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A Comparative Study on the water quality of Selected Rivers in Kerala

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Abstract

The present work was conducted to analyze the water quality status of the selected rivers in Kerala. Five rivers were selected with 15 sites which represent different regions like rural areas and town areas.The rivers are Pambar, Periyar, Muvattupuzha, Meenachil and Thodupuzha and the 15 sites are Chinnar, Kovilkadavu, Munnar, Irumbupalam, Thekkady, Vandiperiyar, Upputhura, Moolamattam, Mrala, Kaliyar, Kacheritazath, Thodupuzha, Teekoy, Erattupetta and Pala. Temperature, atmospheric temperature, pH, turbidity, dissolved oxygen, COD, nitrates, chlorides, iron and bacteriological contamination were the various parameters analyzed. The present study revealed that our rivers are polluted with a variety of reasons. It is also found that the pollution level is very high in town areas. The water samples collected from the town of Pala and Kacheritazath are the best examples for this. It is also found that among all the samples, bacteriological pollution is the most present. As faecal contamination is the major source of coliform bacteria, the reason for this is the increased population level in town areas. The change in physical parameters like pH, temperature and salt concentration may also cause increase in the coliform micro organism in river water. Thus, it is necessary to take immediate action to control the pollution level and save the quality water for the future generations.

1. Introduction

Water is the elixir of life, a precious gift of nature to mankind and millions of other species living on earth. It is one of the most important in shaping the land surface and regulating climate. Water has played a predominant role in governing the distribution of human (Shrivastava & Choudhary, 1996). The primary source of water is precipitation in the form of rain, snow, etc. Water covers more than 70 percent of earth's surface.Without freshwater of adequate quantity and quality sustainable development will not be possible.The water quality will worsen with rising pollution levels and temperature (Rao *et al*., 1998).

The temperature of water body varies with climate,season and time of the day. Turbidity is the cloudiness or haziness of a fluid caused by large numbers of individual particles that are generally invisible to the naked eye, similar to smoke in air. pH is an important limiting chemical factor for aquatic life (Radhakrishnan *et al*., 2005))pH is controlled by the

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balance between dissolved carbon dioxide and the carbonate and bicarbonate ions. Dissolved oxygen in water is of great importance to all aquatic organisms and is considered to be the factor that reflects the biological activity taking place in a water body and determine the changes which are brought out by the aerobic organisms (Reddy & Reddy, 2008). COD is a measure of total oxygen required to completely oxidizes all the organic matter by a strong oxidant such as dichromate or permanganate. Chloride ions are essential for plants and animals. They are stored in plant and animal bodies as sodium chloride. Nitrogen is an essential plant nutrient required by all living plants and animals for building proteins (Tiwary *et al.*, 2005).

Rivers play a vital role in the global water cycle because they drain water from land into seas and oceans. In India, the problem of aquatic environment has become an important issue very recently. Major water quality problem associated with rivers of Kerala are bacteriological pollution. Dumping of solid waste, bathing and discharge of effluents greatly affect the quality of water and pollute it (Usharani *et al.,* 2010).

2. Materials and Methods

Samples for the present study were collected from the surface of the selected rivers *viz,* Pambar, Periyar, Muvattupuzha, Thodupuzha and Meenachil.Water was collected as the sample only after rinsing the bottle with water for 3-4 times. Water samples were collected in one litre glass bottles. After the collection is over, the sample bottles were labeled and subjected to various physico-chemical bacteriological analyses which includes;

- pH (By electrometric method):- For sample analysis, equilibrium between electodes and sample were established by stirring sample to ensure homogeneity and pH is measured.
- TURBIDITY (Using turbidity meter):- Turbidity can be measured either by its effect on the transmission of light-turbidity or by its effect of scattering of light which is termed as Nephelometry. NEPHELO-TURBIDITY METER is used for measuring the turbidity.
- TEMPERATURE:- Temperature measurements are made with mercury filled centigrade thermometer.
- CHLORIDE:- 50 ml sample were taken and 0.5 ml K_2CrO_4were added and titrated with standard $AgNO_3$ solution till silver chromate starts precipitating.$AgNO_3$ were standardized against standard NaCl (By Mohr's method).
- IRON:- (By spectrophotometric determination)

Suitable aliquot about 50 ml of well mixed sample in 125 ml conical flask were taken.Added 2 ml con.HCl followed by 1 ml Hydroxylamine hydrochloride

solution to it.To it 2-3 glass beads were added and boiled for 20-25 minutes to ensure dissolution of Fe.It is transfered to Nessler tubes after cooling to room temperature.10 ml ammonium acetate buffer and 2 ml 1-10 phenanthroline solution were added. Followed by dilution to 100 ml and mixed well. Substituting the sample by distilled water, blank is prepared. For soluble iron determination, known volume of filtered sample were taken, acidified by adding 2ml conc. HCl per 100 ml of sample followed by the addition of 1 ml Hydroxylamine hydrochloride solution and are treated from test 5 onwards for colour development. Calibration curve can be prepared by taking standard iron solution in the same way in the range 1000-4000 mg/litre with 1 cm light path. The developed colour was measured after 10 minutes at 510 nm.The concentration of total or solute Fe present in the sample from calibration curve were calculated and expressed as mg/litre.

- NITRATE:-

50 ml of the water sample were taken in a beaker and evaporated to dryness on a hot plate. 2 ml of phenoldisulphonic acid is added into the beaker and the residue is dissolved.10 ml of conc.NH_3 (to develop color)is added diluted to 100 ml standard volumetric flask. Contents were mixed well and the solution from the standard flask is transferred to a cuvette. The absorbance is measured at 410 nm wavelength filter using colorimeter. A blank solution is prepared by excluding the water sample.A calibration curve is drawn by plotting absorbance against the concentration of NO_3. Using the calibration curve,the concentration of NO_3 in the water sample is determined (By phenoldisulphonic method).

