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STUDIES ON PHYSICO – CHEMICAL CHARACTERISTICS OF KAYAMKULAM ESTUARY, KERALA, INDIA

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ABSTRACT The physico-chemical characteristics of the Kayamkulam estuary were studied for a period of one year from February 2015 to January 2016. The physico-chemical parameters like rainfall, atmospheric temperature, water temperature ,pH, dissolved oxygen, salinity, total dissolved solids, hardness, phosphate, nitrate and silicate were recorded. Atmospheric temperature varied from 30.2 to 35.2 ^{0}C, water temperature 26.9 to 29.7^{0}C,pH varied from 6.5 to 8.4,Total Dissolved Solids varied from 75.5-169.2 mg/l, dissolved oxygen was ranged from 3.2-6 mg/l. salinity was ranged from 27.5-32.2 ppt. Salinity shows seasonal as well as spatial variations. Hardness varies from 150-394 mg/l, phosphate varied from 0.04-.34µg/l, nitrate 0.03-.93µg/l and silicate varied from 10.31-17.9µg/l. The higher values of phosphate and nitrate were recorded from the Ayiramthengu mangrove area of the Kayamkulam estuary. During the study period, all the physico-chemical parameters showed monthly variations.

KEYWORDS : Kayamkulam estuary, salinity, Ayiramthengu, Physico-chemical characteristics

INTRODUCTION

Kerala occupies southern most part of India. Kerala is endowed with two rainy seasons represented by the South-West and North –East monsoons. The former is characterized by heavy rainfall during June – September and latter is marked by the precipitation of lesser magnitude occurring generally between October- December. The coast of Kerala is strikingly bordered by a string of back waters, generally running parallel to the shoreline.(Bijoy Nandan,2005). Out of the 30 backwaters of Kerala, Kayamkulam estuary or Kayamkulam backwater is one of the major estuarine systems and scenic backwaters in the south west coasts of India. Estuary as a complex system receives huge quantity of dissolved chemical inputs from a number of sources as runoff through the course of river (J Das et al ,1997). Estuarine and coastal areas are complex and dynamic aquatic environment (Morris et al,1995). When river water mixes with seawater, a large number of physical and chemical processes takes place,which may influence the water quality. Usually in the near shore waters and estuaries, they exhibit considerable seasonal variations depending on the local conditions of rainfall, tidal incursions, various abiotic and biotic processes, quantum of freshwater inflow affecting the nutrient cycle of different coastal environments(Choudhery and Panigraphy,1991).

Many investigations have been carried out on the physico-chemical features of Indian estuaries (Govindaswamy et al.,2000; Rajasegar.,2003; Balasubhramanian and Kannan.,2005; Rajaram et al.,2005; Ajithkumar et al.,2006;Asha and Diwakar.,2007; Ashok Prabhu et al.,2008;Saravanakumar et al.,2008;Vengadesh et al.,2009; Sankar et al.,2010; Sathish kumar and Anisa .,2012; Dhanakumar et al.,2012 and Vijayakumar et al.,2014). However, very little information is available in relation to physico-chemical characteristics of water in the Kayamkulam estuary. Eventhough Some works has been reported on the physical characteristics and hydrography of Kayamkulam estuary (Mary John.,1958;Haridas et al.,1973; Anon.,1992; and Prabha Devi et al.,1996;Remya Krishnan and Jaya., 2014). The main objective of this study is to present the physical and chemical characteristics of the water of Kayamkulam estuary and to establish the correlations among the different parameters.

