



Study on monthly variation in haematological and biochemical parameters of three Indian major carps under semi-intensive polyculture practice

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Abstract

Present study was designed for eight months to investigate the monthly fluctuations in parameters in the blood of three Indian Major Carps viz, *Labeo rohita*, *Catla catla* and *Cirrhinus mrigala* under Semi-intensive poly culture practice. Highest RBCs count, Hb % and PCV% in all three genera were observed in the month of June while the lowest was observed in March. Highest values of ESR was recorded in the month of September for all three genera and lowest was recorded in March. The comparatively higher increment in total WBCs count was observed from June-September for all three genera. The highest amount of glucose was recorded in the month of September and the lowest was recorded in March in all experimental fishes. Highest amount of protein in all three genera was observed in the month of July and lowest was recorded in October. The amount of cholesterol was observed highest in the month of June while the lowest was recorded in October in all three genera. The data was statistically analyzed by GraphPad prism 5 software followed by ANOVA at different significant level ($P < 0.001$, $P < 0.01$, $P < 0.05$).

Keywords: Indian major carps, PCV, ESR, semi-intensive, poly culture

1. Introduction

Environmental conditions such as temperature, photoperiodism, availability of adequate amount food, competition among species and parasitism are directly associated with the length and weight (isometric and allometric growth) of animals and profit and loss of livestock farmers. Although fish haematology continues to offer the potential of a valuable tool, progress in establishing normal range values for blood parameters has been slow and literature in this area is isolated and often incomplete (Mawdesley - Thomas, 1971) ^[1]. In present study an effort was done to evaluate the monthly variation haematological and biochemical parameters viz., Hb, TEC, WBC, PCV, ESR, serum protein and glucose of three Indian major carps viz; *Labeo rohita*, *Catla catla* and *Cirrhinus mrigala* in semi-intensive polyculture practice and. The semi-intensive culture practice widely accepted in a rural area of Indian subcontinent hence the normal range of haematological and biochemical parameters would be a helpful tool to diagnose the health status of fishes. The fish *L.rohita* is an herbivore and column feeder, *Catla catla* is an omnivore and surface-column feeder while *Cirrhinus mrigala* is herbivore bottom feeder. Although other workers gave a valuable contribution to the estimation of growth and haematological indices of fishes. Das (1965) ^[2] studied the age-related trends in the blood chemistry and haematology of the Indian carp (*Catla catla*). Blaxhall and Daisley (1973) ^[3] studied the routine haematological methods for use with fish blood. Clark *et al.*, (1976) ^[4] recorded the blood parameters of largemouth bass, *Micropterus salmoides*. Kavadias *et al.*, (2004) ^[5] studied annual cycles of growth rate,

feeding rate, food conversion, plasma glucose and plasma lipids in the population of European sea. Nagarajan *et al.*, (2014) ^[6] studied the growth and haematology of the fish *Oreochromis mossambicus*. Kavya *et al.*, (2016) ^[7] studied haematology and serum biochemical changes in response to change in salt concentration in freshwater fish *Notopterus notopterus*. Das *et al.*, (2006) ^[8] studied haematological changes in the three Indian major carps, *Catla catla* (Hamilton), *Labeo rohita* (Hamilton) and *Cirrhinus mrigala* (Hamilton) in acidic and alkaline water pH. Kumar (2016) ^[9] recorded haematological indices of Indian major carps cultured in West Godavari region of Andhra Pradesh. Kulkarni and Bedjargi (2016) ^[10] noticed serum biochemical parameters of Four Fresh Water Indian Carps from a Local Aquatic Body and Jasmin *et al.*, (2018) ^[11] studied haematological changes in *Labeo rohita* due to exposure of pesticides, Difenoconazole and Thiamethoxam.

2. Material and method

2.1 Preparation of the pond, water quality management, stoking and feeding of fishes

The experiment was designed for 8 months (March-October 2017). The stocking pond was prepared before six months in agriculture field of Uttarakhand College of Science & Technology and treated with cow dung @ 6000kg/ha for the growth planktons. The quicklime was added to the soil @ 200kg/ha. For the maintenance of water pH (6.50-8.00) and as anti-parasitic agent. No extra affords were made to control the aquatic diseases. The temperature (22-25°C) and dissolved oxygen (5-6ppm) of water was maintained by

changing the water throughout the experiment by canal system (irrigation purpose). In the summer season, the fresh water was added after 3 days. The fingerlings of freshwater fishes *Labeo rohita*, *Catla catla* and *Cirrhinus mrigala* were brought from Roorkee, Uttarakhand. MS222 used as sedative (50.00mg/L) for fish transportation. The size of 15 days fingerlings was 24-29 mm, 19-23 mm and 24-30 mm recorded for *L.rohita*, *C.catla* and *C.mrigala* respectively. Before stocking they were acclimatized to a water tank containing 100 lit. Water and fed on commercial food but starved for 24 hr before the application of dietary treatment days@3:1 (agrifarming.in 2017) [12]. The commercial feed was supplied by Nugen feed and food, Badauli, Karnal, India. The composition and ingredients of commercially prepared food (2-5 mm diameter, 3-5 mm length, Pellets) is given in table-1. Twenty-five fingerlings of each genus were randomly selected from the pool and stocked in the earthen pond (4.00 × 2.50 × 2.50 metre) which filled 1/3 water. The fishes were reared for 8 months and fed with natural food grown in the pond and commercial feed (twice in a day) @3,2,5,2% body weight/day as starter, grower and finisher, managed according to the duration of the experiment (agrifarming.in 2017) [12]. The dead fishes were removed soon after death.

