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The variations in the nucleic acids DNA and RNA levels in fish *Mugil cephalus* inhabiting Uppanar estuary

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Abstract

A survey was conducted in the Uppanar estuary to scrutinize the levels of DNA and RNA from the selected tissues of the test fish *Mugil cephalus*. The test fish was collected periodically from three different stations (station 1, station 2 and station 3) for a period of one year. In the present study, a significant decrease ($P < 0.05$) in the nucleic acid level, such as DNA and RNA was noticed in selected tissues such as brain, liver, kidney and gill of fish *M. cephalus* in the order of liver, gill, brain, kidney. Station wise as well as season wise results revealed that, the maximum decrease in tissue DNA and RNA level was observed only in S2 during summer followed by post monsoon, pre monsoon and minimum decrease during monsoon. This may be because of this studied area (station 2) is subjected to increased pollution stresses, originating mainly from SIPCOT industrial areas, human activities such as disposal of agricultural, municipal, domestic and other wastes in substantial quantities.

Keywords: Uppanar estuary, DNA and RNA levels, seasonal changes, *M. cephalus*

Introduction

Industrial effluent and municipality wastes are the main reason for unwanted changes in the quality of water and its inhabiting fish (Shakir *et al.*, 2013; Ravikiran and Kulkarni, 2015)^[9, 7]. Pollutants can directly affect cellular organelles and nucleic acids that may lead to cell cycle modulation, and apoptosis (Wang and Shi, 2001)^[14]. Nucleic acids such as DNA and RNA level indicate the degree of protein synthesis.

It is based on the truth that the DNA level per cell is stable within the same species, and the RNA is largely ribosomic and differs with the protein synthesis rate. Nucleic acids are considered as important biomarkers in aquaculture as well as in eco-toxicology assessment due to their role in controlling various activities of cells (Miliou *et al.*, 1998)^[6].

There are several laboratory studies with reference to alterations in nucleic acid level after exposure to various pollutants (Anuradha Shukla and Shukla, 2012; Habib and Abou Shehata Samah, 2013; Shakir *et al.*, 2012)^[2, 5, 10].

RNA plays a significant role in protein synthesis hence depletion in RNA contents also results in depletion in protein level (Tripathi *et al.*, 2002)^[16]. The growth of organisms is based on the increase in protein level and increase in RNA-content or ribosomal activity (Buckley *et al.*, 1999). Nucleic acid indices can be used as an estimate of recent growth among fish showing different kinds of growth dynamics, as these indices are sensitive to both changes in length- and weight specific growth rates (Hame and Rickwood, 1990).

Any change in nucleic acid metabolism results in the reduction in the DNA content. Furthermore, inhibition of DNA synthesis, might affect both protein as well as amino acid levels by decreasing the level of RNA in protein synthesis machinery (Das and Mukherjee, 2003). Studies on the changes in nucleic acid level on fishes in polluted natural environment are scanty. Hence, the goal of the present study is to quantify the changes in the nucleic acids (DNA and RNA) in brain, liver, kidney and gill tissues of the fish *M. cephalus* collected from different stations of Uppanar estuary.

Materials and Methods

The estuary flowing in the SIPCOT area has divided into three sampling stations, approximately 4 km apart from each other. The sampling stations are located at

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Poondiyanuppam (S1), Sangolikuppam (S2) and Kudikadu (S3) in the coastal area of Cuddalore. The test fish *M. cephalus* were collected periodically from three different stations. The fish was sacrificed and the desired organs (brain gill, liver and kidney) were dissected out for quantification of DNA and RNA.

The nucleic acid levels (DNA and RNA) were determined by using the following methods:

Estimation of DNA by- Diphenylamine method of Schneider (1940)^[8].

Estimation of RNA by- Orcinol method of Schneider (1940)^[8].