MATERIALS AND METHODS

Study Area Description

The study area, Kayamkulam backwater is a shallow brackish water lagoon. Kayamkulam backwater occupies area in both Alapuzzha district and Kollam of the total 1,652,33 hectares. Flood waters from the Pamba and Achankoil rivers flow in to the backwater through the commercial canal, which links the backwater with these rivers. Two streams and a canal enter in to the lake during the rainy season. For the purpose of study, three stations were considered as sampling areas within the estuary. The first sampling station (S1) is the Ayiramthengu mangrove and this mangrove area was declared as environmental hot spot after ravaged by the Tsunami in 2004. Station II is at Valiyazheekal near to pozhi, connecting to the Arabian sea. Kayamkulam estuary opens in to the Lakshadweep Sea through Valiyazeekal Azhi. Station III is the Choolatheruvu, a part of Kayamkulam estuary near to National Thermal Power Corporation (NTPC)

Collection and analysis of water samples

Water samples were collected for a period of one year(from February 2015 to January 2016). Water samples were collected monthly from three stations and analysed in the laboratory. Atmospheric temperature and Rainfall data were obtained from the Central Plantation Crops Research Institute(CPCRI) located at Kayamkulam. Water temperature was measured using mercury filled centigrade thermometer and pH was measured using Elico pH meter. Parameters like Total Dissolved Solids, Dissolved oxygen, Salinity and Hardness were determined in accordance with the standard methods of Amerian Public Health Association (APHA,2005). Analyses of dissolved phosphate (PO_4^{3-}),nitrate(NO_3^-) and silicate($Si(OH)_4^-$) were done by spectrophotometric methods described by Parsons et al.(1984).

Data Analysis

The hydrological data were subjected to Pearson correlation analysis using SPPS statistical software, version 20 to evaluate the significant relationship between physico–chemical parameters.

RESULTS AND DISCUSSION

Rainfall

Rainfall is the most important cyclic phenomenon in tropical countries as it brings important changes in the hydrographical characteristics of marine and estuarine environments(Saravanakumar et al.,2008). The observed rainfall during the study period was in the range of 1.8-507.1mm. The rainfall in this area is largely influenced by the two monsoon seasons. The higher values of rainfall were recorded during the monsoon months of July and August (Fig1). Rainfall shows negative correlation with atmospheric temperature (r = -.579), pH(r= -.716) and salinity (r = -.371)(Table1)

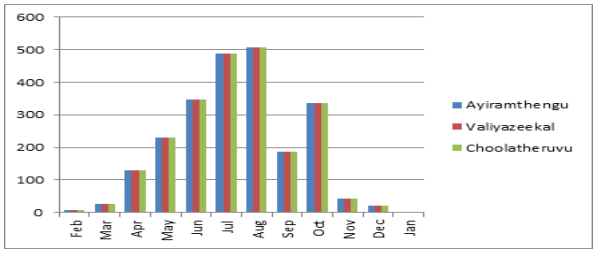

Fig 1: Monthly variation of Rainfall in three stations (Feb 2015-Jan 2016)

Atmospheric and water temperature

Temperature directly influence the distribution of animals in nature and it controls the rate of metabolic and reproductive activities of organisms. In the present study, atmospheric temperature varied from 30.2-35.2^{0}C.Maximum temperature(35.2^{0}C) was recorded in the month of March(Fig2). Water temperature varied from 26.9 to 29.7^{0}C. Highest water temperature was recorded in the month of April at the three stations and lowest in the month of August and October (Fig3). The correlation analysis (Table1) shows that atmospheric temperature shows positive correlation with water temperature (r= .692),pH (r= .823) and salinity (r= .382) and shows negative correlation with rainfall (r= -.579) and dissolved oxygen(r= .-.479). Water temperature shows positive correlation with atmospheric temperature (r = .692),pH (r=.523) and hardness (r = .518) and negative correlation with dissolved oxygen(r = -.630). High water temperature reduces the ability of water to hold essential dissolved elements like oxygen. The present study reported an inverse correlation between water temperature and dissolved oxygen.

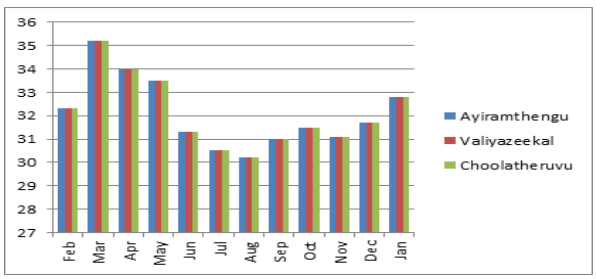

Fig 2: Monthly variation of Atmospheric temperature(0C) (Feb 2015- Jan 2016)

