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ORIGINAL ARTICLE

A STUDY ON THE EFFECTS OF INDUSTRIAL EFFLUENTS ON THE BIOCHEMICAL COMPONENTS OF THE FISH *Mugil cephalus* IN UPPANAR ESTUARY SOUTH EAST COAST OF INDIA

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ABSTRACT

The objective of the present study is to observe the levels of carbohydrate, protein and lipids in fish *Mugil cephalus* from Uppanar estuary, located at Cuddalore district, Tamil Nadu, India. The fish was collected periodically from estuary during post monsoon, summer, pre monsoon and monsoon seasons from three different stations viz; station 1, station 2 and station 3. The present study revealed that the protein, carbohydrate and lipid levels were significantly declined ($P< 0.05$) in liver and gill tissues in the order of summer, post monsoon, pre monsoon and monsoon seasons in station 2 and station 3. Highest reduction in the observed biochemical parameters were noticed in station 2 and this may be due to location of this station nearer to the SIPCOT industries, where mixing of industrial effluents with estuary followed by river runoff, which contribute much of industrial and land derived materials along with domestic, municipal, and agricultural wastes loaded with pesticides. In addition to this, the continuous contribution of pollutants due to human activities may also have a significant contribution of various contaminants in all the stations. Hence, it is recommended that, possible measures should be taken to minimize the levels of contaminants in this study area.

Keywords: Biochemical changes; Gill; Liver; Seasonal variations; *Mugil cephalus* ; Uppanar estuary.

1.INTRODUCTION

Pollution is the most burning problems of our entire life time and constitutes a potential threat to the health and well-being of our entire populations. The congregation of big communities in cities leads to the generation of large quantities of liquid, gaseous and solid wastes. Industries also contribute to colossal quantities of wastes of different nature. Wherever the intensification of industries, the process of treatment of industrial discharges has lagged far behind the industrial growth. The toxic substances present in these wastes can affect the aquatic life thus disrupting the whole systems and pose a threat to human health directly or indirectly (Pappa jeba Sangeetha et al 2016). Direct discharge of industrial effluents in to rivers and run off from fields in to the ponds, lakes and rivers are causing serious concern about water pollution particularly with respect to inland fisheries (Stephen et al., 1987). The industrial wastes generally contains high quantities of dissolved and suspended solids, heavy metals, organic and inorganic chemicals, high BOD and COD, oils and grease, besides toxic metals which cause deleterious effects on the fish when discharged in to water bodies.

Biochemical parameters are suitable tools for assessing environmental influences and stress effects of anthropogenic origin on the condition and health of aquatic vertebrates since there is a close association between the circulatory system of fish and the external environment, the effect of external stressors and toxic substances on exposed fish could be manifested through clinical diagnosis of fish physiology. The body components like protein, carbohydrate and lipid play a significant role in body construction and energy production. They are involved in major physiological events and the assessment can be considered as diagnostic tool to determine the physiological phases of organism (Martein and Arivoli, 2008).

Uppanar River is considered to be one of the polluted rivers in south east coast of India due to industrialization (Balakrishnan, 2014; Usha dahmordran, 2013). Small Industrial Promotion Corporation of Tamil Nadu (SIPCOT) covering an area of about 520 acres with 52 industries is located on the bank of the Uppanar River at Cuddalore. In addition to the industrial wastes, the river receives also the municipal wastes and domestic sewage from Cuddalore town. Various chemicals and metals present in industrial effluents penetrate into the tissues of fishes and cause biochemical alternations, which can be used as indicators for the effects of various anthropogenic pollutants on organisms and are reflect of overall health of the entire population in the ecosystem. The fish *Mugil cephalus* is an important food fish around the world. They spent a great deal of time close to shore around the mouth of streams and rivers or in brackish bays, inlets and

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lagoons with sand or mud bottoms. Therefore, the goal of this study is to find out the carbohydrate, protein, and lipid levels in gill and liver of the grey mullet *M. cephalus* at Uppanar estuary.

