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STUDIES ON PHYSICOCHEMICAL PARAMETER AND BACTERIAL POPULATIONS IN SEDIMENT SOIL AT KARANKADU MANGROVE FOREST, RAMANATHAPURAM (Dt), TAMIL NADU

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Abstract: Mangrove soil condition was essential factor for mangrove reforestation and coastal rehabilitation. The marine environment is a prolific resource for the isolation of microorganisms. The present study was aimed to investigate the analysis of physicochemical characteristics and bacterial populations in sediment soil at Karankadu mangrove forest, Ramanathapuram Dist in Tamil Nadu for a period of one year during April 2013 to March 2014. Physical parameters like pH, Electrical conductivity (EC), Organic carbon (%), Temperature, Salinity, Soil texture, Color, and Chemical parameters of Phosphorus, Potassium, Calcium, Iron, Nitrogen, Manganese, Zinc were analyzed in four seasonal intervals. The nature of soil texture is characterized by the abundance of clay loam. The serial dilution plate technique was employed to enumerate the sediment soil bacteria. Correlation coefficient between the physicochemical parameters of soil and total number of isolated bacterial colonies.
Keywords: Mangroves soil, Physciochemical parameters, pH, Salinity, Bacterial population.

INTRODUCTION

Mangroves are unique intertidal ecosystems of the tropical and subtropical regions of the world that support genetically diverse groups of aquatic and terrestrial organisms. Nearly 60–70% of the world's tropical and subtropical coastlines are covered with mangroves, which are known to be highly productive ecosystems of immense ecological value. Soil bacteria are one of the important biotic components that influence decomposition and nutrient mineralization in the terrestrial ecosystems (Bardgett 2005). Although studies on examining the factors that influence the soil microbial communities in various ecosystems such as agricultural fields, grasslands and forests are substantial (Hossain *et al.,*2011 and Nusslein *et al .,*1999), relatively less information is available on the relationship between soil properties and microbial communities in mangrove forest soils that are characteristically different from other terrestrial ecosystems. Despite being fragile and sparsely distributed,

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these ecosystems are highly productive all over the world (Thatoi and Biswal, 2008). Mangrove ecosystem acts as a buffer between near shore and lagoon or estuarine environments with regard to the influence of freshwater discharge and salinity regime (Ramanathan, 1997). The study of mangrove regions is necessary as they are highly productive and play an important role as breeding and nursery ground for many commercially important fishes especially shrimps (Kathiresan and Bingham, 2001). These microbial communities play an important role in cycling of nutrients such as carbon, nitrogen, sulpur and phosphorous, and thus control the chemical environment of the mangrove ecosystem (Alongi *et al.*, 1993). Microbial activity is also responsible for major nutrient transformations within mangrove ecosystems (Alongi *et al.*, 1993; Kathiresan, 2000; Holguin *et al.,* 2001). Several studies have shown the uniqueness of mangrove sediments with respect to their microbial composition (Gray and Herwig 1996; Urakawa *et al.,* 1999). Hence, in the present investigation an attempt has been made to record physicochemical parameter in four seasons of Karankadu mangrove forest, and also studied the bacterial population.

MATERIALS AND METHODS

Study Area

Mangroves sediment soil samples were collected seasonally from the village, Karankadu, Ramanathapuram (District), Tamil Nadu, India for a period of one year from April 2013 to March 2014.

