J Krishi Vigyan 2020 (Special Issue) : 41-46 DOI : 10.5958/2349-4433.2020.00077.X

Breeding and Fingerling Production of Common Carp (*Cyprinus carpio*) in Coldwater Region with Water Optimization

Preetam Kala*, Bipin Kumar Vishwakarma, Dinesh Mohan and N N Pandey

ICAR-Directorate of Coldwater Fisheries Research, Bhimtal-243136, Uttarakhand

ABSTRACT

An experiment was conducted to breeding and fingerling production of Common carp in recirculatory system for water optimization from May to July, 2019 in fish hatchery of ICAR-DCFR, Bhimtal, Uttarakhand. The recirculatory system with triplicates was used. The system comprised the FRP tank having dimension 1.5×1.0×1.0m for breeding and rearing of common carp. Two females and four males brooder were stocked in each recirculatory system. After seven days Ovatide hormone was given at 0.3ml/kg for female and 0.1ml/kg for male intramuscularly in a single dose. Hydrilla was spread over the tank. After 10 hr, females and males oozed eggs and milts, respectively and hatching started after 72 hr. All hatchlings were kept in the same tank. Yolk sac was absorbed after 76 hr. Daily 10percentof water was exchanged in the morning and evening. Fertilization and hatching rate percentage were 79.93 and 59.79, respectively. The survival rate of hatchlings to yolk sac absorption stage was 53.56percent. The survival rate of fingerlings after 90d was 81.11percent. Water quality parameters *viz.,*average temperature, pH, DO, Free CO_2, Alkalinity, Hardness and Ammonia -nitrogen were 20.2°C, 7.45, 7.29 mg/l, 4.11 mg/l, 97.64 mg/ l, 198.25 mg/ l and 0.068 mg/l, respectively. Common carp culture is popular in India but a shortage of water is foremost constraint for seed production. The dependence of water in seed production can be decreased by water optimizing with recirculatory system for seed production. The water recirculatory system may help to reduce water footprint in seed production of common carp.

Key Words: Breeding, Fertilization, Recirculatory system, Water footprint, Water optimization.

INTRODUCTION

Good quality seed is always a great need for profitable fish farming and several species do not breed in captive; hence artificial breeding is required. Induced breeding is a technique where brooders are stimulated by pituitary gland extracts or various other synthetic hormones for breeding. This technique is commonly known as hypophysation. This technique is used for those fishes which generally do not breed in captive condition. The hypophysation technique in major carps was established in India in 1957 Choudhari and Alikunhi (1957). Later by adopting the same technique, Chinese silver carp and grass carp reared in ponds were successfully bred in India Alikunhi *et al* (1963). In farm conditions, many culturable fishes like Indian major or exotic carps do not breed naturally, due to environmental and hormonal disturbances. Environmental parameters like temperature, rain, photoperiods and water current influence the hormonal activity from pituitary and gonads. Due to the disturbance of the environment that in sufficient release of the hormone causes inefficiency in breeding. Therefore, induced breeding is used in captive conditions. Common carp, *Cyprinus carpio* is one of the promising fish species in the aquaculture sector which belongs to the Cyprinidae family. It is distributed all over the world. It is hardy in nature and can bear variable conditions.The carp culture is popular in India but the shortage of carp seed production is the foremost constraint for marginal farmers. To mitigate this problem breeding and culture in recirculatory aquaculture system may be one alternative. This

*Corresponding Author's Email: preetamkala@gmail.com

system can provide fishery opportunities in those places where environment is favorable but water is not sufficient for bigger ponds.

Recirculating aquaculture systems for Common carp can be one alternative solution for producing seed in less water. It is land-based aquatic system in which water is reused after biological and mechanical treatment. The major advantages of this system are reduced water consumption and the release of nutrients in the environment. Recirculatory systems have greater control over the environmental and water quality parameters, thus enabling optimal conditions for fish culture Heinen *et al* (1996). Thus,the present experiment was envisaged to study the breeding and fingerling production of common carp in a recirculatory system.

MATERIALS AND METHODS

The experiment was conducted in the fish hatchery of Directorate of Coldwater Fisheries Research, Bhimtal, Uttarakhand for 90 d from May 2019 to July 2019.The recirculatory system with triplicates were used for optimizing water.