2.2 Estimation of planktons, haematological and Biochemical parameters

Plankton estimation, haematological and biochemical estimation was done at the end of each month. After netting fishes twenty fishes were from each group were transferred to a plastic tub containing the solution of MS 222 (50.00-100mg/L according to the weight of fishes) and the blood samples were collected after 30 min. from the caudal vein using a sterile needle (21G). Two sets of blood samples from each genus was prepared one for haematological study and other for biochemical study. The blood samples were transferred to the vials containing heparin (5,000 IU) and marked, kept in the icebox, brought to the laboratory, stored at 5°C. All the haematological parameters viz; Hb, RBCs count, PCV, ESR and the total WBCs count were determined by complete blood count machine (haematology analyzer, BC2300) Supplied by Mindray, Delhi. For quantification of serum glucose, protein and cholesterol were done in a UV, VISIBLE-1280 Spectrophotometer manufactured by Shimadzu analytical Pvt. Ltd. India (Mumbai). For the analysis of serum glucose, protein and cholesterol, serum was isolated by centrifugation. The blood samples were centrifuged at 3000 rpm for 30 minutes in a cooling centrifuge. The blood glucose level was measured by a glucose Kit manufactured by KEE GAD Biogen Pvt.Ltd. New Delhi (Young *et al.*, 1975) [13] followed GOD-POD reaction. Total protein was modified Lowry method (Van Noorden *et al.*, 2014) [14] and reaction kit was supplied by Aldrich India, New Delhi. The serum cholesterol was estimated by Lieberman – Burchard reaction and the reaction kit (Enzokit) was manufactured by RFCL, Dehradun (Watanabe 1959) [15]. The results of haematological and biochemical parameters were

compared with their preexisting result determined by various coworkers mentioned in the introduction part and the normal ranges were set for present study. The quantitative analysis of planktons was done according to Heidi *et al.*, (2012) [16]. The data was statistically analyzed by MS office excel 2007.

3. Result

In present study the month of June was observed favorable for the growth of fishes due to favorable environmental condition so all Haemetological and biochemical value were compared with month of June and increment and decline in parameters at different significant level are shown in relevant table. In the present study among zooplanktons the group arthropods was found dominant followed by Rotifera and protozoans while among phytoplanktons group Chlorophyceae found dominant over Bacillariophyceae, Cyanophyceae and Euglenophyceae. The maximum amount of phytoplankton was observed in the month of June while the maximum amount of zooplankton was observed in October and shown in table-2, figure-1&2. Highest RBCs count in all three genera was observed in the month of June while lowest was observed in March and highest RBCs count was observed for *C. mrigala* (4.64-5.20) throughout the experiment while lowest (3.88-4.35) was observed in *L.rohita*, shown in table-3, figure-3. The amount of Hb was observed highest in the month of June in all three genus while lowest was observed in March and highest Hb amount was observed for *C.mrigala* (6.22-6.94) throughout the experiment while lowest was observed for *L.rohita* (4.90-5.72), shown in table-4, figure-4. The highest value of PCV was recorded in the month of June for all experimental fishes throughout the experiment while lowest was recorded in March. The highest values of PCV was recorded for *C.mrigala* (29.12-31.65), while lowest was recorded for *L.rohita* (28.50-31.16) shown in table-5, figure-5. Highest values of ESR was recorded in the month of September for all three genera and lowest was recorded in March and highest values were observed in *L.rohita* (3.91) while lowest was in *C.catla* (1.88), shown in table-6, figure-6. The comparatively higher increment in total WBCs count was observed in the month of September for all three genus. The highest values of Total WBCs count was recorded for *L.rohita* in the month of September (23.88) and the lowest values were also observed in March (20.18) in same genus. And shown in table-7, figure-7. Likewise WBCs and ESR the highest amount of glucose was recorded in the month of September and the lowest was recorded in March in all experimental fishes. Highest and lowest amount of glucose was observed in *L.rohita* (358.10, 211.62), shown in table-8, figure-8. The highest amount of protein in all three genera was observed in the month of July and lowest was recorded in March and highest amount was recorded for *C.catla* (4.83) while lowest was recorded in *L.rohita* (3.02), shown in table-9, figure-9. The amount of cholesterol was observed highest in the month of June while lowest was recorded in October in all three genus and highest amount was noted for *C.catla* (342.60) while lowest was noted for *L.rohita* (258.50) shown in table-10, figure-10.

