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ASSESSMENT OF BACTERIOLOGICAL ANALYSIS OF MULLAI PERIYAR RIVER WATER IN THENI DISTRICT, TAMILNADU, INDIA

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ABSTRACT

Background: River water quality is a critical alarm for mankind as it is directly related to human safety. Mullaiperiyar River is one of the most important rivers in South India. The present study was performed to assess the bacterial quality of Mullaiperiyar river water in Theni district, Tamilnadu, India. River water samples were collected from three different areas including nine stations like upstream area (Lower camp, Kullapa Goundanpatty, Karunakka Muthanpatti), urban stretch area (Surlipatti, Uthamapalayam, Chinnamanur and Veerapandi) and downstream area (Theni-Aranmanaipudur, Vaigai Dam) during the period of 2016 in the month of January to December using standard procedure. The bacteriological analysis of river water samples includes the method such as in the Total Heterotrophic Bacteria (THB), Total Coliform Bacteria (TCB) and Fecal Coliform Bacteria (FCB). It also revealed the presence of the bacteria such as *Escherichia coli*, *Enterobacter aerogenes*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Shigella dysentery*, *Vibrio cholerae*, *Proteus vulgaris*, *Klebsiella pneumoniae*, *Staphylococcus aureus* and *Enterococcus faecalis*. The river was mostly polluted due to the accumulation of xenobiotics compound by anthropogenic manners. The present study revealed that the bacterial quality of the Mullaiperiyar River water was found to be poor and unfit for drinking purpose without treatment and scenario alarms required for proper sanitation and disposal of the drainage system.

KEYWORDS: Mullaiperiyar River, Fecal coliforms, *Shigella dysentery*, Xenobiotics, Sanitation.

INTRODUCTION

Water is essential for all form of life and development of the entire society. Almost 90% of people depend on the ground and river water to fulfill their water requirements.[1] In India 70% of the water was contaminated due to the large amount of domestic and municipal waste, septic tanks and rebuff deposit of industrial effluents and agricultural waste like pesticides and fertilizers are released into river water frequently responsible for surface water pollution.[2,3] River water pollution is playing a critical role in the transmission of human disease. Animals and human faecal contamination are the most significant criteria for poor quality of river water.[4,5] The objective of the present study was to examine the assessment of bacterial analysis in Mullaiperiyar river water in different locations from the month of January to December in 2016. The Mullaiperiyar River is one of the superlative rivers of South India in Kerala and Tamilnadu, it originated from the Sundaramalai hills in the Western Ghats shown in Figure-1. In particular, the river is located within Latitudes 9°31'43 North and Longitudes 77°8'39' East along with the rivers flowing west throughout Kerala State and consequently the name Mullaiperiyar river. The Mullaiperiyar River is the major river system in the Theni district. Theni district is situated in Southwestern districts and located in the south-central part of Tamilnadu. In nature, the place is situated at 9°.39’N and 10’30 north latitude and 77°.00’ and 78’30 of east longitude.[6] As of 2011 survey, Theni district has a population is 1,246 million. Theni district people fully depend upon the Mullaiperiyar River water for all domestic and agricultural purpose in their lifetime.

The Mullaiperiyar River water is most polluted in the accumulation of certain human and animal activities; as long as major water resources for domestic, irrigation, agricultural and industrial purposes are being harmfully affected.[7,8] River water pollution is playing a critical role in the transmission of human disease. The pollution of Mullaiperiyar River is extensively increased from synthetically and improper handling, storage and serving which leads to the serious water-borne diseases shown in Table-1. For hygienic quality measurement, three groups of coliform bacteria are examined. Total coliform bacteria are an ideal marker of microbial pollution in the source of surface water.[9] Faecal indicator bacteria such as *E.coli*, Fecal coliform and faecal streptococci could be transmitted to water through the direct discharge of waste from the intestine of mammals and animals.[10] The presence of pathogenic

bacteria like *E.coli, Vibrio cholera, Salmonella spp, Shigella spp, Clostridium spp, Klebsiella spp, Enterobacter spp, Staphylococcal spp and Streptococcal spp* in mullaiperiyar river water as the following augmentation is frequently related with deterioration in river water quality.[9]

