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Full Length Research Paper

Biochemical modulation in male specimens of *Channa punctatus* (Bloch) under different habitats and seasons

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Studies were undertaken to identify the changes in biochemical parameters including water content, lipid and protein in tissues of liver, testis and muscle of *Channa punctatus* under natural and captive conditions along with physico-chemical parameters for the period January to December, 2008. Result shows that values of lipid in captive condition in muscle, liver and testis ranged from 1 to 4, 1.98 to 5.57 and 1.25 to 4.40%, respectively while in natural habitat, values ranged from 1 to 5, 1.94 to 5.16 and 1.21 to 5.13%, respectively. Water content in captive condition was observed to be in the range of 74.72 to 80.73, 73.97 to 76.92 and 75.56 to 77.97%, respectively and in natural habitat it varied from 72.65 to 80.70, 71.61 to 76.89 and 72.41 to 77.94%, respectively. An increase in water content was observed towards maturation in testis. Protein content in muscle under captive and natural habitat was in the range of 15.97 to 19.37 and 16.70 to 19.40%, respectively. All parameters showed a significant variation ($p<0.01$) and significant correlation ($p<0.01$) among the muscles, liver and testis in specimens under captive as well as natural habitat. Peak spawning period in nature was observed during May to August in captive condition indicating that gonadal development and its cyclicity is influenced by the physico-chemical parameters, food and feeding conditions, environmental factors and other stresses. This study shows that the variation in biochemical changes are influenced by variation in seasons due to physico-chemical parameters of the habitat and perhaps the niche.

Key words: Habitat, *Channa punctatus*, testis, biochemical change, physico-chemical parameter.

INTRODUCTION

Murrels are highly priced fishes all over India for their good keeping quality, unique flavour, nutritive, recuperative and medicinal properties (Chakraborty, 2006). The species is an opportunistic feeder that feeds upon fishes and fish larvae, annelids, crustaceans amphibians and gastropods. Wee (1982) cited a study by Pandey and Dwivedi (1974) in which it was shown that *Channa punctatus* has well developed olfactory organs in the nasal sacs and taste buds extending into oesophagus and thus concluded that this species locates food by odor.

C. punctatus, locally known as Girai, a tropical fish widely used for medicinal purpose, is also an important food source in Asia pacific region (Hossain et al., 2008). This carnivorous air-breather species is encountered in rivers, swamps, ponds, canals, reservoirs, rice fields, small streams, ditches and lakes across Southern Asia (Mohsin and Ambak, 1983; Hossain et al., 2008).

MATERIALS AND METHODS

The yearlings of *C. punctatus* were collected from reservoir and culture pond under captive condition in College of Fisheries, Pantnagar. Sampling was done monthly. The yearlings kept in culture pond under captive conditions were fed twice at 10 AM and 6 PM daily with supplementary feed consisting of rice bran, fish

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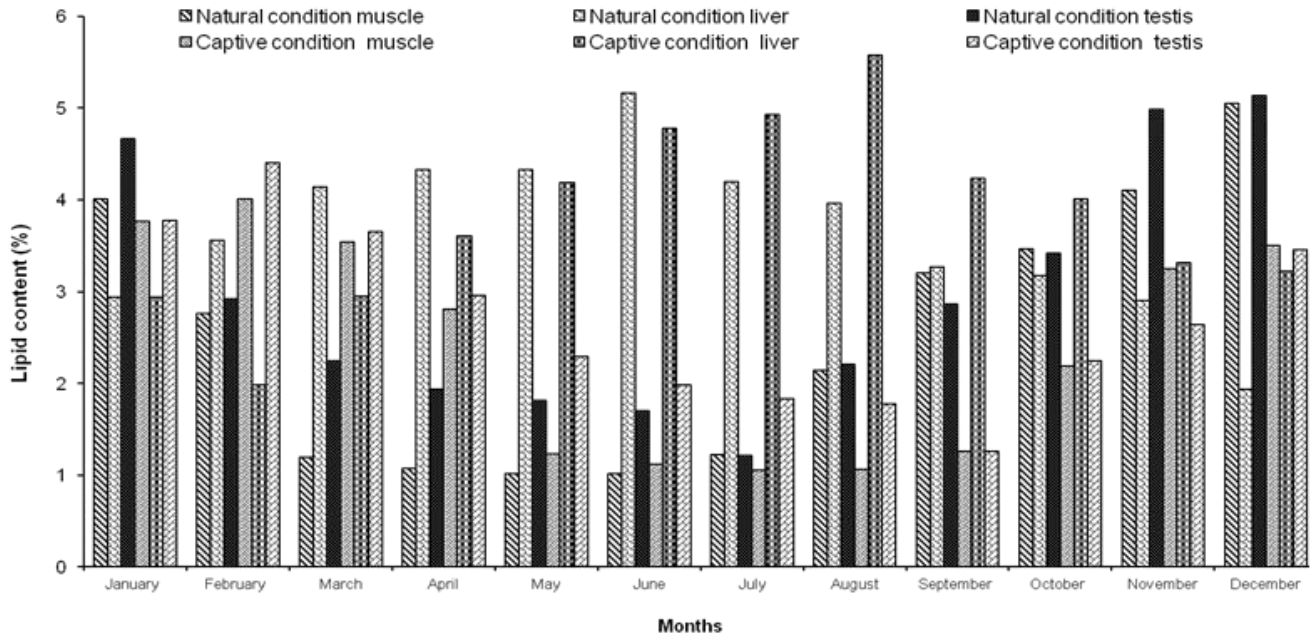

Figure 1. Annual variation in lipid content of liver, muscle and testis of male fish Channa punctatus in natural and captive condition.

meal and oil cake (1:1:1) having 22% protein content as normal practice twice a day

Sampling was done on monthly basis to assess the biochemical changes namely: water content, lipid and protein in tissue of muscle, liver and gonad. For estimation of water content in the tissue from muscle, liver and gonad, sample was weighed by a single pan electronic balance and of which wet weight was taken. All samples were dried in electric oven at 55 to 60°C separately till constant dry weight was recorded and observed. The water percentage in each sample was determined according to following formula,

$$\text{Water}(\%) = \frac{\text{Wet weight}(g) - \text{Dry weight}(g)}{\text{Wet weight}(g)} \times 100$$

Protein was estimated following the Lowry's method as described by Sadasivam and Manickam (1996). Five hundred milligram (500 mg) dried and ground sample was taken and homogenized properly after adding 5 ml of extraction buffer. Then sample was taken in an Eppendorf tube and centrifuged at 9000 rpm for 20 min to remove the debris. The supernatant was separated and stored after measuring its volume for estimation of protein concentration. The lipid extraction was done by the method as described by Folch et al. (1957).

Water quality of experimental ponds was recorded on monthly basis for water temperature, pH and dissolved oxygen, total dissolved solids, alkalinity, CO_2 and conductivity. Dissolved oxygen, free CO_2 and alkalinity were analyzed using titrimetric method (APHA, 1992) and temperature, pH, total dissolved solids and conductivity were measured using electronic digital meter.

RESULTS

Changes in lipid concentration in muscle, liver and testis are shown in Figure 1. Lipid concentration in muscle was 5.05% high in December, higher level was exhibited during September to January (post spawning and resting phase) and started decreasing from February (preparatory phase). Decreasing level of lipid was noticed during March to June with lowest level recorded (1.01%) during May and June (spawning phase) in nature whereas in captive condition specimens, lipid concentration level was high during November to February with maximum value 4.01% in February, which started decreasing from March to October with minimum value 1.05% in July, it had a significant monthly variation (Tables 8 and 9).

In specimens from nature the liver lipid concentration showed a marked variation with increasing trend from January to June with total variation in the range of 1.94 to 5.16% and decreasing trend was recorded from July to December which was lowest in December and highest in June (Figure 1) (Table 8). Monthly variation in lipid concentration was significantly different ($p<0.01$) and had a negative correlation with muscle ($p<0.01$, $r = -0.952$).

