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Effect of temperature on feed intake and feeding ratio of common carp (*Cyprinus carpio*) under laboratory conditions

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Abstract: The current experiment was conducted in the Fish Laboratory of Aquaculture Unit College of Agriculture-University of Basrah to investigate the effects of temperature on feed intake & feeding ratio of common carp (*Cyprinus carpio*). Common carp weight 20.2±0.37g were used in 9 Aquaria Five fishes were put in each aquarium of dimension 60 cm length, 30 cm width & 40cm height to investigate the effects of three water temperatures (22, 26 & 30) ^{0}C on feed intake & feeding ratio. Results of the current experiment showed that the highest daily consumed feed for fishes was (37.84, 46.72 & 36.32 g, while the lowest daily consumed feed for fishes was 20.8, 20.8 & 20.16 g in the temperature degrees (22, 26 & 30 ^{0}C respectively. The average consumed feed & daily feeding rate by the fishes showed significant differences (P≤0.05) between water temperature 22^{0}C with 26^{0}C while there were no significant differences (P>0.05) between water temperature 22^{0}C & 26^{0}C with 30^{0}C. It can be concluded from these results that water temperature 26^{0}C had a positive effect to increase daily consumed feed & daily feeding rate of common carp.

Keywords: Water temperature, daily consumed feed, daily feeding rate.

Introduction

The common carp *Cyprinus carpio* is one of the most important cyprinid species & globally accounts for 10% of freshwater aquaculture production (Valuchamy & Dhanushsri, 2022). Common carp culture is well suited in temperate as well as tropical countries of the globe (Chatterjee et al., 2004). Temperature is directly affecting immunity, metabolic rate & oxygen demand, so it is the major driving factor of the growth & survival of aquatic organisms. The changes in the environmental temperature above the organism's thermal threshold will not only increase the oxygen demand coupled with metabolic shifts but also reduce the feed intake & suppress their immunity (Dawood, 2021). Brett (1979)
stated that water temperature, fish size & feeding rate are three important factors affecting the growth of fish, for this reason Jobling (1993) refereed that determining the specific water temperature at the optimal feeding rate is prerequisite to the success of aquaculture production. Water temperature is a driving force in the fish life because its effects are more than any other single

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factor, growth & live ability in fish are optimum within a defined temperature range (Gadowaski & Caddell, 1991). Being cold-blooded animal, fish is affected by the temperature of the surrounding water which influences the body temperature, growth rate, feed conversion, feed consumption & other body functions (Houlihan et al., 1993). The physiological activities are high at the optimum temperature & hence the organism survives well, The minimum effective temperature is the lowest temperature at which organism can live indefinitely in an active state, while the maximum effective temperature is the highest temperature at which an organism can live indefinitely in an active state, The minimum survival temperature is the lowest temperature at which survival is possible, The maximum survival temperature is the highest temperature at which survival is possible (Arumugam,2010).

Many researchers studied the effects of water temperature on fishes such as Yamamoto *et al.* (2001) who studied the influence of decreasing water temperature & shortening of the light phase on macro nutrient self-selection by rainbow trout *Oncorhynchus mykiss* & common carp, while Kausar & Salim (2006) studied the effects of water temperature on the growth performance & feed conversion ratio of *labeo rohita.* Desai & Singh (2009) studied the effects of water temperature & ration size on growth & body composition of common carp fry, while Oyugi et al. (2012) studied the effects of temperature on the foraging & growth rate of juvenile common carp. Taher (2020) studied the effects of fish weight & water temperature on feed intake of grass carp, C*tenopharyngodon idella*, while Valuchamy & Dhanushsri (2022) studied the effects of temperature on growth of cultivated common carp.

Materials and Methods

The current experiment was conducted in fish laboratory of Aquaculture Unit-Agriculture College-Basrah University. Common carp was brought from earthen ponds of Aquaculture Unit located in Al-Hartha Station for Agricultural Research, North Basrah & was feed on artificial floating pellets (32% protein). Three water temperatures (22, 26 & 30) ^{0}C were investigated. 9 Aquaria. Five fishes were put in each aquarium of dimension 60 cm length, 30 cm width & 40 cm height. There were three replicates for each treatment & repeated for three days interval. The fishes were acclimatized for one week in laboratory aquaria before the beginning of the experiment. Aquaria provided with air pumps & automatic heaters to control the water temperature. The residual floating pellets were collected (after three hours of feeding) in Petri dishes & dried before weighing. The consumed diet for three hours was calculated by the difference between added & residual feeds, then transformed in to the ratio of consumption. Daily feeding (DFR) rates were calculated according to the following equation:

