PHYSICOCHEMICAL PARAMETERS:

Weather condition

The weather during the summer season (March to June) remained bright and sunny throughout the investigation. In winter season (July to October) the weather was bright and sunny with clear or lightly clouded sky. The rainy season was marked with heavily clouded or clouded weather with frequent rain.

Water colour

Observation of water during the research period revealed that the colour of water varied from season to season (Table 1). From month of November to March (winter season) it was found to be clear and transparent but pale, greenish and rarely bluish green in colour. In April and May (summer season) the water was turbid and opaque and from June to October (rainy season) it was fully muddy.

Table 1: Seasonal variation in physicochemical parameter (water colour) of sample pond during 2014 and 2015

Month	Water colour during 2014	Water colour during 2015
JANUARY	Clear, greenish	Clear, greenish
FEBRUARY	Clear, greenish	Clear, bluish green
MARCH	Clear	Clear
APRIL	Dirty	Dirty
MAY	Dirty	Dirty
JUNE	Muddy	Muddy
JULY	Muddy	Muddy
AUGUST	Muddy	Muddy
SEPTEMBER	Muddy	Muddy
OCTOBER	Muddy	Muddy
NOVEMBER	Clear, pale	Clear, pale
DECEMBER	Clear, light green	Clear, light green

Seasonal variation in physicochemical parameters of the sample pond during study period of year 2014 and 2015 were recorded in the Table 2 and 3 for further analysis. The mean seasonal variations of physicochemical parameters during 2014 and 2015 were noted in the Table 4. Mean of season wise variation of physicochemical parameters of the sample pond were recorded in the Table 5.

Table 2: Seasonal variation in physicochemical parameters of sample pond during 2014

Month	pH	Dissolved O_2 in	Free CO_2 in mg l^{-1}	Total Alkalinity in mg l^{-1}	Total Hardness	Calcium in mg l^{-}
JANUARY	7.8	7.3	3.8	58.0	99.6	3.5
FEBRUARY	8.1	8.1	4.0	85.0	96.2	3.3
MARCH	7.8	6.0	4.4	99.0	102.6	4.4
APRIL	7.7	5.7	4.3	119.0	100.8	5.7
MAY	7.3	5.1	8.0	65.0	116.7	6.4
JUNE	6.8	5.0	9.5	46.0	98.5	8.4
JULY	6.6	6.1	10.9	33.0	96.3	9.3
AUGUST	6.8	5.7	9.0	35.0	72.7	7.4
SEPTEMBER	6.9	6.6	8.6	36.0	68.8	7.5
OCTOBER	7.8	6.9	8.8	68.0	69.3	7.1
NOVEMBER	7.7	7.1	5.3	83.0	73.5	5.5
DECEMBER	7.7	7.5	4.7	96.0	96.2	5.1

Table 3: Seasonal variation in physicochemical parameters of sample pond during 2015

Month	pH	Dissolved in mg l^{-1}	Free CO_2 in mg l^{-1}	Total Alkalinityin mg l^{-1}	Total Hardness in mg l^{-1}	Calcium in mg l^{-}
JANUARY	7.7	7.0	4.5	80.0	98.5	4.1
FEBRUARY	8.1	8.2	4.9	92.0	100.1	5.2
MARCH	8.0	6.2	4.8	95.0	100.4	5.3
APRIL	7.9	5.4	6.4	110.0	116.2	6.5
MAY	7.6	4.7	8.7	85.0	118.4	6.6
JUNE	6.7	5.1	8.8	61.0	116.4	7.7
JULY	6.6	6.0	10.5	43.0	92.6	9.5
AUGUST	6.9	7.0	8.4	45.0	89.5	8.6
SEPTEMBER	7.2	5.2	7.4	32.0	90.3	7.1
OCTOBER	7.4	6.5	6.4	57.0	78.2	6.5
NOVEMBER	7.9	6.6	5.2	75.0	72.3	5.6
DECEMBER	8.0	7.5	4.4	93.0	94.7	4.2

Table 4: Mean of seasonal variation of physicochemical parameters in 2014 and 2015

Physicochemical parameters	Summer		Rainy		Winter	
	2014	2015	2014	2015	2014	2015
pH	7.40	7.55	7.025	7.025	7.825	7.925
Dissolved Oxygen	5.45	5.35	6.325	6.175	7.5	7.325
Free CO_2	6.55	7.175	9.325	8.175	4.45	4.75
Total Alkalinity	82.25	87.75	43.0	44.25	80.5	85
Total Hardness	104.65	112.85	76.775	87.65	91.375	91.40
Calcium in mg l^{-1}	6.225	6.525	7.825	7.925	4.35	4.775

Table 5: Mean of season wise variation of physicochemical parameters of the sample pond

Physicochemical parameters	Summer	Rainy	Winter
pH	7.48	7.03	7.88
Dissolved Oxygen in mg l^{-1}	5.4	7.03	7.41
Free CO_2 in mg l^{-}	8.75	6.86	4.65
Total Alkalinity in mg l^{-1}	85.0	43.63	82.75
Total Hardness in mg l^{-1}	108.75	82.21	91.39
Calcium in mg l^{-1}	6.38	7.75	4.57

pH (Hydrogen ion concentration)

During the whole study period the pH of the sample pond fluctuated between 6.6 and 8.1 (Table 2, 3, 4). The maximum pH was observed in February (8.1) and the minimum in July (6.6). An increasing pattern of values were observed from rainy season to summer season (acidic to alkaline) along with modest seasonal variation (Fig 1, 2). The mean value of pH for 2014 was 7.35 and for 2015 it was 7.5. The mean value of pH of the water body during winter, summer, rainy season for the whole study period were 7.88, 7.48 and 7.03 respectively (Table 5).

Dissolved Oxygen (DO)

The values of dissolved oxygen content throughout the study period varied from 4.7 mg l^{-1} to 8.2 mg l^{-1}. During winter season the DO values were higher (6.6 mg l^{-1} to 8.2 mg l^{-1}). Comparatively low values were obtained in monsoon (5.2 mg l^{-1} to

7.0 mg l^{-1}) and summer (4.7 mg l^{-1} to 6.2 mg l^{-1}) (Fig. 3,4). The average dissolved DO concentration of the sample pond in winter; rainy and summer were noted 7.41 mg l^{-1}, 5.4 mg l^{-1} and 7.03 mg l^{-1} respectively (Table 5). However, during the whole study period the water body maintained a fairly agreeable level of dissolved oxygen. It was well above the critical limit (3.0 mg l^{-1}).

Free CO_2

Throughout the study period, the free carbon dioxide was obtained. Round the research period the free carbon dioxide was ranged from 3.8 mg l^{-1} to 10.9 mg l^{-1}. During late summer and rain (May to October) free carbon dioxide of the sample pond was recorded high while low during winter (November to February). (Fig 5, 6). The average free carbon dioxide concentration of the sample pond in winter, rainy and summer were noted 4.65 mg l^{-1}, 8.75 mg l^{-1} and 6.86 mg l^{-1} respectively (Table 5).

Total alkalinity

Throughout the observations phenolphthalein alkalinity was not encountered, where as bicarbonate alkalinity was dominant and it was fluctuated between 32.0 mg l^{-1}(monsoon) and 119.0 mg l^{-1}(early summer). Bicarbonate alkalinity arrived at the highest point in April of both the years. During early part of both winter and summer season high value of total alkalinity was noted and low value during rainy season (Fig 7, 8). It displayed minimum value of 32.0 mg l^{-1} (September, 2014) and maximum value of 119.0 mg l^{-1} ((April, 2014).The mean values of winter, summer and rainy were 82.75 mg l^{-1}, 85.0 mg l^{-1} and 43.63 mg l^{-1} respectively (Table 5). The mean annual alkalinity value of the sample pond was 70.4 6 mg l^{-1}.

Total hardness

The fluctuation of total hardness ranged from 68.8 mg l^{-1} to 118.4 mg l^{-1} with the highest value in May (118.4 mg l^{-1}) and lowest value in September (68.8 mg l^{-1}) (Fig 9, 10). Seasonally average value during winter, summer and rainy were 91.39 mgl^{-1},108.75 mg l^{-1} and 82.21 mg l^{-1} respectively (Table 5). The mean annual total hardness value of the sample pond was 121.1mg l^{-1}.

Calcium

The calcium concentration of the sample pond showed a variation from 3.3mgl^{-1} (winter) to 9.5 mg l^{-1}(rainy) with the minimum value during February 2014 and maximum value during July 2015. The lower value of calcium of the pond was found

during winter (3.3 mg $l^{-1}$to 5.6 mg l^{-1}) and higher value during monsoon (6.5 mg l^{-1} to 9.5 mg l^{-1}) (Fig 11, 12). Seasonally average value of calcium during winter, summer and rainy summer season were recorded as 4.57mg l^{-1}, 6.38 mg l^{-1} and 7.75 mg l^{-1} respectively (Table 5). The mean calcium concentration value of the sample pond was 6.23 mg l^{-1}.

Calculations of mean annual physicochemical parameters: pH, water temperature, turbidity, DO (dissolved oxygen), total hardness, calcium, Magnesium, Carbonate, Bicarbonate, Sulphate, Nitrate, Sodium, Potassium and Chloride during the study period were recorded in the Table-6 for further analysis.

Table 6: Annual mean of physicochemical parameters of sample pond during 2014-2015

Physicochemical parameters	Units	Mean	SD
pH	Stds	7.46	±0.11
Temperature	^{o}C	30.5	±3.1
Turbidity	NTU	1.94	±0.35
DO	mg l^{-1}	6.74	±0.47
Total hardness	mg l^{-1}	121.1	±25.62
Calcium	mg l^{-1}	6.23	±3.1
Magnesium	mg l^{-1}	34	±3.0
Carbonate	mg l^{-1}	21.5	±1.6
Bicarbonate	mg l^{-1}	150	±19.5
Sulphate	mg l^{-1}	20	±1.5
Nitrate	mg l^{-1}	1.0	±0.01
Phosphate	mg l^{-1}	0.07	±0.006
Sodium	mg l^{-1}	20	±1.5
Potassium	mg l^{-1}	2.1	±0.05
Chloride	mg l^{-1}	63	±3.0

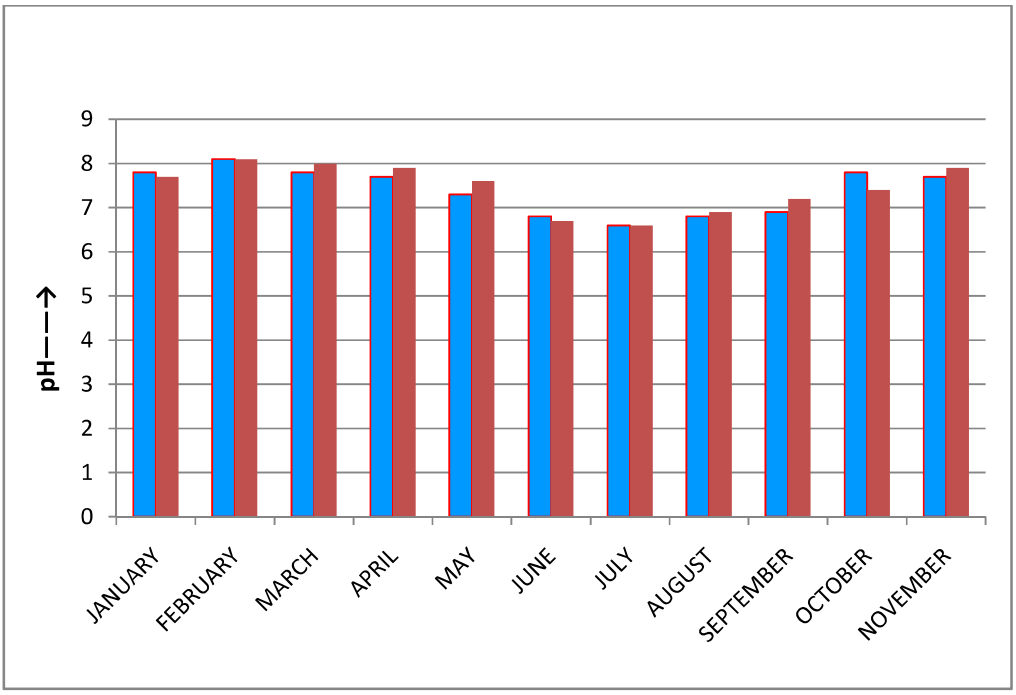

Fig 1: Annual seasonal variation in pH of the sample pond during 2014 and 2015

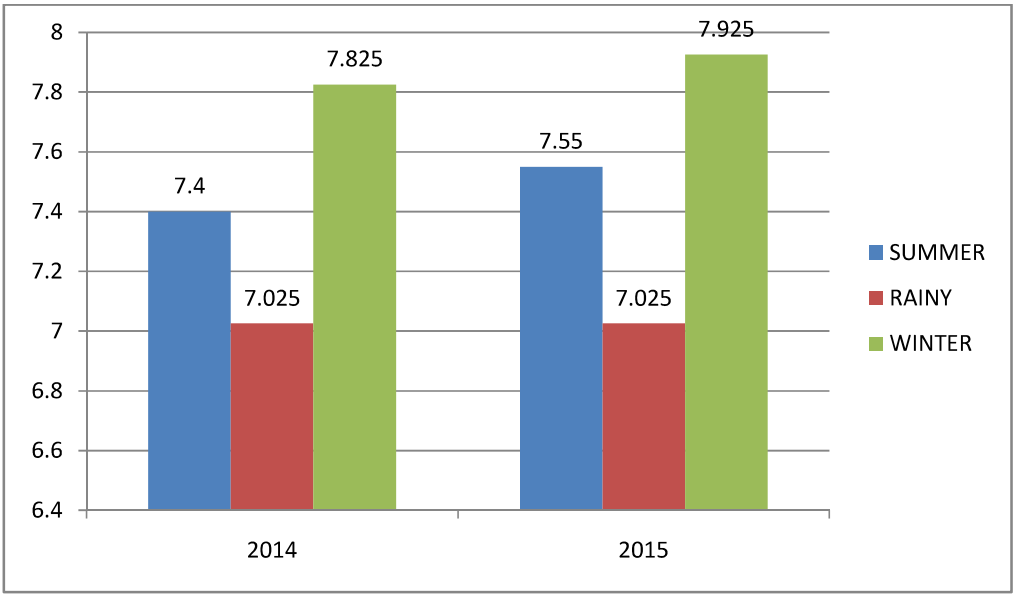

Fig 2: Average seasonal variation in pH of the sample pond

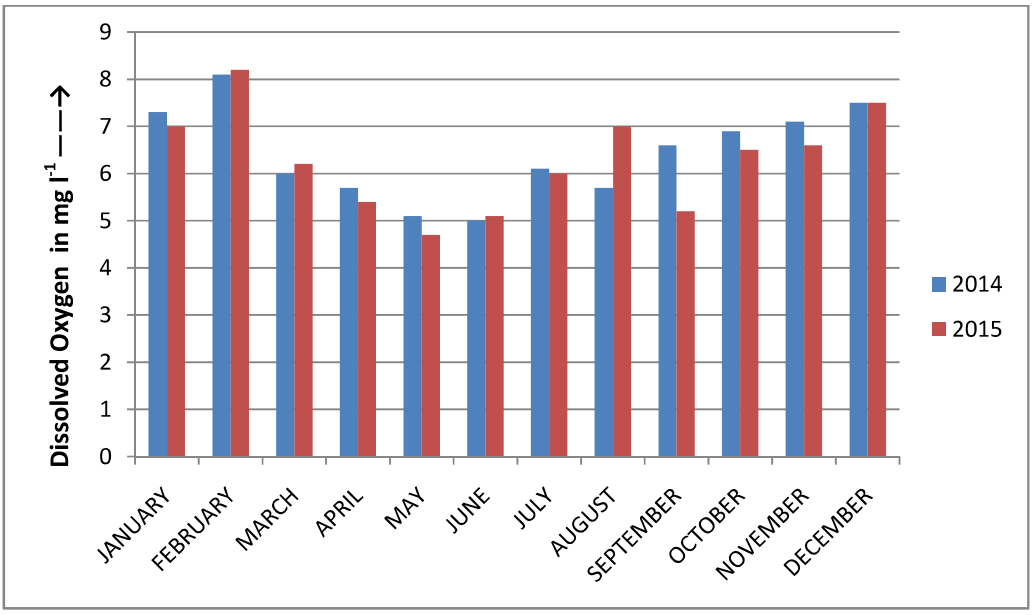

Fig 3: Annual seasonal variation in dissolved Oxygen in mg l^{-1} of the sample pond in 2014 and 2015

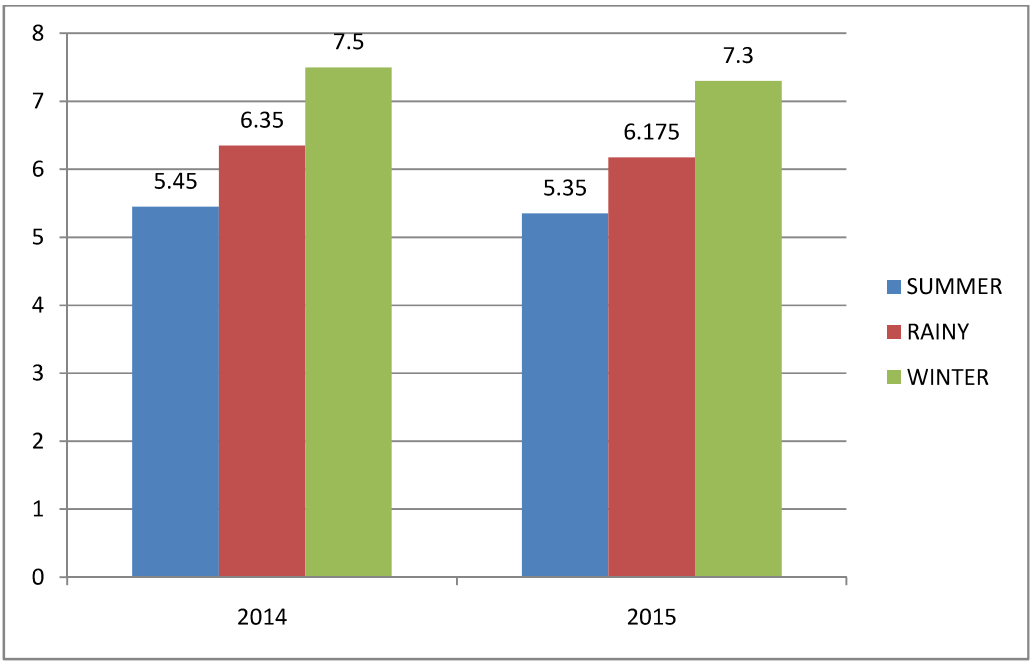

Fig 4: Average seasonal variation in dissolved Oxygen of the sample pond

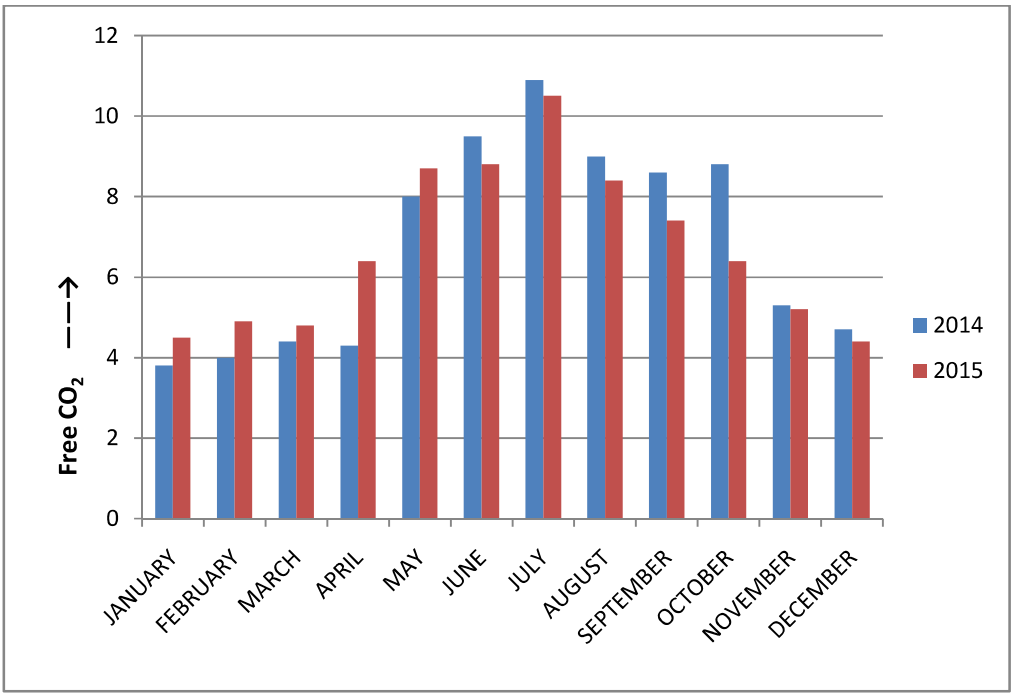

Fig 5: Annual seasonal variation in free CO_2 in mg l^{-1} of the sample pond

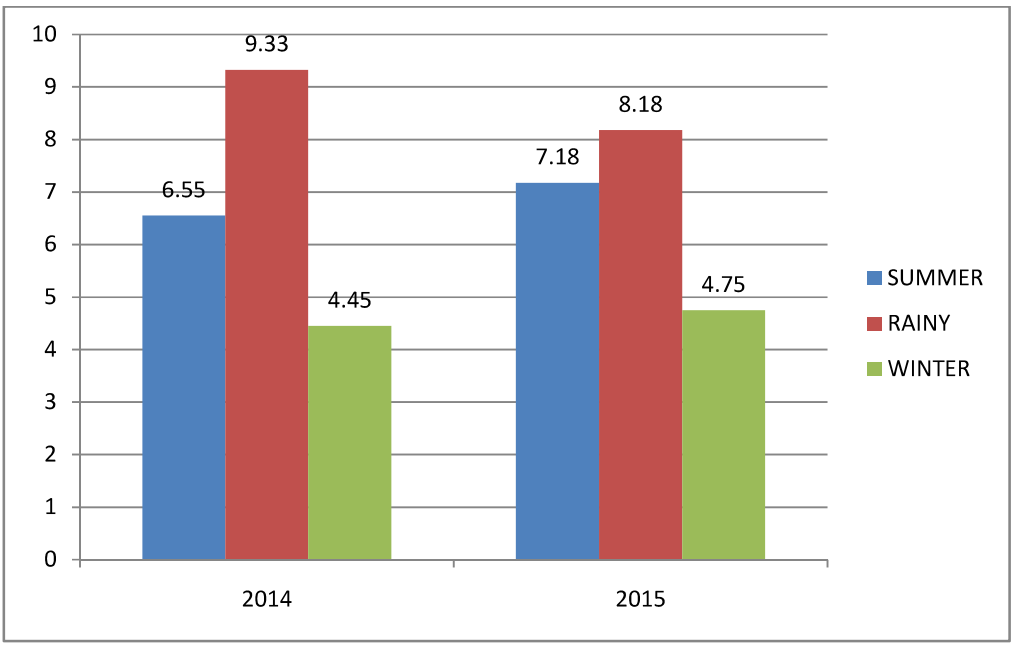

Fig 6: Average seasonal variation in free CO_2in mg l^{-1} of the sample pond

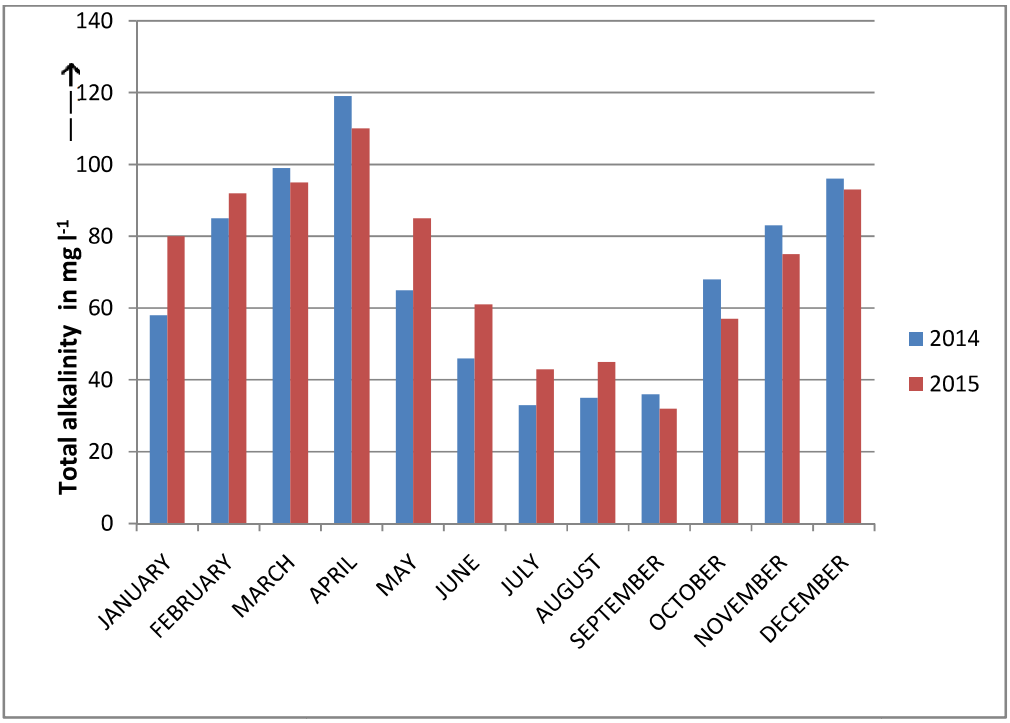

Fig 7: Annual seasonal variation in total alkalinity in mg $l^{-1}$of the sample pond

