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# Indicator Bacterial Assessment of Kuwano River, Lifeline of Basti City, Uttar Pradesh, India

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**Abstract**
Kuwano river, a vital lifeline for Basti District, Uttar Pradesh, India, has faced increasing pressures due to rapid urbanization, industrialization and population growth. These anthropogenic activities have significantly impacted the river's water quality, raising concerns about public health. To comprehensively evaluate the current state of the Kuwano River, this study employed the Most Probable Number (MPN) test to assess indicator bacteria levels in water samples collected from Ahmat Ghat in Basti City. The results revealed alarming levels of microbial contamination, rendering the river water unsuitable for both drinking and bathing. The findings from this research provide valuable baseline data for scientists, professors, policymakers and engineers to develop effective strategies for protecting and restoring the Kuwano River's water quality. By understanding the relationship between indicator bacteria and activities, informed decisions can be made to safeguard this nationally and internally water resource.

**Key Words:** Kuwano River, Indicator Bacteria, Water quality, Basti district

## Introduction

Water is a vital source of power and life, and its quality directly impacts on human health (Bhutiani et al., 2016). Unlike other substances, water's exceptional properties enable it to exist in all three states- solid, liquid, and gas- at temperatures and pressures remarkably close to Earth's surface. This unique property is crucial for sustaining life on our planet (Kumari et al., 2023). As one of the most valuable natural resources, water is crucial for a nation's socioeconomic development. Rivers, in particular, serve as the lifeblood of many communities, providing a vital source of water for various needs. However, water shortages and declining water quality are prevalent issues in both developed and developing nations, especially in the context of sustainable.

Rivers suffer significant damage from human activities such as drinking water extraction, recreation, irrigation, economic exploitation, and the disposal of industrial, municipal, agricultural, and domestic waste (Sharma & Madan, 2019). India boasts a vast network of large, medium, and minor rivers with a combined catchment area of 252.8 million hectares (Basu et al. 2016). The river Kuwano originates in the Bahraich District of Indian state of Uttar Pradesh (UP), India. It flows through the districts of Gonda and Siddharth Nagar before entering Basti District at Chandhokha hamlet in Ramnagar block. The streams Bisuni, Manvar, and Kathinaya in the Basti district feed the Kuwano, which flows from northwest to southeast. After Travelling approximately 55 kilometers through district boundaries, it enters the Kudaraha block near Banpur. In the Gorakhpur district, it merges with the Ghaghara River near the village of Shahpur. The Kuwano river is essential to the city's existence (Hasan & Tewari, 2023). It is considered the lifeline of Basti District's (U.P.) (Kushwaha et al. 2022). Numerous contaminants enter the river system, degrading water quality and harming the aquatic life that lives within the riverine ecosystem (Saxena & Singh, 2020). The primary causes of India's impending freshwater crisis are poor water resource management and environmental deterioration (Kumar et al., 2010). The extremely contaminated river is the main source of industrial waste, municipal sewage, and chemical fertilizer residues that are discharged untreated into waterways, rendering them unsafe for swimming or drinking. River pollution poses a serious health risk to millions of people, turning rivers into septic drains (Basu et al. 2016). According to D.R. Khullar (2006), water pollution is defined as alterations to the physical, chemical, and biological properties of water that may negatively impact aquatic life and humans. This contamination results from numerous and unforced human activities.

According to estimates from the World Health Report 1996, "Fighting Disease, Fostering Development", up to 80% of all skin disorders and illnesses worldwide are caused by poor sanitation, contaminated water, or a lack of access to water. Approximately one in four people in developing nations have access to any form of sanitary facility, and three out of every five do not have access to safe drinking water. The worldwide conference on primary health care (Alma-Ata, 1978) listed eight components of primary health care, including the provision of an adequate quantity of safe water. The most significant vector of disease transmission is drinking water (Kulshrestha & Sharma, 2006; Singh et al., 2013). There are two perspectives regarding the use of bacteria as indicators of water quality: first, the presence of these bacteria can be interpreted as a sign of faecal contamination of the water, indicating the need to ascertain the cause, severity, and remediation measures; second, their presence can be seen as a warning sign of the possible health risks associated with faecal contamination. The risk of water-borne illnesses increases with the amount of indicator bacteria present and the degree of faecal contamination (Baghel et al., 2005). Human's primary concern is the quality of water because it directly affects human welfare. Aquatic ecosystem's water quality features result from a variety of physical, chemical, and biological interactions. When it comes to their age in terms of geology and geochemical makeup, water bodies like lakes, rivers, and estuaries are always changing. Human activity often upsets the dynamic balance of the aquatic system, resulting in pollution that drastically manifests as aquatic life, unpleasant taste and odour. All living things depend on freshwater that is safe, clean, and in sufficient quantities for survival, as well as for the smooth functioning of ecosystems, societies, and economies (Arora et al., 2018).