2.MATERIALS AND METHODS

Study area

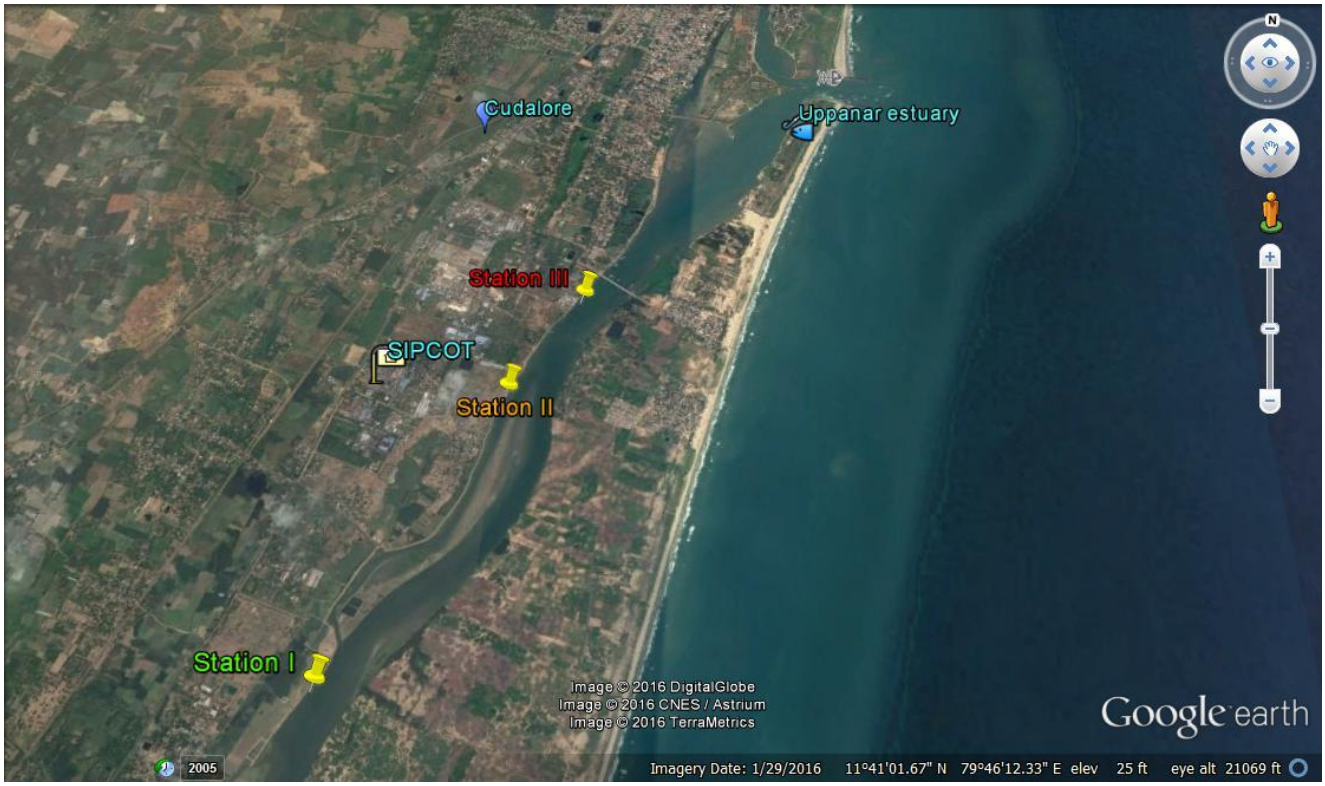

Figure 1: Map Showing the Study Area.

Station 1-Station I is an industrial free zone which is located 4km away from station II and there is no agricultural land and human residents.

Station 2-It is situated nearer to SIPCOT, where the industrial units are discharging their effluents. Municipal wastes and domestic sewage from the nearby Cuddalore town and coconut retting effluents are also released here.

Station 3 – This station lies nearer the mouth of the estuary, which is nearly 4 km away from station II, and in close proximity to the fishing harbour.

Fish sample collection

Fish *M. cephalus* was collected from three different stations at Uppanar estuary during post monsoon, summer, pre monsoon and monsoon season and they were immediately transferred to ice box. Selected tissues (gill and liver) were removed for the biochemical analysis.

Biochemical analysis

Total carbohydrate was estimated by Standard method (Carroll et al. (1956). Protein content of the sample was determined spectrometrically by deploying Lowry's method using bovine serum albumin as standard (Lowry 1951). Lipid was estimated by the method of Barnes and Blackstock, (1973). Statistical analyses were employed to interpret the results using software SPSS 15.0.