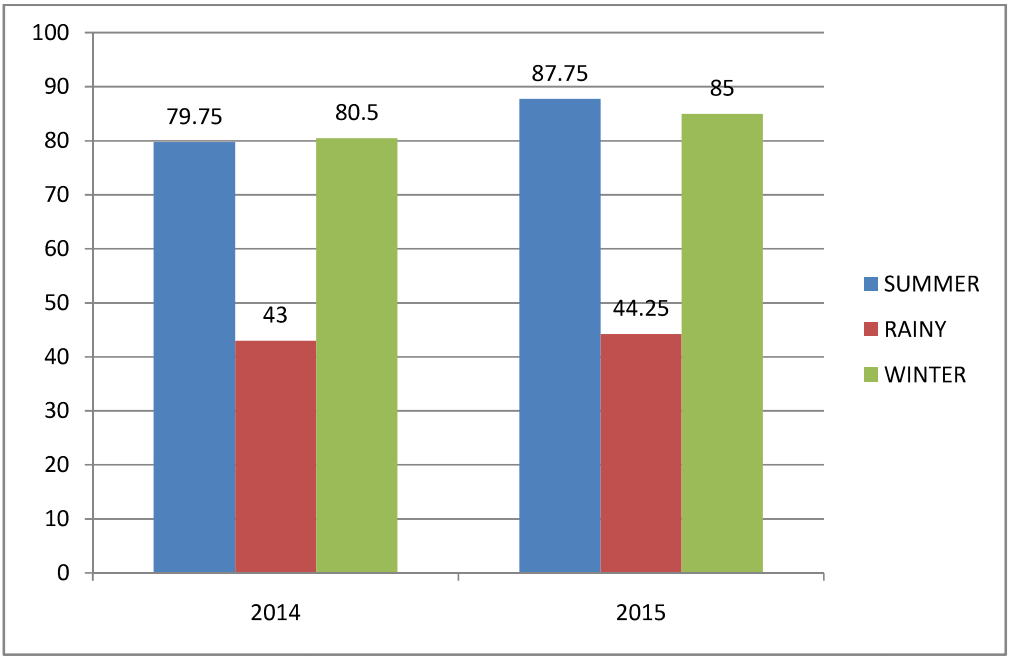

Fig 8: Average seasonal variation in total alkalinity in mg l^{-1} of the sample pond

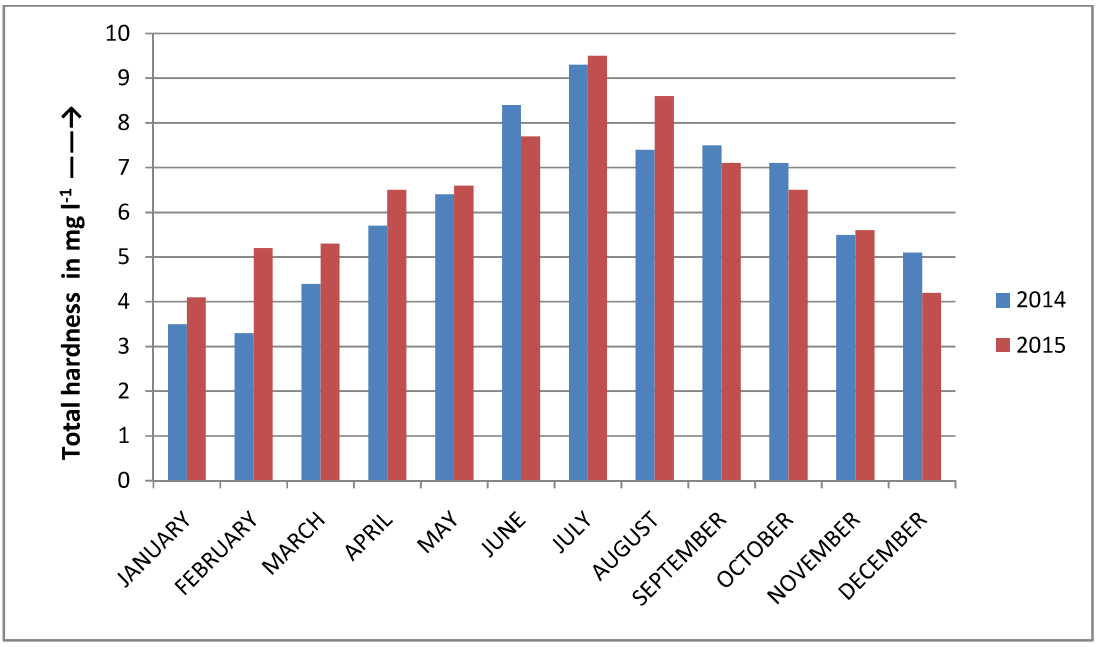

Fig 9: Annual seasonal variation in total hardness in mg l^{-1} of the sample pond

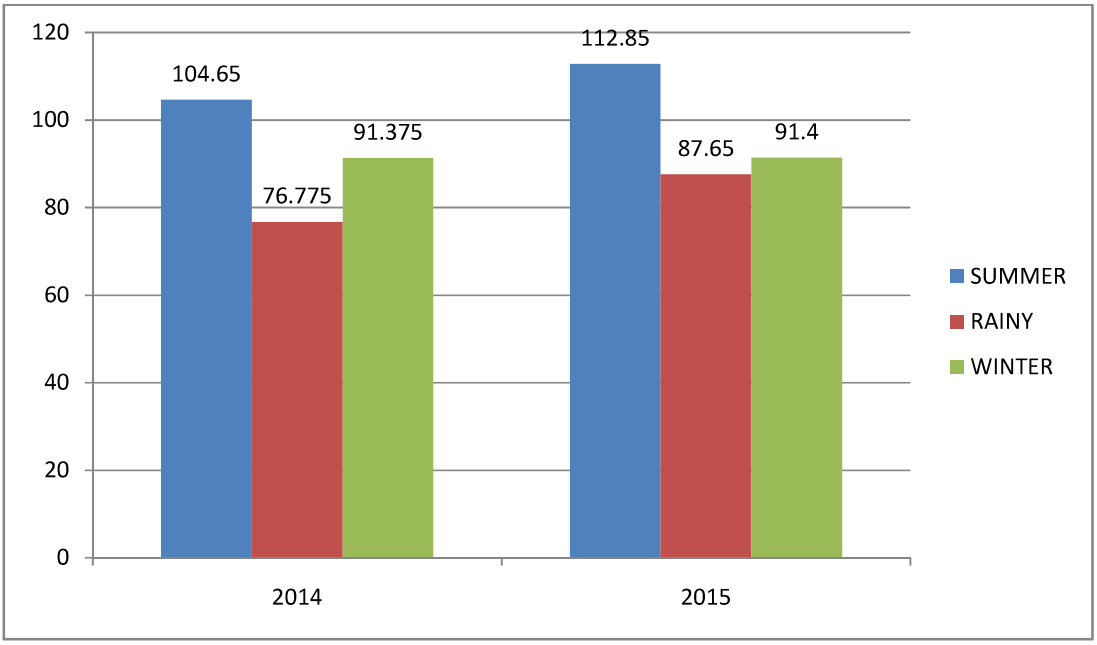

Fig 10: Average seasonal variation in total hardness in mg l^{-1} of the sample pond

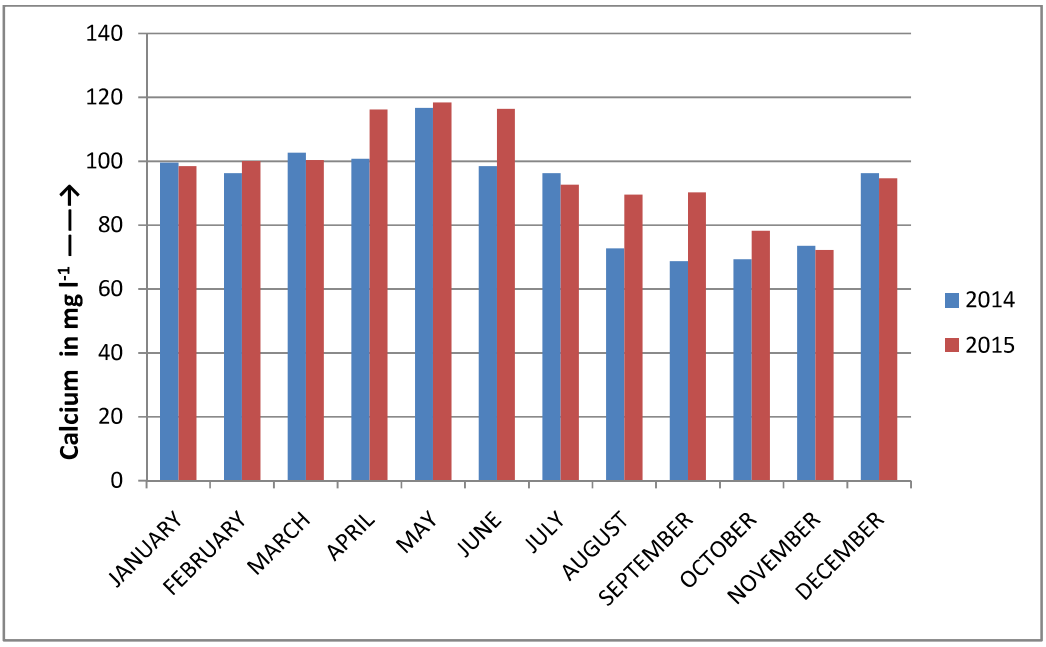

Fig 11: Annual seasonal variation in calcium in mg l^{-1} of the sample pond

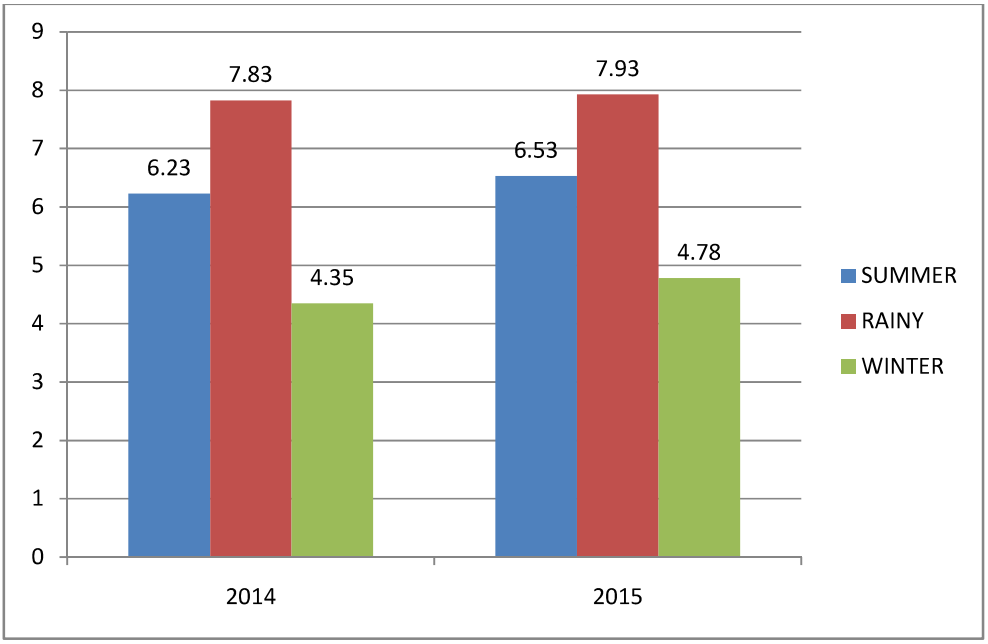

Fig 12: Average seasonal variation in calcium in mg l^{-1} of the sample pond

PLANKTON ANALYSIS

PHYTOPLANKTON:

The phytoplankton population constituted of Chlorophyceae, Bacillariophyceae and Myxophyceae (Cyanophyceae). The Phytoplankton diversity illustrated 10 species of Chlorophyceae, 11 species of Bacillariophyceae and 12 species of Myxophyceae (Table 7). Bacillariophyceae was dominant among all the phytoplankton followed by Chlorophyceae and then Myxophyceae.

Chlorophyceae comprised of *Closteridium, Microspora, Mougeotia, Oedogonium, Oocystis, Staurastrum, Spirogyra, Ulothrix, Volvox,* and *Zygnema.*

Bacillariophyceae was represented by *Amphora, Diatomo, Fragilaria, Frustulia, Gomphonema, Gyrosiga, Melosira, Navicula* and *Vaucheria* during the period of investigation.

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The Blue green algae (Cyanobacteria or Myxophyceae) included *Anabaena, Anacystis, Chlamydomonas, Merismopoedia, Nostoc, Oscillatoria sp., Polycystis, Rivularia, Spirulina* and *Trichomus.*

In both the year population of phytoplankton, especially Chlorophyceae and Bacillariophyceae hit the highest point in winter season, but peak value in Myxophyceae was noticed during summer.

Table 7: List of available Phytoplankton species recorded in sample pond during 2014 and 2015

CHLOROPHYCEAE		2014	2015
	Closterium lanceolatum Kutz	+	+
	Microspora	-	+
	Mougeotia	+	+
	Oedogonium	+++	++
	Oocystis	-	+
	Staurastrum	++	+
	Spirogyra varians Kutz	+++	+++
	Ulothrix Zomata Kutz	+	++
	Volvox globator Ehrwnb	++	++
	Zygnema sp	+++	++
BACILLARIOPHYCEAE			
	Amphora ovalis Kurtz	++	+
	Diatom sp	+++	++
	Fragillaria sp	++	++
	Frustulia	++	++
	Gamphonema lanceolatum (Ehnerb)	+++	++
	Melosira granulate Ralfs	++	++
	Naviculata terostrata Hust	+++	++
	Tabellaria	+++	++
	Vaucheria	++	++
MYXOPHYCEAE			
	Anabaena sp	+	+
	Ancystics	++	+
	Chlamydomonas	+	++
	Merismopoedia	+	++
	Nostoc sp Vanch	+++	++
	Oscillatoria sp	+++	++
	Policystis	+	+
	Rivularia sp	+	++
	Spirulina	+	+
	Trichomus	+	++

Both the years the counts of phytoplanktons were recorded in Table.7 which showed that during summer the peak value was observed in case of Myxophyceae. Among all the groups of phytoplankton, maximum count was encountered during rainy season in both the years of the study in the sample pond.

In both the year population of phytoplankton, especially Chlorophyceae and Bacillariophyceae hit the highest point in winter season. As revealed by the present study among 11 species of Bacillariophyceae, *Diatoma* was dominant which was

collected from the sample pond throughout the year. Chlorophyceae group and Myxophyceae group were dominated by the *Spirogyra* and *Nostoc* respectively.

The Shanon and Weiner diversity index (Hs), species equitability or eveness (j) and species richness index (d) in respect to phytoplanktons were recorded in the Table.8, 9 and 10 respectively.

The diversity index (Hs) ranged from 2.21 to 3.02. Diversity index value was recorded maximum in rainy season and minimum during winter.

Species equitability (j) fluctuated between 0.74 and 0.97. The maximum value of species equitability was recorded in rainy season and minimum value during winter. The species richness index (d) ranges from 3.10 to 7.12. The value of the richness index was recorded maximum in winter season and minimum during rainy season.

Table 8: Shannon and Weiner diversity index of Phytoplankton community of sample pond during the study period.

MONTH	**Shannon and Weiner diversity index (Hs)**
JANUARY	2.48
FEBRUARY	2.94
MARCH	2.75
APRIL	2.81
MAY	2.97
JUNE	2.86
JULY	2.64
AUGUST	3.02
SEPTEMBER	2.21
OCTOBER	2.98
NOVEMBER	3.00
DECEMBER	2.80

Table 9: Pielou species equitability index of phytoplankton community of sample pond during the study period

MONTH	Species equitability/eveness index (j)
JANUARY	0.74
FEBRUARY	0.90
MARCH	0.85
APRIL	0.89
MAY	0.90
JUNE	0.92
JULY	0.94
AUGUST	0.97
SEPTEMBER	0.96
OCTOBER	0.89
NOVEMBER	0.91
DECEMBER	0.87

Table 10: Margalef Species Richness index of phytoplankton community of sample pond during the study period

MONTH	Margalef Species Richness index
JANUARY	4.74
FEBRUARY	5.03
MARCH	4.35
APRIL	4.50
MAY	5.27
JUNE	4.42
JULY	4.24
AUGUST	7.12
SEPTEMBER	3.36
OCTOBER	3.10
NOVEMBER	4.71
DECEMBER	4.37

ZOOPLANKTON

Zooplanktons found in sample water were estimated quantitatively and qualitatively and they were recorded taxonomically after identification. A seasonal fluctuation of these micro-organisms was found in sample pond. The zooplankton population comprised of Protozoa, Rotifers, Cladocera, Copepode and Ostracoda. Among zooplanktons, Cladocera and Protozoa dominated. Results of zooplanktons studies were recorded in Table: 11. Total no. of species found in the pond was 10 and they were identified taxonomically. Out of these 4 species of Protozoa, 2 species of

Rotifera, 3 species of Cladocera, 1 species of Copeopda and 1 species of Ostracoda were identified during the period of study.

Protozoa are represented by *Amoeba, Paramecium*, *Monocystis* and *Verticella. Keratella* and *Monostyla* constitute Rotifera. Copepoda was represented by *Mesocyclops* and Ostracoda was represented by a single species *Cypridopsis*. Cladocera was represented by a *Daphnia, Bosmina* and *Moina*.

Daphnia was identified as the dominant species among all the species of the zooplanktons. It was observed that the number of zooplanktons was generally higher in winter and in certain cases it is higher in summer. The value minimum was found in rainy season.

Peak values of different species were registered in different seasons. Analysis of zooplankton in the count revealed no definite pattern. However a tendency was noticed in case of some species.

The abundance of *Amoeba* with bimodal peak values was observed in both the years. Monocystis species was also encountered in both the years.

Monostyla showed a bimodal peak in both the years of study. It showed peak value in winter and summer in first and second season of investigation respectively. *Cypridopsis* reached its peak during winter in both the years. *Daphnia* exhibited a completely different pattern. In the first year of study recorded abundance of *Daphnia* in sample pond in rainy season while no specific pattern was observed during second year.

Both *Bosmina* and *Moina* showed bimodal peak during investigation without any specific pattern.

The Shannon and Weiner diversity index (Hs), Species Equitability or eveness (j) and Species richness index (d) with respect to zooplanktons were presented in Table 12.

The diversity index (Hs) ranged from 0.63 to 2.30. During winter season the maximum value of diversity index was recorded and minimum value was recorded during rainy season.

Species equitability (j) fluctuated from 0.95 to 1.02. The maximum value of species equitability was recorded during rainy season in the sample pond and minimum value during summer.

The species richness index (d) ranged from 1.11 to 2.77. The species equitability was recorded maximum during winter and minimum during rainy season.

Table 11: List of available zooplankton species recorded from sample pond during 2014 and 2015

Name of zooplankton		2014	2015
PROTOZOA	*Amoeba proteus*	+++	+++
	Paramecium caudatum	+++	++
	Verticella	-	+
	Monocystis agilis	++	++
CLADOCERA	*Bosmina*	+++	+++
	Daphnia cranite	+++	++
	Moina micrura	++	+
COPEPODA	*Mesocyclops leuckartii*	++	+
OSTRACODA	*Cypridopsis*	+	+
ROTIFER	*Keratella tropica*	+++	++
	Monostyla sp	++	+

Table 12: Shannon and Weiner diversity index (Hs), Species equitability/eveness index (j) and Margalef Species Richness index (d) of Zooplankton community of sample pond during study period

MONTH	Hs	j	d
JANUARY	0.98	0.97	2.48
FEBRUARY	1.89	0.95	2.33
MARCH	1.75	0.96	2.0
APRIL	1.72	0.97	2.13
MAY	1.81	0.95	2.13
JUNE	1.74	0.96	1.89
JULY	1.60	0.98	1.93
AUGUST	0.63	1.02	1.11
SEPTEMBER	1.34	0.99	1.83
OCTOBER	2.04	0.97	2.39
NOVEMBER	2.04	0.98	2.29
DECEMBER	2.30	0.99	2.77

PRIMARY PRODUCTIVITY

Primary productivity of the sample pond was calculated and its seasonal and spatial variation was recorded in the Table 13. There was a steady variation of the annual mean GPP from 0.075±0.008gC m^3h^{-1} in September to 0.937±0.101gC m^3h^{-1} in March. Season wise, maximum GPP was observed in summer season and minimum was during rainy season .The systematic trend exhibited a well defined seasonal pattern (Fig 13).

The NPP value ranged from 0.028±0.003 g C $m^3h^{-1}$to 0.832±0.083 g C m^3h^{-1}. During February i.e. in winter season the maximum mean value of NPP was observed whereas minimum value was recorded during August i.e. in rainy season. The maximum and minimum values of NPP showed no systematic pattern in relation to seasons. As per the observation, minimum values were acquired in rainy season (June to September) and an increasing trend was observed from month of September to February. The maximum and minimum mean values were noticed during March (summer season) and August (rainy season) respectively.

It is observed from Table-13 that there was quite high level of community respiration that ranged from 0.027 ±0.002 g C m^3h^{-1} in December to 0.497 ±0.040 g C m^3h^{-1}in April. A definite seasonal pattern was observed with maximum value during summer and minimum value during winter.

The ratio of NPP and GPP was the highest (0.78) in winter and lowest in rainy season. The ratio of NPP and CR was maximum (7.09) in winter and minimum in rainy season. However, the CR percentage of GPP was observed to be highest (0.52) during rainy season and lowest in winter season.

Total and Seasonal ratio between different productivity parameters during 2014-15 are recorded in Table 14.

Table 13: Monthly mean±SD GPP, NPP and CR value in g C m^3h^{-1} of sample pond during 2014-15

Month	GPP	NPP	CR
JANUARY	0.533±0.045	0.704±0.057	0.037±0.003
FEBRUARY	0.567±0.051	0.832±0.083	0.055±0.005
MARCH	0.937±0.102	0.668±0.006	0.403±0.033
APRIL	0.863±0.101	0.597±0.045	0.497 ±0.040
MAY	0.533±0.058	0.52±0.048	0.196±0.022
JUNE	0.557±0.074	0.097±0.013	0.199±0.023
JULY	0.224±0.026	0.098±0.008	0.098±0.007
AUGUST	0.21±0.023	0.028±0.003	0.113±0.02
SEPTEMBER	0.075±0.007	0.39±0.004	0.108±0.012
OCTOBER	0.338±0.05	0.146±0.015	0.146±0.003
NOVEMBER	0.327±0.051	0.321±0.034	0.093±0.006
DECEMBER	0.52±0.063	0.468±0.042	0.027 ±0.002

GPP=Gross Primary Production,NPP= Net Primary Production,CR=Communty Respration

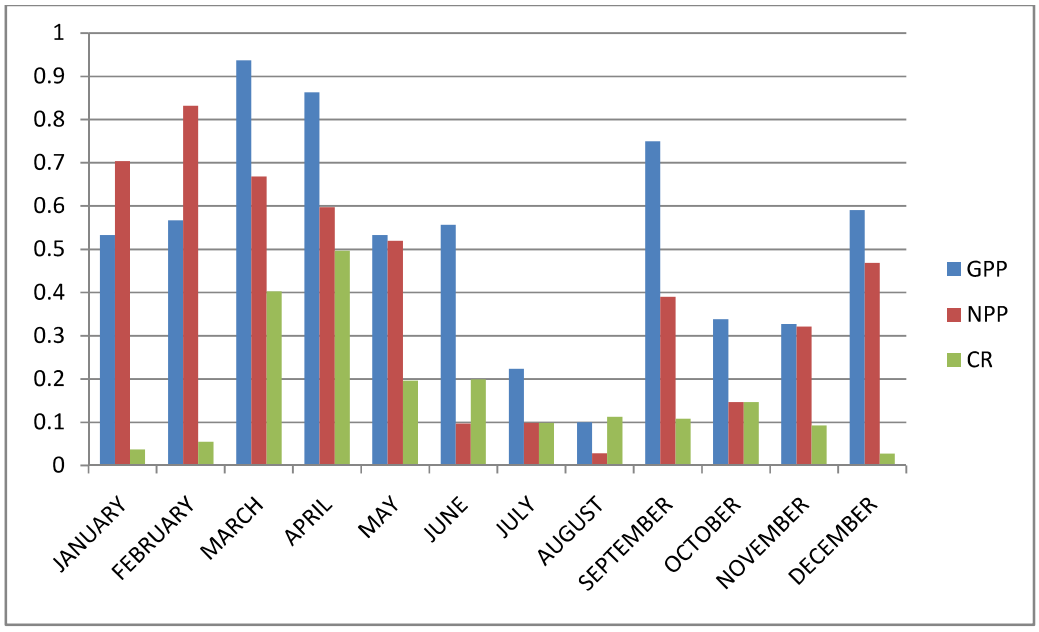


Fig 13: Monthly mean GPP, NPP and CR value in g C m^3h^{-1} of sample pond during 2014-15

Table 14: Total and Seasonal ratio between different productivity parameters, 2014-15

RATIO	TOTAL	SEASONAL		
		S	R	W
NPP:GPP	0.76	0.65	0.43	0.78
NPP:CR	2.67	2.23	0.49	7.09
CR% of GPP	0.15	0.37	0.52	0.04

GPP=Gross Primary Production, NPP=Net Primary Production, CR=Community Respiration

BIOCHEMICAL ANALYSIS

Labeo rohita

The biochemical parameter of muscle and liver were recorded on the basis of season, sex and growth (Table 15, 16).

