# A study on the microbiological pollution of Achankovil river basin during 2018

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**Abstract**

Achankovil river is one of the famous rivers in Kerala that is influenced qualitatively by the famous Sabarimala pilgrimage. The present study focuses to analyze microbial contamination in 8 selected stations along the river basin. Total plate count and E.coli is analysed monthly for a period of one year during 2017-18. Monthly analysis shows that TPC load is ubiquitous all along the river and monsoon enhances it considerably. Faecal contamination by virtue of the presence of *E.coli*, the pathogenic coliform, is prevalent although the study period. Values as high as $16x10^4$cfu/ml TPC was recorded at Konni station during South West Monsoon of 2018. In annual assessment the highest *E.coli* count was found during October 2017. It shows the occurrence of maximum *E.coli* count during post monsoon season which depicts the human intervention in water quality during Sabarimala pilgrimage season. The study shows that Achankovil River water is highly contaminated. Also, prevalence of *E.coli* during other seasons indicates continuous entry of toilet wastes to the river. Breach of sanitary integrity is one important aspect that influences bacterial contamination of river water and hence it is high time to take preventive measures to safeguard the bacteriological quality of the precious water resource. Along with preventive measures, continuous awareness programmes must be devised for protection of the river.

Key words: Achankovil, Total Plate Count, *E.coli*, river basin

## Introduction

Lack of clean water and sanitation is the second most important risk factor in terms of global burden of disease after malnutrition (UNICEF, 2013). Microbial pollution is the foremost problem faced by global fresh water bodies and the situation is not different for Kerala Rivers. Due to high population density, many of the Kerala rivers suffocate with sewage contamination. Coliforms are major contributors that deteriorate the water quality of water bodies making them even unsuitable for recreation. As a result use of fresh water bodies become the source of water borne diseases. The most important microbial diseases transmitted through water are typhoid fever, paratyphoid fever, amoebic dysentery, bacillary dysentery, cholera and infectious hepatitis. Direct opening of septic tank valve to water bodies, discharge of septic tank waste from flats and other household, municipal sewages, cow dung run off, direct disposal and run off of other animal faeces etc are the major organic pollution faced by water bodies in Kerala. Microorganisms also enter into natural waters from air, soil, organic wastes, dead plants and animals etc (Yana *et al.*, 2015; Taye *et al.*,

2015). In this context continuous monitoring and evaluation of micobial quality of river water has become imminent demand to safeguard the primary health of people inhabited in the river basins.

Achankovil river is one among 44 rivers in Kerala that flourishes the life of people in Kollam, Pathanamthitta and Alappuzha districts. The river that lies between 76°25′–76°75′E and 8°75′–9°5N has a drainage area of 1484 $km^2$ with a total length of 128 km with an annual average discharge of about 1.5 $km^2$ $year^{-1}$. It is bounded by hills on three sides on the south (Fig. 1). The main source of Achankovil is at Pasukidamettu, Rishimalai, and Ramakkalteri streams originating from Devarmalai of Western Ghats. The land lies at a height of 20–120 m a.s.l. The climate of the area is characterized by semiarid tropical climate with a mean temperature of 25°C. The area receives an annual rainfall of 2000–5000 mm. The rainfall increases from south to north. The area is influenced by two monsoons, the Southwest Monsoon (June–September) and the Northeast Monsoon (October–December). Plantation and agriculture activities are intense in these regions. The area under forest cover is estimated to be 28% of the total area (i.e. 415.52 $km^2$) in this basin. Many sacred temples are present on the bank of the river and a lot of devotees and during the pilgrimage season of Sabarimala people even from other states and countries often visit Achankovil temple situated in the upstream of Achankovil river. The water quality is disturbed by various anthropogenic activities by the population living near the river (Prakasan and Joseph, 2000). Many thousands of people are living at the bank of River either. Hence the human intervention to the river is high and the present work aims to monitor microbial quality of selected segments of Achankovil River for a period of 12 months.