Results and Discussion

In the present investigation, analysis of nucleic acids was performed in the fish *M. cephalus* collected from different stations of Uppanar estuary in Cuddalore district. The results showed that the maximum decrease in DNA and RNA level was observed at S2 than S1 and S3 (Figs. 1-8). In confirmative with this result, Habib and Samah (2013)^[5] have also noticed a station wise change in the levels of nucleic acid and proteins in cat fish collected from different stations in Egypt. They have correlated these results with the accumulation of heavy metals Cd and Pb in the tissues of the test fish. This consistent report was also made by Ali and Shakoori (2011)^[1]. They have noticed a significant decrease in the levels of DNA and RNA in the test fish, *Tor putitora*

collected from a polluted site of River Kabul than the same fish collected from non polluted Warsak Dam. This maximum reduction in station 2 may be due to the higher level of discharges of SIPCOT industrial effluents with a number of known and unknown pollutants from various sources at this station (Balakrishanan, 2014)^[3]. The fishes involved in long term exposure may have resulted in failure of the body defence mechanism and could have caused tissue degeneration.

In the present study, the decrease in DNA and RNA level was found to be in the order of liver, gill, brain, kidney (Figs. 1-8). The variations in the levels of nucleic acids in tissue samples show the tissue specificity of the nucleic acids. The level of DNA in different tissue indicates cell numbers (WHO, 1984; Cui *et al.*, 1997)^[15, 4]. The fishes involved in long term exposure may have resulted in failure of the body defence mechanism and could have caused tissue degeneration. The reason for high reduction in DNA and RNA levels in selected tissues may be either due to the heavy metal toxicity or to the pesticide toxicity in *M. cephalus* and might have caused genotoxic action by decreased mitotic index and disturbed cell division (Topktas *et al.*, 1996)^[12] or due to inhibitory action of heavy metals on DNA and RNA synthesis (Walter *et al.* 1980)^[13] or by cell death due to focal necrosis (Shivanandappa and Krishnakumari, 1981)^[11]. The decrease in the nucleic acid levels may also be due to the increased activity of liver phosphatases.