Table 15: Seasonal variations in biochemical constituents of muscle of *Labeo rohita* (N=540)

Age-group	SM	SF	RM	RF	WM	WF
MOISTURE %						
A1	77.50±0.95	77.78±1.49	79.81±0.64	81.04±0.72	78.42±0.34	79.16±0.30
A2	76.70±0.88	77.17±1.04	78.15±0.54	78.19±0.24	77.30±0.36	77.13±0.80
A3	75.02±0.85	75.60±0.34	76.84±0.92	78.12±0.63	75.85±0.55	76.21±1.07
ASH %						
A1	1.34±0.10	1.25±0.14	1.24±0.04	1.18±0.24	1.38±0.10	1.40±0.20
A2	1.24±0.14	1.12±0.13	1.18±0.21	1.10±0.10	1.25±0.10	1.18±0.06
A3	1.09±0.20	1.02±0.07	0.92±0.05	0.82±0.03	0.95±0.05	1.10±0.03
PROTEIN %						
A1	17.25±0.75	16.82±0.92	16.04±0.88	16.44±0.18	16.14±0.79	16.27±0.65
A2	17.83±0.17	17.38±0.68	17.20±0.50	16.54±0.34	17.65±0.32	17.57±0.32
A3	18.51±0.21	17.60±0.52	17.24±0.50	16.90±0.12	17.84±0.43	17.75±0.45
LIPID %						
A1	1.17±0.03	1.23±0.18	1.08±0.05	1.08±0.05	1.14±0.06	1.20±0.09
A2	1.38±0.02	1.51±0.04	1.18±0.13	1.27±0.06	1.32±0.07	1.50±0.09
A3	2.06±0.09	2.30±0.15	1.52±0.09	1.48±0.01	1.92±0.12	2.25±0.20
FATTY ACID %						
A1	47.43±0.96	49.82±0.29	46.92±0.98	48.35±0.60	48.22±1.55	48.72±0.97
A2	50.80±0.45	50.27±0.45	49.03±0.67	49.29±0.55	50.82±1.36	51.52±0.72
A3	52.12±0.88	52.37±0.62	49.35±1.57	49.62±0.28	52.82±1.92	54.48±0.49

S= Summer, R=Rainy, W=Winter, M=Male, F=Female, A1=Young, A2=Mature, A3=Mature but adult

Muscle

Moisture:

The major component of the fish muscle was moisture. Seasonal variation of moisture in different seasons was 77.50 (summer) to 81.04(rainy) per cent, 76.70 (summer) to 78.19 (rainy) per cent, 75.02(summer) to 78.12 (rainy) percent in A1, A2, A3 group of fish respectively (Fig 20). Season wise more amount of moisture was found in the rainy season in the female fish of entire group (A1=81.04 per cent, A2=78.19 percent and A3=78.12 per cent) whereas lower value was in the summer season. On the basis of different growth categories moisture content was found to be decreased with increased age.

Ash:

The ash content was ranged from 0.92 to 1.38 percent in male and 0.82 to 1.40 percent in female fish (Fig 14). Both in male and female fish of different age categories had increasing ash content in winter whereas decreased values were observed in summer and rainy season. The ash content was in decreasing order with increasing age. Seasonal variation of ash in different seasons was 1.18 (rainy) to 1.40 (winter) per cent, 1.10 (rainy) to 1.25 (winter) percent and 0.82 (rainy) to 1.10 (winter) percent in A1, A2 and A3 respectively.

Protein:

Season wise analysis showed that in both the sexes the increased values were obtained in the summer but decreased values were in the winter and rainy season (Fig 21). The protein content was ranged from 16.04 (rainy) to 17.25 (summer) per cent, 16.54 (rainy) to 17.83 (summer) percent and 16.90 (rainy) to 18.51 (summer) percent among the age group A1, A2 and A3 respectively.

Lipid:

It was clearly observed in season wise analysis that the maximum value was obtained in the summer and minimum value was in rainy season (Fig 22).The present investigation revealed that total lipid level showed gradual increase with increase age. The lipid content of fish in different groups was varied from 1.08(rainy) to

1.23(summer) per cent, 1.18(rainy) to 1.51(summer) percent and 1.48(rainy) to 2.30 (summer) percent among the age group A1, A2 and A3 respectively.

Fatty acid:

Seasonal and sex wise analysis indicated the higher fatty acid observed in the summer and lower value in the rainy season (Fig 23). Female fish had higher amount of fatty acid in comparison to males in each group. The fatty acid in different age groups was varied from 46.92 (rainy) to 49.82 (summer) per cent, 49.29 (rainy) to 51.52 (winter) percent and 47.62 (rainy) to 52.37(summer) percent respectively.

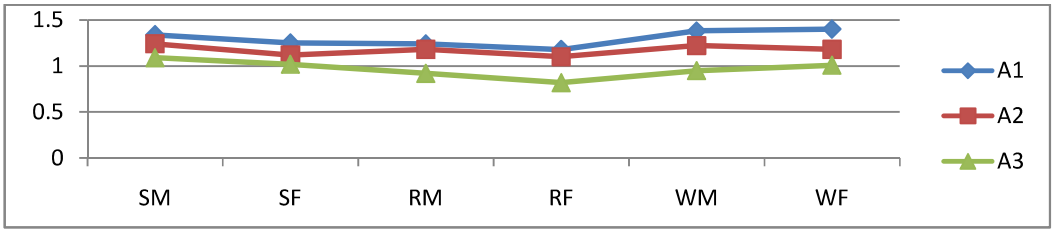


Fig 14: **Seasonal variations in ash content of muscle of *Labeo rohita***

Liver

The biochemical composition of liver tissue of *Labeo rohita* on the basis of growth, sex and season were studied seasonally (Table 16)

Table 16: Seasonal variations in biochemical constituents of liver of *Labeo rohita*

Age-group	**SM**	**SF**	**RM**	**RF**	**WM**	**WF**
MOISTURE %						
A1	72.89±0.82	73.05±0.13	73.42±0.49	73.62±0.78	72.50±0.33	72.38±0.49
A2	71.92±0.80	72.17±0.18	72.93±0.43	73.93±0.24	71.71±0.82	71.82±1.19
A3	71.38±1.12	70.80±0.54	72.10±0.78	72.74±0.51	70.03±0.44	70.54±1.05
ASH %						
A1	0.73±0.01	0.71±0.02	0.67±0.02	0.69±0.03	0.70±0.02	0.75±0.03
A2	0.69±0.03	0.65±0.03	0.60±0.01	0.61±0.01	0.61±0.01	0.65±0.06
A3	0.61±0.02	0.64±0.04	0.61±0.03	0.56±0.01	0.65±0.02	0.63±0.04
PROTEIN%						
A1	11.23±0.03	11.10±0.09	10.80±0.38	10.68±0.05	11.16±0.16	11.12±0.06
A2	11.87±0.15	11.67±0.12	11.35±0.06	11.05±0.12	11.67±0.17	11.30±0.06
A3	12.56±0.47	11.53±0.10	11.42±0.09	10.67±0.10	11.70±0.06	11.43±0.14
LIPID %						
A1	3.57±0.17	3.89±0.14	3.32±0.06	3.47±0.34	3.51±0.06	3.65±0.09
A2	3.63±0.07	4.00±0.05	3.51±0.04	3.88±0.13	3.68±0.12	4.02±0.05
A3	4.02±0.02	4.53±0.07	3.35±0.05	3.00±0.03	3.75±0.04	4.02±0.08
FATTY ACID %						
A1	52.34±0.04	55.35±0.56	50.35±0.85	52.88±0.39	53.55±0.25	54.34±0.61
A2	59.32±0.47	56.15±1.18	57.37±0.70	54.64±0.48	50.97±0.92	55.65±0.32
A3	55.50±0.30	55.95±0.35	50.60±0.60	50.69±0.40	51.58±0.75	56.71±0.23

S=Summer, R=Rainy, W=Winter, M=Male, F=Female, A1=Young, A2=Mature, A3=Mature but adult

Moisture:

Moisture content of liver of *Labeo rohita* was observed to be more in the summer and rainy season and where as decreasing values were in the winter season. Sex wise analysis revealed that female had higher value than that of male fish. In females variation was in the range of 70.54 to 73.93 percent whereas for males, it was in the range of 70.03 to 73 .42 per cent. Variation was more marked in the female in comparison to males (Fig 24).

Ash

Seasonal variation showed that higher value was in the summer and winter, but lower value was noted in rainy season (Fig 15).Variation range in mean values of ash content in different weight groups were 0.67 (rainy) to 0.75 (winter), 0.60 (rainy) to 0.69 (summer) percent and 0.56 (rain) to 0.65 (winter) percent in A1, A2 and A3 respectively.

Protein:

It was observed in both the sexes of *Labeo rohita* that maximum protein content was recorded in the winter season and minimum value in the rainy season (Fig 25). Variation range in mean values of ash content in different age groups were 10.68 (rainy) to 11.23 (summer) per cent, 11.05 (rainy) to 11.87 (summer) percent and 10.68 (rainy) to 12.56 (summer) percent among A1, A2 and A3 respectively

Lipid:

Variation ranges in mean value of lipid content in different groups were 3.32 (rainy) to 3.89 (summer) per cent, 3.51 (rainy) to 4.02 (winter) percent and 3.00 (rainy) to 4.53 (summer) in age group A1, A2 and A3 respectively (Fig 26). Seasonal variation showed that higher value was in the summer and lower value was noted in the rainy season. It was found that increased lipid content observed in the large fish (A3) whereas lower amount of lipid was in smaller size (A1).

Fatty acid:

In present investigation, the mean values were in the range of 50.35 (rainy) to 55.35 (summer) per cent, 50.97 (winter) to 59.32 (summer) and 50.60 (rainy) to 56.71 (winter) in the A, A2 and A3 respectively (Fig 27). In both the sexes the maximum value was obtained in summer whereas minimum in the rainy season. On the basis of weight, more fatty acid was found in the A2 category and least in the A1 group.

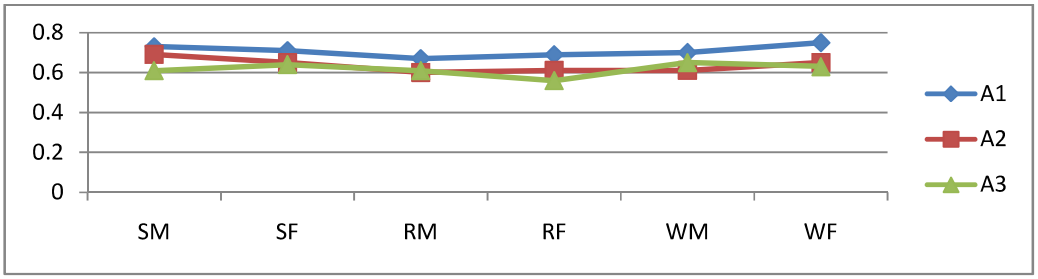


Fig 15: Seasonal variations in ash contents of liver of *Labeo rohita*

Muscle

Table 17: Seasonal variations in biochemical constituents of muscle of *Cirrhinus mrigala* (N=540)

Age group	SM	SF	RM	RF	WM	WF
MOISTURE %						
A1	78.51±0.70	78.89±0.44	79.45±0.54	80.00±0.37	78.43±0.48	77.95±0.20
A2	77.08±0.46	78.19±0.37	78.65±0.38	79.30±0.45	77.05±0.77	78.00±0.29
A3	75.63±0.38	76.98±0.21	77.46±0.53	77.40±0.50	75.40±0.45	75.51±0.36
ASH %						
A1	1.48±0.06	1.35±0.05	1.45±0.02	1.34±0.06	1.50±0.03	1.56±0.02
A2	1.35±0.10	1.38±0.08	1.31±0.03	1.25±0.02	1.37±0.01	1.31±0.06
A3	1.17±0.02	1.16±0.16	1.11±0.05	0.90±0.03	1.19±0.03	1.10±0.04
PROTEIN %						
A1	16.75±0.24	15.25±0.67	16.14±0.18	14.95±0.35	16.45±0.05	15.70±0.10
A2	17.84±0.50	16.17±0.35	17.28±0.44	16.08±0.14	17.47±0.01	16.37±0.14
A3	17.35±0.28	16.14±0.22	16.77±0.80	15.45±0.78	17.33±0.07	16.68±0.09
LIPID %						
A1	1.32±0.54	1.33±0.25	1.10±0.20	1.05±0.22	1.20±0.05	1.32±0.03
A2	1.87±0.21	2.25±0.13	1.58±0.19	2.01±0.11	1.71±0.03	1.80±0.02
A3	2.36±0.23	2.50±0.20	1.65±1.10	1.80±0.36	1.91±0.06	2.30±0.09
FATTY ACID %						
A1	55.08±0.45	55.71±0.04	50.09±0.48	51.20±0.17	55.46±0.10	56.48±0.21
A2	56.12±0.03	58.15±0.14	53.31±0.26	55.01±0.18	55.46±0.08	56.11±0.20
A3	56.35±0.04	55.68±0.10	52.10±0.16	51.31±0.08	55.09±0.22	55.82±0.31

S=Summer, R=Rainy, W=Winter, M=Male, F=Female, A1=Young, A2=Mature, A3=Mature but adult

Moisture:

The biochemical parameter of muscle of *Cirrhinus mrigala* were recorded on the basis of season, sex and growth (Table 17)

The major component of the fish muscle of *Cirrhinus mrigala* was moisture. Seasonal variation of moisture in different seasons was varied from 75.40 (winter) to 79.45 (rainy) percent in male, 75.51(winter) to 80.00 (rainy) percent in female fish. It has been shown that moisture content of *C. mrigala* increased during summer and rain whereas decreased during winter season (Fig 20). Variations of moisture content in different season were 77.95 (winter) to 80.00 (rainy) per cent, 77.05(winter) to 79.30 (rainy) percent in A1, A2 group of fish respectively. Season wise more amount of moisture was found in the rainy season in the female fish of entire group (A1=80.00 per cent, A2=79.30 percent and A3=77.46 per cent) whereas lower value was in the winter season. On the basis of different growth categories moisture content was found to be decreased with increase in age.

Ash:

The ash content was ranged from 1.11 to 1.50 percent in male and 0.90 to 1.56 percent in female fish. The more amount of ash was recovered in both the sexes in the winter season. Male had slightly more ash (1.56 per cent). Age wise analysis showed that higher value was recorded in the lower sized fish and lower value in large sized fish group. The ash content was in decreasing order with increasing age and body weight (Fig 16). Seasonal variation of ash in different seasons were 1.34 (rainy) to 1.56 (winter), 1.25 (rainy) to 1.38 (summer) percent and 0.90 (rainy) to 1.19 (winter) percent in A1, A2 and A3 group of fish respectively.

Protein:

As per season wise analysis protein content varied from 14.95 (rainy) to 17.84 (summer) per cent. Analysis of different age groups showed A2 group had higher mean value of protein content (16.68 per cent) than A1 group of fish (15.87 per cent) and A3 fish (16.62 per cent). In all the three groups, male fish had higher protein content in comparison to that of female fish (Fig 21). The range of variation of protein content were 14.95 (rainy) to16.75 (summer) per cent, 16.08 (rainy) to 17.84

(summer) percent and 15.45 (rainy) to 17.35 (summer) percent among the age group A1, A2 and A3 respectively.

Lipid:

Lipid content fluctuated from 1.10 (rain) to 2.36 (summer) percent in male and 1.05 (rain) to 2.50 (summer) percent in female fish. In both the sex minimum value was obtained in the rainy season and maximum value in summer season (Fig 22). The analysis revealed that increased lipid content was found in the female of each group of *C.mrigala* in comparison to their male counterpart. The mean values in the group A1, A2 and A3 were in the range from 1.05 (rain) to 1.33 (summer) per cent, 1.58 (rain) to 2.25 (summer) percent and 1.65 (rain) to 2.50 (summer) percent respectively.

Fatty acid:

Average seasonal value of fatty acid content in *C. mrigala* throughout the study period was varied between 50.09(rain) to 56.35(summer) percent in male with seasonal mean value 54.34 per cent. The variation in female was 51.20 (rain) to 58.15(summer) percent with seasonal mean value 55.05 per cent. In each group female fish had higher protein content than that of male. The lowest value of fatty acid in male and female fish was noticed in the rainy season but the highest value was in the summer season (Fig 23). Middle sized fish of age group A2 had higher fatty acid value than A1 and A3 irrespective of their sex. The mean values were in the range of 50.09 (rain) to 56.48 (winter) per cent, 53.31 (rain) to 58.15 (summer) percent and 51.31 (rain) to 56.35 (summer) percent in the A1, A2 and A3 age group respectively.

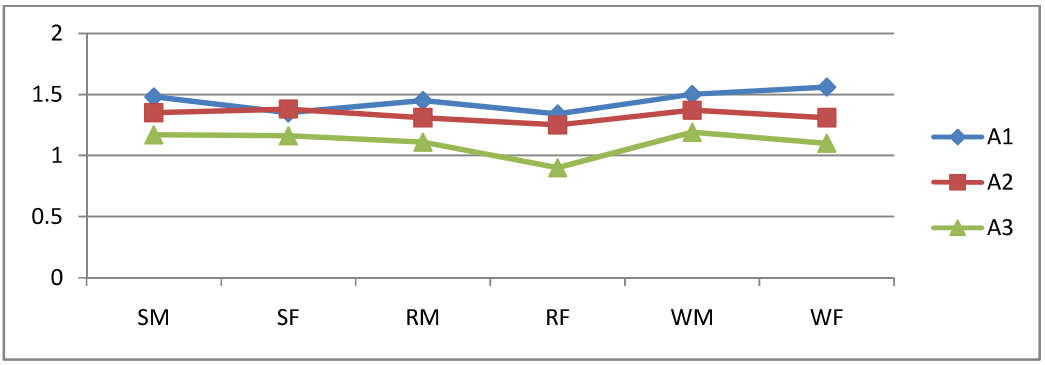


Fig 16: Seasonal variations in ash content of muscle of *Cirrhinus mrigala*

Liver

The biochemical parameter of liver of *Cirrhinus mrigala* were recorded on the basis of season, sex and growth (Table 18)

Table 18: Seasonal variations in biochemical constituents of liver of *Cirrhinus mrigala* (N=540)

Age-group	SM	SF	RM	RF	WM	WF
MOISTURE %						
A1	73.12±0.18	72.00±1.12	72.98±0.97	73.67±0.81	72.48±0.05	71.95±0.10
A2	71.40±0.09	71.93±0.34	72.70±0,39	72.75±0.46	71.50±0.08	70.85±0.11
A3	70.11±0.28	72.17±1.01	72.05±0.74	72.09±0.76	69.30±0.08	68.54±0.18
ASH %						
A1	0.73±0.03	0.71±0.01	0.70±0.01	0.66±0.01	0.71±0.01	0.69±0.02
A2	0.72±0.02	0.70±0.01	0.68±0.02	0.65±0.03	0.70±0.04	0.66±0.02
A3	0.67±0.02	0.64±0.01	0.62±0.02	0.59±0.03	0.65±0.02	0.64±0.01
PROTEIN %						
A1	11.50±0.20	11.07±0.05	10.67±0.03	10.61±0.07	11.15±0.03	11.02±0.14
A2	11.60±0.03	11.42±0.03	11.34±0.04	11.16±0.10	11.62±0.08	11.45±0.07
A3	12.03±0.03	11.45±0.08	11.47±0.10	11.01±0.37	12.06±0.07	12.23±0.04
LIPID %						
A1	3.72±0.05	4.02±0.06	3.34±0.05	3.52±0.03	3.82±0.10	3.87±0.08
A2	4.05±0.05	3.88±0.02	3.57±0.04	3.51±0.07	3.97±0.04	4.06±0.04
A3	4.10±0.15	4.47±0.08	3.51±0.06	3.00±0.10	4.23±0.05	4.26±0.02
FATTY ACID %						
A1	53.12±0.11	55.20±1.09	51.60±1.84	54.28±1.87	54.20±0.08	56.76±0.25
A2	52.54±0.15	53.81±0.62	51.65±1.29	57.27±1.66	55.82±0.16	58.71±0.03
A3	50.10±0.21	52.42±0.10	50.76±1.01	50.28±1.00	54.44±0.13	55.71±0.06

S=Summer, R=Rainy, W=Winter, M=Male, F=Female, A1=Young, A2=Mature, A3=Mature but adult.

Moisture:

Moisture was the major components of the liver. It was found that the moisture contents of liver of *Cirrhinus mrigala* in different seasons varied from 69.30 (winter) to 73.12 (summer) percent in male with seasonal mean value 71.74 per cent. The variation in female was 68.54 (winter) to 73.67 (rain) percent with mean value 71.77 per cent. Moisture content of liver was observed to be more in the summer and

rainy season and where as decreasing values were in the winter season. The size, age, sex wise analysis revealed that in smaller size group (A1) moisture content was higher (73.67 per cent) and lower in larger sized fish (68.54 per cent). Seasonal variations range were 71.95 (winter) to 73.67 (rain) per cent, 70.85 (winter) to 72.75 (rain) percent and 68.54 (winter) to 72.17 (summer) percent in A1, A2 and A3 respectively (Fig 24).

Ash

Ash content fluctuated from 0.62 (rain) to 0.73 (summer) percent with mean value 0.69 percent in male and 0.59(rain) to 0.71(summer) percent with mean value 0.66 percent in female fish. Maximum ash was recovered in both the sexes of *Cirrhinus mrigala* in summer and minimum value in rainy season. Sex wise analysis revealed that male of each age group has higher ash percentage value in comparison to female of that group (Fig 17). It was also noticed that the ash content was highest in small group (A1 group), 0.73 per cent. The seasonal variation range in mean values of ash content in different age groups were 0.66 (rain) to 0.73 (summer) per cent, 0.65 (rain) to 0.72 (summer) percent and 0.59 (rain) to 0.67 (summer) percent in A1, A2 and A3 respectively.

Protein:

It was observed that protein content of *Cirrhinus mrigala* varied from 10.67(rain) to 12.06 (winter) percent in male and 10.61(rain) to 12.23 (winter) per cent. The seasonal mean value of male (11.49 per cent) was higher than that of female (11.27 per cent). In both the sexes of *C.mrigala*, that maximum lipid content was recorded in the winter season and minimum value in the rainy season (Fig 25). Variation of range in mean values of protein content in different age groups were 10.61(rainy) to 11.50(summer) per cent, 11.16(rainy) to 11.62(winter) percent and 11.01(rainy) to 12.23(winter) percent among A1, A2 and A3 respectively

Lipid:

It was observed that the lipid content fluctuated from 3.34 (rain) to 4.23 (winter) percent in male with mean value 3.81 percent in male and 3.00 (rain) to 4.47 (summer) with mean value 3.84 per cent. Variation range in mean value of lipid content in different groups were 3.34 (rainy) to 4.02 (summer) per cent, 3.51(rainy) to

4.06 (winter) percent and 3.00 (rainy) to 4.47 (summer) in age group A1, A2 and A3 respectively. Seasonal variation showed that higher value was in the summer and winter in comparison to noted lower value in the rainy season. It was found that increased lipid content observed in the large fish (A3) whereas lower amount of lipid was in smaller size (A1) (Fig 26).

Fatty acid:

In present investigation, the mean values were in the range of 51.60 (rainy) to 56.76 (winter) per cent, 51.65 (rain) to 58.71 (winter) and 50.28 (rainy) to 55.71(winter) in the A1, A2 and A3 respectively. Female fish in each group had higher fatty acid content than their male counterpart. It was varied between 50.10(rain) to 55.82(winter) percent with mean value 52.69 percent in male and 50.28(rain) to 58.71(winter) percent with mean value 54.92 percent in their female counter parts. In both the sexes the maximum value was obtained in winter whereas minimum in the rainy season. On the basis of weight and age, more fatty acid was found in the medium sized or A2 category and least in the A3 group (Fig 27).

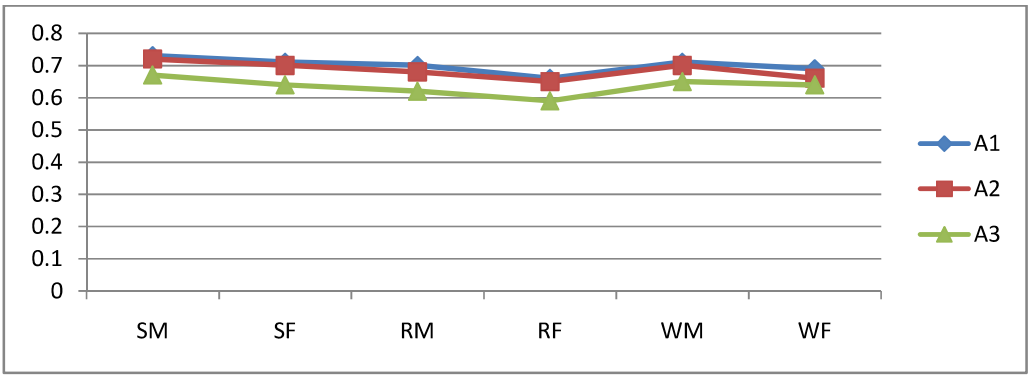


Fig 17: Seasonal variations in ash content of liver of *Cirrhinus mrigala*

Catla catla

Muscle

The biochemical parameter of muscle of *Catla catla* were recorded on the basis of season, sex and growth (Table 19)

Table 19: Seasonal variations in biochemical constituents of muscle of *Catla catla* (N=540)

Age-group	SM	SF	RM	RF	WM	WF
MOISTURE %						
A1	77.28±1.10	77.78±1.49	78.80±1.22	79.58±0.87	78.21±0.64	78.31±0.38
A2	76.70±0.88	77.17±1.04	77.01±1.24	77.60±1.21	76.90±0.40	76.50±1.08
A3	75.02±0.85	75.60±0.34	75.59±1.14	76.68±1.33	74.86±0.68	74.90±0.82
ASH %						
A1	1.39±0.07	1.36±0.07	1.37±0.02	1.20±0.01	1.40±0.04	1.30±0.03
A2	1.35±0.15	1.29±0.11	1.31±0.03	1.17±0.05	1.35±0.04	1.38±0.05
A3	1.28±0.03	1.18±0.19	1.11±0.03	0.95±0.02	1.14±0.06	1.21±0.06
PROTEIN %						
A1	16.78±0.25	15.31±0.73	16.19±0.19	15.11±0.43	16.32±0.30	16.72±0.66
A2	17.75±0.43	16.32±0.43	17.35±0.50	16.09±0.14	17.49±0.30	16.81±0.37
A3	17.45±0.35	16.17±0.24	16.72±0.83	15.21±0.82	17.72±0.20	16.89±0.42
LIPID %						
A1	1.40±0.56	1.51±0.24	1.09±0.21	1.08±0.24	1.26±0.09	1.42±0.12
A2	1.90±0.22	2.28±0.15	1.80±0.24	1.78±0.10	1.83±0.08	1.92±0.32
A3	2.39 ±0.28	2.53±0.20	1.71±0.13	1.64±0.37	2.08±0.20	2.52±0.19
FATTY ACID %						
A1	52.93±1.24	55.61±1.64	51.62±1.88	54.32±1.92	54.82±2.02	55.03±1.02
A2	57.02±1.56	58.62±1.54	56.72±1.33	57.30±1.67	54.41±1.61	55.72±0.48
A3	56.98±1.10	59.78±1.28	50.82±1.08	50.31±1.02	56.72±1.67	57.08±0.65

S=Summer,R=Rainy,W=Winter,M=Male,F=Female,A1=Young,A2=Mature,A3=Mature but adult

Muscle

Moisture:

The major component of the fish muscle was moisture. Seasonal variation moisture of muscle of *Catla catla* in different seasons was 77.28 (summer) to 79.58 (rainy) per cent, 76.50 (winter) to 77.60 (rainy) percent and 74.86 (winter) to 76.68 (rain) in A1, A2, A3 group of fish respectively. It has been shown that moisture content of *Catla catla* increased during summer and rain whereas decreased during

winter season. Season wise more amount of moisture was found in the rainy season in the female fish of entire group (A1=79.58 per cent, A2=77.60 percent and A3=76.68 per cent) and lower value in the winter season. On the basis of different growth categories moisture content was found to be decreased with increase in age (Fig 20).