**Materials and Methods**

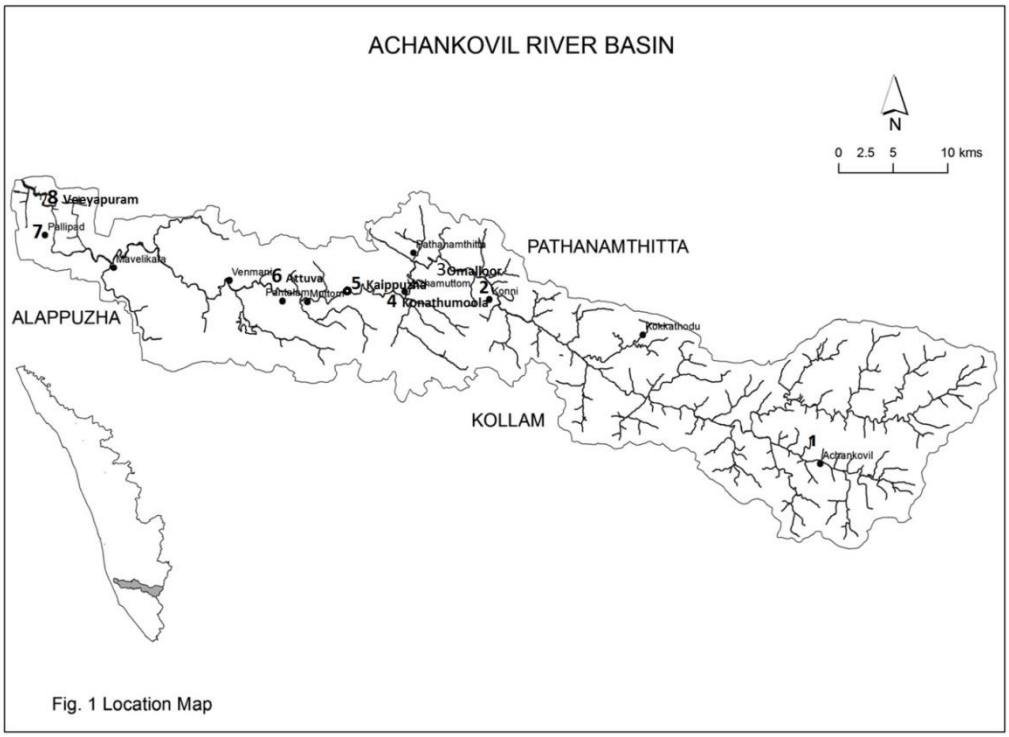



Fig. 1 Location Map

Representatively, 8 stations from origin to end are selected for the present study. Stations selected were Achankovil, Konni, Omalloor, Konathumoola, Kaippuzha, Attuva, Pallippad and Veeyapuram (Fig. 1).

Samples were collected for a period of one year from October 2017 to September 2018. *E.coli* and Total plate count (TPC) were enumerated during the monthly sampling. Collections were made in three seasons such as North East monsoon (October to December), Premonsoon (January to May) and South West monsoon (June to September). During the collection period, Kerala had faced the most devastating flood in August 2018.

Sterilized glass bottles were used for sample collection. The samples are kept in icebox after labeling and transported to the laboratory for the analysis within six hours of collection. The analysis was done at CEPC, Kollam. *E.coli* was counted as MPN/100ml and the TPC by CFU/ML by the reference method, IS: 1622-1981(EDITION 2.4) 2003-2005 and the values are expressed in terms of Mean ±SD.

**Results of analysis**

**Distribution of Total plate count**

Total plate count is the enumeration of total aerobic and mesophilic organisms that includes bacteria, yeast, mold and fungi.