Recirculatory system comprised FRP tank having dimension1.5×1.0×1.0m for breeding and rearing of the spawn of common carp. Primarily the tanks were washed with the help of $KMnO_4$ @ 5ppm. Plastic pipes of 25mm diameter were used to prepare an under-gravel filter. The distance between the two pipes was 15cm. Halves incisions were made on pipes. Under gravel,the filter was positioned at the bottom of the tank than 15cm layer of gravels were evenly distributed over it. A submersible water pump having a water pumping capacity of 3500L/hr was fitted with the under-gravel filter. The inlet of the pump was fit on the under gravel filter. The help of 25mm diameter pipe expanded the outlet into a plastic made basket with muslin cloth which acts as a mechanical filter and aerator.

Two females and four males brooder were stocked in each recirculatory system for seven days. Maturity of male and female was checked by stripping. After seven days Ovatide hormone was given at 0.3ml/kg for female and 0.1ml/kg for male intramuscularly in a single dose. Hydrilla was spread over the recirculatory tank. The eggs were sticky in nature and stuck on hydrilla. After breeding males and females were separated from breeding tanks. Total spawning was checked by slight pressure applied to brooder.

Fecundity

Total numbers of eggs were estimated by the following formula

Fecundity = Total ovary weight x Number of eggin sample / Weight of sample

Rate of fertilization

The fertilized eggs remained translucent and unfertilized eggs become white and dead within 2-3 hr. A total of 500 eggs were counted. The fertilization rate was calculated as:

Fertilization rate (%) = (Number of fertilized eggs / Total number of eggs) x 100

Mean rate of fertilization = Sum of fertilization rate / Number of females

Hatching rate

The fertilized eggs were counted on hydrilla, and then a piece of net was attached to the hydrilla for counting hatchlings. The following formula calculated the hatching rate:

Hatching rate (%) = (Number of hatchlings / Total number of fertilized eggs) x 100

Mean rate of Hatching = Sum of hatching rate / Number of females

Survival rate

Survival rate was measured in different stages, firstly hatchlings to postlarvae stage, post-larvae to fry stage and finally fry to fingerling stage stocked in the system.Survival rate was calculated in rearing experiment by the following formula:

Survival rate (%) = (Number of fish harvested / Total number of fishes stocked) x100

Rearing hatchlings to fingerling stages

After breeding of fishes, all hatchlings were kept in the same tank. Daily 10% of water was exchanged in morning and 10% in the evening.

Feeding

Feed was provided after 4th day of hatching. From 4th day to 15th-day feed was provided at 400percent body weight of fishes. After 15th day to 90th-day feed was provided at 5percent of body weight of fishes. Feed was provided daily into four equal parts.

Water quality parameters

Water quality parameters *viz.,* Dissolve oxygen (mg/l), Free carbon dioxide (mg/l), pH, Total alkalinity (mg $CaCO_3$/l), Total hardness (mg $CaCO_3$/l) and Ammonia - nitrogen (mg/l) were determined by followed standard method and procedure APHA (2005). Temperature, DO, Free cabon dioxide and pH were measured morning and evening Kala *et al* (2019). Temperature of experimental tanks was determined by a digital thermometer. Temperature and Dissolve oxygen were measured daily whereas Free carbon dioxide, pH, Total alkalinity, Total hardness and Ammonia - nitrogen was measured once a week.

Growth of fishes

The growth of fishes was assessed in terms of weight and length fortnightly during the experiment period. Randomly 30 fish were used to measure weight and length. The following parameters were measured to assess fish growth

Bodyweight gain (g) = Mean final weight (g) – initial weight (g)

Length gain (cm) = Mean final length (cm) - mean initial length (cm)

All the descriptive statistics of the data was calculated by using Ms excel-2016.

RESULTS AND DISCUSSION

Average length of male and female was 30.12±0.88 cm and 33.16±0.58 cm, respectively. Average weight of male and female was 555.83±23.53 g and 698.33±24.93 g, respectively. Mean fecundity of fishes was 38834.67±3579.69. The average egg size of common carp was 1.79±0.24 mm diameter ranges from 1.39mm to 1.81mm similar to that reported in Park *et al* (2017) with size ranges 1.75-1.89 mm (average 1.82±0.06 mm) and Uchida (1939) with a diameter of 1.83 mm. The dose of ovatide provided @ 0.3 ml/kg body weight of female and 0.1 ml/kg body weight of male. After 10±1.16 hr, females and males oozes eggs and milts, respectively. After 72±2.12 hr hatching was started at 19.61 ± 0.11°C. According to Park *et al* (2017) time required for the hatching of common carp was 70 hr and 26 min in an average water temperature of 20.0±0.05°C, Cole *et al* (2004) reported that the time

Table1: Breeding and growth details of common carp in recirculatory system.