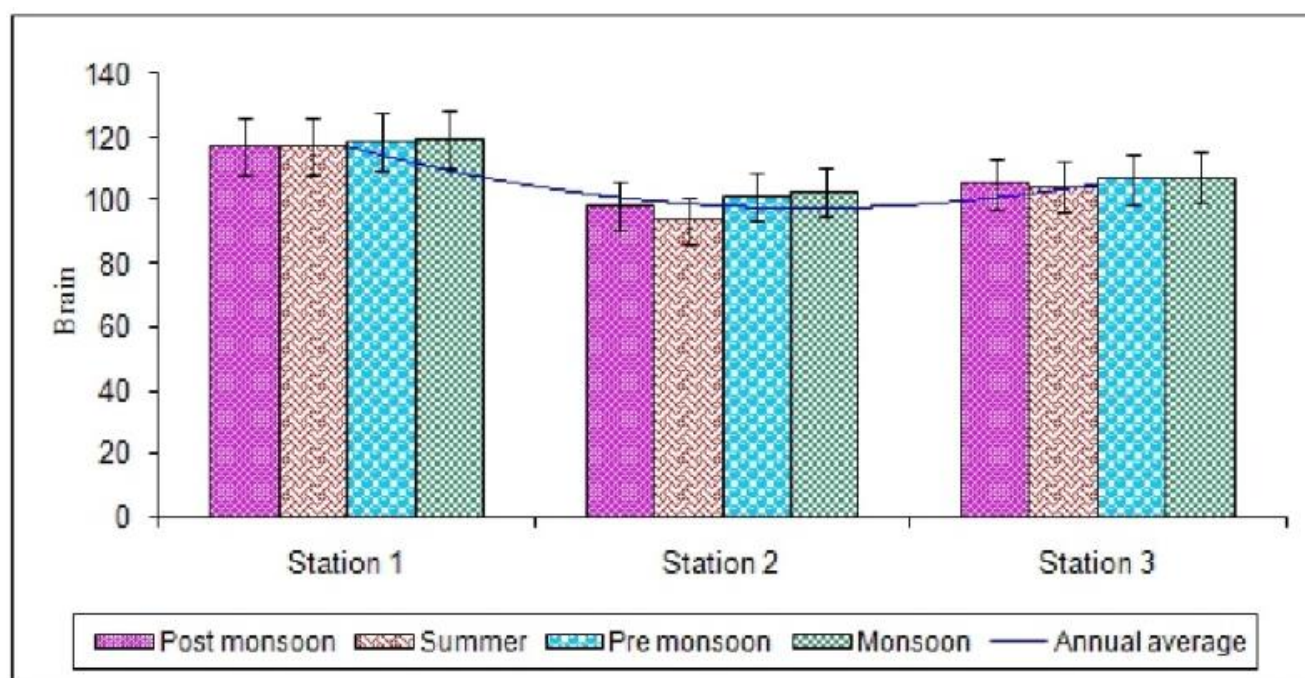


Fig 1: DNA content (mg/gm) in Brain tissue of the fish *M. cephalus* collected from the chosen stations (1, 2 and 3) of Uppanar estuary during various seasons 3

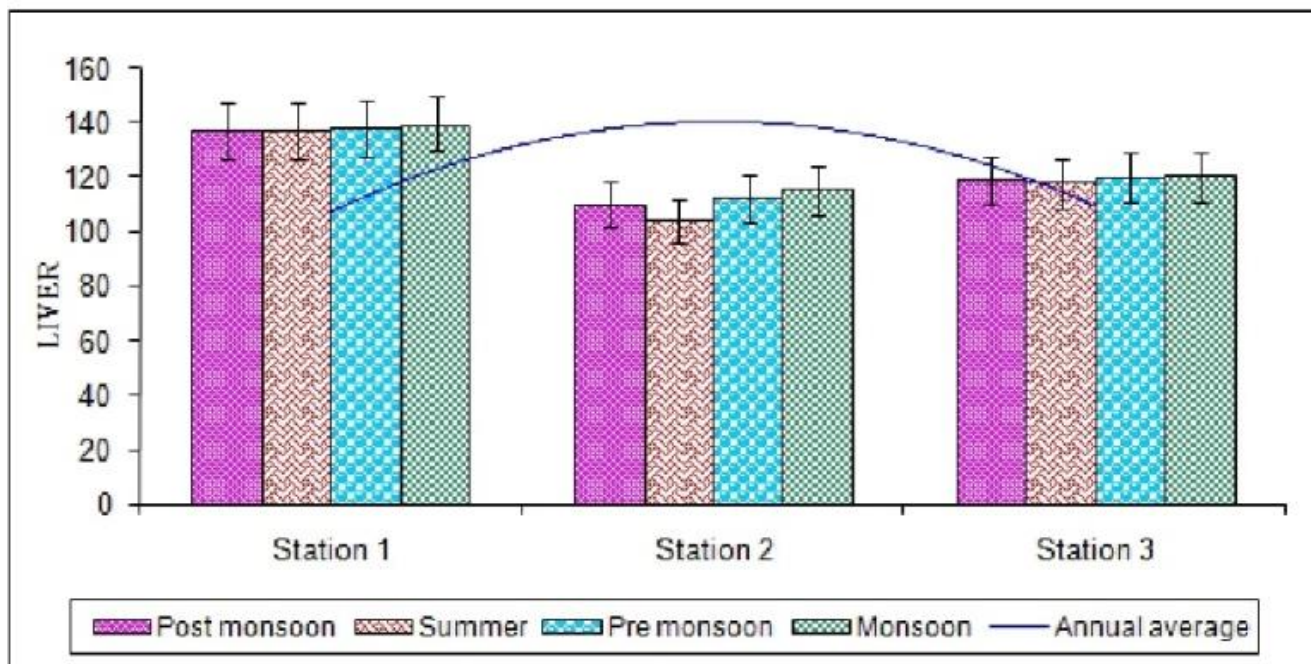


Fig 2: DNA content (mg/gm) in Liver tissue of the fish *M. cephalus* collected from the chosen stations (1, 2 and 3) of Uppanar estuary during various seasons 3

