Seasonal variation of Coliform Bacteria in the Middle Region of Pamba River, Kerala, India

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***Abstract*: Microbiological characteristics of water of Pamba River at its middle region were studied for a period of one year from February 2012 to January 2013. Ten sampling sites were selected for the study. The investigation period was divided in to three seasons; pre monsoon, monsoon and post monsoon. Faecal and Total Coliform counts were analyzed. The results obtained were compared to Bureau of Indian Standards and biochemical characterization was done to identify the bacterial species. Bacterial count at all stations was above permissible limits in all seasons, but in the monsoon season considerable lowering was observed due to dilution. The presence of pathogenic bacteria like, Pseudomonas, Klebsiella, Salmonella, Enterobacter, Shigella etc. is a matter of concern in the present scenario of epidemic outbreaks in Kerala.**

***Key Words*: Pathogenic bacteria, total coliform, faecal coliform, seasonal variation, Pamba River**.

INTRODUCTION

Water is an essential factor for the human and industrial growth. With increasing demand for fresh water for different fields such as agriculture, industry along with needs in day to day human life, fresh water quality of aquatic systems is deteriorating due to many anthropogenic activities (Massoud et al 2006). Anthropogenic activities turned many of our aquatic resources as sites for waste disposal. This has become a major concern all over the world and hence subjected to monitoring water quality for evolving its management. Lack of clean water and sanitation is the second most important risk factor in terms of global burden of disease after malnutrition (WHO and UNICEF, 2000). Water quality monitoring is thus an important practice in environmental studies which can prevent the outbreak of diseases. The water quality is usually described according to its physical, chemical and biological characteristics.

Clean and safe drinking water is required for health protection, which means that it must be free of pathogenic bacteria. Regular monitoring of indicator organism like coliform bacteria in water is useful to find out the bacterial content that makes it unsuitable for human usage and faecal coliforms (FC) is the widely used indicator. Total coliforms (TC) comprise bacterial species of faecal origin as well as other bacterial groups commonly occurring in soil. There are so many works regarding microbiological water quality analysis. Badra et al (2003) studied River Torsa of North Bengal; Gangetic river system by Baghel et al in 2005; Sabae and Rabeh (2007) evaluated Nile water in Egypt; Jalal and Sanalkumar (2012), (2013) studied Achenkovil river in relation to Sabarimala Pilgrimage and Pamba river in relation to Sabrimala pilgrimage, Nairobi River and the adjacent river Athi by Musyoki et al in 2013; Vincy et al (2015) in Meenachil River of Kerala.

Pamba River is considered to be sacred and has importance with respect to Sabariamala pilgrimage, Aranmula boat race, Maramon convention and many other religious gatherings that occur at the river banks. It has been reported that open defecation, leakage of sewage tank, wastewater and solid wastes from the Devaswom mess, Appam and Aravana units and various hotels and restaurants turn the Pamba River highly polluted during the pilgrim season (Kerala State Pollution Control Board, 2006). The major objective of the present work is to assess the microbiological water quality of Pamba River at middle region and to understand the impact of Sabarimala pilgrimage, Aranmula boat race and Maramon convention.