Changes in liver lipid from the specimen of captive condition showed an increasing trend during April to August having a maximum value (5.57%) in August and decreasing trend was found from September to February with minimum value of 1.98% in February. A significant correlation amongst the months ($p<0.01$) and a negative correlation with muscle ($p<0.01$, $r = -0.922$) was recorded (Table 9).

Changes in lipid concentration level in testis of specimens from nature was high from August to January with maximum value of 5.13% in December and started decreasing from January onward to July with minimum value of 1.21% in July (Table 9). Significant different level were found month wise and had negative correlation with

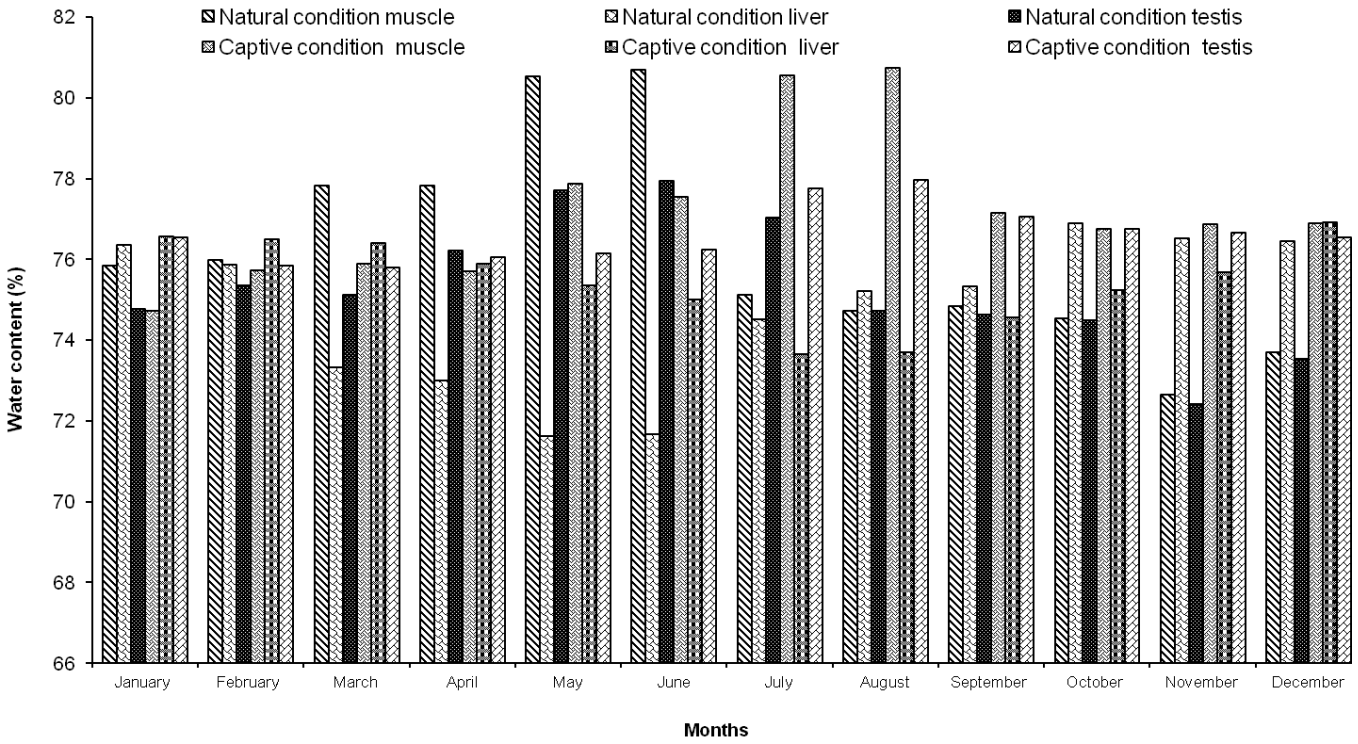

Figure 2. Annual variation in water content of liver, muscle and testis of male fish Channa punctatus in natural and captive condition.

Table 1. Analysis of variance for biochemical composition of lipid (muscle, liver and testis) (%) of male in captive.

Source of variance	D.F.	Sum of square	Mean sum of square	F-value
Months	11	16.922	1.538	20.818**
Lipid	2	40.003	20.001	68.428**
Month × Lipid	22	94.483	4.294	57.914**
Error	72	1.532	0.021	
Total	107	152.942		
Months			0.1819	
Lipid			0.0998	
Month × Lipid			0.3151	

*Significant at 1% level of significance.

Table 2. Analysis of variance for biochemical composition of water content (muscle, liver and testis) (%) of male in nature.

Source of variance	D.F.	Sum of square	Mean sum of square	F-value
Months	11	64.340	5.849	20.818**
Lipid	2	38.451	19.225	68.428**
Month × lipid	22	357.979	16.271	57.914**
Error	72	20.229	0.280	
Total	107	481.00		
Months			0. 6611	
Lipid			0.3305	
Month × lipid			1.1451	

**Significant at 1% level of significance.

liver lipid ($p<0.01$, $r = -0.894$) while positive with muscle lipid ($p<0.01$, $r = 0.945$).

Trend of lipid concentration in testis of specimen from captive condition showed that lipid level was high in the month of February with 4.40%, and minimum in the month of September 1.25% (Table 9). There was a significant variation month wise (Table 1). Correlation between testis and liver lipid was found to be negative ($p<0.01$, $r = -0.877$), and in between nature and captive condition ($p<0.01$, $r = 0.402$) was found to be positive.

Recorded values of water content in muscles of male specimen from nature (Figure 2) shows that higher level of water content in the muscle recorded in the month of June was 80.70% and minimum in December was 72.65% with total variation of 8.05% (Table 8). Statistical analysis of monthly variation showed the significant difference (Table 2). Whereas the values of water content in samples from captive condition showed that higher level of water content in muscle in August was 80.73% and minimum in January was 74.72% with variation of 6.01% (Table 3). Analysis showed month wise significant variation ($p<0.01$).

Values presented in Figure 2 indicate that maximum value of water content in the liver of specimens from nature in the month of October was 76.89% and minimum in June (71.61%) with 5.28% variation (Table 8);

