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Levels of Indicator Microorganisms (Total and Fecal Coliforms) in Surface waters of rivers Cauvery and Bhavani for Circuitously predicting the Pollution load and Pathogenic risks

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Abstract: Indicator organisms are commonly used to assess the quality of surface waters. Fecal coliforms (FC) are the most commonly used bacterial indicator of fecal pollution. Total coliforms (TC) comprise bacterial species of fecal origin as well as other bacterial groups. The coliforms are indicative of the general hygienic quality of the water and potential risk of infectious diseases through water. High FC and TC counts in water are usually manifested in the form of diarrhea, fever and other secondary complications. The present study revealed that, the study area of the River Cauvery and Bhavani were grossly polluted in respect of coliform assessment which is mainly attributed to the open defecation, high amount of raw sewage and barrage sedimentation. Hence the water is not fit for drinking purposes due to higher coliforms counts, which require continuous monitoring and proper disinfection made if the water is to be used for drinking purpose. The severely contaminated stations of Rivers Cauvery and Bhavani with respect to total coliforms are Vairapalayam (1800 MPN/100ml) and Bhavani Sagar (920 MPN/100ml). This study revealed a high degree of variability in the fecal and total coliforms in various stations of these rivers.
Key Words: Fecal Coliform, Total Coliform, River Cauvery, River Bhavani, Indicators.

INTRODUCTION

Coliforms or indicator microorganisms are present in the intestinal tracts of warm blooded animals, including humans[1] and therefore can be excreted in the feces of these animals, although there have been some associations between high levels of indicator bacteria and disease outbreaks[2.] The occurrence of coliforms in surface water has been used as an indicator of fecal contamination, signaling the possible presence of fecal pathogens such as *Salmonella* and *Shigella* species[3.] This is due, in part, to the observed correlation between elevated bacterial counts in water and the rate of occurrence of gastrointestinal symptoms or diseases.

India is rich in water resources, being endowed with a network of rivers that can meet a variety of water requirements of the country[4.] Rivers are waterways of strategic importance across the world, providing main water resources for domestic, industrial and agricultural purposes[5.] Major factors affecting microbiological quality of surface waters in India are discharges from sewage, open defecation and runoff from informal settlements[6.]

Identifying sources of fecal pollution in waters used for human recreation and fish breeding is necessary to reduce the potential for human contact with enteric pathogens. Water contaminated with fecal matter has the capability to pose serious health risks for fish consumers and swimmers[7].

Indicator organisms are commonly used to assess the microbiological quality of surface waters and fecal coliforms (FC) are the most commonly used bacterial indicator of fecal pollution in India. They are found in water that is contaminated with fecal wastes of human and animal origin.

Total coliforms (TC) comprise bacterial species of fecal origin as well as other bacterial groups. The coliforms are indicative of the general hygienic quality of the water and potential risk of infectious diseases from water. High FC and TC counts in water are usually manifested in the form of diarrhea and sometimes by fever and other secondary complications.

River Cauvery, a perennial river in India is chosen for total and fecal coliform studies, the stretch between Stanley Reservoir and Odapalli and its major tributary River Bhavani, the stretch between Bhavani Sagar to Bhavani Kuduthurai during January 2012.

MATERIALS AND METHODS

Study Area

The study area included ten spots starting from Stanley Reservoir to Odapalli of River Cauvery. The spots chosen were Stanley Reservoir, Nerinjipettai, Uratchikottai, Komarapalayam, Bhavani Kuduthurai, R.N. Pudur, B.P. Agraharam, Vairapalayam, Pallipalayam and Odapalli. Another study area was one of the major tributaries of River Cauvery called River Bhavani. The study area included ten spots starting from Bhavani Sagar to Bhavani Kuduthurai where the River Bhavani confluence with River Cauvery. The spots chosen were Bhavani Sagar, Sathiyamangalam, Ariyappampalayam, Periyakodiveri, Bangalapudur, Athani, Aapakkudal, Thalavaipettai, Jambai and Bhavani Kuduthurai. The middle of the river was selected for sample collection, at the depth of about one foot.

Sample collection

The bacteriological analysis includes the testing of fecal and total coliforms populations in the water samples. Previously sterilized borosilicate glass bottles of about 500 ml capacities were used. The cap was removed just before sampling. The collected samples were immediately brought to the laboratory and analysed within four hours. All the precautionary measures were taken during transportation and storage of the sample to avoid contamination by other microbes and environmental factors.

