STUDY OF SHARE OF VISCERAL MASS IN TOTAL BIOMASS, LENGTH-WEIGHT RELATIONSHIP AND CONDITIONS OF IN-POND RACEWAY SYTEM TOTAL LIPIDS IN GRASS CARP (*Ctenopharyndodon idella*), CULTURED UNDER HIGH STOCKING DENSITY CONDITIONS OF IN-POND RACEWAY SYSTEM

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Abstract

In-pond Raceways System (IPRS) is a recent technology introduced for first time in Pakistan (2019) in order to increase aquaculture production. IPRS is the combination of raceway technology, cage culture, recirculating aquaculture and pond culture. Introduction to IPRS in countries like Pakistan where water shortage is a main issue would be a revolutionary step. High stocking density in IPRS may cause stress in fish and affect growth, immunity and survival. Present study aims at investigating the effect of high stocking density on body length, body weight, length-weight relationship (LWR), condition factor, Hepatosomatic index (HSI), Viscerosomatic Index (VSI), and lipid content. It will provide a baseline data for future studies on IPRS in Pakistan. In present study, there were total 6,000 Grass Carp (Ctenopharyndodon idella) (initial wt.= 70.00 ±2.0). The trail period is from August till November, 2020.Samples of five fish were collected after the time interval of 30 days and 50 at the time of harvesting (30 November). After sampling the growth parameters (Total body length, Total body weight, Condition factor and HSI) length-weight relationship, Viscerosomatic index (VSI %) and lipid content were analyzed. Total body length (cm) of Grass Crap increased from 25.20 ± 1.2 – 30.62 ± 0.98 cm, Total body weight (g) increased from 502.0 ± 117.54 – 806.67 ± 63.79 g, Condition factor increased from 2.14 ± 0.18 – 3.00 ± 0.30 %, Hepatosomatic index increased from 1.59 ± 0.14 – 2.58 ± 0.24 %. Viscerosomatic index was observed as 6.06 ± 0.23 -13.43 ± 0.23 %. Regression coefficient (R2) value of Length-weight relationship was 0.534 which showed positive relationship between them. In conclusion, high stocking density in IPRS did not affect the growth in Grass Carp.

Key words- In-pond Raceways System (IPRS) , High stocking density (HSD),Grass Carp (*Ctenopharyndodon idella*)

INTRODUCTION

Aquaculture is the world's fastest-growing food-producing business, with aquaculture produced fish accounting for a major portion of the world's fish supply for human consumption over the last four decades. Aquaculture now accounts for over half of the world's edible fish (45%). Aquaculture, with its continuous growth, is likely to yield more fish for direct human consumption in the near future than capture fisheries (FAO, 2006)..Aquaculture is growing at a rate of more than 10% each year, accounting for more than 30% of all fish consumed. The sea provides a huge amount of the protein and nourishment that humans require. Fish provides about 16 % of the animal protein consumed by the world's population, and over one billion people rely on fish as their primary source of animal protein (FAO, 2000). Aquaculture, which began as a freshwater food production system in Asia, has now extended to all continents, including all aquatic conditions and employing a diverse range of aquatic species (FAO, 2006).

Pakistan has a diverse range of marine and inland aquatic resources. This region's fishing resources have enormous economic growth potential (Mohsin et al., 2015; Mohsin et al., 2017).Water scarcity is becoming an increasingly serious problem in Pakistan, with the country on the edge of being water-scarce. According to the IMF, annual water availability is 1,017 m3/capita, dangerously near to the 1,000 m3/capita scarcity2 criterion. In agriculture, aquaculture, and urbanization , Pakistan has the world's fourth highest rate of water use. Given the high-risk of water scarcity forecast by 2040, it is critical to employ water-saving technologies in all fields, particularly agriculture and aquaculture. The aquaculture industry in Pakistan is transitioning from substantial to semi-intensive production. The lack of knowledge of current aquaculture techniques has been a key hindrance to this industry's growth. As a result, technologies like IPRS, which combine the features and benefits of raceway technology, cage culture, recirculating aquaculture systems, and pond culture, are needed to overcome the major difficulties in Pakistan's aquaculture business (Janjua, 2019)

In 2006, Auburn University developed the IPRS technology to examine a commercialscale unit at a catfish farm in western Alabama. IPRS is based on the idea of concentrating fish in "raceways" within a pond. This method relies on water movement, mixing, and aeration to speed up the assimilation of organic loads in the pond that feeds the fish. IPRS enables more effective prophylactic treatments for fish health management and, as a result, improved yearly pond yields. In-pond raceway systems (IPRS) technology has been in development since the early 1990s, although it has only just begun to be reviewed and deployed in commercial settings(Arana *et al*., 2018).

One of the most important factors affecting fish growth in aquaculture is stocking density. Several investigations were carried out to determine the impact of various rearing density on growth metrics and metabolism in farmed fish species (Montero *et al*., 1999; Herrera *et al*., 2009). Fish body length (cm) and body weight (g) may be reduced as the quantity of fish per unit area increases (Gomes *et al*., 2000). Low stocking densities meant that space and food supplies were not fully used for maximum fish output.(Liu *et al*., 2014). In intensive fish farming, increasing stocking densities could significantly boost productivity per unit area (Zhu *et al*., 2011). High stocking density is commonly utilized in commercial farming systems to maximize the utilization of available cultural space while lowering rearing costs (Huntingford *et al*., 2012; Portz *et al*., 2006) High stocking density (HSD) has been shown to have a negative impact on fish nutrition, growth, survival, and productivity in laboratory tanks, cages, and ponds (Ashley, 2006).

Aside from the potential for increased fish production, the IPRS does not require any water exchange to improve water quality if properly managed. Only enough water is added to compensate for evaporation or seepage. To expedite the assimilation of organic wastes and nutrients produced by fish culture and feeding, the IPRS management strategy uses continuous aeration and mixing of the entire pond volume. Because of the constant, aerated water flow, the water quality and culture environment are steadier and more predictable. The present study was conducted to find out the impact of high stocking density on growth parameters of local fish species Grass carp (Ctenopharyndodon idella) cultured under high stocking density conditions of Inpond Raceway system. This is a base line study which will provide basic knowledge about the growth, share of visceral mass in total biomass, length-weight relationship in grass carp cultured in iprs for the first time in Pakistan. This study will be reference for future study on local specie cultured in IPRS.

