

Influence of salinity on growth increment, feed conversion and body composition of common carp, *Cyprinus carpio* (Linnaeus 1758) fingerlings in the captivity

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Abstract

Present study was conducted to observe the effect of salinity levels (5‰, 10‰, 15‰, 20‰ and 25‰) on growth increment, feed conversion and body composition of Common carp, *Cyprinus carpio* (mean body weight 6 ± 0.04 g) were examined. Fingerlings were randomly distributed into the glass tanks (60×30×45 cm each). 10 fish per tank with two replications. Fish were fed with floating pelleted feed having 35% protein with 3% body day⁻¹ for 60 days. Results show that the growth increment reared on 5‰ - 15‰ salinity were significantly highest in term of weight gain, WG % of initial weight, daily weight gain, specific growth rate, condition factor and survival rate than those reared on 20‰ and 25‰ salinity, feed conversion ratio were found similar in all levels which is not significantly different ($p>0.05$) in all levels. Whole body composition i.e. crude protein (14.62–15.48), moisture (77.11–77.81), crude fat (3.52–3.61), ash (3.66–3.71) contents of fish whole body were not significantly ($p>0.05$) different in various salinity levels. Mean values of water quality were found acceptable for common carp i.e. temperature $28.08\pm 0.13^{\circ}\text{C}$, dissolved oxygen 7.4 ± 0.07 mg L⁻¹, pH 7.7 ± 0.01 and ammonia 0.023 ± 0.004 mg L⁻¹. Relationship between Log body weight and log total length of the present study shows that fingerlings reared on 5‰ -15‰ was significantly ($p<0.05$) higher than 20‰ and 25‰ salinity levels. Histology of gills shows normal appearance of gill filaments and gill lamellae up to 15‰ salinity. Present results prove that Common carp can be reared up to 15‰ salinity to get good growth and higher survival rate.

Keywords: Common carp, *Cyprinus carpio*, Growth, Feed conversion, Salinity

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Introduction

Common carp (*Cyprinus carpio*) belonging to the family Cyprinidae is among the more significant freshwater fishes which are spread worldwide. It's found in brackish water of the Caspian Sea because it is commercially important fish which is capture from fisherman in northern areas of Iran (Sedaghat *et al.*, 2013). Common carp is anadromous fish of Caspian Sea that breed in Iranian rivers and some other countries like Pakistan, India, Bangladesh, Nepal, Thailand etc. Fingerlings of Common carp journey to rivers and chooses stagnant water bodies and sluggish type of waters with sand and silt beds with shell combinations (Kuznetsov *et al.*, 2002). Common carp are regularly cultured and are of abundant marketable value as a food fish, both over their native and introduced range (Sedaghat *et al.*, 2013). Nowadays, world-wide production of common carp is 3.2 million tons and this is greater than double the Salmonids production (FAO, 2010).

Fish consumption increasing throughout the world because fish meat is recommended as an important element for healthy nutrition of humans, generally due to its higher percentage of n-3 extremely unsaturated fatty acids (Balk *et al.*, 2006) and, certainly, fish flesh characterizes the greatest source such type of nutrients in human diet (Topic Popovic *et al.*, 2012; Sarma *et al.*, 2013). Furthermore, feeding of fish meat is stimulated for the high protein content of high biological value, occurrence of

necessary amino acids, minerals and vitamins (Hathwar *et al.*, 2012).

Fish farming production by aquaculture is now exceeded from capture fish production because fish is the major source of human food, predictable that aquaculture fish production will cross the entire fisheries landings in the next decade (OECD/FAO, 2015). Shortage of freshwater in many countries, competition with agriculture and other urban events had augmented the load to develop fish culture on underground brackish water and seawater. Though, utilization of brackish or underground saline water instead of freshwater in fish culture have importance worldwide (Sallam *et al.*, 2017). Freshwater includes lesser salts and ions concentration than brackish water/ underground saline water and seawater. Regulator of salt and water stability in a fine edge is serious to lifecycle in all multicellular creatures, including modern teleost (Jeanette *et al.*, 2007). Salt resistance is a term describing total suitability, or yield, of the fish in a brackish water bodies (Stickney, 1986). It is a combination of various measureable traits, like metabolism, growing, osmoregulation, immune ability and spawning efficiency (Sakamoto and McComick, 2006; Mancera and McCoemick, 2007; Cnaani and Hulata, 2011; Sallam *et al.*, 2017;).