## Sample Collection

All water samples were collected on a single day (June 2024, from 8 AM to 10 AM). The samples were obtained in sterile glass bottles from eighteen distinct locations at Ahmat Ghat, Kuwano River (Latitude 26°46'56.44"N, Longitude 82° 42' 54.19"E), in Basti district, India. Water samples were taken 50 meters from both sides of the ghat and at a depth of 15 inches from the river surface. The first nine samples were collected from the left side of the bridge, where we designated sampling sites between two phases. The first phase included both banks of the river (left and right), and the second phase was the midpoint of the river. The samples from the left side of the river were labeled LA1 to LA3, LB1 to LB3, and LC1 to LC3, with LA2, LB2, and LC2 representing the midpoint of the river.

Second, nine samples were collected from the right side of the bridge, where we established the sampling site between two phases. The first phase encompassed both banks of the river (left and right), while the second phase was the midpoint of the river. The samples from the right side of the river were labeled RA1 to RA3, RB1 to RB3, and RC1 to RC3. Notably, RA2, RB2, and RC2 represented the midpoint of the river. All water samples were transported on ice to the laboratory and analyzed within 24 hours in the Department of Environmental Microbiology at Babasaheb Bhimrao Ambedkar University, Lucknow (Figure 1).

## Materials and Methods

The conventional Most Probable Number (MPN) method was employed to assess water quality. To detect total *coliforms* (TC), fecal *coliforms* (FC), and fecal *streptococci* (FS), samples were inoculated into MacConkey broth tubes and incubated for 48 hours at 37 ± 1ºC. Positive tubes were subsequently incubated at 44.5 ± 1ºC and subcultured in Brilliant Green Bile Broth (BGBB). After 48 hours of incubation, gas production in BGBB at 44.5 ± 1ºC indicated the presence of fecal *coliforms*. For the identification of fecal *streptococci*, water samples were inoculated into Azide Dextrose broth and incubated at 37.5 ± 1ºC for 24 to 48 hours. Following incubation, the number of tubes showing acid and gas production due to lactose fermentation was recorded. Finally, the MPN of coliforms in a 100 ml water sample was determined using the probability table (Macrady table-2). The total bacterial count from colony-forming units (CFU) was then calculated using the appropriate formula.

$$\text{cfu/ml} = \frac{number\ of\ colonies}{amount\ plated} \times dilution$$

(Baghel et al., 2005; Deepesh Kumar, 2013; Jiwintarum et al., 2018; Shahi et al., 2023).

## Results

After the assessment of samples from both left and right side of the Kuwano river, results were suggested as shown in the Table 1, Figure 1, 2, 3, 4 and 5. The data of *coliform* from the water samples taken from both sides of the Kuwano River indicate varying levels of contamination. On the left side, the highest levels of Total *Coliform* (TC), Fecal *Coliform* (FC), and Fecal *Streptococci* (FS) were found in samples LC3 and LA3, suggesting significant pollution, possibly from sewage discharge or agricultural runoff or ritual performance. The lowest contamination levels on this side were observed in sample LC2. Conversely, the right side of the river showed relatively lower contamination levels, with the highest TC, FC, and FS found in sample RA3, while the lowest levels were in samples RA2 and RC1. Overall, the left side of the river appears to be more polluted, indicating a need for targeted water quality improvement and pollution control measures.

**Discussion**

Levels of total *coliforms*, fecal *coliforms*, and fecal *streptococci* are critical indicators of potential contamination, particularly concerning human health risks. Fecal *coliforms* and fecal *streptococci* specifically signal fecal contamination and may suggest the presence of pathogenic microorganisms such as *Escherichia coli* (*E. coli*). In contrast, total coliforms indicate the potential presence of various disease-causing organisms (Cohen & Shuval, 1973). The presence of these bacterial loads suggests that anthropogenic activities are introducing contaminants into the Kuwano River from various sources, including domestic pollutants, untreated sewage discharge, biomedical waste, and small-scale industrial activities. Total *coliforms*, fecal *coliforms*, and fecal *streptococci* are considered indicators of fecal contamination in water (Arora et al., 2018; ji Kushwaha et al., 2021; Kumari et al., 2023b).

