

Effects of Water Temperature on Growth Criteria of Fingerlings of Grass Carp, *Ctenopharyngodon idella* (Valenciennes, 1884)

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Abstract: The current experiment was conducted in the Fish Laboratory of Aquaculture Unit, College of Agriculture, University of Basrah from 28th January to 19th April 2021. Growth criteria of grass carp *Ctenopharyngodon idella* were investigated using four water temperatures (15, 20, 25, and 30 °C). Grass carp fingerlings (4.92 g) were brought from earthen ponds of the Aquaculture Unit in Al-Hartha Station for Agricultural Researches, North Basrah. The results indicated that the highest final weight (7.96 g) was reached by fishes at 15 °C, while the lowest final weight (7.22 g) was at 30 °C. Weight increments for fishes were 3.02, 2.97, 2.76, and 2.22 g for water temperatures of 15, 20, 25, and 30 °C, respectively. Fishes had the highest daily growth rate (0.0425 g/day) at 15 °C and the lowest (0.0312 g/day) at 30 °C. Fishes at 20 °C had the best feed conversion rate of 4.03, while fishes at 30 °C had the worst feed conversion rate of 5.29. It can be concluded that the best growth criteria were obtained from fishes at 15 °C and 20 °C, while the worst was observed at 30 °C.

Keywords: Final weight, Weight increment, Daily growth rate, Specific growth rate, Feed conversion rate

Introduction

Grass carp, *Ctenopharyngodon idella* was belonged to the family Cyprinidae for a long time, but according to recent phylogenetic studies, Tan & Armbruster (2018) shifted this fish to the family Xenocypridinae. FAO (2020) stated that grass carp in 2018 was the most widely cultivated freshwater fish species in the world that consisted 10.5% of world production, followed by silver carp, *Hypophthalmichthys molitrix* (8.8%), Nile tilapia, *Oreochromis niloticus* (8.3%) and common carp, *Cyprinus carpio* (7.7%) from total world production.

It is well known that aquatic plants are an important part of any aquatic ecosystem where they provide habitat for different species of fishes and ensure optimal oxygen regime, while sometimes it is necessary to control these plants, especially in shallow eutrophic ponds. Macrophytes can have a positive and sometimes negative impact on aquatic biotopes (Petr, 2000). Grass carp is an herbivorous fish that feeds on certain aquatic plants and at early life on zooplankton, but in culture conditions, it accepts artificial pelleted feed. Masser

(2002) stated that when desirable vegetation is unavailable, grass carp fingerling feeds on insect larvae, other invertebrates, and even small numbers of fish fry, while in culture conditions, juveniles feed on pelleted diets and continue to consume this diet throughout their lives. Bozkurt et al. (2017) stated that grass carp exclusively feed on aquatic plants consuming 2-3 times their weight every day.

Grass carp have been introduced since 1945 to many regions in Asia, North America, and virtually all of Europe, mainly for culture and also for controlling aquatic vegetation (Pfeiffer & Lovell, 1990; Kırkağaç & Demir, 2006). It is well known that grass carp was introduced in Iraq since 1956. Cudmore & Mandrak (2004) pointed out that this fish is native to northwestern China and southeastern Russia, and it has been introduced into other countries for controlling vegetation. Durborow et al. (2007) stated that grass carps are used in water ponds to consume undesirable aquatic vegetation and filamentous algae. Silva et al. (2014) stated that grass carp is used to control aquatic plants in Brazil. Dick et al. (2016) revealed that 120 individuals of grass carp per hectare gave better control for plants in the lakes.

Osborne & Riddle (1999) stated that water temperature and fish size are strongly affected the feeding and growth of grass carp.

Many laboratory experiments were conducted in Iraq on grass carp with few field studies such as Al-Seyab (1996), Saleh et al. (2008), and Taher (2020a) who studied the effects of fish density on growth and condition factor of grass carp cultivated in earthen ponds. Al-Dubakel et al. (2011) studied growth criteria and the implication of grass carp larvae cultivated in a recirculation system. Al-Shkakarthy & Ahemed (2013) investigated the use of duckweed *Lemna* spp. in feeding grass and common carp. Talal (2013) investigated the cultivation of grass carp in polluted and non-polluted aquatic environments. Taher (2017) conducted some laboratory experiments on the grass carp. Al-Dubakel et al. (2020) studied the partial replacement of fish meal by *Azolla filiculoides* meal in grass carp feed. Abdullah et al. (2020) studied the feeding preferences of grass carp for three species of aquatic plants. Taher (2020b) studied the effects of fish weight and water temperature on feed intake of grass carp. The current experiment aimed to investigate the effects of water temperature on growth parameters of grass carp cultivated in the laboratory.