The polluted river water may cause the health risk for newborn, young kids and public with severe infection such as cholera, dysentery and typhoid fever.[11] The quality of river water is directly related to human health. The lack of attentiveness on the water management scheme may cause bad effects in quality of river water. The domestic water treatment applied may participate in protecting public health Sanitation development has been significant to reduce the water born diseases.[12]

MATERIALS AND METHODS

Area of study

The study area focuses on the Mullaiperiyar River located in Theni district, which is placed within river location map as shown in Figure 2. The river water sample were collected from three areas which included nine stations from upstream area Lower camp (S_1), Kullapa Goundanpatty (S_2), Karunakka Muthan Patti (S_3); middle of urban stretch area as Surlipatti (S_4), Uthamapalayam (S_5), Chinnamanur (S_6), downstream area as Veerapandi (S_7), Theni Aranmanaipudur (S_8) and Vaigai dam (S_9) from the month of January to December in 2016.

Collection of Sample

The water sample was collected from above-mentioned stations of Mullaiperiyar River during the first and end of the third week of every month. River water samples were collected in clean, disinfected polypropylene screw-capped bottles. Before the screw cap bottles were washed with deionized water. At the field, the screw cap bottle was washed twice in the river water and immersed beneath the surface of river water. After collecting the water samples were air tightened and stored in an icebox and transferred immediately to the laboratory.

Bacterial analysis

This bacterial analysis was performed to assess the quality of Mullaiperiyar River water. The collected water samples were analyzed using standard bacterial procedure prescribed by the APHA[13], WHO[14] and BIS.[15]

Bacterial population was examined by standard plating methods followed by the serial dilution technique of collected river water samples were used to enumerate and isolate

bacteria. For the assessment of Total Heterotrophic Bacterial colonies were enumerated by spread plate method using plate count agar medium. The enumerations of total Coliform and fecal coliform bacteria were isolated by a membrane filter (0.45µm Whatman filter paper) technique using Standard Plate Count Agar at 37°C for 24 hours and membrane - Fecal coliform (m-FC) agar (HiMedia™ Mumbai, India) medium at 45^{o}C for 24 hours incubation respectively. After the incubation, the bacterial colonies were counted using Quebec colony counter and recorded as colony forming units per milliliter (CFU/ml). In order to determine the various bacterial population to the river water samples were plated in different types of medium such as Eosin Methylene Blue (EMB) agar (HiMedia™), Mac-Conkey agar (HiMedia™), Mannitol salt agar (HiMedia™), Blood agar (HiMedia™), Salmonella and Shigella agar(HiMedia™) medium. All the inoculated plates were incubated at 37^{o} C for 24 - 48 hours, with the exception of them-FC agar plates, were incubated at 45^{o} C for 24 hours.[6]

Identification of bacteria

The isolated bacterial colonies were classified and characterized by various morphological and biochemical characterization with reference to Bergey's Manual of Determinative Bacteriology.[16] The standard biochemical test includes such as Gram stain, Motility, IMVIC test (Indole, Methyl red, Voges-Proskauer and Citrate utilization test), TSI (Triple Sugar Iron) test, Urease test, oxidase, catalase and coagulase test was performed to confirm the type of bacteria in the river water samples. The record data are presented as the mean value.