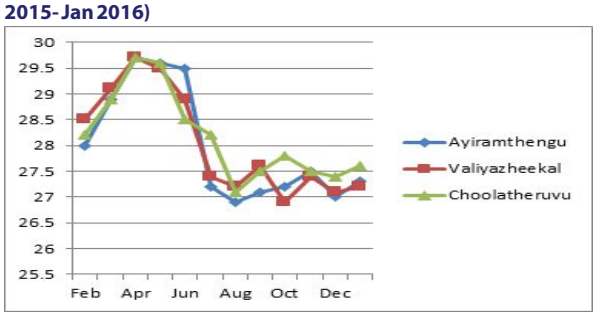

Fig 3: Monthly variation of Water temperature (0C) in three stations (Feb 2015- Jan 2016)

pH

Aquatic organisms are affected by pH because most of their metabolic activities are pH dependent (Wang et al, 2002). The optimal pH range for sustainable aquatic life is pH 6.5-8.2(Murdock et al, 2001). The pH of the estuaries varied from acidic to alkaline. The pH value of water bodies may fluctuate seasonally and annually. In the present study, pH in water was ranged from 6.5 to 8.4. The lowest pH was observed during August at Valiyazheekal and highest value was recorded in April(Fig4). pH of the water samples were positively correlated with atmospheric temperature (r =.823),water temperature (r =..523) and salinity(r=.437) and shows negative correlation with rainfall (r = -.716)(Table1). Lower aquatic organisms showed little reaction to alterations in pH while higher organisms respond quickly to little pH variations(Peter Stiling,2014).

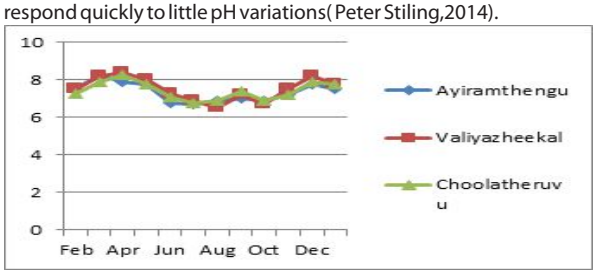

Figure 4: Monthly variation of pH in three stations (Feb 2015-Jan 2016)

Total Dissolved Solids

The estuarine environment is highly turbid and suspension of particles from sediments due to tidal and wave actions(Sadhuram et al,2005). In the present study, Total Dissolved Solids varied from 75.5-169.2 mg/l. Highest value was noted during July at Ayiramthengu and lowest value was recorded in March from the same station (Fig5). Total suspended and dissolved solids affect metabolism and physiology of fish and other aquatic organisms. They are the products of runoffs.

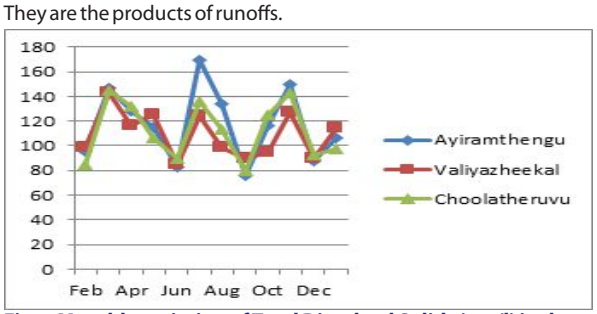

Fig 5: Monthly variation of Total Dissolved Solids (mg/l) in three stations (Feb 2015- Jan 2016)

Dissolved Oxygen

In the present investigation the dissolved oxygen was ranged from 3.2-6 mg/l. The dissolved oxygen range was recorded maximum (6 mg/l) in Valiyazheekal in monsoon periods and the minimum (3.2 mg/l) during dry periods(Fig6). Higher values of dissolved oxygen concentration observed in the monsoon season was due to heavy rainfall and the result of freshwater mixing from the Pamba and Achankoil river. All the stations showed similar trend with similar seasonal changes. Similar observations have been reported by Chandran et al.,1984;J das et al.,1997;Ashok prabhu et al.,2008;Saravanakumar et al.,2008; Sundaramanickam et al.,2008;Sankar et al .,2010 and Vijayakumar et al.,2014 from different estuaries. Correlation analysis of the present study showed that temperature (r=-.479) was negatively correlated with the dissolved oxygen content of the water(Table1). It is well known that temperature and salinity affect the dissociation of oxygen in water(Vijayakumar et al,2000).