Climate of Pakistan is arid and semi-arid with unusual and uneven rainfall (Iqbal *et al.*, 2012). Abundant land is affected with salinity and water-logging and the sub soil or underground water

become brackish/ saline (Jarwar, 2006). These places can be utilized for fish culture which will act as a tool for desalinization of the soil through brackish water fish farming (Jarwar, 2014),

Due to the influence of climate change circumstances, intrusion of sea water into coastal inland areas rapidly and freshwater scarcity because of less precipitation, agriculture lands are disturbed and didn't give profit. Major carps also under stress in saline waters didn't give better yield. It is serious issue to utilize that land for fish farming instead of agriculture and to verify a source of less priced and excellent protein quality (animal origin) in future (Mateen and Iftikhar, 2007; Sedaghat *et al.*, 2013, 2007; Lawson and Anetekhai, 2011).

Salinity of water is an environmental element which effect on growing efficiency of many fish species cultured in ponds, tanks, raceways, and net-cages (Cruz *et al.*, 1990; Watanabe *et al.*, 1990).

The present study reports to investigate suitable range of salinity for desire growth, feed utilization, meat quality and survival ratio of Common carp in controlled conditions. The data regarding this is not available from our country it will be helpful for sustainable fish culture in saline water bodies of coastal areas especially underground saline water of Pakistan.

Materials and methods

Experimental design

Fingerlings of Common carp having mean body weight 5.0 ± 0.01 g and mean total length 7.62 ± 0.02 cm (Table 1) transported from private fish hatchery Thatta into the aquaculture research lab of Marine Biology, University of Karachi. Acclimated for two weeks than distributed into experimental tanks ($60 \times 30 \times 45$ cm) on different salinity levels i.e. 05‰, 10‰, 15‰, 20‰ and 25‰ with two replications 10 fingerlings per tank. All tanks were equipped with well aeration supply throughout experiment.

Table 1: Growth parameter like initial weight, final weight, initial length, final length and weight gain percent of initial weight of Common carp (*Cyprinus carpio*) fingerlings reared at different salinity levels.

Parameters	Salinity level (‰)				
	5 ‰	10 ‰	15 ‰	20 ‰	25 ‰
Initial weight (g)	5 ± 0.04	5 ± 0.03	5 ± 0.04	5 ± 0.04	5 ± 0.03
Final weight (g)	10.6 ± 0.2^a	10.5 ± 0.1^a	10.4 ± 0.2^a	8.2 ± 0.2^b	7.3 ± 0.1^b
Initial length (cm)	7.62 ± 0.03	7.63 ± 0.04	7.61 ± 0.02	7.62 ± 0.03	7.63 ± 0.02
Final length (cm)	11.5 ± 0.3^a	11.4 ± 0.2^a	11.3 ± 0.3^a	8.6 ± 0.4^b	8.5 ± 0.4^b
Weight gain (WG)	5.6 ± 0.01^a	5.5 ± 0.01^a	5.4 ± 0.02^a	3.2 ± 0.01^b	2.3 ± 0.02^b
WG, % of initial weight	257.7 ± 10^a	255.5 ± 11^a	253.3 ± 10^a	91.1 ± 8^b	57.7 ± 8^b

Different superscript in the same row are significantly different ($P < 0.05$). Values are mean SE of 2 replicates.

