



Quantitative Determination of Total and Fecal Coliforms in Groundwater between Tamilnadu and Pondicherry States, India

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ABSTRACT

Water is the elixir of life and it is threatened by the bacterial contamination. Coliform count is the major tool to determine the bacteriological quality of water. The determination is quite easy and informative. The different methodologies are employed depending on suitability but maximum probable number (MPN) is the most accepted. The main objective of this study is to assess the effect of groundwater contamination between Tamilnadu and Pondicherry areas, the water is collected for domestic use and drinking purposes. Samples from (23) place were collected during monsoon, winter and summer seasons and analyzed for the presence of total coliform and fecal coliform. In all samples, total coliforms and fecal coliforms were found. Total coliform bacteria are a collection of relatively harmless microorganisms commonly found in the gut of warm and cold blooded organisms. Part of this collection is the fecal coliform which origin may come only from warm blooded animals and is highly differentiated by their ability to grow at elevated temperatures. The present study concluded most people are concerned about the health risk that coliforms may pose. People exposed to coliform contaminated water may exhibit fever, diarrhea and abdominal cramps, chest pain, or hepatitis. During bathing exposure to coliforms may cause urinary tract infection.

1. Introduction

Water has endless uses namely drinking, industrial, livestock, irrigation, aesthetics, boating, swimming, fishing and so on. However, this elixir of life is being threatened by various pollutions but mainly the bacteriological pollution of water is a serious problem.

Microorganisms that can cause disease are called pathogens. Pathogens that can be spread through drinking water and cause waterborne disease include bacteria, viruses, and protozoa. The number of different types of pathogens that can be present in water as a result of pollution with human or animal faeces is very large and it is not possible to test water samples for each specific pathogen. For example, more than 100 types of enteric viruses have been isolated from human faeces and from sewage. Isolation and identification of some of these viruses is very difficult, or not currently possible. If these viruses or other pathogens are present in water as a result of faecal pollution, a measure is required which will alert water managers to their presence. An indicator of microbial water quality is generally something (not necessarily bacteria), which has entered the water at the same time as faeces, but is easier to measure than the full range of microorganisms which pose the health risk.

Coliform bacteria are described and grouped, based on their common origin or characteristics, as either Total or Fecal Coliform. The Total group includes Fecal Coliform bacteria such as *Escherichia coli* (*E. coli*), as well as other types of Coliform bacteria that are naturally found in the soil. Fecal Coliform bacteria exist in the intestines of warm blooded animals and humans, and are found in bodily waste, animal droppings, and naturally in soil. Most of the Fecal Coliform in fecal material (feces) is comprised of *E. coli*, and the serotype *E. coli* O157:H7 is known to cause serious human illness. Total Coliform do not necessarily indicate recent water contamination by fecal waste, however the presence or absence of these bacteria in treated water is often used to determine whether water disinfection is working properly. The presence of Fecal Coliform in well water may indicate recent contamination of the groundwater by human sewage or animal droppings which could contain other bacteria, viruses, or disease causing organisms. This is why Coliform bacteria are

considered “indicator organisms”; their presence warns of the potential presence of disease causing organisms and should alert the person responsible for the water to take precautionary action [1].

Total coliform bacteria is the most common pollution in rainfall and runoff water [2]. The fecal coliform group is indicative of organisms originating in the intestinal tract of humans and some animals [1]. Similarly, in one of the experiment disinfection of drinking water by direct heating to temperature of 65 °C or above, the results were shown to reduce a total coliform in naturally contamination Water [3].

The United States Environmental Protection Agency defined safe water that is free from pathogenic microorganisms, radioactivity, chemical contamination, or turbidity and should not possess undesirable taste, odor, or color. Total coliform bacteria are a collection of relatively harmless microorganisms residing in the gut of both cold and warm blooded organisms. Part of this collection is the fecal coliform bacteria. Fecal coliform (FC) bacteria can only be associated with the fecal matter of warm blooded animals and can grow at elevated temperatures. In addition, FC bacteria may occur in ambient water coming from domestic sewage or nonpoint sources of pollution. Pathogenic microbes can also be found in fecal material alongside with coliform bacteria. Further, the occurrence of fecal coliform in aquatic environments signifies water contamination via the fecal matter. Hence, their presence in rivers and streams suggests that a potential health risk exists for individuals utilizing the water. Since it is difficult, time-consuming, and expensive to test directly for the presence of a large variety of pathogens, water is usually tested for coliforms. Monitoring the fecal and total coliform is an essential component of any water quality study.