MATERIALS AND METHODS

IPRS Design

First IPRS Demo Site in Pakistan was established at a commercial site of fish farm.

Total of six components of IPRS are:

1. White Water Unit (Aeration System)

2. Raceways

3. Quiescent Zone

4. Sludge Collection Unit

5. Auto Feeders

6. Baffle Wall

IPRS Design is given in Figure 3.1.

Experimental Design

Trial was conducted at IPRS Demo site. Present study was conducted into two groups. Control group was studied in open pond and experimental study was conducted in IPRS. In experimental group a total of 6,000 fingerlings of Grass carp (Ctenopharyngodon idella) were stocked (initial weight: 70.00 ± 1.20 g) in raceways in June, 2020. A total of 3,450 fingerlings were stocked in open pond. Weight of fish was checked on monthly basis to adjust the ration. Fish were fed with the commercial floating feed (Moisture: 10.03, Protein: 30.15, Fat:4.69, Fiber: 4.07, Ash: 7.72, Starch: 22.66) at the rate of 2% of body weight.

Sampling

Present study was conducted at the Department of Zoology, Lahore College for Women University (LCWU).A total of five fish were randomly collected on monthly basis after every 30 days from August till November, 2020. Sampling of control group (open pond) was performed at the time of harvesting only because it was difficult to catch fish in this large water area. It could only be performed when water was drained at the time of harvest in December. Sampled fish were anesthetized with 3ml of clove oil (SIGMA-ALDRICH) mixed in 5 liters of water. Total body weight and total body length were measured. Fish were dissected and its visceral mass was removed and weighed. Weight of liver was also measured. Fish samples were stored at ice and transferred to Fisheries and Aquaculture Laboratory, LCWU, Lahore for lipid extraction.

Growth Parameters

Following growth parameters were measured by using standard formulae:

Condition Factor (%)

Condition factor (K) = Final weight (g) / Final length (cm^3) × 100

Viscerosomatic Index (%)

VSI (%) = 100 × (Viscera weight [g] / Whole fish weight [g]).

Paired T-test was performed to analyze the variability between VSI of IPRS and open pond.

Hepatosomatic Index (%)

HSI (%) = 100 × (Liver weight [g] / Whole fish weight [g]).

Extraction of Total Lipids from Muscles Samples

Extraction of lipids from fish muscles was done by using Soxhlet apparatus at Department of Environmental Sciences, LCWU following Folch method (Folch *et al*., 1957). A total of 90 g of muscle was removed from the fish. Muscle samples were homogenized, using mortar and pestle. The macerated meat was placed inside the thimble. The thimble was prepared using filter paper, kept in the main chamber of the Soxhlet extractor. Methanol and chloroform (1: 2) were used as the solvent to extract both polar and nonpolar lipids. A total of 750 ml of solvent was used for each sample. A Soxhlet apparatus was used at 55° C, below the boiling point of the solvent mixture. The extraction process continued for 2 hours to obtain the maximum lipid.

Evaporation of Solvent

Solvent mixture was transferred in a beaker, allowed to evaporate at room temperature for 2 days. When the mixture remained about 1.5ml after evaporation it was shifted in glass vials. Then solvent in vials was allowed to evaporate at room temperature for overnight so that only lipids were left. The vials were stored at 4°C.

Calculation of Total Lipid (g)

Total Lipids = Lipid content / Total sample weight × Total body weight

Length Weight Relationship

One-way ANOVA and simple linear regression test at confidence level (95%) was performed to analyze length weight relationship.

Statistical Analysis

All the data were expressed as mean ± standard error (S.E.). Statistical analysis was performed through SPSS 21 software at the significance level of (0.05). Data were analyzed by using One-Way ANOVA. For analysis of monthly variation in samples Tukey's and post hoc test were applied**.**