Methodology

Multiple Tube Fermentation technique[8] was used to detect total coliform bacteria which are used as indicator of fecal contamination. The test was performed sequentially in three stages: i. Presumptive coliform test,
ii. Confirmed coliform test, iii. Completed coliform test.
In the membrane filter method for fecal coliform, water sample was passed through a thin sterile membrane filter paper (pore size 0.45µm) which was kept in a special filter apparatus contained in a suction flask. The filter disc that contains the trapped microorganisms was aseptically transferred to a sterile petri dish having an M7hr-FC agar medium and the colonies were allowed to develop. This method enables a large volume of water to be tested more economically[8].

Table 1. Global positioning details of River Cauvery

Station ID	Latitude	Longitude	Fix time
Stanley Reservoir	11^0 47.8321’ N	77^0 48.4167’ E	FEB 22,2009,12.49 am
Nerinjipettai	11^0 38.7247’ N	77^0 45.4309’ E	FEB 21,2009,11.54 pm
Uratchikottai	11^0 47.8321’ N	77^0 41.8451’ E	FEB 22,2009,2.27 pm
Komarapalayam	11^0 27.0983’ N	77^0 41.5489’ E	FEB 21,2009,10.35 pm
Bhavani Kuduthurai	11^0 25.9106’ N	77^0 40.9842’ E	FEB 22,2009,3.00 pm
R. N. Pudur	11^0 25.0124’ N	77^0 40.916’ E	MARCH16, 2009, 10.27 pm
B.P. Agraharam	11^0 22.9942’ N	77^0 42.7541’ E	FEB 21,2009,8.49 pm
Vairapalayam	11^0 22.3000’ N	77^0 43.4805’ E	FEB 21,2009,8.14 pm
Pallipalayam	11^0 20.9635’ N	77^0 45.2311’ E	FEB 21,2009,1.54 pm
Odapalli	11^0 20.4294’ N	77^0 45.3962’ E	FEB 22,2009,12.26 pm

Table 2. Global positioning details of River Bhavani

Station ID	Latitude	Longitude	Fix time
Bhavani Sagar	11^0 47.8321’ N	77^0 48.4167’ E	FEB 22,2009,12.49 am
Sathiyamangalam	11^0 38.7247’ N	77^0 45.4309’ E	FEB 21,2009,11.54 pm
Ariyappampalayam	11^0 33.6661’ N	77^0 44.2954’ E	FEB 21,2009,11.22 pm
Periyakodiveri	11^0 47.8321’ N	77^0 41.8451’ E	FEB 22,2009,2.27 pm
Bangalapudur	11^0 27.0983’ N	77^0 41.5489’ E	FEB 21,2009,10.35 pm
Athani	11^0 25.9106’ N	77^0 40.9842’ E	FEB 22,2009,3.15 pm
Aapakkudal	11^0 25.0124’ N	77^0 40.916’ E	MARCH16, 2009, 10.47 pm
Thalavaipettai	11^0 22.9942’ N	77^0 42.7541’ E	FEB 21,2009,8.41 pm
Jambai	11^0 22.3000’ N	77^0 43.4805’ E	FEB 21,2009,8.10 pm
Bhavani Kuduthurai	11^0 25.9106’ N	77^0 40.9842’ E	FEB 22,2009,3.00 pm

RESULTS AND DISCUSSION

The results of the fluctuations of bacterial populations in different sampling locations of Rivers Cauvery and Bhavani are presented in Table 3.

In River Cauvery total coliforms count was minimum at 110 MPN/100ml in Nerinjipettai station and maximum of 1800 MPN/100ml in Vairapalayam station. The average was 403.5 MPN/100 ml (Fig 1). Fecal coliforms were counted as minimum of 30 colonies/100ml in Nerinjipettai station and maximum of 580 colonies/100 ml in Vairapalayam station. The average coliform count was 126 colonies/100 ml (Fig 2).
When compared to River Cauvery, River Bhavani minimum total coliform count was slightly higher at 130 MPN/100ml in Periyakodiveri and Bangalapudur stations and recorded the maximum of 920 MPN/100ml in Bhavani Sagar station. The average was 279.5 MPN/100 ml (Fig 1). Fecal coliforms were counted as minimum of 40 colonies/100ml in Bangala Pudur station and maximum of 310 colonies/100 ml in Bhavani Sagar station. The average coliform count was 106.8 colonies/100 ml (Fig 2).
Knowledge of indicator organism source is necessary for risk assessment and remediation of polluted waters including application, such as total maximum daily load assessment. Consequently, the field of microbial source tracking, which seeks to determine the origin of fecal material in water, has emerged[9].