Feeding protocol

Commercial floating pelleted diet manufactured by Oryza Organics Private Limited, Lahore-Pakistan,

having 30% crude protein, 5.8% crude fat, 6.7% crude fiber, 9.8% moisture and 8.4% ash was offered at 3% of total biomass twice in a day at 9:00 and 16:00 (Shah *et al.*, 2014). Body weight and total length of each fingerling was measured weekly basis and the amount of provided feed was adjusted accordingly. Siphoning was done after 60 minutes of feeding to remove waste material from the bottom of tanks and maintained the required water level of each tank by adding water (Shah *et al.*, 2014).

Measurement and analysis

At the end of the experiment, all fish from each tank were individually weighed and their total length was measured for calculation of weight gain = Mean final weight – Mean initial weight, mean daily weight gain = Fresh weight gain in fish (g)/Culture period (days), percent weight gain of initial = $100 \times \frac{\text{final weight} - \text{initial weight}}{\text{initial weight}}$, feed conversion ratio = $\frac{\text{Diet given}}{\text{Weight gain}}$, condition factor = $\frac{\text{final weight}}{\text{final length}^3} \times 100$, specific growth rate = $\frac{\text{Ln final weight} - \text{Ln initial weight}}{\text{Culture period (days)}} \times 100$ and survival % = $100 \times \frac{\text{Final number of fish}}{\text{Initial number of fish}}$ were determined (Abbas *et al.*, 2011; Daudpota *et al.*, 2016). Major water quality parameters were monitored throughout experimental period, like temperature, pH, dissolved oxygen (D.O) and ammonia. Temperature of the water was checked on daily basis with the help of digital thermometer (GH ZEAL LTD-LONDON ENGLAND). Dissolve oxygen (DO) of

the water was noticed by the help of portable test kit (Merck KGaA, 64271, Germany). The water pH was calculated by pH meter (EzDO 6011, Taiwan) and ammonia of the water was monitored with portable test kits (Merck KGaA, 64271, Germany) and salinity was observed by hand-held Refractometer (ATAGO, S/Mill-E, 0.100‰, made in Japan) on daily basis (Daudpota *et al.*, 2016).

Histological studies

The specimens were dissected for getting gills samples and have processed for studying histological changes with following method (Bernet *et al.*, 1999). samples were cut into portions (3-5 μm) thick and was processed separately. Tissues were fixed in 10% formalin up to 15 minutes than tissues were transferred into the fixative (10% formalin) up to 24 h. For the light microscopy Microtome was used to cut tissue into sections (3-5 microns) with a steel blade fixed. Best sections were found from paraffin blocks that were cool and moist. These sections were floated in a water bath at 41°C to 47°C for broadening. Stretched ribbon was placed on a slide holding Glycerin and Albumin in same ratio. Than slides were identified by diamond markers, were dried in an oven at 31-90°C, then dipped in xylene. After that slides were prepared by using Mayer's hematoxylin for 2-3 minutes. Slides were identifying for histological changes and compared to the normal histological slides.

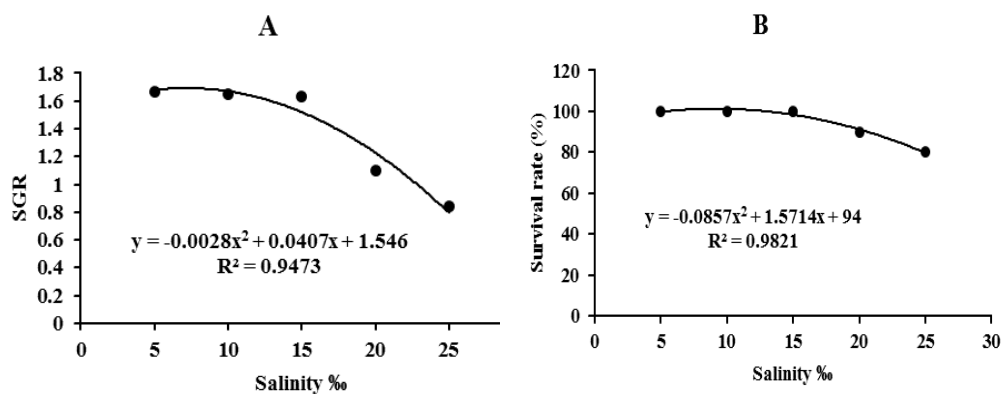
After 60 days of the experiment completion, three fishes were caught

from each experimental tank. After that, these fishes were frozen and stored for chemical analysis. Fish body constituents like lipid, protein, ash, moisture etc. were determined (AOAC, 2000) at PCSIR laboratories complex, Karachi. The data thus obtained was analyzed statistically by using statistical software's like Minitab, SPSS (Zar, 1996).