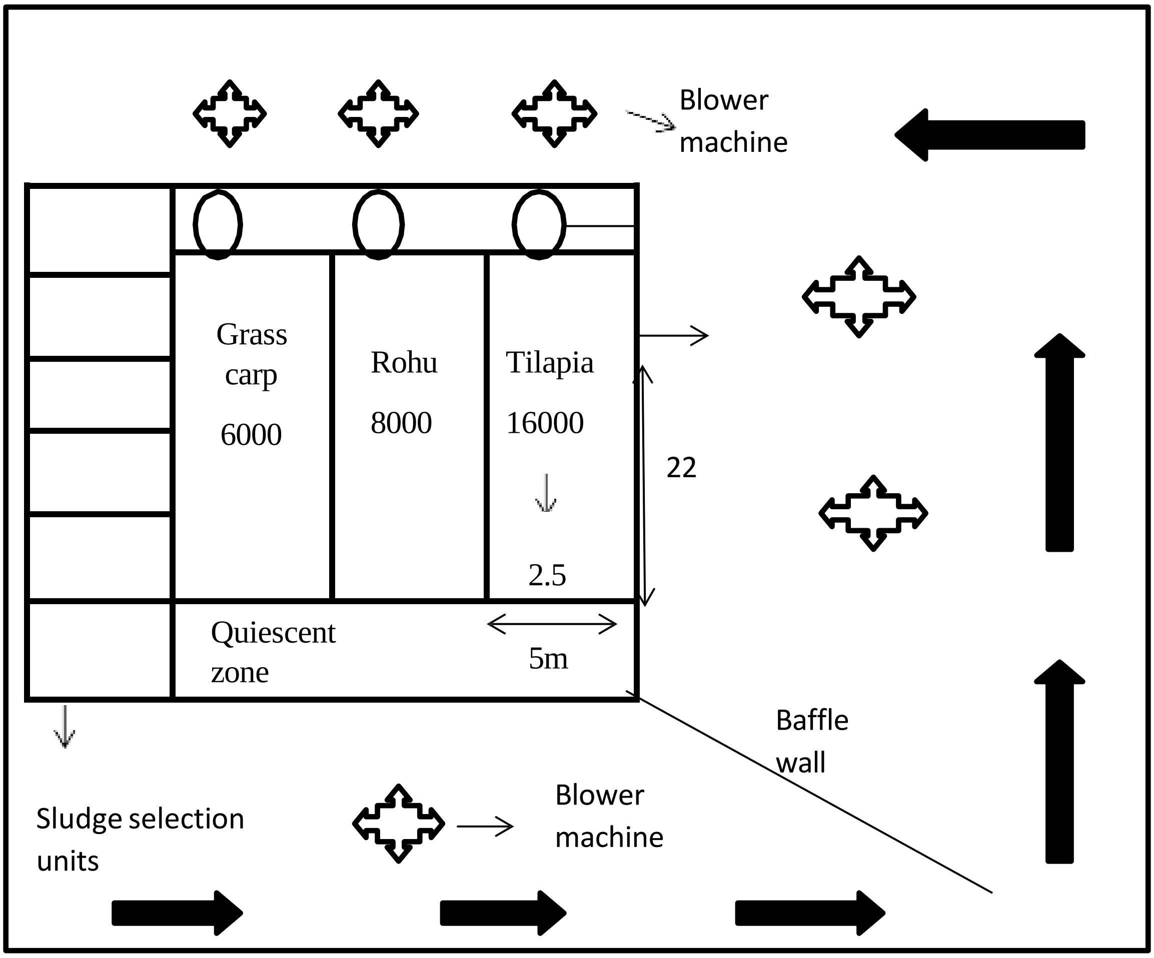


Fig.3.1. Design of IPRS demo site.Introduction of innovative In-pond raceways system technology to improve aquaculture production in sustainable and economical way in Pakistan

RESULTS

Total Body Length (cm)

There was significant difference ($P < 0.05$) between monthly mean values throughout the study period in IPRS raceways ($F_{3, 20}$ =3.079) (Fig.4.1). Total body length in this group was observed within the range of (25.20 ± 1.2 – 30.62 ± 0.98 cm). Value of total body length in open pond (control group) at the time of harvesting (November, 2020) was noted to be (31.33 ± 0.32 cm).

Total Body Weight (g)

Monthly mean values of total body weight were found to be significantly ($P < 0.05$) different throughout the study period in IPRS raceways ($F_{3, 20}$ =13.316) (Fig. 4.2). Total body weight in this group was observed within the range of (502.0 ± 117.54 – 806.67 ± 63.79 g). Value of total body weight in open pond (control group) at the time of harvesting (November, 2020) was observed to be (826.67 ± 10.51 g).

Condition Factor (%)

Monthly mean values of condition factor were found to be significantly different ($P < 0.05$) through the study period ($F_{3, 20}$= 2.269) (Fig. 4.3). Value of K in iprs was observed within the range of (2.14 ± 0.18 – 3.00 ± 0.30 %). Value of condition factor in open pond (control group) at the time of harvesting (November, 2020) was observed to be (2.28 ± 0.30 %).

Liver Weight (g)

Monthly mean values of liver weight were found to be significantly different ($P < 0.05$) throughout the study period ($F_{3, 20}$=1.936) (Fig. 4.4). Value of liver weight was observed within the range of (8.41 ± 0.44 – 14.88 ± 1.6 g). Value of Liver weight in open pond (control group) at the time of harvesting (November, 2020) was observed to be (15.56 ± 0.81 g).

Hepatosomatic Index (%)

Monthly mean values of hepatosomatic index (%) found to be significantly different ($P < 0.05$) throughout the study period ($F_{3, 20}$ =4.663) (Fig.4.5). Value of HSI was observed within the range of (1.59 ± 0.14 – 2.58 ± 0.24 %). Value of HSI in open pond (control group) at the time of harvesting (November, 2020) was observed to be (1.89 ± 0.10 %).

Lipid Contents (g)

There was significant difference ($P < 0.05$) between monthly mean values throughout the study period (F 3, 20=5035514.7) (Fig.4.6). Total Lipid content was observed within the range of (14.05 ± 5.92 – 41.28 ± 5.92 g). Value of total lipid content in open pond (control group) at time of harvesting (November, 2020) was observed to be (37.84 ± 5.92 g).

Viscerosomatic Index (%)

There was insignificant difference (P= 0.47) between mean value of vsi of iprs and control group (open pond) (t= -2.041) calculated at the time of harvesting (November, 2020). Vsi value of iprs was observed in range of (6.06 ± 0.23 -13.43 ± 0.23 %) while value of vsi of open pond (control group) was observed in range of (6.03 ± 0.23 -13.68 ± 0.23 %).Scatter plot drawn between the viscerosomatic index of IPRS and open pond in (Fig. 4.7 and 4.8). Mean value of iprs was (9.18 ± 0.23) while mean value of open pond (control group) was (9.27 ± 0.23).

Length-Weight Relationship

Simple linear regression where correlation coefficient value was (R^2 = 0.53) and Length-weight relationship allometric coefficient (b) value was (2.14) which shows negative allometric growth for samples (Fig 4.9).