Ash:

The ash content of muscie of *Catla catla* was ranged from 1.11(rainy) to 1.40(winter) percent in male with seasonal mean 1.30 percent and 0.95(rainy) to 1.38(winter) percent in female fish with the mean value 1.23 per cent. The more amount of ash was recovered in both the sexes in the winter season. Both the sexes of fish of different age categories had increased ash content in winter and summer and decreased values in rainy season. The ash content was in decreasing order with increasing age and body weight. Seasonal variation of ash in different seasons were 1.20(rainy) to 1.40(winter), 1.17(rainy) to 1.38 (winter) percent and 0.95(rainy) to 1.28 (summer) percent in A1, A2 and A3 group of fish respectively (Fig 18).

Protein:

It is observed that protein content of *Catla catla* varied from 15.11 (rainy) to 17.75 (summer) per cent. Sex wise protein content varied from 16.19(rain) to 17.75 (summer) percent in male with mean value 17.08 percent and 15.11 (rain) to 16.89 (winter) percent in female fish with mean value 16.07 per cent. Analysis of different age group showed A2 group had higher mean value of protein content (16.97 per cent) than A1 group of fish (16.07 per cent) and A3 fish (16.69 per cent). In all the three groups, male fish had higher protein content than the female fish. The range of variation of protein content were 15.11 (rainy) to 16.78 (summer) per cent, 16.09 (rainy) to 17.75 (summer) percent and 15.21 (rainy) to 17.72 (winter) percent among the age group A1, A2 and A3 respectively (Fig 21).

Lipid:

Lipid content fluctuated from 1.08 (rain) to 2.39 (summer) percent in male and 1.08 (rain) to 2.53 (summer) percent in female fish. In both the sex, minimum value was obtained in the rainy season and maximum value in summer season (Fig 22). The analysis revealed that increased lipid content was found in the female of each group of *Catla catla* in comparison to their male counterpart. The mean values in the group A1,

A2 and A3 were in the range from 1.08 (rain) to 1.51 (summer) per cent, 1.78 (rain) to 2.28 (summer) percent and 1.64 (rain) to 2.53 (summer) percent respectively.

Fatty acid:

Average seasonal value of fatty acid content in *Catla catla* throughout the study period was varied between 50.82 (rain) to 57.02 (summer) percent in male with seasonal mean value 54.67 per cent. The variation in female was 50.31 (rain) to 59.78 (summer) percent with seasonal mean value 55.97 per cent. In each group female fish had higher protein content than that of male. The lowest value of fatty acid in male and female fish was noticed in the rainy season but the highest value was in the summer season (Fig 23). Middle sized fish of age group A2 had higher fatty acid value than A1 and A3 irrespective of their sex. The mean values were in the range of 51.62. (rain) to 55.61 (summer) per cent, 54.41 (winter) to 58.62 (summer) percent and 50.31 (rain) to 59.78 (summer) percent in the A1, A2 and A3 age group respectively.

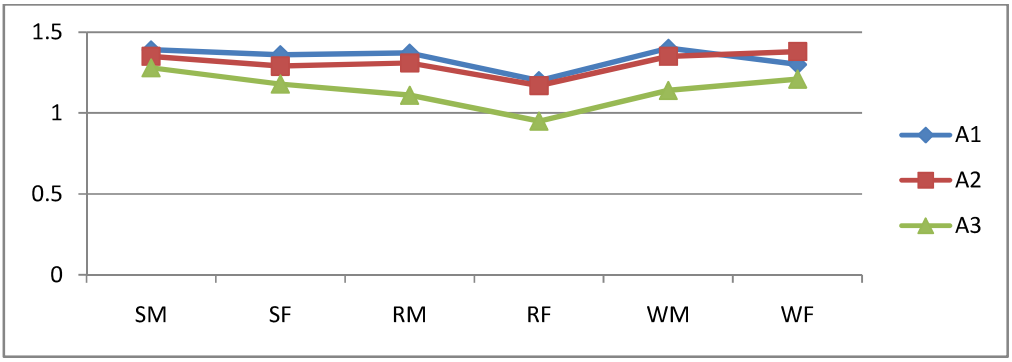


Fig 18: Seasonal variations in ash content of muscle of *Catla catla*

Liver

The biochemical parameters of liver of *Catla catla* were recorded on the basis of season, sex and growth (Table 20).

Table 20: Seasonal variations in biochemical constituents of liver of *Catla catla* (N=540)

Age	SM	SF	RM	RF	WM	WF
MOISTURE %						
A1	72.78±0.58	71.96±1.11	73.70±1.02	73.67±0.81	73.60±1.10	73.20±1.36
A2	71.47±1.10	71.90±0.32	72.75±0.46	72.95±0.22	71.80±0.90	71.60±1.07
A3	70.27±1.03	71.12±1.01	72.11±0.77	72.74±0.51	68.97±0.74	69.70±0.85
ASH %						
A1	0.73±0.02	0.72±0.02	0.71±0.01	0.67±0.02	0.71±0.02	0.68±0.03
A2	0.71±0.01	0.70±0.01	0.67±0.02	0.66±0.03	0.65±0.04	0.67±0.04
A3	0.66±0.01	0.64±0.01	0.63±0.02	0.57±0.03	0.67±0.02	0.65±0.03
PROTEIN %						
A1	11.04±0.41	10.90±0.21	10.56±0.31	10.35±0.26	11.15±0.23	11.11±0.21
A2	11.78±0.33	11.46±0.40	11.26±0.26	11.06±0.32	11.67±0.30	11.34±0.20
A3	12.16±0.31	12.03±0.26	11.43±0.38	10.92±0.45	12.01±0.31	11.93±0.38
LIPID %						
A1	3.51±0.53	3.62±0.27	3.21±0.20	3.28±0.20	3.72±0.32	3.89±0.16
A2	4.02±0.25	4.36±0.13	3.67±0.21	4.10±0.10	4.08±0.23	4.27±0.30
A3	4.47±0.26	4.63±0.20	3.82±0.13	3.20±0.35	4.31±0.20	4.38±0.22
FATTY ACID %						
A1	52.96±1.22	56.58±1.63	51.62±1.87	54.28±1.88	54.55±0.74	56.32±3.80
A2	58.04±0.56	59.62±0.54	56.67±1.30	57.28±1.66	53.68±1.20	55.56±1.53
A3	57.93±1.05	59.71±1.22	50.78±1.00	50.28±1.00	52.28±0.80	56.57±0.91

S=Summer, R=Rainy, W=Winter, M=Male, F=Female, A1=Young, A2=Mature, A3=Mature but adult.

Moisture

It was observed that the value of moisture content was varied from 68.67 (winter) to 73.70 (rain) percent in male and 69.70 (winter) to 73.67 (rain) percent in female *Catla catla.* In both the sex percentage of moisture content increased during summer and rainy whereas decreased in winter. Season wise more amount of moisture was found in the rainy season in the female of entire group (A1= 73.67, A2=72.95 and

A3=72.74per cent) and lower value in summer. Seasonal variation of moisture in different seasons was 71.96 (summer) to 73.70(rain), 71.47(summer) to 72.95 (rain) and 68.97 (winter) to 72.74 (rain) percent in A1, A2and A3 group of fish respectively. The total moisture content showed a gradual decrease with increase weight (Fig 24).

Ash:

The ash content was ranged from 0.63 (rain) to 0.73 (summer) percent in male and 0.57 (rain) to 0.72 (summer) percent in female fish. Male have slightly more ash content (0.68 per cent) than the female (0.66 per cent). It was observed that moisture content increased during summer season and decreased during rain and winter. The ash content in *Catla catla* was in decreasing order with increasing age and body weight. Seasonal variation of ash in different age groups varied from 0.67 (rain) to 0.73 (summer) per cent, 0.65 (winter) to 0.71 (summer) percent and 0.57(rain) to 0.67 l (winter) percent in A1, A2 and A3 respectively. Season wise more amount of ash was found in summer season (Fig 19).

Protein:

It is observed that protein content varied from 10.35(rainy) to 12.16(summer) per cent. Sex wise protein content varied from 10.56(rain) to 12.16summer) percent in male with mean value 11.45 percent and 10.35(rain) to 12.03 (winter) with mean value 11.23 per cent. Analysis of different age group showed A3 group had higher mean value of protein content (11.75 per cent) than A1 group of fish (10.85 per cent) and A2 fish (11.43 per cent). In all the three groups, male fish had higher protein content in comparison to that of female fish. The range of variation of protein content were 10.35 (rainy) to 11.15(winter) percent , 11.06(rainy) to 11.78(summer) percent and 10.92(rainy) to 12.16 (summer) percent among the age group A1, A2 and A3 respectively (Fig 25).

Lipid:

As per analysis lipid content fluctuated from 3.21(rain) to 4.47(summer) percent in male with mean value 3.87 percent and 3.20(rain) to 4.63(summer) percent in female fish with mean value 3.96 per cent. So female had slightly more lipid content than their male counterpart. It was clearly observed in season wise analysis that the maximum value was obtained in the summer and minimum value was in rainy

season (Fig 26). The present investigation revealed that mean lipid value of age group A1, A2 and A3 were 3.52, 4.08 and 4.14 percent respectively showing gradual increase with increase of age. The mean value of lipid content of fish in different groups A1, A2 and A3 were in the range 3.21(rainy) to 3.89(winter) per cent, 3.67(rainy) to 4.36 (summer) percent and 3.20 (rainy) to 4.47 (summer) percent respectively.

Fatty acid:

In present investigation, the mean values were in the range of 54.28 (rainy) to 56.58 (summer) per cent, 53.68 (winter) to 59.62 (summer) and 50.28 (rainy) to 59.71(winter) in the A1, A2 and A3 respectively. In both the sexes the maximum value was obtained in summer whereas minimum in the rainy season. As per sex wise analysis, fatty acid content was from 50.78 (rain) to 58.04 (summer) percent in male fish with mean value 54.28 percent and 50.28 (rain) to 59.71 (summer) in females with mean value 56.24 percent (Fig 27). On the basis of age and body weight, more fatty acid was found in the A2 category (54.61 per cent) than A3 category (54.59 per cent) and least in the A1 group (54.38 per cent).

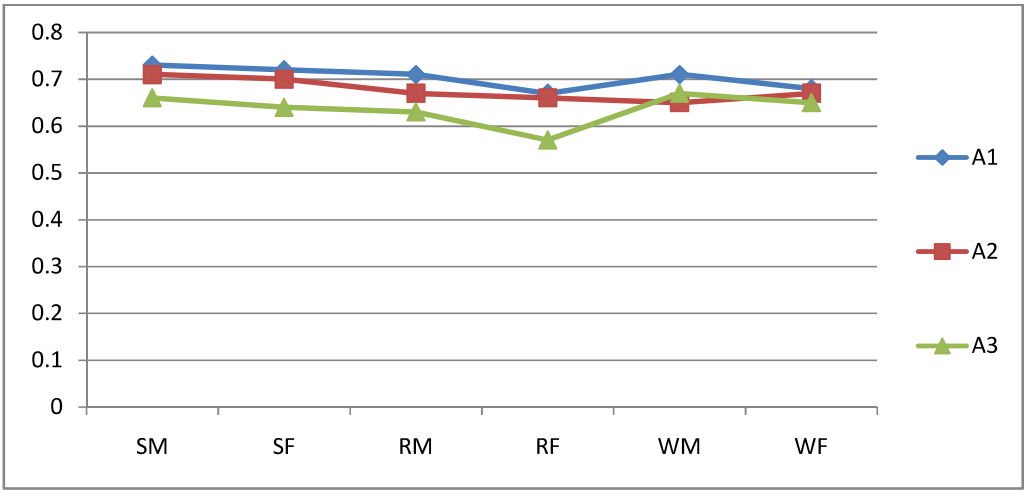


Fig 19: Seasonal variations in ash content of liver of *Catla catla*

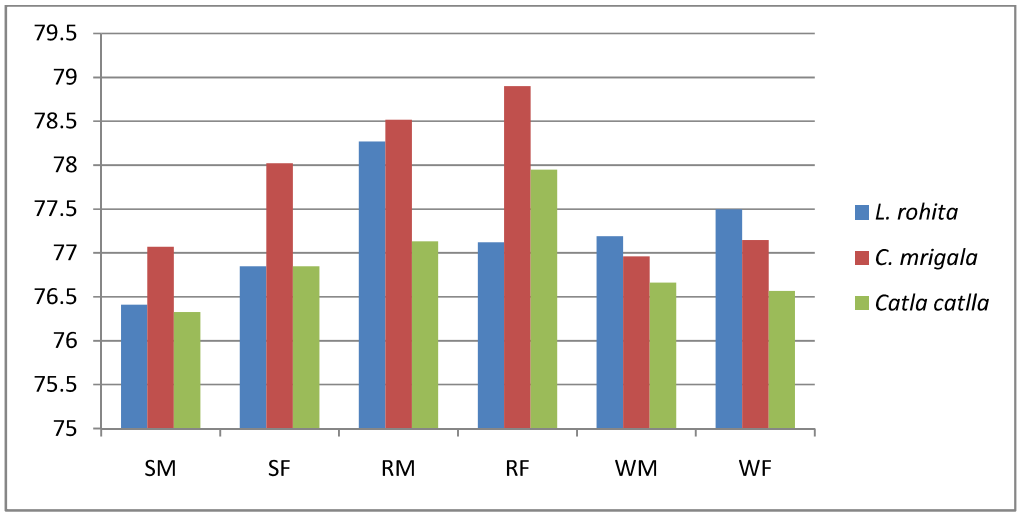


Fig 20: Seasonal variations in moisture content of muscle of the three species of Indian major carps (S- summer, R- Rainy, W- winter, M- male, F- Female)

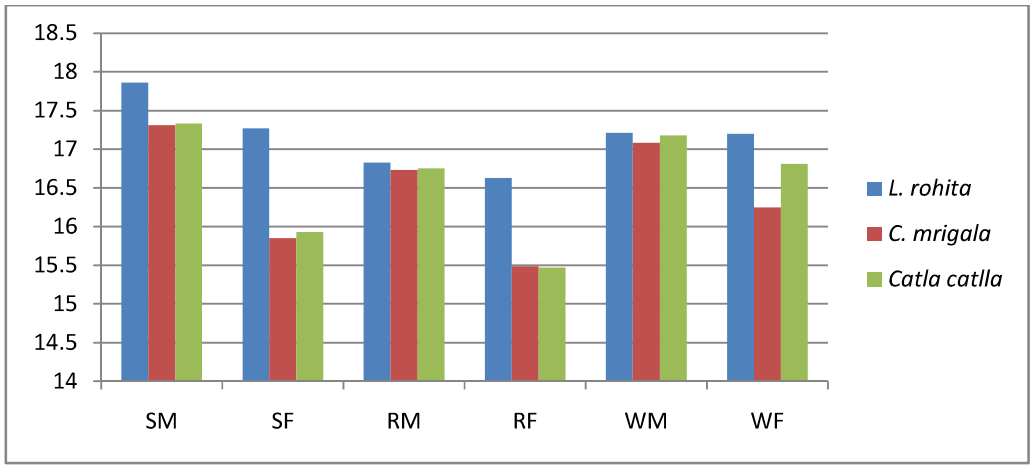


Fig 21: Seasonal variations in protein content of muscle of the three species of Indian major carps (S- summer, R- Rainy, W- winter, M- male, F- Female)

Fig 22: Seasonal variations in lipid content of muscle of the three species of Indian major carps (S- summer, R- Rainy, W- winter, M- male, F- Female)

Fig 23: Seasonal variations in fatty acid content of muscle of the three species of Indian major carps (S- summer, R- Rainy, W- winter, M- male, F- Female)

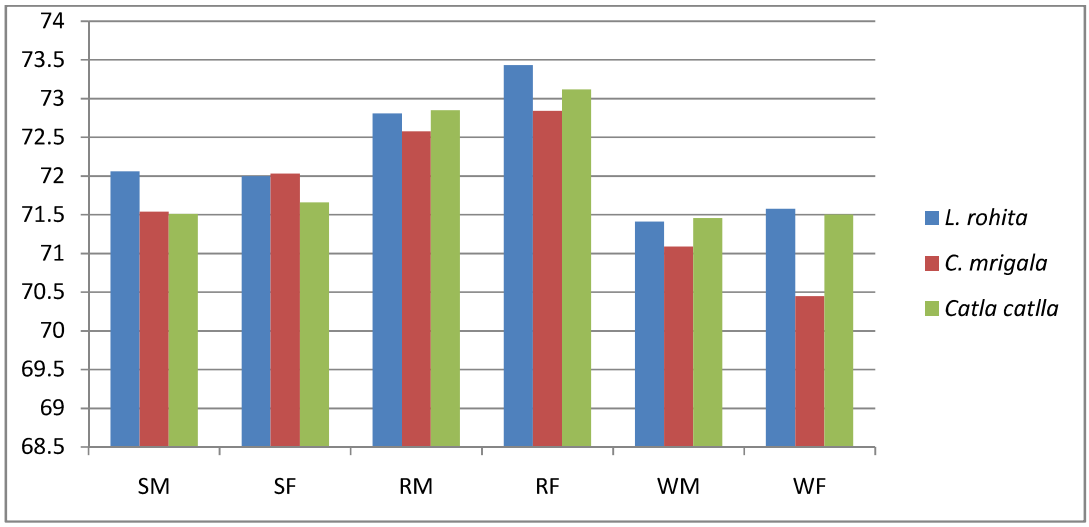


Fig 24: Seasonal variations in moisture content of liver of the three species of Indian major carps (S- summer, R- Rainy, W- winter, M- male, F- Female)

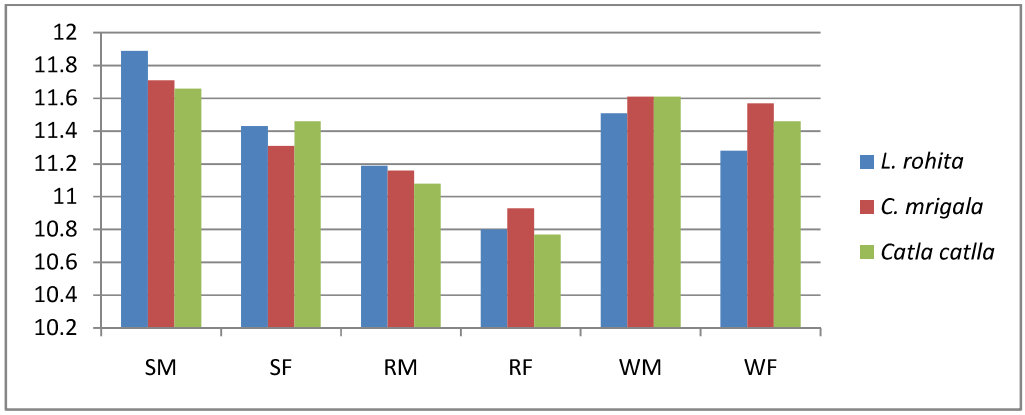


Fig 25: Seasonal variations in protein content of liver of the three species of Indian major carps (S- summer, R- Rainy, W- winter, M- male, F- Female)

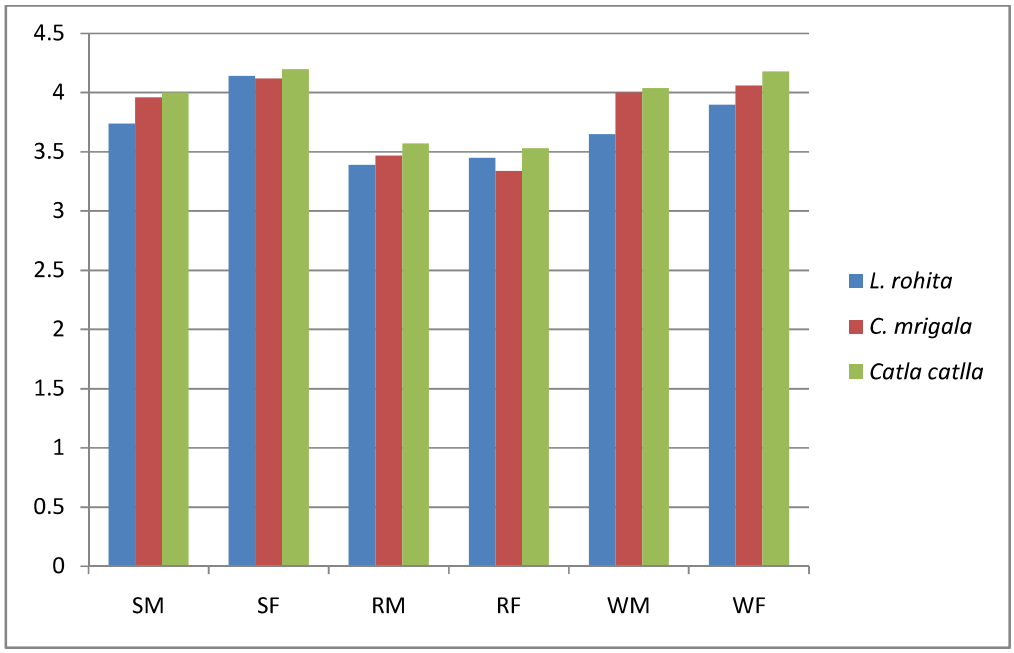


Fig 26: Seasonal variations in lipid content of liver of the three species of Indian major carps (S- summer, R- Rainy, W- winter, M- male, F- Female)

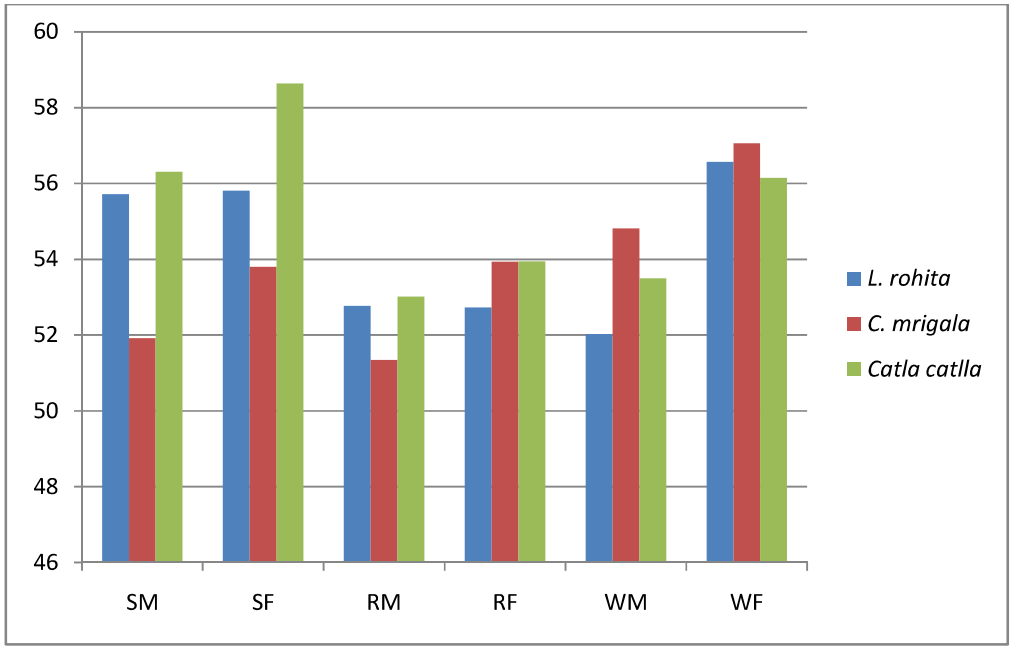


Fig 27: Seasonal variations in fatty acid content of liver of the three species of Indian major carps (S- summer, R- Rainy, W- winter, M- male, F- Female)

MORPHOMETRIC FEATURES

The morphometric features like total length, standard length and biological parameters were measured and determined following the standardized protocols Various biometric factors and anatomical factors and biological parameters were measured and recorded for further statistics. All the biometric, anatomical and biological factors were recorded and calculated. Anatomical findings were revealed in Plate: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18 and 19.

