

Seasonal analysis of certain biochemical parameters of carps cultured in domestic sewage oxidation ponds

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ABSTRACT

Aquaculture from domestic sewage water is an alternate solution for growing scarcity of food to the pressures of population by producing fish and prawn using treated domestic waste effluents. It is an economically viable process particularly in the developing countries, including West Bengal, India. Keeping in view of the above viability, we have cultured three species of fishes *Cyprinus carpio*, *Labeo rohita*, and *Cirrhinus mrigala* in domestic sewage oxidation ponds designed as per National Environmental Engineering Research Institute, India. Biochemical parameters such as serum lactate and serum cholesterol have been investigated in the present study to determine the quality of fishes cultured in sewage oxidation ponds for human consumption. Among all experimental fishes, *C. carpio* exhibited higher serum lactate (360.40 µg/ml) as compared to *L. rohita* (301.43 µg/ml) and *C. mrigala* (286.73 µg/ml). Similarly, high serum cholesterol values were observed in *C. carpio* as compared to other two species in all the three seasons. During the monsoon season, maximum serum cholesterol were observed in sewage cultured *C. carpio* (430.45 mg/100 ml) and minimum (278.40 mg/ml) in summer season followed by *L. rohita* (248.25 and 198.21 mg/100 ml) and *C. mrigala* (278.40 and 238.37 mg/100 ml). The fishes cultured in fresh water control ponds showed comparatively low values of serum lactate and cholesterol than the experimental fishes. Our results support the concept that good survival and adjustment of the fishes to the pre-treated nutritive domestic sewage water leads to their significant growth with an increased biochemical profile especially with higher levels of cholesterol, which are season dependent.

1. INTRODUCTION

Domestic sewage water fish culture is one of the best solutions for the scarcity of food and water for the growing population. The treated waste water can be used for landscape irrigation, agriculture, and production of fish and prawn for human consumption. The concept of sewage oxidation ponds has been found to be a good alternative for fish growth, which is a low cost and sustainable method for domestic waste treatment as well. The organic matter and other nutrients get reduced by algae and bacteria in the presence of sun light and in turn they become food for fish in the sewage oxidation ponds [1–8].

Fishes and their biochemical parameters can be considered as bio-indicators or bio-monitors of aquatic system for assessing

the quality of water and also the survival and growth rates of fishes grown in such environments [8–15]. Bio-chemical and pathological changes of fishes exposed to varying degrees and types of environmental pollution or stress have been measured by several investigators since last many years [9,16–20]. But little work has been done on the biochemical assessment of fishes grown in domestic sewage oxidation ponds to determine the quality of fish for human consumption. In this context, the serum lactate and cholesterol levels were studied in carps, *Cyprinus carpio*, *Labeo rohita*, and *Cyprinus mrigala* cultured in domestic sewage ponds for a period of 1 year.

2. MATERIALS AND METHODS

The experimental work was carried out in Shahpura Sewage oxidation ponds located at T.T. Nagar, 10 km south-east of Bhopal city (25°–17'). There were eight sewage oxidation ponds constructed in two series of primary and secondary as per specifications of National Environmental Engineering Research Institute, Nagpur. Each pond had an area of 0.4 hectares. The

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ponds were typical sewage oxidation ponds, designated to treat biologically three million gallons of domestic sewage per day. Sewage from adjacent area was collected in a sump near Habibganj Railway Station, from where it was pumped to the oxidation ponds and detained for a period of 15–20 days for rapid microbiological transformation using sunlight. The raw sewage enters the primary pond through three inlets and after the specified detention period, the biologically treated effluent goes out from secondary pond through the outlet. The oxidation ponds are best choice for sewage purification where natural sunlight, tropical conditions, and biological oxidation takes place to reduce the excessive nutrients present in these ponds. In the present study, out of eight ponds as mentioned above, four were selected for fish culture. Two being primary, designated as IA and IIIA and two as secondary termed as IB and IIIB. The primary ponds receive untreated sewage and the secondary ponds receive treated sewage loads.

2.1. Analysis of Serum Lactate and Serum Cholesterol

Live, mature, and healthy *C. carpio*, *L. rohita*, and *Cirrhinus mrigala* weighing $1,200 \pm 50$ g were caught from sewage oxidation ponds and immediately brought for analysis. After 1–2 hours of laboratory acclimatization, they were used for biochemical analysis. By severing, caudal peduncle blood was collected in the pre oven sterilized centrifuge tubes and subjected to centrifugation for a period of 5 minutes at 3,000 rpm. The centrifuge tubes were stored at 4°C for serum precipitation. All the experiments were repeated 3–4 times and the data were statistically analyzed using standard methods [21,22]. Serum lactate was estimated following the procedure of Barker and Summerson [23] and Huckbee [24] as cited in Hawk's Physiological Chemistry [25]. Serum lactate values were expressed as µg per 1 ml of serum. Serum cholesterol was estimated colorimetrically by the method of Sacketh as described in "Microanalysis in Medical Biochemistry" by King and Wotton [26]. Serum cholesterol values are expressed in milligram per 100 ml of serum.