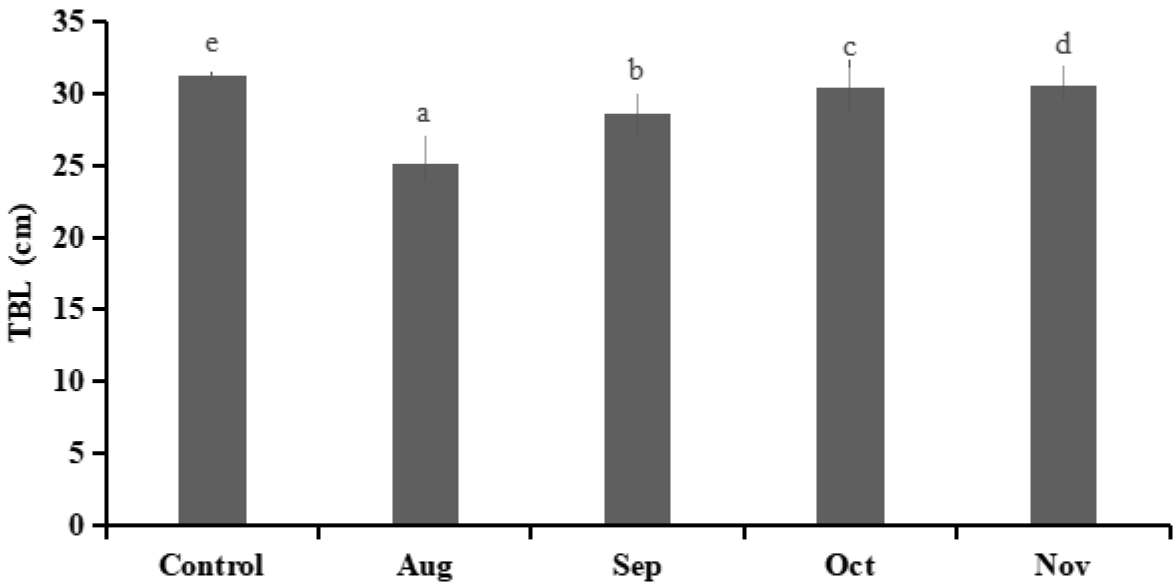
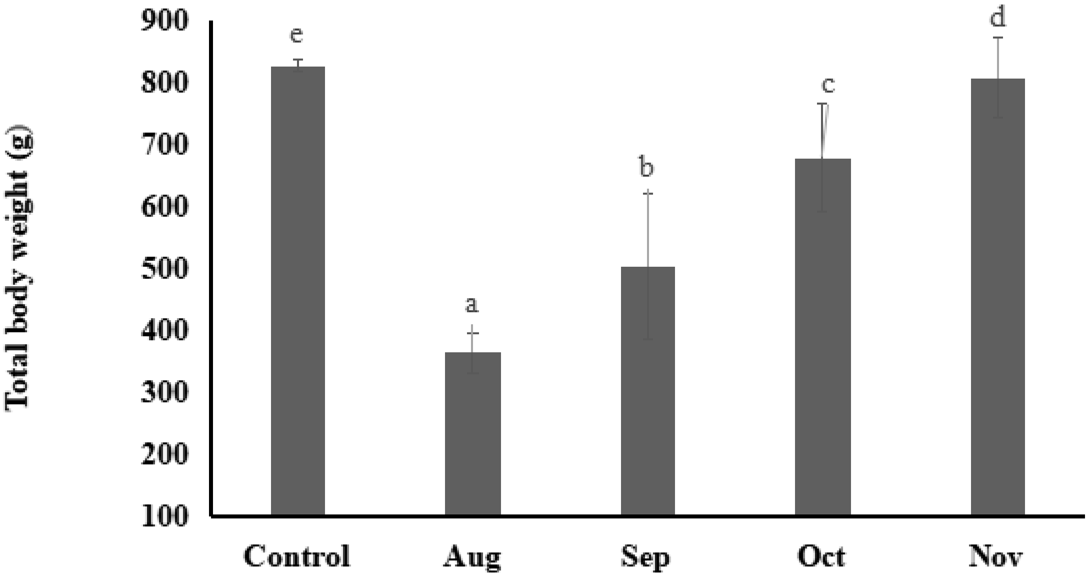


Fig.Determination of Total body length (mean±SE) of grass carp *Ctenopharyngodon idella* of all sample collected at four sample points (August - November ,2020) One way ANOVA and Tukey's post-hoe test ($P<0.05$)were performed to analyze the variability between the four monthly groups.Values of subsets of post-hoe have been shown by letters above the error bars test was performed to compare the variability between the Raceways group and Traditional pond group.



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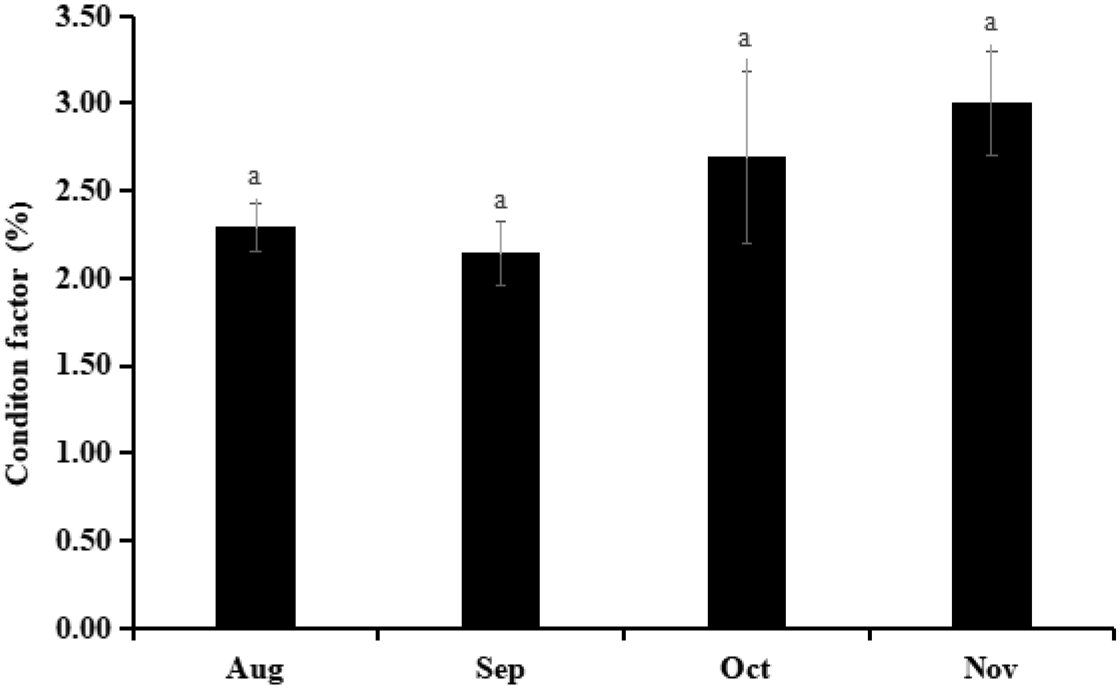

Fig. Condition factor (%) (Mean±SE) of grass carp *Ctenopharyngodon idella* all sample collected at four sample points (August - November ,2020) One way ANOVA and Tukey's post-hoe test ($P<0.05$)were performed to analyze the variability between the four monthly groups.