Results

Results of present study show that the growth parameters of Common carp (fingerlings in term of weight gain (WG), Survival rate and Specific growth rate (SGR) reared on 05‰ to 15‰ salinity was significantly ($p < 0.05$) higher than of those reared on 20‰ and 25‰ salinity (Fig. 1, Table 1). Protein efficiency ratio (PER) reared on 05‰ to 15‰ salinity was significantly ($p < 0.05$) higher than of those reared on 20‰ and

25‰ salinity mentioned in (Fig. 1). Food conversion ratio (FCR) was found similar among all salinity levels which is non-significantly different ($p < 0.05$) presented in Fig. 1. In the present findings condition factor (CF) were found significantly ($p < 0.05$) higher reared on salinity 20‰ and 25‰ than those reared on 05‰ to 15‰ mentioned in Fig. 1. Daily weight gain was significantly higher ($p < 0.05$) on 05‰ to 15‰ salinity than reared on 20‰ and 25‰ (Fig. 1). Weight gain and percent of initial weight gain from 05‰ to 15‰ salinity was obtained significantly ($p < 0.05$) highest than reared on 20‰ and 25‰ salinity reported in Table 1. Relationship between mean body weight with time in days on different salinity levels were also found significantly ($p < 0.05$) higher up to 15‰ (Fig. 3).



In addition, the relationship between Log body weight and log total length of the present study shows that Common carp fingerlings reared on