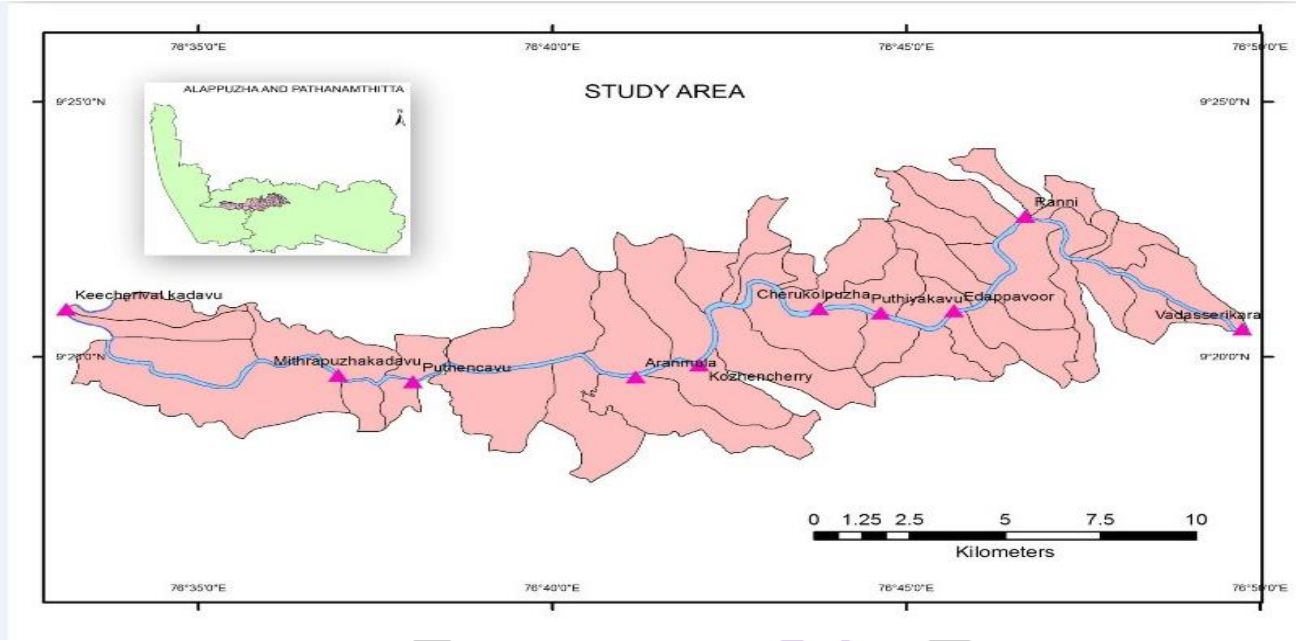
MATERIALS AND METHODS

The Pamba River is the third longest river in Kerala after Periyar and Bharathapuzha. It has a length of 176 Km. The River originates at Pulachimalai Hill in the Western Ghats at an altitude of 1650 m and flows through the lands of Pathanamthitta district and the Kuttanad area of Alappuzha District. The present work was done in the middle region of Pamba River starting from Vadasserikkara to Keecherival, covering a distance of 45 kilometers. Vadasserikkara, Ranni, Edappavoor, Puthiyakavu, Cherukolpuzha, Kozhencherry, Aranmula, Puthencavu, Mangalam mithrapuzha kadavu and Keecherival were the ten sites selected for the study based on the topography and levels of human intervention. Vadasserikkara is the region were the last major tributary Kallar joins with Pamba River. From there Pamba River flows in a single stretch without any bifurcation until Keecherival near Valanjavattom where it joins with Manimala River. In the middle region, the river flows mostly through agricultural lands. Sampling was done at monthly intervals during February 2012 to January 2013

Samples were collected in sterilized bottles and brought to the laboratory in iceboxes as early as possible. The analysis was mostly confined to the essential characteristics of drinking water, as specified by BIS (2012). MPN (Most Probable Number) tube test is the technique (APHA,2005) used for total coliforms (TC) and faecal coliforrns (FC). Monthly data were pooled into seasonal data and statistical analysis was conducted.

The most probable number (MPN) of coliform bacteria was determined by the three tube dilution method using EC broth. A 10ml, 1ml and 0.1ml of appropriate diluted samples were inoculated into respective dilution tubes containing inverted Durham's tubes. 10ml samples were inoculated into 10ml double strength EC broth and 1ml and 0.1ml sample into single strength medium of 10ml each. Inoculated tubes were incubated at 44.4°C for 24-48 hours and examined for the growth and gas production. The MPN index

was determined by checking the number of positive tubes in each set and comparing the values with standard MPN table. Enteric bacteria isolated on respective selective or differential media were identified on the basis of their colonial, morphological and Biochemical properties following Bergey's Manual of Determinative Bacteriology, 1994.