Materials and Methods

The current experiment was conducted in the aquaria of Fish Laboratory of Aquaculture Unit, College of Agriculture, University of Basrah from 28th January to 19th April 2021. Each aquarium measured 60 cm in length, 30 cm in width and 40 cm in height. In this experiment, four water temperatures (15, 20, 25 and 30 °C) were tested with two replicates for each treatment. Grass carp fingerlings (4.92 g) were brought from earthen ponds of the Aquaculture Unit in Al-Hartha Station for Agricultural Researches, North Basrah. Nine fishes in each aquarium were acclimatized in the laboratory for ten days before the start of the experiment. Aquaria were provided with air pumps and equipped with automatic heaters to control water temperature. The fishes were fed daily at a 3% feeding rate using commercial pellets prepared by the Agricultural Consultant Office, College of

Agriculture (fishmeal 20%, soybean meal 20%, wheat flour 35%, wheat bran 23% and vitamins-minerals premix 2%). Fishes were weighed every two weeks and fish feed quantity was changed after each weighing.

Throughout the experiment period, six samples from each treatment were taken 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) = $100 * [(\ln FW) - (\ln IW)] / \text{days}$

FCR = Feed consumed/ Fish weight increment

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

Statistical software SPSS IBM (23) and Excel 2013 were used for analyzing the data by least-square analysis.

Results

Table 1 shows the average fish weight with standard deviation measured during the experiment at different water temperatures. Initial average fish weights ranged from 4.77-5.24 g. The growth parameters for fishes reared at various water temperatures are shown in Table 2. Fishes reared in water temperature of 15 °C reached the maximum final weight (7.96 g), whereas fishes reared in water temperature of 30 °C reached the lowest final weight (7.22 g) (Figure 1). There were no significant differences ($p>0.05$) between 15 °C with 20 °C and 25 °C, while there were significant differences ($p<0.05$) between both 15 °C and 25 °C with 30 °C, according to statistical analysis of final weight. Weight increments for fishes were 3.02 g, 2.97 g, 2.76 g, and 2.22 g for water temperatures of 15 °C, 20 °C, 25 °C, and 30 °C, respectively (Figure 2). Statistical analysis of weight increments revealed no significant differences ($p>0.05$) between 15 °C with 20 °C as well as between 20 °C and 25 °C, while there were significant differences ($p<0.05$) between 15 °C with 25 °C and also between 30 °C with the other three treatments.

Fishes reared in water temperature of 15 °C had the highest daily growth rate (0.0425 g/day), whereas fishes reared in water temperature of 30 °C had the lowest daily growth rate (0.0312 g/day) (Figure 3). Statistical analysis of daily growth rate revealed no significant differences ($p>0.05$) between 15 °C with 20 °C as well as between 20 °C and 25 °C, but significant differences ($p<0.05$) between 15 °C with 25 °C and 30 °C as well as between 25 °C with 30 °C. Specific growth rates for fishes were 0.6708, 0.6848, 0.6211 and 0.5174 %/day for water temperatures of 15 °C, 20 °C, 25 °C and 30 °C, respectively (Figure 4). Statistical analysis of specific growth rates showed that there were no significant differences ($p>0.05$) between 15 °C with 20 °C and 25 °C, while there were significant differences ($p<0.05$) between 30 °C with the other three treatments.

Best feed conversion rate was 4.03 for fishes reared in water temperature of 20 °C, while worst feed conversion rate was 5.29 for fishes reared in water temperature of 30 °C (Figure 5). Statistical analysis of feed conversion rate indicated that there were no significant differences ($p>0.05$) between 15 °C with 20 °C and 25 °C, while there were significant differences ($p<0.05$) between 30 °C with the other three

treatments. The best growth criteria were obtained from fishes reared in water temperature of 15 °C and 20 °C, while worst growth criteria were obtained from fishes reared in water temperature of 30 °C.