Table 1: Composition and ingredients of commercially prepared food for experimental fishes

| S. No | Name of ions/vitamin substances | Amount/% | S. No | Name of ions/vitamin substances | Amount/% |
|-------|---------------------------------|-----------|-------|---------------------------------|---------------|
| 1 | Protein, minimum | 12.00% | 10 | Selenium | 0.60-0.61ppm |
| 2 | Fat, minimum | 5.50% | 11 | Vitamin E, minimum | 225.00IU/lb |
| 3 | Fibre, maximum | 23.00% | 12 | Vitamin A, minimum | 3500.00 IU/lb |
| 4 | Lysine, minimum | 0.70% | 13 | Biotin, minimum | 3.60mg/lb |
| 5 | Calcium | 0.8-1.00% | 14 | Starch, maximum | 7.00% |
| 6 | Phosphorus minimum | 0.50% | 15 | Sugar, maximum | 4.00% |
| 7 | Magnesium minimum | 0.50% | 16 | Ferrous Carbonate | QS |
| 8 | Zinc minimum | 220.00ppm | 17 | Manga nous Oxide | QS |
| 9 | Copper minimum | 65.00ppm | 18 | Cod liver oil | 1% |

Ingredients

Alfalfa, Shredded Beet Pulp, Wheat Middlings, Ground Oat Hulls, Ground Soy Hulls, Ground Flaxseed, Soya Oil, Calcium Lignin Sulfonate, Calcium Carbonate, Mono-dicalcium Phosphate, Salt, Vitamin A, Natural flavor, Vitamin

C, Biotin, B-12 Concentrate, Calcium Pantothenate, Choline Chloride, Natural Vitamin E, Tocopherols, Vitamin D,L-Lysine, Magnesium Oxide, DL-Methionine, Niacin, Riboflavin, Selenium, Thiamine, Cobalt Carbonate, Copper Sulphate, Manganous Oxide, Calcium Iodate, Zinc-Oxide.

Table 2: Monthly Variation in planktons ($\times 10^3$ organism/L).

| Plankton group | March | April | May | June | July | Aug | Sep | Oct |
|-------------------|-------------------------------|--------------------------------|--------------------------------|-------------------------------|--------------------------------|--------------------------------|-------------------------------|-------------------------------|
| Chlorophyceae | 12.24 \pm 2.20 ** | 14.41 \pm 4.12 ^{ns} | 15.68 \pm 3.40 ^{ns} | 17.15 \pm 2.60 | 16.52 \pm 4.60 ^{ns} | 11.10 \pm 2.20 *** | 9.60 \pm 2.60 *** | 8.62 \pm 1.80 *** |
| Bacillariophyceae | 8.25 \pm 2.50 ^{ns} | 8.63 \pm 3.41 ^{ns} | 9.22 \pm 2.50 ^{ns} | 9.88 \pm 1.50 | 9.44 ^{ns} \pm 2.10 | 6.92 ^{ns} \pm 0.82 | 6.64 ^{ns} \pm 1.20 | 5.95 \pm 1.10 * |
| Cynophyceae | 6.65 \pm 2.10 ^{ns} | 6.82 \pm 2.20 ^{ns} | 7.34 \pm 1.40 ^{ns} | 7.91 \pm 1.60 | 7.30 ^{ns} \pm 1.60 | 4.64 ^{ns} \pm 0.60 | 4.28 ^{ns} \pm 0.60 | 4.2 [*] \pm 0.82 |
| Euglinophyceae | 3.80 \pm 0.62 ^{ns} | 3.88 \pm 0.50 ^{ns} | 3.92 ^{ns} \pm 0.80 | 4.02 \pm 0.40 | 3.60 ^{ns} \pm 0.60 | 3.40 ^{ns} \pm 0.50 | 2.84 ^{ns} \pm 0.80 | 2.65 ^{ns} \pm 0.40 |
| Zooplanktons | | | | | | | | |
| Atrhopoda | 9.34 ^{ns} \pm 2.20 | 10.44 ^{ns} \pm 1.80 | 7.21 ^{**} \pm 1.20 | 8.13 [*] \pm 1.40 | 6.24 ^{***} \pm 1.80 | 7.28 ^{**} \pm 0.80 | 8.28 [*] \pm 1.50 | 10.64 \pm 2.80 |
| Rotifers | 8.20 ^{ns} \pm 2.20 | 8.41 ^{ns} \pm 0.62 | 5.10 ^{**} \pm 1.20 | 5.96 [*] \pm 0.80 | 4.98 ^{***} \pm 1.20 | 5.03 ^{***} \pm 1.20 | 5.86 [*] \pm 1.60 | 8.64 \pm 2.00 |
| Protozoans | 2.23 ^{ns} \pm 0.60 | 2.48 ^{ns} \pm 0.50 | 1.30 ^{ns} \pm 0.20 | 1.80 ^{ns} \pm 0.40 | 1.22 ^{ns} \pm 0.20 | 1.28 ^{ns} \pm 0.20 | 1.32 ^{ns} \pm 0.50 | 2.86 \pm 0.40 |

All monthly values are mean of 4 observations compared with the month of June and October for phytoplanktons and zooplanktons respectively, marked with *** (P<0.001), ** (P<0.01), * (P < 0.05) and ns (non-significant)

Table 3: Monthly variation in total Red Blood Cells count($\times 10^6$ /mm³) in experimental fishes

| Name of fish | March | April | May | June | July | Aug. | Sept. | Oct. |
|------------------|-------------------------------|-------------------------------|-------------------------------|-----------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| <i>L.rohita</i> | 3.88 \pm 0.08 ^{ns} | 4.26 \pm 0.04 ^{ns} | 4.33 \pm 0.08 ^{ns} | 4.35 \pm 0.15 | 4.28 \pm 0.10 ^{ns} | 4.22 \pm 0.10 ^{ns} | 4.18 \pm 0.06 ^{ns} | 4.12 \pm 0.06 ^{ns} |
| <i>C.catla</i> | 4.14 \pm 0.06 ^{ns} | 4.20 \pm 0.08 ^{ns} | 4.37 \pm 0.08 ^{ns} | 4.48 \pm 0.10 | 4.35 \pm 0.12 ^{ns} | 4.30 \pm 0.12 ^{ns} | 4.22 \pm 0.04 ^{ns} | 4.20 \pm 0.08 ^{ns} |
| <i>C.mrigala</i> | 4.64 \pm 0.40 ^{ns} | 4.71 \pm 0.20 ^{ns} | 5.14 \pm 0.10 ^{ns} | 5.20 \pm 0.40 | 5.18 \pm 0.08 ^{ns} | 5.08 \pm 0.12 ^{ns} | 4.95 \pm 0.10 ^{ns} | 4.88 \pm 0.12 ^{ns} |