Season schedule of soil sample

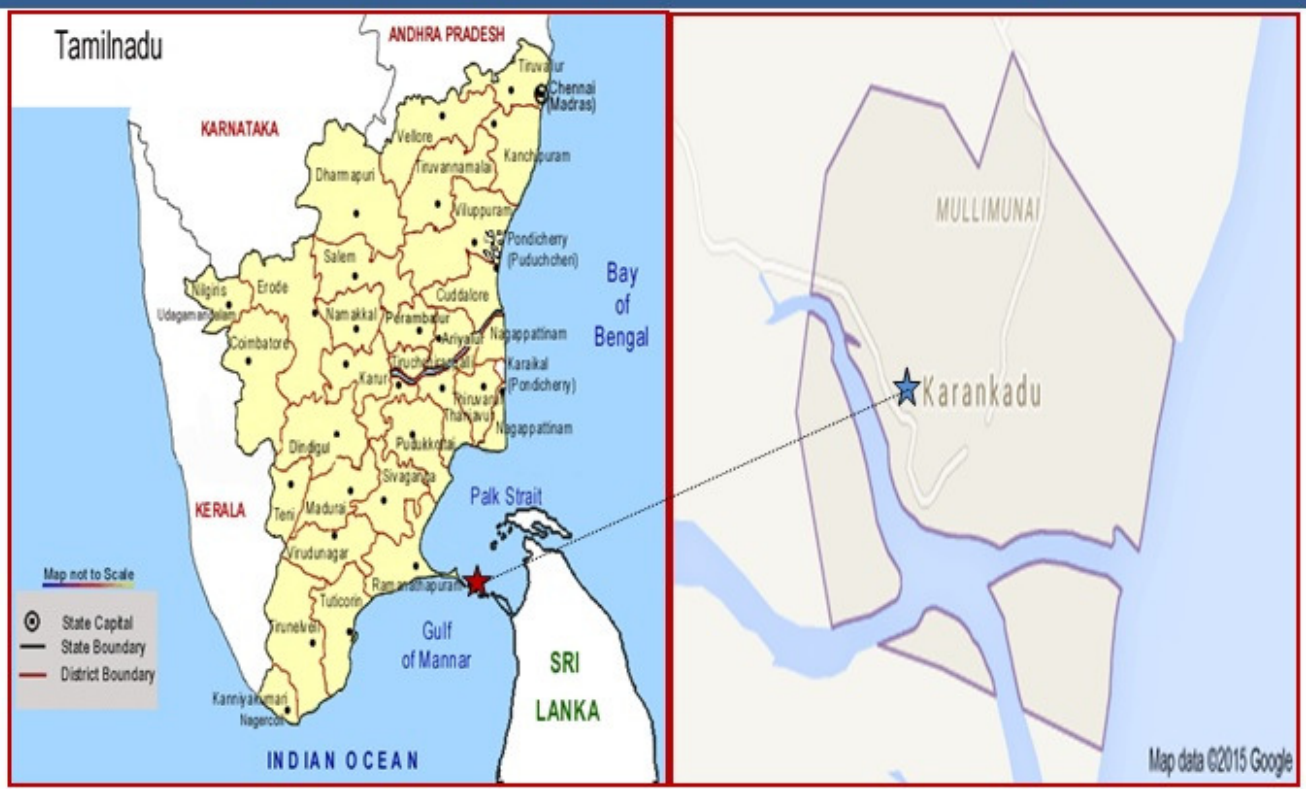
The climate is monsoon and the calendar year has been divided into four seasons viz., summer (April - June), Pre monsoon (July - September), Monsoon (October- December), and Post monsoon (January - March).

Collection of soil sample

The sediment soil samples were collected from karankadu mangroves. The collected soil samples were brought to the laboratory in sterilized zip-lock polythene bags handpicked air dried and stored in containers for further analysis. Soil samples were collected from the study site at random during the four seasons in the year of April 2013 to March 2014.

Soil sample collection Area from Karankadu mangrove forest

Map showing the sample collection Area from Karankadu mangrove forest



★ → **sampling station**

Physicochemical parameter of soil analysis

The collected soil sample was air dried at room temperature (37˚C) for 1-3 days. Physical parameters like pH, Electrical conductivity (EC), Organic carbon (%), Colour, Texture, Temperature and Chemical parameters like phosphorus, potassium, copper, iron, manganese, zinc, and other nutrients were analysed. It can be determined by various titration methods. The pH of the suspension was determined using pH meter (Equiptronics, india). Electrical conductivity of soil was determined in the filtrate of the water extract using conductivity meter. The soil samples were determined in accordance with standard analytical methods

(Subramanyam and Sambamurthy, 2002). The statistical analysis was carried out with the SPSS software.

Isolation of bacterial colonies

Isolation of soil bacteria was performed by serial dilution and pour plate method (Aneja, 2002). One gram of soil sample was serially diluted in sterilized distilled water to get a concentration range from 10^{-4} to 10^{-6}. A volume of 0.1 ml of each dilution was transferred aseptically to nutrient agar plates. The sample was poured uniformly. The plates were incubated at 37°C for 24 hr. The bacterial isolates were further sub cultured to obtain pure culture. Pure isolates on nutrient agar slants were maintained at 4ºC.