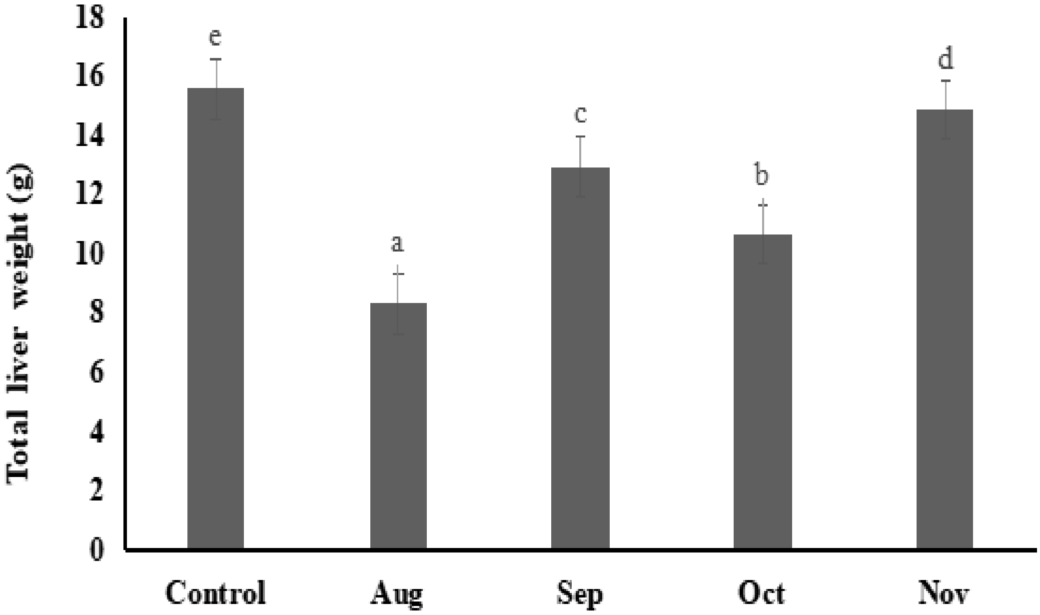

Fig..Determination of Total liver weight (mean±SE) of grass carp *Ctenopharyngodon idella* of all sample collected at four sample points (August - November ,2020) One way ANOVA and Tukey's post-hoe test ($P<0.05$)were performed to analyze the variability between the four monthly groups.Values of subsets of post-hoe have been shown by letters above the error bars test was performed to compare the variability between the Raceways group and Traditional pond group.

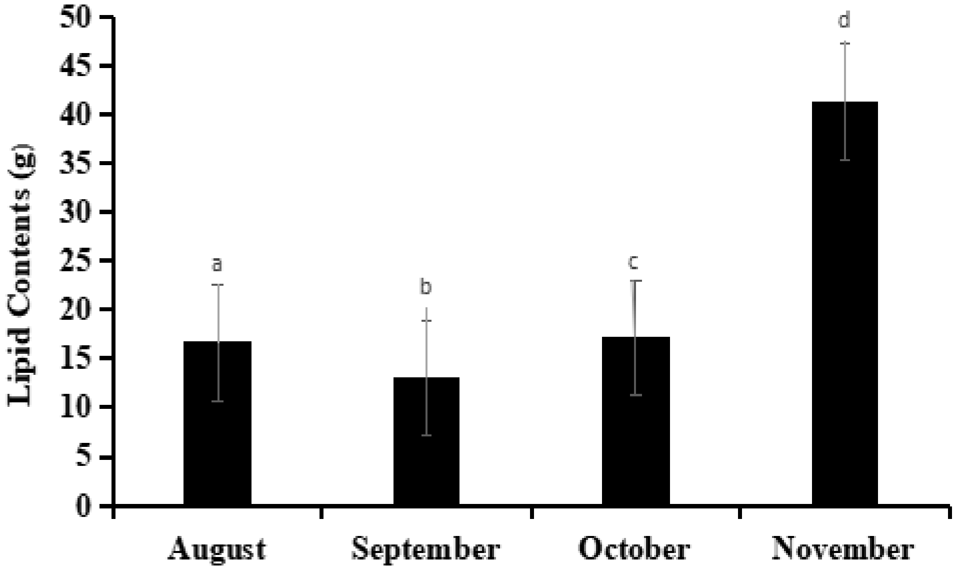

Fig. Total lipid contents (Mean ± SE) of grass carp (*Ctenopharyngodon idella)* of all sample collected at four sample points (August - November, 2020). One way ANOVA and Tukey's post-hoe test (***P*** < 0.05) were performed to analyze the variability between the four monthly groups.