Coliform bacteria typically do not pose a direct threat to human health. However, they are monitored as indicator organisms to detect potential fecal contamination and associated health risks (Joshua Smith, 2008). Fecal matter is a source of potentially pathogenic bacteria and viruses. Therefore, the presence of fecal coliforms in water indicates a potential public health issue, such as gastroenteritis. This study is significant because freshwater is a finite resource, and its careful management is essential to meet the growing demand driven by rising living standards and population growth due to technological advancements (Singh & Choudhary, 2007).

The analysis of water samples from both sides of the Kuwano River reveals varying levels of contamination. The right side of the Kuwano River is chosen because it has a Hindu temple where people come to worship and perform rituals. These activities often involve throwing liturgical materials into the river, which contributes to pollution. The left side exhibited higher levels of Total *Coliform* (TC), Fecal *Coliform* (FC), and Fecal *Streptococci* (FS), particularly in samples LC3 and LA3, indicating significant pollution likely from sewage discharge or agricultural runoff. The lowest contamination on this side was in sample LC2. Conversely, the right side showed relatively lower contamination, with the highest levels in sample RA3 and the lowest in samples RA2 and RC1. Overall, the left side of the river is more polluted, highlighting the need for targeted water quality improvement and pollution control measures. The presence of total *coliforms,* fecal *coliforms*, and fecal *streptococci* are critical indicators of potential contamination, particularly concerning human health risks. These bacterial loads suggest that anthropogenic activities are introducing contaminants into the Kuwano River from various sources, including domestic pollutants, untreated sewage discharge, biomedical waste, and small-scale industrial activities. Monitoring these indicators is essential for detecting fecal contamination and associated health risks, such as gastroenteritis. This study underscores the importance of careful freshwater management to meet the growing demand driven by rising living standards and population growth due to technological advancements. The results can serve as a foundation for legislative changes aimed at improving water quality. The baseline data generated on the Kuwano River will be valuable for various management and assessment purposes for this site of national and international importance.

## Conclusion

The analysis indicates higher contamination on the left side of the Kuwano River, primarily from sewage and agricultural runoff. This highlights the need for targeted water quality improvements. The study underscores the importance of managing freshwater resources to meet growing demands and supports legislative changes for better water quality.

## Acknowledgement

Not Applicable

## Conflict of Interest

The authors collectively affirmed the absence of any conflicts of interest.

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**Table 1: The assessment of samples from both left and right side of the Kuwano river**

| **Sample Name** | **Total *Coliform* (organisms/100ml)** | **Faecal *Coliform* (organisms/100ml)** | **Faecal *Streptococci* (organisms/100ml)** |
|---|---|---|---|
| **LA1** | 300 | 200 | 20 |
| **LA2** | 200 | 80 | 35 |
| **LA3** | 500 | 350 | 80 |
| **LB1** | 400 | 200 | 20 |
| **LB2** | 280 | 90 | 35 |
| **LB3** | 300 | 135 | 40 |
| **LC1** | 500 | 280 | 100 |
| **LC2** | 110 | 50 | 20 |
| **LC3** | 900 | 350 | 170 |
| **RA1** | 200 | 100 | 20 |
| **RA2** | 110 | 40 | 35 |
| **RA3** | 900 | 400 | 50 |
| **RB1** | 200 | 100 | 20 |
| **RB2** | 150 | 90 | 35 |
| **RB3** | 500 | 150 | 50 |
| **RC1** | 150 | 50 | 10 |
| **RC2** | 200 | 50 | 20 |
| **RC3** | 350 | 100 | 50 |