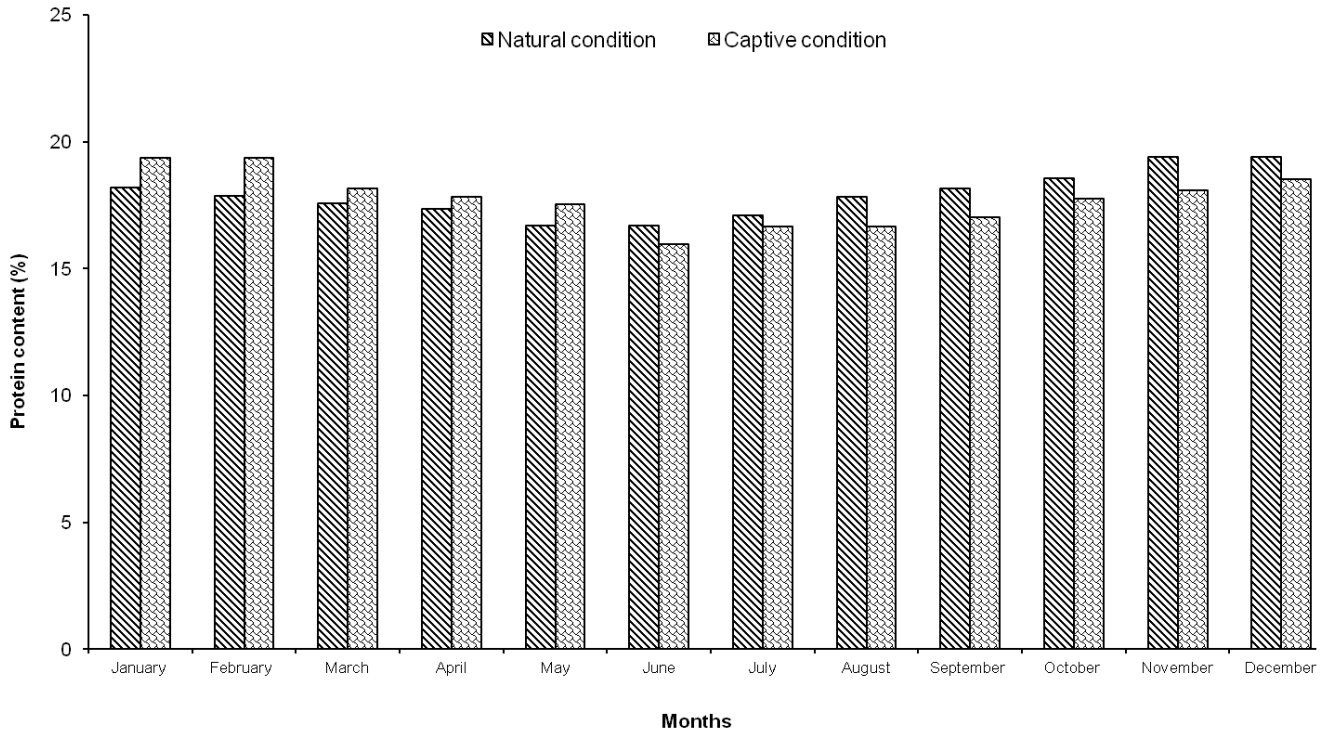

Figure 3. Annual variation in protein content of liver, muscle and testis of male fish Channa punctatus in natural and captive condition.

Table 3. Analysis of variance for biochemical composition of water content (muscle, liver and testis) (%) of male in captive.

Source of variance	D.F.	Sum of square	Mean sum of square	F-value
Months	11	23.375	2.488	11.054**
Lipid	2	56.541	28.270	125.583
Month × lipid	22	140.125	6.369	28.293**
Error	72	16.208	0.225	
Total	107	240.250		
Months			0.5818	
Lipid			0.2959	
Month × lipid			1.025	

**Significant at 1% level of significance.

Table 4. Analysis of variance for biochemical composition of protein (%) of male in nature.

Source of variance	D.F.	Sum of square	Mean sum of square	F-value
Months	11	26.976	2.452	160.86**
Error	24	0.365	0.015	
Total	35	27.342		
CD at 1%			0.2819	

**Significant at 1% level of significance.

monthly wise there was significant difference (Tables 2 and 3). In captive conditions, maximum water content was in December (76.92%) and minimum in August (73.97%) (Table 9) with the variation of 2.95%; monthly wise, there was significant difference ($p<0.01$) and negative correlation with water content in muscle ($p<0.01$, $r = -0.841$).

Water content in testis of specimens from nature was high in June (77.94%) and minimum (72.41%) in November (Table 8); variation of 2.47% showed significant difference amongst the months ($p<0.01$) and had non-significant correlation with muscle and liver water content ($p<0.01$, $r_1 = -0.137$; $p<0.01$, $r_2 = -0.177$).

Captive conditions specimens had maximum water content in August (77.97%) and minimum in February (75.56%) (Table 9). Variation of 2.47% showed significant monthly variation ($p<0.01$) and had non-significant correlation with muscle and liver water content ($p<0.01$, $r = -0.137$; $p<0.01$, $r = 0.177$).

Changes in the protein content of muscle in the male specimen from nature and captive conditions are shown in (Figure 3, Tables 8 and 9). Protein value was high (19.40%) in the month of November and minimum (16.70%) in May with the variation of 2.70%. It showed month wise significant difference (Table 4) and had significant correlation ($p<0.05$, $r = 0.411$).

While the case of specimens from captive conditions ranged from 15.97 to 19.37%; value was at its maximum in January and minimum in June (16.70±0.140). It also showed significant variation (Table 5).

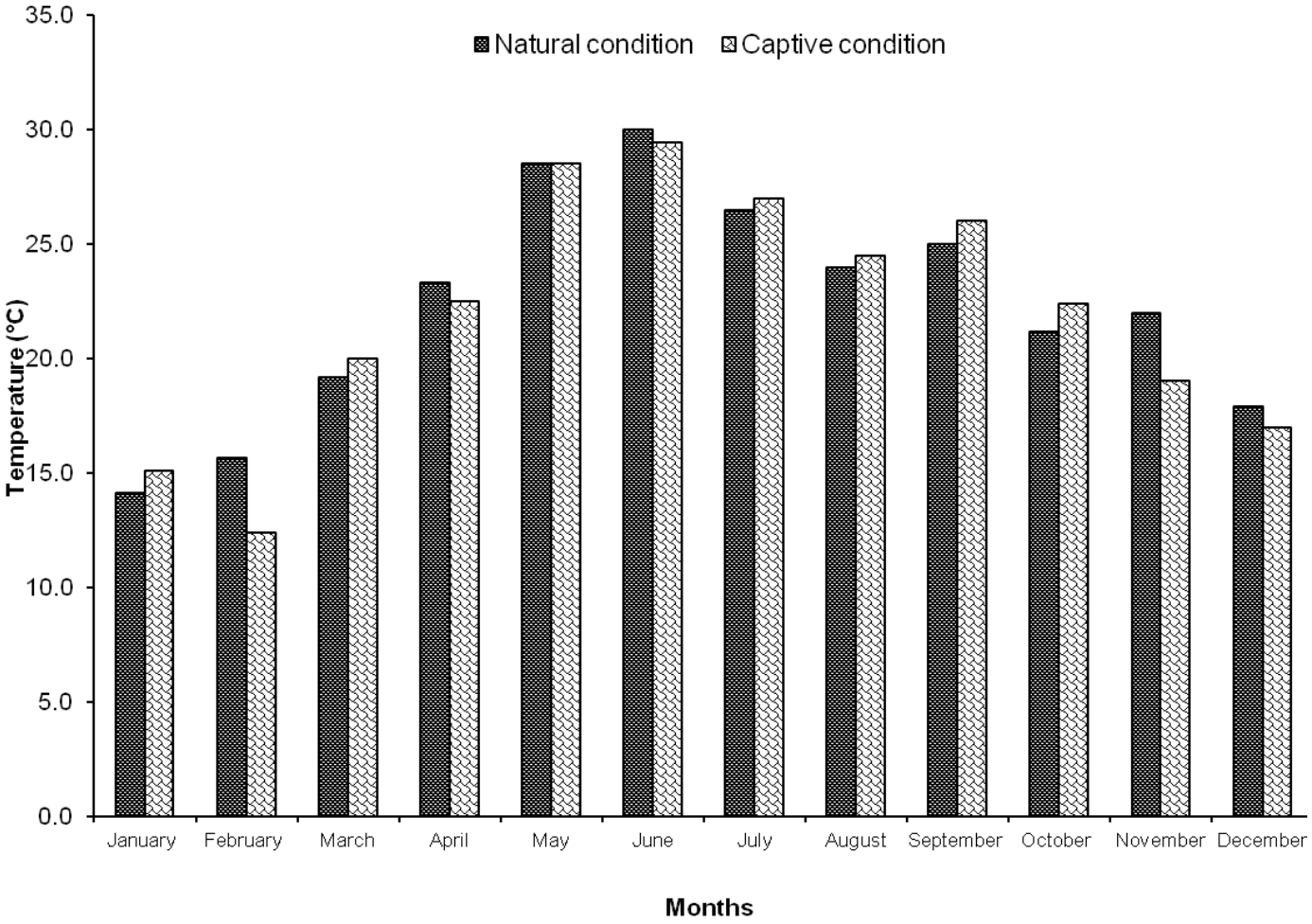

Figure 4. Annual variation in temperature during experiment.

Table 5. Analysis of variance for biochemical composition of protein (%) of male in captive.

