MONSOONAL INFLUENCE ON WATER CHEMISTRY AND PRIMARY PRODUCTIVITY OF KAPPIL BACKWATERS, KERALA, INDIA

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ABSTRACT

Kappil backwaters of Thiruvananthapuram district, Kerala, were assessed for the influence of rainfall on the distribution pattern of its physical, chemical and productivity parameters. Monsoon months were found to attribute high nutrients in all sampling stations. A higher extent of dissolved oxygen and gross and net productivity values (497.25 mgC/m^3/hr. and 444.75 mgC/m^3/hr.) were also attained during north-east monsoon. Electrical conductivity and salinity values were higher during non monsoon months and showed more or less similar distribution pattern in all stations. Thus a marginal influence of rainfall on the distribution of both physico-chemical and productivity parameters were noticed.

Keywords: Kappil backwaters, physico-chemical parameters, primary productivity, nutrients

INTRODUCTION

Estuaries are unique ecospots and are the most productive ecosystem in the world with varying physico-chemical properties and highly diverse flora and fauna. India is bestowed with a large network of water bodies linking the inland fresh water system, the rivers with the estuaries and coastal seas. In India there are 113 major and minor estuaries which are connected to a combined river length of 45,000 km. (Ramesh and Purvaj, 2009). The coastal areas of Kerala has perennial estuaries covering an area of 2,42,600 ha (Biju Kummar and Sushama, 2000). These estuaries are rich sources of nutrients as they are interconnected with the country’s vast network of rivers. Kerala is blessed with 44 rivers and 30 brackish water perennial estuaries. Among these backwaters, seven are estuaries (Bijoy Nandan, 2004).

Primary production is an important factor in assessing the fertility of a water body (Feebarani, 2009) and is well dependent on water quality. The primary productivity of a tropical estuary is always dependent on the availability of nutrients (Renjith et. al., 2004). Usually estuarine environments are enriched with nutrients through many sources. Berner and Berner (1987) well documented a number of nutrient sources for phytoplankton in the surface water. Nutrients are essential for the growth and wellbeing of primary and secondary producers in an estuary (Muraleedharan Nair, 1995). The supply of fresh nutrients and their effective regeneration is an important factor determining the productivity of an aquatic ecosystem (Resmi, 2004). Physical, geological, chemical and biological processes are acting as controlling factor in the distribution and variation of nutrients in estuarine systems (Aston, 1980).

Water quality of an aquatic ecosystem is considered as essential for the wellbeing of all life associated with it. Criteria are developed for water quality in relation to its use such as drinking, recreation, agriculture, industry etc. Degradation of water quality destroys the availability of water for humans and biological system, increasing financial costs, and decreasing species diversity and abundance of resident communities (Adakole et al., 2008). Deterioration of water quality is happening as a result of rapid industrialization, unscientific development process and also due to the disposal of solid and liquid wastes into water resources (Alemayehu et al., 2005, Unnisa and Khailillullah, 2004).

The production capacity of an aquatic ecosystem can be monitored by assessing the GPP and NPP. GPP in terms measures the amount of energy produced by the primary producers in an aquatic ecosystem for a particular period of time, while NPP measures the amount of net useful energy produced by the primary producers (Akrum, 2002). Surface water contains a rich variety of micro-organisms. Phytoplanktons are photosynthesizing microscopic organisms and they are treated as the primary production agents of an aquatic ecosystem. Phytoplanktons are microscopic plants, treated as primary producers in aquatic ecosystem and are
suspended in the aquatic environments with no mobility or very little mobility (Joseph, 1988). Ghosal et al. (2011) stated that planktons are primary production agents, engaged in the production of organic compounds with the help of sunlight and maintains in the aquatic food web. Nutrients are bio stimulants and are utilized by photosynthetic organisms to generate organic matter. The growth and development of phytoplantons are dependent on the availability of such nutrients (Haridevi, 2013).