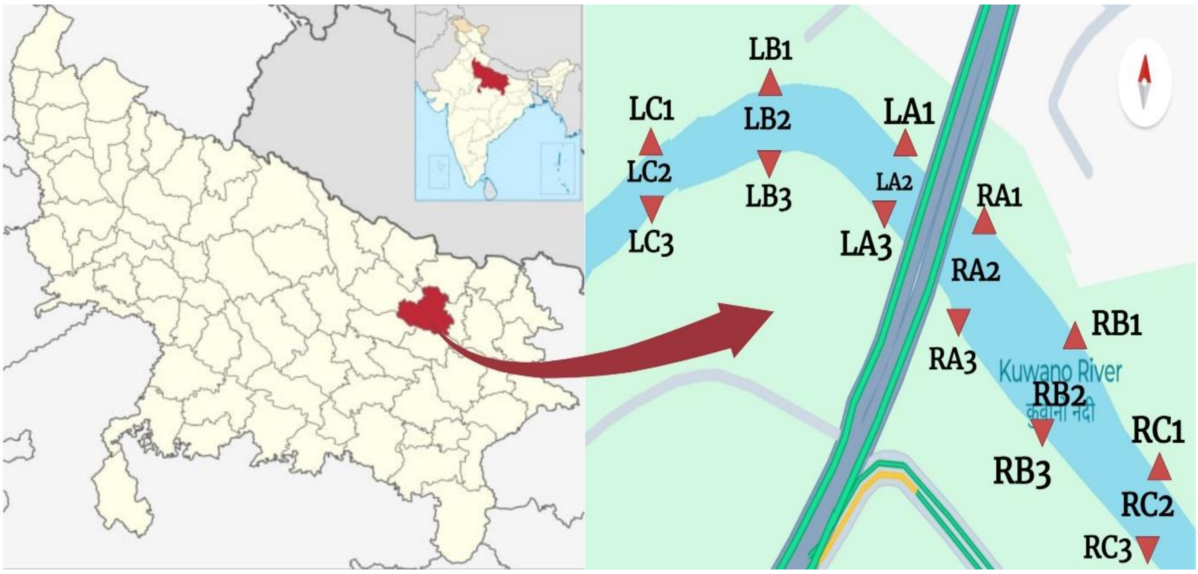


**Figure 1: Sampling site of the Kuwano River, Basti District, U.P., India (Latitude 26°46'56.44"N, Longitude 82° 42' 54.19"E)**