Table 1. **Monthly distribution of TPC in Achankovil river basin during 2017-2018**

Unit: CFU/ml

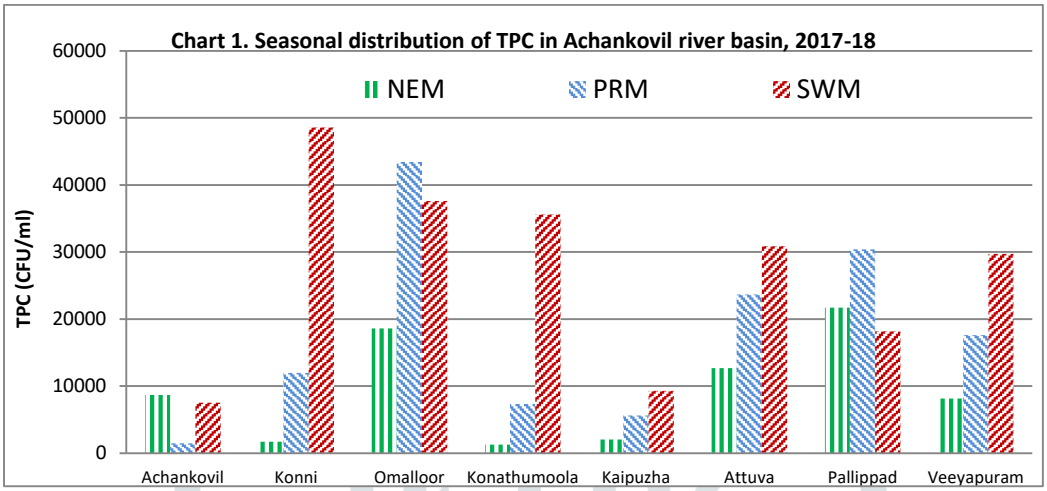
| | Achankovil | Konni | Omalloor | Konathu moola | Kaippuzha | Attuva | Pallippad | Veeya puram | Mean ± SD |
|---|---|---|---|---|---|---|---|---|---|
| Oct | $12x10^2$ | $16 x10^2$ | $9 x10^2$ | $6.1 x10^2$ | $4.2 x10^2$ | $31 x10^2$ | $11 x10^2$ | $40 x10^2$ | $16.2 x10^2 \pm 12.7 x10^2$ |
| Nov | $18 x10^2$ | $23 x10^2$ | $19 x10^2$ | $11 x10^2$ | $15 x10^2$ | $13 x10^3$ | $13 x10^3$ | $12 x10^3$ | $58.3 x10^2 \pm 56.8 x10^2$ |
| Dec | $23 x10^3$ | $12 x10^2$ | $53 x10^3$ | $21 x10^2$ | $42 x10^2$ | $22 x10^3$ | $51 x10^3$ | $85 x10^2$ | $20.63 x10^3 \pm 21.1 x10^3$ |
| Jan | $9.8 x10^2$ | $19 x10^2$ | $52 x10^3$ | $77 x10^2$ | $49 x10^2$ | $34 x10^3$ | $39 x10^3$ | $37 x10^3$ | $22.2 x10^3 \pm 20.4 x10^3$ |
| Feb | $11 x10^2$ | $11 x10^3$ | $49 x10^3$ | $90 x10^2$ | $18 x10^2$ | $20 x10^3$ | $23 x10^3$ | $29 x10^{23}$ | $17.99 x10^3 \pm 15.99 x10^3$ |
| Mar | $18 x10^2$ | $20 x10^3$ | $47 x10^3$ | $90 x10^2$ | $14 x10^2$ | $68 x10^2$ | $29 x10^3$ | $16 x10^3$ | $16.4 x10^3 \pm 15.6 x10^3$ |
| April | $13 x10^2$ | $15 x10^3$ | $68 x10^3$ | $10 x10^3$ | $21 x10^2$ | $85 x10^2$ | $26 x10^3$ | $15 x10^2$ | $15.4 x10^3 \pm 17.8 x10^3$ |
| May | $23 x10^2$ | $12 x10^3$ | $12 x10^2$ | $11 x10^2$ | $18 x10^3$ | $49 x10^3$ | $35 x10^3$ | $45 x10^2$ | $82.5 x10^3 \pm 54.7 x10^3$ |
| June | $27 x10^3$ | $16 x10^4$ | $14 x10^4$ | $14 x10^4$ | $34 x10^3$ | $51 x10^3$ | $42 x10^3$ | $66 x10^3$ | $14.7 x10^3 \pm 15.1 x10^3$ |
| July | $16 x10^2$ | $13 x10^3$ | $90 x10^2$ | $8 x10^2$ | $17 x10^2$ | $40 x10^3$ | $18 x10^3$ | $34 x10^3$ | $98.4 x10^2 \pm 10.8 x10^3$ |
| Aug | $7 x10^2$ | $20 x10^3$ | $9.8 x10^2$ | $11 x10^2$ | $9.7 x10^2$ | $29 x10^3$ | $12 x10^3$ | $14 x10^3$ | $98.4 x10^2 \pm 10.8 x10^3$ |
| Sep | $9 x10^2$ | $14 x10^2$ | $4.7 x10^2$ | $4.6 x10^2$ | $5.6 x10^2$ | $35 x10^2$ | $7.1 x10^2$ | $50 x10^2$ | $16.3 x10^2 \pm 16.9 x10^2$ |
| | **Annual mean ± SD** | | | | | | | | **$18.8 x10^3 \pm 21.2 x10^3$** |