Table 1: Average weight of grass carp during the experiment.

Date	Grass carp weight (g±SD) in different temperatures (°C)							
	15		20		25		30	
	A1	A2	A3	A4	A5	A6	A7	A8
7/2/2021	5.05±1.19	4.84±1.50	4.77±1.44	4.72±1.46	4.85±1.37	5.12±0.79	4.77±1.22	5.24±1.55
22/2	5.51±1.07	5.36±1.50	5.08±1.50	5.17±1.38	5.14±1.12	5.56±0.56	4.85±1.21	5.46±1.60
8/3	6.22±1.14	6.22±1.92	5.87±1.47	6.02±1.41	5.76±1.65	6.37±0.62	5.47±1.34	6.20±1.65
22/3	6.59±1.44	6.60±2.11	6.44±1.65	6.65±1.63	6.22±1.97	6.97±0.87	5.92±1.53	6.53±1.83
5/4	7.34±1.75	7.3±2.38	7.05±1.83	7.21±1.97	6.92±2.17	7.33±1.16	6.47±1.75	6.99±1.98
19/4	8.00±1.67	7.92±2.33	7.67±1.82	7.77±1.90	7.59±2.17	7.90±1.11	7.02±1.62	7.42±2.15

Table 2: Growth criteria of grass carp in different treatments.

Growth criteria	Treatments for different temperatures (°C)							
	15		20		25		30	
	A1	A2	A3	A4	A5	A6	A7	A8
FW (g)	8.00	7.92	7.67	7.77	7.59	7.90	7.02	7.42
Average	7.96 ^a		7.72 ^{ab}		7.75 ^a		7.22 ^b	
WI (g)	2.95	3.09	2.90	3.05	2.74	2.78	2.25	2.18
Average	3.02 ^a		2.97 ^{ab}		2.76 ^b		2.22 ^c	
DGR (g/day)	0.0415	0.0435	0.0408	0.0429	0.0386	0.0392	0.0317	0.0308
Average	0.0425 ^a		0.0419 ^{ab}		0.0389 ^b		0.0312 ^c	
SGR (%/day)	0.6469	0.6947	0.6688	0.7009	0.6311	0.6111	0.544	0.4908
Average	0.6708 ^a		0.6848 ^a		0.6211 ^a		0.5174 ^b	
FCR	4.22	3.99	4.08	3.97	4.27	4.64	4.94	5.63
Average	4.10 ^a		4.03 ^a		4.46 ^a		5.29 ^b	

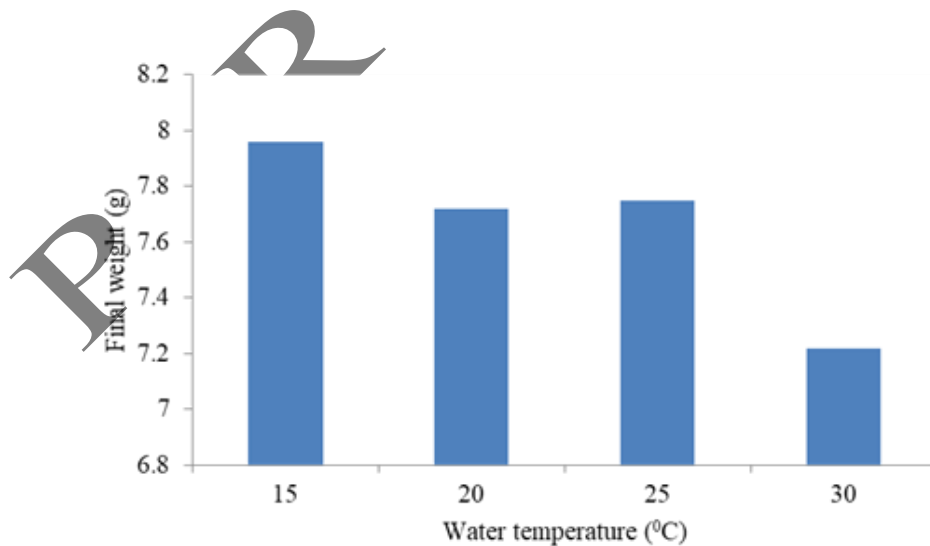


Figure 1: Final weights for fishes reared at different water temperatures.