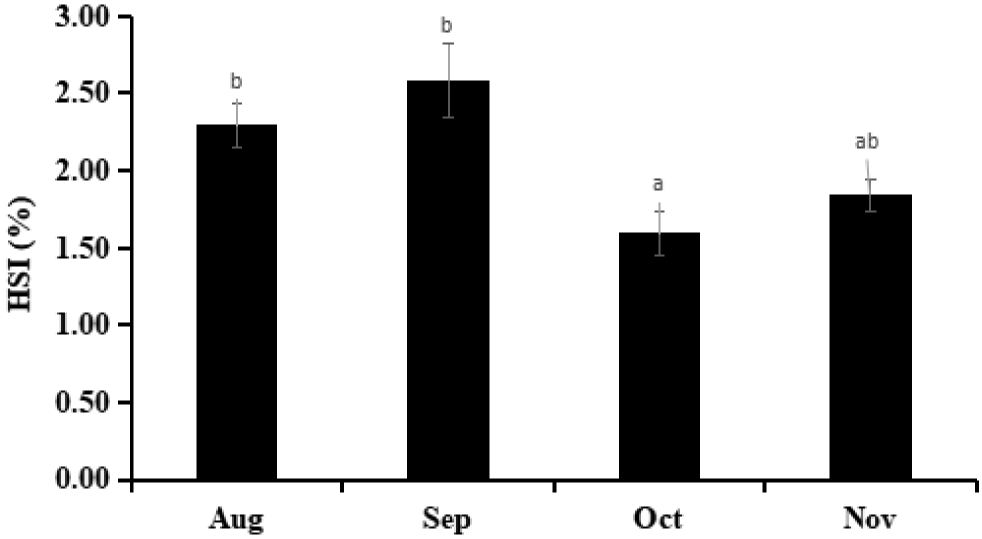

Fig. Hepatosomatic index (Mean ± SE) of grass carp (*Ctenopharyngodon idella*) of all sample collected at four sample points (August - November, 2020). One way ANOVA and Tukey's post-hoe test ($P < 0.05$) were performed to analyze the variability between the four monthly groups.

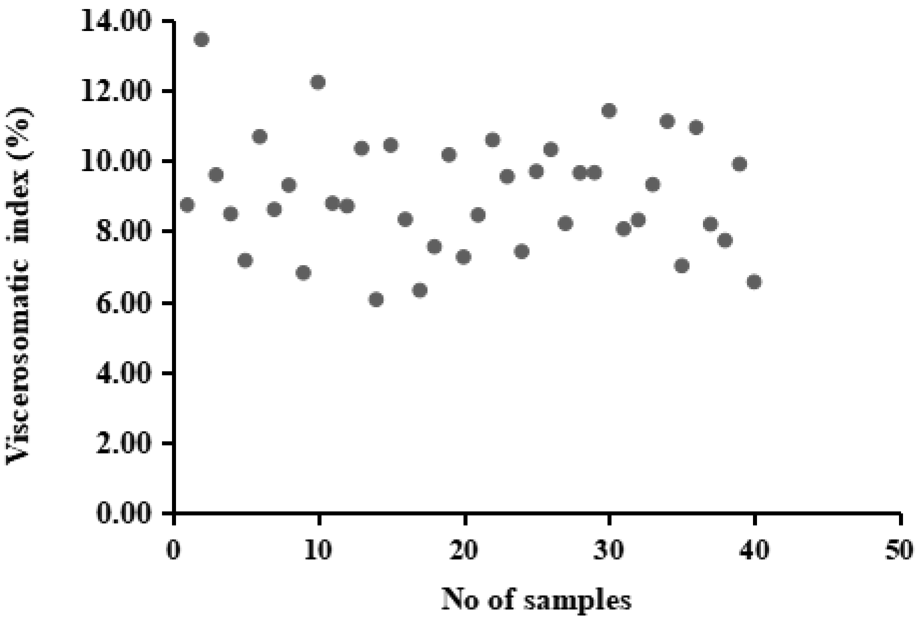

Fig. Viscerosomatic index (Mean ± SE) of grass carp (*Ctenopharyngodon idella)* calculated at time of harvest (December, 2020) cultured in In-pond Raceways.

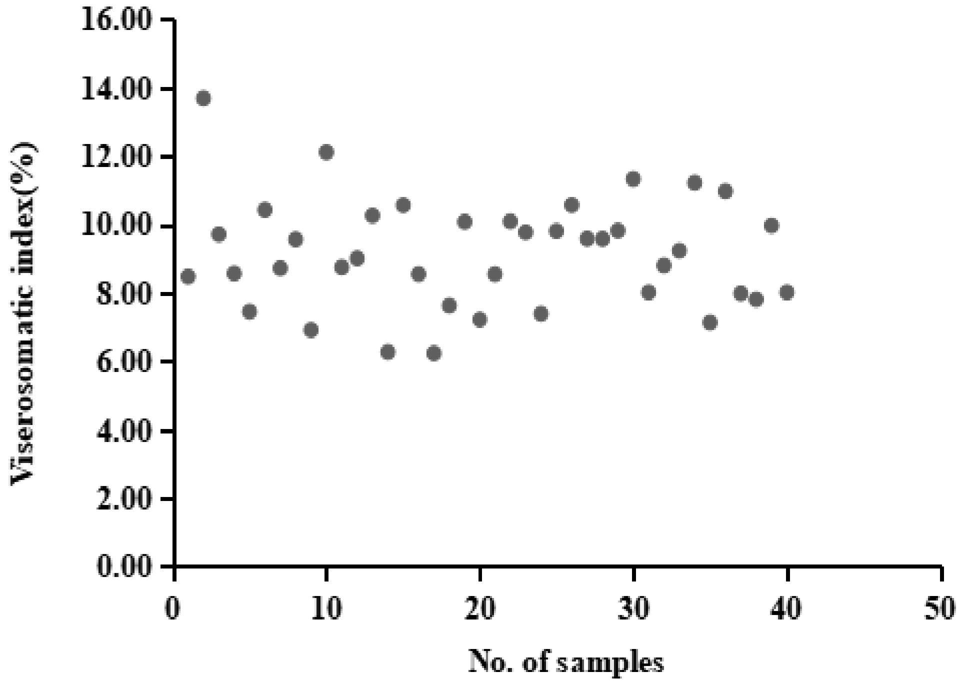

Fig. Viscerosomatic index (Mean ± SE) of grass carp (*Ctenopharyngodon idella*) calculated at time of harvest (December, 2020) cultured in control pond.