Source of variance	D.F	Sum of square	Mean sum of square	F-value
Months	11	36.541	3.321	7.282**
Error	24	10.947	0.456	
Total	35	47.488		
CD at 1%			1.5423	

**Significant at 1% level of significance.

Protein content in case of nature had positive and significant correlation with lipid of muscles and testis (r_1 = 0.922 and r_2 = 0.902) and also shows significant positive correlation ($p<0.01$, r = 0.412) with liver water content whereas negative with liver lipid ($p<0.01$, r = 0.534). It had significant negative correlation with water content of muscle and testis ($p<0.01$, r_1=0.839, r_2=-0.888). In captive condition specimens positive and significant correlation of protein with lipid of muscle and testis ($p<0.01$, r_1 = 0.802 and r_2 = 0.769) was found, and while with liver lipid negative and significant correlation ($p<0.01$, r = -0.789) was also observed. Correlation of protein with water content of muscle and liver was significant ($p<0.01$, r_1 = -0.548, r_2 = 0.689) and water content of testis was non-significant.

Observations regarding physico-chemical parameter (natural habitat vs. captive condition) are presented in Figures 4 to 10. Parameter like temperature ranged from 17.9 to 30°C and 12.38 to 29.41°C, pH 7.03 to 7.5 and 7.10 to 7.80; dissolved oxygen (D.O.) 5.40 to 8.00 ppm and 5.50 to 7.06 ppm; total dissolved solid (TDS) 155 to 301 ppm and 160 to 177 ppm, and conductivity 198 to 307 us/cm, 255 to 289 us/cm were recorded in natural habitat as well as captive condition, respectively. There, month wise and between sources, variation was significantly different (Tables 6 and 7). While free carbon dioxide (Free CO_2) ranged from 0.00 to 1.63 and 0.00 to 1.83 ppm, alkalinity values ranged from 88 to 139 and 102 to 125 ppm in natural habitat and captive conditions respectively. There month wise variation was significant but between the

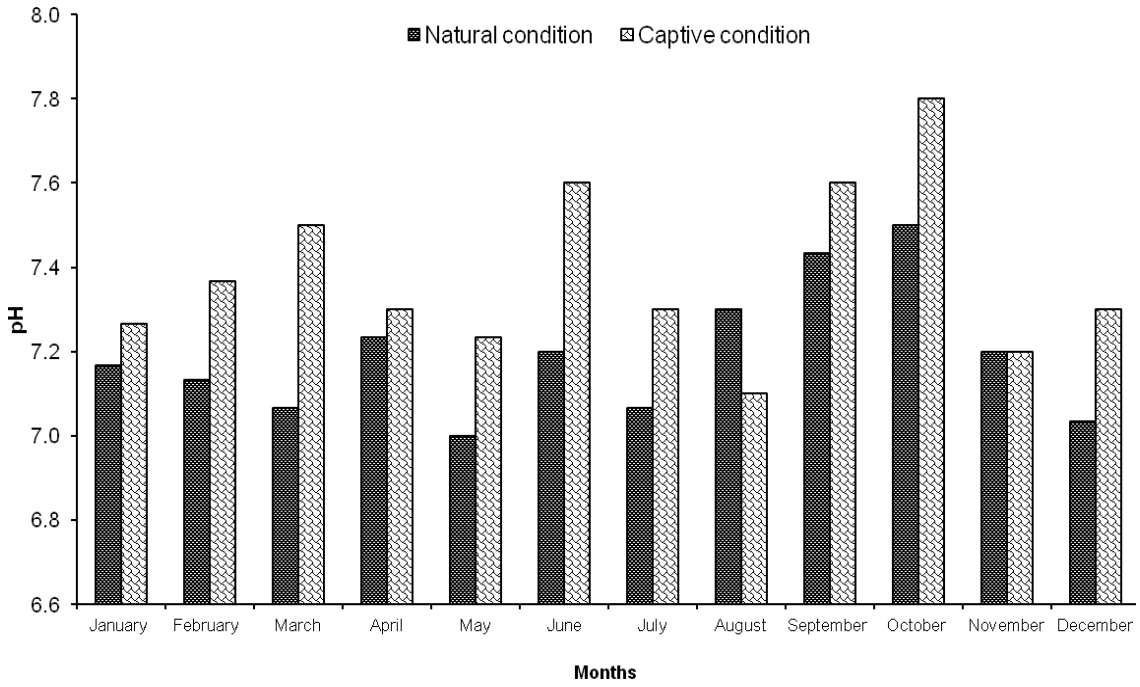

Figure 5. Annual pH variation during experiment.

Table 6. Physico-chemical parameter in nature.

Month	Temperature (°C)	pH	D.O. (ppm)	CO_2 (ppm)	Alkalinity (ppm)	TDS(ppm)	Conductivity (µs/cm)
January	14.13±0.05	7.16±0.28	6.10±0.10	91.00±1.00	0.00±0.00	154.00±1.00	224.00±1.00
February	15.66±0.05	7.13±0.05	5.90±0.10	0.00±0.00	90.00±1.00	165.00±1.00	265.00±1.00
March	19.17±0.14	7.06±0.11	6.20±0.10	1.00±0.50	99.00±1.00	168.00±1.00	268.00±1.00
April	23.33±0.20	7.23±0.05	5.70±0.10	1.33±0.28	99.33±4.93	170.00±1.00	281.00±1.00
May	28.50±0.10	7.00±0.00	5.40±0.10	0.00±0.00	102.00±1.00	169.00±1.00	235.00±1.00
June	30.00±0.5*	7.20±0.20	6.40±0.05	1.63±0.32	95.00±1.00	301.00±1.00	293.00±1.00
July	26.50±0.50	7.06±0.11	6.06±0.10	0.15±0.25	105.00±1.00	271.33±5.85	307.00±1.00
August	24.00±0.50	7.30±0.10	6.60±0.10	1.30±0.26	88.00±1.00	198.00±1.00	300.66±1.52
September	25.00±0.50	7.43±0.15	6.50±0.10	1.06±0.11	90.00±1.00	181.00±1.00	265.00±1.00
October	21.16±0.28	7.50±0.10	7.00±0.00	0.20±0.34	127.00±1.00	164.00±1.00	254.00±1.00
November	22.00±0.50	7.20±0.10	8.00±0.00	0.46±0.41	130.00±1.00	155.00±1.00	231.66±6.65
December	17.90±0.10	7.03±0.05	7.20±0.10	1.10±0.10	139.00±1.00	169.00±1.00	198.00±1.00
Minimum	17.90±0.10	7.00±0.00	5.40±0.10	0.00±0.00	88.00±1.00	154.00±1.00	198.00±1.00
Maximum	30.00±0.50	7.50±0.10	8.00±0.00	1.63±0.32	139.00±1.00	301.00±1.00	307.00±1.00

Values are mean± SD.

sources was negative (Tables 6 and 7).

DISCUSSION

Biochemical composition in terms of lipid, water content and protein content in tissue of muscle, liver and gonads for reproduction and other activity varied significantly.