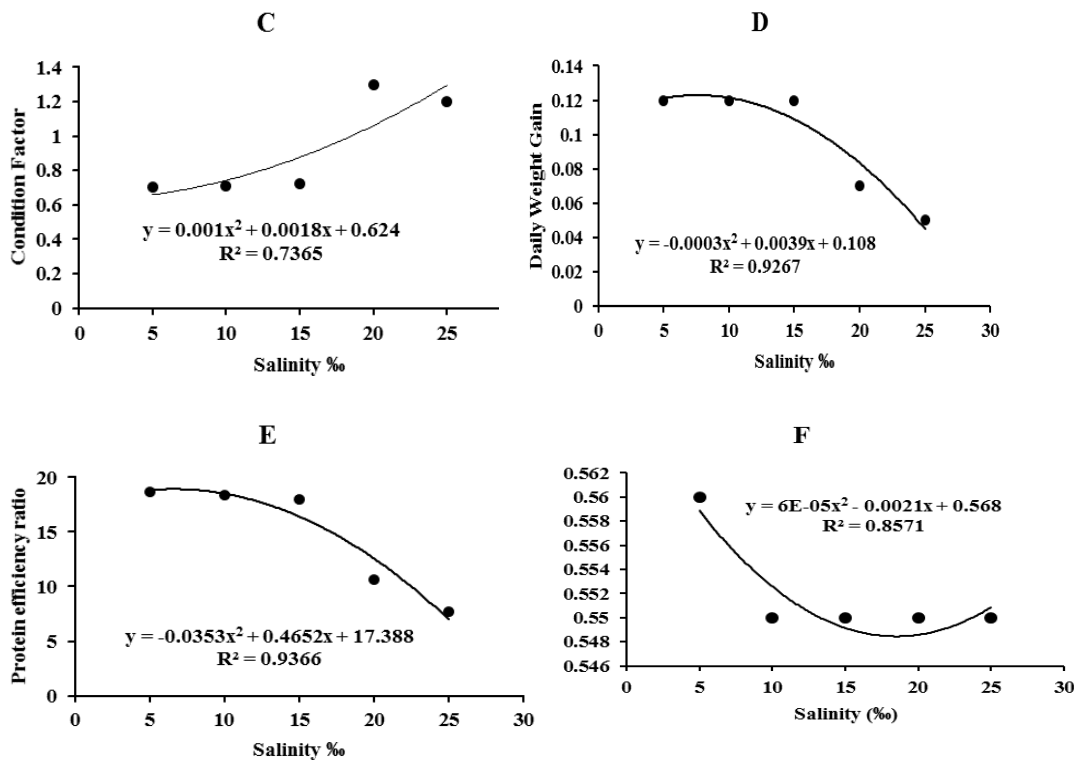


Figure 1: Growth performance of Common carp (*Cyprinus carpio*) in terms of specific growth rate (A), Survival percentage (B), Condition factor (C), Daily weight gain (D), Protein efficiency ratio (E) and Food conversion ratio (F).

05‰, 10‰ and 15‰ was significantly ($p < 0.05$) higher than 20‰ and 25‰ salinity levels (Fig. 2).

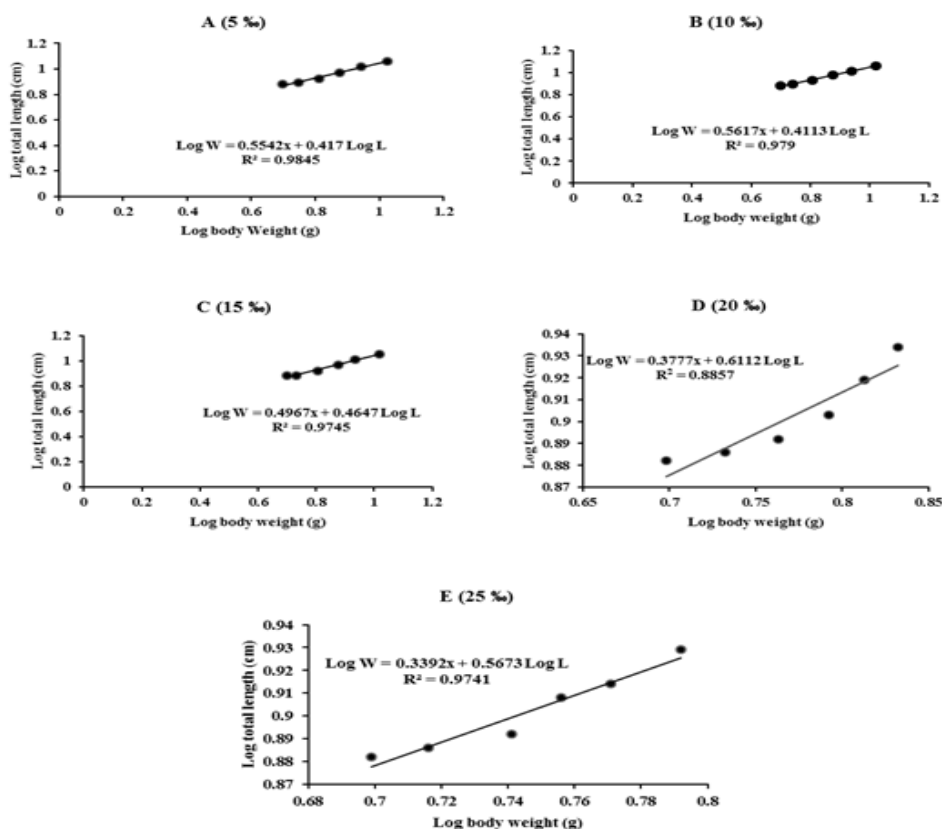


Figure 2: Log total length (cm) and log body weight (g) relationship of Common carp (*Cyprinus carpio*) fingerlings reared at different salinity levels for 60 days.