All monthly values are mean of 20 observations and \pm is S.D. compared with the month of June and all values are found ns (non-significant at *, ** and *** level).

Table 4: Monthly variation in Hemoglobin (gm/ml) in experimental fishes

| Name of fish | March | April | May | June | July | Aug. | Sept | Oct. |
|------------------|-------------------------------|-------------------------------|-------------------------------|-----------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| <i>L.rohita</i> | 4.90 \pm 0.20 *** | 5.20 \pm 0.50*** | 5.45 \pm 0.10* | 5.72 \pm 0.20 | 5.65 \pm 0.50 ^{ns} | 5.58 \pm 0.10 ^{ns} | 5.51 \pm 0.50 ^{ns} | 5.39 \pm 0.10** |
| <i>C.catla</i> | 6.10 \pm 0.50 ^{ns} | 6.16 \pm 0.40 ^{ns} | 6.24 \pm 0.20 ^{ns} | 6.35 \pm 0.24 | 6.81 \pm 0.50*** | 6.69 \pm 0.22** | 6.45 \pm 0.14 ^{ns} | 6.40 \pm 0.20 ^{ns} |
| <i>C.mrigala</i> | 6.22 \pm 0.20*** | 6.31 \pm 0.15*** | 6.56 \pm 0.50** | 6.94 \pm 0.22 | 6.86 \pm 0.50 ^{ns} | 6.78 \pm 0.40 ^{ns} | 6.72 \pm 0.20 ^{ns} | 6.62 \pm 0.50** |

All monthly values are mean of 20 observations and \pm is S.D compared with the month of June and marked with *** (P<0.001), **P<0.01), (P < 0.05) and ns (non-significant).

Table 5: Monthly variation in Packed Cell Volume (%) in experimental fishes

| Name of fish | March | April | May | June | July | Aug. | Sept | Oct |
|------------------|---------------------------------|---------------------------------|---------------------------------|------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| <i>L.rohita</i> | 28.50 ^{***} \pm 2.50 | 28.76 ^{***} \pm 2.00 | 28.86 ^{***} \pm 0.80 | 31.16 \pm 1.20 | 29.12 ^{***} \pm 0.82 | 29.05 ^{***} \pm 2.60 | 29.03 ^{***} \pm 0.80 | 28.95 ^{***} \pm 1.20 |
| <i>C.catla</i> | 28.65 ^{***} \pm 1.00 | 28.82 ^{***} \pm 1.60 | 29.20 ^{***} \pm 2.20 | 31.60 \pm 2.00 | 29.55 ^{***} \pm 1.00 | 29.53 ^{***} \pm 1.40 | 29.48 ^{***} \pm 2.50 | 29.40 ^{***} \pm 1.64 |
| <i>C.mrigala</i> | 29.12 ^{***} \pm 2.00 | 29.26 ^{***} \pm 1.20 | 29.52 ^{***} \pm 2.50 | 31.95 \pm 2.50 | 29.62 ^{***} \pm 2.00 | 30.60 \pm 1.62 | 29.55 ^{***} \pm 1.80 | 29.52 ^{***} \pm 2.40 |

All monthly values are mean of 20 observations and \pm is S.D. compared with the month of June and all values are found ns (non-significant at *, ** and *** level)

Table 6: Monthly variation in Erythrocytes Sediment Rate (in first hr.) in experimental fishes

| Name of fish | March | April | May | June | July | Aug. | Sept | Oct |
|------------------|--------------------|-------------------------------|-------------------|-----------------|---------------------|---------------------|---------------------|---------------------|
| <i>L.rohita</i> | 1.92 \pm 0.02*** | 2.14 \pm 0.04 ** | 2.25 \pm 0.02 * | 2.20 \pm 0.06 | 3.20 \pm 0.08 *** | 3.60 \pm 0.04 *** | 3.91 \pm 0.08 *** | 3.86 \pm 0.02 *** |
| <i>C.catla</i> | 1.88 \pm 0.06*** | 1.96 \pm 0.04 *** | 2.15 \pm 0.06 * | 2.10 \pm 0.04 | 2.24 \pm 0.06 *** | 2.92 \pm 0.06 *** | 3.80 \pm 0.06 *** | 3.75 \pm 0.04 *** |
| <i>C.mrigala</i> | 2.70 \pm 0.08*** | 2.85 \pm 0.06 ^{ns} | 2.76 \pm 0.05 * | 2.81 \pm 0.08 | 2.95 \pm 0.04 *** | 3.39 \pm 0.02 *** | 3.64 \pm 0.02 *** | 3.60 \pm 0.08 *** |

All monthly values are mean of 20 observations and \pm is S.D. compared with the month of June and marked with *** (P<0.001), **P<0.01), * (P < 0.05) and ns (non-significant).