Month wise variation in proximate biochemical composition was found to be high in natural condition and this might be due to local ecological impact and natural genuine feed availability. Mohanty and Samantaray (1996) reported the seasonal variation in their biochemical composition. Lipid fat and protein content in various organs affected by the species, sex, age, water temperature, degree of pollution, nutritional condition, seasonal variation and its origin (Gill and Weatherly, 1984; Lathi, 1987; Folch et al., 1957; Akpmar, 1986a; Konar et al., 1999; Agren et al., 1987; Dutta et al., 1985; Yilmaz et al., 1995, 1996). The above results have similar

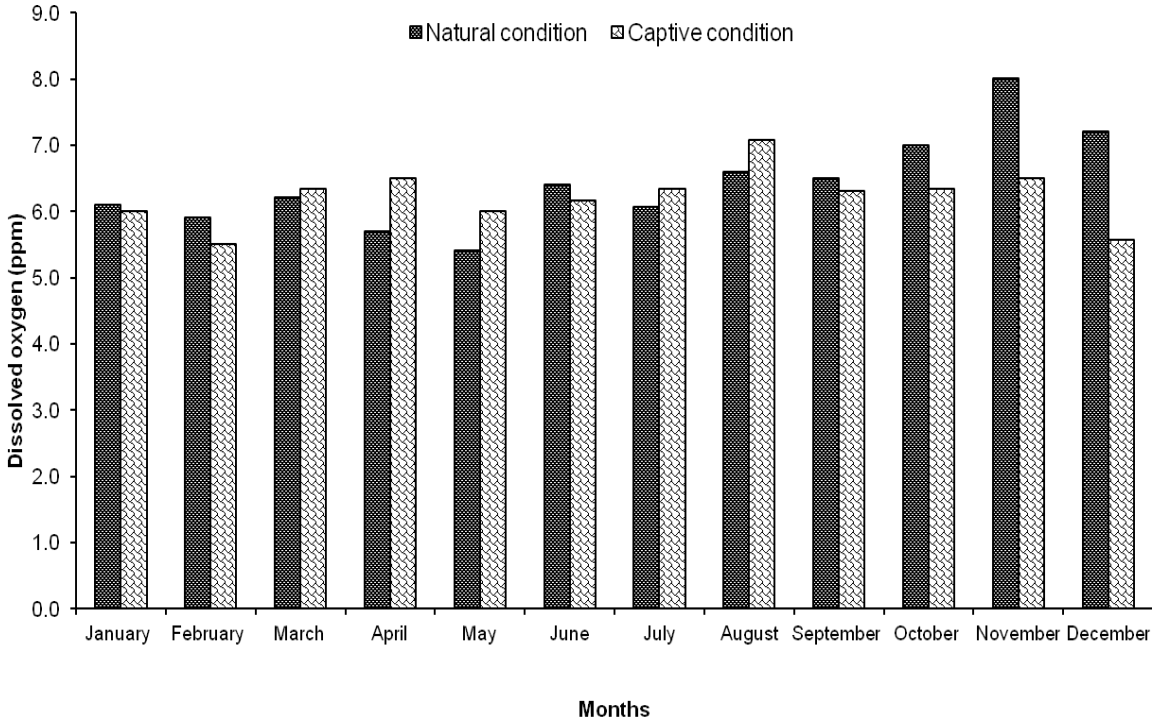

Figure 6. Annual variation in dissolved oxygen (DO) during experiment.

Table 7. Physico-chemical parameter in captive.

Month	Temperature (°C)	pH	D.O. (ppm)	CO_2 (ppm)	Alkalinity (ppm)	TDS (ppm)	Conductivity (µs/cm)
January	15.08±0.14	7.26±0.15	6.00±0.50	1.16±0.28	125.00±1.00	160.00±2.00	287.00±2.00
February	12.38±0.20	7.36±0.32	5.50±0.50	1.83±0.28	116.33±1.52	168.00±2.00	275.00±2.00
March	20.00±0.50	7.50±0.50	6.33±0.28	0.00±0.00	120.00±1.00	177.00±2.00	289.00±2.03
April	22.50±0.50	7.30±0.10	6.50±0.50	0.00±0.00	124.33±0.57	162.16±2.02	276.30±2.06
May	28.50±0.50	7.23±0.15	6.00±0.50	0.42±0.28	108.00±1.00	170.00±2.00	282.00±1.99
June	29.41±.14	7.60±0.10	6.16±1.25	0.69±0.13	110.00±2.00	169.00±2.00	284.00±1.85
July	27.00±0.50	7.30±0.10	6.33±0.15	1.00±0.10	115.00±2.00	171.00±2.00	290.00±2.00
August	24.50±0.50	7.10±0.10	7.06±0.11	0.50±0.10	102.66±0.76	163.00±2.00	259.16±2.02
September	26.00±0.50	7.60±0.10	6.30±0.10	0.70±0.10	106.83±0.76	161.00±2.00	258.00±2.00
October	22.40±0.40	7.80±0.10	6.33±0.28	0.10±0.17	110.00±2.00	168.00±2.00	261.00±2.05
November	19.00±0.50	7.20±0.10	6.50±0.50	0.66±1.15	110.66±1.44	170.00±2.00	255.00±2.00
December	17.00±0.50	7.30±0.10	5.56±0.81	0.90±0.21	121.33±1.52	164.00±2.00	257.00±2.00
Minimum	15.00±0.14	7.10±0.10	5.50±0.50	0.00±0.00	102.66±0.76	160±2.00	255.00±2.00
Maximum	29.41±0.14	7.60±0.10	7.06±0.11	1.83±0.28	125.00±1.00	177.00±2.00	290.00±2.00

Values are mean± SD.

findings reported by several scientists (Ackman and Eaton, 1976; Klutymans and Zandee, 1973; Kinsella et al., 1977; Mute et al., 1989; Jafri and Khwaja, 1968; Zden, 2007; Zuraini et al., 2006; Mohanty and Samantaray, 1996).

The lipid content of muscle, liver and testis in the specimens from nature as well as captive conditions was found to be closely correlated. Increase in lipid in liver and subsequent decrease in muscle and testis during spawning period was observed in both conditions. There was negative correlation of testis and muscle with liver lipid. The water content in the gonads during pre-spawning period at its culmination phase may be one of the reasons for the decrease in lipid in testis of male in

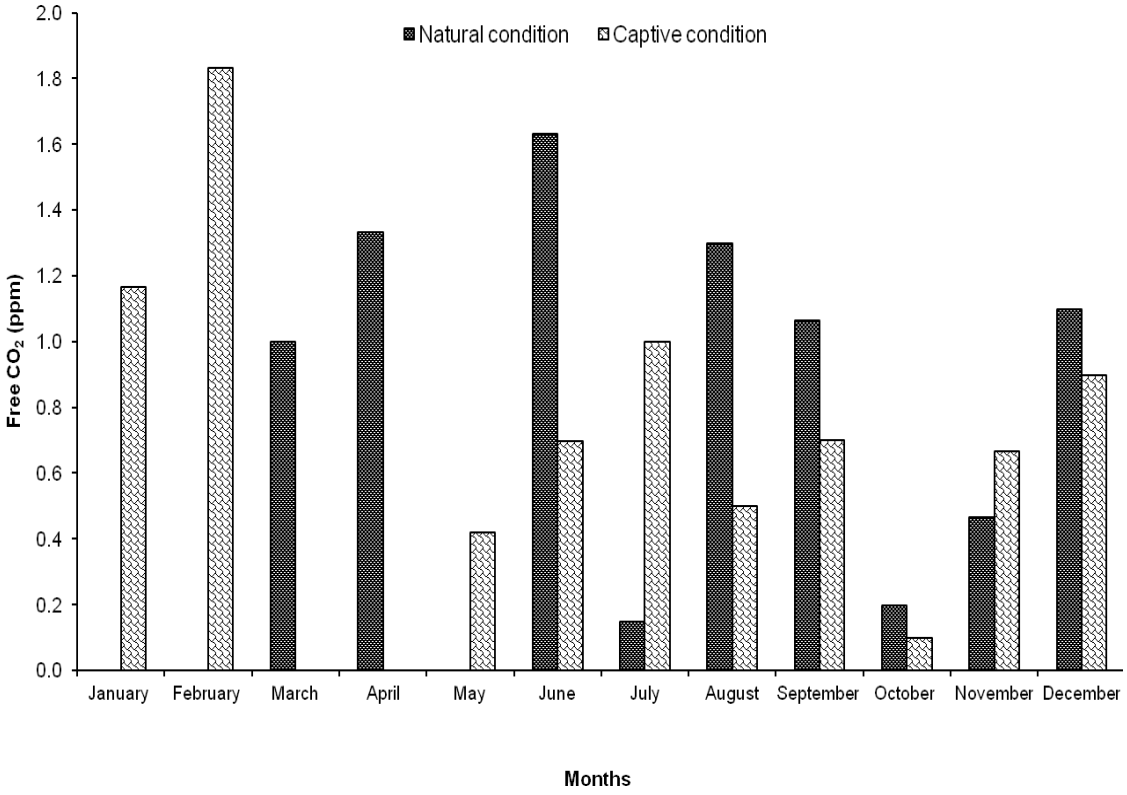

Figure 7. Annual variation in free CO_2 during experiment.