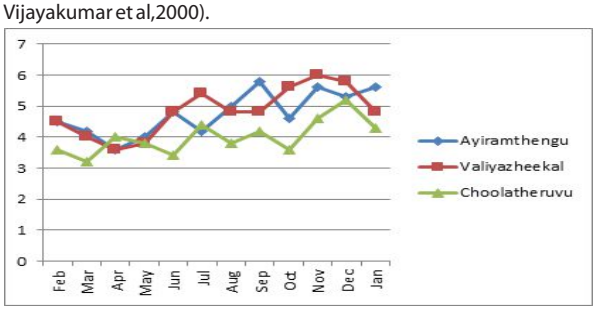

Fig 6: Monthly variation of Dissolved Oxygen (mg/l) in three stations (Feb 2015- Jan 2016).

salinity

Salinity levels in estuary shows seasonal variations. In this study, Salinity was ranged from 27.5-32.2 ppt. Throughout the study period , the higher values of salinity level were recorded from the Valiyazheekal because of its proximity to the sea. The lowest value of salinity was recorded at the Choolatheruvu in the month of August (Fig7). In the present study, salinity in all the stations was high during dry period and low during the monsoon period. During monsoon months, more freshwater from the Achankoil and Pampa river enters the estuary,so salinity is lower at these times. On the other hand, dry weather periods mean less fresh water entering the estuary, so higher salinity level was found. Higher values during the dry period may be attributed to high degree of evaporation and also due to dominance of neritic water from open sea (Senthilkumar et al ,2002). Similar trends in the salinity values were also reported from various parts in the south east coast of India(Chandran et al.,1984;Palanichamy and Rajendran.,2000; Ashok prabhu et al.,2008; Saravanakumar et al.,2008;Sankar et al .,2010 and Vijayakumar et al.,2014 .Salinity had positive correlation with atmospheric temperature (r= .382),pH (r = .437) and dissolved oxygen (r =.345). Statistical analysis revealed that salinity had highly significant negative correlation with rainfall ®= -.579)(Table1).

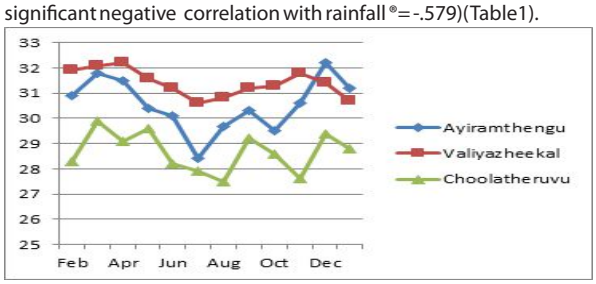

Fig 7: Monthly variation of Salinity (ppt) in three stations (Feb 2015- Jan 2016).

Hardness

Hardness of water increases due to industrial discharge of effluents containing salts of calcium and magnesium and also due to run off fertilizers from agricultural lands. In the present study, hardness of water varied from 150-394 mg/l and showed its maximum range in Valiyazheekal on June and the lowest value in Ayiramthengu on September(Fig8). Hardness of water samples shows positive correlation with water temperature (r= .518) (Table1).

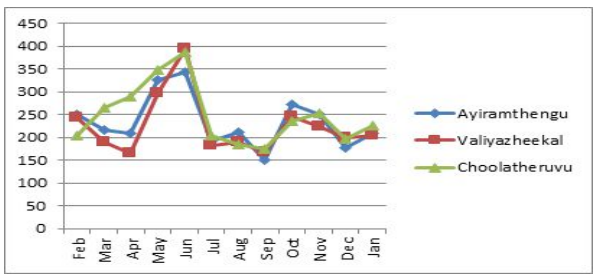

Fig 8: Monthly variation of Hardness (mg/l) in three stations (Feb 2015- Jan 2016).