Table 7: Monthly variation in total White Blood Cells Count($\times 10^3/\text{mm}^3$) in experimental fishes

| Name of fish | March | April | May | June | July | Aug. | Sept. | Oct. |
|------------------|--------------------------------|--------------------------------|--------------------------------|------------------|--------------------------------|---------------------------------|---------------------------------|---------------------------------|
| <i>L.rohita</i> | 20.18 ^{ns} \pm 2.50 | 20.21 ^{ns} \pm 2.12 | 20.26 ^{ns} \pm 2.28 | 20.28 \pm 2.80 | 21.88 [*] \pm 1.20 | 22.92 ^{***} \pm 2.62 | 23.88 ^{***} \pm 3.20 | 23.60 ^{***} \pm 1.82 |
| <i>C.catla</i> | 21.92 ^{ns} \pm 3.74 | 22.02 ^{ns} \pm 1.80 | 21.98 ^{ns} \pm 2.10 | 22.02 \pm 0.66 | 23.18 ^{ns} \pm 0.82 | 23.25 ^{ns} \pm 2.20 | 23.53 ^{ns} \pm 2.50 | 23.49 ^{ns} \pm 1.80 |
| <i>C.mrigala</i> | 21.65 ^{ns} \pm 1.20 | 22.60 ^{ns} \pm 2.40 | 22.06 ^{ns} \pm 3.60 | 22.25 \pm 1.40 | 22.65 ^{ns} \pm 1.66 | 22.88 ⁿ \pm 2.60 | 22.98 ^{ns} \pm 2.24 | 22.88 ^{ns} \pm 1.60 |

All monthly values are mean of 20 observations and \pm is S.D. compared with the month of June and marked with *** (P<0.001), ** P<0.01), *(P < 0.05) and ns (non-significant)

Table 8: Monthly variation in serum glucose (mg/dl) in experimental fishes

| Name of fish | March | April | May | June | July | Aug. | Sept. | Oct. |
|------------------|----------------------------------|----------------------------------|----------------------------------|--------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
| <i>L.rohita</i> | 211.62 ^{***} \pm 5.16 | 221.46 ^{***} \pm 8.10 | 244.21 ^{***} \pm 6.80 | 280.62 \pm 10.80 | 312.46 ^{***} \pm 12.22 | 346.52 ^{***} \pm 8.64 | 358.10 ^{***} \pm 8.20 | 332.82 ^{***} \pm 10.42 |
| <i>C.catla</i> | 218.20 ^{***} \pm 6.21 | 231.55 [*] \pm 8.24 | 240.64 ^{ns} \pm 5.40 | 238.00 \pm 8.22 | 282.48 ^{***} \pm 10.10 | 318.00 ^{***} \pm 8.12 | 331.00 ^{***} \pm 12.10 | 328.20 ^{***} \pm 10.20 |
| <i>C.mrigala</i> | 215.60 ^{***} \pm 6.26 | 208.72 ^{***} \pm 8.42 | 218.81 ^{***} \pm 5.28 | 228.20 \pm 5.16 | 245.65 ^{***} \pm 8.12 | 261.42 ^{***} \pm 10.42 | 276.42 ^{***} \pm 6.22 | 272.64 ^{***} \pm 6.40 |

All monthly values are mean of 20 observations and \pm is S.D. compared with the month of June and marked with *** (P<0.001), ** P<0.01), *(P < 0.05) and ns (non-significant).

Table 9: Monthly variation in total serum protein (gm/dl) in experimental fishes.

| Name of fish | March | April | May | June | July | Aug. | Sept. | Oct. |
|------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|-----------------|--------------------------------|--------------------------------|--------------------------------|
| <i>L.rohita</i> | 3.02 ^{***} \pm 0.06 | 3.15 ^{***} \pm 0.08 | 3.36 ^{***} \pm 0.06 | 3.44 ^{ns} \pm 0.06 | 3.47 \pm 0.02 | 3.38 ^{***} \pm 0.02 | 3.27 ^{***} \pm 0.04 | 3.18 ^{***} \pm 0.06 |
| <i>C.catla</i> | 4.12 ^{***} \pm 0.02 | 4.32 ^{***} \pm 0.04 | 4.56 ^{***} \pm 0.06 | 4.79 ^{ns} \pm 0.08 | 4.83 \pm 0.08 | 4.77 ^{***} \pm 0.06 | 4.66 ^{***} \pm 0.04 | 4.50 ^{***} \pm 0.04 |
| <i>C.mrigala</i> | 3.40 ^{***} \pm 0.02 | 3.65 ^{***} \pm 0.06 | 3.80 ^{***} \pm 0.02 | 3.95 ^{***} \pm 0.02 | 4.22 \pm 0.08 | 4.15 ^{***} \pm 0.02 | 4.09 ^{***} \pm 0.06 | 3.98 ^{***} \pm 0.08 |

All monthly values are mean of 20 observations and \pm is S.D. compared with the month of July and marked with *** (P<0.001), ** P<0.01), *(P < 0.05) and ns (non-significant).