DFR = Daily consumed feed (g)/ Total fish weight (g)

Data from the experiment were tested by analysis of variance (ANOVA) to determine the difference between the means & 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 a temperature of 22, 26 & 30 ^{0}C in the first day of experiment. The highest ratio of consumed diets (68.49%) occurred in temperature 26^{0}C, while the lowest ratio of consuming (35.39%) was recorded in temperature 22^{0}C. Table 2 shows diet consumed in three hours with a temperature of (22, 26 & 30) ^{0}C in the second day of experiment. The highest ratio of consumed diets (72.48%) occured in temperature 26 ^{0}C, while the lowest ratio of consuming (44.90%) was recorded in temperature 22 ^{0}C. The highest ratio of consumed diets (83.31%) was recorded at 26^{0}C, while the lowest (36.31%) was recorded in temperature 22 ^{0}C in the third day of experiment (Table, 3). Table (4) shows daily consumed diet for common carp at different temperatures. The highest daily consumed diets were (37.84, 46.72, 36.32) g & the lowest daily consumed diets for fishes were 20.8, 27.36, 20.16 g in the temperature degrees of 22, 26 & 30 ^{0}C, respectively.

Table 1: Diet consumed in three hours with three water temperatures at date 9/12/2021

Temperature (^{0}C)	Average fish weight (g)	Aquarium No.	Added diet (g)	Residual diet after 3 hours	Consumed diet (g)	Consumed Diet (%)
22	20.1	1	7.13	4.36	2.77	38.85
	20.0	2	7.12	4.25	2.87	40.31
	20.2	3	7.13	4.41	2.72	38.15
26	20.1	4	7.05	3.51	3.54	50.21
	20.2	5	7.14	2.25	4.89	68.49
	20.3	6	7.04	3.37	3.67	52.13
30	20.3	7	7.15	3.02	4.13	57.76
	20.1	8	7.12	4.60	2.52	35.39
	20.2	9	7.13	3.39	3.74	52.45

Table 2: Diet consumed in three hours with three water temperatures at date 20/12/2021.

Temperature (^{0}C)	Average fish weight (g)	Aquarium No.	Added diet (g)	Residual diet after 3 hours	Consumed diet (g)	Consumed Diet (%)
22	20.2	1	7.03	3.86	3.17	45.09
	20.6	2	7.13	3.92	3.21	45.02
	19.7	3	7.15	3.94	3.21	44.90
26	20.7	4	7.06	2.71	4.35	61.61
	20.4	5	7.05	1.94	5.11	72.48
	19.8	6	7.18	3.76	3.42	47.63
30	20.2	7	7.13	3.92	3.21	45.02
	19.5	8	7.10	2.56	4.54	63.94
	20.5	9	7.18	3.54	3.64	50.70

Table 3: Diet consumed in three hours with three water temperatures at date 21/12/2021.

Temperature (^{0}C)	Average fish weight (g)	Aquarium No.	Added diet (g)	Residual diet after 3 hours	Consumed diet (g)	Consumed Diet (%)
22	20.3	1	7.16	4.56	2.60	36.31
	20.5	2	7.03	3.61	3.42	48.65
	19.6	3	7.01	2.28	4.73	67.48
26	20.8	4	7.00	2.95	4.05	57.86
	20.6	5	7.01	1.17	5.84	83.31
	19.7	6	7.06	3.09	3.97	56.23
30	20.8	7	7.00	3.79	3.21	45.86
	19.7	8	7.11	3.63	3.48	48.95
	20.5	9	7.00	2.61	4.39	62.71

Table 4: Daily consumed diet for common carp at three water temperatures.