- COD (CHEMICAL OXYGEN DEMAND):- 20 ml of sample were taken in the round bottom flask. Distilled water, ml taken in the standard round bottom flask. Fill the condenser with water. Heated 0-70 degree celsius.Then,20 ml sample+10ml $K_2Cr_2O_2$ +0.4 gm Hg_2SO_4 +a pinch of silver sulphate +30 ml con.H_2SO_4 .The instrument should be switched on and were allowed to condense for 2 hours.The condenser is then cooled and washed down with distilled water. It is diluted to 140 ml and was titrated with FAS using 5 drops of Ferrain indicator. End point is reddish brown colour. Blank were refluxed in the same manner using distilled water instead of sample. After 2 hours, the apparatus were switched off. Then after disconnecting from the top its marked zero. The condenser was washed (By titrimetric method).
- DISSOLVED OXYGEN:- A bottle with sample water was taken.1 ml of $MnSO_4$ followed

by 1 ml of alkaline iodide was added to the water sample.The reagents are added at the bottom of the bottle. So that, 2 ml of the water is displaced from the top. The stopper of the bottle is replaced making sure that no air bubbles are included.The bottle is shaken vigorously for at least half a minute and then the bottle is kept aside until the precipitate hard settle. Then 1-2 ml of conc.H_2SO_4 was added below the water level and allows it to go down along the side of the bottle.The stopper was replaced taking care to exclude air bubbles. A few air bubbles will be appeared due to the release of oxygen from carbonate in the presence of acid.Bottle was shaken vigorously and all the precipitate was digested by the acid.50 ml of these liquid was taken in a conical flask and titrated against the standardized sodium thiosulphate.When ground colour of iodine disappeared,a few drops of starch solution was added and shaken well.The end point was marked by the first complete disappearance of the blue colour. Titration must be repeated to get concordant values (By Wingler's method).

- BACTERIOLOGICAL ANALYSIS:-There are different methods in which number of tubes used may vary. Accordingly the range of countable bacteria will also vary. There are 5,1,1 tube method, 3,3,3 tube method, 5,5,5 tube method.Medium used is Mac Conkey broth. Only coliforms can grow in this medium. The media were prepared into double and single strength and pipetted out 10 ml of each into prescribed tubes containing Durham's tubes.The media were sterilized at 15 lb pressure at 121 degree celsius for 15 minutes. Samples were collected for dechlorinating treated water, sodium thiosulphate were used 20 mg for 200 ml.Pipettes are sterilized using ethyl alcohol and hot air oven or flame sterilized. Into double strength media 10 ml of samples were added into single strength media 1 ml of sample were added. Into another set of tubes and 0.1 ml of sample were added to another set of tubes and the number of tubes depend in the method that is being adopted.Then after ensuring that there is no air, air bubble, in Durham's tube and after being shaken,the tubes are put for incubation at 37-38 degree celsius for 48 hours in an incubator. If air bubbles are seen in the Durham's tube then that tube can be considered as positive and others are negative.The faecal coliform amount was also determined. One of the most heard faecal coliform bacteria is *E.coli*. Majority of the coliforms

- isolated from water are gut organism *Escherichia coli*, the presence of which is definitive proof of faecal contamination (mpn technique).

3. Results and Discussion

The present work has been carried out in order to study the level of water quality, collected from different sites of the rivers-Pambar, Periyar, Muvattupuzha, Meenachil and Thodupuzha. This study involves the determination of various parameters including temperature, atmospheric temperature, turbidity, pH, dissolved oxygen,COD, chlorides,nitrates,iron.Along with this,bacteriological pollution is also determined. The temperatures of all sites lies between 20^0 c -28^0 c.All the river water showed slightly acidic nature throughout the sampling points except the Kacheritazath water sample showing a pH of 7.02.

An assessment of water quality in river Pamba was conducted by Jalal &Kumar (2013).Lakshmi and Madhu (2014) showed that the overall water quality index as "poor" quality index in the river. Also, Nandakumar, (2005). studied the Microbiological characteristics of Periyar River water at Alwaye and treated drinking water supply of Ernakulum District of Kerala and was founded that the THB count and coliform in a higher amount.Comparing with these results there is not much variations in present study.The coliform count is more present in the site V of Periyar river.i.e., Upputhura river site.Whereas the COD level is more in site III of Periyar, which is the Thekkady river site proving that the pollution status still continues.

Among the Muvattupuzha river, the Kacheritazath river site is the most polluted one and among the Meenachil river the water sample from the Pala town is found to be the most pollutant.The industrial effluents and hospitals are considered to the cause of this.In 2003, Ajaykumar conducted a study of the impact of land deterioration on the watershed health and a study on the physical components of the catchment area of Vazhikadavu Dam of Meenachil river and revealed that deteroration happened both quanlitatively and quantitatively.Thus,edaphic factors of the region also has a vital role in maintaining the ecosystem balance.

In the case of Thodupuzha river,water samples from Mrala and Thodupuzha town are more pollutant than the Moolamattam water sample.The coliform count is more in Thodupuzha town sample whereas other parameters indicate higher pollution in Mrala sample.The Pambar samples too indicate the presence of high coliform bacteria content.

Among all the samples it is found that bacteriological pollution is the most present. Fecal contamination is the major source of coliform bacteria. However, change in physical parameters like pH,temperature and salt concentration may also cause increase in the coliform microorganism in river water. The increased population rate is also a

reason for pollution rate in town areas.

To a large extent, water pollution can be controlled by diluting its effects.Instead of disposing sewage waste into water bodies, it is better to treat them before discharge. By doing this, the toxic waste content is reduced and the remaining work is done through natural treatment by the water body itself. If the secondary treatment of water is done, then this can be reused in agricultural fields and sanitary systems.

Water Hyacinth is a very special plant which can absorb dissolved toxic waste like cadmium and other such elements. Planting these in areas prone to such kinds of pollutants will reduce the harmful effects to a large extent.There are certain chemical methods which help in the control of water pollution;Ion exchange process, Reverse osmosis, Precipitation and Coagulation are the chemical methods. On the individual scale, adopting the methods of reducing, reusing and recycling wherever possible will go a long way in reducing the effects of water pollution and also controlling it.

15 different sites of the rivers viz. Pambar, Periyar, Muvattupuzha, Thodupuzha and Meenachil are the study area selected for the present study. The details are given in the Table-1.