2. Experimental Methods

2.1 Study Area

Pondicherry is situated in the East Coast of India between two Major Ports of India namely, Chennai and Tuticorin. It is about 170 km south of Chennai and about 165 km North of Tiruchirappalli. Pondicherry is divided into two parts: the French quarters and the Indian quarters. For the same reason, French style colonial compounds and walls are a common tourist attraction here. The city offers excellent sites for soothing yoga and peaceful meditation. Karaikal is a very old temple town in Pondicherry. It is on the east coast, about 135 km from Pondicherry and

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300 km from Chennai towards south. The town is small with a total of 161 sq km with marine time climate and located on the Koramandel coast of the Bay of Bengal. The total population of the study area is approximately about two lakhs of which majority depends on groundwater for drinking, domestic and agricultural purposes. The soil nature of our selected study areas has been recorded possessing herbaceous organic deposits with underlying sandy textured sediments. Agriculture is one of the main occupations of the people of the Union territory of Pondicherry. About 45% of the total population of Pondicherry is engaged in agriculture. Paddy forms a major crop of Pondicherry agriculture. In the Union Territory, about 90% of the agricultural area is irrigated through modern technology. Pondicherry is mainly irrigated through water tanks and tube wells. The vegetation of Tamilnadu and Pondicherry comprises various types of plants including woody plant group, hedge plants, ornamental plants, hydrophytes and halophytes etc. The crops that are commonly grown in the region are paddy, pulses, coconuts, cotton, chillies, vegetables, sun flower and groundnuts etc.

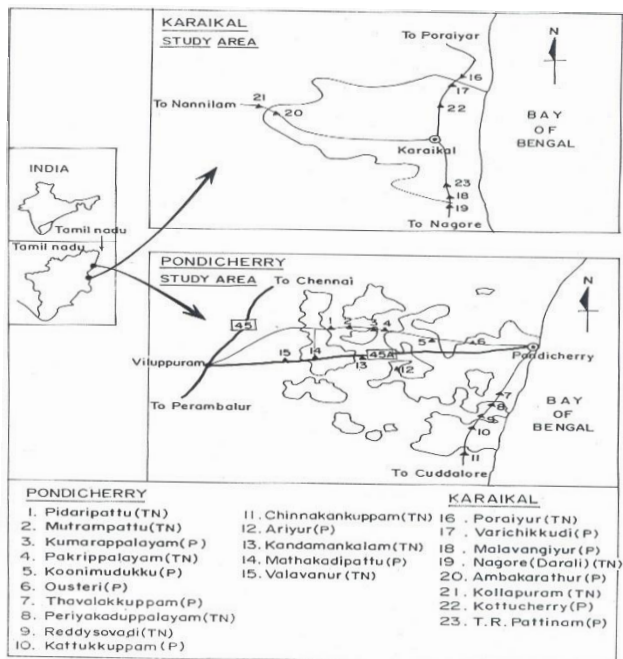


Fig. 1 Location map showing sampling stations

2.2 Collection of Samples

Water samples were collected in 100 mL plastic bottles from the selected 23 spots. Thereafter, samples for total Coliform and fecal Coliform were tested.

2.3 Analytical Techniques

2.3.1 Total Coliform Count

100 mL of water samples were filtered into a membrane filter using a sterile filtration unit. After filtration, forceps were used to place the membrane filter on M-Endo Broth in invert plate. The plate was then incubated in an incubator at a temperature of 45 °C for 24 h. The plates were then checked for bacteria colony growth [4-6].

2.3.1 Fecal Coliform Count

The same method was followed in total coliform count but after filtration, forceps were used to place the membrane filter on an MEC Broth in invert plate and the plate was then incubated in an incubator at a temperature of 37 °C for 24 h. Growing bacteria colony was the checked for growth.