Weight of male (g)	555.83±23.53	
Length of male (cm)	30.12±0.88	
Weight of female (g)	698.33±24.93	
Length of female (cm)	33.16±0.58	
Fecundity	38834.67±3579.69	
Egg size mm	1.79±0.06	
Fertilization rate %	79.93±2.27	31084.55±3778.40
Hatching rate %	59.79±1.33	13696.98±3233.47
Survival rate of hatchlings to post larvae %	53.56±2.43	8492.13±3011.47
Survival rate 4th to 15th day	61.65±3.88	4500.67±1975.68
Survival rate of fingerlings after 90 days	81.11±2.29	3645.621±1185.67

required for hatching was 55 hr at 25°C, and 120 h at 18°C. These findings indicated that at higher water temperature time requirement decreased. Length and weight of hatchlings were 0.498 ± 0.025 cm and 0.0247± 0.024 g respectively. The size of the postlarvae was directly proportional to the size of fertilized eggs. Incubation time and fecundity were also related to the size of fertilized eggs. Park *et al* (2017)reported the length of *C. carpio* hatching as 5.31 mm and Cole *et al* (2004) reported the average total length of hatchling was 3.72 mm. These findings contrast with the present study. Variation in length may be due to the differences in the size of fertilized eggs and different geographical areas. After 76±2.47 hr yolk sac was absorbed. The time required for absorption of the egg yolk after hatching differed, between 4–5 d for *C. carpio*, while *C. carassius* required 5 d Han *et al*(2001); *Rhynchocypris oxycephalus* required 6 d Han *et al*(1999); *Pungtungia herzi* required 7–8 d Lee *et al*(2002). After yolk sac absorption total length and weight of post-larvae were 0.72± 0.021cm and 0.0272± 0.019 g, respectively.

Survival rate of hatchlings to yolk sac absorption stage was 53.56±2.43percent. Survival of 4th to 15thday-old fishes was 61.65±3.88 percent. Survival rate of fingerlings after 90d was 81.11±2.29 percent.Penaz *et al* (1983) have studied the early development of cultured common carp. The mean size of hydrated eggs was 1.6-1.65 mm. At 25°C embryonic development lasted 90 hrwhen the embryo was 6 mm long and its weight was 2.2 mg. The best hatching results were achieved at temperatures in the range of 15-22.5^{O}C Penaz *et al* (1983). At higher temperatures (above 25°C), the number of defective hatched individuals increased. At l0 ^{0}C, a high mortality of embryos was observed Penaz *et al* (1983). After 90 d of culture period, the average total length and weight gain of common carp in recirculatory system were 6.97 ± 0.25 cm and 6.52 ± 0.52 g, respectively.

Water quality parameters

All the water quality parameters obtained in recirculatory systems were within acceptable ranges for breeding and culture of common carp. The average of morning and evening temperature of the breeding day was 19.61 ± 0.11 °C. Average temperature, pH, DO, Free CO_2, Alkalinity, Hardness and Ammonia-nitrogen were 20.2 ± 1.1°C, 7.45 ± 1.17, 7.29 ± 1.37 mg/ l, 4.11 ± 1.61 mg/ l, 97.64 ± 4.23 mg/ l,198.25 ± 4.13 mg/ l and 0.068 ± 0.01 mg/ l,respectively during the experimental period. The eggs incubation period mostly depends on water quality parameters like temperature and salinity Liao (1975). According to the fish life cycle and ecological characteristics, optimum water

Table 2: Average weight gain (g) and Length gain (cm) of Common carp recorded at different time interval in during 90 d of the culture period.

Parameter		Sampling day						
Day	Hatchling	4	15	30	45	60	75	90
Length (cm)	0.498 ± 0.025	0.72± 0.021	1.19 ± 0.01	2.25 ± 0.22	4.21± 0.15	5.16 ± 0.12	6.13 ± 0.20	6.97 ± 0.25
Weight (g)	0.0247 ± 0.024	0.0272± 0.019	0.04± 0.003	1.14 ± 0.72	2.6 ± 0.09	4.14 ± 0.16	5.28 ± 0.14	6.52 ± 0.52
Length gain (cm)	0.0498	0.222 ± 0.005	0.47 ± 0.005	1.07 ± 0.73	1.95 ±0.37	0.95 ± 0.76	0.97 ± 0.81	0.84 ± 0.61
Weight gain (g)	0.0247	0.0025 ± 0.016	0.0128± 0.013	1.1 ± 0.37	1.46± 1.17	1.54 ± 0.13	1.14 ± 0.35	1.24 ± 0.32
Total Weight gain (g)		6.50 ± 0.54						
Total Length gain (cm)		6.47 ± 0.27						

Table 3: Water quality parameters and range (in parenthesis) in recirculatory system.