MATERIALS AND METHODS

Kappil backwater is a shallow brackish water system, which lies between 8°77’75.90” to 8°78’88.13”N latitudes and 76°67’58.46” to 76°67’68.83”E longitudes. The main fresh water inflows of this back water system is a small river called Ayiroor Puzha. Unlike the other larger river systems of Kerala, the 17 km. long Ayiroor Puzha originates at Navayikulam, a midland part of Kerala and flows in to the Edava Nadayara Kayal. Ithikkara River, which originate from the Western Ghats and flows down to the Parvur Kayal is also a contributing factor for the ecology of Kappil backwaters. The lake shares it’s shores to both Kollam and Thiruvananthapuram districts. It is connected to Parvur kayal by Maniyamkulam canal. A natural pozhi (bar mouth) can be seen here, which connects Kappil Backwaters to the Arabian Sea. But during summer months a sand bar is formed in between the lake and the sea. Two boat clubs operated by the district tourism promotion councils of Kollam and Thiruvananthapuram districts are functioning here and facilitates boating for tourists. Some part of this backwater is widely used for husk retting. These areas are apparently polluted and secrete a foul smell. This backwater is often used for fishing, retting, recreation, aquaculture etc.

Prior to the study, detailed investigation was made on the study area and according to the geographical and biological importance, three stations were fixed for sample collection. These are I. Kappil pozhi, II. Kappil Bridge and III. Kilimukkam kayal. Monthly water samples were collected from these 3 stations during October 2015 to March 2016. Rainfall data was also collected for the study period from Metrological department. Samples were analysed for both physico-chemical (temperature, pH, electrical conductivity, turbidity, salinity, nitrite, nitrate, phosphate, silicate and dissolved oxygen) and productivity parameters. The primary productivity was analysed by winkler’s light and dark bottle method. The current study was carried to find out how the rainfall is affecting the distribution of physico-chemical and primary productivity parameters in a tropical aquatic ecosystem. All the analyses were carried out following standard methods (APHA, 2012).

RESULTS AND DISCUSSION

Physico-chemical properties:

Rainfall data, obtained from meteorological department, showed a decreasing trend towards the end of the study period (Figure 1). In first three months (October, November and December), the study area received higher rainfall from the northeast monsoon. Highest rainfall of 218 mm was recorded in the month of October 2015. January, February and March 2016 were found as dry months with little or no little rainfall. Rainfall was found positively correlated with nitrite, nitrate, silicate, DO, GPP and NPP and negatively correlated with water temperature, pH, EC, turbidity and salinity (Table 1).

Water temperature was found increasing towards the end of the study period and showed more or less similar distribution pattern in all stations (Figure 2). Minimum water temperature was observed during October 2015 in all sampling stations and is due to fresh water inflows from the heavy rainfall. Maximum temperature during March 2016 may be due to the solar radiation and stagnant condition of water. Minimum temperature during rainy season and maximum in summer months was reported earlier in Cochin backwaters (Meera and Nandan, 2010). Similar condition was also observed by Satheesh et al. (2009) from Pondicherry Mangroves and by Geetha (1997) from Ashtamudy Lake. Water temperature was found positively correlated with EC, Salinity and phosphate and found negatively correlated with nitrite, nitrate, silicate, GPP and NPP (Table 1).
Acidic nature of water was found in station I throughout the period of study. Lower pH values in all stations were observed during monsoon months. By the end of northeast monsoon, pH values were slightly increased and showed alkaline nature, except station I. Higher pH was measured in station III and (8.4) in March 2016. Lower value was measured at station I (4.8) during October 2015 (Figure 3). Ranjith Kumar et. al. (2017) reported similar minimum and maximum pH values during monsoon and non-monsoon months from Eramalloor region of Vembanad backwaters. The acidic nature of water during rainy months was also reported by Meera et. al. (2010) from Valanthakad backwaters. pH values showed a strong significant positive correlation with DO and negative correlation with EC, turbidity, salinity and nitrate (Table 1).