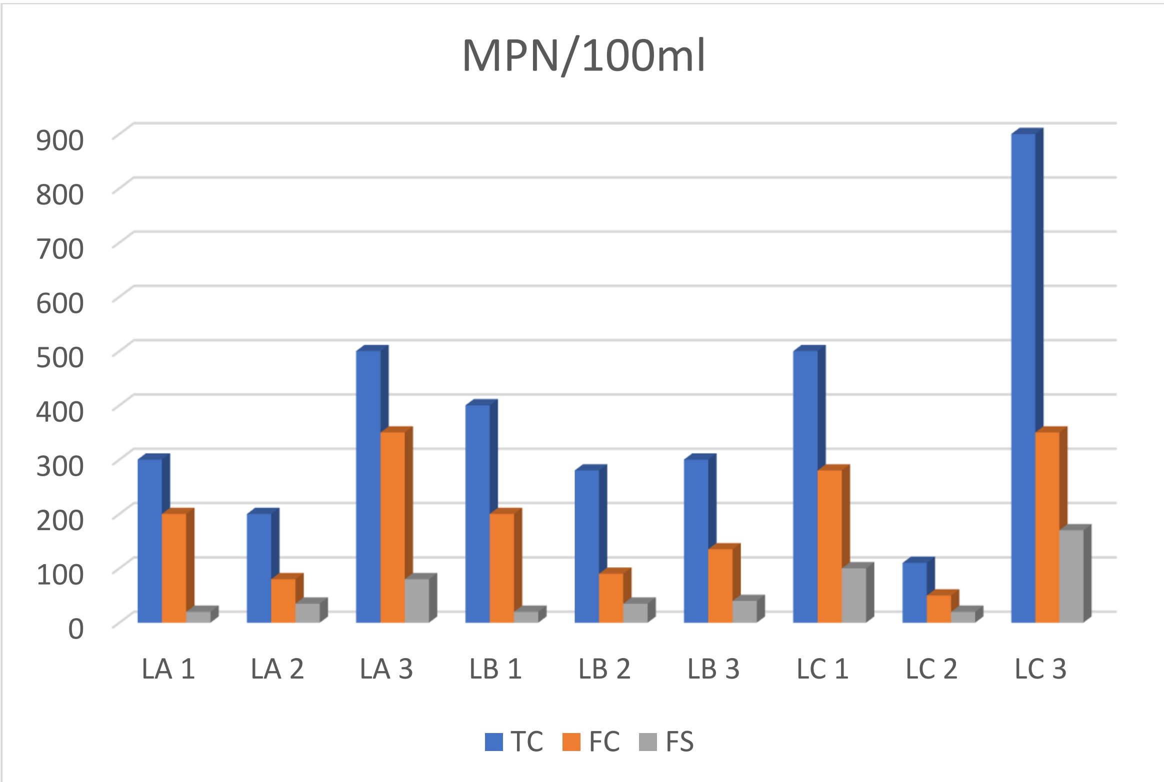


**Figure 2: Study area of Left Side of Ghat**

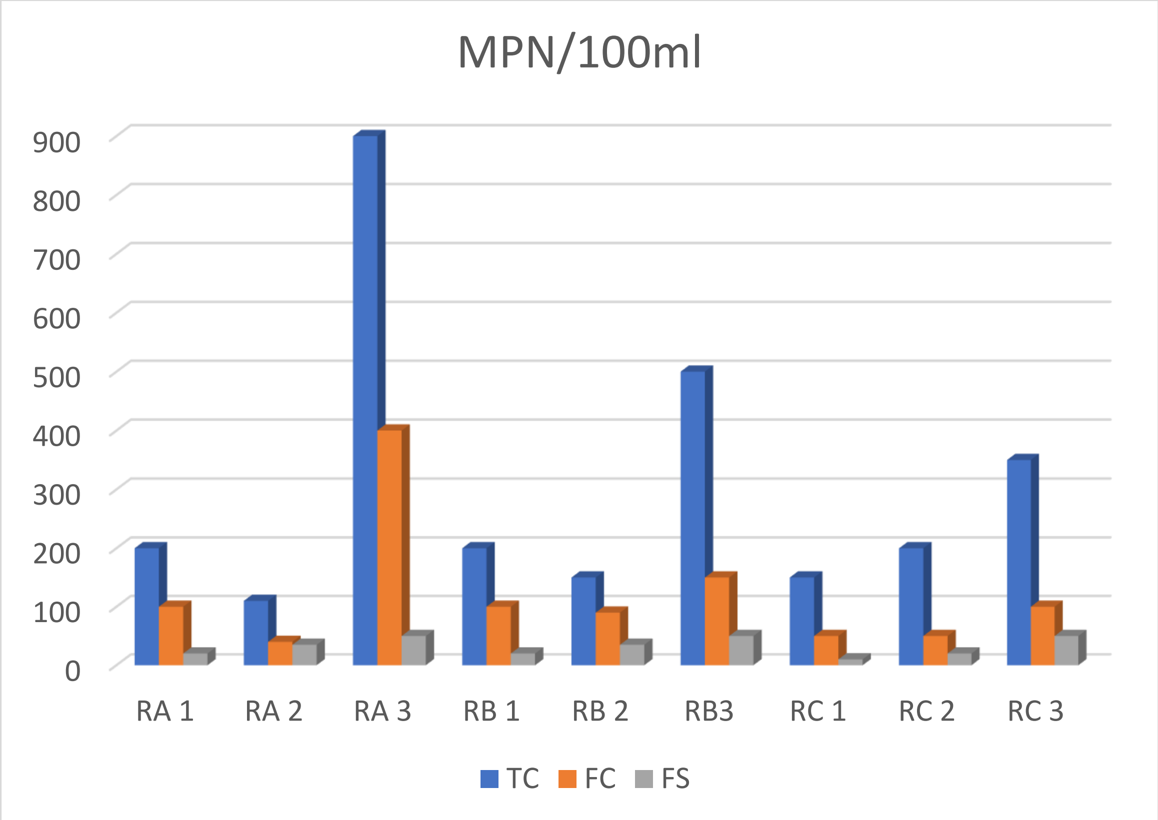


**Figure 3: Study area of Right Side of Ghat**

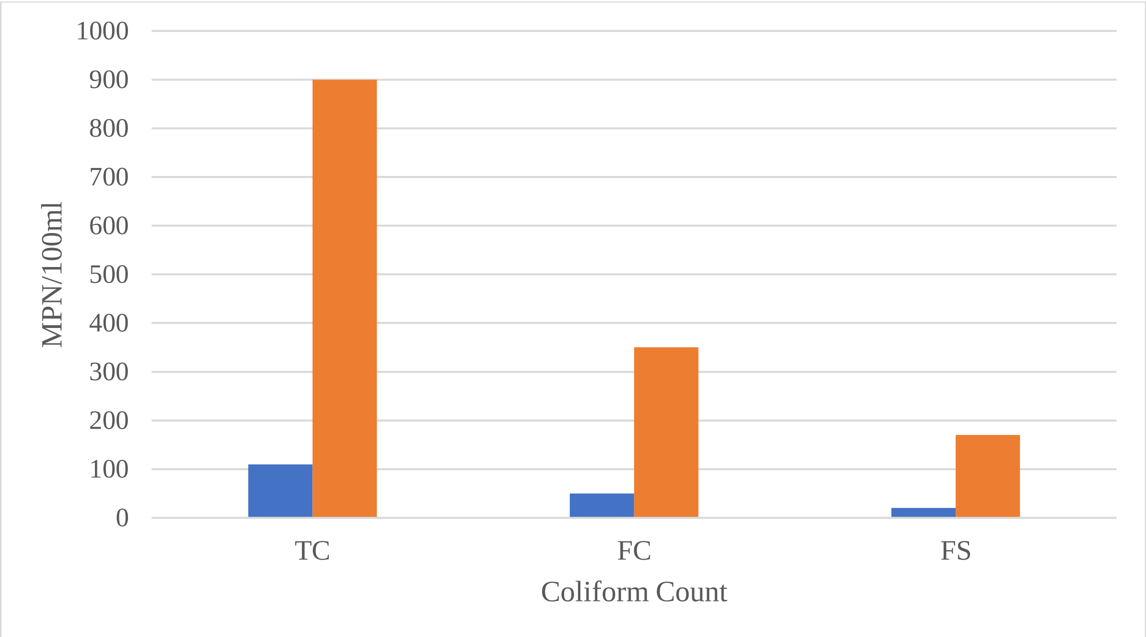