3. RESULTS AND DISCUSSION

Serum lactate of carp fishes *C. carpio*, *L. rohita*, and *C. mrigala* cultured in the sewage oxidation ponds was analyzed at every 3-month period for a year and compared with the values obtained from control fishes grown in a fresh water control pond of same dimension where the fishes were fed with normal diet. The values are expressed in µg/ml (Fig. 1). All the values are mean of 3–4 replicates. *Cyprinus carpio* cultured in sewage ponds exhibited higher values at 3-month period (140.37 µg/ml) at 6-month period (218.48 µg/ml), at 9-month period (290.13 µg/ml) and 360.40 µg/ml at the end of the experiment, i.e., 12-month period. *Cyprinus carpio* from normal control pond exhibited 125.90, 164.30, 201.36, and 270.71 µg/ml at the period of 3, 6, 9, and 12 months, respectively. Thus, the experimental *C. carpio* recorded high lactate as compared to its control counterpart (Fig. 1). *Labeo rohita* and *C. mrigala* of experimental ponds recorded 131.50 and 129.00 µg/ml serum lactate at the time of 3-month period and showed higher serum values of 301.43 and 286.73 µg/ml at the end of the experiment, i.e., at 12-month period. Thus, serum lactate values of all three carp fishes cultured in oxidation ponds exhibited higher values in comparison to the control cultured fishes. It was noted that *C. carpio* recorded higher values of lactate as compared to other two experimental fishes, i.e., *L. rohita* and *C. mrigala*, probably because its mainly a polyphagous feeder and was perhaps more suited to adjust to the sewage – excessive nutrient environment (Fig. 1).

Serum cholesterol was estimated seasonally, (i.e., winter, summer, and monsoon) for a period of 1 year in all the carps: *C. carpio*, *L. rohita*, and *C. mrigala* cultured in sewage oxidation ponds and the values were compared with the same fishes cultured in normal fresh water control waters (Fig. 2). It was observed that high serum cholesterol was recorded in the monsoon season in *C. carpio*, *L. rohita*, and *C. mrigala* cultured in sewage oxidation ponds (Fig. 2) and minimum values in

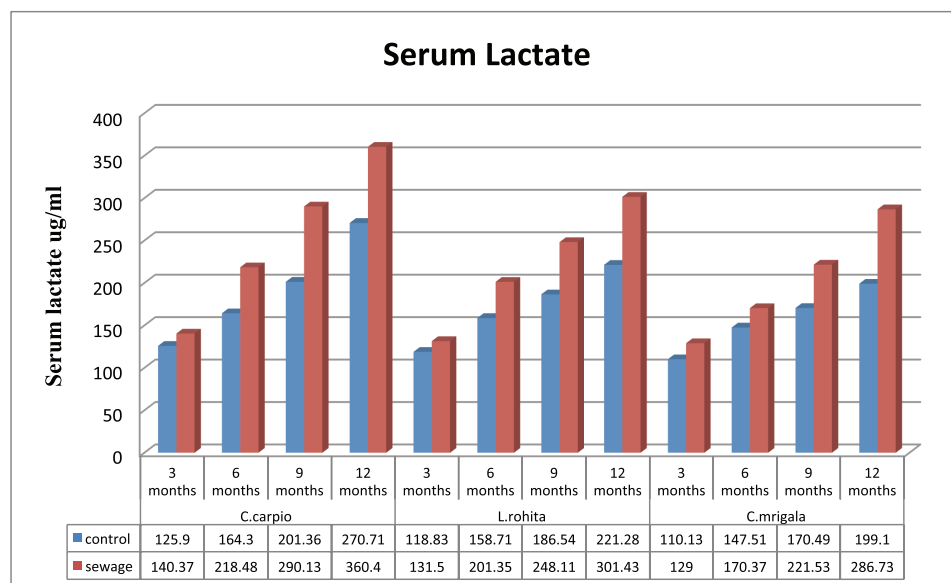


Figure 1: Serum lactate values of carps (*C. carpio*, *L. rohita*, and *C. mrigala*) cultured in control and sewage oxidation ponds.