Table 8. Seasonal changes in biochemical in male specimens of *Chhana punctatus* in nature.

Month	Lipid (%)			Water content (%)			Protein (%) in muscle
	Muscle	Liver	Testis	Muscle	Liver	Testis	
January	4.01±0.15	2.94±0.03	4.66±0.07	75.83±0.05	76.36±0.08	74.76±0.07	18.20±0.03
February	2.76±0.17	3.56±0.13	2.92±0.24	75.98±0.06	75.86±0.25	75.35±0.57	17.85±0.10
March	1.19±0.06	4.14±0.03	2.25±0.08	77.83±0.64	73.31±0.31	75.11±1.68	17.58±0.16
April	1.07±0.03	4.33±0.05	1.93±0.05	77.83±0.64	72.99±0.47	76.21±0.73	17.34±0.07
May	1.01±0.05	4.33±0.07	1.81±0.06	80.52±1.00	71.61±0.50	77.72±0.56	16.70±0.16
June	1.01±0.03	5.16±0.04	1.70±0.09	80.70±0.72	71.66±0.55	77.94±0.76	16.70±0.14
July	1.22±0.21	4.19±0.06	1.21±0.17	75.11±0.04	74.51±0.41	77.02±0.16	17.10±0.14
August	2.14±0.04	3.96±0.01	2.20±0.02	74.73±0.17	75.21±0.19	74.73±0.04	17.81±0.10
September	3.20±0.05	3.27±0.03	2.86±0.10	74.83±0.14	75.32±0.64	74.63±0.15	18.16±0.09
October	3.46±0.02	3.17±0.03	3.41±0.09	74.53±0.64	76.89±0.06	74.50±0.62	18.56±0.11
November	4.10±0.03	2.90±0.03	4.99±0.09	72.65±0.43	76.53±0.08	72.41±0.55	19.40±0.17
December	5.05±0.04	1.94±0.21	5.13±0.15	73.68±0.14	76.45±0.06	73.53±0.35	19.39±0.04
Minimum	1.01±0.03	1.94±0.21	1.21±0.17	72.65±0.43	71.61±0.50	72.41±0.55	16.70±0.14
Maximum	5.05±0.04	5.16±0.04	5.13±0.15	80.70±0.70	76.89±0.06	77.94±0.76	19.40±0.17

Values are mean± SD.

both conditions. Krivobok (1964) reported that the weight of liver in male *C. harengus* increased during the spawning but decreased during maturation and spawning. The changes in the liver weight was mainly associated with water content. The water content increased after spermiation and spawning and decrease during maturation and spawning. The water content of the liver of Atlantic cod (*Gadus morhua)* depleted from autumn to summer and increased during winter (Holdway and Beamish, 1984). Water content in the muscle of

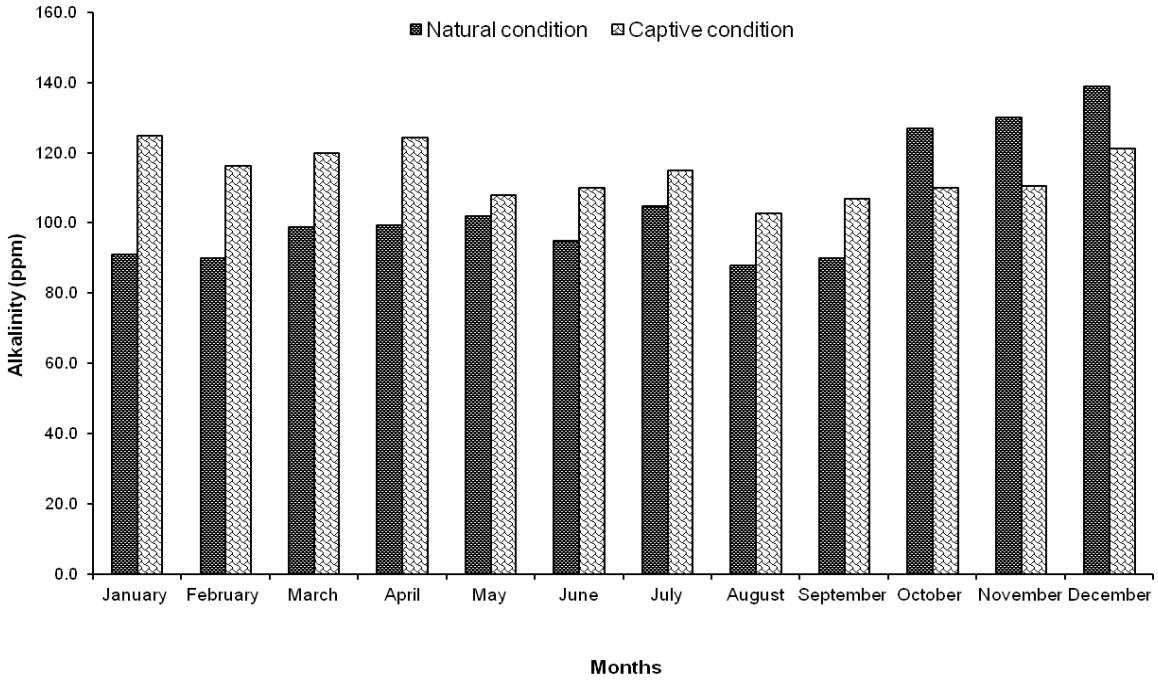

Figure 8. Annual variation in alkalinity during experiment.

Table 9. Seasonal changes in biochemical in male specimens of *Chhana punctatus* in captive condition.

Month	Lipid (%)			Water content (%)			Protein (%)
	Muscle	Liver	Testis	muscle	Liver	Testis	in muscle
January	3.76±0.10	2.94±0.06	3.77±0.16	74.72±0.43	76.56±0.04	76.53±0.66	19.37±0.10
February	4.01±0.15	1.98±0.25	4.40±0.01	75.73±0.10	76.48±0.10	75.56±0.32	19.30±0.03
March	3.54±0.07	2.95±0.06	3.65±0.08	75.88±0.09	76.40±0.11	75.79±0.09	18.16±0.08
April	2.80±0.21	3.60±0.08	2.96±0.28	75.69±0.56	75.89±0.30	76.05±0.10	17.80±0.06
May	1.23±0.04	4.19±0.07	2.29±0.08	77.87±0.69	75.35±0.36	76.15±0.06	17.54±0.11
June	1.11±0.03	4.78±0.02	1.98±0.09	77.54±1.26	75.00±0.47	76.25±0.77	15.97±2.30
July	1.05±0.09	4.93±0.04	1.83±0.07	80.56±1.04	73.64±0.46	77.75±0.54	16.66±0.20
August	1.06±0.03	5.57±0.31	1.78±0.08	80.73±0.76	73.70±0.51	77.97±0.76	16.66±0.18
September	1.26±0.17	4.24±0.06	1.25±0.14	77.14±0.08	74.57±0.41	77.05±0.19	17.09±0.14
October	2.18±0.01	4.00±0.05	2.25±0.07	76.76±0.21	75.24±0.15	76.76±0.08	17.74±0.10
November	3.20±0.09	3.31±0.02	2.64±0.49	76.86±0.10	75.68±0.10	76.67±0.11	18.09±0.09
December	3.50±0.02	3.22±0.06	3.46±0.07	76.90±0.11	76.92±0.11	76.53±0.66	18.52±0.07
Minimum	1.05±0.09	1.98±0.25	1.25±0.14	74.72±0.43	73.64±0.46	75.56±0.32	15.97±2.30
Maximum	4.01±0.15	5.57±0.31	4.40±0.01	80.73±0.76	76.92±0.11	77.97±0.76	19.32±0.10

Values are mean± SD.