TPC broadly varied from $4.2x10^2$cfu/ml at Kaippuzha during October 2017 to $16x10^4$ cfu/ml at Konni during June 2018. Annual mean value of TPC was $18.8 x10^3 \pm 21.2 x10^3$cfu/ml.

Table 2. **Seasonal variation of Mean and Standard Deviation of TPC in Achankovil river basin during 2017-18**

| | Achankovil | Konni | Omalloor | Konathu moola | Kaippuzha | Attuva | Pallippad | Veeyapuram |
|---|---|---|---|---|---|---|---|---|
| | Mean ± SD | | | | | | | |
| NEM | $86.7x10^2 \pm 12.4 x10^2$ | $17x10^2 \pm 5.6 x10^2$ | $18.6x10^3 \pm 29.8 x10^3$ | $12.7x10^2 \pm 7.6 x10^2$ | $20.4x10^2 \pm 19.5 x10^2$ | $12.7x10^3 \pm 94.5 x10^2$ | $21.7x10^3 \pm 26.1 x10^3$ | $81.7x10^2 \pm 40.1 x10^2$ |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| PRM | $15x10^2$± $5.5 x10^2$ | $11.98x10^2$± $66 x10^2$ | $43.4x10^3$± $25.0 x10^3$ | $73.6x10^2$± $35.9 x10^2$ | $56.4x10^2$± $70.5 x10^2$ | $23.7x10^3$ $17.9 x10^3$± | $30.4x10^2$± $65.4 x10^2$ | $17.6x10^2$± $15.3 x10^2$ |
| SWM | $75.5x10^2$± $12.9 x10^2$ | $48.6x10^3$± $74.7 x10^3$ | $37.6x10^3$± $68.4 x10^3$ | $35.6x10^3$± $69.6 x10^3$ | $93.1x10^2$± $16.5 x10^3$ | $30.9x10^3$± $20.3 x10^3$ | $18.2x10^3$± $17.4 x10^3$ | $29.8x10^3$± $27 x10^3$ |




Seasonal mean value fluctuated between $12.7x10^2$±$7.6 x10^2$ during North East Monsoon at Konathumoola and $48.6x10^3$±$74.7 x10^3$ during South West Monsoon at Konni. During North East Monsoon the mean values varied from $12.7x10^2$±$7.6 x10^2$ at Konathumoola to $21.7x10^3$±$26.1x10^3$ at Pallippad. During premonsoon period, the count ranged from $15x10^2$±$5.5 x10^2$ at Achankovil to $43.4x10^3$± $25.0 x10^3$ at Omalloor and during South West Monsoon period from $75.5x10^2$±$12.9 x10^2$ at Achankovil to $48.6x10^3$± $74.7 x10^3$ at Konni (Table 2 and Chart 1).

