Winter growth of three cyprinid fish raised in earthen ponds in Basrah Province Southern Iraq

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Abstract

In this study, common carp (Cyprinus carpio, L., 1758), grass carp (Ctenopharyngodon idella, Valenciennes, 1844), and silver carp (Hypophthalmichthys molitrix, Valenciennes, 1844) growth over the winter was investigated. The investigation was carried out in two earthen ponds at the Marine Sciences Center of the University of Basrah in the winters of 2015, 2016, and 2017. Each pond contained 5000 fish/ha of common carp (50 %), grass carp (30 %), and silver carp (20 %). For common, grass, and silver carp, the weight ranges were 45–200 g, 30–80 g, and 15–154 g, respectively. Temperatures in the winters of 2015, 2016, and 2017 ranged from 12.5 to 18.1 °C, 9.5 to 13.1 °C, and 9.2 to 13.9 °C, respectively. The weight gain of common, grass, and silver carp fish were 80, 65, and 52 g, respectively, over the winter of 2015. In the winter months of 2016, it was 32, 31, and 20 g, while in the winter months of 2017, it was 66, 32, and 15 g. The common, grass, and silver carp had the highest specific growth rates (SGR) in the winter of 2016 at 0.719, 1.195, and 2.355 % g/day. Common and silver carp had the highest gross production in the winter of 2017, at 705 and 265 kg/ha/90 days, respectively, while grass carp had the highest gross production at 226 kg/ha/90 days. Fish production may be more effective with a restricted feeding time. Producers can lower their labor and feed costs by not feeding or feeding less during the winter.

Keywords: *common carp, grass carp, silver carp, growth performance, earthen ponds.*

INTRODUCTION

Success in fish farming depends on maximizing production to reduce costs. Feed costs can be decreased by taking advantage of the compensation growth pattern. Producers and researchers are always looking for novel ways to lower these costs (Sealey et al., 1998; Small et al., 2016). Various investigations have been made on whether restricted feeding during the winter can be managed to maximize compensated gain for the following season (Kim and Lovell. 1995; Okwoche and Lovell.

1997; Ali & Wootton, 2003). For fish, the water temperature was identified as an "abiotic factor" (Brett, 1971). Temperature is one of the environmental factors that significantly affect an animal's molecular, biochemical, and physiological characteristics (Pankhurst and King 2010; Strüssmann et al. 2010). Species and populations can only survive and perform their physiological functions within a specific temperature range, which helps determine their abundance and distribution in any given habitat (Anguilleta 2009; Schulte et al. 2011). Water temperature is an important factor because it significantly affects ectotherm growth, differentiation, and survival rates (Georgakopoulou et al. 2010). Since fishes are the most common ectotherms and cannot control their body temperature through endogenous heat production, the temperature is the main factor determining how their biological systems function (Scott and Johnston 2012). According to Shahjahan et al. (2017), fish metabolism, distribution, reproduction, and survival are impacted by water temperature, and rates of biochemical reactions can roughly double in response to a temperature increase of 10 °C. Fish are cold-blooded, so the temperature of the water affects a variety of physiological processes, including body temperature, rate of growth, ability to consume food, and the conversion of food into energy (Viadero, 2005; Stevens & Balahura, 2007; Volkoff & Rønnestad, 2020). Fish metabolism has been found to significantly decline in low-temperature regions, which affects fish growth (Halver 1972; Jhingran 1985; Pörtner 2001). Fish grow and diversify at their highest levels in a specific temperature range (Gadowaski and Caddell, 1991; Le François et al., 2002; Cascarano et al., 2021). Every fish species has a preferred temperature range in which they can grow most effectively (Oyugi et al., 2011). The ideal temperature range for freshwater fish growth is between 25 and 30 °C (Anonymous, 1983). Fish growth was highest in the spring and summer and decreased or stopped entirely in the fall and winter (Dobson and Holmes, 1984; Pessanha & Araújo, 2003). The climate of Iraq is characterized by a hot and dry summer, which lasts for about four and a half months, and a mild winter of three months. Temperatures in Basra drop below 20°C during the winter months (January to March), which is too cold for carp to feed and grow. Carps prefer 23 °C and 30 °C as the ideal growth temperatures (Fao,2009), The main objective of overwintering is to obtain a high survival rate for the fish and to keep the fish in good condition for future growth in the production ponds. The Winter Feeding Program helps prevent weight loss and keep fish healthy (Al-Shamma et al., 1996). Studies have shown that fish fed during the winter get much more weight than fish not fed (Robinson, et al.,1998; Larsen et al., 2001). The current study aims to take advantage of the winter to provide additional growth, which will help to increase extra weight in the future growth season, keeping in mind the information provided can be a means of understanding how temperature affects the growth performance of fish, particularly during the winter season. Restrictive feed strategies could be effective tools for improving the effectiveness of fish production. Producers can save money by lowering feed and labor costs by not feeding or restricting feed during the winter.