RESULT AND DISCUSSION

The quality of river in the Mullaiperiyar was studied by assessment of bacterial population in the nine areas during the period of 2016. The results of the bacterial analysis were exposed the higher concentration of Total heterotrophic, Total coliform and Fecal coliform bacteria in the all collected water sample region. The analyzed bacterial parameters were confirmed significant variation from normal values the incidence of constant pollution in the river water. The Mullaiperiyar river water is most essential part of the spread pathogens. The varieties of pathogens are transmitted through human and animal wastes. The human and animal fecal contaminations are the most significant criteria for poor quality of river water.[17] The pathogenic microorganisms are entering into consumption; irrigation and frivolous water property cause a risk to human health. According to WHO, almost 80% of the infections in human beings are caused by polluted water.[18] The results of the bacterial investigations were revealed the maximum amount of Total Heterotrophic Bacteria (THB), Total Coliform

Bacteria (TCB) and Fecal Coliform Bacteria (FCB) in the all collected mullaiperiyar river water sample region.

Enumeration of Total Heterotrophic Bacteria (HPC)

The mean value of THB variation in river water ranged between 7.0×10^4 - 25.3×10^4 CFU/ml during in the month of January to March, 8.5×10^4 – 29.5×10^4 CFU/ml in the month of April to June, 10.5×10^4 – 25.2×10^4 CFU/ml in the month of July to September and 10.5×10^4 - 27.0×10^4 CFU/ml in the month of October to December in the year of the 2016. The minimum THB was observed in the in the month of January (7.0×10^4 CFU/ml in S_1). The maximum THB was recorded in the month of August (35.5×10^4 CFU/ml in S9) in the year of 2016. Generally, the THB counts were highly present in May, June and August) during the year of 2016, as shown in Table-2 and Figure-3. The total heterotrophic bacteria are indicated the high organic compound present in river water.[19] Total heterotrophic bacterial counts were higher in summer, lower in the winter season. The determinant of main growth is temperature, accessibility of nutrients, including assimilable of organic carbon and defect of disinfectants.[20]

Enumeration of Total Coliform Bacteria (TCB)

Total coliform bacteria are an ideal marker of microbial pollution in the source of surface water.[9] In the Mullaiperiyar river, water samples total coliform bacteria counts for all sampling area were enormously high. In the year of 2016, the microbial load of the human pathogenic total coliform bacteria was confirmed and recorded from between 5.0×10^4 - 18.5×10^4 CFU/ml during in the month of January to March, 6.5×10^4 - 22.0×10^4 CFU/ml in the month of April to June, 7.5×10^4 - 18.0×10^4 CFU/ml in the month of July to September and 7.3×10^4 – 25.3×10^4 CFU/ml in the month of October to December in the year of the 2016. The minimum TCB was observed in the in the month of January (5.0×10^4 CFU/ml in S_1).The maximum TCB was recorded in the month of November (25.5×10^4 CFU/ml in S_9) in the year of 2016. The TCB counts were highly present in the June and December in the year of 2016 as shown inTable-3 and Figure-4. The finding of high coliform count indicates that the river water is contaminated through faecas. The huge quantity of urban sewage and septic tank discharges may be the source of the high concentration bacterial indicators in river water.[21]

Enumeration of Fecal Coliform Bacteria

Fecal coliforms are mostly presented in untreated waters, raw sewage and soils subjected to pollution from fecal substances. A fecal coliform is a group of total coliforms that are found

particularly in the intestine and faeces of warm-blooded animals. Faecal indicator bacteria such as *E.coli*, Fecal coliform and fecal *streptococci* could be transmitted to water through the direct discharge of waste from the intestine of mammals and animals.[22]

The bacterial load of faecal coliforms was enumerated by the mean value of FCB variation in river water ranged between 5.3×10^3 - 19.2 $\times10^3$ CFU/ml during in the month of January to March, 6.0×10^3 - 22.5×10^3 CFU/ml in the month of April to June, 6.5×10^3 -19.0×10^3 CFU/ml in the month of July to September 6.5×10^3 -21.0×10^3 CFU/ml in the month of October to December in the year of the 2016. The minimum FCB was observed in the in the month of January (5.3×10^3 CFU/ml in S_1). The maximum FCB was recorded in the month of June (22.5×10^3 CFU/ml in S_9) in the year of 2016. The FCB counts were highly present in the June, October and December in the year of 2016 as shown in Table-4 and Figure- 5). This shows a large number of coliforms in river water sample was contaminated by human and animal fecal substances.[23] The highest number of Total Heterotrophic, Total Coliform and Fecal coliform Bacteria were examined from the Theni-Aranmanai Pudur area (station 8); due to the entry of polluted water inflow from another river connected in the center of Theni city.