3.RESULTS

Carbohydrate

Table 1 indicates the levels of carbohydrate in gill and liver tissues of *M.cephalus*. The mean carbohydrate level in gill and liver tissues was found to be decreased significantly ($P< 0.05$) in station 2 than station 3 and station 1, season wise results revealed that the minimum level of carbohydrate was observed during summer followed by pre monsoon, post monsoon and maximum level was observed during monsoon.

Protein

Table 2 indicates the level of protein in gill and liver tissues of *M.cephalus*. The mean protein level in gill and liver tissues was found to be decreased significantly ($P< 0.05$) in station 2 than the other stations, season wise results revealed that the minimum level of protein was observed during summer followed by pre monsoon, post monsoon and maximum level was noticed during monsoon.

Total lipid

Table 3 represents the level of lipid in gill and liver tissues of *M. cephalus*. The mean lipid level in gill and liver tissues was found to be reduced significantly ($P< 0.05$) in station 2 than the other stations, season wise results revealed that the minimum level of lipid was observed during summer followed by pre monsoon, post monsoon and maximum level was recorded during monsoon.

Table 1. Carbohydrate level changes (mg/g) in gill and liver of *M. cephalus* collected from the chosen stations (1, 2, and 3) of Uppanar estuary during various seasons

Seasons	Stations		
	Station 1	Station 2	Station 3
	GILL		
Post monsoon	4.26 ± 0.32[a]	2.86 ± 0.22[b]	3.46 ± 0.26[c]
Summer	2.69 ± 0.21[a]	1.88 ± 0.14[b]	2.52 ± 0.19[c]
Pre monsoon	3.49 ± 0.27[a]	2.59 ± 0.20[b]	2.91 ± 0.22[c]
Monsoon	4.69 ± 0.36[a]	3.28 ± 0.25[b]	3.69 ± 0.28[c]
	LIVER		
Post monsoon	6.29 ± 0.48[a]	4.49 ± 0.34[b]	5.16 ± 0.39[c]
Summer	4.47 ± 0.34[a]	3.18 ± 0.24[b]	3.91 ± 0.30[c]
Pre monsoon	6.09 ± 0.46[a]	4.06 ± 0.31[b]	4.76 ± 0.36[c]
Monsoon	7.39 ± 0.57[a]	5.72 ± 0.44[b]	5.26 ± 0.40[c]

Values are expressed as mean ± SD., Sample size (N)=6. Different letter designation denotes significant at $P < 0.05$ difference between the stations.

Table 2. Protein level changes (mg/g) in gill and liver of *M. cephalus* collected from the chosen stations (1, 2, and 3) of Uppanar estuary during various seasons

Seasons	Stations		
	Station 1	Station 2	Station 3
	GILL		
Post monsoon	4.26 ± 0.32[a]	2.86 ± 0.22[b]	3.46 ± 0.26[c]
Summer	2.69 ± 0.21[a]	1.88 ± 0.14[b]	2.52 ± 0.19[c]
Pre monsoon	3.49 ± 0.27[a]	2.59 ± 0.20[b]	2.91 ± 0.22[c]
Monsoon	4.69 ± 0.36[a]	3.28 ± 0.25[b]	3.69 ± 0.28[c]
	LIVER		
Post monsoon	6.29 ± 0.48[a]	4.49 ± 0.34[b]	5.16 ± 0.39[c]
Summer	4.47 ± 0.34[a]	3.18 ± 0.24[b]	3.91 ± 0.30[c]
Pre monsoon	6.09 ± 0.46[a]	4.06 ± 0.31[b]	4.76 ± 0.36[c]
Monsoon	7.39 ± 0.57[a]	5.72 ± 0.44[b]	5.26 ± 0.40[c]

Values are expressed as mean ± SD., Sample size (N)=6. Different letter designation denotes significant at $P < 0.05$ difference between the stations.

Table 3. Total lipids level changes (mg/g) in gill and liver of *M. cephalus* collected from the chosen stations (1, 2, and 3) of Uppanar estuary during various seasons

Seasons	Stations		
	Station 1	Station 2	Station 3
	GILL		
Post monsoon	4.26 ± 0.32[a]	2.86 ± 0.22[b]	3.46 ± 0.26[c]
Summer	2.69 ± 0.21[a]	1.88 ± 0.14[b]	2.52 ± 0.19[c]
Pre monsoon	3.49 ± 0.27[a]	2.59 ± 0.20[b]	2.91 ± 0.22[c]
Monsoon	4.69 ± 0.36[a]	3.28 ± 0.25[b]	3.69 ± 0.28[c]
	LIVER		
Post monsoon	6.29 ± 0.48[a]	4.49 ± 0.34[b]	5.16 ± 0.39[c]
Summer	4.47 ± 0.34[a]	3.18 ± 0.24[b]	3.91 ± 0.30[c]
Pre monsoon	6.09 ± 0.46[a]	4.06 ± 0.31[b]	4.76 ± 0.36[c]
Monsoon	7.39 ± 0.57[a]	5.72 ± 0.44[b]	5.26 ± 0.40[c]

Values are expressed as mean ± SD., Sample size (N)=6. Different letter designation denotes significant at $P < 0.05$ difference between the stations.