Table 10: Monthly variation in serum cholesterol (mg/dl) in experimental fishes

| Name of fish | March | April | May | June | July | Aug. | Sept. | Oct. |
|------------------|-----------------------------------|----------------------------------|-----------------------------------|--------------------|---------------------------------|-----------------------------------|----------------------------------|-----------------------------------|
| <i>L.rohita</i> | 258.50 ^{***} \pm 10.20 | 275.82 ^{***} \pm 5.50 | 282.64 [*] \pm 12.20 | 290.52 \pm 8.10 | 285.72 ^{ns} \pm 8.10 | 281.24 [*] \pm 6.50 | 275.50 ^{***} \pm 5.22 | 268.62 ^{***} \pm 10.10 |
| <i>C.catla</i> | 280.32 ^{***} \pm 6.20 | 292.71 ^{***} \pm 8.50 | 315.88 ^{***} \pm 10.50 | 342.60 \pm 10.12 | 336.22 ^{ns} \pm 6.50 | 331.44 ^{***} \pm 11.10 | 323.46 ^{***} \pm 8.60 | 312.50 ^{***} \pm 8.40 |
| <i>C.mrigala</i> | 269.40 ^{***} \pm 10.50 | 281.10 ^{***} \pm 6.20 | 288.66 ^{ns} \pm 8.20 | 295.52 \pm 10.50 | 291.48 ^{ns} \pm 6.10 | 286.38 ^{***} \pm 8.12 | 278.10 ^{***} \pm 6.10 | 271.50 ^{***} \pm 6.50 |

All monthly values are mean of 20 observations and \pm is S.D compared with the month of June and marked with *** (P<0.001), ** P<0.01), *(P < 0.05) and ns (non-significant).

Figures

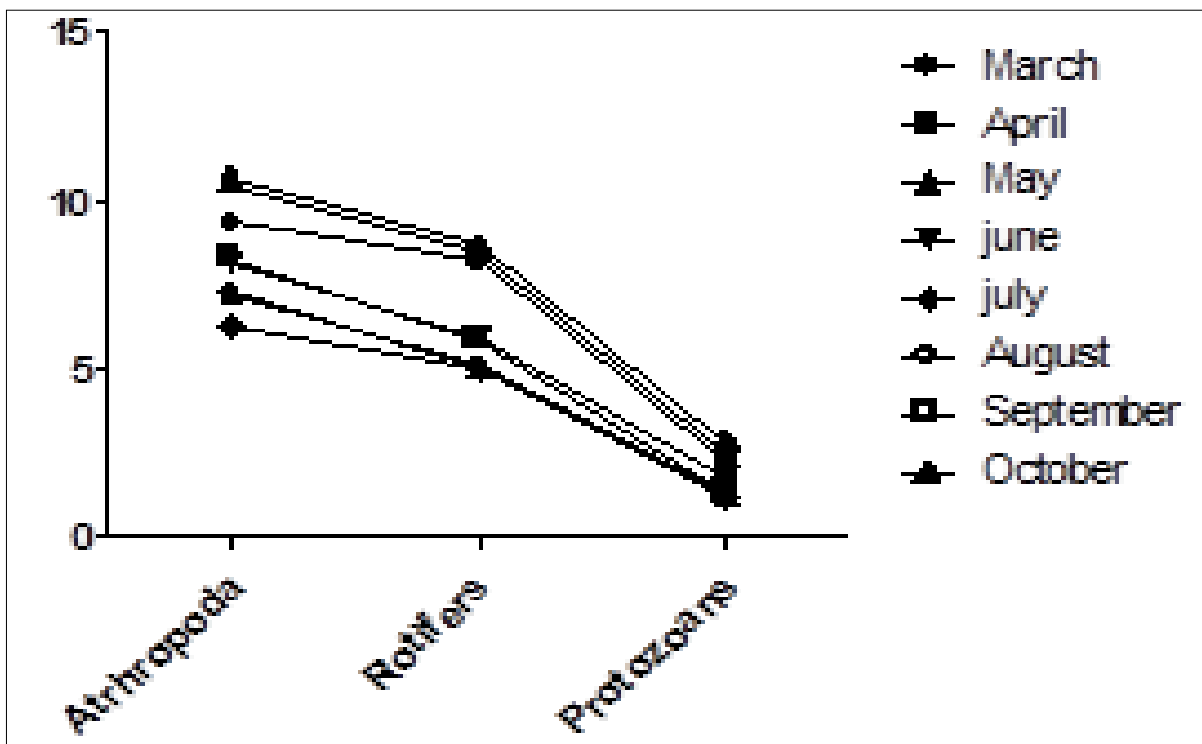


Fig 1: Monthly variation in phytoplanktons($\times 10^3/\text{L}$).

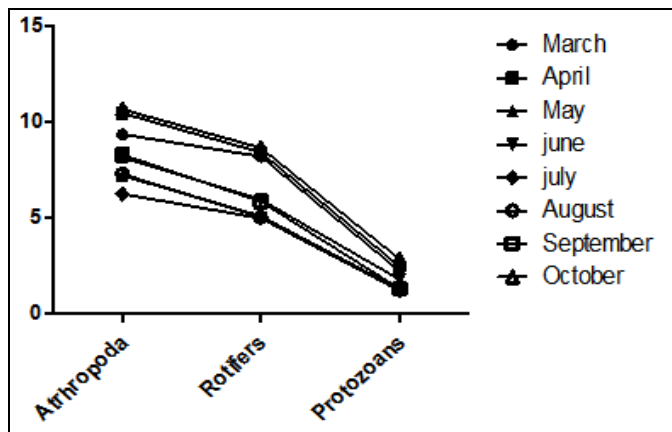


Fig 2: Monthly variation in phytoplanktons($\times 10^3/L$).