Distribution of electrical conductivity in the Kappil backwaters is presented in Figure 4. Highest values were recorded from Station 1 during the entire period of study. In the present study the highest value of EC was recorded in Station 1 (27357 µS) during March 2016 and it may be due to the heavy salinity and the accumulation of organic and inorganic materials, as it is the bar mouth of the estuary. Conductivity is directly proportional to the salt load in a water body and is an index of ionic content of the aquatic ecosystem (Ajibare, 2014). The lowest value was found in Station 3 (6060 µS) during October 2015. Higher values in all Stations were found during the summer months. Mary (2009) observed maximum electrical conductivity during dry months in Poovar estuary. Similar trend in the distribution of EC was also noticed in Ashtamudi backwaters by Seema (2015). Statistical analysis showed that electrical conductivity was positively correlated with water temperature, turbidity, salinity and phosphate and showed negative correlation with rainfall, pH, nitrite, DO, GPP and NPP (Table 1).

Water samples from Kappil backwaters were found more turbid during monsoon months. Maximum turbidity was monitored during October 2015 in all stations. Station I recorded the highest value (8.3 NTU) during October 2015 and station III recorded the lowest value (3.1 NTU) during December 2015 (Figure 5). The re-suspension of bottom sediment by tidal stirring action during the monsoon season was documented by Thasneem (2016) from Cochin backwaters. Bijoy Nandan et. al. (2014) has also observed similar condition in Kodangallur-Azhikode estuary. Turbidity was found positively correlated to rainfall, EC, salinity, nitrate, phosphate and silicate and found negatively correlated with pH and DO (Table 1).

Salinity plays an important role in controlling various physical, chemical and biological process of an aquatic environment. The salinity level broadly varied between 10.9 ppt (Station 3) to 27.1 ppt (Station 1) and is presented in Figure 6. Sumesh (2013) noted a salinity range of 12\% to 34\% in Thikkumbhagom Kayal. Santhanam and Perumal (2003) in Vellar estuary showed a salinity range between 3\% to 34\%. In the present study the higher values of salinity recorded during non-monsoon months might be due to the limited fresh water inflows and high evaporation rate. The lower values were found during rainy season and it may be due to the heavy surface water inflow from rainfall. Fluctuations in salinity values between months among the study period showed that rainfall has a great influence on salinity. Salinity was found positively correlated with water temperature, EC, turbidity and phosphate and found negatively correlated with rainfall pH, nitrite, DO, GPP and NPP (Table 1).

During the study period nitrite values were fluctuated in between 0.41 mg/l to 0.98 mg/l (Figure 7). Both these values were observed in station I during December and October respectively. Higher concentration of nitrate in all stations was recorded during monsoon months. Maximum nitrite concentration during monsoon months is mainly due to the heavy river discharges and surface runoff. The same condition in the distribution of nitrite was noticed by Anitha (2014) in Thengapattanam estuary. Higher values in monsoon and lower values in summer season were also reported by Karuppiah et. al. (2011), Prabu (2008) and Manikannan et. al. (2011). Nitrite values were found positively correlated with rainfall, turbidity, nitrate, silicate, DO, GPP and NPP and found negatively
correlated with water temperature, EC and salinity (Table 1).

Nitrate concentration in the water samples of Kappil backwaters was also high in monsoon period. Nitrate values ranged between 1.02 mg/l in station III to 4.47 mg/l in station I (Figure 8). Similar condition of higher values during monsoon and lower values during pre-monsoon was also reported by Soundarapandian et al., (2009) and Anitha (2014). By the beginning of summer nitrate values showed an increasing tendency. This may be due to the decomposition of accumulated organic waste material brought in to the backwaters during the monsoon months. Formation of nitrate through decomposition of organic waste materials was also reported in Pennar estuary by Ravaniah et al. (2010). Nitrate was showed a strong positive correlation with rainfall, turbidity, nitrite, phosphate, silicate, GPP and NPP and showed negative correlation with water temperature and pH (Table 1).