Plate 1: Morphological study

Plate 2: *Labeo rohita* (**Hamilton**)

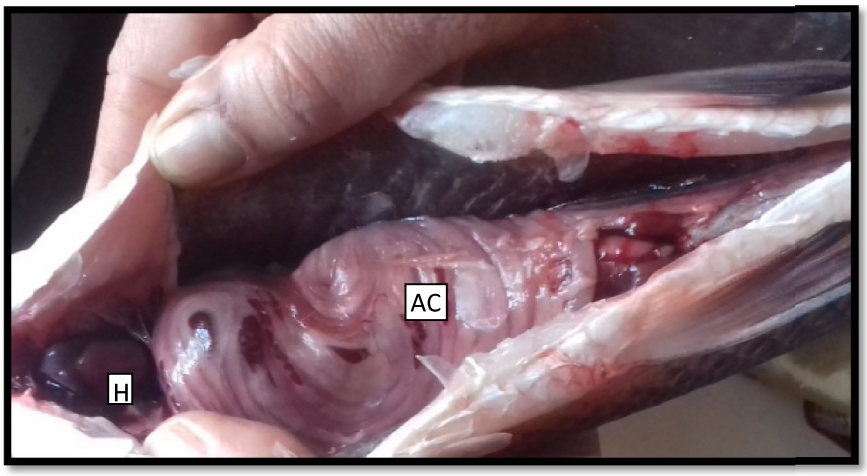


Plate 3: Anatomical display of *Labeo rohita* (**Hamilton**)

H=Heart, AC= Alimentary canal

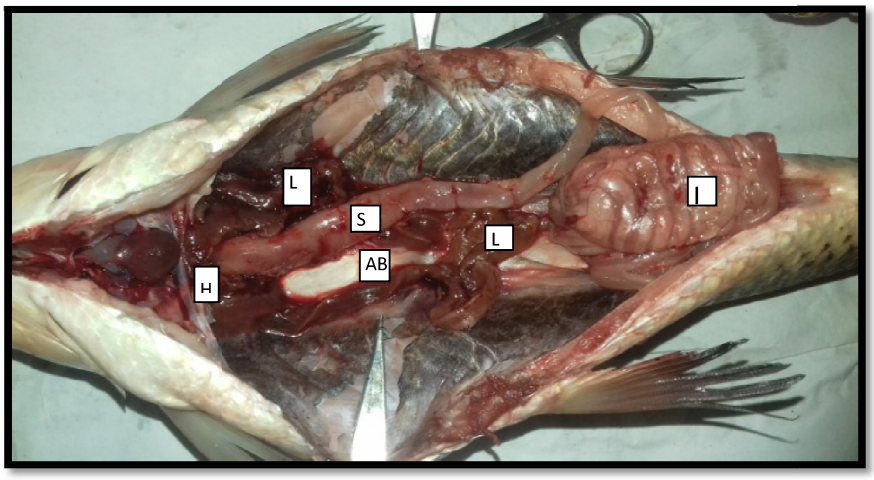


Plate 4: Anatomical display of *Labeo rohita* (male) (**Hamilton**)

H=Heart, L=Liver, S=stomach, I=Intestine, AB= Air bladder

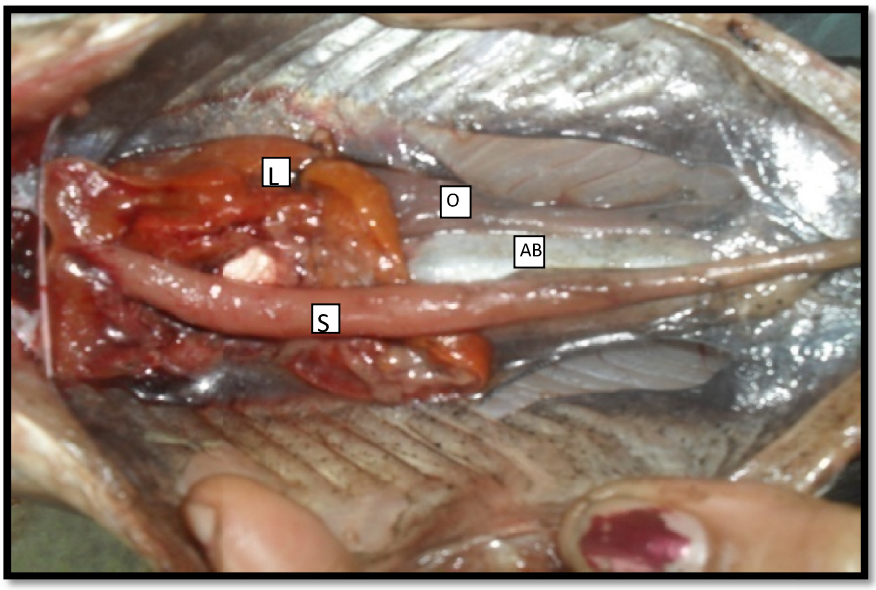


Plate 5: Anatomical display of *Labeo rohita* (female) (**Hamilton)**

H=Heart,L=Liver,S=Stomach,O-Ovary,AB=Airbladder

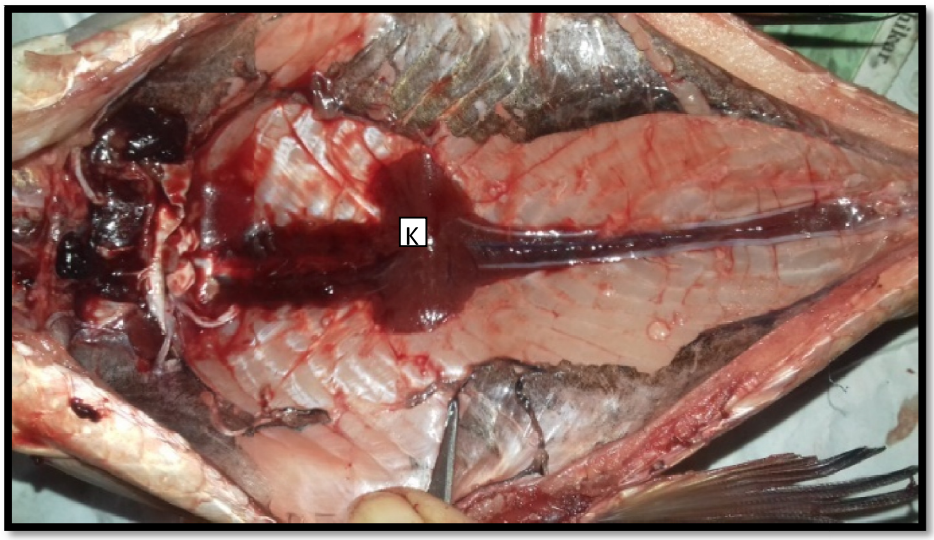
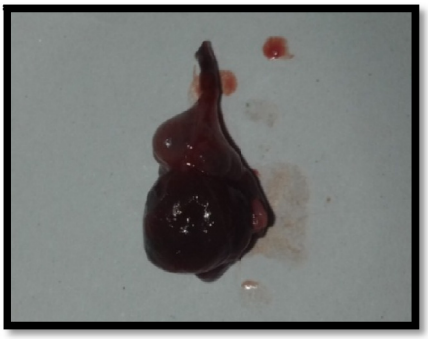


Plate 6: Anatomical display of *Labeo rohita* (**Hamilton**)

K=Kidney



Heart

Liver

Stomach

Kidney

Gonads (Testes in pair)

Plate 7: Anatomical display of *Labeo rohita* (male) (**Hamilton**)

Plate 8: *Cirrhinus mrigala* **(Hemilton)**

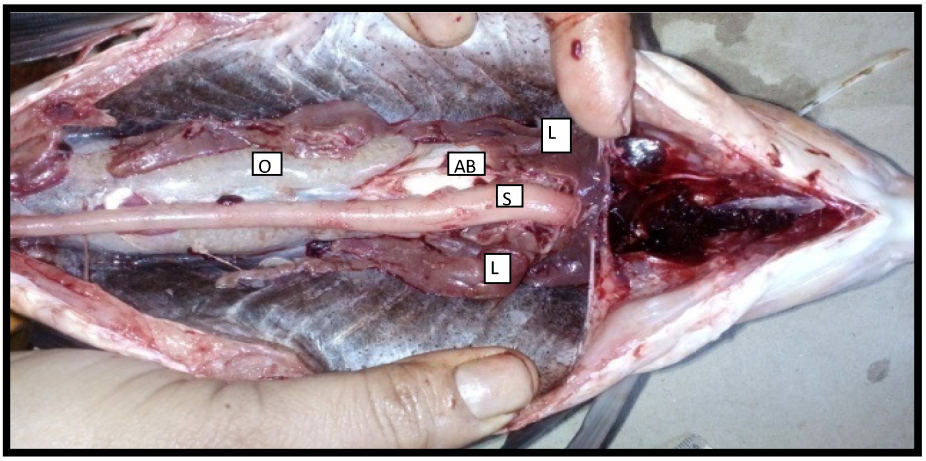


Plate 9: Anatomical display of *Cirrhinus mrigala* (female) **(Hemilton)**

H=Heart, L=Liver, S=stomach, I=Intestine, AB= Air bladder, O=Ovary

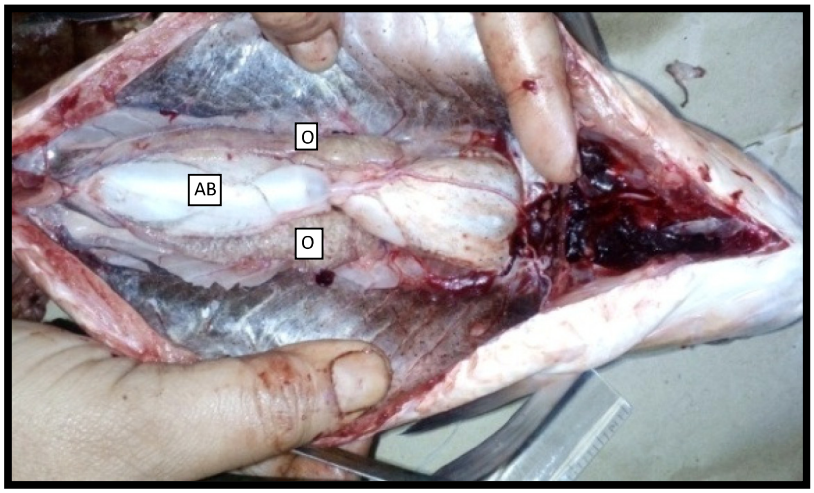


Plate 10: Anatomical display of *Cirrhinus mrigala* (female) **(Hemilton)**

AB= Air bladder, O=Ovary

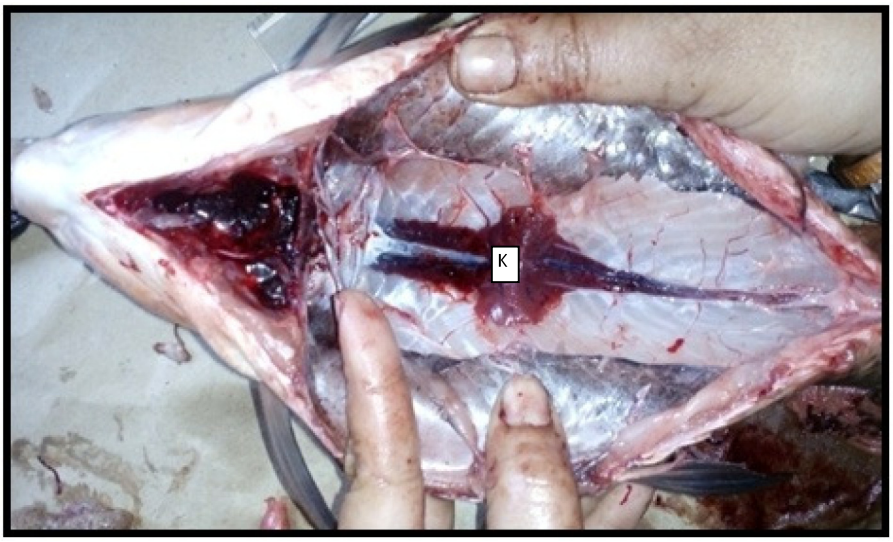


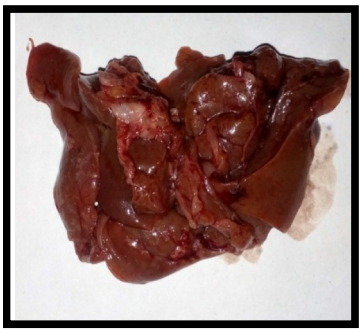
Plate 11: Anatomical display of *Cirrhinus mrigala* (female) **(Hemilton)**

K=Kidney

Stomach

Kidney

Heart



Liver

Air bladder

Ovary

Plate 12: Anatomical display of *Cirrhinus mrigala* (female) **(Hemilton)**

Plate 13: *Catla catla* (**Hamilton)**

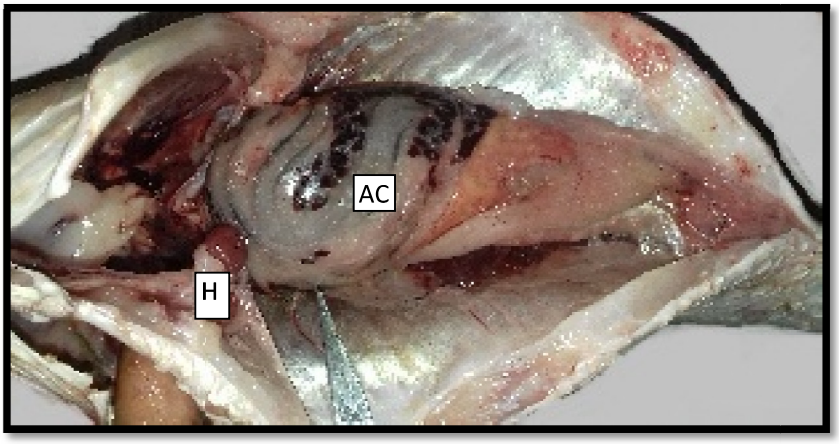


Plate 14: Anatomical display of *Catla catla* (**Hamilton**)

H=Heart, AC= Alimentary canal

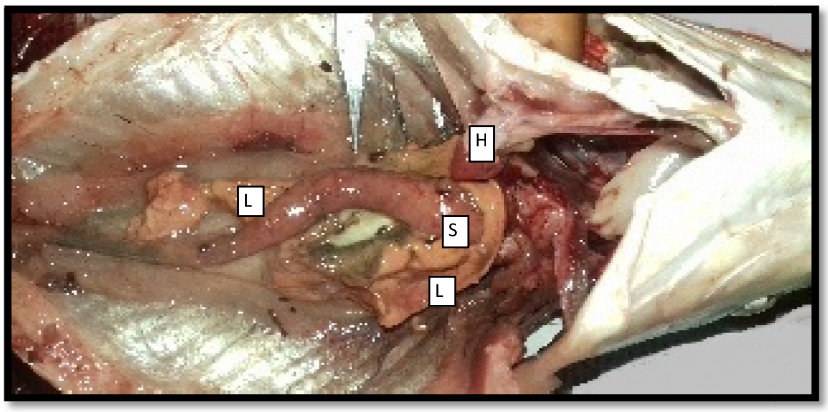


Plate 15: Anatomical display of *Catla catla* (male) **(Hemilton)**

H=Heart, L=Liver, S=stomach

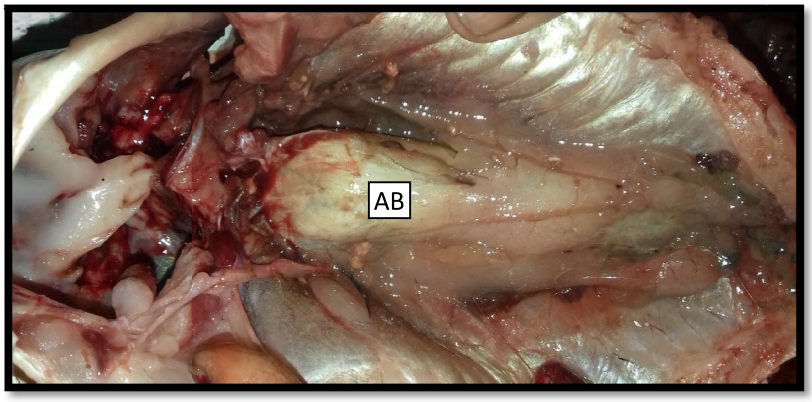


Plate 16: Anatomical display of *Catla catla* (male)**(Hemilton)**

AB= Air bladder

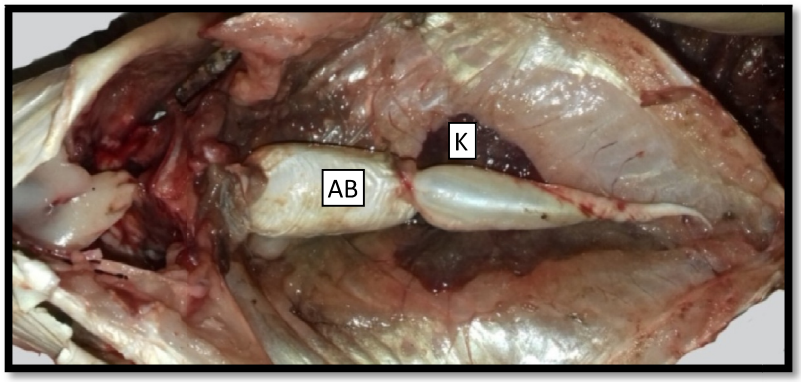


Plate 17: Anatomical display of *Catla catla* (male) **(Hemilton)**

AB= Air bladder. K=Kidney

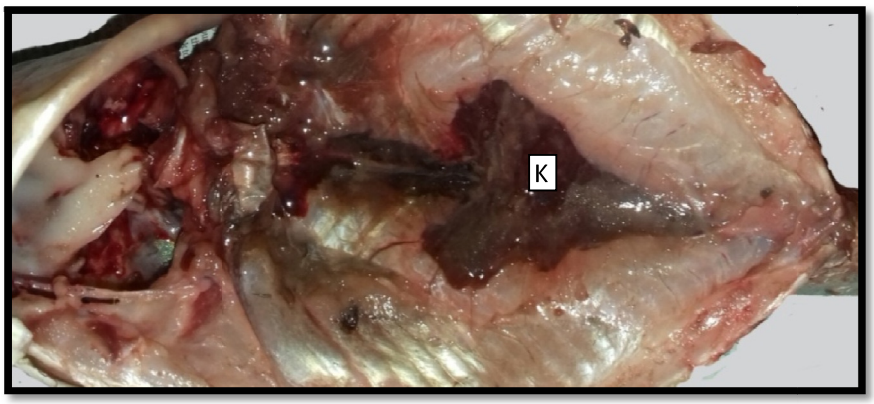


Plate 18 : Anatomical display of *Catla catla* (male) **(Hemilton)**

K=Kidney

Heart

Liver

Stomach

Kidney

Testes (pair)

Air bladder

Plate 19: Anatomical display of *Catla catla* (male) **(Hemilton)**

Statistical analysis of ANOVA of one way classification of biometric traits of Indian major carps

Table 21: Mean ± SE of biometric traits (BW, TL and SL) of Indian major carps (N=540)

Sl No	Factors	Sub factors	BW(g)	TL (cm)	SL (cm)
1	Overall		467.78±8.06	35.79±0.21	27.43±0.18
2	Season	Summer	446.81±12.92	35.52±0.34	27.15±0.27
		Rainy	478.17±14.27	35.56±0.36	27.23±0.28
		Winter	478.37±14.62	36.28±0.40	27.90±0.36
3	Species	L.rohita	445.08^{a}±14.14	34.68^{a}±0.34	26.76^{a}±0.27
		C.mrigala	453.42^{a}±15.02	36.47^{b}±0.42	28.26^{b}±0.36
		C.catla	504.85^{b}±12.28	36.21^{b}±0.32	27.27^{ab}±0.28
4	Age group	A1	263.22^{a}±4.41	30.33^{a}±0.12	22.94^{a}±0.09
		A2	449.57^{b}±5.56	35.83^{b}±0.16	27.54^{b}±0.12
		A3	689.23^{c}±5.16	41.17^{c}±0.20	31.78^{c}±0.20
5	**Sex**	M	469.59±11.75	35.78±0.32	27.50±0.27
		F	465.97±11.08	35.79±0.28	27.35±0.23

*Means with different superscripts differ significantly ($p \leq 0.05$) within a column under a factor, BW-Body weight, Tl – Total length and SL – Standard length

The average weight, body length and standard length of all carps under study were recorded in the Table 21 as 467.78±8.06 g, 35.79±0.21 and 27.43±0.18 cm, respectively. The body weight of the carps raised under summer, rainy and winter season were 446.81±12.92, 478.17±14.27 and 478.37±14.62 g, respectively without any significant difference among those. Similarly the total length and standard length recorded in summer, rainy and winter season were 35.52±0.34, 35.56±0.36, 36.28±0.40; and 27.15±0.27, 27.23±0.28, 27.90±0.36 cm respectively without any

significant difference among those (Fig 28). As per the species is concerned ,the body weight of three carps *L.rohita, C.mrigala* and *Catla catla* were recorded 445.08±14.14, 453.42±15.02 and 504.85±12.28 g, respectively having no significant difference among the first two species, but both of them are strongly related to third one separately. However, the total length of of three carps *L.rohita, C.mrigala* and *Catla catla* recorded were 34.68±0.34, 36.47±0.42 and 36.21±0.32cm, respectively with significant difference of *L.rohita* with *C.mrigala* and *C.catla* separately, but there is no significant difference between *C.mrigala* and *C.catla*. At the same time, standard length were 26.76±0.27, 28.26±0.36, 27.27±0.28cm, respectively with significant difference between *L.rohita and C.mrigala,* but each of them showed no significant difference with *Catla catla* (Fig 29). Growth wise in different age groups, the carps under investigation had the body weight, total length and standard length recorded were 263.22±4.41, 449.57±5.56, 689.23±5.16g; 30.33±0.12, 35.83±0.16, 41.17±0.20 cm; and 22.94±0.09, 27.54±0.12, 31.78±0.20 cm respectively , with significant difference among those (Fig 30). However, as per the sex is concerned in the experimental major carps body weight, total length and standard length were recorded 469.59±11.75, 465.97±11.08; 35.78±0.32, 35.79±0.28; and 27.50±0.27, 27.35±0.23 cm respectively, without any visible significant difference (Fig.31).

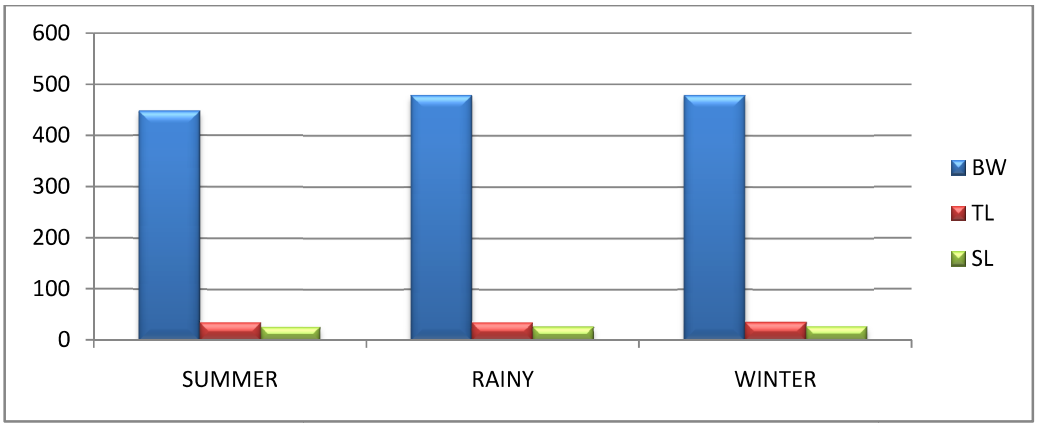


Fig 28: Season wise biometric traits (BW, TL and SL) of Indian major carps

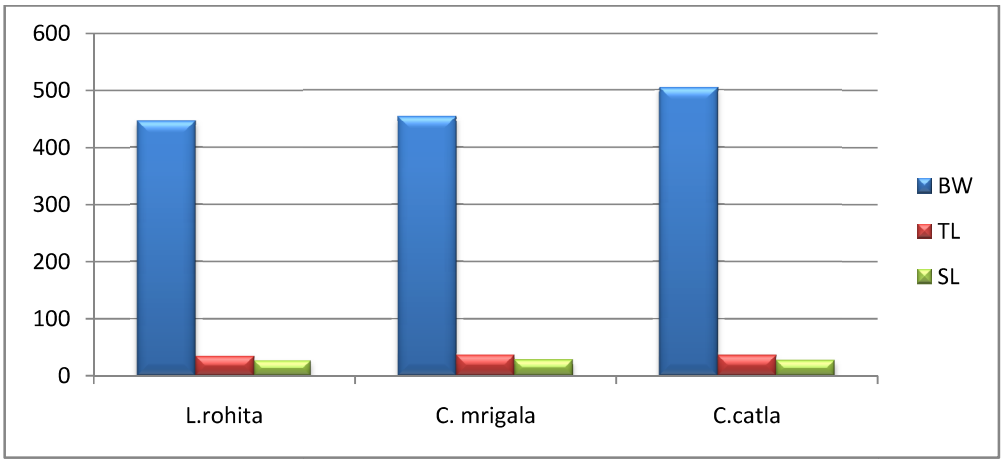


Fig 29: Species wise biometric traits (BW, TL and SL) of Indian major carps

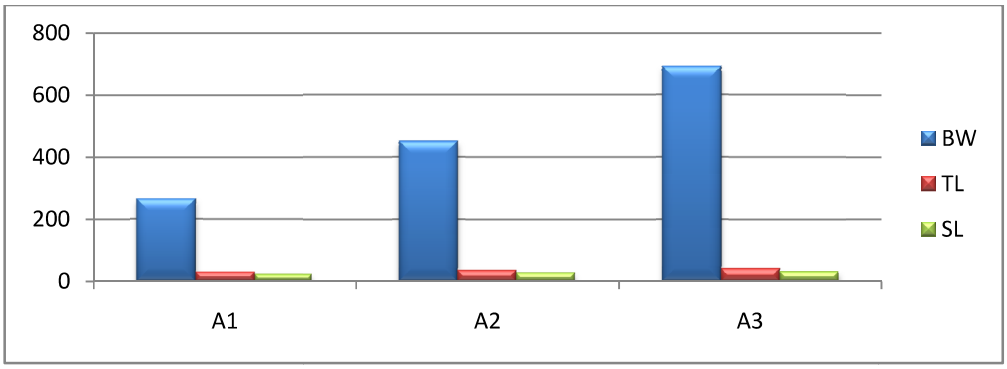


Fig 30: Age wise biometric traits (BW, TL and SL) of Indian major carps

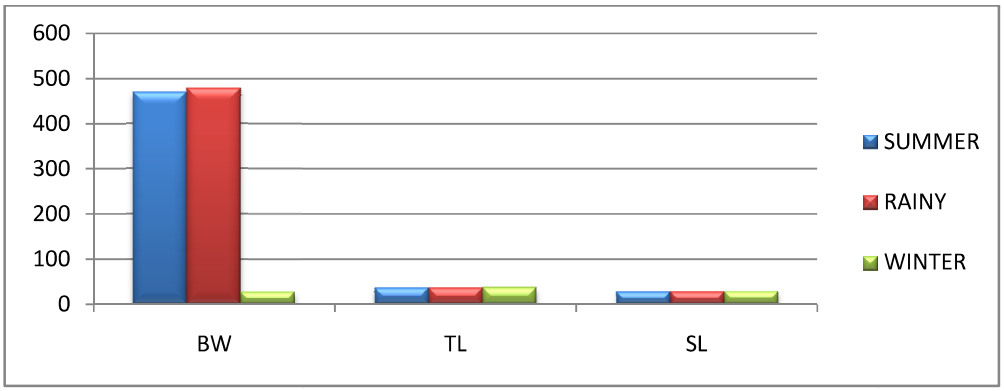


Fig 31: Sex wise biometric traits (BW, TL and SL) of Indian major carps

Table 22: Mean ± SE of biometric traits (LHF1, LAF1, LFCP) of Indian major carps (N=540)

Sl No	Factors		LHF1(cm)	LAF1(cm)	LF1CP(cm)
1	Overall(mean)		13.17±0.83	6.47±0.05	7.80±0.08
2	Season	Summer	12.88^{a}±0.13	6.39±0.08	7.87±0.13
		Rainy	13.23^{ab}±0.15	6.46±0.07	7.58±0.14
		Winter	13.40^{b}±0.15	6.57±0.082	7.95±0.16
3	Species	*L. rohita*	12.72^{a}±0.13	6.08^{a}±0.07	7.96^{a}±0.09
		C. mrigala	13.40^{b}±0.17	6.09^{a}±0.08	8.78^{b}±0.15
		C.catla	13.38^{b}±0.10	7.25^{b}±0.06	6.66^{c}±0.14
4	Age group	A1	11.16^{a}±0.06	5.58^{a}±0.58	6.20^{a}±0.08
		A2	13.31^{b}±0.07	6.57^{b}±0.07	7.68^{b}±0.10
		A3	15.03^{c}±0.10	7.27^{c}±0.06	9.50^{c}±0.13
5	S	M	13.16±0.12	6.47±0.07	7.81±0.12
		F	13.18±0.11	6.47±0.06	7.79±0.12

*Means with different superscripts differ significantly($p \leq 0.05$) within a column under a factor, LHF1: Length from head end to base of dorsal fin, LAF1–Length of area of dorsal fin , LF1CP - Length from the end of dorsal fin to caudal peduncle .