Materials and methods

The experiment was conducted to determine the effect of Fish growth over the winter months (January, February, and March) in two earthen fish ponds at the Marine Sciences Center-University of Basra, each measuring about 0.25 hectares. Each pond was stocked with three species of cyprinid, common carp C. carpio (50%), grass carp C. idella (30 %), and silver carp H. molitrix (20 %), at a stocking rate of 5000 fishes/ha, throughout the winter months of 2015, 2016 and 2017. Weight gain (WG) and specific growth rate (SGR) were studied by taking 15 fish of each species every 15 days. Both fish ponds received organic manure at a rate of 0.4 kg / m2, one week before the stocking of fish (Taher and Al-Dubakel,2020). No additional food was provided to fish and natural food was the only source. The temperature of the water (°C), dissolved oxygen (mg / l), and pH were measured every 15 days. Growth parameters were measured as follows:

Weight gain :

WG (g) = final weight(g)-initial weight(g)

Specific growth rate:

SGR % g /day = (LnW2 – LnW1/t) ×100. Where, Ln is the natural log; W1 is the initial fish weight, W2 is the final fish weight in grams and t is the period of the experiment in days.

Gross fish production:

Gross fish production was calculated according to Apu et al. (2012)

Gross weight = No. of fishes harvested × average final weight

Gross fish production (kg/ha/90 days) = Gross weight (kg) of fish per ha. per month × 3

Results

Water Quality Parameters

Water temperature, dissolved oxygen, and pH are shown in (Table 1). The temperature ranged between 12.5-18.1 ° C, 9.5-13.1 ° C, and 9.2-13.9 ° C, with mean of 15.3 ± 2.8, 11.3 ± 1.8, and 11.55 ± 2.35 during the winter months of 2015, 2016, and 2017, respectively. Dissolved oxygen (DO) ranged from 5.8-7.4 mg / l, 5.2-6.3 mg / l, and 5.5-6.8 mg / l during the winter months of 2015, 2016, and 2017, respectively. During the different winter months, the pH values of pond water ranged from 7.2-8.1. 7.1-8.3 and 7.5-8.6 respectively.

Table 1. Ranges and (mean values ± SD) of water quality parameters observed throughout the study period.

Winter season	Water Temperature ° C	Dissolve Oxygen mg/l	pH
2015	12.5-18.1 (15.3 ± 2.8)	5.8-7.4 (6.6 ± 0.8)	7.2-8.1 (7.05 ± 0.45)
2016	9.5-13.1 (11.3 ± 1.8)	5.2-6.3 (5.75 ± 0.55)	7.1-8.3 (7.7 ± 0.6)
2017	9.2-13.9 (11.55 ± 2.35)	5.5-6.8 (6.13 ± 0.65)	7.5-8.6 (8.05 ± 0.55)

Changes in fish weight

Individual weights of common, grass, and silver carp increased over the 90 days of the experiment (Table 2). The total body weight of common carp increased from 125 g to 219 g, 45 g to 86 g, and 200 g to 282 g in the winter of 2015, 2016, and 2017 respectively. In Grass carp, it was 80 to 151 g, 30 and 88 g, and 71 to 126 g, and between 60 to 129 g, 15 to 125 g, and 154 to 256 g in silver carp during the winter of 2015, 2016, and 2017 respectively.

Table 2. Changes in fish weight (g) of common, grass, and silver carp, reared in Earthen ponds of Marine Science Center Aquaculture station during the winter season of 2015, 2016, and 2017.