3. Results and Discussion

Coliforms are bacteria that are always present in the digestive tracts of animals, including humans, and are found in their wastes. They are also found in plant and soil material. The most basic test for bacterial contamination of a water supply is the test for total coliform bacteria. Total coliform counts give a general indication of the sanitary condition of a water supply [7].

Coliform populations are indicators for pathogenic organisms. They should not be found in drinking water but are usually present in surface water, soil and faeces of humans and animals. Human waste contaminant in water causes water-borne diseases such as diarrhea, typhoid and hepatitis. High coliform populations in all the water samples are an indication of poor sanitary conditions in the community. Inadequate and unhygienic handling of solid-wastes in the rural area could have generated high concentration of microbial organisms [8].

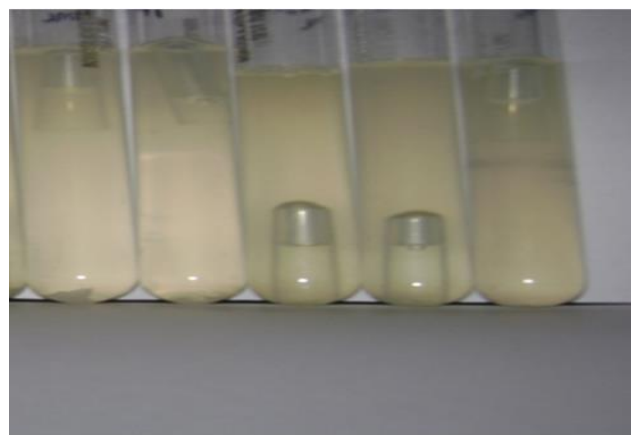


Fig. 2 Bacteriological analysis showing gas production

Table 1 The Faecal Coliform count in groundwater samples by MPN method

Sampling Station	Oct 2010	Jan 2011	Apr 2011	Oct 2011	Jan 2012	Apr 2012	Oct 2012	Jan 2013	Apr 2013
1	12	13	11	14	12	12	16	13	12
2	10	7	10	9	7	8	11	8	8
3	17	14	9	14	12	10	13	10	9
4	9	12	12	15	14	13	10	11	12
5	14	10	7	19	9	8	20	19	15
6	20	17	15	14	15	14	15	14	13
7	13	8	11	10	7	9	17	13	12
8	15	13	13	18	12	13	12	12	10
9	8	10	6	11	10	9	14	14	11
10	14	11	10	13	9	8	16	13	14
11	13	12	9	15	11	10	18	15	14
12	19	15	14	20	14	13	20	20	18
13	14	13	10	15	12	12	13	11	10
14	13	6	5	14	7	6	11	9	7
15	13	11	9	13	12	11	14	16	12
16	10	9	8	10	8	7	12	10	6
17	7	6	5	8	7	6	10	7	8
18	17	13	11	17	15	13	19	14	11
19	16	18	16	18	18	17	17	18	16
20	18	12	10	19	12	11	19	17	15
21	20	13	12	18	14	14	20	19	18
22	11	11	8	12	9	8	15	12	10
23	19	15	13	20	14	13	19	17	14
Average	14.00	11.69	10.17	14.60	11.30	10.65	15.26	13.56	11.95

	Seasonal Average	Total Average
Monsoon	14.00	14.62
Winter	11.69	12.18
Summer	10.17	10.92

Season	Total average
Monsoon	14.62
Winter	12.18
Summer	10.92
Mean	12.57

The Faecal Coliform counts in water samples are observed to be 14.62, 12.18 and 10.92 in monsoon, winter and summer seasons, respectively. The values are higher than that of WHO permissible limit (0/100 ml MPN coliforms). The mean average value was found to be 12.57. It indicates that the water in all the station is unsuitable for drinking and agricultural purpose.