Parameter		Average of morning and evening parameters
Temperature during breeding day (°C)	19.53 ±0.05 (morning) 19.7 ± 0.1 (evening)	19.61 ± 0.11 (19.5-19.7)
Temperature morning (°C) *	19.5 ± 1.21	20.2 ± 1.1
Temperature evening (°C) *	20.9 ± 0.99	(19.1-22.3)
pH morning	7.4 ± 0.15	7.45 ± 1.17
pH evening	7.5 ± 0.18	(7.1-7.73)
DO morning (mg/l) *	7.24 ± 1.26	7.29 ± 1.37
DO evening (mg/l) *	7.33± 1.48	(6.64-7.9)
Free CO2 morning (mg/l)	4.33 ± 1.90	4.11 ± 1.61
Free CO2 evening (mg/l)	3.89 ± 1.32	(2.4-6.8)
Total alkalinity (mg/l)	97.64 ± 4.24 (88.2-117.6)	
Total hardness (mg/l)	198.25 ± 4.13 (178.1-207.4)	
Ammonia – nitrogen (mg/l)	0.068 ± 0.01 (0.04-0.089)	

Values are given as mean ± SD (n= 21), * mean ± SD (n= 270)

temperature is varied; water temperature is an important physical parameter which affects survival, egg development stages and growth of larvae Cho *et al* (2015). Most Cyprinidae, comprising *C. carpio, C. carassius, R. oxycephalus, M. koreensis*, and *Z. Koreanus* demonstrated a pattern of short incubation time with higher water temperatures of 20.0°C. Since, *R. oxycephalus, P. nigra,* and *P. herzi* showed different incubation times in water temperatures of 19.0°C; the phenomenon may be related to the fertilized egg size, the larger sized eggs requiring longer incubation periods, rather than being affected by water temperature, although its effects cannot be ignored Sadoand Kimura (2002). The more concentration of dissolved oxygen does not appear to benefit a fish because gills cannot carry more oxygen to the blood and higher concentration of oxygen also make fish sluggish Colt (2006). In recirculatory system, feed is divided into small portions because after feeding respiration rate increases which decreases the dissolved oxygen, thus oxygen level can be optimized. Optimum pH value for the most aquatic animal is 6.5-9 for good growth and health Lekang(2007). High pH value increases ammonia toxicity due to unionized (NH_3) whereas in low pH value ammonia will be in ionized form, which fish can rather tolerate (Lekang, 2007; Tyson *et al,* 2008). Aquaculture system which is operated at low alkalinity, is likely to meet a high concentration of ammonia due to the drop in efficacy of nitrification Summerfelt *et al* (2015). Fish and other microorganisms released the CO_2 through respiration and it will be accumulated in the system if it is not removed as quickly as it is produced. Freshwater fish can tolerate the CO_2 concentration greater than 100-200 mg/l but that high concentration decreased growth rate Colt (2006). Temperature is inversely proportional to the concentration of CO_2. The concentration of CO_2 below 20 mg/L decreases the stress to fishes. Ammonia concentration increase in the recirculatory system indicates that high density of fishes and biofilter is not working properly but daily water change decreases the ammonia.

CONCLUSION

Breeding of common carpin circulatory system decreased the water footprint, dependency on natural seed collection, provides pure seed, easy to learn for farmers**,** fulfill the seed demand of farmers and the expenditure cost was lower than the natural collection of spawns. The dependence of water in seed production can be decreased by using the recirculatory system for seed production and can be diversified in those areas where water scaracity and temperature are major constraints for seed production of common carp.

REFERENCES

Alikunhi K H, Sukumaran K K and Parameswaran S (1963) Induced spawning of Chinese carps *Ctenopharyngodon idellus* (C. & V.) and *Hypophthalichthys molitrix* (C. & V.) in ponds at Cuttack, India. *Curr Sci*32: 103-126.

