

Effect of different salinity level on spawning, fertilization, hatching and survival of common carp, *Cyprinus carpio* (Linnaeus, 1758) in semi-artificial environment

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Abstract

The effects of various salinity levels among (0‰, 5‰, 10‰, 15‰, and 20‰) for successful breeding of common carp, *Cyprinus carpio* were investigated. The duration of study was 75 days. Ripe broodstock (30) having a mean weight (male 1027±2.4g and female 1084.8±23g) were selected and stocked into spawning tanks (2000 L). The ratio among male and female was 2:1. They were fed with commercial floating pelleted feed having 35% crude protein with 2% body weight twice a day. Broodstock were injected with ovaprim hormone 0.5 mg kg⁻¹ female and male 0.2 mg kg⁻¹ respectively, after successful spawning broodstock were removed from spawning tanks. The results showed that the highest fecundity, fertility, hatchability and survival of fry were obtained on salinity of 0‰ to 10‰ and significantly decreased on 15‰ and 20‰. The eggs per gram body weight were also recorded in all treatments and highest eggs were obtained, i.e. 45-60 per female on salinity of 0‰-10‰. Water temperature (22.4±0.2°C), dissolved oxygen (6.5±0.2 mg L⁻¹), pH (7.2±0.2) and ammonia (less than 0.03±0.06 mg L⁻¹) were monitored throughout the study period. Water quality parameters remained within the recommended range. Our results suggest that common carp, *C. carpio* may give maximum eggs up to 10 ‰ salinity with 81% survival of the fry.

Keywords: Common carp, Breeding, Ovaprim, Salinity, Semi-natural

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Introduction

The aquaculture production increasing rapidly in all over the world, it contributes 50 percent of the total world's food fish production (FAO, 2014; Kevin *et al.*, 2015). Finfish demand is likely to exceed all accessible supplies quickly due to the uprising changes taking place in the nutritional habits of people worldwide and fishery foodstuffs has promoted as a healthy food by medical communities (Dawczynski *et al.*, 2010; Siriwardhana *et al.*, 2012; FAO, 2014). Fishery product has documented highest increase in value national and international markets in the recent years, in compression of any other food item (Kevin *et al.*, 2015; De Silva, 2016).

Pakistan has massive freshwater, brackish and marine water resources with a 1046 km of coastline. Being situated in a drainage basin of the Himalayas, it has wide areas of inland waters. Area between 33° N and 20° N establishes a huge network of rivers, canals, reservoirs, lakes and waterlogged areas, etc., with an area of about 8.6 million hectares (Khan *et al.*, 2016).

Aquaculture in Pakistan from marine or brackish water does not sustain yet. Climate of Pakistan is dry due to uneven rainfall (Iqbal *et al.*, 2012; Khan *et al.*, 2016). Most areas changed into underground saline water and these areas can be utilized for fish cultivation (Jarwar, 2014), for this activity mass quantity fish seed needed throughout the season. Common carp (*Cyprinus carpio*) belongs to Cyprinidae family,

considered as a major family of freshwater fish. It usually lives in freshwater atmospheres, particularly ponds, lakes and rivers, and also lives in the low salinity water ecosystems (Barus *et al.*, 2001). It is broadly distributed all over the world, especially in Asian and European countries (Kloskowski, 2011; Weber and Brown, 2011; Parkos and Wahl, 2014). Due to high popularity, its distribution has been extended broadly through human introduction. *C. carpio* is third most species worldwide. It is known as a potential candidate for profitable aquaculture in worldwide due to its high adaptive capability in both atmospheres and nutrition (Soltani *et al.* 2010; Manjappa *et al.*, 2011; Rahman, 2015; Khan *et al.*, 2016). Common carp (*C. carpio*) creates a significant part in inland fish production so that it is introduced into inland waters like ponds, dam, reservoirs, lakes and streams in different areas (Vilizzi and Tarkan, 2015; Khan *et al.*, 2016). *C. carpio* have ability to alter ecological features of aquatic systems due to this currently calls as 'ecological engineer' by different scientists (Matsuzaki *et al.*, 2009; Bajer and Sorensen, 2015; Rahman, 2015).

Economical value of this specie has been increased by the growth increment, high meat yield, non-selective habitation use, delicious meat and production obtainability in fish farms (Demirkalp, 1992; Khan *et al.*, 2016).