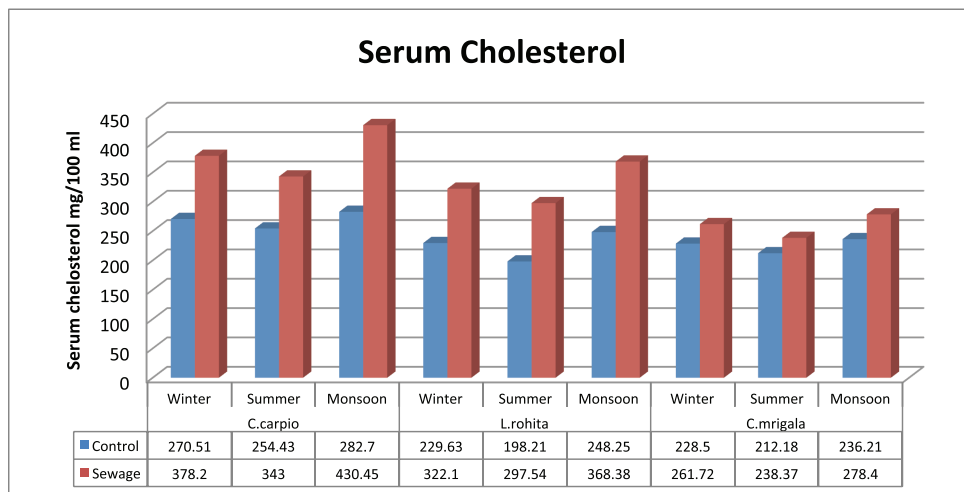


Figure 2: Serum cholesterol values of carps cultured in control and sewage oxidation ponds in three seasons (winter, summer and monsoon) for a period of 1 year.

summer season. *Cirrhinus mrigala* from sewage ponds exhibited 378.20 mg/100 ml cholesterol values in winter, 343 mg/100 ml in summer, and high 430.45 mg/100 ml cholesterol in monsoon period. The control *C. carpio* recorded 270.51, 254.43, and 282.70 mg/100 ml cholesterol values, respectively, in winter, summer monsoon seasons which are quite low as compared to the experimental fishes (Fig. 2). The other fishes *L. rohita* of sewage ponds exhibited 322.10, 297.54 and 368.38 mg/100 ml and whereas *C. mrigala* exhibited 261.72, 238.37, and 278.40 mg/100 ml serum cholesterol values in winter, summer and monsoon seasons, respectively, which were found higher than their fresh water control cultured fishes (Fig. 2). Thus, *C. carpio* grown in sewage oxidation ponds exhibited higher cholesterol values in all seasons compared to other experimental fishes *L. rohita* and *C. mrigala* because this fish is a polyphagous feeder and it did not face any stress in the sewage oxidation ponds and also was able to maximally utilize the available total nutrients to show a healthy growth pattern.

In the present study, the fishes *C. carpio*, *L. rohita*, and *C. mrigala* cultured in domestic sewage oxidation ponds exhibited higher serum lactate values as compared to the fresh water cultured control fishes (Fig. 1). The reason for higher lactate values may be due to their increased feeding habits and related more physiological activities. Active swimmers have high glucose and lactate levels as compared to less active sluggish forms [5,7,12,20,27,28]. Another reason for high serum lactate levels may be due to large amounts of glycogen present in the liver of the experimental fish is converted in to lactate [7,15,29].

Serum cholesterol values were also observed high in *C. carpio*, *L. rohita*, and *C. mrigala* (Fig. 2) as compared to the control ones. All the fishes recorded high serum cholesterol values in monsoon and minimum in summer seasons. Cholesterol plays an important part in body metabolism and a unique role in maturation of sexual organs spawning eggs and deposition of fats. Some work has been done on serum cholesterol in carps and other fishes on short term exposure to toxicants, heavy metals and to the starvation conditions. They observed slight alterations in hematological and biochemical experiments [8,14,19,30–34]. However, little attempt

has been made on the assessment of biochemical parameters of fishes grown in sewage ponds, and hence the present work is first report of its kind.

The reason for higher values of serum cholesterol in monsoon season is due to their active metabolic activities and high rate of feeding to recover their normal values after spawning. Low serum cholesterol values of these fishes in summer are probably due to high temperature and peak ripeness of the gonads in both the sexes. In this period (summer), the fishes consume less amount of food and use the deposited fat in their tissues for the development of gonads. Earlier workers have also reported similar findings [14,35–39]. The higher values of serum lactate and cholesterol in the fishes are not due to any kind of toxicological, physiological stress or any other reason. The physiochemical characters, high nutrient environment and disease-free surroundings were the important conditions to the survival and growth rates of the fishes grown in sewage ponds [1,3,5,15,40–42].

4. CONCLUSION

The present study shows that the major carps were best adjusted to the domestic sewage oxidation pond environments as they are herbivorous and utilized the excessive nutrients and organic matter present in the ponds. The serum lactate and cholesterol assessment of the fishes in the present study reveals that there is no negative impact on the fishes survival and growth in the domestic sewage secondary and tertiary oxidation ponds. However, more studies have to be done on biochemical assessment of sewage-oxidation-pond grown fishes for human consumption point of view.

5. ACKNOWLEDGMENTS

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6. CONFLICTS OF INTEREST

The authors report no financial or any other conflicts of interest in this work.

7. ETHICAL APPROVALS

Not applicable.

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