Phosphate

In the present study, phosphate concentrations at Station I, II and III were varied from 0.22-0.34 µg/l ,0.04-0.09 µg/l and 0.05-0.23µg/l respectively(Fig9). Among the three sampling stations, Valiyazheekal(station II) showed decreased concentration of phosphate. In Ayiramthengu mangrove (station I) region the higher values of phosphate were recorded during the monsoon season. The high phosphate level in the Ayiramthengu area during the monsoon season may be due to the inflow of freshwater and the discharge of fertilizers from the nearby paddy fields. The addition of super phosphate applied in the agricultural fields as fertilizers and alkyl phosphates used in households ,as detergents can be other sources of inorganic phosphates(Bragadeeswaranet al ,2007). Phosphate shows a strong positive correlation with silicate (r = .588) and nitrate ®= .784)(Table1).

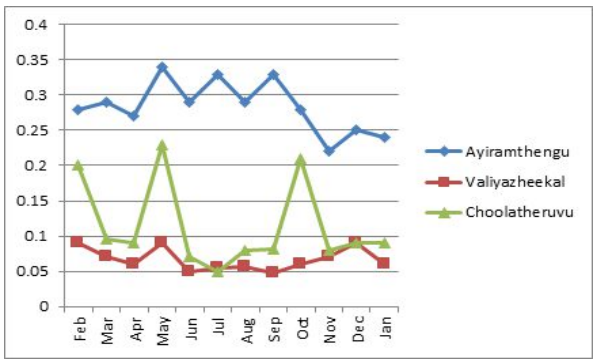

Fig 9: Monthly variation of Phosphate (µg/l) in three stations (Feb 2015- Jan 2016).

Nitrate

The highest level of nitrate was recorded from Ayiramthengu and the lowest was in the Valiyazheekal.(Fig 10). The recorded higher monsoonal values of nitrates in the mangrove area may be due to freshwater inflow, mangrove leaves litter fall decomposition and terrestrial run-off during the monsoon. Another possible way of nitrates entry is through oxidation of ammonia form of nitrogen to nitrite formation (Rajasegar,2003). Nitrate shows strong positive correlation with phosphate (r = .784) and silicate (r = .692)(Table1).

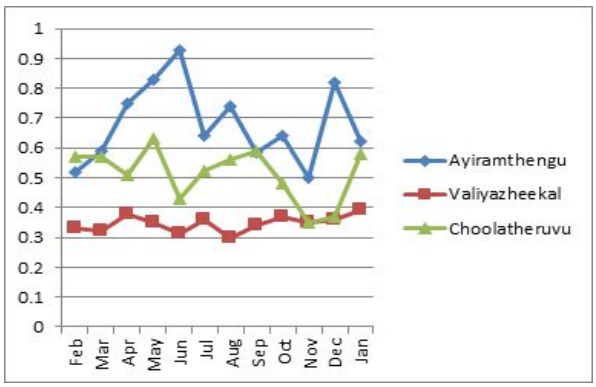

Fig 10: Monthly variation of Nitrate (µg/l) in three stations (Feb 2015- Jan 2016).

Silicate

In the present study, highest values of silicate were recorded from the Choolatheruvu (station III). Values of silicate at three stations ranged from 16.2 -17.5µg/l(station I),10.31-11.83µg/l(station II),15.3-17.9µg/l(station III) respectively(Fig11). Silicate was negatively correlated with dissolved oxygen (r = -.333) and salinity (r= -.636) and also shows positive correlation with phosphate (r = .588) and nitrate(r = .692)(Table1)