Species	Winter season	Date of measurement						
		1st Jan	15th Jan	30th Jan	15th Feb	28th Feb	15th Mar	30th Mar
Common carp	2015	125 ± 5.49	128 ± 5.05	153 ± 8.79	163 ± 6.35	201 ± 5.21	205 ± 1.25	219 ± 3.42
	2016	45 ± 1.64	47 ± 0.23	52 ± 1.06	55 ± 1.18	60 ± 2.13	77 ± 2.09	86 ± 2.57
	2017	200 ± 4.82	208 ± 1.23	217 ± 1.65	227 ± 1.81	230 ± 0.23	266 ± 2.07	282 ± 2.13
Grass carp	2015	80 ± 7.31	87 ± 2.56	91 ± 1.69	100 ± 3.27	143 ± 7.76	145 ± 2.01	151 ±2.25
	2016	30 ± 1.45	33 ± 0.18	34.5 ± 1.04	37.5 ± 1.16	43 ± 1.02	61 ± 2.15	88 ± 2.58
	2017	71 ± 2.94	85 ± 1.46	89 ± 0. 28	90 ±0.83	91 ± 1.06	111 ± 1.57	126 ± 3.12
Silver carp	2015	60 ± 5.12	63 ± 2.59	74 ± 2.45	85 ± 2.24	110 ± 3.12	112 ± 0.28	129 ± 1.36
	2016	15 ±1.07	16 ± 0.97	17 ± 0.88	24 ±0.26	28 ± 0.84	45 ± 2.037	125 ± 4.60
	2017	154 ± 5.06	160 ± 4.29	173 ± 2.04	175 ± 1.55	187 ± 1.69	190 ±1.05	256 ± 2.13

Growth Performance

Table (3), shows the initial body weight, final body weight, weight gain, and specific growth rate of common, grass, and silver carp during the winter months of 2015, 2016, and 2017. Silver carp gained a higher body weight of 110g and 111 g during the winter months of 2016 and 2017, followed by common carp (94 g) during the winter months of 2015, Silver carp attained a lower weight gain 0f 24 g during the winter months of 2017. The specific growth rates (SGR) of common carp were 0.623, 0.381, and 0.719 % g/ day in the winter of 2015, 2016, and 2017 respectively, where it was 0.381, 0.381, and 1.195 % g/ day in grass carp and it was 0.850, 2.355 and 0.603% g/ day in silver carp during the winter season of 2015, 2016 and 2017 respectively.

Fish Production

In the winter months of 2015, 2016, and 2017, the gross fish production was 547.5, 215, and 705 kg/ha/90 days for common carp, 226, 132, and 139 kg/ha/90 days for grass carp, and 129, 125, and 265 kg/ha/90 days for silver carp, respectively (Table 3).

Table 3. Initial body weight, final body weight, weight gain, specific growth rate, and Gross production of common, grass, and silver carp during the winter months of 2015, 2016 and 2017

Species	Winter season	Initial weight(g)	Final weight (g)	Weight gain(g)	Specific growth rate (% g/day)	Gross production (kg/ ha/90 days)
Common carp	2015	125 ± 5.09	219 ± 3.42	94	0.623	547.5
	2016	45 ± 1.06	86 ± 2.57	41	0.719	215
	2017	200 ± 4.82	282 ± 2.13	82	0.381	705
Grass carp	2015	80 ±7.31	151 ±2.25	71	0.381	226
	2016	30 ±1.45	88 ± 2.58	58	1.195	132
	2017	71 ± 2.94	126 ± 3.12	24	0.234	139
Silver carp	2015	60 ± 5.12	129 ±1.36	69	0.850	129
	2016	15 ± 1.07	125 ± 4.60	110	2.355	125
	2017	154 ± 5.06	256 ± 2.13	111	0.603	265