RESULTS AND DISCUSSION

Mangrove soil at Karankadu showed four seasonal variations with respect to both major nutrient concentrations and microbial population. The numbers of bacterial colonies were isolated by pour plate technique. The highest bacterial populations were present in summer and slightly low during monsoon (Table: 1). Several studies suggested that soil microbial diversity had seasonal fluctuations (Lipson and Schmidt, 2004 and Smit *et al.,* 2001). In the present study total soil bacterial density was range from 81 to 113(CFU/g) in karankadu mangroves forest. The analysis of soil elements of Cu, Z, C, Mg, Mn, S, K, Fe, N, P were determined (Table: 2). The pH of soil is one of the most important physicochemical parameter, which influence the mineral nutrient of soil quality and microorganism activity. The soil pH was slightly alkaline ranging from 7.79 to 7.83 at four seasons (Fig: 1,Table: 1). The sediment pH was high in summer and low during monsoon possibly due to redox changes in the sediments and water column apart from the influence of freshwater (Ramanathan, 1997). Mangrove soil is always alkaline as reported by various authors (Tam *et al.,* 1995; Tam and wong, 1998). The temperatures were recorded ranging from 20 ˚C to 38˚C with the maximum during summer and the minimum during monsoon and post monsoon. Salinity studies vary from 34.9 to 39.3 ppt. Salinity is considered to be the basic and prime factor among the environmental variables in the marine environment and it is one of the most fluctuating parameter. The maximum salinity was recorded during the summer and the minimum during monsoon in four seasons of the year 2013-2014 (Fig: 2, Table: 1).

Table- 1 Seasons of the year for soil analysis (2013-2014)

S.No	Seasons	pH values	Salinity values (ppt)	Total no. of bacterial colonies (Total colony count x 10^{-4} to 10^{-6} CFU/g)
1.	Summer (April-June)	7.96	39.3	113
2.	Pre monsoon (July-September)	7.79	37.2	98
3.	Monsoon (October-December)	7.40	31.9	81
4.	Post monsoon (January-March)	7.83	36.5	92

Fig 1: Seasonal variation of pH values

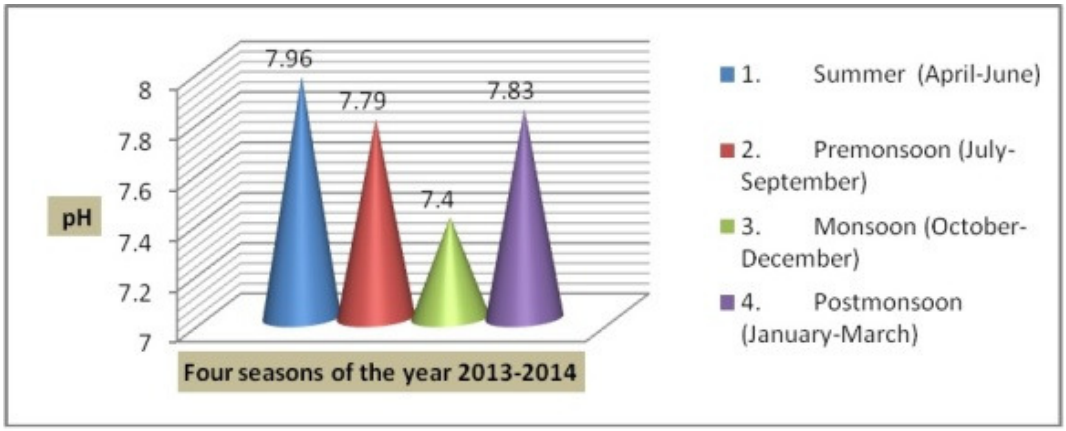
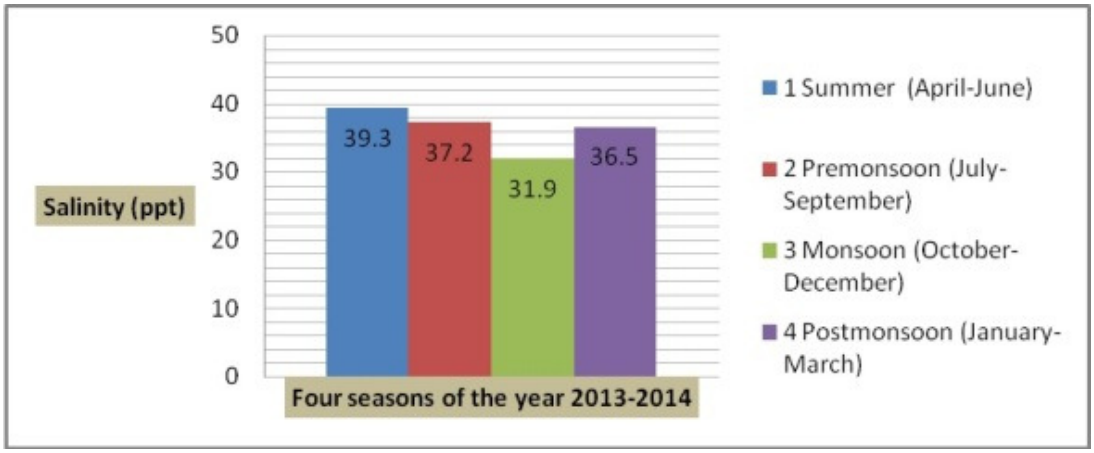