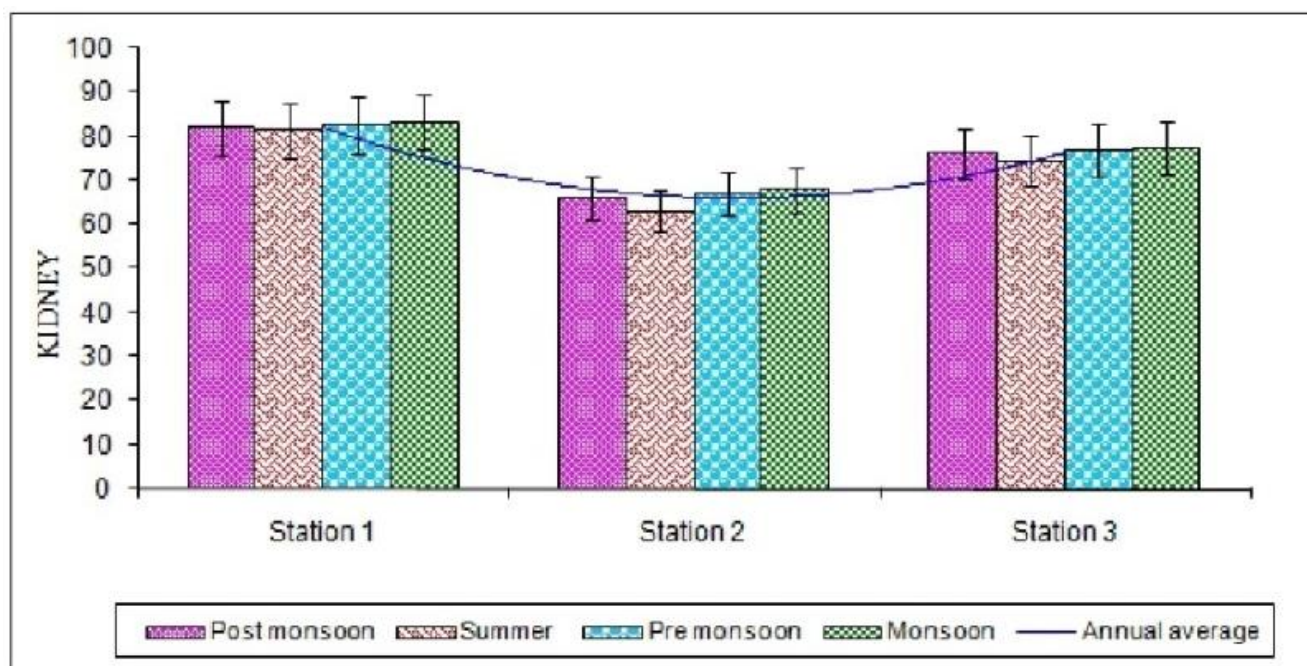


Fig 3: DNA content (mg/gm) in Kidney tissue of the fish *M. cephalus* collected from the chosen stations (1, 2 and 3) of Uppanar estuary during various seasons 3