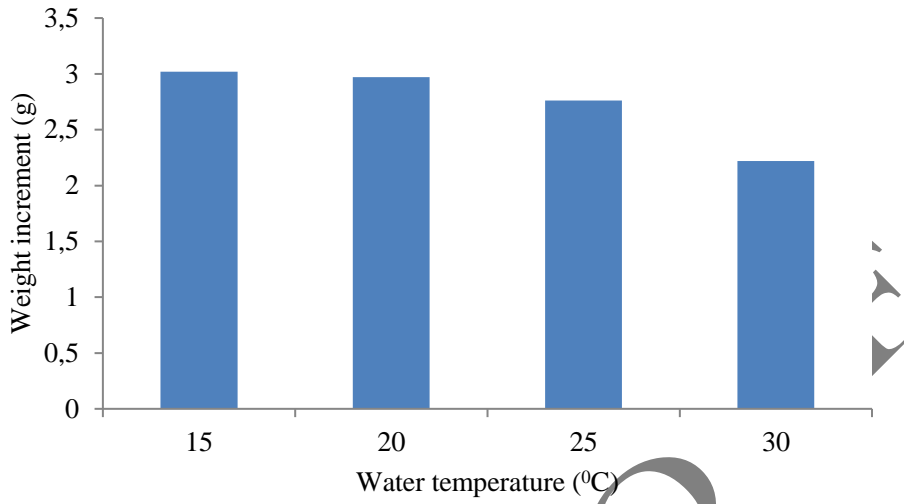


Figure 2: Weight increments for fishes reared at different water temperatures.

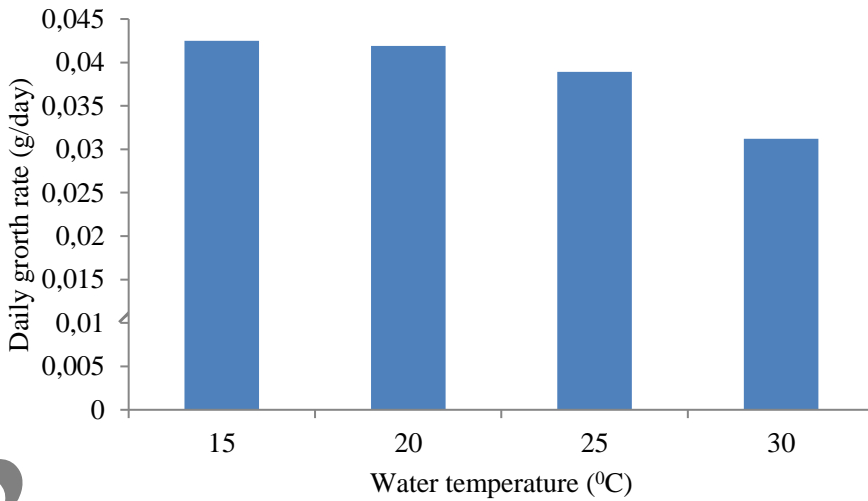


Figure 3: Daily growth rates for fishes reared at different water temperatures.

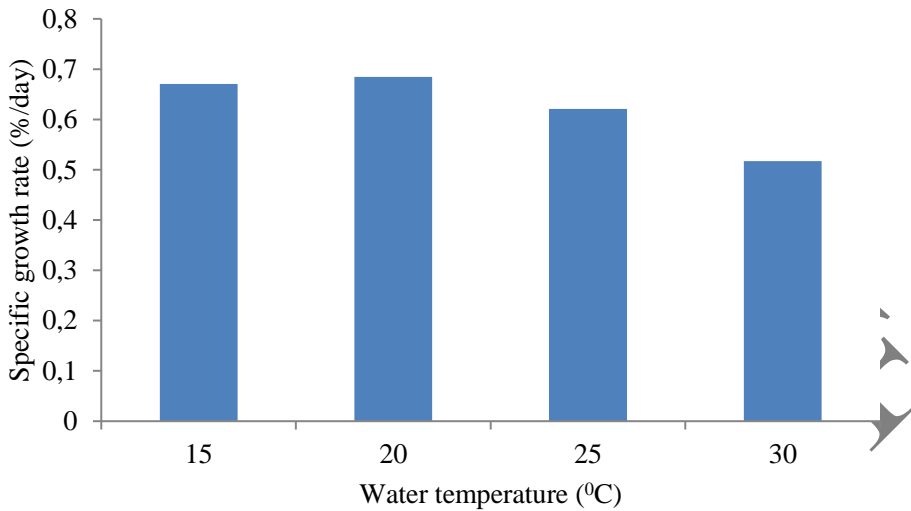


Figure 4: Specific growth rates for fishes reared at different water temperatures.