Traditionally, the common carp is cultivated extensively and semi-intensively in Pakistan. In 1964 this

specie imported from Thailand for the first time and released into ponds, lakes and reservoirs. Because this specie has ability to breed in confined water bodies without any special efforts (Khan *et al.*, 2016). For sustainable aquaculture of common carp, availability of good quality juveniles in sufficient quantities is the primary need. It could be possible by introducing its semi-artificial or fully artificial spawning techniques with ovaprim hormone to meet the demands of the fish farmers (Iqbal *et al.*, 2012; Kevin *et al.*, 2015).

Ovaprim hormone is used commonly for inducing breeding to finfish artificially because it has a salmon gonadotropin-releasing hormone equivalent and a dopamine antagonist, this hormone is very effective in finfish species (Malik *et al.*, 2014; Shoaib *et al.*, 2014). Hence, the current study was designed to evaluate the optimal salinity level for breeding of common carp, *C. carpio* in semi-artificial environment with ovaprim hormone.

Materials and methods

Experimental design

The experiment was conducted during 10th February 2015 to 24th April 2015 in private fish farm at Gahro, Thatta, Sindh-Pakistan. All preparation needed for semi-artificial breeding of common carp (*C. carpio*) fish were done in 5 cemented rectangular tanks (14x6x3 ft.).

Experimental diet

Brood-stock was fed commercial floating pelleted feed (Oryza Organic,

Pvt, Ltd, PK) containing 35% crude protein at 2% body weight of total biomass with two times daily during the conditioning period.

Selection and stocking of breeders

Broodstock of one-year old Common carp were obtained from Fish World Hatchery, District Thatta, Sindh, Pakistan and transported in oxygenated polyethylene bags to experimental place. They were acclimatized for a period of two weeks before the study. Mature healthy brooders thirty (30) numbers (10 females and 20 males) having body weight 1070 grams to 1091 grams were identified through external sign for breeding trail. Belly of mature female is swollen and bulky whereas male having streamlined and more torpedo shaped belly. The pectoral fins of mature males are rough and females have smooth. After that selected brooders were kept in five treatments according to salinity levels described as T₁ (0‰), T₂ (5‰), T₃ (10‰), T₄ (15‰), and T₅ (20‰), respectively. The ratio was, 2:4 females and males per tank (Table 1).

Use of stimulating hormone

Ovaprim a synthetic hormone produced by Syndel Laboratories (Canada) was used in artificial stimulation for spawning of *C. carpio* through single application. Both female and male *C. carpio* were administered single dose of the inducing hormone intraperitoneal at the base of anal fin. Female brooders received a dosage of 0.5mL Kg⁻¹ body weight while male brooders received 0.2 mL Kg⁻¹ body weight simultaneously. The brood fish after

receiving the dosage were released into the breeding tank for courtship and spawning.

Spawning and courtship behavior

Spawning activity started immediately after injecting hormone and were taken 1-9hrs. The courtship behavior noted at the bottom of the breeding tank. Male shows aggressive behavior towards the female, males showed chasing behavior and touching to the females frequently. A unique behavior was noted. Male of common carp attracting to female for courtship via surrounding female in order to hold female brooder in a certain place. Male are excited and became closer to the female and female is staying quite passive moving charmingly escaping from approaching to male. Active male finally chased to female and usually swam below the female. Even the aggressive male blocked the path way of female in this way it cannot escape by male and continuously hit the female vent, and often hit the head of female also. Throughout copulating their dorsal fins were continuously wide-open on the water surface and there was considerably splashing of water and chasing from one corner to another. At the breeding time males were associated at one side of female and scrubbed their body beside the female and shade the sperms on releasing eggs from female. Eggs are adhesive in nature and attached on submerged plants "*Hydrilla verticillate*" and fertilized outside the body. After the completion breeding process, female hangs down the head and breath

heavily. Brooders stay at the corner of spawning tank and did not show any aggressive sign during shifting to a separate tank after breeding processes. *C. carpio* are cannibalistic some time they eat their eggs and young ones in starvation if not separated from the spawning tanks.

Determination of fertilization rate

After some time (1 to 3hrs) one mL of water collected from depth to identify and calculate egg fertilization ratio.