Temperature (^{0}C)	Date	Aquarium No.	Total fish weight (g)	Daily consumed feed (g)
22	19/12/2021	1	20.1	22.16
		2	20.0	22.96
		3	20.2	21.76
	20/12/2021	1	20.2	25.36
		2	20.6	25.68
		3	19.7	25.68
	21/12/2021	1	20.3	20.80
		2	20.5	27.36
		3	19.6	37.84
26	19/12/2021	4	20.1	28.32
		5	20.2	39.12
		6	20.3	29.36
	20/12/2021	4	20.7	34.80
		5	20.4	40.88
		6	19.8	27.36
	21/12/2021	4	20.7	32.40
		5	20.4	46.72
		6	19.8	31.76
30	19/12/2021	7	20.3	33.04
		8	20.1	20.16
		9	20.2	29.92
	20/12/2021	7	20.2	25.68
		8	19.5	36.32
		9	20.5	29.12
	21/12/2021	7	20.8	25.68
		8	19.7	27.84
		9	20.5	35.12

Table (5) shows average daily consumed diet & average daily feeding rate in different water temperatures. Statistical analysis of average consumed feed & daily feeding rate shows significant differences ($P \leq 0.05$) between water temperature 22^0C with 26^0C while there were no significant differences ($P>0.05$) between water temperature 22 ^{0}C & 30 ^{0}C & between 26 ^{0}C with 30 ^{0}C.

Table 5: Average daily consumed diet & average daily feeding rate for common carp at three water temperatures

Temperature (^{0}C)	Daily consumed diet (g)	Daily feeding rate
22	2.78	1.3
	3.19	1.2
	3.58	1.4
Average	3.18 ±0.4 a	1.3 a
26	4.03	1.6
	4.29	1.8
	4.62	1.8
Average	4.31±0.29 b	1.7 b
30	3.46	1.3
	3.79	1.5
	3.69	1.4
Average	3.65 ±0.169 ab	1.4 ab

Discussion

Carp have the capacity to grow faster in regions of higher temperatures & longer growing seasons, with the fastest growth recorded in equatorial populations where water temperatures remain > 20^0C all the year (Oyugi et al., 2012). Jauncey & Ross (1982) have reported that most species cease to feed at low temperatures (below 16^0C).

Results of the current experiment indicated that water temperature between 22^0C & 26^0C affected the daily consumed feed & daily feeding rates because high water temperature increased the feed intake & metabolic rate of the fish, while the water temperature of 30 Cº didn't affected too much because this temperature may be out of the optimum range of temperature for common carp.

Korwin- Kossakowski (2008) estimated that the water temperature of 26-28 ^{0}C was optimum temperature for the larvae of common carp. According to Oyugi et al. (2012) the maximum growth rate of common carp was between 24-28^{0}C. Pang et al. (2016) reported that 25^0C was optimum temperature for common carp juvenile in contrast, Zeng et al. (2018) reported that 28 ^{0}C was the optimum temperature for common carp juvenile. Valuchamy & Dhanushsri (2022) reported that the

temperature between 28 & 34 ^{0}C did not affect the growth and also is the optimum range of temperature of common carp for fresh water aquaculture.

Desai & Singh (2009) found that 6% feeding ratio is optimal for growth of common carp fry at both temperatures of 28 ^{0}C & 32 ^{0}C. Taher (2020) reported that the water temperature affected the daily feeding rate of grass carp too much comparing with the low effect of fish size & stated that the highest daily consumed feed & daily feeding rates especially for large fishes were recorded at the water temperatures of 25 & 30^{0}C, while the lowest value recorded at a water temperature of 10^{0}C .

Kausar & Salim (2006) stated that water temperature ranging from 24-26^{0}C seemed to be the most effective for rearing of *Labeo rohita*, where the lower body weight gain maintained in low water temperature (20-22^{0}C). Fadel et al. (2011) found that the highest final weight, weight gain & specific growth rate in Nile tilapia, *Oreochromis niloticus* feed 7% feeding ratio at 28 ^{0}C water temperature. This results indicated that the growth increased by increasing feeding level at each water temperature & also by increasing water temperature at each feeding level.

Based on the observations & results of the current study, it is clearly indicated that the temperature 26^{0}C did in creas of the daily consumed feed & daily feeding rates & therefore the growth of common carp, further it is confirmed that the temperature in between 26 & less than 30^{0}C is the optimum range of temperature of common carp.

References

Arumugam, N. (2010). Concepts of Ecology (Environmental Biology). Saras Publication, Tamil nadu, India, 688 pp.

Brett, J. R. (1979). Environmental factors & growth. In: Hoar, W.S., Randall, D. J. & Brett, J. R. (Eds.), Fish Physiology. Academic Press, New York: 599–675.