Table 3. **Monthly distribution of *E.coli* in Achankovil river basin during 2017-2018**

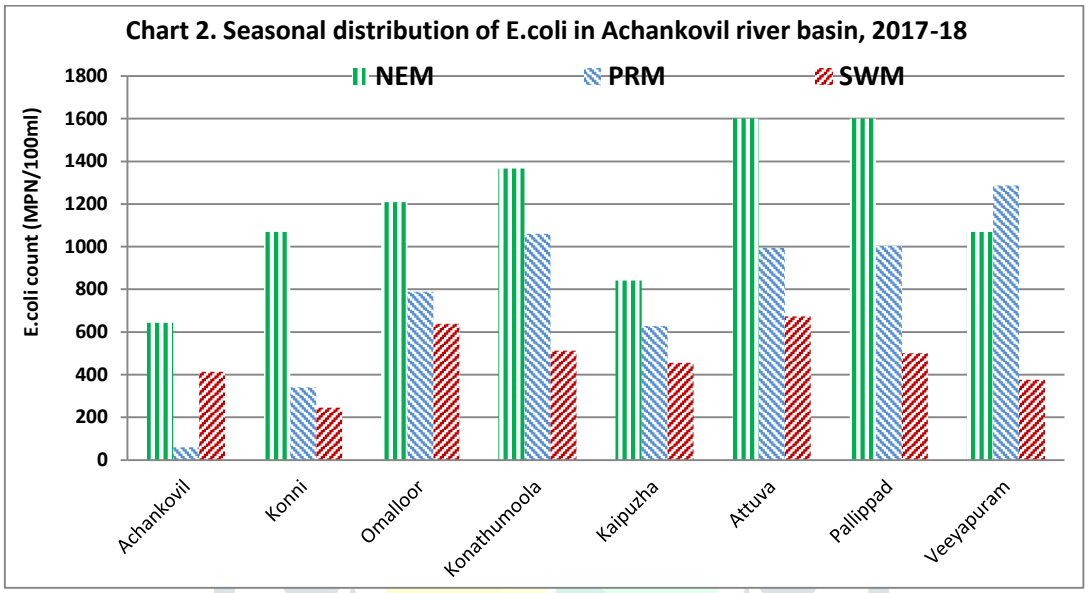
| | Achankovil | Konni | Omalloor | Konathumoola | Kaipuzha | Attuva | Pallippad | Veeyapuram | Mean ±SD |
|---|---|---|---|---|---|---|---|---|---|
| Oct | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | **1600±0** |
| Nov | 110 | 1600 | 426 | 1600 | 900 | 1600 | 1600 | 1600 | **1180±618** |
| Dec | 220 | 9 | 1600 | 900 | 22 | 1600 | 1600 | 7 | **745±765** |
| Jan | 50 | 350 | 500 | 1600 | 300 | 1600 | 1600 | 1600 | **950±706** |
| Feb | 27 | 500 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | **1266±631** |
| Mar | 60 | 240 | 1600 | 1600 | 500 | 1600 | 212 | 1600 | **927±730** |
| April | 35 | 110 | 70 | 7 | 240 | 2 | 2 | 33 | **62±81** |
| May | 130 | 500 | 170 | 500 | 500 | 170 | 1600 | 1600 | **646±610** |
| June | 1600 | 900 | 1600 | 1600 | 1600 | 240 | 300 | 22 | **983±704** |
| July | 27 | 40 | 13 | 2 | >2 | 350 | 300 | 280 | **127±154** |
| Aug | 17 | 24 | 40 | 150 | 50 | 500 | 500 | 300 | **198±209** |
| Sep | 12 | 17 | 900 | 300 | 170 | 1600 | 900 | 900 | **600±564** |

*E.coli* count varied broadly from less than 2 MPN/100ml in July 2018 at Kaippuzha to 1600MPN/100ml in October 2017 at all stations and many other stations. Annual mean value of *E.coli* varied from 62±81MPN/100ml in April 2018 to 1600±0 MPN/100ml in October 2017.