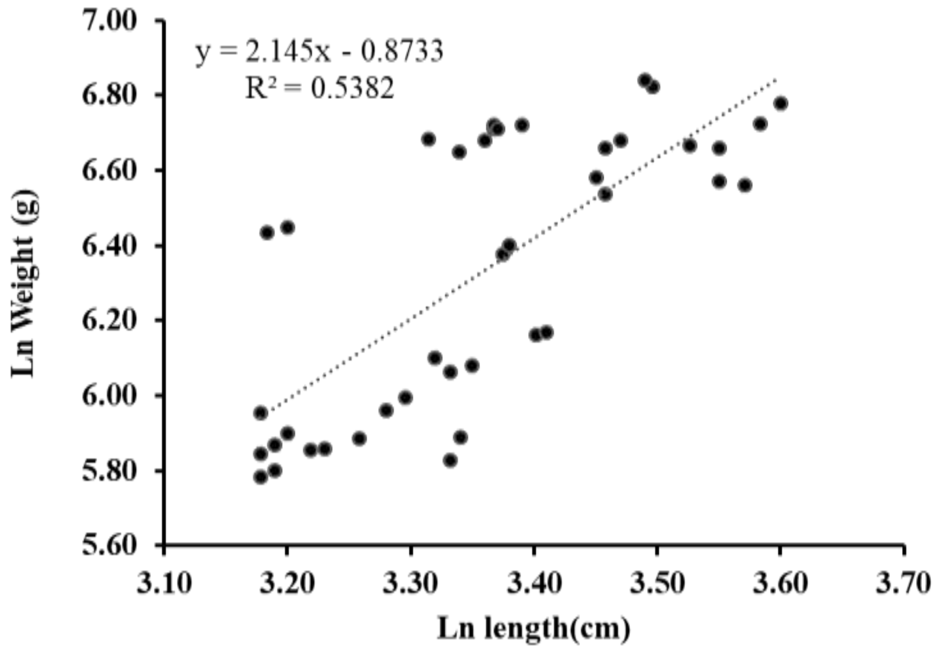

Fig. 4.9 Length-Weight relationship of grass carp (*Ctenopharyngodon idella)* of all sample collected at four sample points (August - November, 2020). Linear Regression test ($P < 0.05$) were performed to analyze the relationship between them.

DISCUSSION

The present study was conducted to investigate the impact of stocking density on growth parameter (total body length, total body weight, condition factor and hepatosomatic index) length-weight relationship, and total lipid content of Grass carp (*Ctenopharyngodon idella*) harvested at in-pond raceways. The IPRS cell was stocked with Grass carp fingerlings (n=6000) in 2020. Fish demonstrate high growth rate and average weight increased within a time period of 4 months. Quality feed for Grass carp in raceways culture system is necessary for better growth and production. The result indicates that production system increase productivity, contributing to food security and produce high quality fish. Total body weight (g), total body length (cm) of Grass carp were increased throughout the study period and not affected by stocking density. There was no decrease neither in average weight nor in individual weight gain due to high aeration and maintained dissolved oxygen.

Total body weight and total body length was monitored during the study of four months at IPRS and found to increase from August 2020 to November 2020. The mean body length observed was in the range of 25.20 ± 1.21 cm to 30.62 ± 0.98 cm while mean body weight was 364.20 ± 32.04 g to 806.67 ± 63.79 g. similar results were found by (verma, 2018). He studied growth performance and condition factor of Indian major carp during September to November. In his study he found the weight of *Catla catla* was in the range 57.04 (1.528 ± 4.832) to 111.29 (2.110 ± 6.680) g whereas, average weight of *Labeo rohita* was observed as 30.504 (1.255 ± 3.971) to 65.65 (1.964 ± 6.212) gm and *Cirrhinus mrigala* as 47.43(0.838 ± 2.650) gm to 17.41 (0.472 ± 1.493) gm. Value of length of *Catla catla* was noticed in the range of as 16.86 (0.158 ± 0.499) cm to 21.93 (0.223 ± 0.704) cm, *Labeo rohita* was analyzed as 13.81 (0.233 ± 0.736)cm to 18.38 (0.293 ± 0.928) cm. Whereas the length of *Cirrhinus mrigala* was observed in the range as 11.25 (0.172 ± 0.544) cm to 16.74 (0.170 ± 0.538) cm.Christina *et al*. (2016) also conducted study on length-weight relationship and condition factor of freshwater fish *tilapia Mossambica*. They found the value for mean total length (cm) as (11.82- 46.11) and total weight (g) as (37.32-147.44). These results are in correlation with present study. His study estimates LWR of 1050 freshwater fish *tilapia Mossambica*. The fish samples were collected from river Thamirabarani during January–March 2016. The relationship between length and weight was analyzed by measuring length and weight of fish specimens collected from study area.

Condition factor (K) is an important factor which accurately describes the well-being of fish in aquatic environment. The condition factor (length-weight relationship) value showed significant difference during experimental period. Results of present study indicate that

Condition factor (K) was not affected by high stocking density. The value of condition factor was 3.00 ± 3.00. Similar results were found by (Huang *et al.*, 2002).There study showed that condition factor and survival rate did not affect significantly by stocking density. Information on condition factor can be vital for fisheries management in capture fisheries sector and provides information on specific condition under which organisms are developing (Araneda *et al*., 2008).

The condition factor (K) of a fish reflects physical and biological circumstances and fluctuations by interaction among feeding conditions, parasitic infections and physiological factors (Le Cren, 1951).Similar result was found by (verma, 2018). Condition Factor (K) for *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala* were estimated in the range of 1.054-1.342, 1.057-1.242 and 0.931-1.222 respectively. Another researcher (Kaur *et al.,* 2018) Studied biometrics and biology of Rohu (*Labeo rohita*) and they analyzed the value of condition factor as 1.06.

In present study Length-weight relationship was studied through linear regression at confidence level (95%) to analyze relationship between them. The value of regression coefficient (R^2) was 0.53. Similar study performed by (Christina *et al.*, 2016) and found the value of R^2 as 0.618. Another researcher (Oliveira *et al*., 2020) studied Length-weight relationship and condition factor for twelve fish species. The value of R^2 during their study was in the range of 0.723 for *Callichthys*. In present findings the value of allometric growth coefficient (b) is 1.13 which is in correlation with the results of (Christina *et al*., 2016**)** who found the value as 1.28. Another experiment conducted by (Kaur *et al.,* 2018) and found value of b coefficient varied from 1.455 to 2.761 for *Labeo rohita*. Growth is said to be positive allometric when the weight of an organism increases more than length (b>3) and negative allometric when length increases more than the weight (b<3) (Wotton, 1991).