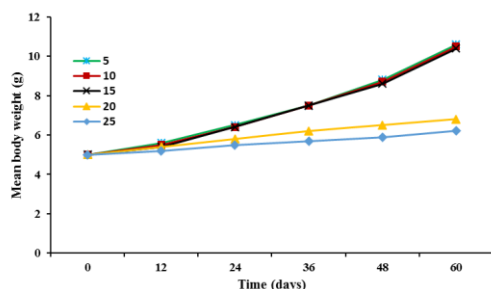


Figure 3: Relationship between mean weight of fish with time (days) at different salinity levels.

Body composition and histology

Crude protein content (14.62–15.48), moisture (77.11–77.81), crude fat (3.52–3.61), ash (3.66–3.71) content of fish whole body were not significantly ($p>0.05$) different, present study prove that common carp fingerlings reared on different salinity did not affected by salinity levels (Table 2). Histology of the gills show normal appearance of gill filaments and gill lamellae up to 15‰ salinity (Fig. 4).

Table 2: Proximate whole-body composition of Common carp (*Cyprinus carpio*) on initial stage and after 60 days rearing period at different salinity levels.

Body composition	Initial	5 ‰	10 ‰	15 ‰	20 ‰	25 ‰
Crude protein	14.62±0.32 ^a	15.44±0.11 ^b	15.45±0.12 ^b	15.44±0.21 ^b	15.47±0.23 ^b	15.48±0.24 ^b
Moisture	77.81±0.22 ^a	77.11±0.23 ^b	77.12±0.21 ^b	77.13±0.21 ^b	77.12±0.24 ^b	77.13±0.24 ^b
Crude fat	3.61±0.29 ^a	3.54±0.24 ^b	3.55±0.26 ^b	3.52±0.24 ^b	3.53±0.25 ^b	3.54±0.26 ^b
Ash	3.71±0.41 ^a	3.68±0.42 ^b	3.67±0.43 ^b	3.68±0.43 ^b	3.66±0.44 ^b	3.67±0.42 ^b

Different superscript in the same row are significantly different ($P<0.05$). Values are mean SE of 2 replicates.

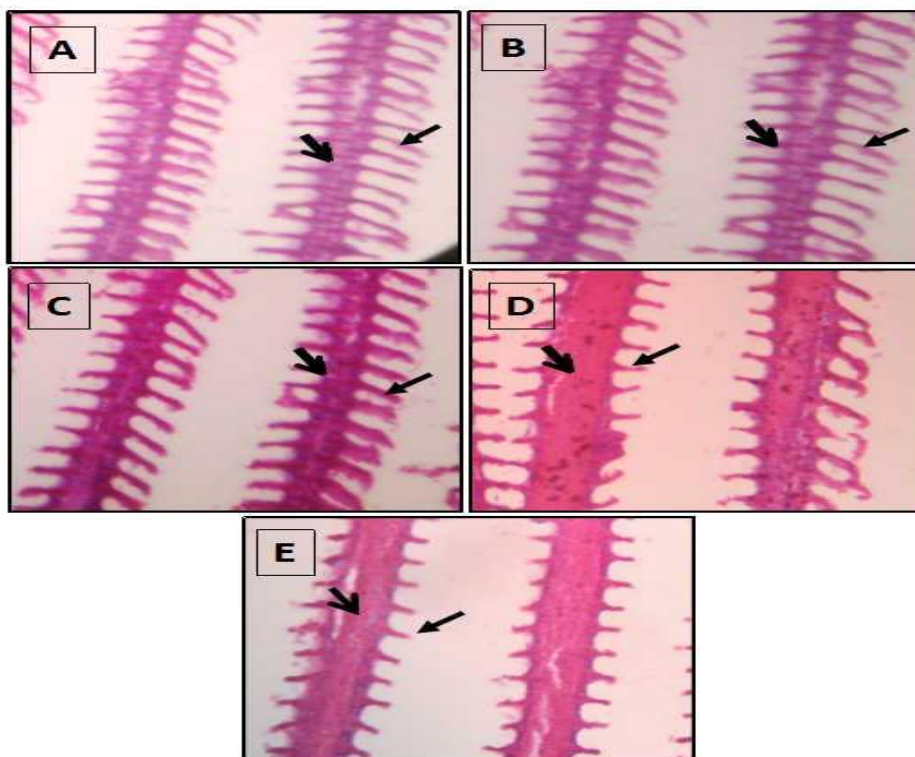


Figure 4: Figure. Histological view of Common carp gills through light microscope reared on different salinity levels for 60 days. A-5 ‰, B-10 ‰, C-15‰, D-20 ‰ and E-25 ‰, from A to C gills filaments (GF →) and gill lamellae (GL →) show normal appearance but when salinity level increases than 15 ‰ it shows negative impact on the appearance of gill filaments and gill lamellae.