Identification of Heterotrophic bacteria

In the present study, around 10 bacterial species such as *Escherichia coli, Enterobacter aerogenes, Pseudomonas aeruginosa, Salmonella typhi, Shigella dysentery, Vibrio cholerae, Proteus vulgaris, Klebsiella pneumoniae, Staphylococcus aureus* and *Enterococcus faecalis,* were isolated in different types of medium like Nutrient agar, Mac Conkey agar, Eosin Methylene Blue (EMB) agar, Blood agar, Deoxycholate Citrate Agar (DCA), Salmonella-Shigella (SS) agar, Thiosulfate-Citrate-Bile salt- Sucrose (TCBS) agar and Mannitol Salt agar.

The presence of small colonies with green metallic sheen in the EMB agar plates confirmed *E.coli.*[24] *Escherichia coli*, was used as an indicator of water quality of fecal pollution, was commonly present in the gastrointestinal tract of human and animals.[2] *Klebsiella pneumoniae* are natural inhabitants of various water environments. It is caused by pneumonia, diarrhea, urinary tract infection, respiratory infection, wound infection, meningitis, septicemia and bacteria.[25] The purpose of their occurrence may help to evaluate the river water quality of fecal pollution as it is normally present in the gastrointestinal tract of human and animals. Mannitol salt agar was used to isolate and enumerate *Staphylococcus*

aureus (appearance of yellow colonies) and *Enterococcus faecalis* (appearance of pink colonies).[26] *Staphylococcus aureus* and *Proteus vulgaris* usually produce enterotoxin.[27] *Salmonella typhi, Shigella dysentery and Proteus vulgaris* was the intestinal flora and was frequently spread in water and soil.[28,29] *Salmonella* has regularly found in sewage from sewage treatment plants, industrial waste and in the river that receives a mixture of sewage and industrial wastes. *Pseudomonas aeruginosa* was the most widespread bacterial contamination in river water sources and may lead to severe progressive pulmonary disease. The presence of *Pseudomonas aeruginosa* and *Proteus vulgaris* in river water is undesirable, as ensuing augmentation is frequently associated with deterioration in river water quality.[30] *Enterobacter aerogenes* was isolated from the river water samples may be originated from soil and plants area that enter the river water. It is mostly present in fecal substances than the other bacteria and more flexible in non- enteric surroundings.[31] The *Vibrio cholerae* can survive and growth of suitable environmental conditions in the river and other aquatic environments.[32] All the bacterial characteristics were summarized in Table 5. These bacteria are interrelated with river water pollution and disease incidence in human beings. In additional biochemical tests were used to identify the isolated bacteria shown in Table- 6 from the river water samples in the suggestion to the Bergey's Manual of Systematic Bacteriology.[33]

Recently, this study was done by Sivamanikandan and Ahmed John, 2015 reported that bacteriological quality in the river was compared to existing results. As finding the result, rapidly increase of urbanization, industrialization and other developmental behaviors in the last few decades have caused the Mullaiperiyar river water system is being infected by various sources.

Table -1: Anthropogenic activities are observed at Mullaiperiyar River in Theni district.