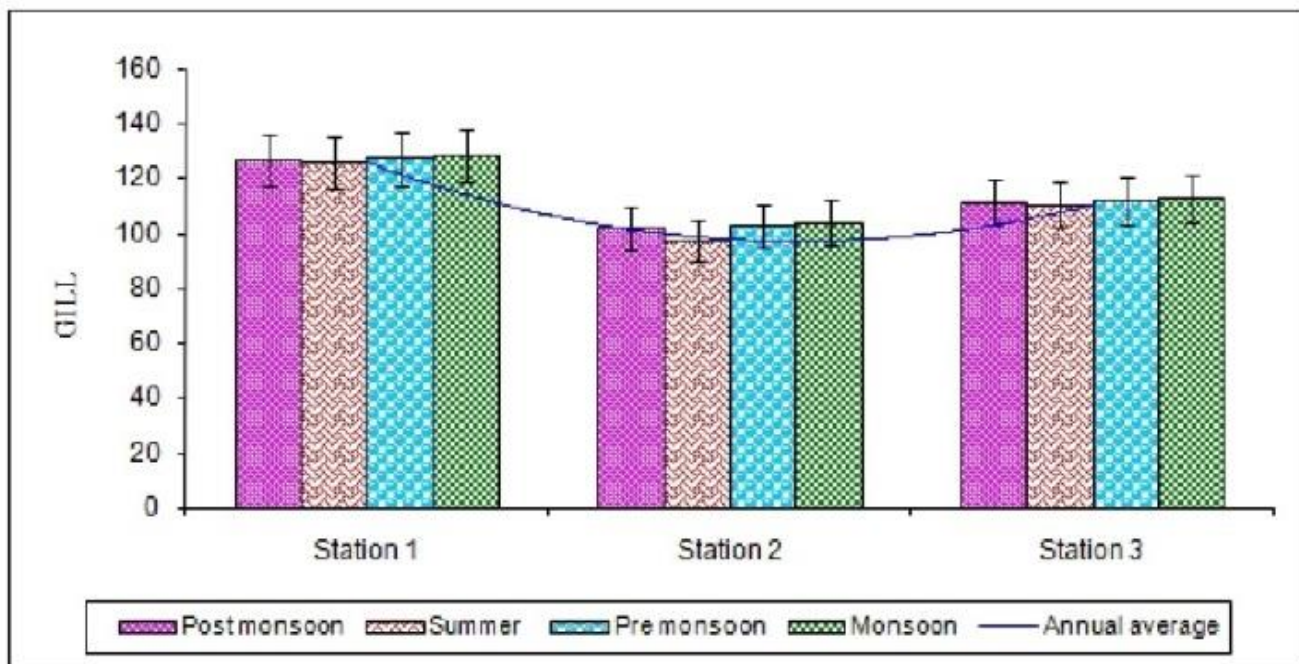


Fig 4: DNA content (mg/gm) in Gill tissue of the fish *M. cephalus* collected from the chosen stations (1, 2 and 3) of Uppanar estuary during various seasons 3