Egg samples were identified through a magnifying glass and fertile eggs counted by the help of brush (soft thin). Fertile eggs have a transparent shell with black spot and unfertile eggs are pale in color and black spot also absent. For the determination of the fertilization ratio in eggs following formula were used:

$$\text{Fertilization rate} = \frac{\text{Number of fertilized eggs}}{\text{Total number of eggs}} \times 100$$

Determination of hatching rate

To calculate hatching ratio, samples were collected from hatching tank and total number of fertile eggs in the sample and number of hatched larvae were counted through visual observations. Then hatching rate was calculated by following formula:

$$\text{Hatching rate} = \frac{\text{Number of hatchlings}}{\text{Total number of fertilized eggs}} \times 100$$

Determination of survival rate

To determine the survival percentage, dividing the final number of seed from initial number of seed than multiply by

100. Then survival rate was determined by the following formula:

Survival (%)

$$= \frac{\text{Total number of remaining seed}}{\text{Initial number of seed}} \times 100$$

Determination of eggs per body weight

Total collected eggs from females were divided by a total weight of female gives the degree of egg producing per gram per body weight. The Formula is given below:

Egg body weight⁻¹

$$= \frac{\text{Total number of collected eggs}}{\text{Weight of female (g)}}$$

Embryonic and larval stages

Samples of eggs before fertilization and at every 30min interval were taken for further studies. The developmental stages were divided into embryonic, larval and post larval development. The embryonic stage occurs in the egg shell till to hatching. The larval stage was considered from egg yolk till to exogenous feeding during this larva can move vertically. The stage of post larva starts when they swim horizontally because of egg yolk finished completely and looking for external feed (artificial) in the water. All the stages were monitored under the microscope taking live specimens and microphotographs of the developmental stages of eggs and larvae were taken.

Water quality parameters

Basic water quality parameters were monitored throughout the experiment, the water temperature on daily with a mercury thermometer, dissolve oxygen

(DO) was monitored at the same time with a portable test kit (Merck KGaA, 64271, Germany), pH was determined by using pH meter (EzDO 6011, Taiwan) and ammonia was estimated by portable test kits (Merck KGaA, 64271, Germany) on a weekly basis. Larvae were fed with artificial feed 3 times (8.00, 12.00 and 16.00 hrs) on a daily basis after yolk sac finished. Samples of eggs before fertilization and at every 30-min, interval was taken for further studies.

Data analysis

The statistical analysis of the results was carried out using the analysis of variance (ANOVA) to determine the significance difference ($p=0.05$). Duncan's Multiple Range Test (DMRT) was used to separate means where there is a significant difference. Correlation analysis (r) was carried out to determine the relationship between salinity and breeding parameters.

Results

Results of the present study shows highest values of fecundity (125700 ± 141 , 108000 ± 142 , 99450 ± 35), fertility (103074 ± 141 , 86400 ± 142 , 79560 ± 35) and hatchability (82459.2 ± 13.1 , 69120 ± 13.1 , 63648 ± 8.5) were obtained on T_1 (0 ‰), T_2 (5‰) and T_3 (10‰) while lowest fecundity, fertilization and hatchability were observed on T_4 (15‰) and T_5 (20‰) i.e. (26280 ± 14 , 1130 ± 0), (7884 ± 14 , 87.8 ± 6) and (3784 ± 5.0 , 28.1 ± 2) of common carp (*C. carpio*) respectively by single dose of ovaprim hormone (syndel laboratory, Canada)

injected intraperitoneal at different salinity levels, which are significantly different among treatments ($p \leq 0.05$) (Table 2). Fertilization in percent was (82% -80%) on T₁, T₂ and T₃, which are greater than T₄ and T₅ (30% and 7.8%), hatchability in percent was (80%) on T₁, T₂ and T₃ while (48% and 32%)

achieved on T₄ and T₅ which are significantly different ($p \leq 0.05$) and survival rate was also found higher on T₁, T₂ and T₃ (80%-81%) while lowest (40% and 32%) on T₄ and T₅, respectively (Table 1).

Table 1: Morphometric and breeding performance of common carp, *Cyprinus carpio* (Linnaeus 1758) on different salinity levels.