The average Length from head end to base of dorsal fin(LHF1), length of area of dorsal fin(LAF1),length from the end of dorsal fin to caudal peduncle (LF1CP) of all carps under study were recorded as 13.17±0.83, 6.47±0.05and 7.80±0.08cm in Table 22 respectively. The length from head end to base of dorsal fin (LHF1) of the carps raised under summer, rainy and winter season were 12.88±0.13, 13.23±0.15and 13.40±0.15 cm, respectively with striking significant difference between summer and winter season and also there was no significant difference of both these seasons with corresponding values of rainy season and without any significance in summer and winter with that in rainy season. But season wise mean recorded for length of area of dorsal fin(LAF1),length from the end of dorsal fin to caudal peduncle(LF1CP) under summer, rainy and winter season were 6.39±0.08,6.46±0.07, 6.57±0.082 cm and 7.87±0.13, 7.58±0.14, 7.95±0.16 respectively without any significant difference among those . As per the species is concerned ,the LHF1 of three carps *L.rohita, C. mrigala and Catla catla* were recorded 12.72±0.13, 13.40±0.17 and 13.38±0.10 cm respectively with no significant difference between mrigala and catla but corresponding values of both these species have significant difference with that of

rohu. However corresponding values of LAF1 major carps in *L.rohita, C. mrigala and Catla catla* were recorded 6.08±0.07, 6.09±0.08, 7.25±0.06 cm with no significant difference between rohu and mrigala but both these values were significantly different from that of catla. Similarly corresponding values of LF1CP were 7.96±0.09, 8.78±0.15, 6.66±0.14 cm with significant difference between them. Age wise the experimental carps grouped under age groups A1, A2 and A3 shown LHF1 values as 11.16±0.06, 13.31±0.07 and 15.03±0.10 respectively with significant difference among those. Similarly, the corresponding values of LAF1 were recorded 5.58±0.58, 6.57±0.07 and 7.27±0.06 respectively with significant difference among them. Likewise the corresponding values of LF1CP were 6.20±0.08, 7.68±0.10 and 9.50±0.13 respectively with significant difference among them. As per the sex of experimental major carps considered, male and female population shown LHF1, LAF1 and LF1CP were recorded 13.16±0.12, 13.18±0.11; 6.47±0.07, 6.47±0.06; 7.81±0.12, 7.79±0.12 respectively with no significant difference among them.

Table 23: Mean ± SE of biometric traits (LF1, LF2, LF3, LF4, LF5) of Indian major carps (N=540)

Sln	Factors		LF1	LF2	LF3	LF4	LF5
1	Overall(mean)		6.24±0.05	5.64±0.04	5.15±0.03	5.28±0.04	8.38±0.05
2	Season	Summer	6.20^{a}±0.06	5.65±0.65	5.14±.06	5.24±0.06	8.38±0.08
		Rainy	6.53^{b}±0.11	5.70±0.07	5.18±0.06	5.30±0.07	8.43±0.11
		Winter	5.99^{a}±0.69	5.58±0.06	5.12±0.59	5.30±0.06	8.34±0.07
3	Species	*L. rohita*	6.04^{a}±0.11	5.48^{a}±0.07	4.96^{a}±0.06	5.04^{a}±0.07	7.94^{a}±0.08
		C. mrigala	6.07^{a}±0.06	5.60^{a}±0.07	4.85^{a}±0.06	5.09^{a}±0.06	8.31^{b}±0.09
		C.catla	6.61^{b}±0.06	5.84^{b}±0.05	5.63^{b}±0.05	5.71^{b}±0.05	8.89^{c}±0.07
4	Age group	A1	5.28^{a}±0.05	4.81^{a}±0.05	4.42^{a}±0.04	4.47^{a}±0.03	7.40^{a}±0.06
		A2	6.56^{b}±0.10	5.61^{b}±0.03	5.17^{b}±0.05	5.26^{b}±0.05	8.28^{b}±0.07
		A3	6.88^{c}±0.37	6.50^{c}±0.04	5.84^{c}±0.03	6.10^{c}±0.03	9.47^{c}±0.06
5	Sex	M	6.23±0.07	5.62±0.06	5.18±0.05	5.34±0.05	8.36±0.07
		F	6.26±0.07	5.66±0.04	5.12±0.04	5.22±0.05	8.41±0.07

*Means with different superscripts differ significantly ($p \leq 0.05$) within a column under a factor ,LF1 – Length of dorsal fin, LF2 – Length of pectoral fin ,LF3 – Length of pelvic fin,LF4 – Length of anal fin , LF5 – Length of caudal fin

The average length of dorsal fin(LF1), length of pectoral fin(LF2), length of pelvic fin(LF3), length of anal fin(LF4), length of caudal fin (LF5) of all carps under study were recorded as 6.24±0.05, 5.64±0.04, 5.15±0.03, 5.28±0.04 and 8.38±0.05 cm respectively (Table 23). The LF1 of the carps reared under summer, rainy and winter season were 6.20±0.06, 6.53±0.11 and 5.99±0.69 cm respectively with significant difference of both summer and winter season with rainy season. Corresponding values of LF2, LF3, LF4 and LF5 were with ranges of 5.65±0.65, 5.70±0.07, 5.58±0.06 cm; 5.14±.06, 5.18±0.06, 5.12±0.59 cm; 5.24±0.06, 5.30±0.07, 5.30±0.06 cm; 8.38±0.08, 8.43±0.11, 8.34±0.07 cm respectively with no significant difference among them in three seasons. As per the species is concerned the values of LF1, LF2, LF3, LF4 of *L. rohita, C. mrigala* and *Catla catla* ranged with 6.04±0.11, 6.07±0.06, 6.61±0.06; 5.48±0.07, 5.60±0.07, 5.84±0.05; 4.96±0.06, 4.85±0.06, 5.63±0.05; 5.04±0.07, 5.09±0.06, 5.71±0.05 respectively with no significant difference between *L. rohita* and *C. mrigala* where as corresponding values of both *L. rohita* and *C. mrigala* differ significantly from that of *Catla catla* separately. However, corresponding values of LF5 were 7.94±0.08, 8.31±0.09 and 8.89±0.07 cm respectively which differ significantly among the three species. As per the age of the carps is concerned, the values of LF1, LF2, LF3, LF4, LF5 of three age group A1, A2 and A3 were 5.28±0.05, 6.56±0.10, 6.88±0.37 cm; 4.81±0.05, 5.61±0.03, 6.50±0.04 cm; 4.42±0.04, 5.17±0.05, 5.84±0.03 cm; 4.47±0.03, 5.26±0.05, 6.10±0.03; 7.40±0.06, 8.28±0.07, 9.47±0.06 respectively with significant difference among them. However, as per the sex is concerned LF1, LF2, LF3, LF4 and LF5 of male and female carp population are recorded 6.23±0.07 and 6.26±0.07 cm; 5.62±0.06 and 5.66±0.04 cm; 5.18±0.05 and 5.12±0.04 cm; 5.34±0.05 and 5.22±0.05 cm; 8.36±0.07 and 8.36±0.07 cm respectively, without any visible significant difference between them.

Table 24: Mean ± SE of biometric traits (DF2F3, DF3F4, DF4F5, DEF2) of Indian major carps (N=540)

Sl No	Factors	Sub factors	DF2F3	DF3F4	DF4F5	DEF2
1	Overall (mean)		7.70±0.07	7.02±0.06	3.54±0.03	4.31±0.02
2	Season	Summer	7.59±0.10	6.86^{a}±0.10	3.61^{b}±0.05	3.87^{a}±0.05
		Rainy	7.68±0.11	6.83^{a}±0.08	3.42^{a}±0.04	4.51^{b}±0.03
		Winter	7.82±0.13	7.37^{b}±0.11	3.58^{ab}±0.06	4.56^{b}±0.01
3	Species	*L.rohita*	7.97^{a}±0.10	7.02^{ab}±0.09	3.40^{a}±0.04	4.31±0.05
		C.mrigala	8.36^{b}±0.10	7.31^{b}±0.11	3.55^{ab}±0.05	4.26±0.04
		C.catla	6.77^{c}±0.11	6.74^{a}±0.10	3.65^{b}±0.04	4.36±0.034
4	Age group	A1	6.33^{a}±0.06	5.68^{a}±0.04	2.99^{a}±0.03	4.10^{a}±0.06
		A2	7.69^{b}±0.08	7.10^{b}±0.05	3.60^{b}±0.04	4.37^{b}±0.03
		A3	9.06^{c}±0.09	8.28^{c}±0.08	4.02^{c}±0.04	4.47^{b}±0.03
5	Sex	M	7.65±0.10	7.00±0.08	3.53±0.37	4.29±0.03
		F	7.74±0.09	7.04±0.08	3.55±0.04	4.34±0.03

*Means with different superscripts differ significantly ($p \leq 0.05$) within a column under a factor ,DF2F3 – Distance between pectoral fin and pelvic fin in cm , DF3F4 – Distance between pelvic and anal fin in cm , DF4F5 – Distance between pelvic and caudal fin in cm , DEF2– Distance between eye and pectoral fin in cm .

The average distance between pectoral fin and pelvic fin (DF2F3), distance between pelvic and anal fin (DF3F4), distance between pelvic and caudal fin (DF4F5) and distance between eye and pectoral fin (DEF2) of all carps under study were recorded as 7.70±0.07cm, 7.02±0.06 cm, 3.54±0.03 cm and 4.31±0.02 cm respectively (Table 24). The DF2F3 of the carps reared under summer, rainy and winter season were 7.59±0.10 cm, 7.68±0.11 cm and 7.82±0.13 cm respectively with no significant difference between them. Corresponding values of DF3F4 were 6.86±0.10 cm, 6.83±0.08 cm, 7.37±0.11cm respectively with no significant difference between summer and rainy season whereas both these seasons show significant difference with winter season. However the corresponding values of DF4F5 of carps in these three seasons were 3.61±0.05 cm, 3.42±0.04 cm, 3.58±0.06 cm respectively with significant difference between the values of summer and rainy season again the DF4F5 values of both the season not differ significantly from winter season separately. DEF2 values of of the carps reared under summer, rainy and winter season were 3.87±0.05 cm, 4.51±0.03 cm and 4.56±0.01 cm respectively with no significant difference among the values of rainy and winter season, whereas the

corresponding values in summer shown significant difference with rainy and winter season. As per the species is concerned the DF2F3 values were 7.97±0.10 cm, 8.36±0.10 cm and 6.77±0.11 cm with strong significant difference among themselves. However the DF4F5 were recorded with significant difference between *L.rohita* and *C.catla* and corresponding values of both the species didn't differ significantly from that of *C.mrigala* separately. Similarly the DEF2 values of *L. rohita, C. mrigala* and *Catla catla* were 4.31±0.05, 4.26±0.04 and 4.36±0.034 cm respectively concerned there is no significant difference among them. As per the age of the carps is concerned, the DF2F3 value of age group A1,A2 and A3 were recorded 6.33±0.06, 7.69±0.08 and 9.06±0.09 cm respectively with significant difference among them . Similarly corresponding values of DF3F4 recorded were 5.68±0.04, 7.10±0.05 and 8.28±0.05 cm which differ significantly from each other. Again DF4F5 values recorded in these three groups were 2.99±0.03, 3.60±0.04 and 4.02±0.04 cm respectively which differ significantly among them. Corresponding values DEF2 were of 4.10±0.06, 4.37±0.03, and 4.47±0.03 cm with no significant difference between values of A2 and A3 but no difference between those of A1 with A2 and A3. However, as per the sex is concerned DF2F3, DF3F4, DF4F5 and DEF2 of male and female carp population are recorded 7.65±0.10 and 7.74±0.09; 7.00±0.08 and 7.04±0.08; 3.53±0.37 and 3.55±0.04; 4.29±0.03 and 4.34±0.03 cm respectively, without any visible significant difference among them.

Table 25: Mean ± SE of biometric traits (WF1MF2, WF1F3, WF1F4) of Indian major carps (N=540)

Sl No	Factors		WF1MF2	WF1F3	WF1F4
1	Overall(mean)		9.84±0.07	9.87±0.07	6.63±0.06
2	Season	Summer	9.86±0.14	9.96±0.13	6.49±0.08
		Rainy	10.03±0.13	9.77±0.14	6.71±0.10
		Winter	9.64±0.10	9.87±0.11	6.69±0.10
3	Species	*L.rohita*	9.42^{a}±0.12	9.50^{a}±0.12	6.46^{a}±0.10
		C.mrigala	9.0^{b}±0.10	9.27^{a}±0.12	6.81^{b}±0.11
		C.catla	11.14^{c}±0.09	10.83^{b}±0.12	6.62^{ab}±0.08
4	Age group	A1	8.43^{a}±0.09	8.31^{a}±0.05	5.36^{a} ±0.04
		A2	9.89^{b}±0.10	9.8^{b}±0.10	6.76^{b} ±0.08
		A3	11.20^{c}±0.89	11.44^{c} ±0.10	7.76^{c} ±0.06
5	Sex	M	9.87±0.11	9.86±0.11	6.70±0.09
		F	9.82±0.10	9.87±0.10	6.56±0.07

*Means with different superscripts differ significantly ($p \leq 0.05$) within a column under a factor ,WF1MF2 - Width from dorsal to mid of pectoral fin in cm ,WF1F3 – Width from dorsal to pelvic fin in cm ,WF1F4 - Width from dorsal to anal fin in cm

The average width from dorsal to mid of pectoral fin in cm (WF1MF2) , width from dorsal to pelvic fin in cm(WF1F3) and width from dorsal to anal fin in cm (WF1F4) of all carps under study were recorded in Table 25 as 9.84±0.07 , 9.87±0.07 and 6.63±0.06 cm respectively. The WF1MF2 of the carps reared under summer, rainy and winter season were 9.86±0.14, 10.03±0.13 and 9.64±0.10 cm respectively with no significant difference between them. Corresponding values of WF1F3 were 9.96±0.13, 9.77±0.14, 9.87±0.11 cm respectively with no significant difference among them. However, the corresponding values of WF1F4 of carps in these three seasons were 6.49±0.08, 6.71±0.10 and 6.69±0.10 cm respectively with no significant difference among their values .As per the species is concerned the WF1MF2 values of *L. rohita, C. mrigala and Catla catla* were 9.42±0.12, 9.0±0.10 and 11.14±0.09cm respectively with significant difference among themselves. However the corresponding values of WF1F3 were recorded 9.50±0.12, 9.27±0.12 and 10.83±0.12 cm which showed no significant difference between summer and rainy season but values of both summer and rainy differ significantly from that of winter season separately. Similarly the WF1F4 values of *L. rohita, C. mrigala and Catla catla* were 6.46±0.10, 6.81±0.11and 6.62±0.08 cm respectively concerned there is significant difference between *L.rohita* and *C.mrigala,* but both of them shown no significant difference with *C.catla* separately. As per the age of the carps is concerned, the WF1MF2 value of age group A1, A2 and A3 were recorded 8.43±0.09, 9.89±0.10 and 11.20±0.89cm respectively with significant difference among them . Similarly corresponding values of WF1F3 recorded were 8.31±0.05, 9.8±0.10 and 11.44 ±0.10 cm which differ significantly from each other. Again WF1F4 values recorded in these three groups were 5.36 ±0.04, 6.76 ±0.08 and 7.76 ±0.06 cm respectively which differ significantly among them. However, as per the sex is concerned WF1MF2, of male and female carp population were recorded 9.87±0.11 and 9.82±0.10; 6.70±0.09 respectively; corresponding values of WF1F3 were 9.86±0.11 and 9.87±0.10 respectively; and corresponding values of WF1F4 were recorded 6.70±0.09 and 6.56±0.07 respectively with no significant difference among them.

Table 26: Mean ± SE of biometric traits (ABL1, ABL2 and ABW) of Indian major carps (N=540)

Sl No	Factors	Sub factors	ABL1	ABL2	ABW
1	Overall(mean)		6.0972± 0.057	7.1431±0.086	3.277±0.08
2	Season	Summer	5.908^{a}±0.092	6.938 ^{a} ±0.164	2.870 ^{a} ±0.101
		Rainy	6.129 ^{ab}±0.103	7.02 ^{ab} ±0.142	3.688 ^{b} ±0.177
		Winter	6.255^{b}±0.101	7.47 ^{b} ±0.140	3.278 ^{ab}±0.080
3	Species	*L.rohita*	5.369^{a}±0.095	7.058 ^{a} ±0.072	2.840 ^{a} ±0.101
		C.mrigala	5.856^{b}±0.089	8.529 ^{b} ±0.146	3.330 ^{b} ±0.163
		C.catla	7.06^{c}±0.064	5.84 ^{c} ±0.145	3.663^{b}±0.140
4	Age group	A1	5.262^{a}±0.086	5.670 ^{a} ±0.085	1.552^{a} ±0.021
		A2	6.075^{b}±0.089	7.230 ^{b} ±0.124	3.056^{b} ±0.061
		A3	6.950^{c}±0.080	8.521 ^{c} ±0.149	5.211^{c} ±0.127
5	Sex	M	6.207±0.085	7.128±0.122	3.379±0.125
		F	5.988±0.076	7.158±0.123	3.175±0.102

*Means with different superscripts differ significantly (p≤0.05) within a column under a factor, ABL1 – Length of anterior chamber of airbladder, ABL2 –Length of posterior chamber of airbladder, ABLW –Weight of airbladder

The average length of anterior chamber of airbladder (ABL1), length of posterior chamber of airbladder cm (ABL2) and weight of airbladder (ABLW) of all carps under study were recorded as 6.0972± 0.057cm, 7.1431±0.086 cm and 3.277±0.08 cm respectively (Table 26). The ABL1 of the carps reared under summer, rainy and winter season were 5.908±0.092-cm, 6.129±0.103, 6.255±0.101 cm respectively and corresponding seasonal measurements of ABL2 were 6.938 ±0.164, 7.02 ±0.142, 7.47 ±0.140cm respectively with significant difference between the corresponding values of summer and winter season where again the values of both of the season did not differ significantly with rainy season separately. ABLW of the carps in three seasons were recorded 2.870 ±0.101, 3.688±0.177 and 3.278±0.080 g respectively, with significant difference between summer and rainy season whereas corresponding values of ABW of these two seasons differed insignificantly and

separately with ABW in winter (Fig 32). As per the age of the carps concerned, ABL1 values of *L. rohita, C. mrigala and Catla catla* were 5.369±0.095 cm, 5.856±0.089 cm and 7.06±0.064 cm with strong significant difference among themselves. However, the corresponding values of ABL2 were 7.058±0.072cm, 8.529 ±0.146cm, and 5.84±0.145 cm respectively with significant difference among them. Again corresponding values of ABLW of the three carps were 2.840±0.101, 3.330±0.163 and 3.663±0.140 g respectively where corresponding value of *L.rohita* shown significant difference with *C.mrigala* and *Catla catla*, but values of both these had no significant difference with each other. As per the age of the experimental carps is concerned length of anterior chamber of air bladder (ABL1) of age group A1, A2 and A3 were recorded as 5.262±0.086, 6.075±0.089 and 6.950±0.080 cm with significant difference among them. Again length of the posterior chamber of air bladder (ABL2) and its weight (ABW) of corresponding age groups were 5.670±0.085, 7.230±0.124, 8.521 ±0.149 cm; 1.552 ±0.021, 3.056 ±0.061, 5.211 ±0.127g with strong significant difference among themselves. However, as per the sex is concerned ABL1, ABL2 and ABW of male and female carp population are recorded 6.207±0.085 and 5.988±0.076 cm; 7.128±0.122 and 7.158±0.123 cm; 3.379±0.125g and 3.175±0.102 g respectively, without any visible significant difference.

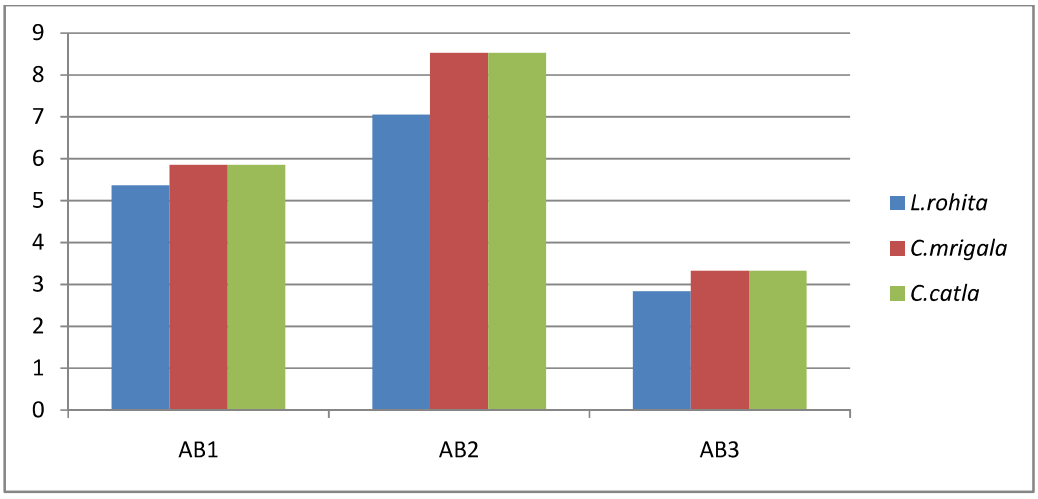


Fig 32: Biometric traits (ABL1, ABL2 and ABW) of Indian major carps

ABL1 – Length of anterior chamber of airbladder (cm), ABL2 –Length of posterior chamber of airbladder (cm), ABLW –Weight of airbladder (g)

Table 27: Mean ± SE of anatomical traits (HW, STL, STW, LW, GW, KW) of Indian major carps (N=540)

Sl No	Factors	Subfactor	HW(g)	STL(cm)	STW(g)	LW(g)	GW(g)	KW(g)
1	Overall(mean)		0.46±0.01	10.13±0.10	1.81±0.05	5.18±0.13	4.96±0.79	0.99±0.04
2	Season	Summer	0.42±0.02	10.05^{a}±0.17	1.63^{a}±0.08	5.36^{a}±0.21	5.89^{a}±1.87	1.34^{a}±0.06
		Rainy	0.47±0.02	10.4^{ab}±0.15	1.67^{a}±0.08	4.43^{b}±0.20	7.55^{ab}±1.44	1.61^{b}±0.08
		Winter	0.48±0.02	9.86^{b}±0.15	2.14^{b}±0.09	5.73^{b}±0.22	1.45^{b}±0.17	1.62^{b}±0.08
3	Species	L. rohita	0.40^{a}±-.02	10.55^{a}±0.18	2.36^{a}±0.11	4.51^{a}±0.21	2.91^{a}±1.05	1.40^{a}±0.06
		C.mrigala	0.42^{a}±0.02	9.90^{a}±0.14	1.60^{a}±0.06	5.11^{a}±0.21	10.28^{a}±2.08	1.40^{a}±0.08
		C.catla	0.55^{b}±0.02	9.94^{b}±0.15	1.49^{b}±0.07	5.90^{b}±0.21	1.70^{b}±0.17	1.75^{b}±0.08
4	Age group	A1	0.22^{a}±0.003	8.20^{a}±0.08	1.01^{a}±0.04	2.61^{a}±0.07	1.41^{a}±0.34	0.73^{a}±0.03
		A2	0.46^{b}±0.14	9.96^{b}±0.09	1.68^{b}±0.06	5.15^{b}±0.17	3.96^{a}±0.87	1.48^{b}±0.06
		A3	0.69^{c}±0.01	12.22^{c}±0.12	2.75^{c}±0.10	7.75^{c}±0.18	9.49^{b}±2.14	2.40^{c}±0.07
5	Sex	M	0.45±0.02	10.12±0.12	1.86±0.07	5.17±0.17	0.02^{a}±0.002	1.53±0.06
		F	0.47±0.01	10.14±0.14	1.78±0.07	5.19±0.18	9.90^{b}±1.53	1.52±0.06

*Means with different superscripts differ significantly ($p \leq 0.05$) within a column under a factor, HW – Weight of heart, STL – Length of stomach, STW – Weight of stomach, LW – Weight of liver, GW – Weight of gonads (pair), KW - Weight of kidney

The average weight of heart, length of stomach, weight of stomach, weight of liver , weight of gonads (pair), weight of kidney of all carps under study were recorded in Table-27 as, 0.46±0.01, 10.13±0.10, 1.81±0.05, 5.18±0.13, 4.96±0.79, 4.96±0.79 and 0.99±0.02 respectively, without any significant difference among those. The length of stomach and weight of gonads of the carps raised under summer, rainy and winter season were 10.05±0.17, 10.4±0.15, 9.86±0.15; 5.89±1.87, 7.55±1.44, 1.45±0.17 respectively with striking significant difference between summer and winter season and without any significant difference of them with rainy season. Season wise the weight of stomach of the carps raised under summer, rainy and winter season were 1.63±0.08, 1.67±0.08 and 2.14±0.09 g respectively with significant difference between summer and winter season and no significant difference was found between summer and rainy season. Again in summer, rainy and winter season weight of liver and kidney were recorded 5.36±0.21, 4.43±0.20, 5.73±0.22; 1.34±0.06, 1.61±0.08, 1.62±0.08 g with significant difference of summer

with winter and rainy season and without any significant difference between rainy and winter season. As per the species concerned in summer, rainy and winter season weight of heart, length of stomach, weight of stomach, weight of liver, weight of gonads (pair), weight of kidney were 0.40±0.02, 0.42±0.02, 0.55±0.02; 10.55±0.01, 9.90±0.14, 9.94±0.15; 2.36±0.11, 1.60±0.06, 1.49±0.07; 4.51±0.02, 5.11±0.2, 5.90±0.2; 2.91±1.05, 10.28±2.08, 1.70±0.17 g respectively, without any significant diffenence between summer and rainy season, but there was significant difference of values of summer and rainy season with winter(Fig 33). During the course of growth, in different age group of major carps A1, A2 and A3 weight of heart, length of stomach, weight of stomach, weight of liver, weight of kidney were recorded 0.22±0.003, 0.46±0.14, 0.69±0.01; 8.20±0.08, 9.96±0.09, 12.22±0.12; 1.01±0.04, 1.68±0.06, 2.75±0.10; 2.61±0.07, 5.15±0.17, 7.75±0.18; 0.73±0.03, 1.48±0.06, 2.40±0.07 g respectively, with significant difference among them. But in different age group of major carps A1, A2 and A3 mean weight of gonads (pair) were recorded as 1.41±0.34, 3.96±0.87 and 9.49±2.14 g respectively, without any significant difference between A1 and A2 group, but there is significant difference of A1 and A2 with A3 group of carps. In present investigation, male and female major carps had shown no significant difference among them in their length of stomach, weight of heart, stomach, liver and kidney, but gonads (testes) of male (0.020±.002) and gonads (ovaries) of female ones(9.90±1.53) showed significant difference.