RESULT AND DISCUSSION

The coliforms are indicative of the general hygienic quality of the water and potential risk of infectious diseases from water. The result shows that all the water samples in the 10 selected sites were contaminated with high load of bacterial population than standard limits. During the study period both faecal and total coliform count was maximum during post monsoon, which is followed by pre monsoon. Minimum seasonal average was observed in the monsoon season (Table I & II, Fig. I & II). Site 4 shows minimum seasonal average of faecal and total coliforms in all seasons during the study period. (Table I & II, Fig. I & II). Maximum seasonal average of faecal coliforms was observed in site 7 in post monsoon and pre monsoon. It is closely followed by Site 6 and Site 2 (Table I, Fig. III & V). During the Monsoon season Site I showed maximum seasonal average for faecal coliforms which is followed by Site II (Table I, Fig IV). From figures III, IV & V it is evident that sites 5, 8, 9 and 10 are also heavily contaminated with faecal coliforms (Table I). Site IV recorded minimum seasonal average of faecal coliforms and total coliforms during the entire study period. Maximum seasonal average for total coliforms was recorded at Site 7 and Site 6 followed closely during post monsoon and pre monsoon respectively. (Table II, Fig. III and V). Maximum seasonal average during the monsoon season was at site 10, which is followed by site 6 and site 1 (Table II, Fig. IV). Site 4 showed minimum seasonal average for total coliforms in all the seasons. (Table II, Fig. III, IV & V)

From this study it is evident that deterioration of river water quality is much higher at site 7 and site 6 which is closely followed by sites 2, 5, and 10. This is because anthropogenic disturbance is very high in these regions. The famous Sabarimala pilgrimage coincides with post monsoon season and millions of pilgrims visit the temple during this time. Pamba River being the holy river in connection with Sabarimala, pilgrims as a ritual take a holy dip in the river and also use the river for their various sanitation purposes Jalal (2012). During the summer season (pre monsoon) people depend on the river for their various water requirements and also there is a reduction in water flow. This may be the cause of high coliform count during the season. High content of total coliforms and faecal coliforms during pre monsoon and post monsoon in Indian rivers was reported by several authors (Rajurkar et al., 2003; Radhakrishnan et al., 2007, Chetna et al., 2006).

The presence of pathogenic bacteria in the river water is a matter of great concern. Considerable work has been done about the survival of pathogenic bacteria in the aquatic ecosystem.(Sigua et al.2010, Nagvenkar and Ramaiah 2009, Sood et al. 2008, Augustyn et al 2016). E coli were present in all sites during the study period. (Table III). The presence of *Pseudomonas aeruginosa, Klebsiella pneumoniae, Enterobacter aerogens, Vibrio cholera, Staphylococcus aureus, shigella* sp. etc. indicate the discharge of sewage into the river water and also their persistence to a detectable level, which poses a greater health risk. Bacterial pathogens can cause many diseases such as typhoid, paratyphoid, salmonellosis, cholera, shigellosis etc. (Olaolu et al, 2014)

Results of the present study indicate that the water of middle region of Pamba River is highly contaminated in all seasons, especially in the post monsoon and pre monsoon. Deterioration in water quality was more prevalent at S7, S6 and S2, where, anthropogenic disturbances were high. The assessment of bacterial water quality mainly depends on physical and chemical parameters of water and the level of human interventions on the water body at the time of sampling. Hence bacteriological assessment is time and space specific.

Table I: Seasonal Variation in Faecal Coliforms

FAECAL COLIFORM											
year	**Season**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**
2012-2013	premonsoon	520±40	885±40.41	297.5±35	245±5.77	872.5±33.04	895±28.87	895±28.87	860±11.55	500±46.19	457.5±5
	Monsoon	282.5±5	267.5±18.93	162.5±25	150±24.49	260±24.49	260±24.49	257.5±20.62	185±10	177.5±9.57	200±11.55
	Postmonsoon	542.5±40	895±28.87	315±40.41	250±20	885±40.41	902.5±35	907.5±25	872.5±33.04	500±46.19	520±40

Table II: Seasonal Variation in Total Coliforms

TOTAL COLIFORM											
year	**Season**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**
2012-2013	premonsoon	1125±50	1150±100	622.5±20.62	607.5±5	1125±50	1425±150	1475±250	975±83.47	1150±100	1250±100
	Monsoon	635±5.77	632.5±15	392.5±25	365±10	607.5±5	635±5.77	625±12.91	627.5±12.58	607.5±5	637.5±5
	Postmonsoon	1175±150	2100±605.53	932.5±15	920±11.55	1550±191.49	2550±173.21	2550±173.21	1200±115.47	1200±115.47	1325±50