Table – 1 Selected sites of the present study

RIVERS	SITES
PAMBAR	**Chinnar**
	Kovilkkadavu
PERIYAR	**Munnar**
	Irumbupalam
	Thekkady
	Vandiperiyar
	Upputhura
MUVATTUPUZHA	**Kacheritazath**
	Kaliyar
MEENACHIL	**Theekoy**
	Erattupetta
	Pala
THODUPUZHA	**Moolamattam**
	Mrala
	Thodupuzha

Water quality Parameters

Eleven important water quality parameters namely pH,

Chloride, Turbidity, Iron, Nitrate, COD, DO, Total coliform, Faecal coliorm, Temperature and Atmospheric temperature were analyzed from water sample taken from the study sites.

Table – 2. Temperature of the water samples taken from the study area

RIVERS	SITES	TEMPERATURE (^{0}C)
PAMBAR	Chinnar	28
	Kovilkkadavu	25
PERIYAR	Munnar	28
	Irumbupalam	24
	Thekkady	21
	Vandiperiyar	26
	Upputhura	20
MUVATTUPUZHA	Kacheritazath	25
	Kaliyar	26
MEENACHIL	Theekoy	26
	Erattupetta	27
	Pala	27
THODUPUZHA	Moolamattam	20
	Mrala	25
	Thodupuzha	24

Fig.1 – Range of Temperature of the water samples taken from the study area

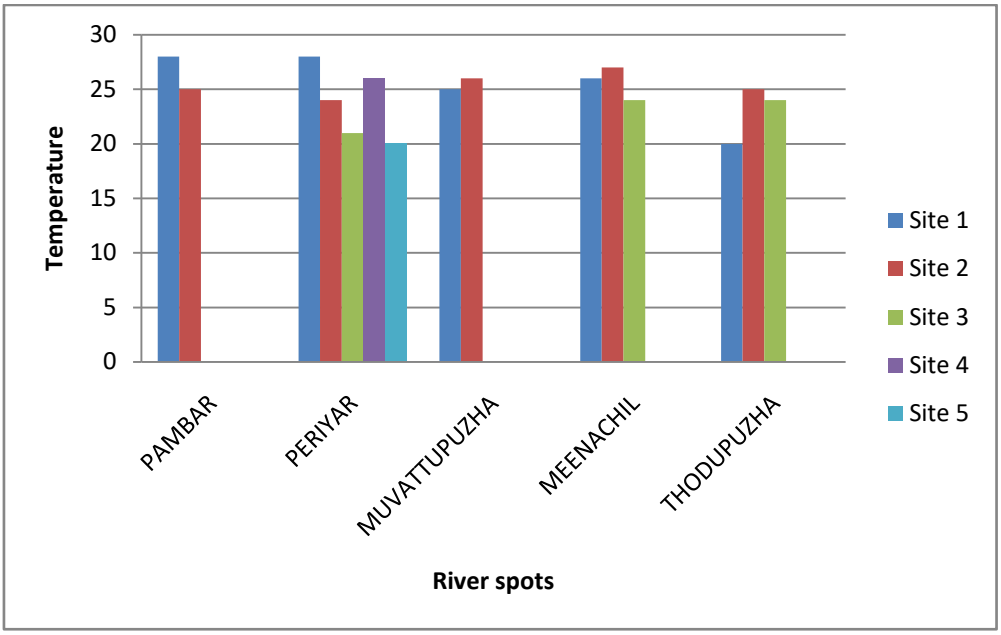


Table – 3. Atmospheric Temperature of the study area

RIVERS	SITES	ATMOSPHERIC TEMPERATURE
PAMBAR	Chinnar	33
	Kovilkkadavu	30
PERIYAR	Munnar	30
	Irumbupalam	31
	Thekkady	29
	Vandiperiyar	30
	Upputhura	24
MUVATTUPUZHA	Kacheritazath	32
	Kaliyar	28
MEENACHIL	Theekoy	26
	Erattupetta	27
	Pala	30
THODUPUZHA	Moolamattam	28
	Mrala	25
	Thodupuzha	32