The microbiological quality of water is measured by the analysis and enumeration of indicator coliforms[10]. The natural host range of indicator organisms in River Cauvery and Bhavani includes fecal matter of warm-blooded animals particularly human beings, some cold-blooded animals[11], sediments[12] and free-living strains[13]; therefore, the source of fecal pollution is often ambiguous.

Table 3. Levels of Total and Fecal Coliforms in Rivers Cauvery and Bhavani

River Cauvery				River Bhavani			
SI. No	Sampling Locations	Indicator Microorganisms		SI. No	Sampling Locations	Indicator Microorganisms	
		Total Coliform (MPN/100 ml)	Fecal Coliform (Colonies/100 ml)			Total Coliform (MPN/100 ml)	Fecal Coliform (Colonies/100 ml)
1	**Stanley Reservoir**	175.0	50.0	**1**	**Bhavani Sagar**	920.0	310.0
2	**Nerinjipettai**	110.0	30.0	**2**	**Sathiyamangalam**	250.0	110.0
3	**Uratchikottai**	150.0	50.0	**3**	**Ariyappampalayam**	140.0	70.0
4	**Komarapalayam**	250.0	80.0	**4**	**Periyakodiveri**	130.0	50.0
5	**Bhavani Kuduthurai**	280.0	130.0	**5**	**Bangala Pudur**	130.0	40.0
6	**R.N. Pudur**	120.0	40.0	**6**	**Athani**	280.0	100.0
7	**B.P. Agraharam**	175.0	60.0	**7**	**Aapakkudal**	175.0	60.0
8	**Vairapalayam**	1800.0	580.0	**8**	**Thalavaipettai**	210.0	68.0
9	**Pallipalayam**	550.0	120.0	**9**	**Jambai**	280.0	130.0
10	**Odapalli**	425.0	120.0	**10**	**Bhavani Kuduthurai**	280.0	130.0

Fig. 1. Total Coliform levels at different locations of Rivers Cauvery and Bhavani

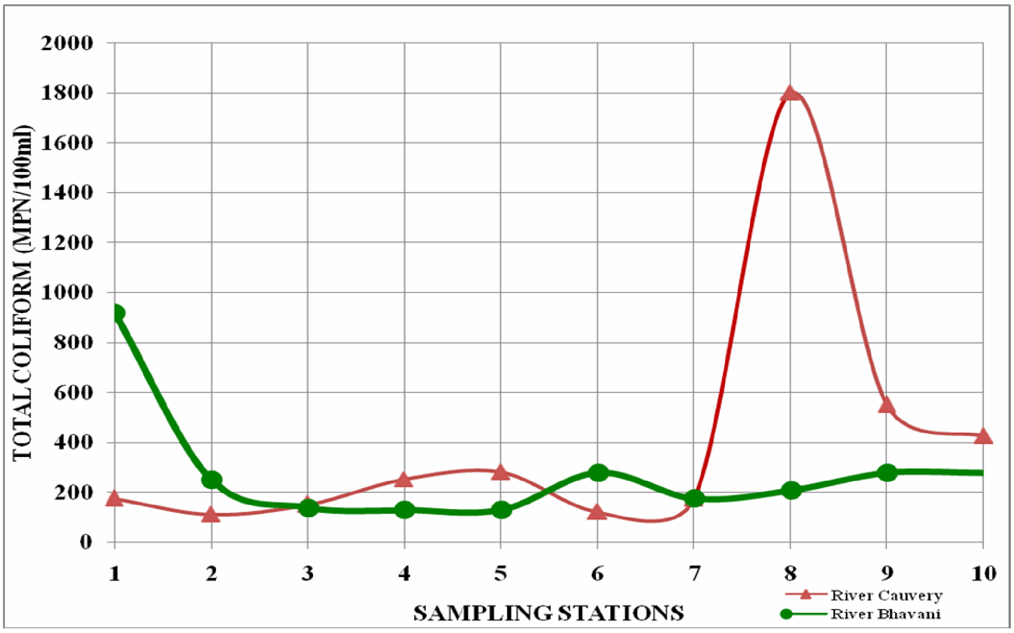
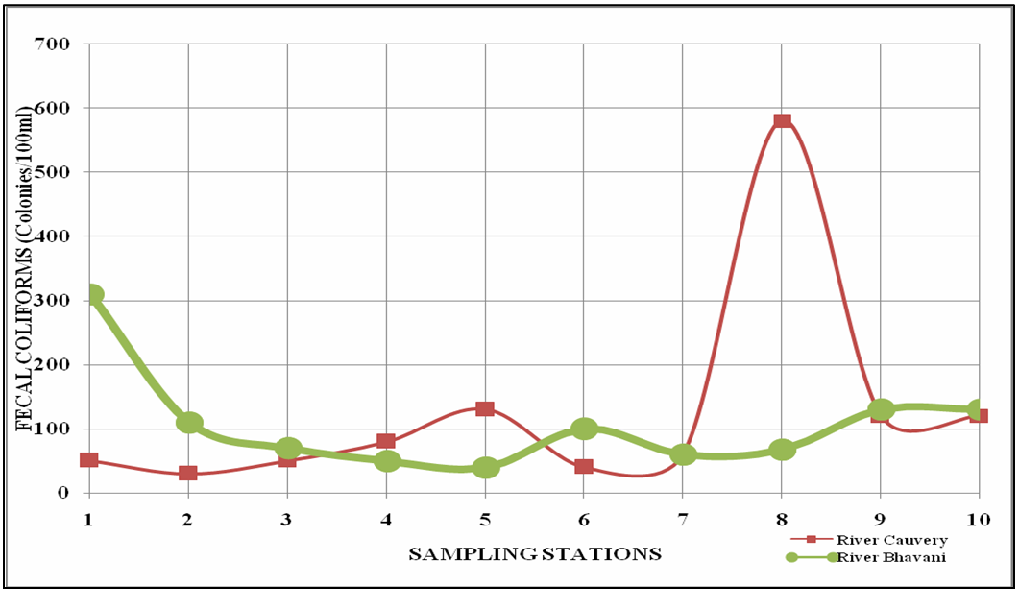


