (%)	Consumed diet % (% from fish weight)
12-2-2020	55	1	4.00	3.11	0.89	22.25	0.23
	55	2	4.00	2.51	1.49	37.25	0.39
	400	3	7.00	5.62	1.38	19.71	0.36
	400	4	7.00	5.95	1.05	15.00	0.27
13-2-2020	55	1	4.00	3.14	0.86	21.50	0.22
	55	2	4.00	2.88	1.12	28.00	0.29
	400	3	7.00	5.46	1.54	22.00	0.19
	400	4	7.00	5.55	1.45	20.71	0.18

Table (3) Diet consumed in three hours with a temperature of 20 °C.

Date	Average fish weight (g)	Aquarium No.	Added diet (g)	Residual diet after 3 hours (g)	Consumed diet (g)	Consumed diet (%)	Consumed diet % (% from fish weight)
16-2-2020	55	1	4.00	3.34	0.66	16.50	0.17
	55	2	4.00	3.42	0.58	14.50	0.15
	400	3	7.00	5.51	1.49	21.29	0.19
	400	4	7.00	5.29	1.71	24.43	0.21
17-2-2020	55	1	4.00	3.00	1.00	25.00	0.26
	55	2	4.00	2.09	1.91	47.75	0.50
	400	3	7.00	4.78	2.22	31.71	0.28
	400	4	7.00	5.38	1.62	23.14	0.20

Table (4) Diet consumed in three hours with a temperature of 25 °C.

Date	Average fish weight (g)	Aquarium No.	Added diet (g)	Residual diet after 3 hours (g)	Consumed diet (g)	Consumed diet (%)	Consumed diet % (% from fish weight)
18-2-2020	55	1	4.00	1.52	2.48	62.00	0.64
	55	2	4.00	3.05	0.95	23.75	0.25
	400	3	7.00	5.39	1.61	23.00	0.20
	400	4	7.00	4.72	2.28	32.57	0.29
19-2-2020	55	1	4.00	1.08	2.92	73.00	0.76
	55	2	4.00	2.71	1.29	32.25	0.34
	400	3	7.00	2.37	4.63	66.14	0.58
	400	4	7.00	4.72	2.28	32.57	0.29

Table (5) Diet consumed in three hours with a temperature of 30 °C.

Date	Average fish weight (g)	Aquarium No.	Added diet (g)	Residual diet after 3 hours (g)	Consumed diet (g)	Consumed diet (%)	Consumed diet % (% from fish weight)
23-2-2020	55	1	4.00	1.41	2.59	64.75	0.67
	55	2	4.00	2.99	1.01	25.25	0.26
	400	3	7.00	5.5	1.50	21.43	0.19
	400	4	7.00	3.14	3.86	55.14	0.48
24-2-2020	55	1	4.00	1.18	2.82	70.50	0.73
	55	2	4.00	3.18	0.82	20.50	0.21
	400	3	7.00	2.51	4.49	64.14	0.56
	400	4	7.00	5.22	1.78	25.43	0.22

Table (6) Daily consumed diet for grass carp at different temperatures .

Temperature (°C)	Date	Aquarium No.	Total fish weight (g)	Daily consumed feed (g)
10	10-2-2020	1	385	3.84
		2		3.68
		3	800	8.96
		4		9.44
	11-2-2020	1	385	7.04
		2		6.48
		3	800	6.48
		4		8.16
15	12-2-2020	1	385	7.12
		2		11.92
		3	800	11.04
		4		8.40
	13-2-2020	1	385	6.88
		2		8.96
		3	800	12.32
		4		11.60
20	16-2-2020	1	385	5.28
		2		4.64
		3	800	11.92
		4		13.68
	17-2-2020	1	385	8.00
		2		15.28
		3	800	17.76
		4		12.96
25	18-2-2020	1	385	19.84
		2		7.60
		3	800	12.88
		4		18.24
	19-2-2020	1	385	23.36
		2		10.32
		3	800	37.04
		4		18.24
30	23-2-2020	1	385	20.72
		2		8.08
		3	800	12.00
		4		30.88
	24-2-2020	1	385	22.56
		2		6.56
		3	800	35.92
		4		14.24

Table (7) Average daily consumed diet and average daily feeding rate for small grass carp (55 g) in different water temperatures.

Temperature (°C)	Daily consumed diet (g)	Daily feeding rate
10	5.26 $\pm$ 1.75 a	0.0137 $\pm$ 0.0045 a
15	8.72 $\pm$ 2.33 ab	0.0227 $\pm$ 0.0060 ab
20	8.30 $\pm$ 4.88 ab	0.0216 $\pm$ 0.0127 ab
25	15.28 $\pm$ 7.52 b	0.0397 $\pm$ 0.0195 b
30	14.48 $\pm$ 8.32 b	0.0376 $\pm$ 0.0216 b

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

Table (8) Average daily consumed diet and average daily feeding rate for large grass carp (400 g) in different water temperatures.

Temperature (°C)	Daily consumed diet (g)	Daily feeding rate
10	8.26 $\pm$ 1.30 a	0.0103 $\pm$ 0.0016 a
15	10.84 $\pm$ 1.71 ac	0.0135 $\pm$ 0.0021 ab
20	14.08 $\pm$ 2.56 abc	0.0176 $\pm$ 0.0032 ab
25	21.6 $\pm$ 10.60 bc	0.0270 $\pm$ 0.0132 b
30	23.26 $\pm$ 11.90 b	0.0291 $\pm$ 0.0149 b

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

DISCUSSION

Grass carp feeding strategies in pond culture may be influenced by

some factors such as fish size, water temperature, availability of plants and stocking densities (Opuszynski and

Shireman, 1995). Osborne and Riddle (1999) pointed out that the feeding and growth of grass carp is strongly influenced by water temperature and fish size.