**Table 4. Seasonal variation of Mean and Standard Deviation of *E.coli* count in Achankovil river basin 2017-18**

Unit: MPN/100ml

| | Achankovil | Konni | Omalloor | Konathu moola | Kaippuzha | Attuva | Pallippad | Veeyapuram |
|---|---|---|---|---|---|---|---|---|
| | Mean ± SD | | | | | | | |
| NEM | $6.4x10^2$ $\pm 8.3 x10^2$ | $10.7 x10^2$ $\pm 9.2 x10^2$ | $12.1 x10^2$ $\pm 6.8 x10^2$ | $13.7 x10^2$ $\pm 4 x10^2$ | $8.4 x10^2$ $\pm 7.9 x10^2$ | $16 x10^2$ $\pm$Nil | $16 x10^2$ $\pm$Nil | $10.7 x10^2$ $\pm 9.2 x10^2$ |
| PRM | 60±41 | $3.4 x10^2$ $\pm 1.7 x10^2$ | $7.9 x10^2$ $\pm 7.6 x10^2$ | $10.6 x10^2$ $\pm 7.6 x10^2$ | $6.3 x10^2$ $\pm 5.7 x10^2$ | $9.9 x10^2$ $\pm 8.3 x10^2$ | $10 x10^2$ $\pm 8.2 x10^2$ | $12.9 x10^2$ $\pm 7 x10^2$ |
| SWM | $4.1 x10^2$ $\pm 7.9 x10^2$ | $2.5 x10^2$ $\pm 4.4 x10^2$ | $6.4 x10^2$ $\pm 7.6 x10^2$ | $5.1 x10^2$ $\pm 7.4 x10^2$ | $4.6 x10^2$ $\pm 7.7 x10^2$ | $6.7 x10^2$ $\pm 6.3 x10^2$ | $5 x10^2$ $\pm 2.8 x10^2$ | $3.8 x10^2$ $\pm 3.7 x10^2$ |




*E.coli* count broadly fluctuated between 60±41 MPN/100ml at Achankovil during premonsoon 2018 and $16x10^2$±Nil MPN/100ml at Attuva and Pallippad during North East Monsoon 2017. It varied from 60±41MPN/100ml at Achankovil in premonsoon to $12.9x10^2$±7 $x10^2$ MPN/100ml at Veeyapuram during premonsoon, $2.45x10^2$±$4.4x10^2$MPN/100ml at Konni to $6.7x10^2$±$6.3x10^2$ MPN/100ml at Attuva during South West Monsoon and $6.4x10^2$±$8.3x10^2$ at Achankovil to 16 $x10^2$±Nil MPN/100ml at Attuva and Pallipad during North East Monsoon (Table 4 and Chart 2).

## Discussion

Total Plate Count, also termed as Total Viable Count (TVC), provides information on the number of aerobic bacteria present in a sample. In the present study all the samples showed the presence of TPC. The total plate count may include the indicator bacteria also. Coliforms are the major organisms in the indicator group and *E.coli* are the most dangerous bacteria which presence rules out the portability of water. Though the Total plate count was found to be higher in the river basin in all the stations throughout the rainy seasons, there is an increase in the count at Konni, Omalloor and Konathumoola, especially during South West monsoon. This could be attributed to the surface run off during the monsoon. However, *E.coli* count is seen elevated during