G.morhua in sexually mature fish was highest during peak maturity stage (March to April) and lowest during October to November (Love, 1980). Idler and Bitners (1960) found that the water content of *Onchorhynchus nerka* increased during the spawning.

Protein content in muscle under both the condition varied monthly. Correlation of protein with lipid and ash content in muscle was positive and significant.

Physico-chemical properties of water body reflect the productivity status in particular environmental conditions. Water temperature in natural habitat ranged from 17.9 - 30°C and in captive conditions 12.3 to 29.41°C. Pattern of fluctuation under both conditions was more or less in the same trend but more pronounced in natural habitat. In natural habitat highest temperature was recorded in June and lowest in December. In captive condition high value of

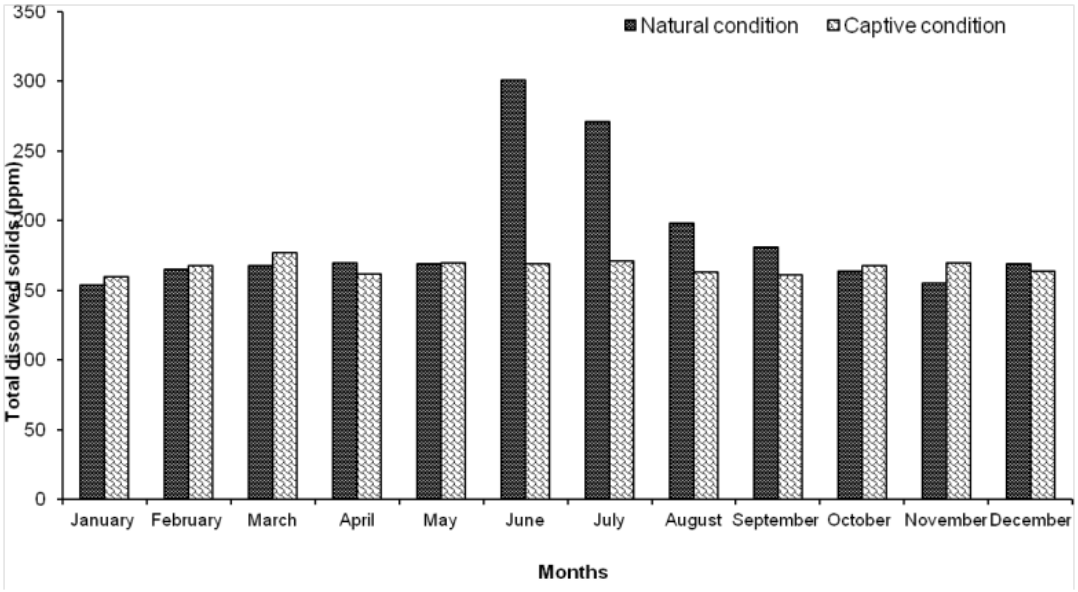

Figure 9. Annual variation in total dissolved solids (TDS) during experiment.

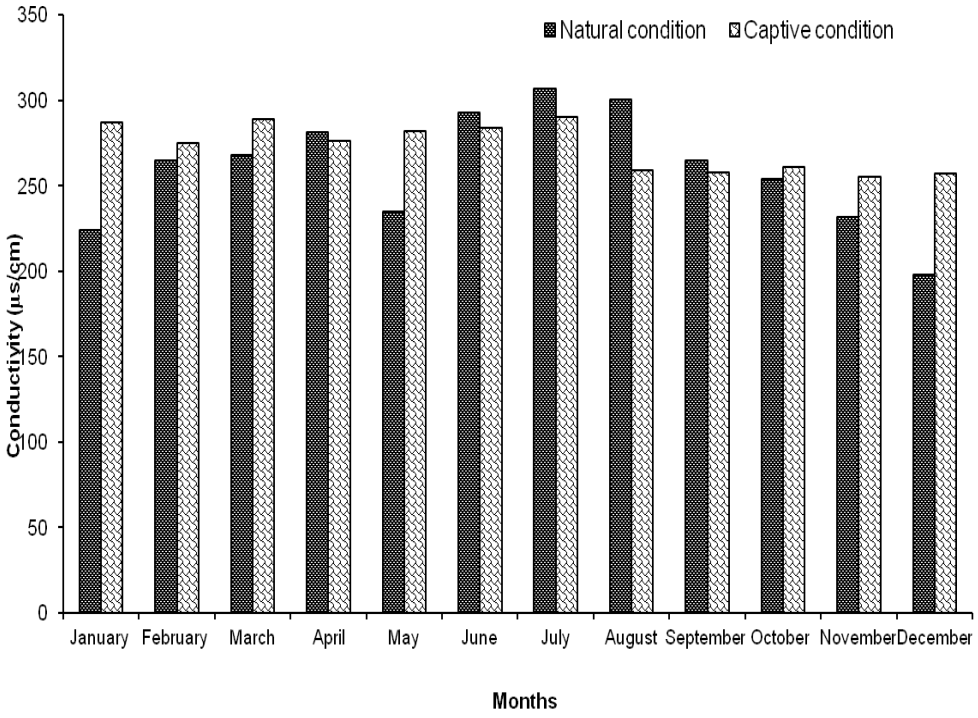

Figure 10. Annual variation in conductivity during experiment.

temperature was recorded in June and low in February. Similar trend of fluctuation was reported by Baruah et al. (1998), Zutshi (1976), Ehsan et al. (1996) and Saha and Hossain (2002). Fluctuation in water temperature may be due to the seasonal variations in rainfall and standing crop concerned water body. pH values in natural habitat and captive conditions were recorded in the range of 7.03 to 7.50, and 7.10 to 7.80, which is in permissible limit. These results are similar to the findings reported by Patra and Azadi (1987), Khan et al. (1990), Acharjee et al. (1997) and Baruah et al. (1998).

Dissolved oxygen in water body is the driver for the existence of life under water. There were seasonal fluctuations. Value of dissolved oxygen in natural habitat

was recorded maximum (8.00 mg/L) in November and Minimum (5.40 mg/L) in May whereas in captive condition maximum value was 7.06 mg/L in August and minimum (5.50 mg/L) in February. In any water body, dissolved oxygen should not be less than 5.00 mg/L for well being of organisms in water. The present results which have similar finding with the study of Baruah et al. (1998), Meye et al. (2009) and Hossain et al. (2008) reported that dissolved oxygen higher than 5.00 mg/L indicates higher autotrophic activity in captive conditions. Free CO_2 in natural habitat and captive conditions ranges from 0.00 to 1.83 mg/L with minor seasonal fluctuations in both the conditions. There were non-significant variations between natural habitat and captive conditions. Zutshi (1976) also reported the minor fluctuation in free CO_2. Variation in CO_2 depends upon the other factors like temperature, algal bloom, and photosynthetic activities. Seasonal trend of increasing and decreasing of alkalinity was almost same. Variation in alkalinity in any water body might be due to temperature, rainfall, pH, dissolved oxygen, phytoplankton growth and photosynthesis (Zutshi, 1976). Bhuiyan (1970) recorded total alkalinity of medium productive water body ranging from 25 to 100 mg/L. The present findings have been corroborated with the conclusion of several workers (Zutshi, 1976; Bhuiyan, 1970; Chowdhury and Mazumder, 1981). TDS in water body is the result of edaphic factor, organic and inorganic load in terms of dissolved solid matter. Baruah et al. (1998) reported high turbidity level was due to high concentration of dissolved and suspended solid matters. The significant variation in physico-chemical and environmental condition might be the reason associated with it, as conductivity is the reflection of ionized substances of inorganic matter present in ecosystem (Baruah et al., 1998).