Water quality

Major water quality parameters such as temperature, dissolved oxygen, pH and ammonia were monitored daily basis throughout study period and found within the acceptable range for the

experimental fish i.e. water temperature was 28.08 ± 0.13 °C, dissolved oxygen was 7.4 ± 0.07 mg L⁻¹, water pH was 7.7 ± 0.01 and ammonia never exceeded 0.023 ± 0.004 mg L⁻¹ (Table 3).

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

Salinity (‰)	Temperature (°C)	Dissolved oxygen (mg L ⁻¹)	pH	Ammonia (mg L ⁻¹)
5	28.2	7.5	7.6	0.021
10	28.1	7.4	7.6	0.022
15	28.2	7.4	7.7	0.021
20	27.9	7.3	7.8	0.021
25	28	7.4	7.8	0.031
Mean	28.08	7.4	7.7	0.0232
SE±	0.13	0.07	0.1	0.004

Discussion

Control of salts and water stabilities is critical mission in life for all higher creatures including fishes. Salt approval

describe widespread fitness or production of a fish in a saline and brackish water environment. It is a combination of assessable traits like as metabolism, growth increment, osmoregulation, immunology, and

fecundity or spawning capacity, each factor influenced through different genes that cause genomic variance. Physiological studies of biochemical trail underlying phenotypic modifications in salt approval can lead to genetic studies for intra and inter-specific alteration among fish species reported by Cnaani and Hulata (2011).

In current findings, growth of fish increased with salinity levels up to 15‰, and shows positive correlation on growth performance in term of weight gain, specific growth rate, condition factor and survival rate of fingerlings.

Specific growth rate (SGR) of the present study on 05‰ to 15‰ is higher than the previous findings of Sallam *et al.* (2017) they find 0.56 - 0.85 on Red tilapia reared upon different salinities from 9 – 36 ‰ and in contrast on 20‰ and 25‰. Rahim *et al.*, (2017) find 3.21 on used of fish oil which is almost similar with the current findings u to 15‰ salinity and lessor results were achieved i.e. 2.82-2.83 by using soybean oil, olive oil and palm oil in the feed of black fin Sea Bream (*Acanthopagrus berda*). Another finding of Kapute *et al.*, (2016) they obtained SGR 1.8 on *Tilapia rendalli* at 200 m² pond size these are higher than the present findings. Results of SGR 0.9 to 2.2 on different feeding levels of mangrove Red snapper (*Lutjanus argentimaculatus*) reported by Abbas and Siddiqui (2009) which are in contrast with the current report. Solomon and Okomoda (2012) find out 0.65 to 1.4 SGR on use of different duckweed percentages in artificial diet

of *Oreochromis niloticus* these values are lesser from the present study results, in the research of Daudpota *et al.*, (2016) on comparative study of tilapia *Oreochromis* species they got 2.1-2.2 SGR these outcomes are higher from our study.

Weight gain of the present research outcomes obtained higher than the previous achievements of Solomon and Okomoda (2012) they got 1.56-1.92 WG, using different percentage of duckweed in artificial diet for *O. niloticus*, research findings of Daudpota *et al.* (2016) reported 2.5-4.8 WG on Nile tilapia at 10‰ salinity with various feeding levels in tanks which are lesser from present findings i.e. 5‰ to 15‰ and in contrast with the 25‰ and 30‰ results.