Stations	Sources of Pollution from mullaiperiyar river water							
	Urban sewage	Washing clothes	Bathing	Agriculture waste	Solids waste	Cattle bathing	Animal waste	oil leakage
S1	x	x	xx	x	xx	x	x	-
S2	xx	xx	xx	x	x	Xx	xxx	-
S3	xx	xx	xxx	xx	xx	Xx	xxx	-
S4	xxx	xx	xxx	xxx	xx	Xx	xx	x
S5	xxx	xxx	xx	xxx	xx	Xx	xx	xx
S6	xxx	xxx	xxx	xxx	xx	X	x	x
S7	xxx	xxx	xxx	xxx	xxx	Xx		x
S8	xxx	xxx	x	x	xxx	Xx	xx	xxx
S9	xxx	xx	xxx	x	xx	Xx	x	x

Here X – Normal, XX – Moderate, XXX – Heavy, - NA.

Table-2: THB of Mullaiperiyar river water at Theni district in the year of 2016.

Month and Year	Total Heterotrophic Bacteria -2016 (Total Colony Count × 10^4 CFU/ml)								
	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9
Jan -2016	7.0	7.5	9.5	10.0	13.0	15.2	17.5	19.0	21.5
Feb -2016	7.5	8.5	9.0	11.5	14.5	16.0	18.5	22.0	24.5
Mar-2016	8.0	8.5	9.5	12.0	15.5	17.5	18.5	23.5	25.3
Apr -2016	8.5	9.0	10.4	13.5	16.0	18.3	19.5	24.0	26.5
May-2016	9.5	9.5	12.0	14.5	17.5	18.5	21.3	25.0	27.0
June -2016	10.0	12.0	14.5	16.0	18.5	20.0	23.5	27.5	29.5
July -2016	10.5	12.5	15.5	17.0	20.5	22.5	25.4	29.5	31.2
Aug -2016	11.4	13.0	16.0	18.5	21.4	23.5	26.3	32.0	35.5
Sep -2016	10.3	10.5	13.5	15.4	17.5	15.3	18.2	20.4	25.2
Oct -2016	10.5	10.5	11.4	13.5	15.5	16.3	17.3	21.3	25.4
Nov-2016	11.0	12.5	14.0	15.5	17.0	19.5	21.0	24.0	26.5
Dec-2016	11.5	12.0	13.5	15.0	17.5	20.0	22.5	25.3	27.0

Values are presented in mean (CFU/ml).

Table- 3: TCB of Mullaiperiyar river water at Theni district in the year of 2016.

Month and Year	Total Coliform Bacteria -2016 (Total Colony Count × 10^4 CFU/ml)								
	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9
Jan -2016	5.0	6.0	6.5	7.0	8.0	10. 3	12.2	15.5	17.4
Feb -2016	5.5	6.5	7.3	8.2	9.5	11.5	13.5	16.3	18.5
Mar-2016	6.0	6.5	7.5	8.5	11.0	13.3	15.2	18.0	18.5
Apr -2016	6.5	7.0	7.4	9.2	11.5	13.5	15.5	19.2	19.5
May-2016	6.5	7.3	8.5	9.5	12.5	14.5	16.3	20.0	21.5
June -2016	7.0	8.5	9.3	10.0	13.5	14.0	16.5	21.3	22.0
July -2016	7.5	7.5	8.2	9.5	12.0	13.5	16.0	20.5	22.5
Aug -2016	7.2	7.5	8.0	10.5	13.0	15.2	18.4	21.5	24.3
Sep -2016	6.5	7.4	8.2	8.5	11.5	12. 0	14.2	16.5	18.0
Oct -2016	7.3	7.5	8.5	10.0	13.5	15.2	17.5	19.5	22.0
Nov-2016	6.5	7.5	9.0	11.5	14.2	16.5	18.0	21.4	25.5
Dec-2016	7.2	8.5	9.5	12.0	15.5	17.3	19.5	22.0	25.3

Values are presented in mean (CFU/ml).

Table - 4: FCB of Mullaiperiyar river water at Theni district in the year of 2016.