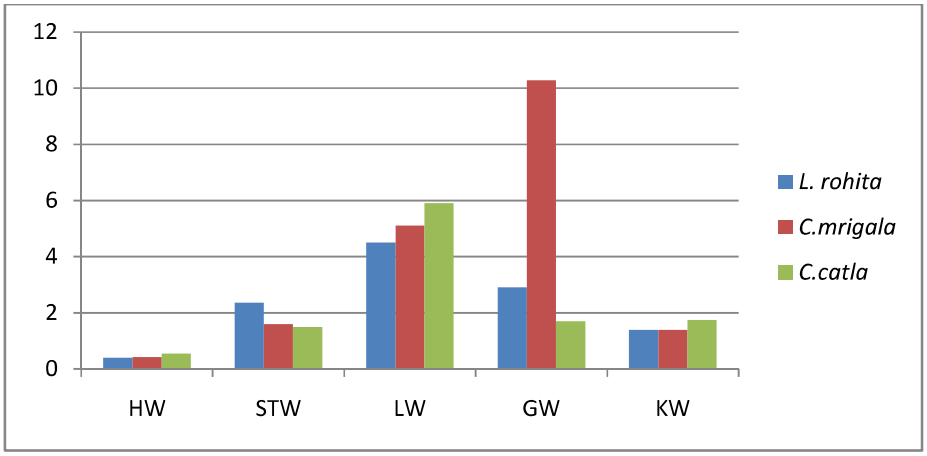


Fig 33: Anatomical traits (HW, STL, STW, LW, GW, KW) of Indian major carps

HW – Weight of heart(g), STL – Length of stomach(cm), STW – Weight of stomach(g), LW – Weight of liver(g), GW – Weight of gonads (pair) (g), KW - Weight of kidney(g)

Table 28: Mean ± SE of biological parameter (K, GaSI, HSI, GSI) of Indian major carps (N=540)

Sl No	Factors	Sub factors	K	GaSI	HIS	GSI
1	Overall(mean)		2.18±0.04	0.53±0.075	1.11±0.08	0.99±0.33
2	Season	Summer	2.15±0.08	0.36±0.036	1.38^{a}±0.21	1.24±0.68
		Rainy	2.25±0.07	0.67±0.17	0.85^{ab}±0.07	1.45±0.75
		Winter	2.13±0.08	0.17±0.14	1.11^{b}±0.08	0.31±0.09
3	Species	L.rohita	2.17^{a}±0.055	0.53±0.03	1.03^{a}±0.09	0.54^{a}±0.28
		C.mrigala	1.85^{b}±0.053	0.43±0.08	1.21^{ab}±0.23	2.17^{ab}±0.99
		C.catla	2.52^{c}±0.043	0.64±0.21	1.09^{b}±0.06	0.39^{b}±0.10
4	Age group	A1	$2.10±0.09^{a}$	$0.46±0.09^{a}$	$0.98±0.07^{a}$	0.58^{a} ±0.35
		A2	$2.18±0.08^{b}$	$0.38±0.03^{b}$	$1.13±0.09^{b}$	$1.03±0.74^{b}$
		A3	$2.26±0.08^{c}$	$0.76±0.20^{c}$	$1.23±0.22^{c}$	$1.34±0.60^{c}$
5	Sex	M	2.16±0.06	0.56±0.12	0.05±0.06	0.07±0.036
		F	2.19±0.07	0.50±0.10	1.15±0.15	1.91±0.62

*Means with different superscripts differ significantly ($p \leq 0.05$) within a column under a factor, K – Condition factor, GaSI – Gastrosomatic index, HSI – Hepatosomatic index and GSI – gonadosomatic index

The average biological parameters, conditional factor (K), gastrosomatic index (GaSI), hepatosomatic index (HSI) and gonadosomtic index (GSI) of all carps under study were recorded as 2.18±0.04, 0.53±0.075, 1.11±0.08 and 0.99±0.33 respectively (Table 28). The K of the carps reared under summer, rainy and winter season were 2.15±0.08cm, 2.25±0.07, 2.13±0.08 cm respectively and corresponding seasonal measurements of GaSI were 0.36±0.036, 0.67±0.17, 0.17±0.14cm and those of HSI values were 1.38±0.21, 0.85±0.07, 1.11±0.08 respectively with significant difference in HIS of summer and winter season with each other and also separately with rainy season. However, corresponding values of GSI were recorded, 1.24±0.68, 1.45±0.75 and 0.31±0.75 with no significant difference between them (Fig 34). Condition factor (K) of *L.rohita, C.mrigala* and *Catla catla* were 2.17±0.055, 1.85±0.053 and

2.52±0.043 respectively with significant difference among them in relation to species. However, gastrosomatic index (GaSI) of corresponding species, were recorded 0.53±0.03, 0.43±0.08 and 0.64±0.21 respectively with no significant difference among them. Similarly, Hepatosomatic index (HSI) and gonadosomatic index (GSI) of corresponding species were recorded as 1.03±0.09, 1.21±0.23, 1.09±0.06; 0.54±0.28, 2.17±0.99, 0.39±0.10 respectively with significant difference of L.rohita and C. catla with each other and with *C.mrigala* separately (Fig 35). As per the age concerned, K value of the major carps grouped under age group A1, A2 and A3 were 2.10±0.09, 2.18±0.08 and 2.18±0.08 respectively with strong significant difference among them. Corresponding values of GaSI values were recorded as 0.46±0.09, 0.38±0.03 and 0.76±0.20 respectively with strong significant difference among them. Similarly, the corresponding values of HSI and GSI were 0.98±0.07, 1.13±0.09, 1.23±0.22 and 0.58±0.35, 1.03±0.74, 1.34±0.60 with powerful significant difference among them (Fig 36). As per the sex is concerned K, GaSI, HSI and GSI of male and female carp population are recorded 2.16±0.06 and 2.19±0.07; 0.56±0.12 and 0.50±0.10; 0.05±0.06 and 1.15±0.15; 0.07±0.036 and 1.91±0.62 respectively, without any visible significant difference among them (Fig 37).

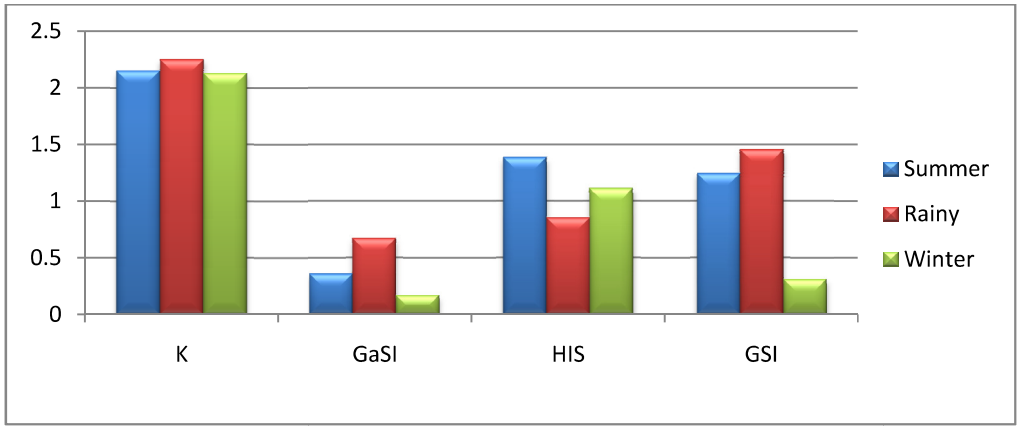


Fig 34: Season wise bioiogical parameter (K, GaSI, HSI, GSI) of Indian major carps

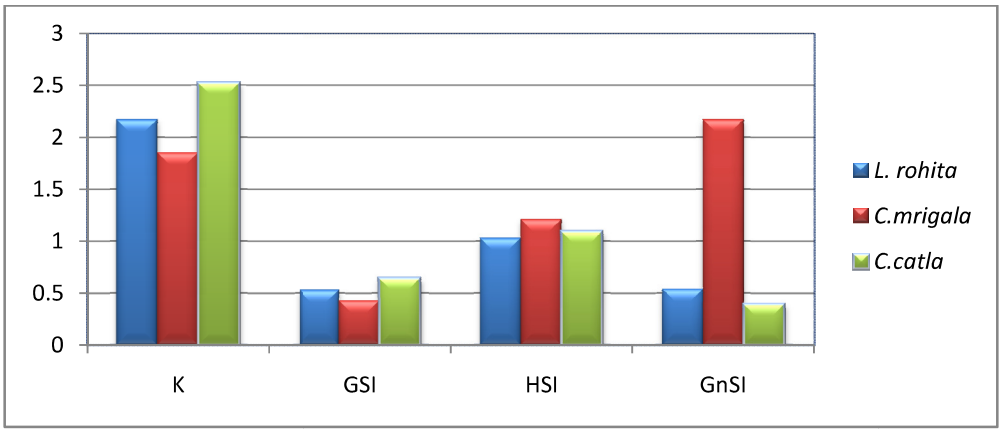


Fig 35: Species wise bioiogical parameter (K, GaSI, HSI, GSI) of Indian major carps

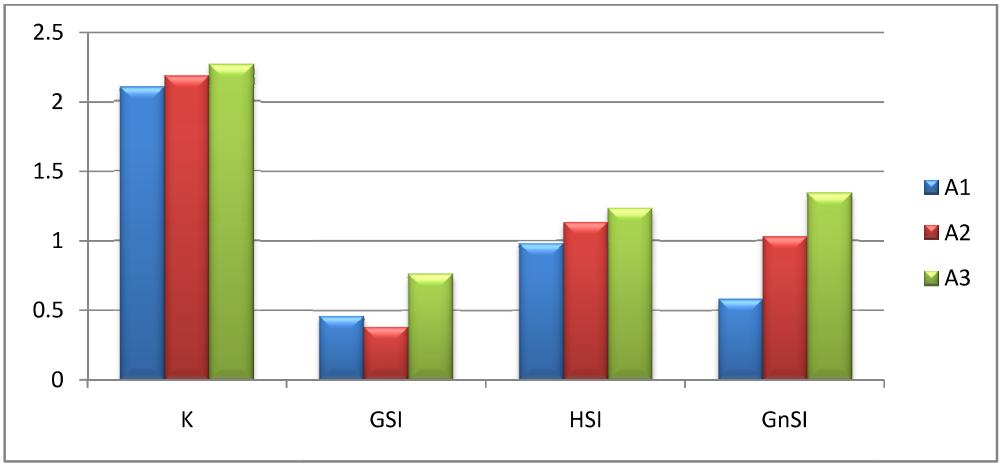


Fig 36: Age group wise bioiogical parameter (K, GaSI, HS, GSI) of Indian major carps

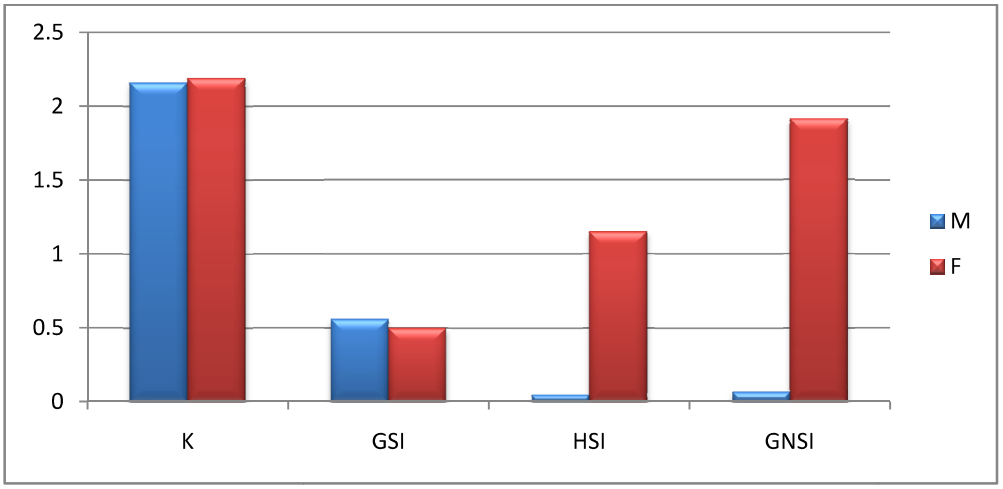


Fig 37: Sex wise bioiogical parameter (K, GaSI, HSI, GSI) of Indian major carps

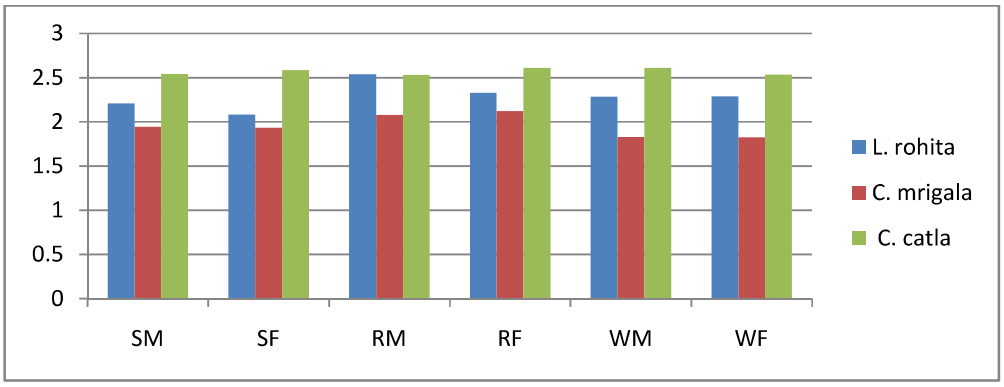


Fig 38: Condition factors of the three species of Indian major carps

(S- summer, R- Rainy, W- winter, M- male, F- Female)

The present findings of Condition factors (K) of Indian major carps revealed that among the three species C. catla were most favourably adapted with respect to their survival , condition of their health and maturity (Fig 38).

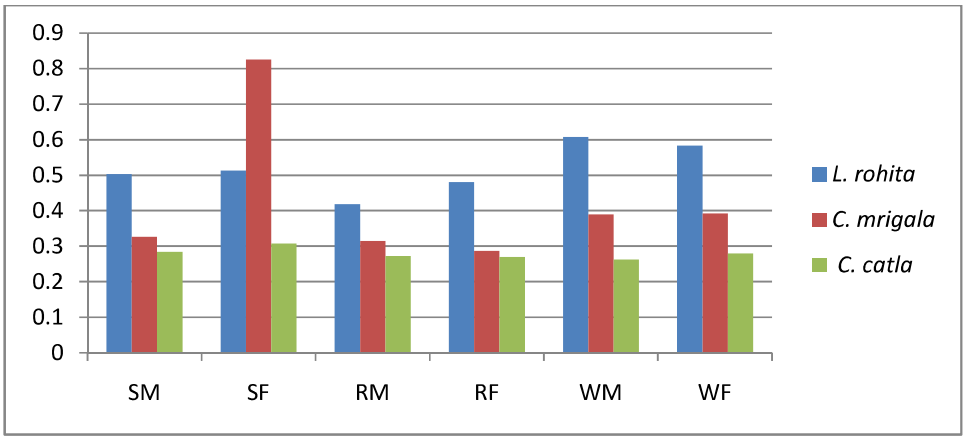


Fig 39: Gastrosomatic index (GaSI) of the three species of Indian major carps

(S- summer, R- Rainy, W- winter, M- male, F- Female)

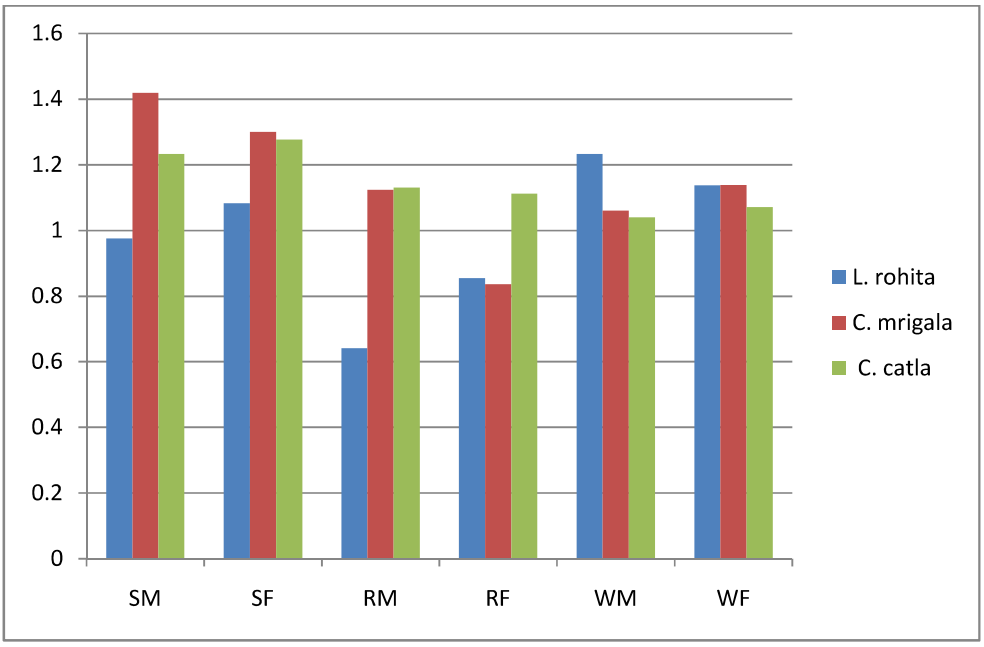


Fig 40: Hepatosomatic index (HSI) of the three species of Indian major carps

(S- Summer, R- Rainy, W- winter, M- male, F- Female)

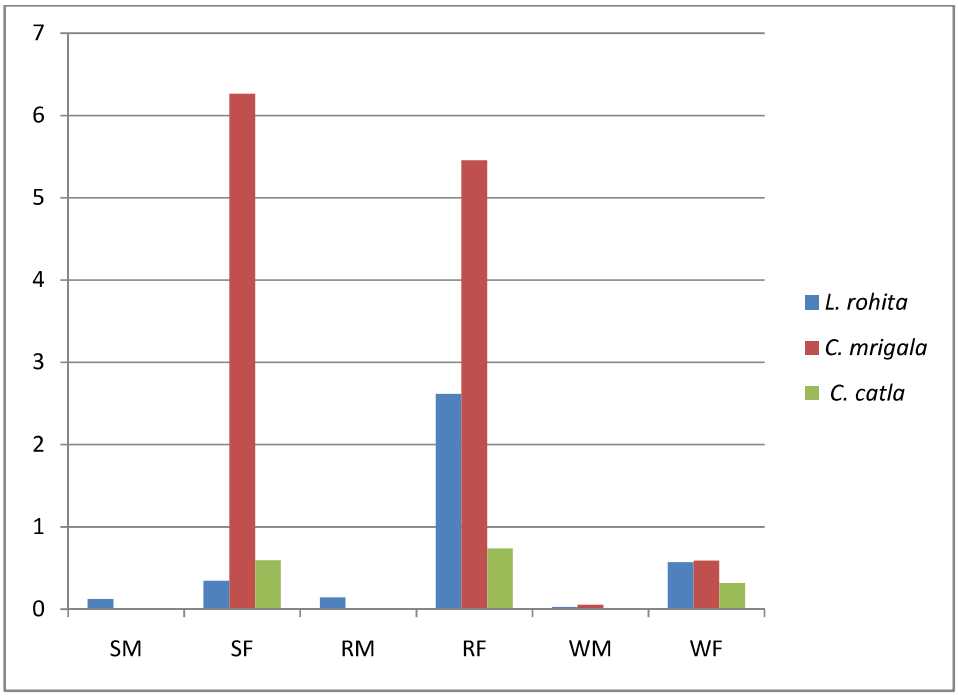


Fig 41: Gonadosomatic index (GSI) of the three species of Indian major carps

(S- Summer, R- Rainy, W- winter, M- male, F- Female)

The GaSI, HSI and GSI vaues of three species of Indian major carps were placed in Fig 39, 40 and 41 for studies comparative studies. *C. mrigala* excelled in the whole period of the study with higher levels of GaSI, HIS and GSI.

CORRELATION ANALYSIS:

Correlation analysis (sex wise):

Table 29: Correlation coefficient(r) matrix among biological parameters of **male** Indian major carps

Parameter	BW	TL	SL	HW	STL	STW	LW	GTW	KW
BW	1.000								
TL	.951**	1.000							
SL	.919**	.981**	1.000						
HW	.872**	.819**	.776**	1.000					
STL	.818**	.796**	.803**	.751**	1.000				
STW	.597**	.557**	.552**	.542**	.669**	1.000			
LW	.796**	.805**	.777**	.766**	.65**	.590**	1.000		
GTW	-.020	-.046	-.005	-.077	-.019	.027	-.133*	1.000	
KW	.743**	.724**	.703**	.774***	.689**	.463**	.711**	-.080	1.000
**. Correlation is significant at the 0.01 level (2-tailed).									

BW-Body weight, Tl – Total length, Sl – Standard length, HW – Weight of heart, STL – Length of stomach, STW – Weight of stomsach, LW – Weight of liver, GTW – Weight of gonads testes (pair), KW - Weight of kidney

Correlation among different biological parameters of male Indian carps, were presented in the Table-29. Analysis of correlation among male Indian carps showed significant and positive correlation of body weight with standard length, heart weight, stomach length, stomach weight, liver weight and kidney weight ranging from the values 0.597 to 0.951 at $p \leq 0.01$ whereas body weight was insignificantly and negatively correlated with gonad(testis) weight($r=-0.020$ at $p \leq 0.01$). At the same time analysis of correlation matrix revealed that total length showed significant and strongly positive correlation with standard length($r=0.981$ at $p \leq 0.01$), heart weight($r=0.819$ at $p \leq 0.01$), stomach length($r=0.796$ at $p \leq 0.01$), stomach weight($r=0.597$ at $p \leq 0.01$), liver weight($r=0.805$ at $p \leq 0.01$) and kidney weight($r=0.724$ at $p \leq 0.01$) along with insignificant and negative correlation with gonad(testis) weight ($r=-0.046$ at $p \leq 0.01$). Standard length of the carps exhibited significant and positive correlation with all the body parameters i.e. heart

weight(r=0.776 at p≤0.01), stomach length(r=0.803 at p≤0.01), stomach weight(r=0.552 at p≤0.01), liver weight(r=0.777 at p≤0.01) and kidney weight(r=0.703 at p≤0.01) except gonad (testis) weight(r=-0.005 at p≤0.01). As per the analysis of correlation of heart weight of carps with other biological parameters concerned, it showed a positive and significant correlation with stomach length(r=0.751at p≤0.01), stomach weight(r=0. 542 at p≤0.01), liver weight(r=0.766 at p≤0.01) and kidney weight(r=0.774 at p≤0.01) but negative correlation with gonad(testis) weight(r=-0.077 at p≤0.01).Though stomach length showed a positive and significant correlation with stomach weight(r=0.669 at p≤0.01), liver weight(r=0.653 at p≤0.01) and kidney weight(r=0.689 at p≤0.01) but negative correlation with gonad(testis) weight(r=-0.019 at p≤0.01). But stomach weight was significantly and positively correlated with the other body parameter such as liver weight(r=0.590 at p≤0.01), gonad (testis) weight(r=-0.027) at p≤0.01) and kidney weight(r=0.463 at p≤0.01). Liver weight exhibited a significant and positive correlation with kidney weight (r=0.711 at p≤0.01) an insignificant and negative correlation with gonad weight(r=-0.133 at p≤0.01). Again gonad weight exhibited n insignificant and negative correlation with gonad weight(r=-0.080 at p≤0.01)

Moreover, during the whole correlation analysis among the biological parameters no significant correlation at the 0.05 level was encountered.