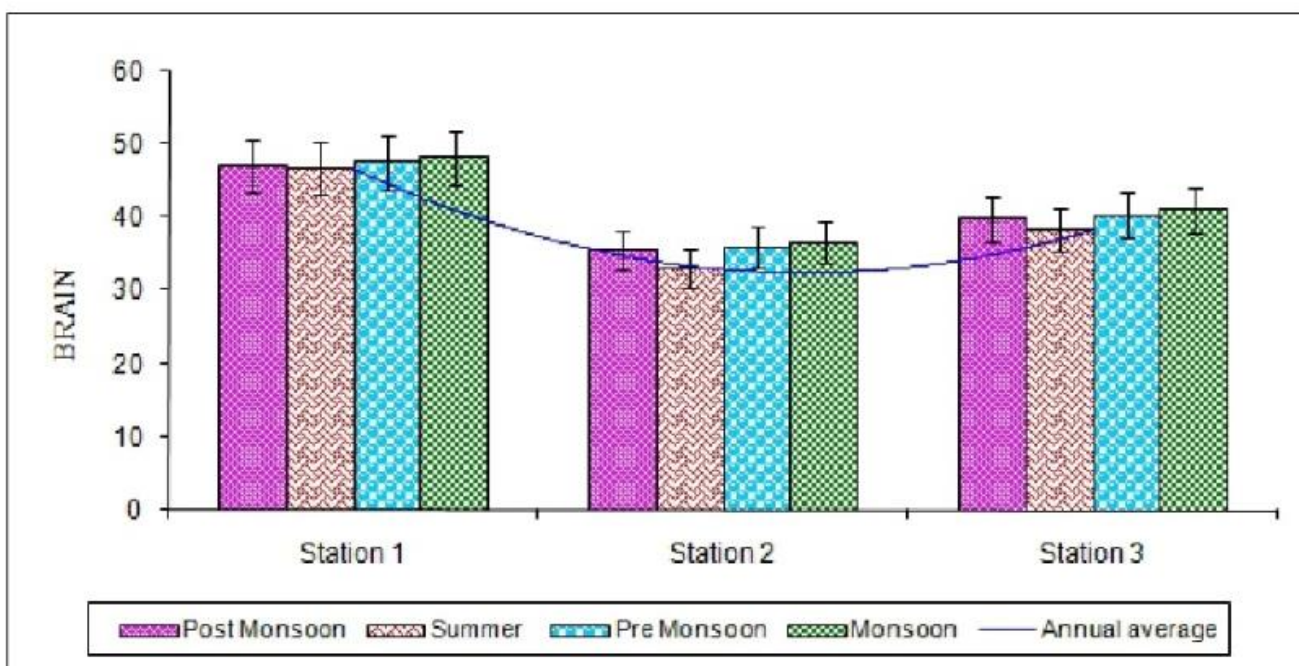


Fig 5: DNA content (mg/gm) in Brain tissue of the fish *M. cephalus* collected from the chosen stations (1, 2 and 3) of Uppanar estuary during various seasons 3