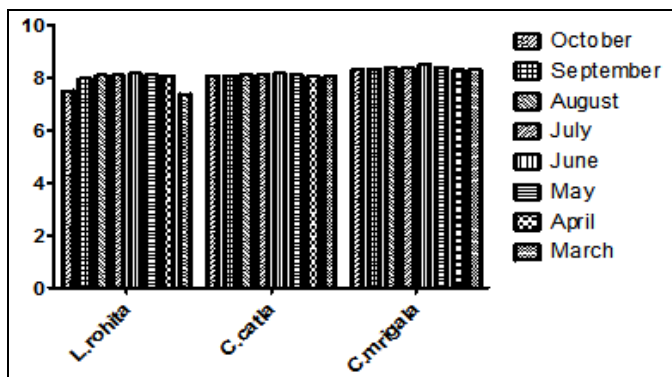


Fig 3: Monthly variation in RBCs($10^6/mm^3$) in experimental fishes.

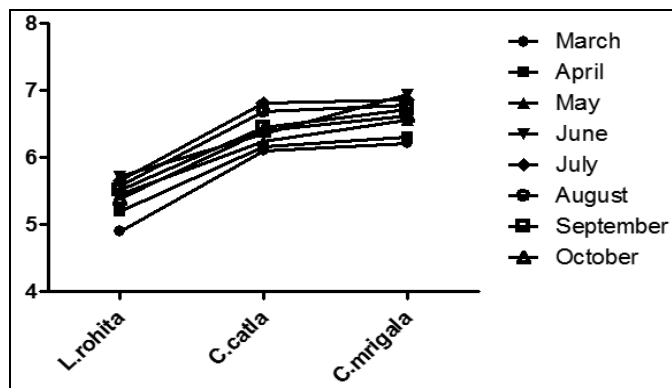


Fig 4: Monthly variation in Hb (gm/100ml) in experimental fishes.

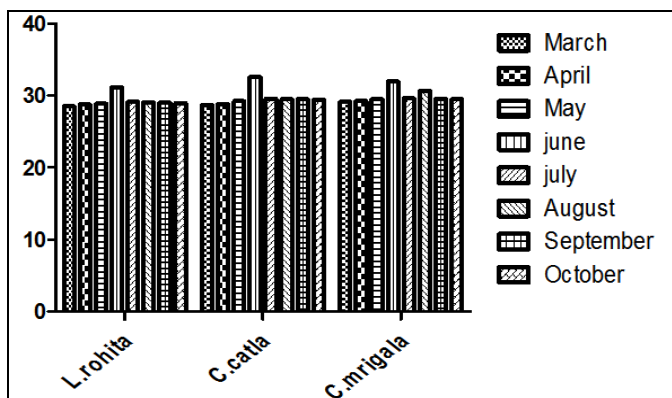


Fig 5: Monthly variation in PCV(%) in experimental fishes.

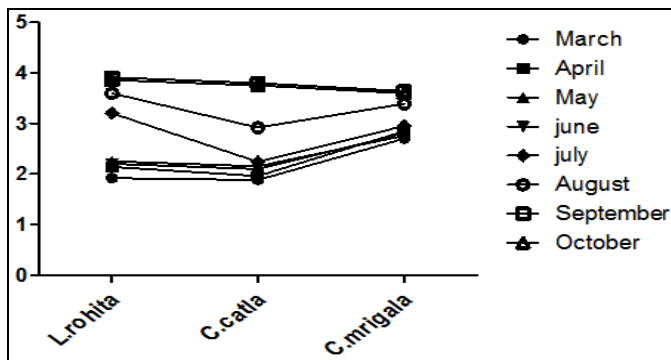


Fig 6: Monthly variation in ESR (/hrs.) in experimental fishes

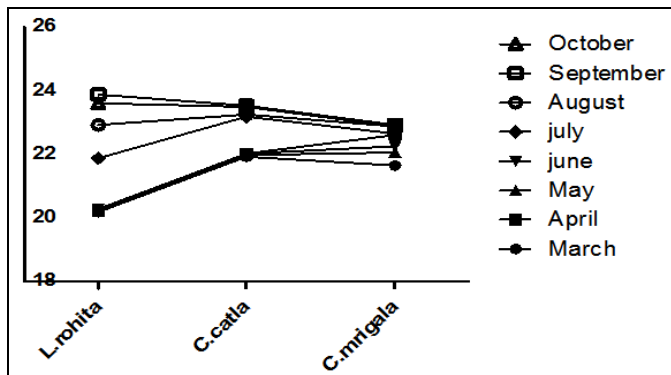


Fig 7: Monthly variation in WBCs($10^3/mm^3$) in experimental fishes

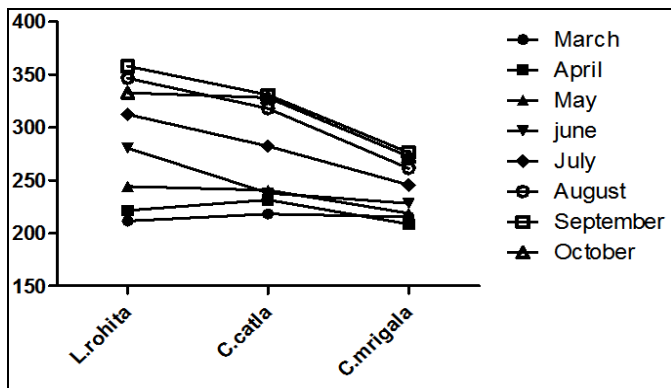


Fig 8: Monthly variation in serum glucose (mg/dl) in experimental fishes.