Table 30: Correlation coefficient(r) matrix among biological parameters of **female** Indian Major carps

Parameter	BW	TL	SL	HW	STL	STW	LW	GOW	KW
BW	1.000								
TL	.940**	1.000							
SL	.908**	.979**	1.000						
HW	.819**	.781**	.722**	1.000					
STL	.771**	.731**	.713**	.707**	1.000				
STW	.630**	.579**	.600**	.568**	.678**	1.000			
LW	.811**	.796**	.778**	.734**	.618**	.706**	1.000		
GOW	.312**	.343**	.344**	.141*	.209**	.025	.227**	1.000	
KW	.723**	.682**	.653**	.676**	.582**	.468**	.612**	.037	1.000
**. Correlation is significant at the 0.01 level (2-tailed).									
*. Correlation is significant at the 0.05 level (2-tailed).									

GOW– Weight of gonads ovaries (pair)

Analysis of correlation among different biochemical parameters of female Indian major carps were represented in the Table-30. Body weight with different biological parameters showed significant positive correlation with all other biological parameters such as total length, standard length, heart weight, stomach length, stomach weight, liver weight, gonad(ovary) weight and kidney weight with r value fluctuating between 0.312 to 0.940 at $p \leq 0.01$. Similarly a strong positive correlation was also observed by the total length with standard length, heart weight, stomach length, stomach weight, liver weight, gonad (ovary) weight and kidney weight with r value varying from 0.343 to 0.979 at $p \leq 0.01$. Likewise standard length of the carps displayed significant positive correlation with heart weight($r=0.722$ at $p \leq 0.01$), stomach length($r=0.713$ at $p \leq 0.01$), stomach weight($r=0.600$ at $p \leq 0.01$), liver weight($r=0.778$ at $p \leq 0.01$), gonad (ovary) weight($r=0.344$ at $p \leq 0.01$), and kidney weight ($r=0.722$ at $p \leq 0.01$). As well heart weight was significantly correlated with stomach length($r=0.707$ at $p \leq 0.01$), stomach weight($r=0.568$ at $p \leq 0.01$), liver weight($r=0.734$ at $p \leq 0.01$), gonad(ovary) weight($r=0.141$ at $p \leq 0.05$), and kidney weight ($r=0.676$ at $p \leq 0.01$).Stomach length was significantly and positively correlated with stomach weight($r=0.678$ at $p \leq 0.01$), liver weight($r=0.618$ at $p \leq 0.01$), gonad(ovary) weight($r=0.209$ at $p \leq 0.01$), and kidney weight ($r=0.582$ at $p \leq 0.01$).Stomach weight also showed a significant correlation with liver weight($r=0.706$ at $p \leq 0.01$) and kidney weight ($r=0.468$ at $p \leq 0.01$) whereas it displayed no significant correlation with gonad(ovary) weight($r=0.025$) . However, liver weight displayed significant positive correlation with ovary weight ($r=0.227$ at $p \leq 0.01$) and kidney weight ($r=0.037$ at $p \leq 0.01$) but no correlation was found between ovary weight and kidney weight($r=0.037$ at $p \leq 0.01$).

Correlation analysis (species wise):

Table 31: Correlation coefficient(r) matrix among biological parameters of ***Labeo rohita***

Parameter	BW	TL	SL	HW	STL	STW	LW	GW	KW
BW	1.000								
TL	.963**	1.000							
SL	.948**	.984**	1.000						
HW	.877**	.869**	.847**	1.000					
STL	.790**	.754**	.747**	.746**	1.000				
STW	.736**	.707**	.699**	.674**	.632**	1.000			
LW	.786**	.749**	.730**	.697**	.568**	.861**	1.000		
GW	.217**	.206**	.196*	.304**	.175*	.062	.094	1.000	
KW	.551**	.546**	.533**	.492**	.452**	.450**	.514**	-.045	1.000
**. Correlation is significant at the 0.01 level (2-tailed).									
*. Correlation is significant at the 0.05 level (2-tailed).									

GW– Weight of gonads

Correlation analysis among different biochemical parameters of *Labeo rohita* were represented in the Table-31. Analysis of correlation matrix indicated that body weight showed significant positive correlation with all other biological parameters such as total length, standard length, heart weight, stomach length, stomach weight, liver weight, gonad weight and kidney weight with r value changing from 0.217 to 0.963 at $p \leq 0.01$. Similarly a strong positive correlation was also observed by the total length with standard length, heart weight, stomach length, stomach weight, liver weight, gonad weight and kidney weight with r value varying from 0.206 to 0.984 at $p \leq 0.01$. Also standard length of the carps displayed significant positive correlation with heart weight($r=0.847$ at $p \leq 0.01$), stomach length($r=0.747$ at $p \leq 0.01$), stomach weight($r=0.699$ at $p \leq 0.01$), liver weight($r=0.730$ at $p \leq 0.01$) and kidney weight ($r=0.533$ at $p \leq 0.01$), where as it showed a significant positive correlation with gonad weight at $p \leq 0.05$($r=0.196$). Heart weight was also significantly correlated with stomach length($r=0.746$ at $p \leq 0.01$), stomach weight($r=0.674$ at $p \leq 0.01$), liver weight($r=0.697$ at $p \leq 0.01$), gonad weight($r=0.304$ at $p \leq 0.01$), and kidney weight ($r=0.492$ at $p \leq 0.01$). Stomach length was significantly and positively correlated with stomach weight($r=0.632$ at $p \leq 0.01$), liver weight($r=0.568$ at $p \leq 0.05$) and kidney weight ($r=0.452$ at $p \leq 0.01$) but it was significantly correlated to gonad weight($r=0.175$ at $p \leq 0.01$). Stomach weight also showed a significant correlation with liver

weight(r=0.861 at p≤0.01) and kidney weight (r=0.450 at p≤0.01) whereas it displayed no significant correlation with gonad (ovary) weight(r=0.062. However, liver weight displayed significant positive correlation with kidney weight (r=0.514 at p≤0.01) but no correlation was found with gonad weight(r=0.094). Moreover, a negative correlation was found between kidney wight and gonad weight.

Table 32: Correlation coefficient(r) matrix among biological parameters of ***Cirrhinus mrigala***

Parameter	BW	TL	SL	HW	STL	STW	LW	GW	KW
BW	1.000								
TL	.966**	1.000							
SL	.952**	.986**	1.000						
HW	.882**	.831**	.808**	1.000					
STL	.845**	.800**	.810**	.832**	1.000				
STW	.701**	.667**	.654**	.768**	.746**				
LW	.846**	.819**	.833**	.707**	.675****	.676**	1		
GW	.286**	.246*	.208*	.113*	.240*	.004	.251*	1.000	
KW	.760**	.681**	.678**	.854**	.687**	.635**	.629****	0.055	1.000
**. Correlation is significant at the 0.01 level (2-tailed).									
*. Correlation is significant at the 0.05 level (2-tailed).									

All the records of correlation analysis among different biochemical parameters of the *Cirrhinus mrigala* were represented in the Table-32. Correlation matrix analysis indicated that body weight showed significant positive correlation with all other biological parameters such as total length, standard length, heart weight, stomach length, stomach weight, liver weight, gonad weight and kidney weight with r value ranging between 0.286 and 0.966 at p≤0.01. Similarly a strong positive correlation was also observed by the total length with standard length, heart weight, stomach length, stomach weight, liver weight and kidney weight with r value fluctuating between 0.667 to 0.986 at p ≤0.01 where as total length shows a significant positive correlation with gonad weight (r = 0.246) at p≤0.05. Correspondingly, standard length of the carps displayed significant positive correlation with , heart weight, stomach length, stomach weight, liver weight and kidney weight with a range of r value between 0.654(stomach weight) to 0.833(liver weight)at p≤0.01,but it varied significantly and positively with gonad weight(r= 0.208) at p≤0.05. Heart weight was also significantly correlated with stomach length (r=0.832 at p≤0.01), stomach weight(r=0.768 at p≤0.01), liver weight(r=0. 707 at

p≤0.01), gonad weight (r=0.113 at p≤0.05), and kidney weight (r=0.854 at p≤0.01). Stomach length was significantly and positively correlated with stomach weight(r=0.746 at p≤0.01), liver weight(r=0.675 at p≤0.01), gonad weight(r=0.240 at p≤0.05) and kidney weight (r=0.687 at p≤0.01). Stomach weight also showed a significant correlation with liver weight(r=0.676 at p≤0.01) and kidney weight (r=0.635 at p≤0.01) whereas it showed no significant correlation with gonad weight(r=0.004). However, liver weight displayed significant positive correlation gonad weight (0.251 at p≤0.05) and kidney weight (r=0.629 at p≤0.01) but no correlation was found between gonad weight and kidney weight(r=0.055). Moreover, no negative correlations among different parameters were encountered during correlation analysis of the table.

Table 33: Correlation coefficient(r) matrix among biological parameters of ***Catla catla***

Parameter	BW	TL	SL	HW	STL	STW	LW	GW	KW
BW	1.000								
TL	.939**	1.000							
SL	.937**	.992**	1.000						
HW	.829**	.850**	.863**	1.000					
STL	.847**	.891**	.869**	.797**	1.000				
STW	.831**	.854**	.850**	.877**	.809**	1.000			
LW	.752**	.852**	.845**	.844**	.804**	.908**	1.000		
GW	.216*	.197*	.147*	.218*	.361**	.262*	.257*	1.000	
KW	.866**	.916**	.928**	.786**	.854**	.835**	.824**	.171*	1.000
**. Correlation is significant at the 0.01 level (2-tailed).									
*. Correlation is significant at the 0.05 level (2-tailed).									

Analysis of correlation matrix among different biochemical parameters of *Catla catla* were represented in the Table-33. Correlation analysis indicated that body weight resulted a significant positive correlation with all other biological parameters such as total length, standard length, heart weight, stomach length, stomach weight, liver weight and kidney weight with r value ranging between 0.829(heart weight) to 0.939(total length) at p≤0.01 except gonad weight which showed a positive significant correlation with r value 0.216 at p≤0.05. A strong positive correlation was also observed by the total length with standard length, heart weight, stomach length, stomach weight, liver weight and kidney weight with r value varying between 0.850 to 0.992 at p≤0.01, along with an exception that gonad weight

confirmed positive significant correlation(r = 0.197) at p≤0.01. As well, standard length of the carps showed significant positive correlation with heart weight(r=0.863 at p≤0.01), stomach length(r=0.869 at p≤0.01), stomach weight(r=0.850 at p≤0.01), liver weight(r=0.845 at p≤0.01), gonad weight(r=0.147 at p≤0.05) and kidney weight (r=0.928 at p≤0.01). Heart weight was also significantly correlated with stomach length(r=0.797 at p≤0.01), stomach weight(r=0.877 at p≤0.01), liver weight(r=0.844 at p≤0.01), gonad weight(r=0.141 at p≤0.01), and kidney weight (r=0.786 at p≤0.01). Significant and positive correlation was displayed by stomach length with stomach weight(r=0.809 at p≤0.01), liver weight(r=0.804 at p≤0.01), gonad weight(r=0.218 at p≤0.05), and kidney weight (r=0.854 at p≤0.01). Similarly stomach weight showed a significant correlation with liver weight(r=0.908 at p≤0.01), gonad weight (0.361 at p≤0.01) and kidney weight (r=0.835 at p≤0.01). However, liver weight displayed significant positive correlation ovary weight(r=0.257 at p≤0.05) and kidney weight (r=0.824 at p≤0.01) and also there was a significant correlation between gonad weight and kidney weight(r=0.171 at p≤0.05).

Correlation analysis (season wise):

Table 34: Correlation coefficient(r) matrix among biological parameters of Indian major carps in summer season

Parameter	BW	TL	SL	HW	STL	STW	LW	GW	KW
BW	1.000								
TL	.942**	1.000							
SL	.910**	.986**	1.000						
HW	.779**	.688**	.628**	1.000					
STL	.737**	.702**	.705**	.667**	1.000				
STW	.594**	.507**	.536**	.521**	.680**	1.000			
LW	.827**	.789**	.782**	.674**	.540**	.620**	1.000		
GW	.301**	.315**	.345**	.049	.133*	-.042	.327**	1.000	
KW	.449**	.397**	.346**	.516**	.415**	.192**	.329**	-.024	1.000
**. Correlation is significant at the 0.01 level (2-tailed).									
*. Correlation is significant at the 0.05 level (2-tailed).									

Analysis of correlation matrix among different biochemical parameters of the three different species of Indian major carps in summer season were represented in the Table 34. Analysis of correlation matrix pointed to the fact that body weight was significantly and positively correlated with all other biological parameters such as total length, standard length, heart weight, stomach length, stomach weight, liver

weight, gonad weight and kidney weight with r value varying between 0.301(gonad weight) to 0.942(total length) at p≤0.01. In the same way, a strong positive correlation was also observed by the total length with standard length, heart weight, stomach length, stomach weight, liver weight, gonad weight and kidney weight with r value varying between 0.315(gonad weight) to 0.986(standard length) at p ≤0.01. Standard length of the carps also displayed significant positive correlation with heart weight, stomach length, stomach weight, liver weight and kidney weight with r value varying between 0.345(gonad weight) to 0.782(liver weight) at p ≤0.01 where as it showed a significant correlation with gonad weight(r=0.133) at p≤0.05. Similarly, heart weight was also significantly correlated with stomach length(r=0.667 at p≤0.01), stomach weight(r=0.521 at p≤0.01), liver weight (r=0. 674 at p≤0.01) and kidney weight (r=0.516 at p≤0.01), but it was negatively correlated with gonad weight(r=0.049). Stomach length was significantly and positively correlated with stomach weight (r=0.680 at p≤0.01), liver weight(r=0.540 at p≤0.01) and kidney weight (r=0.415 at p≤0.01) where as it showed a significant correlation with gonad weight(r=0.133) at p≤0.05. Stomach weight also showed a significant correlation with liver weight(r=0.620 at p≤0.01) and kidney weight (r=0.192 at p≤0.01) whereas it displayed no significant correlation with gonad weight(r=0.049) . However, liver weight displayed significant positive correlation gonad weight(r=0.327 at p≤0.01) and kidney weight (r=0.329 at p≤0.01) but a negative correlation was found between gonad weight and kidney weight(r=0.024).

Table 35: Correlation coefficient(r) matrix among biological parameters of Indian major carps in rainy season

Parameter	BW	TL	SL	HW	STL	STW	LW	GTW	KW
BW	1.000								
TL	.940**	1.000							
SL	.909**	.971**	1.000						
HW	.862**	.891**	.852**	1.000					
STL	.812**	.811**	.818**	.791**	1.000				
STW	.603**	.541**	.569**	.589**	.716**	1.000			
LW	.738**	.741**	.701**	.837**	.686**	.621**	1.000		
GTW	.188*	.227*	.174*	.210*	.199*	.089	.032	1.000	
KW	.750**	.757**	.743**	.728**	.667**	.488**	.713**	-.006	1.000
**. Correlation is significant at the 0.01 level (2-tailed).									
*. Correlation is significant at the 0.05 level (2-tailed).									

Correlation analysis among different biochemical parameters of the three different species of Indian major carps during rainy season were represented in the Table 35. Correlation analysis indicated that body weight showed significant positive correlation with all other biological parameters such as total length(r=0.940 at p≤0.01), standard length(r=0.909 at p≤0.01), heart weight(r=0.862 at p≤0.01), stomach length(r=0.812 at p≤0.01), stomach weight(r=0.603 at p≤0.01), liver weight(r=0.738 at p≤0.01) and kidney weight (r=0.750 at p≤0.01) except with gonad weight(r= 0.188) where correlation is positive and significant at p≤0.05. Similarly a strong positive correlation was also observed by the total length with standard length(r=0.971 at p≤0.01), heart weight(r=0.891 at p≤0.01), stomach length(r=0.811 at p≤0.01), stomach weight(r=0.541 at p≤0.01), liver weight(r=0.741 at p≤0.01) and kidney weight (r=0. 757 at p≤0.01) along with a exceptional positively significant correlation with gonad weight (r=0.227) at p≤0.05. Likewise standard length of the carps displayed significant positive correlation with heart weight(r=0.852 at p≤0.01), stomach length(r=0.818 at p≤0.01), stomach weight(r=0.569 at p≤0.01), liver weight(r=0.701 at p≤0.01), and kidney weight (r=0.743 at p≤0.01) excluding gonad weight with significant correlation(r=0.174) at p≤0.05. Heart weight was also significantly correlated with stomach length(r=0.791 at p≤0.01), stomach weight(r=0.589 at p≤0.01), liver weight (r=0.837 at p≤0.01) and kidney weight (r=0.728 at p≤0.01) apart from a positive significant correlation with gonad weight(r=0.210) at p≤0.05. Stomach length was significantly and positively correlated with stomach weight(r=0.632 at p≤0.01), liver weight(r=0.568 at p≤0.01) and kidney weight (r=0.452 at p≤0.01) with an exception of positive significant correlation (r= 0.199) at p≤0.05. Stomach weight also showed a significant correlation with liver weight(r=0.621 at p≤0.01) and kidney weight (r=0.488 at p≤0.01) whereas it displayed no significant correlation with gonad weight(r=0.089). Similarly, liver weight though displayed significant positive correlation kidney weight (r=0.713at p≤0.01) but no correlation was found with gonad weight(r= 0.032). On the other hand, kidney weight showed a negative correlation with gonad weight(r=- 0.006).

Table 36: Correlation coefficient(r) matrix among biological parameters of Indian major carps in winter season

Parameter	BW	TL	SL	HW	STL	STW	LW	GW	KW
BW	1.000								
TL	.957**	1.000							
SL	.924**	.984**	1.000						
HW	.887**	.811**	.754**	1.000					
STL	.834**	.784**	.761**	.748**	1.000				
STW	.642**	.629**	.598**	.540**	.685**	1.000			
LW	.893**	.878**	.849**	.800**	.786**	.723**	1.000		
GW	.956**	.337**	.343**	.252*	.318**	.339**	.345**	1.000	
KW	.905**	.859**	.834**	.833**	.805**	.628**	.926**	.364**	1.000
**. Correlation is significant at the 0.01 level (2-tailed).									
*. Correlation is significant at the 0.05 level (2-tailed).									

Analysis of correlation matrix among different biochemical parameters of the three different species of Indian major carps during winter season were represented in the Table 36. Analysis of correlation matrix indicated that body weight showed significant positive correlation with all other biological parameters such as total length, standard length, heart weight, stomach length, stomach weight, liver weight, gonad(ovary) weight and kidney weight with r value fluctuating between 0.642(stomach weight) to 0.957(total length) at p≤0.01. Similarly a strong positive correlation was also observed by the total length with standard length, heart weight, stomach length, stomach weight, liver weight, gonad(ovary) weight and kidney weight with r value varying between 0.629(stomach weight) to 0.984(standrd length) at p ≤0.01. Likewise standard length of the carps displayed significant positive correlation with heart weight(r=0.754 at p≤0.01), stomach length(r=0.761 at p≤0.01), stomach weight (r=0.598 at p≤0.01), liver weight (r=0.849 at p≤0.01), gonad weight(r=0.343 at p≤0.01), and kidney weight (r=0.834 at p≤0.01). Heart weight was also significantly correlated with stomach length(r=0.748 at p≤0.01), stomach weight(r=0.540 at p≤0.01), liver weight(r=0.800 at p≤0.01) and kidney weight (r=0.833 at p≤0.01) apart from a positive significant correlation with gonad weight(r= 252) at p≤0.05. Stomach length was significantly and positively correlated with stomach weight(r=0.685 at p≤0.01), liver weight(r=0.786 at p≤0.01), gonad weight(r=0.318 at p≤0.01) and kidney weight (r=0.805 at p≤0.01). Stomach weight

also showed a significant correlation with liver weight(r=0.723 at p≤0.01), gonad weight(r=0.339 at p≤0.01) and kidney weight (r=0.628 at p≤0.01) However, liver weight displayed significant positive correlation gonad weight(r=0.345 at p≤0.01) and kidney weight (r=0.926 at p≤0.01). Also a strong positive correlation was found between gonad weight and kidney weight(r=0.364 at p≤0.01).

PERCENTAGE ANALYSIS:

The percentage analysis of anatomical traits (**HW, STL, STW, LW, GW, and KW**) of Indian major carps with respect to BW0 was recorded in the Table -37.

Percentage analysis of the average weight of heart, length of stomach, weight of stomach, weight of liver , weight of gonads (pair), weight of kidney to body weight of all carps under study were recorded in Table-30 as, 0.098%, 2.16%, 0.39%, 1.107%, 0.06% and 0.211% respectively. The season wise percentage analysis revealed that percentage of heart weight to body weight of summer, rainy and winter season were 0.904%, 0.908% and 0.100% respectively with no significant difference between them. Similarly, species wise analysis of percentage of heart weight with respect to body weight showed no significant difference among the values of *L.rohita* (0.09%), *C.mrigala* (0.093%) and *C. catla* (0.109%) Along with the age, percentage of HW increases from 0.084% of A1 to 0.102% of A2 and 0.100% of A3. The HW percentage to BW is slightly higher in males (0.101%) than in female carps (0.096%). Likewise, percent of STL to BW was recorded highest in summer season (2.25%) than in rain (2.17%) and winter (2.06%). Species wise percentage analysis revealed that percent of STL to BW was recorded highest in *L.rohita* (2.37%) than in *C.mrigala* (2.18%) and *C. catla* (1.97%). It is found that with the increase of age, percentage of STL to BW decreases (A1=3.115%, A2=2.215% and A3=1.77%).

Table 37: Percentage analysis of anatomical traits (**HW, STL, STW, LW, GW, KW**) of Indian major carps w.r.t. BW **(N=540)**

SlNo	Factors		BW	HW	%	STL	%	STW	%	LW	%	GW	%	KW	%
1	Overall		467.78±8.06	0.46±0.01	0.098	10.13±0.10	2.16	1.81±0.05	0.39	5.18±0.3	1.107	4.96±0.79	0.06	0.99±0.04	0.211
2	Season	Summer	446.81±12.92	0.42±0.02	0.094	10.05±0.17	2.25	1.63±0.08	0.36	5.36±0.21	1.20	5.89±1.87	1.32	1.34±0.06	0.30
		Rainy	478.17±14.27	0.47±0.02	0.098	10.4±0.15	2.17	1.67±0.08	0.35	4.43±0.20	0.93	7.55±1.44	1.58	1.61±0.08	0.33
		Winter	478.37±14.62	0.48±0.02	0.100	9.86±0.15	2.06	2.14±0.09	0.45	5.73±0.22	1.20	1.45±0.17	0.30	1.62±0.08	0.34
3	Species	*L.rohita*	445.08±14.14	0.40±0.02	0.090	10.5±0.18	2.37	2.36±0.11	0.53	4.51±0.21	1.01	2.91±1.05	0.65	0.40±0.06	0.31
		C.mrigala	453.42±15.02	0.42±0.02	0.093	9.90±0.14	2.18	1.60±0.06	0.35	5.11±0.21	1.13	10.28±2.08	2.27	1.40±0.08	0.308
		C.catla	504.85±12.28	0.55±0.02	0.109	9.94±0.15	1.97	1.49±0.07	0.29	5.90±0.21	1.17	1.70±0.17	0.34	1.75±0.08	0.35
	Age group	A1	263.22±4.41	0.22±0.003	0.084	8.20±0.08	3.115	1.01±0.04	0.379	2.61±0.07	0.991	1.41±0.34	0.536	0.73±0.03	0.277
		A2	449.57±5.56	0.46±0.14	0.102	9.96±0.09	2.215	1.68±0.06	0.374	5.15±0.17	1.15	3.96±0.87	0.88	1.48±0.06	0.329
		A3	689.23±5.16	0.69±0.01	0.100	12.22±0.12	1.77	2.75±0.10	0.398	7.75±0.18	1.124	9.49±2.14	1.377	2.40±0.07	0.348
5	Sex	M	469.59±11.75	0.45±0.02	0.096	10.12±0.12	2.155	1.86±0.07	0.396	5.17±0.17	1.10	0.02±0.002	0.004	1.53±0.06	0.326
		F	465.97±11.08	0.47±0.01	0.101	10.14±0.14	2.176	1.78±0.07	0.382	5.19±0.18	1.113	9.90±1.53	2.125	1.52±0.06	0.326

BW – Body weight, HW – Weight of heart, STL – Length of stomach, STW – Weight of stomsach, LW – Weight of liver, GW – Weight of gonads (pair), KW - Weight of kidney

According to season wise percentage analysis of STW to BW, lowest percentage was observed in rainy season (0.35%) in comparison to summer (0.36%) and highest value was observed in winter season (0.45%). Species wise analysis of percentage of STW to BW displayed a gradual decrease of values from *L.rohita* (0.53%) to *C.catla* (0.29%). However, highest percentage of STW to BW was found in A3 (0.398%), lower value in A1 (0.379%) and lowest value in A2 (0.374%). Sex wise a slight higher percentage of STW to BW was observed in male (0.396%) than female ones (0.382). Percentage of STL to BW was found more in females (2.176%) than in males (2.155%) Indian carps. As per percentage analysis of LW to BW concerned, almost same percent was found in both summer and winter season (1.20%) and lowest percent in rainy season (0.93%). Species wise, percentage of LW to BW was highest in *C.catla* (1.17%), lower in *C.mrigala* (1.13%) *and* lowest in *L.rohita* (1.01%). Along with the increase of age the percentage of STW to BW was increased from 0.991% (A1) to 1.15% (A2) and lower down in age group A3 Indian carps (1.124%). It was found that the percentage of LW to BW in male Indian carps (1.10%) which was lower than the percentage value in females (1.113%). However, as per the percentage of GW to BW concerned , season wise highest and lowest value were observed in rainy season (1.58%) to winter(0.30%) and species wise values were found in *C.mrigala* (2.27%) to *C.catla* (0.34%). However, age wise analysis of percentage of GW to BW showed a steady increase in percentage of A1 (0.536%) to A3 (0.377%) and sex wise lower percentage of male carps (0.004%) was found than that of females (2.125%). As per the percentage of KW to BW was concerned the percentage of summer, rainy and winter were 0.30%, 0.33% and 0.34% respectively with highest value in winter season. Species wise and age wise percentage analysis of KW to BW revealed that highest value and lowest value were observed in *C.catla* (0.35%) and *C.mrigala* (0.308%); A3 (0.348%) and A1 (0.277%) respectively. However, same percentage value of KW to BW was observed in both male Indian carps (0.326%) and females (0.326%).