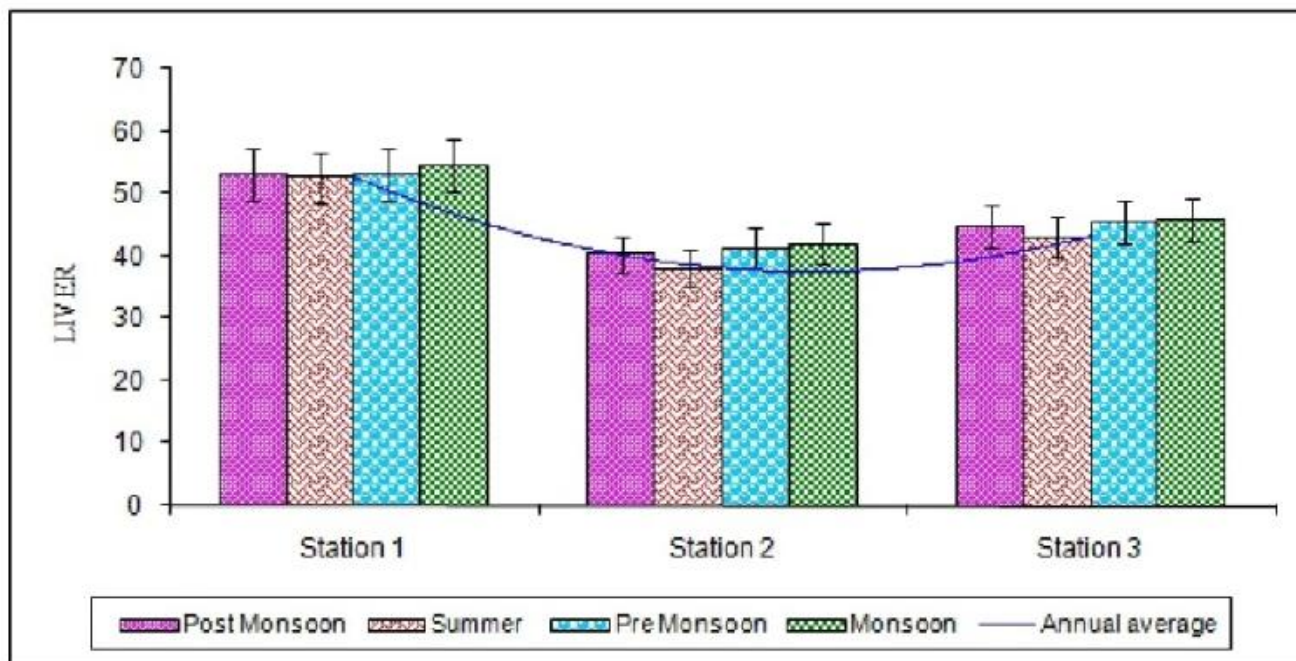


Fig 6: RNA content (mg/gm) in Liver tissue of the fish *M. cephalus* collected from the chosen stations (1, 2 and 3) of Uppanar estuary during various seasons 3

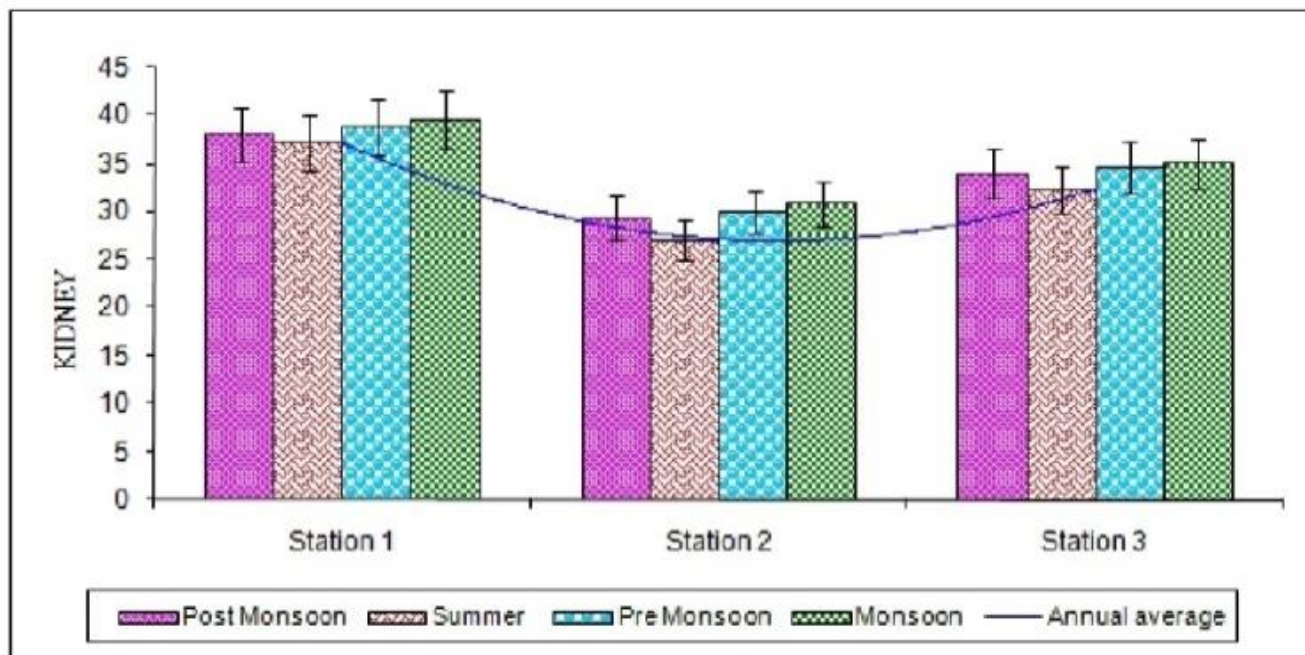


Fig 7: RNA content (mg/gm) in Kidney tissue of the fish *M. cephalus* collected from the chosen stations (1, 2 and 3) of Uppanar estuary during various seasons 3