Discussion

Every fish has a comfortable temperature range to which it is adapted, and when the temperature goes above or below that range, the fish experiences thermal stress. The normal activities of fish may become seriously disrupted by this type of temperature fluctuation (Beitinger et al., 2000; Ashaf-Ud-Doulah et al., 2020). The cold and sunny weather may have contributed to the highest and lowest temperatures measured in the fish ponds for this study (18.1° C and 9.2° C). According to Likongwe et al. (1996), the air temperature is matched by the temperatures of shallow and small water bodies. In the present experiment, the temperature in the ponds during the winter months was below the temperature of the carps producing water, carps prefer 23 °C and 30 °C as the ideal growth temperatures (Fao,2009), The value of dissolved oxygen in the water is found to be higher than the minimum reported by Gonzalez et al. (2002) for these species (3.25 mg/L). According to Banerjea (1967), water with a dissolved oxygen content of 5 to 7 mg/l was reasonable or good in terms of productivity, and water with a dissolved oxygen content of less than 5 mg/l was unproductive. In the current study, dissolved oxygen levels were within the ideal range for fish farming. During the different winter months, the pH values of pond water were found to be alkaline and ranged from 7.2-8.1. 7.1-8.3 and 7.5-8.6 respectively during 2015, 2016, and 2017. Siddik et al. (2014), in agreement with the current study, state that pond fish culture requires a pH range of 6.5 to 9.0. Michael (1969) reported that the appropriate pH range for production was 7.3 to 8.4. Nasir et al., (2019) reported that water with a pH ranging from 7 to 8 was the best range for the growth performance and survival rate of carp. According to the pH of the water found in this study, the experimental ponds were appropriate for fish farming. Therefore, the fish growth was unaffected. These are in agreement with the results obtained by Hussein (2010) and Ponce Palafox (2010). Tropical species will die at temperatures between 10 and 20 ° C, and most do not grow below 25 ° C. Warm water species typically do not grow at temperatures below 10 to 15 ° C but tolerate much lower winter temperatures (Siddik et al. 2014). Fishes in the current study show a different increase in weight during winter months, which was in agreement with Al-Shamma et al. (1996). Taher (1986) reported negative growth for common carp in their natural environment during winter months in Hor Al-Hammar at Basrah Province.

Al-Shamma et al. (1996) recorded a weight increase in common carp in the middle region of Iraq exposed to different feeding regimes during winter months (January 1993 to March 1994). The specific growth rate (SGR) of fish increases with high water temperatures and decreases with low temperatures, according to studies on a variety of fish species (Wurtsbaugh and Davis, 1977; Cui and Wootton, 1988; Van Ham et al.,2003; Handeland et al., 2008). However, there are very few reports on carp rearing during the winter (Tiwari et al., 2006; Desai & Singh 2009). The specific growth rate in the summer season was higher because the environment is suitable for fish growth (Handeland et al., 2008; Peng et al., 2014; Pang et al., 2016). The carp need at least 18 ºC minimum temperature for growth (Hussein, 2012). It is indicated that the specific growth rate (SGR) is strongly dependent on water temperature. Also added manure or fertilizer had a positive effect on the dissolved oxygen, phytoplankton, and primary productivity (Vromant et al., 2002), which was reflected in growth performance in the current study. Taher and Al-Dubakel (2020), studied the production of common carp reread in different densities in earthen ponds in Basrah province southern Iraq, it ranged between 281- 433 kg /ha / 125 days, and Hossain et al. (2014) reported mean gross productions of mirror carp C.carpio Ver. specularis) in winter and summer seasons 1581.94± 71.55 kg/ ha/ 60 days and 4262.74± 147.81kg/ ha/ 60 days respectively. The gross production of mirror carp, however, was found to be higher in the summer than in the winter. since the conditions were favorable for fish growth. In their study on the stocking of carps in polyculture, Alim et al. (2005) revealed that the stocking of 20 % of large carps had no impact on the survival rate or the output of rohu and catla (but not as same as common carp). Hepher et al. (1989) conducted an experiment to determine the effects of fish density and species combination on the growth and utilization of natural food in ponds. They observed that at densities of 1300 carps/ha (2116 kg/ha in 156 days), the polyculture produced more of all combined species. Compared to lower densities, the total rate of silver carp growth was slower at 2600 carps/ha.

Conclusions

•Temperature is one of the environmental factors that significantly affect fish growth.

•The water temperature ranges in southern Iraq appeared to be the most beneficial for growing carp species.

•To understand how well the fish grew, it may be essential to understand how water temperature affects the fish's growth.

•The production and the specific growth rate (SGR %g/day) of common, grass, and silver carp in the current study were both reasonably good.

•Take advantage of the winter period to obtain higher growth in the later stages of carp fish growth.

•Restrictive feed strategies could be effective tools for improving the effectiveness of fish production.

•Producers can save money by lowering feed and labor costs by not feeding or restricting feed during the winter.

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