APHA (2005). *Standard methods for the examination of water and waste water.* American Public Health Association, Washinington DC.

Chaudhuri H and Alikunhi K H (1957). Observation on the spawning of Indian carps by hormone injection. *Curr Sci* **26**: 382-383.

Cho J K, Hong C G, Park J Y, Son M H, Park C K and Park J M (2015). Effects of water temperature and salinity on the egg development and larvae of sevenband grouper, *Epinephelus septemfasciatus*. *Korean J Ichthyology* **27**(1): 21-25.

Cole N J, Hall T E, Martin C I, Chapman M A, Kobiyama A, Nihei Y, Watabe S, Johnson I A (2004). Temperature and the expression of myogenic regulatory factors (MRFs) and myosin heavy chain isoforms during embryogenesis in the common carp *Cyprinus carpio* L. *J Experi Bio***207**:4239-4248.

Colt J(2006).Water quality requirements for reuse systems. *Aquac. Eng* **34**: 143–156.

FAO (2018). *The state of world fisheries and aquaculture.* Food and Agriculture Organization of the United Nations, Rome.

Han K H, Jin D S, Yoo D J, Beak S R and Hwang D S (2001). The early life history of the crucian carp, *Carassius auratus* in Korea. *Bull Yosu Nat Univ***16**:379-387.

Han K H, Noh B Y, Oh S H, Park J T, Cho J K and Seong K B (1999). Early life history and spawning behavior of Chinese minnow, *Rhyncho cypri soxycephalus* reared in the laboratory. *Korean J Ichthyol* **11**:177-183.

Lee S H, Han K H, Hwang D S (2002). The early life history and spawning behavior of the *Pungtungia herzi*. *J Ins for Basic Sci Yosu Nat Univ* **4**:115-126.

Heinen J M, Hankins J A and Adler P R (1996). Water quality and waste production in a recirculating trout-culture system with feeding of a higher-energy or a lower-energy diet. *Aquaculture Res* **27**(9): 699-710.

Kala P, Tamuli K K, Borthakur S and Bhagabati S K (2019). Effect of different stocking densities of *Amblypharyngodon mola* (Hamilton, 1822) on the growth of Indian major carps in polyculture system. *J Ento Zool Stu* **7**(4): 844-854.

Kryzhanovskiy S G (1949). The rules of ecological and morphological peculiarities of fish development in Cyprinoidei and Siluroidei. *Trans Inst. Morf. Zsiv***1**: 5-332.

Kuo C M, Shehadeh Z H and Milken K K (1973). A preliminary report on the development, growth and survival of laboratory reared larvae of the grey mullet, *Mugil cephalus* L. *J Fish Biol* **5**(4): 459-470.

Lekang O I (2007). *Aquaculture engineering*. Blackwell Pub.

Liao I C (1975). Experiments on induced breeding of the grey mullet in Taiwan from 1963 to 1973. *Aquaculture* **6**(1): 31-58.

Park J M, Mun S J, Yim H S and Han K H (2017). Egg Development and Larvae and Juveniles Morphology of Carp,*Cyprinus carpio* in Korean. *Dev and Reprod* **21**(3): 287.

Penaz M, Prokes M, Kouril J and Hamackova J (1983). Early development of the carp, *Cyprinus carpio*. *Acta Sci Nat Bmo* **17**(2): l-39.

Sado T and Kimura S (2002). Descriptive morphology of the eggs, larvae, and juveniles of two cyprinid fishes belonging to the *Zaccotemminckii* species' group. *Ichthyol Res* **49**:245-252.

Summerfelt S T, Zühlke A, Kolarevic J, Reiten B K M, Selset R, Gutierrez X and Terjesen B F (2015). Effects of alkalinity on ammonia removal, carbon dioxide stripping, and system pH in semi-commercial scale water recirculating aquaculture systems operated with moving bed bioreactors. *Aquacultural Eng* **65**: 46-54.

Tyson R V, Simonne E H, Treadwell D D, White J M and Simonne A (2008). Reconciling pH for ammonia biofiltration and cucumber yield in a recirculating aquaponic system with perlite biofilters. *Hort Sci* **43**(3): 719-724.

Uchida K (1939). The fishes of Tyosen. Part 1. Nematognathi, Eventognathi Bull Fish Exp Sta Gav Gener Tyosen 6, p: 456.

Received on 15/06/2020 Accepted on 10/08/2020