Fig 2: Seasonal variation of salinity values



Table–2 Physicochemical analysis of soil sample

S. No	Name of the Parameters	Year of April 2013 to March 2014			
		Summer	Pre monsoon	Monsoon	Post monsoon
1.	Colour	Brown/black	Dark black	Dark black	Dark black/greyish
2.	EC (dsm^{-1})	0.56	0.61	0.30	0.42
3.	Organic carbon %	0.33	0.39	0.42	0.28
4.	Organic matter %	0.72	0.58	0.69	0.61
5.	Available Nitrogen (mg/g)	102.5	90.2	78.32	82.5
6.	Available Phosphorus (mg/g)	3.21	2.50	3.32	3.48
7.	Available Potassium (mg/g)	85	89	79	92
8.	Available Zinc (mg/g)	0.56	0.48	0.54	0.36
9.	Available Copper (mg/g)	0.93	0.65	0.70	0.88
10.	Available Iron (mg/g)	3.79	4.80	5.19	4.11
11.	Available Manganese (mg/g)	3.17	2.10	3.21	3.56
12.	Clay (%)	11.2	12.41	16.35	14.01
13.	Cation Exchange (C.Mole $proton^{+}$/kg)	21.8	18.5	17.90	19.70
14.	Calcium (C.Mole $proton^{+}$/kg)	5.6	7.2	6.6	6.8
15.	Magnesium (C.Mole $proton^{+}$/kg)	3.6	4.8	6.5	4.2
16.	Sodium (C.Mole $proton^{+}$/kg)	3.18	2.98	2.54	2.45
17.	Potassium (C.Mole $proton^{+}$/kg)	0.16	0.21	0.19	0.28

The correlation between the number of bacterial colonies and physicochemical parameters revealed that pH, Electrical Conductivity were positively correlated. The Organic carbon Organic matter, available Phosphorus, zinc, copper, iron, Manganese, Sodium, Potassium were negatively correlated. However the relationship in available nitrogen, Calcium, Copper, Phosphorus, Potassium, were statistically significant at 0.05 level (Table: 3).

Table – 3 Correlation between total number of bacterial colonies and physicochemical parameters of soil in four seasons