Month and Year	Fecal Coliform Bacteria -2016 (Total Colony Count × 10^3 CFU/ml)								
	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9
Jan -2016	5.3	6.0	7.2	8.0	10.2	12.0	13.5	15.0	17.0
Feb -2016	5.5	6.5	7.0	8.3	10.5	12.2	14.0	16.0	18.5
Mar-2016	6.0	6.5	7.3	8.5	10.2	12.4	14.3	17.0	19.2
Apr -2016	6.0	6.5	7.5	9.0	11.5	13.5	15.0	17.2	19.5
May-2016	6.3	6.5	7.3	8.5	11.4	13.2	14.5	18.2	19.5
June -2016	7.2	7.5	8.3	9.5	13.5	14.2	15.5	20.4	22.5
July -2016	6.5	7.0	7.5	9.0	13.0	13.5	15.2	19.5	21.0
Aug -2016	6.5	7.2	8.0	9.5	14.2	14.5	16.4	19.5	20.4
Sep -2016	6.0	6.5	7.5	8.0	11.5	12.2	14.5	17.2	19.0
Oct -2016	6.5	7.3	8.2	9.5	13.0	14.5	17.0	19.2	21.5
Nov-2016	5.5	6.0	6.4	7.0	9.5	11.0	13.3	17.4	19.2
Dec-2016	6.0	6.5	7.5	8.2	11.2	13.5	15.2	19.3	21.0

Values are presented in mean (CFU/ml).

Table -5: Characteristics of bacteria isolates from Mullaiperiyar river water samples at Theni district.

Isolated organisms	Types of Media	Morphological characters of bacteria
E.coli	Mac Conkey agar	Bright pink colour colonies produced
	EMB agar	Green metallic sheen colonies produced
Klebsiella pneumoniae	Mac Conkey agar	Bright pink colour, mucoid colonies are produced
Proteus vulgaris	Mac Conkey agar	Produced non lactose fermented colourless colonies.
Salmonella typhi	Mac Conkey agar	Pale yellow colonies are produced
	Salmonella Shigella agar	Black colour colonies produced
Shigella dysenteriae	DCA agar	Light pink colour colonies produced
	Salmonella Shigella agar	Colourless colonies produced
Enterobacter aerogenes	EMB agar	Pink colour colonies without metallic sheen are produced
Vibrio cholera	TCBS agar	Large yellow colour colonies produced
	Blood agar	Large colonies surrounded by zone of green coloured produced.
Pseudomonas aeruginosa	Nutrient agar	Large bluish colour colonies are produced
	Blood agar	β haemolytic colonies are produced
Staphylococcus aureus	Mannitol Salt agar	Yellow colour colonies produced
	Blood agar	Clear zone of β haemolysis
Enterococcus faecalis	Blood agar	λ – haemolysis colonies are produced

Table -6: Confirmatory results of different biochemical test in gram-positive bacteria in Mullaiperiyar river water samples at Theni district.

Bio chemical Test	Gram -Positive Bacteria	
	Staphylococcus aureus	***Enterococcus faecalis***
Gram Stain	+	+
Motility	-	-
Haemolysis	+	-
Mannitol	+	+
Catalase	+	-
Methyl e Red	+	-
Voges Proskauer	+	+
Coagulase	+	-
Oxidase	-	-
Acid from Glucose	+	+
Gas from Glucose	-	-

Table -7: Confirmatory results of various biochemical test in gram-negative bacteria in Mullaiperiyar river water samples at Theni district.