	Salinity				
	T1-0‰	T1-5‰	T2-10‰	T3-15‰	T4-20‰
<i>Morphometric parameters</i>					
Weight (g)/ Female	1047± 2.8	1080± 2.8	1105±7.1	1095±4.2	1097±2.8
length (cm)/ Female	25.4±0.1	25.5±0.24	25.9±0.3	25.8±0.1	25.7±0.3
Girth (cm)/ Female	12.7±0.01	12.8±0.01	13.2±0.14 ^b	13.1±0.1	13.1±0.15
<i>Breeding parameters</i>					
Total number of eggs	125700±141	108000±142	99450±35	26280±14	1130± 0
Total number of fertilized eggs	103074±141	86400±142	79560 ±35	7884±14	87.8±6
Total number of unfertilized eggs	22626±4.4 b	21600±4.4 ^b	19890±9.6 ^b	18396±4.1 ^b	1042.2±0
Total number of hatchlings	82459.2±13.1 ^a	69120±13.1 ^a	63648±8.5 ^a	3784±5.0 ^a	28.1±2
Total number of fry	65967.4±5.1 ^a	55296±5.1 ^a	51554±10.6 ^a	1703±7.7 ^a	9±0.02
Fertilization %	82.0±0.7 ^a	80±0.3 ^a	80±0.2 ^a	30±0.4 ^b	7.8±0.4
Hatchability %	80±0.7 ^a	80±0.2 ^a	80±0.1 ^a	48±0.2 ^a	32±0
Survival %	80±0.0 ^a	80±0.1 ^a	81±0.4 ^a	40±0.4 ^a	32±0

Unlike superscripts in a row show significant difference ($p < 0.05$). Values are mean ± standard error.

Table 2: Total weight and number of fertilized eggs of common carp (*Cyprinus carpio*) on different salinity levels.

Salinity (‰)	Total weight (g) of female	Total fertilized eggs	Fertilized eggs (g)*
0	2095 ± 42 ^c	125700 ± 141 ^a	60 ± 3.5 ^a
5	2160 ± 14 ^{bc}	108000 ± 142 ^b	50 ± 2.8 ^b
10	2210 ± 7.1 ^a	99450 ± 35 ^c	45 ± 4.0 ^c
15	2190 ± 7.0 ^b	26280 ± 14 ^d	12 ± 2.4 ^d
20	2195 ± 1.4 ^{ab}	87.8 ± 6 ^e	0.04 ± 01 ^e

Different letters in the same row represent significant difference ($p < 0.05$); values are mean ± standard error.

□ Number of eggs per gram= total number of eggs weight⁻¹ of female (g)

Regression values showed that the relationship between salinity and breeding parameters such as fecundity (degree of egg producing), number of fertilized eggs, number of hatchlings and number of survived fry was highly

significant among T₁, T₂, and T₃ while T₄ and T₅ was non-significant (Fig. 1). The quantity of fertilized eggs, hatching rate and survival rate was not significantly different up to 10‰ salinity. Above this level of salinity, all

breeding parameters were found to be inversely proportional (Table 1). Water quality parameters such as temperature ($22.4\pm 0.2^{\circ}\text{C}$), dissolved oxygen

($6.5\pm 0.2 \text{ mg L}^{-1}$), pH (7.2 ± 0.2) and ammonia (less than $0.03\pm 0.06 \text{ mg L}^{-1}$) throughout the study period (Table 3).