	TNC	pH	EC	OC	OM	S	AN	AP	AK	AZ	AC	AI	AM	C	CIE	CA	MG	SO	K
TNC	1																		
pH	0.744	1																	
EC	0.796	0.188	1																
OC	-0.348	-0.335	-0.177	1															
OM	0.289	0.813	-0.300	0.114	1														
S	0.542	-0.157	0.940	-0.069	-0.586	1													
AN	0.555	0.948	-0.034	-0.073	0.954*	-0.365	1												
AP	-0.326	0.372	-0.823	-0.192	0.656	-0.955*	0.507	1											
AK	0.234	-0.218	0.515	-0.736	-0.721	0.599	-0.516	-0.449	1										
AZ	0.339	0.497	0.078	0.646	0.720	-0.100	0.678	0.040	-0.807	1									
AC	0.545	0.788	0.066	-0.825	0.462	-0.202	0.622	0.482	0.266	-0.136	1								
AI	-0.137	0.493	-0.633	0.350	0.905	-0.811	0.735	0.771	-0.891	0.655	0.170	1							
AM	-0.183	0.407	-0.656	-0.542	0.488	-0.797	0.425	0.928	-0.093	-0.242	0.704	0.511	1						
C	-0.951*	-0.515	-0.928	0.399	0.020	-0.756	-0.272	0.553	-0.476	-0.123	-0.419	0.435	0.350	1					
CIE	0.866	0.892	0.454	-0.656	0.468	0.150	0.701	0.131	0.246	0.139	0.889	0.065	0.328	-0.753	1				
CA	-0.644	-0.988*	-0.054	0.243	-0.893	0.289	-0.983*	-0.476	0.353	-0.560	-0.742	-0.622	-0.462	0.384	-0.815	1			
MG	-0.828	-0.553	-0.697	0.792	0.032	-0.513	-0.259	0.237	-0.677	0.233	-0.736	0.437	-0.077	0.874	-0.868	0.421	1		
SO	0.895	0.558	0.824	0.094	0.255	0.633	0.462	-0.530	-0.018	0.605	0.140	-0.087	-0.525	-0.853	0.576	-0.483	-0.526	1	
K	-0.480	-0.573	-0.214	-0.555	-0.705	-0.011	-0.710	0.035	0.710	-0.988*	0.053	-0.575	0.274	0.275	-0.262	0.615	-0.084	-0.717	1

*** Correlation is significant at the 0.05 level.**

OC-Organic Carbon (%), EC-Electric conductivity, S-Salinity, AN-Available Nitrogen, AP-Available Phosphorus, AK-Available Potassium, AZ- Available Zinc(mg/g), AC-Available Copper (mg/g), AI-Available Iron(mg/g) , AM- Manganese(mg/g), AK-Available Potassium, Ca-Calcium (mg/g), Mg-Magnesium(mg/g), SO- Sodium (mg/g), K- Potassium (mg/g), CIE-Cation exchange.

The mangrove soil in Karankadu areas indicated that the soil were dark black, greyish with dark black and the texture of clay was presented in soil. Choudhary (1962) found that the soil of sudarban in finely textured and the sub soil is stratified and the greater depth is compacted. Organic matter values in four seasons were 0.58 to 0.72 respectively (Table: 2). Organic matter concentrations were present greatest in the summer. Choudhury (1962) mentioned that the organic matter in mangrove soil belong over 5%. Due to more decomposition of plant and animal residues in mangrove areas the percentage of organic matter is higher than other soil

tract. For this reason the biological activity in mangrove forest area is highly active. Zafar *et al*., (1999) stated that organic matter varied between 0.86 and 1.9% in the intertidal muddy beach. The organic carbon content is related to mud percentage in the soil (Escourt 1967; Anderson, 1977 and Mayer *et al*., 1985).

The electrical conductivity values ranges from 0.30 to 0.61(dsm^{-1}) in four seasons of year. Available of nitrogen in the soil was varied from 78.32 to 102.5. The highest value present in summer and the low value in monsoon. The phosphorus content maximum present in post monsoon and minimum present in pre monsoon. The total amount of potassium was maximum in pre monsoon and minimum in monsoon. The macronutrient of zinc, copper, manganese was present maximum in summer and minimum in pre monsoon and post monsoon. In the present study of micronutrient iron is 5.19 in monsoon and 3.79 in summer. The Calcium content in soil sample ranges from 5.6 to 7.29 (c.mole $proton^{+}$/kg) commonly, other heavy metals are also occurs in all of four seasons in Karankadu mangrove forest.

Conclusion

In the present study soil sample analysis focusing on physicochemical parameters of the soil collected in four seasons of the year 2013-2014 from Karankadu mangrove forest was performed. The correlation studies positive and negatively presented between total population of bacterial colonies and physicochemical parameters. It is significant at 0.05 level. Analysing various parameters provide the soil health status. The present baseline information of the physicochemical characteristics of sediment and soil texture is useful tool for further ecological assessment and monitoring of these coastal ecosystems of Karankadu mangrove forest, Ramanathapuram (Dist), at Tamilnadu in India.

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