Biochemical Test	Gram-Negative bacteria							
	E.coli	*Enterobacter aerogenes*	*Klebsiella pneumoniae*	*Vibrio cholerae*	*Proteus vulgaris*	*Salmonella typhi*	*Shigella dysenteriae*	*Pseudomonas aeruginosa*
Gram Stain	-	-	-	-	-	-	-	-
Motility	+	+	-	+	+	+	-	+
Indole	+	-	-	+	+	-	-	-
Methyl Red	+	-	-	-	+	+	+	-
Voges-Proskauer	-	+	+	+	-	-	-	-
Citrate Utilization	-	+	+	+	+	-	-	+
Urease	-	-	+	-	+	-	-	-
Triple Sugar Iron (TSI)	A/A Gas +	A/A Gas +	A/A Gas +	A/A Gas +	AL/A Gas +	AL/A Gas -	AL/A Gas +	AL/AL Gas -
Hydrogen Sulphide (H_2S)	-	-	-	-	+	+	-	-
ONPG	+	+	+	+	-	-	-	+
Catalase	+	+	+	+	+	+	+	+
Oxidase	-	-	-	+	-	-	-	+
Mannitol	+	+	+	+	-	+	+	-

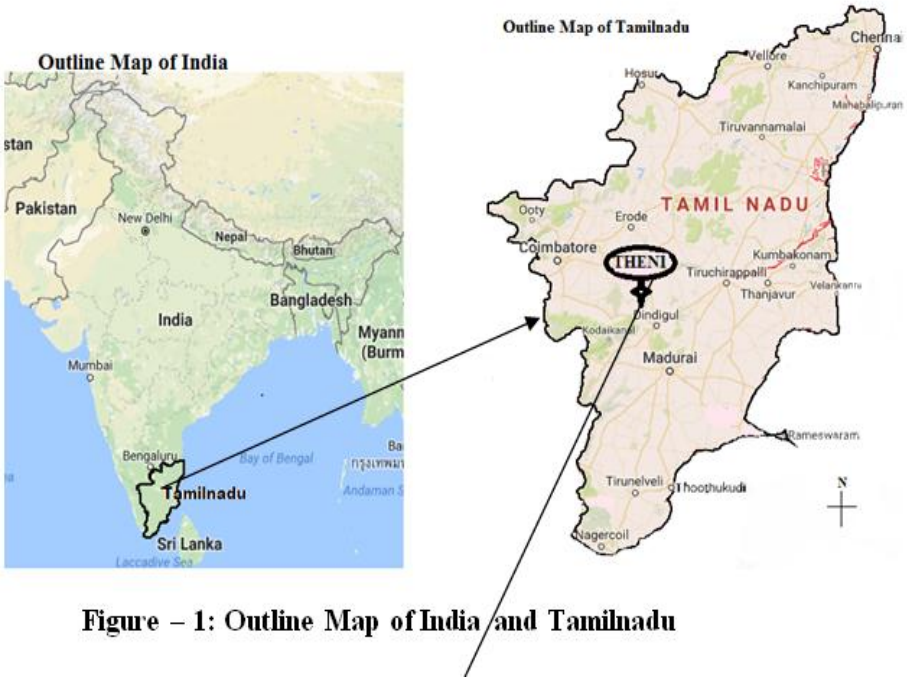

Figure – 1: Outline Map of India and Tamilnadu

Figure – 2: Map of Mullaiperiyar river study area in Theni district

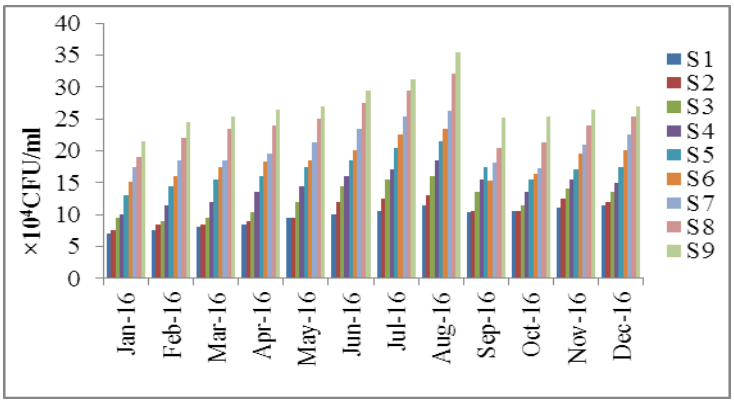

Figure-3: Monthly variations in THB of Mullaiperiyar river water at Theni district in 2016.