Figure I: Seasonal Variation in Faecal Coliforms

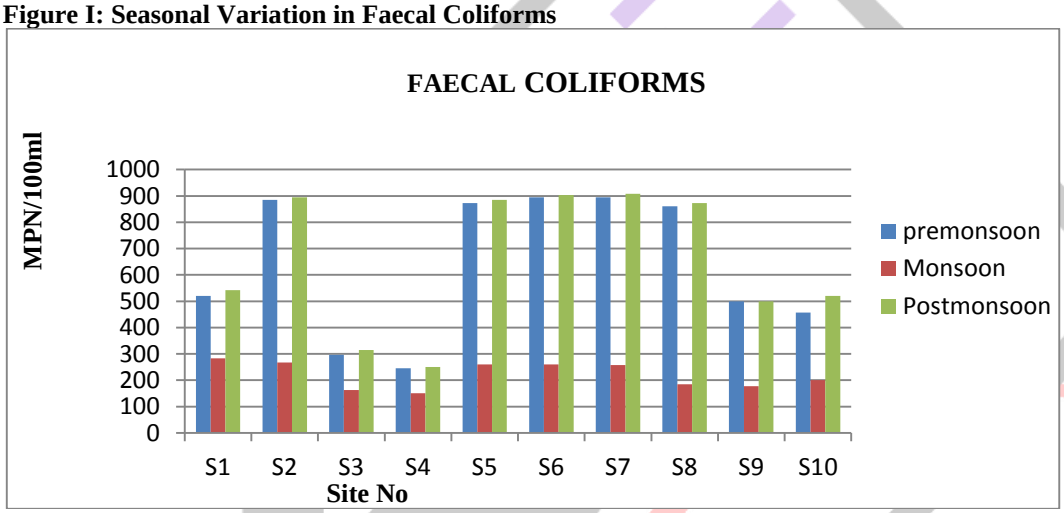


Figure II: Seasonal Variation in Total Coliforms

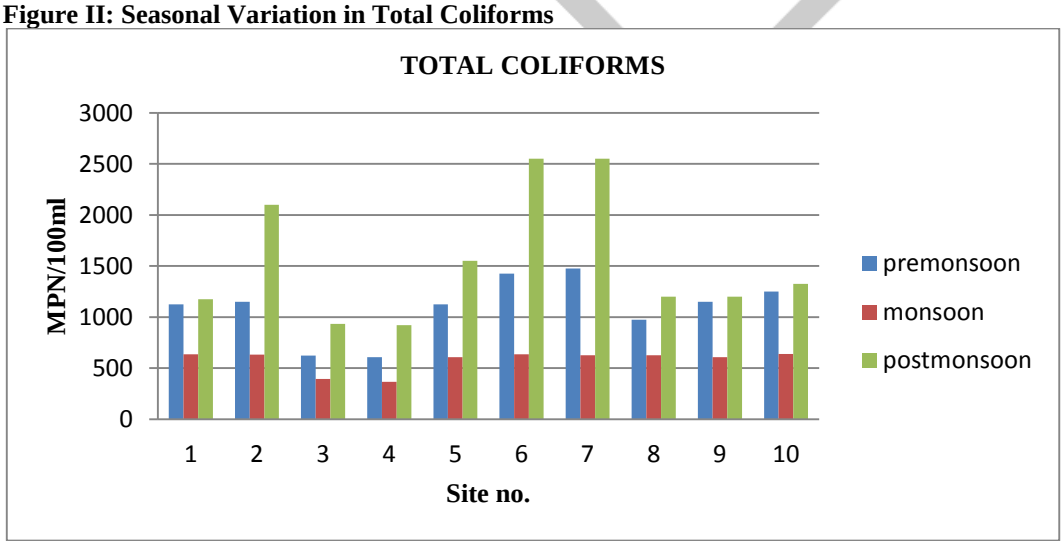


Fig III: Distribution of FC and TC during Pre Monsoon season

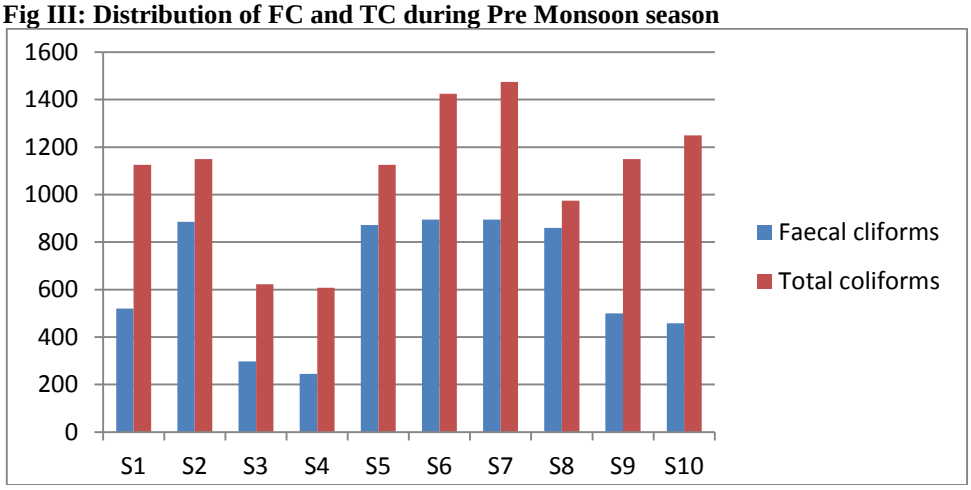


Fig IV: Distribution of FC and TC during Monsoon season

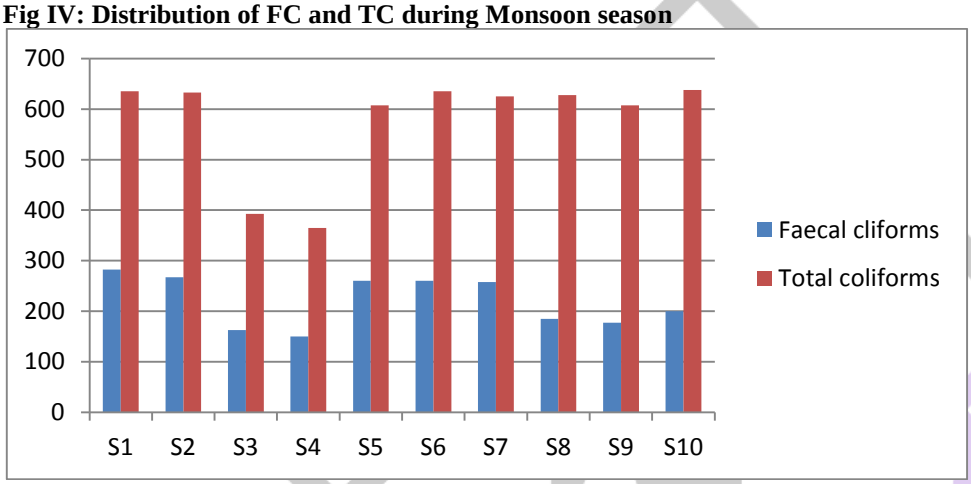


Fig V: Distribution of FC and TC during Post Monsoon season

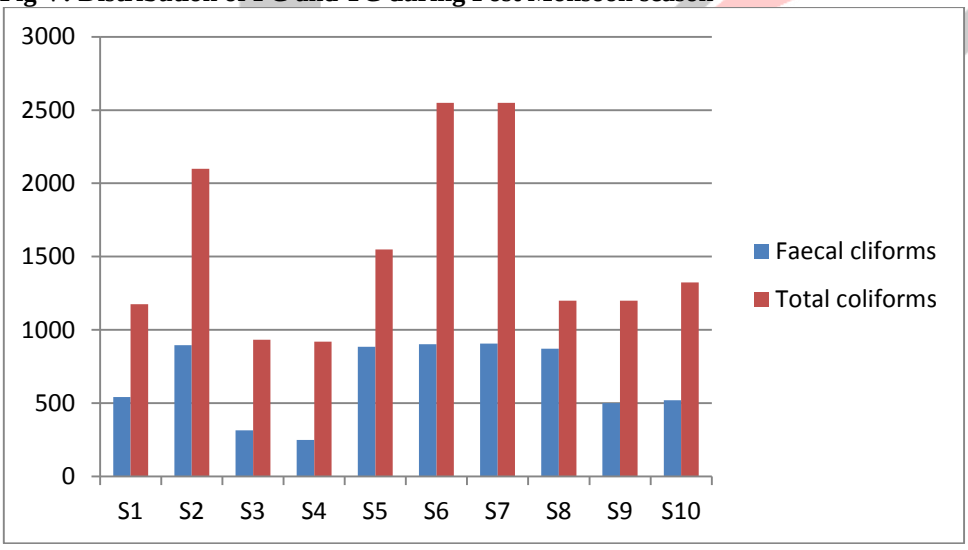


Table III: Distribution of Bacterial Species during the study period in the study area

Sl. No.	Bacterial Species	Sampling Sites									
		1	2	3	4	5	6	7	8	9	10
1.	*Acinetobacter lwoffii*	-	-	-	+	-	-	-	-	-	-
2.	*Aeromonas hydrophila*	-	+	-	-	-	-	+	-	-	-
3.	*Bacillus sp.*	-	-	-	-	-	+	+	-	-	-
4.	*Citrobacter freundii*	-	-	-	-	-	-	+	-	-	-
5.	*Citrobacter koseri*	-	-	+	-	-	-	-	-	-	-
6.	*Enterobacter sp.*	-	-	+	-	+	-	+	-	-	+