North East monsoon which indicated that Sabarimala pilgrimage adds to the fecal load in the river in the post south west monsoon period compared to other seasons. *E.coli* count is found increasing downstream till Attuva, remains stable at Pallippad and then decreases in the open water at the confluence area. The presence of *E.coli* in fresh water is due to disposal of sewage containing faecal contaminants in to the water body. In many parts of Achankovil river apart from the direct entry of toilet wastes and streams carrying toilet wastes, sanitary remains of Sabarimala pilgrimage substantially add to the overall faecal contamination. An earlier study also documented that the river water is polluted due to municipal sewages disposal and septic tank discharge which was unhealthy for human consumption (Mallika et al, 2017). According to WHO (2004), there should be no *E.coli* in 100ml sample, but here all the stations in all month exceeds the limit. The overall condition of bacteriological quality of the present Achankovil river shows that the water is unfit for human consumption.

TPC range from $1.1x10^3$/ml before pilgrimage season to $9.4x10^3$/ml during pilgrimage (North East monsoon) was reported by Jalal and Sanalkumar in 2012. This proves that anthropogenic interference during that period is the major cause of bacteriological pollution of Achankovil river. Study by Jalal and Sanalkumar (2012) agrees to this observation. However, a study by Sanalkumar et al (2013) found the overall fecal coliform count of various stations in the river as 12.41 x $10^2$ during summer season. This shows the continuous input of fecal contaminants in to the river. Breach of sanitary integrity is one important aspect that influences bacterial contamination of river water. High coliform counts due to anthropogenic activities of pilgrimage were reported from the adjacent Pampa river also by Koshy (2001). Usharani et al (2010) reported $17.5x10^2$ MPN/100ml faecal coliforms from Noyyar river in Tamil Nadu. Comparatively lesser *E.coli* counts (01 to 07MPN/100ml) were reported from Indrayani river, Pune (Jadhav et al, 2013). Values as high as 279 to 3800 CFU/100ml were also reported by Medha and Hysko (2014). *E.coli* count of 225.0 MPN/100ml was observed in surface waters of Coorg and Wynad Districts in Western Ghats during summer 2011 by Divya and Chauhan (2016). In contrast to the present study, higher concentration of fecal coliform during summer season attributed to low water level, high organic matter, low bacterivores and optimum growth-supporting nutrient that favor bacterial growth has been reported from Chaliyar river in Kerala by Jithesh and Radhakrishnan (2015). Oommen (2008) also reported in their study on Pampa river that during pre-monsoon and post-monsoon seasons, the quantum of river water decreased and the bacterial contamination increased. This shows that unlike other rivers, contaminants from Sabarimala pilgrimage is the decisive contributor to the *E.coli* count in Achankovil river.

**Conclusion**

Monthly and seasonal analysis of bacteriological quality of Achankovil river basin shows high bacterial pollution is prevalent in the river in its full stretch. The river at Konni area showed the highest total plate count ($16x10^4$cfu/ml) during June 2018. Seasonal mean values also showed the maximum TPC

($48.6x10^3 \pm 74.7x10^3$cfu/ml) during South West Monsoon at Konni. Maximum *E.coli* count was found at North East Monsoon season, especially during pilgrimage season, followed by Premonsoon and South west Monsoon. In contrast, the highest TPC count was obtained during South West Monsoon period. However, annual mean value of *E.coli* was the highest during North East Monsoon period 2017. This indicates that Sabarimala pilgrimage is the major contributor to the fecal contamination in the river in the post south west monsoon period especially in downstream stations. Faecal contamination seen during other seasons indicates the continuous entry of toilet wastes to the river. The present study clearly shows that the river water is bacteriologically polluted continuously by municipal and domestic sources. Breach of sanitary integrity is one important aspect that influences bacterial contamination of the river and hence it is high time to take preventive measures to safeguard the quality of the precious water resource. Pollution of river water can be reduced by providing proper sanitation facility to pilgrims and also by proper treatment of municipal sewage and domestic wastes. The water quality is depleting rapidly with the change in human life style and hence awareness programmes for the people in the river basin must be devised for protection of the river. This is particularly relevant as a public health initiative to prevent the impending possibility of water borne diseases in the basin.

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