Figure – 2: Range of Atmospheric temperature of the study area

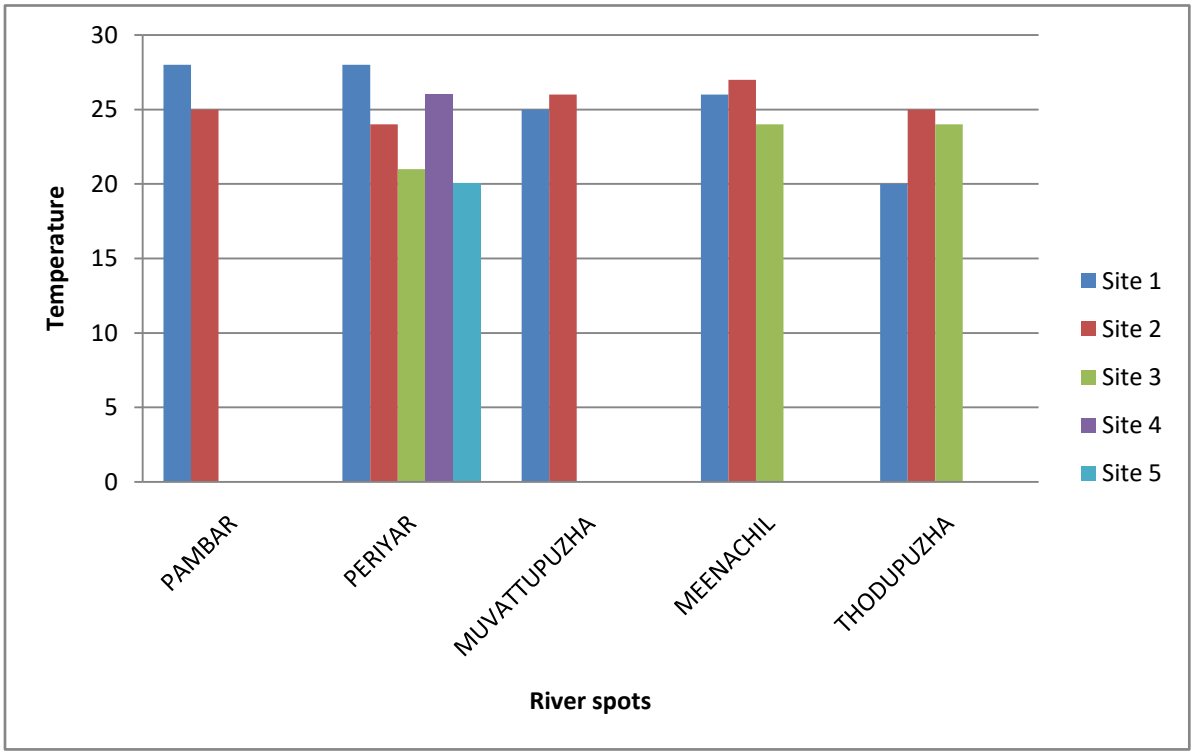


Table – 4.Turbidity of the water sample taken from the study area

RIVERS	SITES	TURBIDITY
PAMBAR	Chinnar	1.4
	Kovilkkadavu	4.0
PERIYAR	Munnar	1.2
	Irumbupalam	2.5
	Thekkady	2.8
	Vandiperiyar	0.5
	Upputhura	0.6
MUVATTUPUZHA	Kacheritazath	0.8
	Kaliyar	1.0
MEENACHIL	Theekoy	0.7
	Erattupetta	0.9
	Pala	1.2
THODUPUZHA	Moolamattam	0.4
	Mrala	0.4
	Thodupuzha	1.0

Figure – 3 Range of turbidity of the water sample taken from the study area

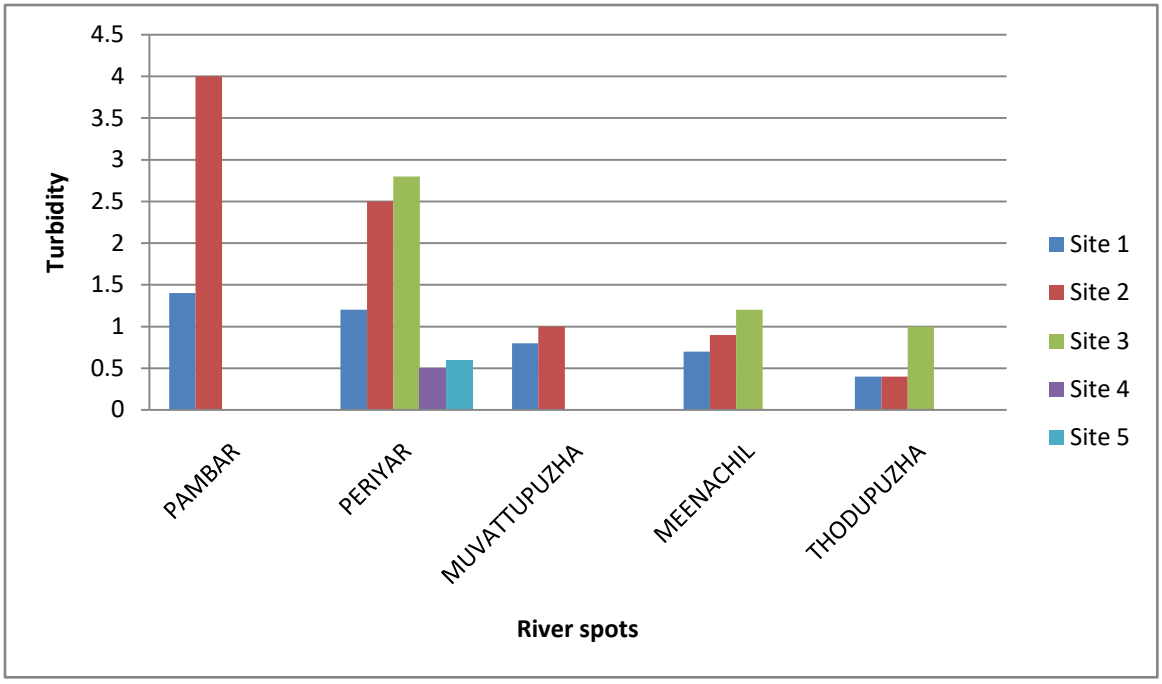


Table – 5 pHof the water sample taken from the study area

RIVERS	SITES	PH
PAMBAR	Chinnar	6.31
	Kovilkkadavu	6.53

PERIYAR	Munnar	6.51
	Irumbupalam	6.52
	Thekkady	6.43
	Vandiperiyar	6.48
	Upputhura	6.32
MUVATTUPUZHA	Kacheritazath	7.02
	Kaliyar	6.31
MEENACHIL	Theekoy	6.85
	Erattupetta	5.45
	Pala	5.2
THODUPUZHA	Moolamattam	6.22
	Mrala	6.18
	Thodupuzha	6.95

Figure – 4 Range of pH of the water sample taken from the study area

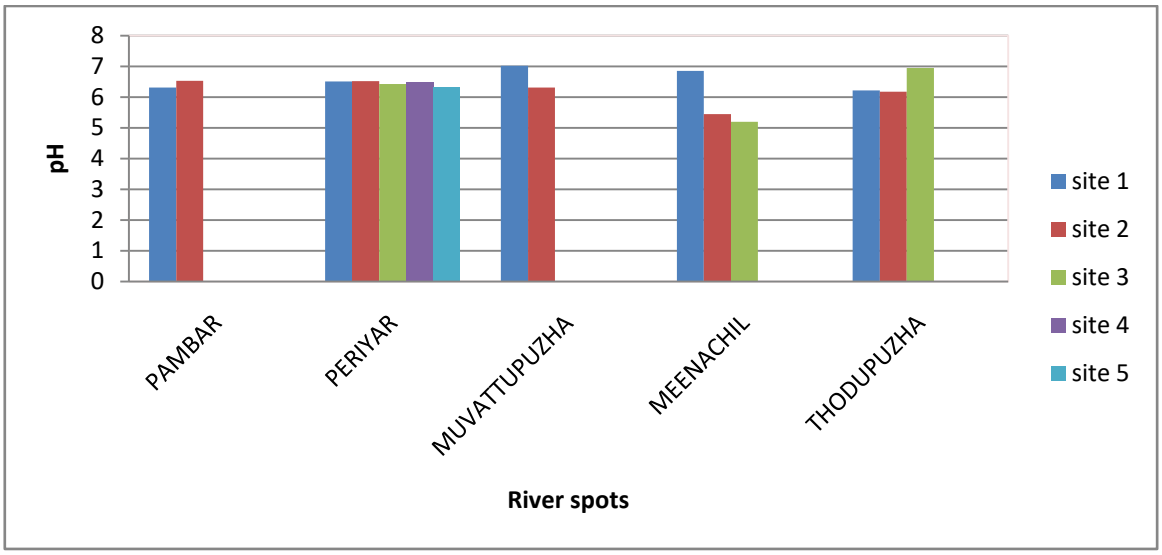


Table – 6 Dissolved Oxygen of the water sample taken from the study area

RIVERS	SITES	DISSOLVED OXYGEN
PAMBAR	Chinnar	6.8
	Kovilkkadavu	5.0
PERIYAR	Munnar	6.8
	Irumbupalam	6.0
	Thekkady	6.5
	Vandiperiyar	6.5
	Upputhura	6.8