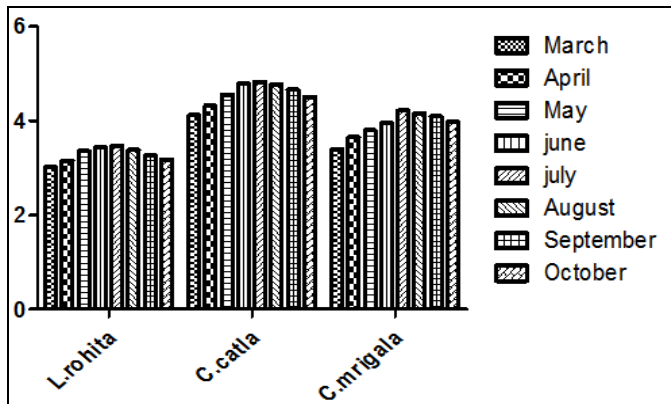


Fig 9: Monthly variation in serum protein (gm/dl) in experimental fishes.

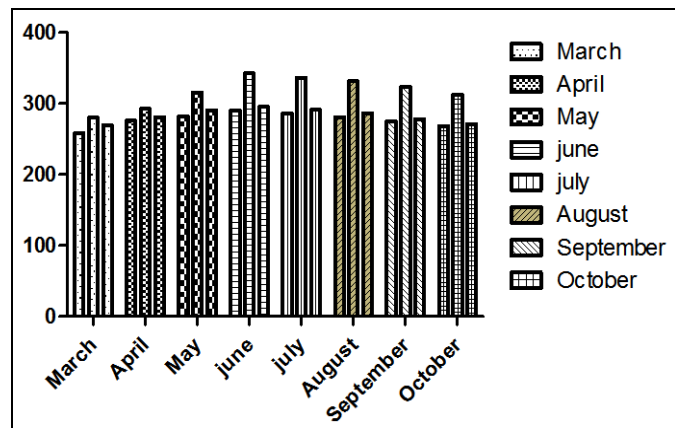


Fig 10: Monthly variation in serum cholesterol (mg/dl) in experimental fishes.

4. Discussion

The growth of planktons depends on nutrition and appropriate photoperiodism (Gibson and Fitzsimons 1991) [17]. In the present study high growth rate was observed from April-June due to increased photoperiodism and intensity of sunlight (increased photosynthesis in phytoplankton) and decreased was observed in other months when compared with the month of June while the growth of zooplanktons was adversely effected by photoperiodism. Increased RBCs production rate, increased Hb synthesis rate and increased PCV rate was observed from April-June month might be due to the availability of enough amount of phytoplanktons or by elevated temperature induced the hematopoiesis in experimental fishes (Capitano *et al.*, 2012) [18]. In present study no anaemia or erythrocytopenia and polycythemia or erythrocytosis were determined in all experimental fishes when correlated with the data of other coworkers (Das *et al.*, 2006, Kumar (2016, Kulkarni and Bedjargi 2016 and Jasmin *et al.*, 2018) [8-11]. Increased value of ESR is the indicator of stress in all vertebrates. The increased ESR values of recorded for all three genera from the month of August –October (table-6) it might be due to stress caused by improper food supply (live food) because decreased growth of planktons was observed in these months, or due change of water temperature caused stress as recorded by Jagtap & Mali (2012) [19] in freshwater fish *Channa punctatus*, or by parasitic infection as Stephens *et al.*, (1967) [20] noticed the effects of Coccidiosis caused by *Eimeria maxima* in young chickens. Further increased total WBCs count from August –October as an indicated stress in all three genera as a result of immune response (Table-7). However in *C.catla* and *C.mrigala* mild stress was observed because total WBCs count is just above the normal ranges ((Das *et al.*, 2006, Kumar 2016, Kulkarni and Bedjargi 2016 and Jasmin *et al.*, 2018) [8-11] but in *L.rohita* it is much higher than the other two species. Finally increased serum glucose level (hyperglycemia) confirmed environmental stress in fish *L.rohita* (Sibergeld, 1974, Malini *et al.*, 2018) [21-22]. In the present study among three Indian Major Carps, *L.rohita* found more sensitive for the environmental stress. No hypo and hyperproteinemia was observed in all experimental fishes however increased protein synthesis rate was also noticed from April-July in comparison to other months but not above their normal ranges. it might be

due to availability of enough protein-rich food grew naturally or supplied by supplementary feeding as described by Zeb and Javed (2018) [23] in cyprinids. No hypo and hypercholesterolemia was observed in all experimental fishes when compared with normal range. Cholesterol synthesis rate increased continuously from April-July months it might be due to a favourable environmental condition caused increased production of planktons in pond water.

5. Conclusion

On the basis of present study it can be concluded that the months from April -May provided favourable environmental conditions for three Indian Major Carps namely *L.rohita*, *C.catla* and *Cirrhinus mrigala*. Among three IMCs the fish *L.rohita* found more sensitive to environmental stress.

6. References

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