Fig. 2. Fecal Coliform levels at different locations of Rivers Cauvery and Bhavani



To accurately estimate the human health risk associated with exposure to fecal pathogens, an indicator should not proliferate in the environment, should persist as long as pathogens and should be present at the same time at concentrations proportional to the concentrations of pathogens[14].

Fecal pollution from failing septic systems, urban and agricultural runoff and wild animals affects human and environmental health[15.] Most of the stations of River Cauvery and Bhavani receive untreated sewage and septic tank over flows. According to Krishnamoorthy and Nagarajan[16] river water was grossly polluted by total and fecal coliform organisms are mainly attributed to the high amount of raw sewage.

According to Gholami *et al.,*[17] the main cause of deterioration in water quality of River Cauvery in Krishna Raja Sagar, in Karnataka was due to the lack of proper sanitation, unprotected river sites and high anthropogenic activities. The banks of River Cauvery downstream between Stanley reservoir and Odapalli and

River Bhavani are used as open toilet for most of the villages alongside the rivers. They are no proper toilet facilities in these villages and hence they resort to use river banks for defecation.

According to Donderski and Wilk[18]**,** the unhygienic conditions of water associated with drinking and recreation may result in human infections and diseases through the ingestion of pathogenic microorganisms which are indicated by the presence of indicator bacteria.

Mallin *et al.,*[19] found that fecal coliform densities were positively correlated with turbidity and negatively with salinity. However, the presence or absence of these bacteria in water is often used to determine whether disinfection of water is working properly or not.

According to CPCB[20], the Total Coliforms level should not exceed 50 MPN/100ml to recommend the water as potable without conventional treatment but after disinfection and the class of water is “A”. The concentrations shall be 500 MPN/100ml or less the water would be recommended for outdoor bathing only and the class of water is “B”. But the level of total coliforms organism shall be 5000 MPN/100ml or less must the water source used for drinking after conventional treatment and disinfection and the class of water is “C”. In the present investigation minimum Total Coliform levels in River Cauvery and Bhavani was 110 MPN/100ml in Nerinjipettai station and 130 MPN/100ml Periyakodiveri and Bangalapudur respectively. The water quality class of these rivers is “B” and it is recommended for outdoor bathing only. The maximum of 1800 MPN/100ml in Vairapalayam station and 920 MPN/100ml in Bhavani Sagar station, the water was not fit for drinking without treatment and disinfection. The class of water is “C”.

CONCLUSION

Thus the present study revealed that, the study area of the River Cauvery and Bhavani are grossly polluted in respect to coliform assessment which is mainly attributed to the open defecation, high amount of raw sewage and barrage sedimentation, which require continuous monitoring and proper disinfection if the water is to be used for drinking purposes. The severely contaminated stations of Rivers Cauvery and Bhavani with respect to total coliform are Vairapalayam (1800 MPN/100ml) and Bhavani Sagar (920 MPN/100ml) This study demonstrated a high degree of variability in the fecal and total coliform organisms in the stations of these rivers.

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