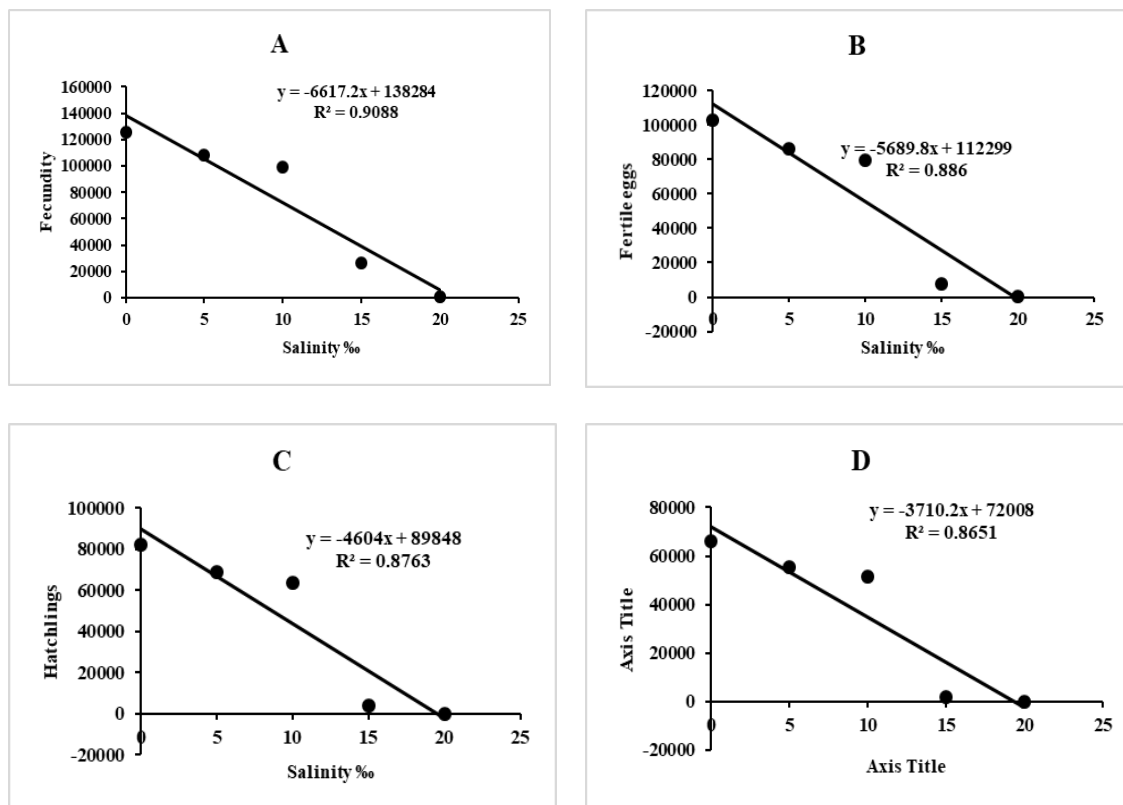


Figure 1. Regression of salinity on fecundity (A), fertility (B), hatchability (C) and fry (D) of common carp (*Cyprinus carpio*) among all treatments.

Table 3: Water quality parameters and their fluctuation throughout the study period.

Salinity (%)	Temperature ($^{\circ}\text{C}$)	Dissolve oxygen (mg L^{-1})	pH	Ammonia (mg L^{-1})
01	$22.3 \pm 0.2^{\text{d}}$	$6.5 \pm 0.08^{\text{b}}$	$7.3 \pm 0.03^{\text{b}}$	$0.03 \pm 0.001^{\text{a}}$
05	$22.5 \pm 0.4^{\text{b}}$	$6.6 \pm 0.03^{\text{a}}$	$7.2 \pm 0.04^{\text{c}}$	$0.02 \pm 0.001^{\text{b}}$
10	$22.6 \pm 0.4^{\text{a}}$	$6.4 \pm 0.05^{\text{c}}$	$7.4 \pm 0.06^{\text{a}}$	$0.03 \pm 0.002^{\text{a}}$
15	$22.4 \pm 0.5^{\text{c}}$	$6.4 \pm 0.07^{\text{c}}$	$7.3 \pm 0.02^{\text{b}}$	$0.02 \pm 0.001^{\text{b}}$
20	$22.2 \pm 0.6^{\text{d}}$	$6.6 \pm 0.02^{\text{a}}$	$7.2 \pm 0.04^{\text{c}}$	$0.03 \pm 0.002^{\text{a}}$
Mean	$22.4 \pm 0.2^{\text{c}}$	$6.5\pm 0.2^{\text{b}}$	$7.2\pm 0.2^{\text{c}}$	0.03 ± 0.01

Different letters in the same row represent significant difference ($p < 0.05$); values are mean \pm standard

Fertile eggs of *C. carpio* were sticky, demersal and sphere-shaped naturally. Eggs were to be found singly and were very sticky during the development development proceeded. The capsule

time. Eggs turn into shining as width of the fertile egg was 0.9 mm to 1.1 mm and the yolk sac sphere was 0.6-0.7 mm. Embryo development: fertilized eggs presented a spot (blastodisc) on

one pole which was differentiated under the macroscopic observations. The blast-disc was divided into two

formation of four cells (Fig. 1A). The 16-cells stage was found after 3 hours and 10 minutes of fertilization (Fig.1B).