The observed variation of phosphate was ranged from 0.62 mg/l to 1.08 mg/l (Figure 9). Maximum value was observed at station II during October 2015 and minimum value was found at station III during December 2015. Phosphate values also showed an increasing tendency by the beginning of summer. Increasing tendency of phosphate values during summer months may be due to the exchange of phosphorous between sediments and overlaying water. The low consumption of planktons and precipitating condition also contributes higher phosphate values during summer season. Such a condition was also noticed in the current study area by Madhukumar (1996). Phosphate was found positively correlated with water temperature, EC, turbidity, salinity and nitrate (Table 1).

Silicate is an important nutrient for the plankton’s growth. It is also useful for the skeleton formation of diatoms and radiolarians (Kannappan 2015). In the current analysis, it was found that silicate content was high during monsoon months and it emphasise that the backwater gets maximum concentration of silicate from freshwater inflows. Maximum silicate values were observed at station II during November 2015 (1.77 mg/l) and minimum value was found at station I during January 2016 (1.06 mg/l) (Figure 10). Silicate values were found positively correlated with rainfall, turbidity, nitrite, nitrate, phosphate, silicate, GPP and NPP and negatively correlated with water temperature (Table 1).

Aquatic organisms requires sufficient amount of dissolved oxygen to survive and carry out their normal life functions. Availed DO in an aquatic ecosystem can be used to indicate the level of organic pollution and the self-purification capacity of the water body (Koshy, 2013). Observed distribution of DO is presented in Figure 11.
DO levels reached its peak during October 2015 in all sampling stations and it might be due to influx of fresh water in to the backwater system. Maximum Do levels during monsoon months due to the freshwater inflows were also noticed in Poonthura estuary by Anila Kumary and Abdul Aziz (1992). Station I recorded the lowest DO levels throughout the study period and it might be due to the heavy salinity. The inverse relationship of salinity and DO was observed by Sujatha et. al. (2009) in Ashtamudi and Vembanad estuaries. Accumulation of organic compounds and high bacterial activities in the sedimentary layers also results in to the lower DO levels in the water column (Thasneem, 2016). In the present study DO values were found to have strong positive correlation with rainfall, pH, nitrite, GPP and NPP and negatively correlated with EC, turbidity and salinity (Table 1).

Primary productivity:
Primary productivity of aquatic ecosystem always depends on some physico-chemical and environmental parameters such as light, temperature, salinity and availability of nutrients (Virginia, 2005). In the present study phytoplankton productivity was noticed high during October 2015 (GPP 497.25 mgC/m³/hr, NPP 444.75 mgC/m³/hr) and both these values were observed at station III. Lowest gross and net primary productivity values were noticed in station 1 (117.89 mgC/m³/hr and 32.89 mgC/m³/hr) during March 2016. The primary productivity values observed in the current study is presented in Figure 12 & 13.

Maximum productivity values were observed during northeast monsoon period in all stations. Similar maximum productivity values during monsoon months also reported in Valanthakad Backwater by Meera and Nandan (2010). Higher primary productivity during monsoon season was also noticed by Bindu (2005) in Cochin backwaters. Similar observations were also reported by Vaheeda (2008) from brackish waters of Kodungallur area. Results from Rajakkamangalam estuary in Kanyakumari also show resemblance of current findings (Prema et. al. 2004). Bijoy Nandan and Abdul Azis (1994) also recorded higher productivity values during monsoon and lower during pre-monsoon in Kadinamkulam estuary. Productivity values also show marginal variation between stations and months.

Gross primary productivity values showed significant positive correlations with rainfall, nitrite, nitrate, silicate, DO and NPP and showed negative correlations with water temperature, EC and salinity (Table 1).

Net primary productivity was found positively correlated with rainfall, nitrate, nitrate, silicate, DO and GPP and
found negatively correlated with water temperature, EC and salinity (Table 1).

CONCLUSION

Nutrient parameters except phosphate measured maximum values during the rainy months. Both GPP and NPP were also recorded highest values during the same period. It emphasise that primary productivity of Kappil estuary is greatly influenced by the heavy nutrient supply during the monsoon months. Dissolved oxygen level in station I was very low during summer months. DO values were recorded below 5 mg/l in all months during summer in station I. Higher salinity values were recorded in summer months and it is reflected in DO values.

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