MUVATTUPUZHA	Kacheritazath	7.6
	Kaliyar	6.8
MEENACHIL	Theekoy	6.3
	Erattupetta	5.5
	Pala	4.4
THODUPUZHA	Moolamattam	7.0
	Mrala	7.0
	Thodupuzha	6.5

Figure – 5 Range of Dissolved Oxygen of the water sample taken from the study area

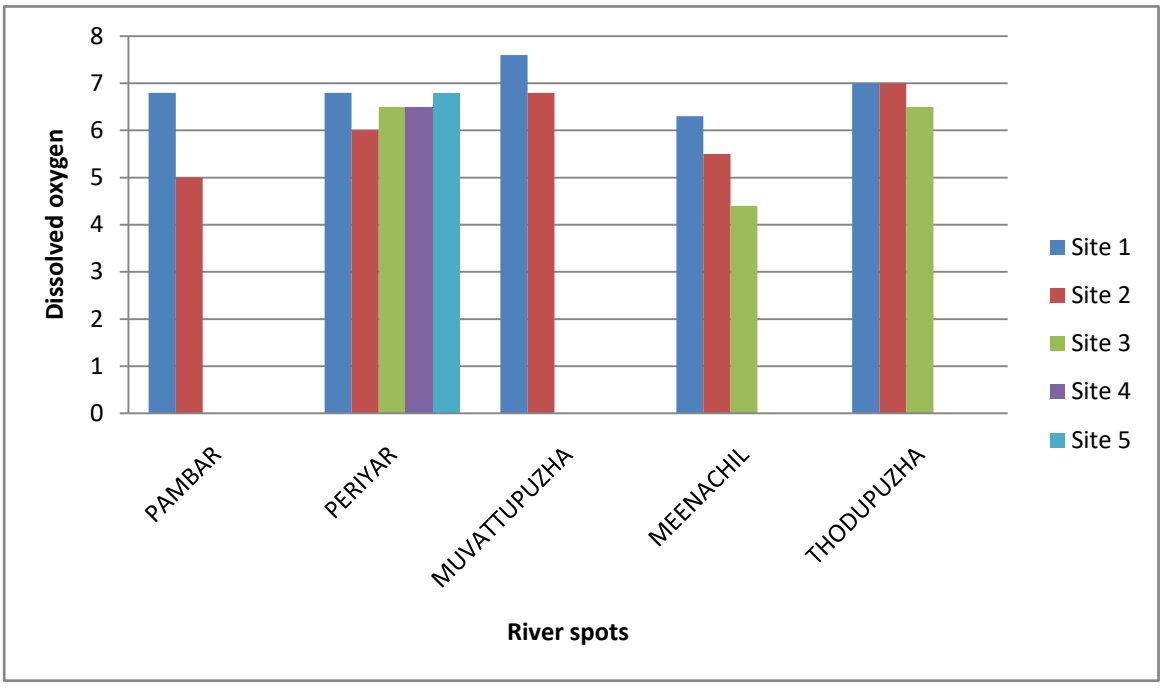


Table – 7 COD of the water sample taken from the study area

RIVERS	SITES	COD
PAMBAR	Chinnar	6
	Kovilkkadavu	2
PERIYAR	Munnar	2
	Irumbupalam	4
	Thekkady	10
	Vandiperiyar	2
	Upputhura	2
MUVATTUPUZHA	Kacheritazath	11
	Kaliyar	8
MEENACHIL	Theekoy	6
	Erattupetta	8

	Pala	10
THODUPUZHA	Moolamattam	5
	Mrala	9
	Thodupuzha	6

Figure –6 Range of COD of the water sample taken from the study area

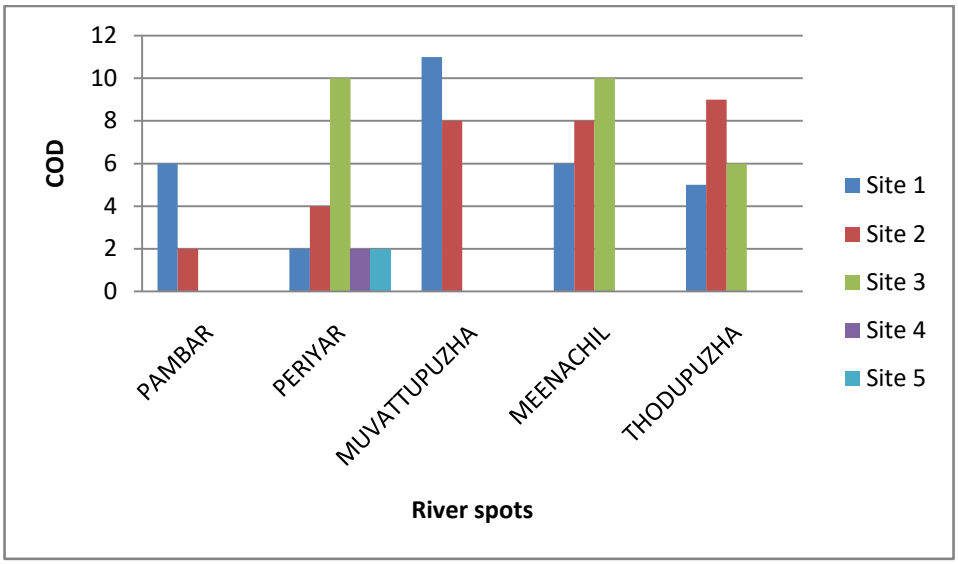


Table – 8 Chloride of the water sample taken from the study area

RIVERS	SITES	CHOLRIDES
PAMBAR	Chinnar	12
	Kovilkkadavu	10
PERIYAR	Munnar	12
	Irumbupalam	18
	Thekkady	12
	Vandiperiyar	12
	Upputhura	14
MUVATTUPUZHA	Kacheritazath	14
	Kaliyar	12
MEENACHIL	Theekoy	12
	Erattupetta	12
	Pala	14
THODUPUZHA	Moolamattam	14
	Mrala	14
	Thodupuzha	12