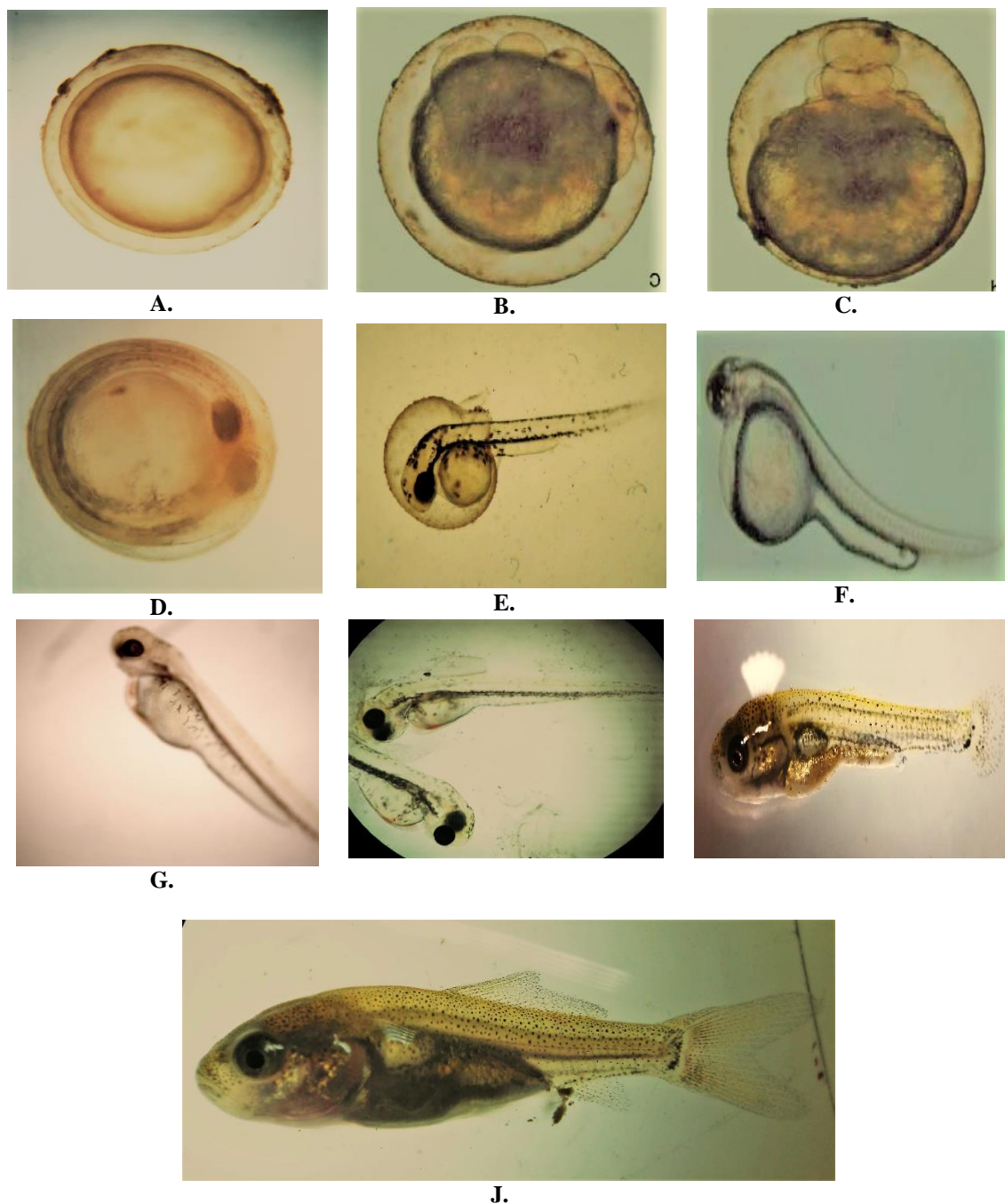


Figure 2: Photographs shows common carp (*Cyprinus carpio*) during embryonic, larval and fry development stages. (A) fertilized egg (B) 16 cell stage (C) Morula stage (D) 35 hours old embryo (E) 73 hours' embryo (F) Just hatched larva (G) 2 days old larva (H) 4-day old larva (I) 16 days old fry (J) 38 days old fry.