Chatterjee, N.; Pal, A. K.; Manush, S. M.; Das, T. & Mukherjee, S. C. (2004). Thermal tolerance & oxygen consumption of *Labeo rohita* & *Cyprinus carpio* early fingerlings acclimated to three different temperatures. J. Therm. Biol. (2004), 29(6): 265–270.

Dawood, M. A. (2021). Nutritional immunity of fish intestines: Important insights for sustainable aquaculture. Rev. Aquac., 13(1): 642-663. DOI: 10.1111/raq.12492.

Desai, A. S. & Singh, R. K. (2009). The effects of water temperature & ration size on growth & body composition of fry of common carp, *Cyprinus carpio*. J. Therm. Biol., 34(6): 276-280. DOI:10.1016/j.jtherbio.2009.03.005

Fadel, A. H. I. & El-sayed Magouz, F. I. (2011). Effect of temperature & feeding level on growth of Nile tilapia (*Oreochromis niloticus*). J. Arabian Aquacul. Soc., 6(2): 223-236. DOI:10.1046/j.1365-2109.2002.00700.

Gadowaski, D. M. & Caddell, S. M. (1991). Effects of temperature on early-life-history stages of California halibut *Paralichthys californicus.* J. Fish Bull., 89: 567-576.

Houlihan, D. F.; Mathers, E. M. & Foster, A (1993). Biochemical correlates of growth rate in fish. In Fish Ecophysiology. J. C. Rankin & F. B. Jensen (Eds.). Chapman & Hall, London. UK: 45-71. DOI:10.1007/978-94-011-2304-4_2.

Jobling, M. (1993). Bioenergetics: feed intake & energy partitioning. In Rankin, J. C. Jensen, F. B. (Eds.), Fish Eco-physiology. Chapman & Hall, London: 1–44. DOI: 10.1007/978-94-011-2304-4_1

Jauncey, K. & Ross, B. (1982). The effects of varying dietary protein levels on the growth, feed conversion, protein utilization & composition of juvenile tilapias (*Sarotherodon mossambicus*). Aquaculture, 27: 43-54.

Kausar, R. & Salim, M. (2006). Effect of water temperature on the growth performance & feed conversion ratio of *Labeo rohita*. Pak. Vet. J., 26(3): 105-108.

Korwin-Kossakowski, M. (2008). The influence of temperature during the embryonic period on larval growth & development in carp, *Cyprinus carpio* L., & grass carp *Ctenopharyngodon idella* (Val.): theoretical & practical aspects. Arch. Pol. Fish.,16: 231–314. DOI: 10.2478/s10086-008-0020-6.

Oyugi, D. O.; Cucherousset, J.; Baker, D. J. & Britton, J. R. (2012). Effects of temperature on the foraging & growth rate of juvenile common carp, *Cyprinus carpio*. J. Therm. Biol., 37(1): 89-94.

Pang, X. U.; Shi-Jian, F. U. & Yao-Guang, Z. (2016).Acclimation temperature alters the relationship between growth & swimming performance among juvenile common carp (*Cyprinus carpio*). Comp. Biochem. Physiol., 199: 111–119.

Taher, M. M. (2020). Effects of fish weight & water temperature on feed intake of grass carp, *Ctenopharyngodon idella* (Cuvier & Valenciennes, 1884). Basrah J. Agric. Sci., 46(2): 103-114.

Valuchamy, M. A. & Dhanushsri, M. (2022). Effect of temperature on growth of freshwater cultivable fish common carp, *Cyprinus carpio*. DOI: 10.2139/ssrn.4136625.

Yamamoto, T.; Shima, T.; Furuita, H.; Shiraishi, M.; Sánchez-Vázquez, F. J. & Tabata, M. (2001). Influence of decreasing water temperature & shortening of the light phase on macronutrient selfselection by rainbow trout *Oncorhynchus mykiss* & common carp *Cyprinus carpio.* Fish. Sci., 67(3): 420-429. DOI:10.1046/j.1444-2906.2001.00260.x.

Zeng, L. Q.; Cheng, F. U.& Shi-Jian, F. U. (2018). The effects of temperature & food availability on growth, flexibility in metabolic rates & their relationships in juvenile common carp. Comp. Biochem. Physiol., 217: 26-34. DOI:101016/j.cbpa.2017.12.011.