Results of the current experiment indicated that the highest daily consumed feed and daily feeding rates especially for large fishes were recorded at a water temperature of 25 and 30 °C, while the lowest values recorded at a water temperature of 10 °C. Opuszynski (1972) stated that no plants are consumed by grass carp at temperatures below 12°C and intensive feeding occurs above 20°C. Kilambi and Robinson (1979) reported the optimum temperature for grass carp growth to be between 18.3 and 24.9°C, while Pfeiffer & Lovell (1990) stated that optimum temperature was between 26-30°C. Grass carp consume vegetation intermittently at temperatures as low as 3°C, and they eat steadily at 10 to 16 °C, with optimal consumption at 21 to 30 °C (Masser, 2002). Durbin *et al.* (2007) stated that feed consumption of grass carp is greatest at water temperatures of 26.5-29.5 °C, and the fish stops eating when water temperature falls below 12 °C. Pfeiffer & Lovell (1990) suggest that 26-30 °C is the optimum range for

grass carp grown to 175 g in ponds with supplemental feeding.

It was found that a temperature range of 26-33°C suitable for the growth of bighead carp, *Arisichthys nobilis*, as better weight gain and lower feed conversion rate were recorded during this period, while lower growth was observed when the average water temperature was 7-15°C (Afzal *et al.*, 2008).

It can be concluded from the results of the current experiment that water temperature affected the daily feeding rate too much comparing with the low effect of fish weight. Osborne and Riddle (1999) demonstrate that relative feeding rates decline with an increase in fish weight (Grass carp about 300 g average weight consume about 100% of *Hydrilla*, while of 1 kg average weight consume 50% and fish of 3 kg consume only 30% of their respective body weights. Wu *et al.* (2016) stated that the range of feeding rate of juvenile grass between 2.64-3.18%, and it's very high compared with the result of current experiment because of the difference in average fish weight.

Daily consumed feed of small fish (55 g average weight) was (1.05, 1.74, 1.66, 3.06, 2.90) g for the

temperature of (10, 15, 20, 25, 30) °C respectively. Essa *et al.* (2004) in 15 weeks experiment of cultivation grass carp (30.6 g average weight) in concrete ponds, recorded an average

daily consumed pelleted feed of 1.95 g per fish.

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تأثير وزن الاسماك ودرجة الحرارة في تناول غذاء الكارب العشبي *Ctenopharyngodon idella* (Cuvier and Valenciennes, 1884)

ماجد مكي طاهر

وحدة الاستزراع المائي- كلية الزراعة- جامعة البصرة

Email: maj61ae@yahoo.co

الخلاصة

اجريت الدراسة الحالية في مختبر اسماك وحدة الاستزراع المائي في كلية الزراعة جامعة البصرة لغرض معرفة تأثير وزن الاسماك ودرجات الحرارة في تناول غذاء اسماك الكارب العشبي، *Ctenopharyngodon idella* (Cuvier and Valenciennes, 1884). اختبرت خمسة درجات حرارة (10 و 15 و 20 و 25 و 30)°م وحجمان للأسماك (معدل وزن 55 و 400 غم). بينت نتائج التجربة الحالية بان اعلى تناول يومي للغذاء من قبل الاسماك الكبيرة بلغ (9.44 و 12.32 و 17.76 و 37.04 و 35.92) غم، بينما اقل تناول يومي للغذاء من قبل الاسماك الصغيرة بلغ (3.68 و 6.88 و 4.64 و 7.60 و 6.56) غم لدرجات الحرارة (10 و 15 و 20 و 25 و 30)°م على التوالي. اظهرت نتائج معدل تناول الغذاء ومعدل التغذية اليومي للأسماك الصغيرة وجود فروق معنوية ($P \leq 0.05$) بين درجة الحرارة 10°م وكل من درجة الحرارة 25 و 30°م، بينما لا توجد فروق معنوية ($P > 0.05$) بين 10 و 15°م مع 20°م، وكذلك بين (15 و 20 و 25)°م مع 30°م. بينت نتائج معدل استهلاك غذاء الاسماك الكبيرة وجود فروق معنوية ($P \leq 0.05$) بين درجة الحرارة 10 و 15°م مع درجة الحرارة 30°م، بينما لا توجد فروق معنوية ($P > 0.05$) بين درجة الحرارة 20°م مع بقية درجات الحرارة الاربعة. أثبتت نتائج معدل التغذية اليومية للأسماك الكبيرة وجود فروق معنوية ($P \leq 0.05$) بين درجة الحرارة 10°م مع كل من درجة الحرارة 25 و 30°م، بينما لا توجد فروق معنوية ($P > 0.05$) بين بقية درجات الحرارة. يستنتج من هذه نتائج هذه الدراسة بان درجة الحرارة تؤثر في معدل تناول الغذاء اليومي بشكل كبير مقارنة مع تأثير اقل لحجم الاسماك.

الكلمات المفتاحية: الاحواض الزجاجية، درجة الحرارة، استهلاك الغذاء اليومي، معدل التغذية اليومي.