4.DISCUSSION

The disposal of industrial effluents in the aquatic environment is toxic to fishes and sometimes resulted in death, which may be due to abnormal physico-chemical characteristics of industrial effluents (Mishra et al., 1988; Pawar, 1988).

In the present study the analyzed biochemical parameters in gill and liver tissues were showed significant seasonal changes in all the stations. Among the stations studied, station 2 showed higher variations in the biochemical parameters and this could be attributed to various pollutants in the industrial effluent discharge from SIPCOT and also from other sources in this station. The above results are in accordance with the reports of Balakrishnan (2014), who has observed similar findings in the test fish from Uppanar estuary. In the present study the significant decreases in all the biochemical parameter were observed in liver tissue, since liver is the active metabolic site and also a chief detoxifying organ, the pollutant stress predominately affect the liver.

Carbohydrate typically contributes to structural support, protection and serves as nutrient and stored energy which increase or decrease according to organism need (Yerragi et al 2000). It is stored as glycogen in fish tissue to supply the energy needs when there are hypoxic condition and lack of food (Olangnathan and Patterson, 2013). Carbohydrates are considered to be degraded first under the stress condition of animals. In the present study, significant decrease in the level of carbohydrate has been noticed in the gill and liver of fish at station 2 and station 3 respectively, which may be due to high energy demand required for the hepatic synthesis of detoxifying enzymes (Hori et al., 2006). The recorded findings in the present study is corroborated with the observations of Valarmathi and Azariah (2002), they have noticed the reduced level of tissue carbohydrates in the toxicant exposed animals. They have also stated that this may be due to the glycogenolysis, possibly by increasing the activity of glycogen phosphorylase to meet the energy need under stressful environment or the toxicant may have an effect of glycogenesis by inhibiting the carbohydrate metabolism. According to Rani et al. (2000), the decline in carbohydrate level may be due to utilization of stored glycogen possibly through anaerobic glycogenolysis to meet the energy demand under heavy metal stress.

In the present study, a significant decrease in the levels of protein in gill and liver of the test fish was noticed in station 2 and station 3. This may be due to the stress in the test fish provoked by various contaminants in this study area. Stress has been reported to accelerate protein metabolism in man and animals (Nichol and Rosen, 1963). Protein decrease may be due to stress in fish as protein is likely to undergo hydrolysis and oxidation through TCA cycle to meet the increased demand for energy caused by the stress (Somnath, 1991).

Lipids play an important physiological role for storage of energy and vitamins. The depletion in the total lipid in tissues could be due to their active mobilization towards the blood and/or tissue metabolism (Murthy et al., 1994). In the present study, a significant decrease in the lipid levels in gill and liver was noticed in the test fish from station 2 especially during summer season, when compare to other two stations. It may

be suggested that, pollutants inhibited lipid synthesis and started mobilizing the stored lipids either through β-oxidation or through a gradual unsaturation of lipid molecules (Jha and Jha 1995). Rao et al. (1985) have rightly pointed out that the decline in the lipid level might be due to the consumption of lipid to meet the supplementary energy requirement under stress.

5.CONCLUSION

The changes in carbohydrate, protein and lipid content in fish due to stress induced by various contaminants in the uppanar estuary. The contaminants can cause its effect at cellular, even at molecular level and ultimately the biochemical alterations. In the present study levels of carbohydrate, protein and lipid were found to be decreased significantly in liver and gill of *Mugil cephalus* at station 2 when compare with the other two stations. This may be due to the discharges of industrial effluents, domestic wastes, agricultural wastes and municipality wastes from Cuddalore town. From these results, it is concluded that the fish *Mugil cephalus* can be considered as the bio indicator species and the biochemical parameters as the biomarkers to indicate the intensity of pollution in uppanar estuary.

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