Figure –7 Range of Chloride of the water sample from the study area

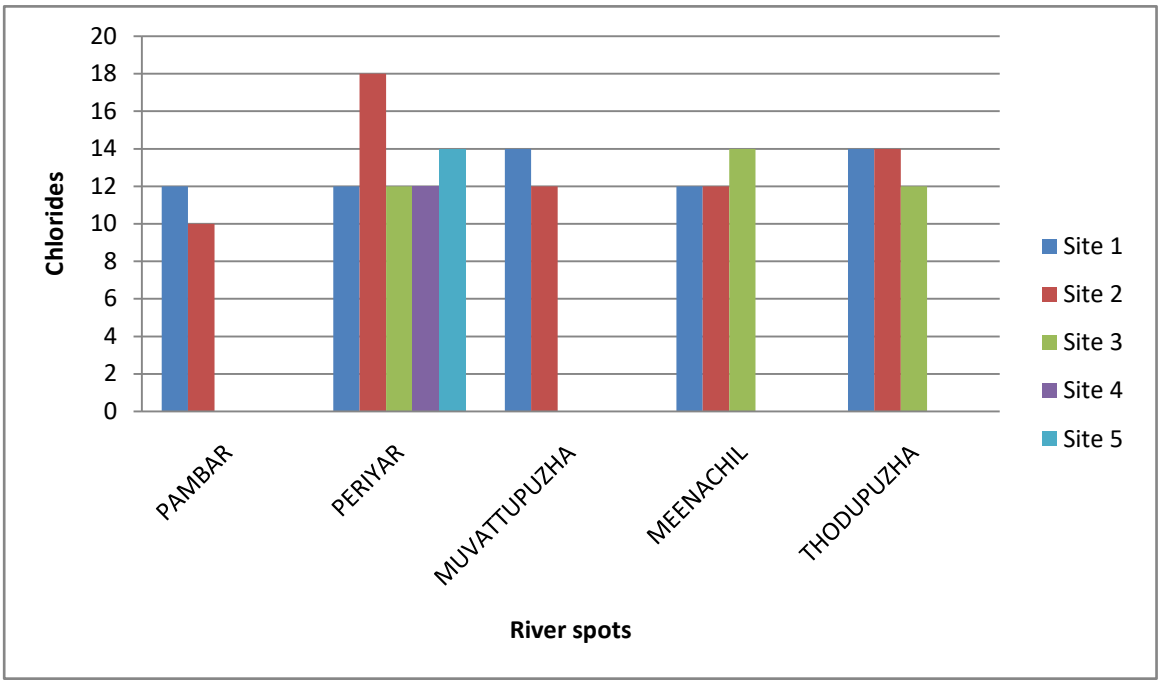


Table – 9 Nitrate of the water sample taken from the study area

RIVERS	SITES	NITRATES
PAMBAR	Chinnar	1.461
	Kovilkkadavu	0.797
PERIYAR	Munnar	2.082
	Irumbupalam	0.753
	Thekkady	1.240
	Vandiperiyar	1.594
	Upputhura	2.126
MUVATTUPUZHA	Kacheritazath	4.06
	Kaliyar	1.018
MEENACHIL	Theekoy	0.765
	Erattupetta	1.344
	Pala	1.789
THODUPUZHA	Moolamattam	1.594
	Mrala	1.639
	Thodupuzha	0.256