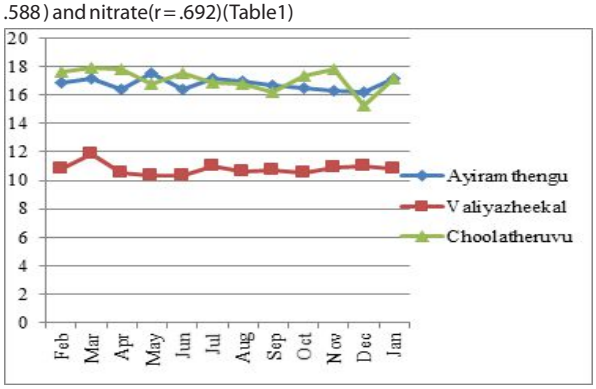

Fig 11: Monthly variation of Silicate (µg/l) in three stations (Feb 2015- Jan 2016)

TABLE - 1 Pearson correlation matrix for physico–chemical factors of Kayamkulam Backwater

		At.temp	Wat temp	Rain fall	pH	TDS	DO	Salinity	Hardness	Phosphate	Silicate	Nitrate
At.temp	Pearson Correlation	1	.692**	-.579**	.823**	.257	-.479**	.382*	.147	.068	.061	.070
	Sig. (2-tailed)		.000	.000	.000	.131	.003	.021	.392	.695	.724	.685
Wat temp	Pearson Correlation	.692**	1	-.131	.523**	.143	-.630**	.178	.518**	.049	.053	.150
	Sig. (2-tailed)	.000		.448	.001	.407	.000	.298	.001	.777	.758	.382
Rainfall(mm)	Pearson Correlation	-.579**	-.131	1	-.716**	.087	-.079	-.371*	.124	.014	-.017	.097
	Sig. (2-tailed)	.000	.448		.000	.615	.645	.026	.470	.936	.920	.573
pH	Pearson Correlation	.823**	.523**	-.716**	1	.099	-.237	.437**	.001	-.094	-.082	-.063
	Sig. (2-tailed)	.000	.001	.000		.567	.164	.008	.996	.586	.636	.713
TDS	Pearson Correlation	.257	.143	.087	.099	1	-.230	-.106	-.075	.111	.188	.002
	Sig. (2-tailed)	.131	.407	.615	.567		.177	.540	.665	.518	.271	.991
DO	Pearson Correlation	-.479**	-.630**	-.079	-.237	-.230	1	.345*	-.272	.018	-.333*	-.144
	Sig. (2-tailed)	.003	.000	.645	.164	.177		.039	.109	.915	.047	.403
Salinity	Pearson Correlation	.382*	.178	-.371*	.437**	-.106	.345*	1	-.128	-.002	-.636**	-.173
	Sig. (2-tailed)	.021	.298	.026	.008	.540	.039		.456	.992	.000	.313
Hardness	Pearson Correlation	.147	.518**	.124	.001	-.075	-.272	-.128	1	.061	.138	.116
	Sig. (2-tailed)	.392	.001	.470	.996	.665	.109	.456		.723	.423	.501
Phosphate	Pearson Correlation	.068	.049	.014	-.094	.111	.018	-.002	.061	1	.588**	.784**
	Sig. (2-tailed)	.695	.777	.936	.586	.518	.915	.992	.723		.000	.000
Silicate	Pearson Correlation	.061	.053	-.017	-.082	.188	-.333*	-.636**	.138	.588**	1	.692**
	Sig. (2-tailed)	.724	.758	.920	.636	.271	.047	.000	.423	.000		.000
Nitrate	Pearson Correlation	.070	.150	.097	-.063	.002	-.144	-.173	.116	.784**	.692**	1
	Sig. (2-tailed)	.685	.382	.573	.713	.991	.403	.313	.501	.000	.000	

***.Correlation is significant at the 0.05 level (2-tailed).**

tailed)

****.Correlation is significant at the 0.01 level (2 –tailed)**

CONCLUSION

This study has demonstrated that there is a strong relationship between estuarine physico-chemical characteristics and seasons. Estuaries are the integral part of the coastal environment. Estuaries have variable physico-chemical properties. The fluctuation creates a stressful environment for aquatic organisms. The statistical analysis of this study showed that the physico-chemical parameters observed in all the three stations were varied significantly between the stations with some exceptions. Atmospheric temperature, water temperature ,pH, TDS, hardness and nitrate were not varied significantly between the stations . But dissolved oxygen, salinity, phosphate and silicate were varied significantly between the locations.

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