7.	*Enterobacter aerogenes*	+	+	+	-	+	+	-	+	-	+
8.	*Enterococcus sp*	-	-	-	-	-	+	-	-	-	-
9.	*Escherichia coli*	+	+	+	+	+	+	+	+	+	+
10.	*Klebsiella sp*	-	-	-	-	-	-	+	-	-	-
11.	*Klebsiella oxytoca*	+	+	-	-	+	+	-	-	-	-
12.	*Klebsiella pneumoniae*	+	+	+	-	+	+	+	+	+	+
13.	*Proteus mirabilis*	+	-	-	+	-	+	+	-	+	-
14.	*Proteus morganii*	-	-	+	-	-	-	-	-	-	-
15.	*Proteus vulgaris*	-	-	-	-	-	+	-	+	+	-
16.	*Providencia alcalifaciens*	-	-	-	-	-	-	-	-	-	+
17.	*Pseudomonas aeruginosa*	+	+	-	+	+	+	+	+	+	+
18.	*Salmonella enterica*	-	+	-	-	-	+	+	+	-	-
19.	*Salmonella paratyphi B*	-	-	-	-	-	-	+	-	-	-
20.	*Salmonella typhi*	-	-	+	-	-	+	-	-	-	-
21.	*Serratia liquefaciens*	-	+	-	-	-	-	-	+	-	-
22.	*Serratia marcescens*	-	-	-	-	-	+	-	-	-	-
23.	*Shigella*	-	-	-	-	-	+	-	-	+	-
24.	*Staphylococcus aureus*	-	-	-	-	+	+	+	-	-	-
25.	*Vibrio cholerae*	-	+	-	-	-	+	+	+	-	+

CONCLUSION

In the present study an attempt has been made to assess the bacteriological quality of river water of Pamba at its middle region. The total coliform count and faecal coliform count was found to exceed the permissible limit in all the ten study sites. Also the presence of several pathogenic bacteria poses a threat to human health as it may cause several water borne diseases. Pamba River is considered as a holy river and in addition to this it is the main water supply source of the nearby towns and villages. In order to prevent water borne epidemics from this water source regular monitoring of the water for bacterial contamination is recommended. Pollution can be reduced by providing proper sanitation facilities to the pilgrims. Regular monitoring of water quality along with creating awareness among the public will help in the sustainable management of Pamba River.

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