Table 2 The Total Coliform count in groundwater samples by MPN method

Sampling Station	Oct 2010	Jan 2011	Apr 2011	Oct 2011	Jan 2012	Apr 2012	Oct 2012	Jan 2013	Apr 2013
1	25	22	20	27	24	22	25	24	23
2	38	33	29	41	35	32	42	39	36
3	26	21	20	28	23	23	31	28	25
4	45	42	39	47	43	41	49	46	44
5	39	35	31	40	36	34	42	40	37
6	47	41	36	50	42	39	52	49	46
7	26	22	21	29	25	22	32	29	25
8	50	49	47	51	50	49	53	48	46
9	46	41	37	48	43	41	51	47	44
10	38	29	26	39	30	28	41	39	33
11	24	24	23	25	27	24	28	26	21
12	29	22	20	33	23	22	37	35	32
13	22	24	21	27	25	25	29	27	29
14	42	41	35	44	44	37	46	42	38
15	39	36	32	35	38	33	37	33	31
16	34	32	29	38	35	31	40	37	33
17	28	24	23	32	27	26	33	30	27
18	29	26	24	31	29	28	35	32	29
19	48	44	38	49	48	38	51	49	45
20	47	41	40	49	38	45	52	50	48
21	39	40	35	42	36	35	45	41	38
22	40	33	31	45	33	32	48	46	41
23	49	46	44	50	47	48	50	48	48
Average	36.95	33.39	30.47	39.13	34.82	32.82	41.26	38.47	35.60

Seasonal Average	Total Average
Monsoon	36.95
Winter	33.39
Summer	30.47
	39.13
	34.82
	32.82
	41.26
	38.47
	35.60
	32.96

Season	Total average
Monsoon	39.11
Winter	35.56
Summer	32.96
Mean	35.87

The TC bacterial count found in three seasons - monsoon, winter and summer are found to be higher than the permissible limit of WHO (10/100 mL of MPN coliforms). The average TC values in the three seasons are found as 39.11, 35.56 and 32.96 in monsoon, winter and summer, respectively. The mean average value of TC in three seasons is 35.87 and it indicates that the water in the above stations are unsuitable for drinking and agricultural purposes.

Organic matters occurring in polluted waters serve as excellent nutritional source for the growth and proliferation of microorganisms. Bacteria are the most commonly used microbial tracer organism since they grow well in aqueous media and they are also easily detectable. The most probable number (MPN) is a suitable and widely used parameter to determine the microbial quality of water. In the observation of our study areas the MPN for total coliform and bacterial count are noted to be very high than the permissible limit of WHO (0/100 mL of MPN coliforms) in all the three seasons. Large microbial pollution in monsoon and winter seasons increases MPN values compared to summer season. The increase in microbial load is probably due to the accumulation of human and animal excreta, the addition of sewages, dumping of cabbages and industrial wastes [9]. The microorganisms in the stagnant surface water resources happen to grow in abundance as they attain ample of nutrients in the

water bodies. The polluted surface water on percolation into the ground may contaminate the deep-well water even though some amounts of the organisms get filtered by the soil layers. High MPN values suggest that the water is not suitable for drinking purposes.

The total coliform count amounting to collective pathogens like *Escherichia coli*, *Enterobacter aerogenes*, *Staphylococcus aureus*, *Sulmonella* and *Shigella* on the biological examination of our study water samples (Table 2) shows potable higher value during rainy season whereas decreased value to some extent in the summer season. Land washings and domestic wastes by rain will augment the high potent of bacterial count [10, 11]. The considerable depleted value of microorganisms during summer may be due to less biological activities at very low humidity and unfavourable conditions for bacterial growth such as pH, temperature, DO, nutrient, sunlight and other biological factor. Thus the presence of harmful microbes in the groundwater is said to be the reason for causing dysentery, typhoid, cholera, etc., [12]. The World Health Organization has reported that about 30,000 people die every day in developing countries because of unsanitary water supply. The absence of bacterial organisms in some stations indicates that the environmental conditions (temperature, etc.,) are not favourable for the bacterial growth.

4. Conclusion

In the present investigation, it is necessary to disinfect groundwater and tap water before human use in order to avoid the potential risk of contracting diseases. The microbiological quality that adversely affected the quality of groundwater is likely to arise from a variety of sources. Hence it is important to apply strong prevention measures to save groundwater from contamination in these studied locations.

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