different cells through upright cleavage within 1 hour and 40 minutes after fertilization, after 1 hour and 55

minutes second cleavage was noted the Successive cleavage increased cell number and reached the morula stage

within 6 hours and 15 minutes of fertilized. A cap like creation was observed over the animal pole, which progressively upgraded in size. Yolk invasion was over started after 8 hours of fertility and finished after 20 hours of fertility. Skull and caudal fin end of the embryo grow into distinct at yolk sac mass stage (Fig. 1D). Yolk-sac incursion was finished and the explosion pore was nearly end. Variations of embryo: flexible bony structure called Notochord was evidently observed on 53 hours after fertility at similar time 22 somites (division of the body) were established and lens creation was begun and heart development was nearly finished. Blood movement started over the yolk into the undeveloped heart lying frontal to the yolk sac and 90-94 heartbeats per minute were recorded at this stage. After 73 hours of fertilization caudal section was separated from yolk sac and became free (Fig. 1E). In the final stage of embryonic development, the growing embryo occupied the entire perivitelline space; a frequent jerking movement of the tail beating to the egg shell. Hatching happened in 75-81hrs after fertilization and the hatchlings were transparent characterized by the existence of an almost round egg yolk. Recently hatched larvae were slim, straight and crystal clear, slowly tapering to the tail. The hatchlings ranged between 2.1 and 2.6 mm in length and tried to hide in any shelter they find. At this stages swim bladder, mouth or vent. They breathe by absorbing oxygen through the fine blood capillaries that surround the yolk

sac are absent, which were still attached to the gut. Head of hatchlings was found above the egg yolk, and brain was clearly visible. 2-day old larva: length of the larvae was 2.6-2.9 mm, transparent, fin fold developed and heaving bulk yolk sac. 3-days the hatchlings showed free movement, larvae were able to effectively stick to the tanks walls or any particle in the tank, feeding started from externally. After 16 days of hatching a distinct mutation occurred, black and orange coloration were appeared. At this stage the larvae increased 6.2-6.7 mm in size. Fingerling stage observed after spending 36 days from hatching. In this phase the fingerlings size increases about 18.0-23.3 mm in length, distinguished 8 fin-rays in the dorsal-fin and 7-9 in the tail fin. Fins were well developed with 17-18 pectoral fin-rays, 18-21 pelvic fin-rays and 5-6 anal fin-rays. Body was completely covered by scales and look like similar to an adult (Fig. 1 J).

Discussion

Productivity and sustainability of aquaculture depend upon quality seed in adequate quantity of commercially important fish species, which could be possible by induce spawning and nursing from small to large scale at hatcheries. And it could be supervised by several characteristics such as brood-stock management, breeding techniques, nursing methodologies, farming and marketing. The present study provides data about ability to produce a maximum spawning rate and survival rate of common carp (C.

carpio) on different salinity levels in semi artificial conditions. The Findings of the present study show that fecundity of *C. carpio* did not differ significantly up to 10 ‰ salinity with a single dose of ovaprim hormone on semi-artificial spawning. However, significant variations were found in fecundity on 15–20 ‰ salinity. Usually the bigger fish released higher number of eggs (Gosh *et al.*, 2012). The relationship of fecundity (degree of egg producing) and the body weight is therefore relative. Female *C. carpio* deposits about 100,000 eggs Kg⁻¹ (Freeman, 1987; Gosh *et al.*, 2012). The Maximum fertilization ratio of eggs was gained between treatments; 1, 2 and 3 (80% – 82%). These results are in contrast with the results of (Brian, 2015), they got 82%-85% fertilized eggs from *O. niloticus* with different tank background colours. Rodriguez-Montes de Oca *et al.* (2015) found 66.7%, 71.8% and 65% fertilized eggs from Nile tilapia on different salinity levels, i.e. 0‰, 5‰ and 15‰ which are lower the current results from treatment 1-3 and higher than treatment 4-5. Rehman *et al.* (2015) reported 67%–81% fertilization rate with HCG+HMG and HCG+Ovaprim artificial stimulating hormones on snakehead fish (*Channa marulius*). Akinwande *et al.* (2012) attained 80% fertilization percentage of *Clarias* species (intraspecific hybrids), these results are lower than the current results of treatments 1-3 and higher from those of treatment 4-5. Martins *et al.* (2015) investigated the effect of salinity on artificial reproduction of silver catfish