**Figure 4: Indicator Bacterial range of Left side of Kuwano Ghat**

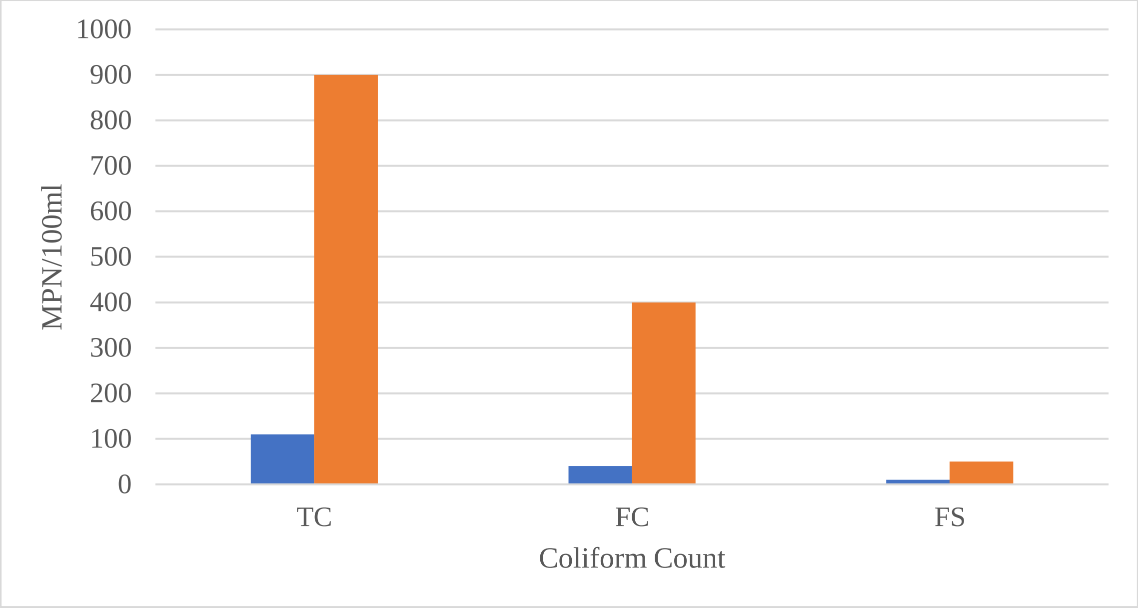


**Figure 5: Indicator Bacterial range of Right side of Kuwano Ghat**