Figure – 8 Nitrate amount of the water sample taken from the study area

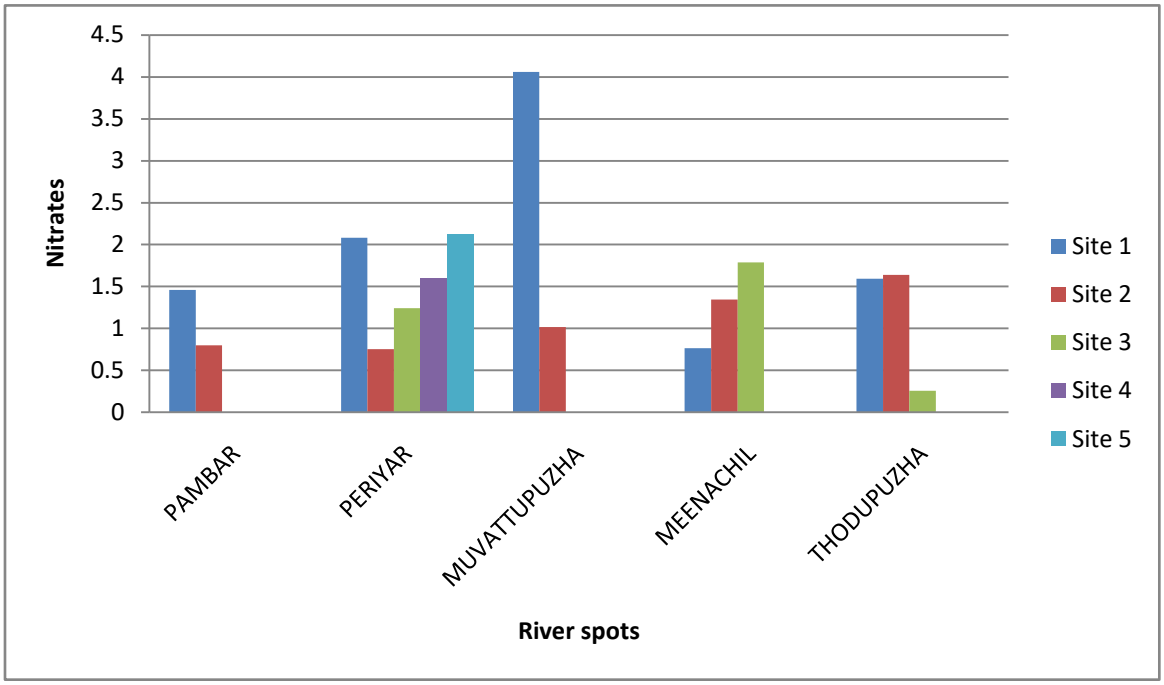


Table – 10 Iron of the water sample taken from the study area

RIVERS	SITES	IRON
PAMBAR	Chinnar	0.61
	Kovilkkadavu	0.71
PERIYAR	Munnar	0.47
	Irumbupalam	0.68
	Thekkady	0.46
	Vandiperiyar	0.36
	Upputhura	0.34
MUVATTUPUZHA	Kacheritazath	0.01
	Kaliyar	0.28
MEENACHIL	Theekoy	0.30
	Erattupetta	0.35
	Pala	0.42
THODUPUZHA	Moolamattam	0.11
	Mrala	0.12
	Thodupuzha	0.2

Figure – 9 Iron of the water sample taken from the study area

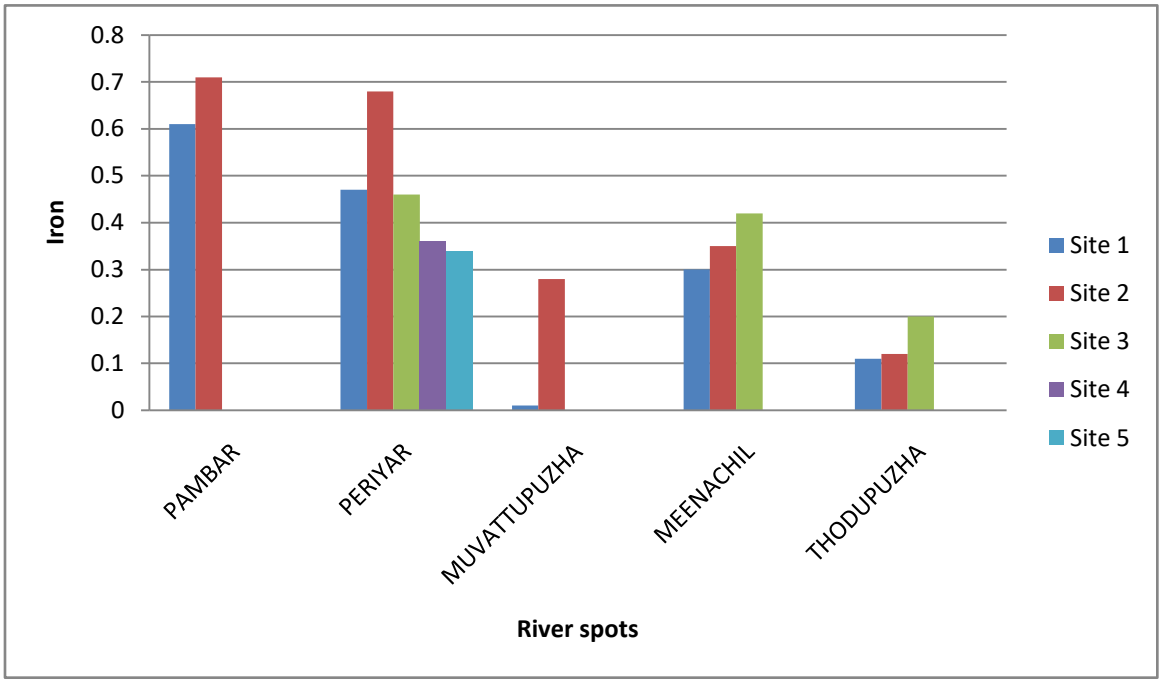


Table – 11 Total coliform of the water sample taken from the study area

RIVERS	SITES	TOTAL COLIFORM
PAMBAR	Chinnar	11000
	Kovilkkadavu	4600
PERIYAR	Munnar	2100
	Irumbupalam	2400
	Thekkady	1500
	Vandiperiyar	430
	Upputhura	11000
MUVATTUPUZHA	Kacheritazath	11000
	Kaliyar	11000
MEENACHIL	Theekoy	1600
	Erattupetta	4400
	Pala	11000
THODUPUZHA	Moolamattam	2400
	Mrala	1200
	Thodupuzha	11000