(*Rhamdia quelen*) and reported 85%–93% fertilization rate, which are higher than the present results and Similar results were reported by Abdel-Hakim *et al.* (2008) on different salinity range. Bazlur Rehman *et al.*, 2011, found the maximum fertilization ratio 51.47% among the four treatments with the use of different doses of ovaprim hormone to comet gold fish (*C. auratus*) which are lower than the present findings treatments 1–3 and higher from treatment 4–5. Almeida *et al.* (2013) obtained 89%–92% hatching on different strains of Nile tilapia which are higher than the current findings. Akinwande *et al.* (2012) reported hatchability rate 79.1%-83.3% of *Clarias* species which are in contrast with the present results of treatments 1, 2 and 3 and highest from treatments 4 and 5. Martins *et al.* (2015) got the highest results (83.3%) at 0‰ salinity for silver catfish, *Rhamdia quelen*, which are similar to the present results from 1-3 treatments and higher than treatments of 4-5. Maximum 65.3% hatching percentage was obtained on various turbidity levels for *Clarias gariepinus* by (Yong-Sulem *et al.*, 2008) which is lesser than treatment 1-3 and greater than 4 and 5 treatments. Bazlur Rehman *et al.*, 2011, found 36% to 44.35% using ovaprim hormone with different dosage to comet gold fish (*C. auratus*) which are lesser than the present study.

Survival percentage in fry of common carp, *C. carpio* in the present study found maximum (80%-81%) from treatment 1-3 which is higher than previous studies of (Hakim and Gamal,

2009) they found survival rate 38% to 70% for common carp and in between 4–5 treatments (32% - 40%). Abdel Hakim *et al.*, 2008, they achieved 30%-83% these results are in between of the present results. Mubarik *et al.*, 2015, they were obtained survival percentage (39.4%-91.0 %) with fry of *C. carpio* at different concentrations of rock salt (0-30 mg L⁻¹).

Brian (2015) reported survival rate of fry as 71.4% in Nile tilapia with subject to red background color that is lower than the treatments 1-3 and greater from treatment 4-5. Moreover, Olufeagba and Okomoda (2015) gotten survival rate of 10.47%-90.4% on parental and experimental crosses in *Heterobranchus longifilis*. However, present study results are in between of these findings. The highest number of eggs g⁻¹ body weight was recorded in treatment 1–4 (12–60) were higher from the results of (Ahmed *et al.*, 2007). They obtained 1–5 eggs g⁻¹ body weight in *Tilapia niloticus* and also greater than (Mashai *et al.*, 2016). They got 2.77 eggs g⁻¹ on Nile tilapia in brackish water. Only in treatment 5 shows lower results from above studies of pervious scientist.

In the present study, embryonic development completed in 45-73 hours' after fertilization time and about 3 days' after fertilization time period and it showed lesser duration than the previous findings of (Fujimura and Okada, 2007; Haniffa *et al.*, 2007) also lowest than (Gabi *et al.*, 2009) they achieved on Zebra fish, *Danio rerio* and common carp, *C. carpio*. Larval development stage takes 36 days to

complete these findings are more or less similar with (Haniffa *et al.*, 2007; Bazlur Rahaman *et al.*, 2011) they found larval development in 35 days after hatching. These variations in current findings due to climatic and geographical changes or environmental factors such as temperature, dissolved oxygen etc. Water quality parameters were suitable for common carp (*C. carpio*) throughout the spawning period and more or less similar with the findings of previous scientists (Ghosh *et al.*, 2012; Malik *et al.*, 2014; Horváth *et al.*, 2015). They recommended that water temperature (18°C–24°C), dissolved oxygen (4.0 mg L⁻¹–6.0 mg L⁻¹, pH (6–8), ammonia (0.01 mg L⁻¹–0.1 mg L⁻¹) are suitable for successful breeding of *Cyprinid* species.

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