FCR of the current study at all salinity levels were obtained 0.55 – 0.56 these findings are greater than the findings of Rahim *et al.* (2017) got 0.046 – 0.072 on the use of various source of oils in the diet of black fin sea bream (*Acanthopagrus berda*), and in other finding of Rahim *et al.* (2017) obtained 0.20-0.40 FCR on various ration levels for sea bream (*Acanthopagrus berda*), Daudpota *et al.* (2014) obtained 0.48-0.49 FCR at different stocking ratio of red tilapia in nylon made hapa which are slightly lower from current study, another results obtained by Daudpota *et al.* (2016) FCR 0.84 on red tilapia in concrete tanks these values are little bit greater than the present results. Solomon and Okomoda (2012) got 1.94-6.29 on using duckweed with different percentage into the feed of

Nile tilapia (*O. niloticus*) these are much higher results than our study. Muin *et al.* (2017) got highest FCR 2.91 – 3.31 from current outcomes fed with different levels of black soldier fly (*Hermetia illucens*, L) maggot meal diet into Nile tilapia, *O. niloticus*.

In the present study, the protein efficiency ratio (PER) were 7.66–18.66 on all salinity levels, these values are highest from the previous findings of Muin *et al.* (2017) reported 1.02 – 1.17, fed with different levels of black soldier fly (*Hermetia illucens*, L) maggot meal diet into Nile tilapia (*O. niloticus*). Daudpota *et al.* (2016) find out 1.28 – 2.39 PER on Nile tilapia (*O. niloticus*) at cultured at 10‰ salinity with various feeding levels are much lesser than the present findings. Rahim *et al.* (2017) obtained FER 1.36 – 1.47 on the use of various source of oils in the diet of black fin sea bream (*Acanthopagrus berda*) these values are also least than the present outcomes.

Daily weight gain in the present experiment were 0.05–0.12 at all salinity levels these findings are lowest than the previous findings reported by Arshad Hossain *et al.*, (2011) they got 0.20 – 0.33 DWG on using dietary lipid levels into the feed of sub adults' silver pomfrets (*Pampus argenteus*, E) these are greater than the current results. Maximum DWG 0.18 of *Tilapia rendalli* was obtained on 10‰ salinity under laboratory conditions reported by Jeremiah and Joseph (2008) which is also lessor than the present findings.

Condition Factor was 0.7 – 1.3 among all treatments which are lowest achievements than the previous

outcomes of Daudpota *et al.* (2016) they found maximum 2.6, Rahim *et al.* (2017) 2.78 and Daudpota *et al.* (2014) got 1.7 on different fish species culture. Survival rate was higher up to 15% similar results were achieved by different scientist on different species, Daudpota *et al.* (2014) on Nile tilapia, Abbasi Ghadikolaei *et al.*, (2017) on Common carp (*C. carpio*), Rahim *et al.* (2017) on Sea bream (*Acanthopagrus berda*) got 100 % survival rate while lower results were obtained on 20 - 25‰ salinity in the present study.

Taking into consideration that the effects of various salinity levels on the Common carp (*C. carpio*), body composition, protein percentage in fish meat contained at a comparatively constant level. It comes into view that the salinity levels did not shows great change into protein, moisture, lipid and ash contents these findings are in similarity with the pervious outcomes by Daudpota *et al.*, (2016), Rahim *et al.*, (2017).

Ertan *et al.* (2015) says water quality in fish culture system directly affected to fish metabolic activity, feed utilization efficacy and survival ratio. In the current experiment, water quality was calculated from all salinity levels and found suitable ranges for Common carp species. These values are similar with the previous results reported by Daudpota *et al.* (2014), Malik *et al.* (2014), Chughtai *et al.* (2015), Iqbal *et al.*, (2014), Emmanuel *et al.*, (2014) and Shah *et al.*, (2014).

It is concluded that fingerlings of Common carp (*C. carpio*) can be cultured up to a 15‰ salinity level with

the similar culture condition at underground saline / brackish water and coastal waters. This specie has potential and it would be productive for sustainable aquaculture.

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Conflict of interest

None declared

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