Conclusion

Correlation and pattern of biochemical changes in tissues from muscle, liver and gonad was found in accordance with the intrinsic and extrinsic factors under both the conditions. Hence it can be concluded from the present study that changes in pattern of biochemical cycle might be governed by local intrinsic and extrinsic factors.

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REFERENCES

Acharjee B, Dutta A, Chowdhury M (1997). An account of the aquatic macrophytes in some beels of lower Brahmputra basin, Assam. In : changing perspectives of Inland Fisheries (eds. Vass, K.K. and Sinha, M.). Proc. of Nat. seminar, March 16-17, 1997 IFSI, Barrackpore, India, pp. 228-234.

Ackman RG, Eaton CA (1976). Fatty acid composition of the decapods shrimp, *Pandulus borealis*, in relation to that of the euphasid, *Meganyctiphanus noruegica.* J. Fish. Res. Bd. Can. 33:1634-1638.

Agren J, Mute P, Hannmen O, Harranen J, Pentila I (1987). Seasonal variations of lipid fatty acids of Boreal Fresh water fish species. Comp. Biochem. Physiol. 88B:905-909.

Akpmar MA (1986a). *Cyprinus carpio* L. (Osteichthys:Cyprinidae) Karaciger Yag asitlerinin mevsimsel degisimi. Dogo Tv. Biol. 10(3):232-239.

APHA (1992). Standard method for the examination of water and waste water. American Public Health Association. 1015 eighteenth Street, New York Washington. D.C. 20035:874.

Baruah BK, Talukdar S, Borthakur R (1998). Limnological studies of ponds in relation to pisciculture. Environ. Ecol. 16(3):518-522.

Bhuiyan BR (1970). Physico-chemical qualities of some ancient tanks of Sibsagar, Assam. Environ. Health. 12:129-134.

Chakrabarty NM (2006). Murrels and murrel culture. Narendra Publication VIII.112 ISBN8185375070.

Chowdhury SH, Mazumder A (1981). Limnology of lake Kaptai : Physico-chemical features. Bangladesh J. Zool. 9(1):59-72.

Dutta H, Das AB, Farkas T (1985). Role of environmental temperature in seasonal changes of fatty acid composition of hepatic lipid in air breathing Indian Teleost, *Channa punctatus (*Bloch*).* Comp. Biochem. Physiol. 81(B):341-347.

Daviglus ML, Stemler J, Orencia AJ, Dyer AR, Greenland PL, Walsh MK, Shekelle RB (1997). Fish consumption and the 30-year risk of fatal myocardial infarction. N. Eng. J. Med. 336:1046-1053.

Ehsan MA, Hossain MS, Mazid MA, Mollah MFA, Rahman S, Razzaque A (1996). Limnology of Chanda Beel. Bangladesh J. Fish. Res. 1(1):31-34.

Folch J, Lee M, Sladane-stanley GHA (1957). Simple method for isolation and purification of total lipids from Animal tissues. J. Biol. Chem. 226:496-509.

Gill HS, Weatherly AH (1984). Protein, lipid and calorie content of blunt nose minnow, *Pimephales notatus* rafinosque, during growth at different temperatures. J. Fish Biol. 25:491-500.

Holdway DA, Beamish FWH (1984). Specific growth rate and proximate body composition of Atlantic cod (*Gadus morhua* L.). J. Exp. Mar. Biol. Ecol. 81:147-170.

Hossain MK, Latifa GA, Rahman MM (2008). Observation on induced breeding of snakehead murrel, *Channa striatus* (Bloch, 1973). Int. J. Sustain. Crop. Prod. 3:65-68.

Hu CD, Chinenov Y, Kerppola TK (2002). Visualization of interactions among Bztp and Rel family proteins in living cells using biomolecular fluorescence complementation. Mol. Cell 9(4):789-798.

Idler DR, Bitners I (1960). Biochemical studies on Sockeye salmon during spawning migration IX fat, protein and water in the major internal organs and cholesterol in the liver and gonads of the standard fish. J. Fish. Res. Board Can. 17:113-122.

Jafri AK, Khwaja DK (1968). Seasonal changes in the Biochemical composition of the Fresh Water Murrel, *Ophiocephalus punctatus*. Hydrobiologia 32(1-2):206-218.

Khan MA, Srivastava KP, Dwivedi RK, Singh DN, Tyagi RK, Mehrotra SN (1990). Significance of ecological parameters in fisheries management of a newly impounder reservoir- bachhra reservoir. In : Contributing to the fisheries of inland open water system in India, Jhinran, A.G., Unnithun, V.K. and Ghosh, A.(eds.) Part-I Inland Fisheries Society of India. CIFRI, Barrackpore, India, pp. 100-108.

Kinsella JE, Shimp JL, Mai J, Weihranch J (1977). Fatty acid content and composition of fresh water fin fish. Jacob 54:424-429.

Klutymans JHFM, Zandee DI (1973). Lipid metabolism in the northern Pike (*Esox lucius* L.)I. the fatty composition of the northern pike. Comp. Biochem. Physiol. 451-458.

Konar V, Canpolat A, Yilmaz O (1999). Capoeta trutta ve barbus rajanorum mystaseusun Kas Dokularmdaki total lipid ve Yag Asidi Miktar ve Bilesimlerinin Ureme Peryodu Suresince Degisimi,Trop. J. Biol. 23(3):319-331.

Krivobok MN (1964). On the role of the liver in the maturation of the ovaries of the Baltic herring (*Clupea harengus membras* L.). Vop.

Ikhtiol. 4:483-494.
Lathi E (1987). Total lipid and cholesterol of liver and muscle in some fish species, Especially vendace (*Coregonus albula* L.) in Finland. Arch. Hydrobiol. 110:133-142.
Love RM (1980). Water content of cod (*Gadus callarias* L.) muscle. Nature 185:692.
Meye JE, Omoruwou PE, Mayor ED (2009). Food and feeding habits of *Syndontis ocellifer* (Boulenger, 1900) from River Adofi, Southern Nigeria. Trop. Freshw. Biol. 17(1):1-12.
Mohanty, SS, Samantaray K (1996). The Third Indian Fisheries Forum, proceedings 11-14 October, 1993, Pantnagar, U.P. pp.191-192.
Mohsin AKM, Ambak MA (1983). Fresh water fishes of peninsular Malaysia. Penerbitan University Pertanian Malaysia, Kuala Lumpur, 284 pp.
Mute P, Agren JJ, lindovist OV, Hanninen O. (1989). Fatty acid composition of vendace (*Coregonus albula* L.) muscle and its plankton feed. Comp. Biochem. Physiol. 92B:75-79.
Patra RWR, Azadi MA (1987). Ecological studies on the planktonic organism of the Halda River. Bangladesh J. Zool. 15(2):109-123.
Sadasivam S, Manickam A (1996). Biochemical methods. Pub. New age international (P) Limited. 256 pp.
Saha BK, Hossain MA (2002). Saldu beel fishery of Tangail, Bangladesh. J. Zool. 30(20):187-194.
Yilmaz O, Konar V, Celik S (1995). Elazig Hazar golundeki Capoeta Umbla'nm disi ve erkek bireylerinde bazi dokularmm total lipid ve yag aside bilesimleri Biyokimya dergisi, 20:31-42.
Yilmaz, O, Konar V, Celik S (1996). Elazig Hazar golundeki Capoeta Capoeta umbla (Heckel, 1843) nm (Siraz) total lipid ve yag aside miktarmm aylara ve mevsimlere gore degisimi. Tr. J. Fish Biol. 20:245-257.
Zden EN (2007). Comparison of biochemical composition of three aquaculture fishes (*Dicentrachus labrax, Sparus aurata,Dentex dentex*). Int. J. Food Sci. Nutr. DOI.10.10 80 109 637 480 701 400 729.
Zuraini A, Somchit MN, Solihah MH, Goh Y, Arifah AK (2006). Fatty acid and amino acid composition of three local Malaysian *Channa* spp fish. Food Chem. 97(4):674-678.