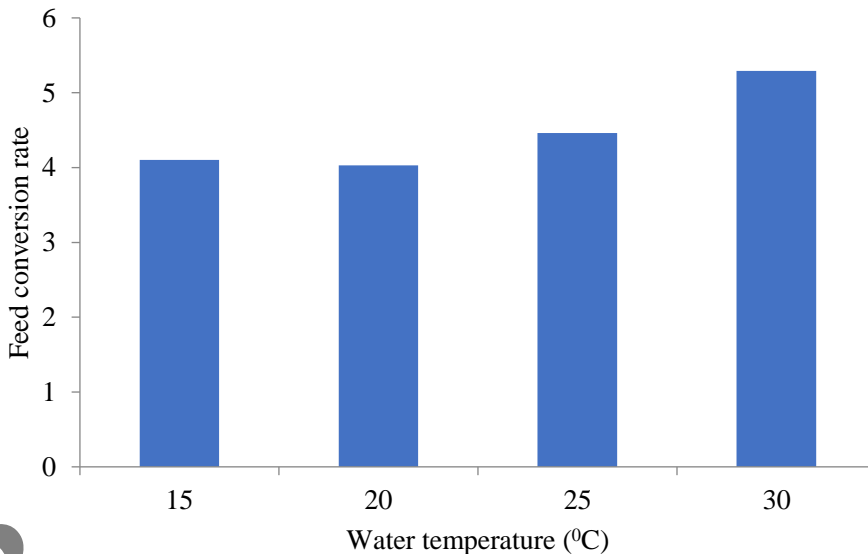


Figure 5: Feed conversion rates for fishes reared at different water temperatures.

Discussion

Water temperature has long been recognized to affect all activities of poikilothermic animals, including feeding and reproduction. There was a relative positive relationship between water temperature and the growth of most fishes within tolerance limits. Osborne & Riddle (1999) recorded water temperature and fish size as the main factors affecting the growth of grass carp.

Results of the current experiment proved that the highest growth of grass carp was reached by fishes reared at water temperatures of 15 °C and 20 °C, followed by 25 °C, while the lowest growth was reached by fishes reared at 30 °C. Osborne & Riddle (1999) found that feeding efficiency and weight increments of grass carp increased with increasing water temperature with the better feed conversion rate. Opuszyński (1972) stated that grass carp stopped feeding at a temperature less than 12 °C, while the highest feed consumption occurred at a temperature above 20 °C. Kilambi & Robinson (1979) reported a water temperature of 18.3-24.9 °C as optimum for the growth of cultivated grass carp, while Pfeiffer & Lovell (1990) stated that the optimum range was between 26-30 °C. Masser (2002) reported that grass carp eats vegetation intermittently at low temperature (3°C) and eats steadily at a range of 10-16 °C, while the optimum feeding occurred at 21-30 °C.

Durborow et al. (2007) pointed out that the highest feed consumption by grass carp occurred between 26.5-29.5 °C and fish stopped feeding when the temperature was below 12 °C. Taher (2020b) stated that water temperature affected the daily feeding rate of grass carp, and statistical analysis of the 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 15 and 20 °C. The same previous researcher pointed out that grass carp continued consuming floating pellets even at 10 °C.

Al-Dubakel et al. (2020) recorded growth criteria of grass carp that differed from the current experiment, such as weight increment (1.55-2.50 g), daily growth rate (0.028-0.042 g/day), specific growth rate (0.062-1.000) and very high feed conversion rate (25-40.6). In comparison to the current experiment, Taher (2017) found that grass carp fed pellets had higher weigh increments (8.14 g) and a higher daily growth rate (0.17 g/day). Finally, the ideal water temperature for grass carp cultivation ranged from 15 to less than 30 °C.

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