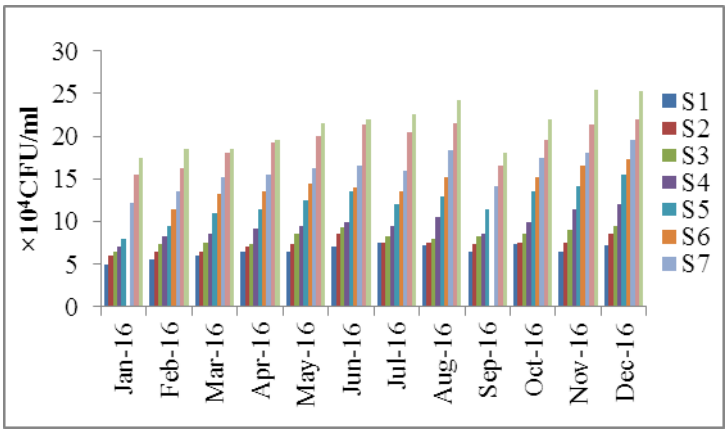

Figure-4: Monthly variations in TCB of Mullaiperiyar river water at Theni district in 2016.

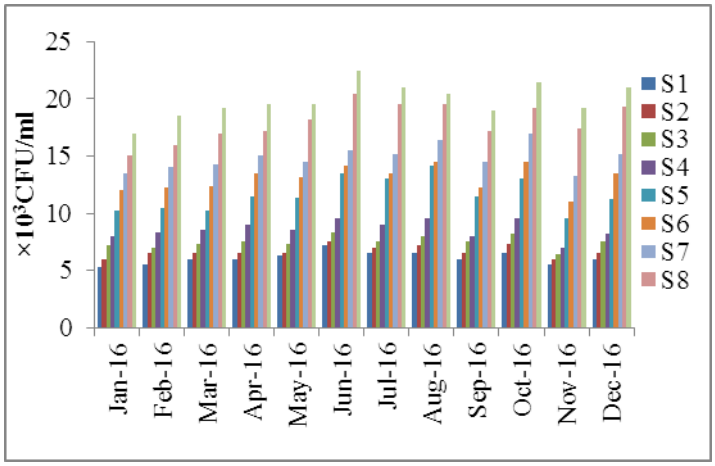

Figure-5: Monthly variations in FCB of Mullaiperiyar river water at Theni district in 2016.

CONCLUSION

The present study of mullaiperiyar river water results is confirmed that about all stations of river water were not fit for directly utilization purposes by various types of pathogenic bacteria which greater than the permissible limit. The incidences of all pathogenic bacteria in the river water are impacted by sewage discharge, open septic drainage and agriculture waste. The use of this water for drinking and other domestic purposes may cause health hazards. The Mullaiperiyar River water was focused to monitor bacterial quality and to treat before utilization in order to avoid the epidemic of waterborne disease. The following methods to protect the Mullaiperiyar River water systems by

1. No defecation should be allowed near river water sources.
2. Pollution from domestic, industrial, agricultural and other wastes should not establish access to river sources.
3. Solid wastes should not be dumped near the riverside.
4. Drainage transport sewage and other waste substances should be diverted away from the river water sources.
5. Additional efficient environmental laws and community awareness programme must be assumed with respect to the possible risk of industrial and other waste to the surroundings.
6. The regular basic bacteriological investigation of drinking water must be accepted by analyzing the presence of different types of microorganisms by the various culture techniques.
7. Keeping away from septic tanks in the surrounding areas of rivers.

8. Chlorination of water which is the most common and suggested method.
9. Efficient treatment method to be working to avoid waterborne diseases. The primary and secondary biological treatment process such as sedimentation and coagulation, activated sludge process, chemical treatment and anaerobic digestion for the combined waste matters.

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