Figure – 10 Total coliform of the water sample taken from the study area

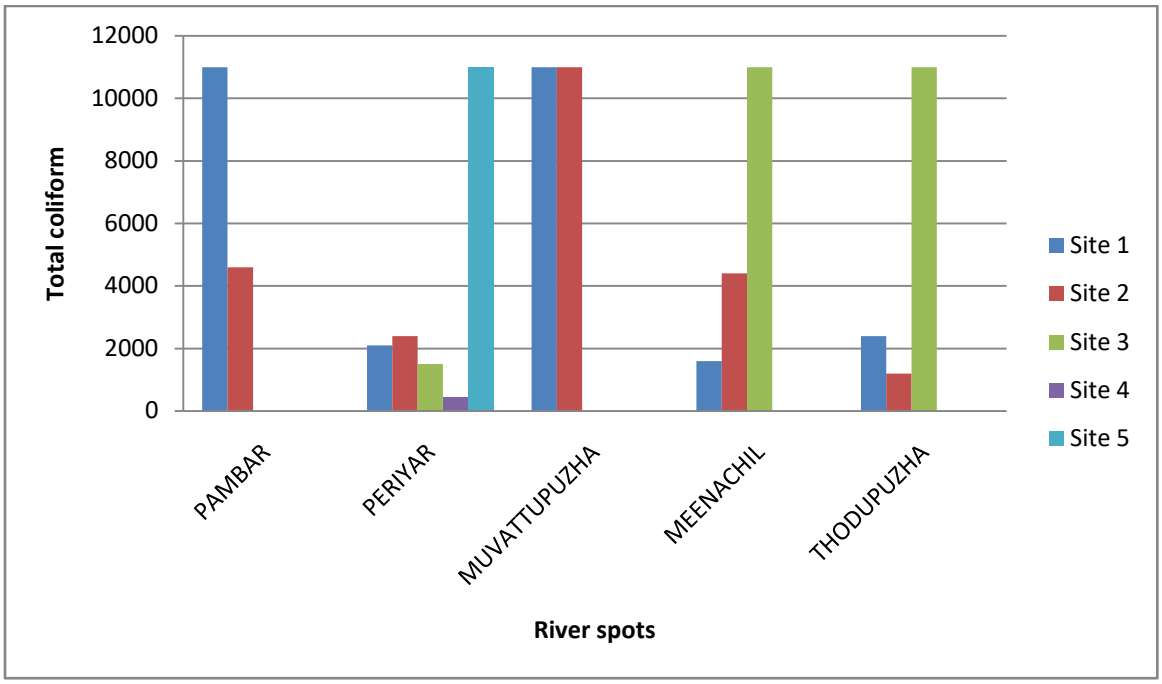


Table – 12 Fecal coliform of the water sample taken from the study area

RIVERS	SITES	FAECAL COLIFORM
PAMBAR	Chinnar	NIL
	Kovilkkadavu	360
PERIYAR	Munnar	200
	Irumbupalam	440
	Thekkady	90
	Vandiperiyar	NIL
	Upputhura	420
MUVATTUPUZHA	Kacheritazath	230
	Kaliyar	2100
MEENACHIL	Theekoy	90
	Erattupetta	100
	Pala	300
THODUPUZHA	Moolamattam	110
	Mrala	200
	Thodupuzha	430

Figure – 11 Fecal coliform of the water sample taken from the study area

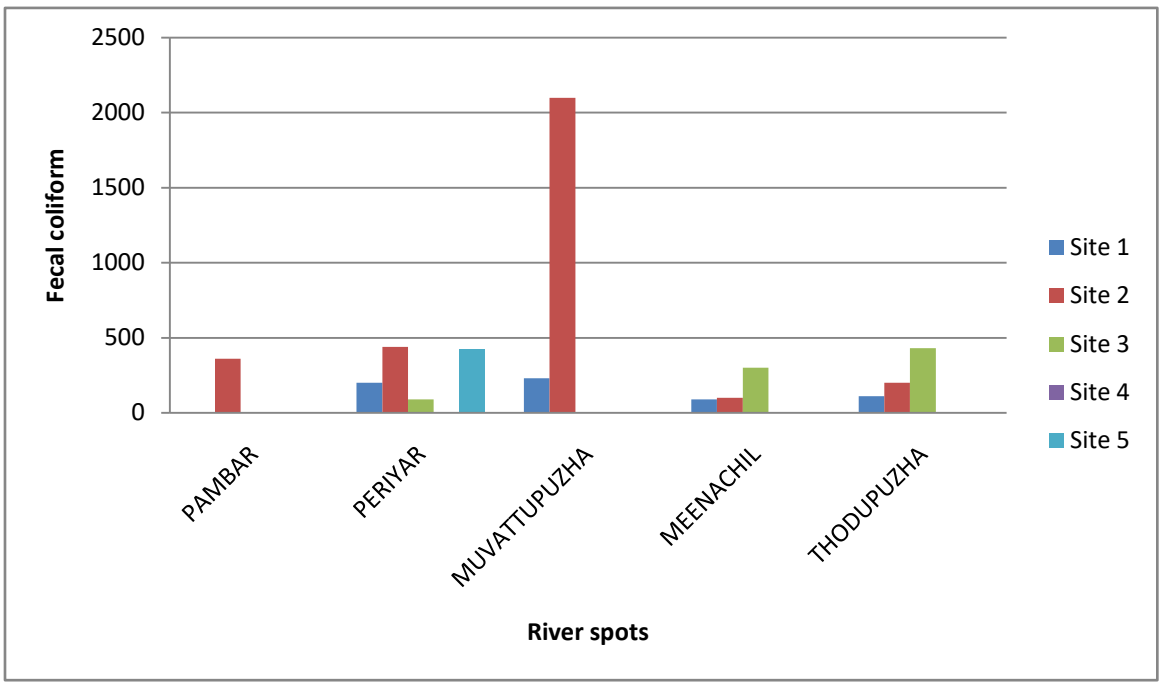
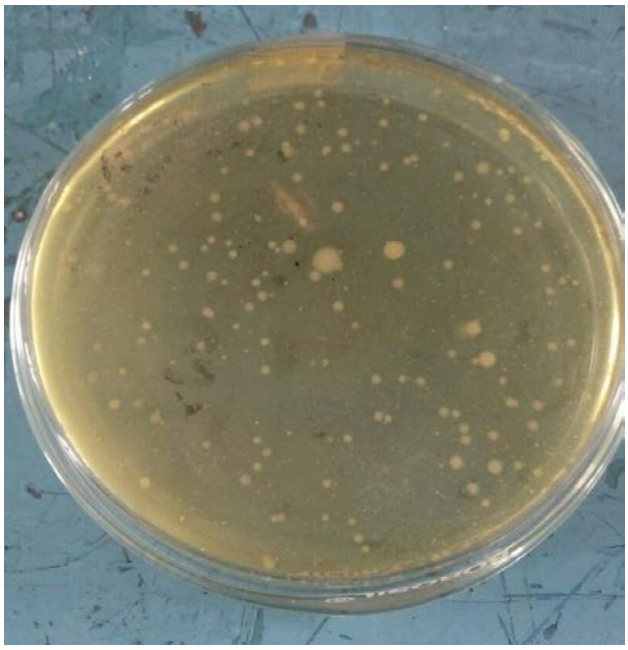


Figure -15 Streak plate showing the presence of E.coli colonies



4. Conclusion

Water is an essential requirement of human life and activities associated with industry, agriculture, and others and consider it as one of the most delicate parts of the environment. Thus, the water quality is affected by a wide range of natural and human influence.In the present study, the water quality of various river sites of Kerala is generated.All the river water

showed slightly acidic nature throughout the sampling points except the Kacheritazath water sample. It is found that the higher COD rate is present in Thekkady river site. The coliform bacterial content is the most founded problem among all the samples. The total coliform is higher in sites namely Upputhura, Kaliyar, Thodupuzha. The faecal content is higher in Kaliyar water sample. Kacheritazath, Chinnar, Pala and Since this river water is used for drinking and other domestic purposes it must be the urgently processed or chlorinated before sup plying.

5. References

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