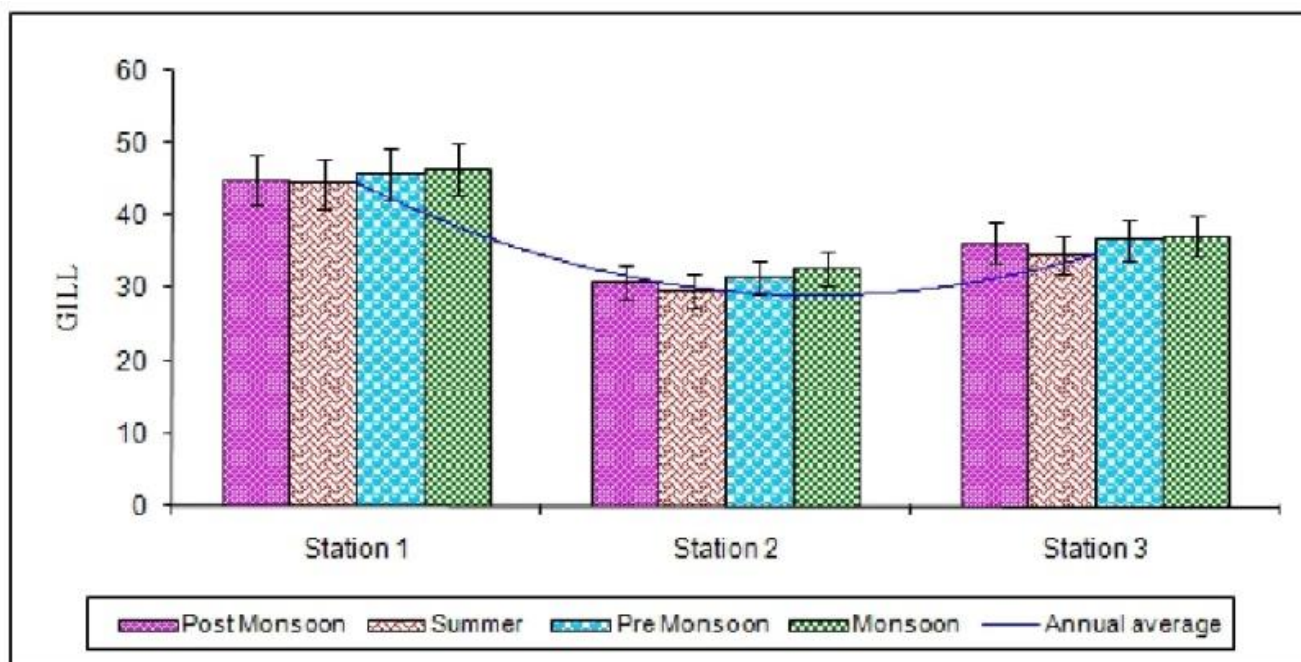


Fig 8: RNA content (mg/gm) in Gill tissue of the fish *M. cephalus* collected from the chosen stations (1, 2 and 3) of Uppanar estuary during various seasons 3

Thus, Nucleic acids and protein contents are regarded as important biomarkers of the metabolic potential of cells, as these play the main role in regulating different activities of cells. Their ratios also provide significant information about the way in which, or the mechanism by which, these contents regulate the multifaceted activities of cells. Therefore, there is a necessary to develop and apply efficient technologies to notice, manage, and correct human induced degradation of aquatic systems.

Conclusions

Based on the results of the present study it can be concluded that the significant decrease in the DNA and RNA content might be due to the discharges of SIPCOT effluents with a number of known and unknown pollutants. The reasons for the decreased levels of nucleic acid are the enzyme inhibition, mitotic changes, impairment of nucleic acid metabolism, increased activity of phosphatases and the degradation of cells. On compilation of all these results it appears that the disruption of DNA synthesis might have reflected in RNA synthesis.

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