Stocking density during study period had no significant effect on the survival rate of fish. There is a strong trend for total production increment with increasing stocking density. These findings are in agreement with those reported by Cruz and Ridha (1991) for tilapia (*O. niloticus*). In their experiment yields of big and small tilapia stocked at different densities were not significantly different (P> 0.05). Big tilapia constituted 76.21% of the yield at 200 fish me^3, 68.76% at 250 fish me^3 and 63.96% at 300 fish $m-{}^3$. Stocking density is considered to be one of the important factors that affects fish growth, feed utilization and the gross fish yield (Liu and Chang, 1992). In many cultivated fish species, growth is inversely related to stocking density and this is mainly attributed to social interactions (Haylor 1991; Silva *et al*., 2000).

Moreover, studies on the other fish species showed an inverse relationship between stocking density and growth parameters, which were considered to be a density- dependent category, such as the cases found for Chinook salmon (*Oreochromis tshaytscha*) (Martin and Wertheimer, 1989), African catfish (*Clarias gariepinus*) (Haylor, 1991) and Arctic charr (*Salvelinus alpinus*) (Jrgensen, Christiansen and Jobling 1993).In tilapia, experiments on the effect of stocking density have been conducted on different fish sizes including fry and juveniles (El-Sayed, 2002), sub- adults (D'Silva and Maughan, 1995) and large tilapia (Yi and Diana, 1996). Studies were also conducted using different culture systems such as tanks (Bailey *et al*.,2000), ponds (Diana *et al*., 2004) and net cages (Cruz and Ridha 1991; Yi *et al*., 1996). All these studies showed the direct relation of stocking density and growth performance. However, some studies carried out by Siddiqui *et al*., 1989 Watanabe *et al*., 1990 showed the absence of the direct relation of stocking density.

Canario (1998) studied the effective stocking density (0.35, 1.3, and 3.2 Kgm^{-3}) for the growth of giltheald sea bream, Sparus aurata, and found that fish in the highest density group grew 25% slower than fish in slower density (0.7, 1.1, 1.5 and 1.8 Kgm^{-3}) on the growth of *turbot*, *Scophthalmus* maximus for 45 days, and found that the stocking inversely affected the growth rate and mean weights. Silva *et al*. (2000) also studied the effect of stocking density (2, 3 and 4 Kgm^{-3}) on the growth of tetra hybrid red tilapia, and found that the final bodyweight gain was significantly higher at a density of 2 and 3 Kgm^{-3}while the largest biomass and feed consumption were observed at a density of 4 Kgm^{-3}.

The stress axis in fish acts through the hypothalamus pituitary chromaffin axis and the hypothalamus pituitary inter renal axis which, respectively, stimulate the production of catecholamines and cortisol. Catecholamine activates glycogenolysis and cortisol gluconeogenesis resulting in increased production of glucose which is needed to combat stress (Pickering 1993; Schreck 1996). Although the effects of packing density and transportation stress on the physiological responses, bacterial density, and growth of *L. rohita* fingerlings have been investigated (Hasan and Bart, 2007).

The study of viscerosomatic and hepatosomatic indicators plays a key role in fish metabolism, particularly digestion and absorption, digestive enzyme synthesis and secretion, and glucose metabolism (Mclaughlin, 1983). The mean of viscerosomatic index and hepatosomatic index of Grass carp under high stocking density were normal. This indicated that the VSI and HSI were not affected by the high stocking density. In present study viscerosomatic index (VSI) of the fish was recorded as 9.18 ± 0.23 and HSI in the range of (1.59 ± 0.14) to (2.58 ± 0.24). These observations are not in agreement with (Ighwela, 2014) who reported the value of VSI in the range of (1.50 ± 0.58 to 1.66 ± 0.31), while HSI value was in the range of (0.39 ± 0.068 to 0.47 ± 0.077).Fish oil, which is high in n-3 fatty acids, is found in many marine and cold-water fish species. These lipids, which are required for brain development and memory enhancement, could be employed as supplements in a range of foods. Total lipid content was determined using the Soxhlet method in this study, and the value was found to be in the range of (15.58 % to 22.20 %). These investigations are linked to one another (Prabhakara *et al*., 2010). They discovered that the lipid content of rohu and murrel was around 20% and 22%, respectively

The internal organs of a fish are called viscera. These are high in protein and other nutrients like polyunsaturated fatty acids, phospholipids, soluble vitamins, and bioactive compounds (Shirahigue *et al*., 2016), making them appealing for a variety of applications in technological applications that promote product development and significant advancements in the fish industry (Feltes *et al*., 2010). The selling rate of fish viscera is 10 Rupees per kilogramme, according to local fish market estimates. The visceral mass of a kilogramme of fish is estimated to be between 200 and 250 grammes, and it is used in chicken feed and fertilizers. The current study looked into protein wastage in the form of visceral mass, which is not available to consumers and causes farmers to lose money. The average viscerosomatic index (VSI) of rohu cultivated in IPRS was 9.18 0.23, which showed the wastage.

Fish Market Mori Gate Lahore (12-02-2021)					**Viscera Rate(PKR)**
Species	**Weight**	**Price (PKR)**		**Viscera Weight**	
		Whole Sale Rate	**Retail Market Rate**		
	1 kg	200	250	56-60 g	
Rohu	2 kg	260-280	325-350	84-90 g	
					10Rupees Per Kg
	1 kg	180-190	250-275	50-60 g	
Grass carp	1.25 kg	200-210	300-350	90-100 g	
	1.5 kg	220-230	420-460	150-160 g	
	2 kg	250-260	550-600	180-190 g	
Sera	1 kg	190	250	150-200 g	
Tilapia	1 kg	400	600	65-70 g	

CONCLUSION

• IPRS technology helps to get more production from smaller land area.Due to better aeration and water quality, there is no effect of high stocking density on viscerosomatic index, hepatosomatic index and lipid content.This study will provides a baseline data for future studies on local fish species cultured in IPRS in Pakistan.

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DECLARATIONS

Ethics statement

The research presented in this article was approved by research ethical review committee of Lahore College for Women University, Lahore.

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