# Detection of Pathogenic Bacteria in Water Bodies

Zummy Dahria Mohamed Basri
Politeknik Sultan Azlan Shah
Email: zummy.dahria@psas.edu.my

Raja Norazilla Raja Yunus
Politeknik Sultan Azlan Shah
Email: raja_norazilla@psas.edu.my

Sapinah Hadi
Politeknik Sultan Azlan Shah
Email: sapinah@psas.edu.my

**Abstract**
Water is one of the requirements for the existence of all living organisms. Although water is a critical necessity for life, it also poses a threat to human health and well-being because of its role in transmission and dissemination of infectious diseases. The problem of water pollution caused by the contamination of water sources with bacteria is one of the main factors contributing to the human health risk. The main aims of this paper is to detect the presence of pathogenic *E.coli*, *Salmonella spp*. and *Shigella spp.* in selected water bodies, including river, waterfall, pond and coastal. The highest *E.coli*, *Salmonella spp*. and *Shigella spp.* were detected in a pond in Perak with an average of $7.89x10^3$, $6.096x10^3$ and $3.876x10^3$ CFU/mL, respectively. However, the lowest concentrations of *E.coli* and *Salmonella spp*. were detected in a waterfall with mean of $2.5x10^1$ and $1.233x10^1$ CFU/mL, respectively. Surprisingly, no *Shigella* species was detected in the waterfall. The findings from this study indicated the occurrence of *E.coli*, *Salmonella spp.* and *Shigella spp.* in water environment that may pose a potential human health risk.
**KEYWORDS -** human health risk, pathogenic bacteria, water environment

## 1.0 Introduction

Water is an important source of human life. Clean water sources are indispensable for human use today. However, many water pollution has been reported since recently. Water pollution can result in various health risks to humans. Identified sources of water pollution are caused by human activities and natural events. Pollution from animal and human faeces contributes to water pollution in general. Microbial pollution in water originates from diverse sources such as effluent from wastewater treatment plant (WWTP), domestic waste, and effluent from large livestock farms (Rathi, et al., 2010). The main objective of this paper is to detect the presence of pathogenic *E.coli*, *Salmonella spp*. and *Shigella spp.* in selected water bodies, including river, waterfall, pond and coastal.

## 2.0 Literature Review

The wastes of humans and animals are the main sources of bacteria in the water. The pollution can come from runoff from livestock farms, pastures, chicken coops and other livestock companies. Additional sources might come from human activities such as seepage and discharge from septic tanks and

sewage treatment. These sources can enter and absorb into water bodies such as lakes, rivers, seas and so on. *Escherichia coli* (*E.coli*) is gram-negative bacteria and a type of fecal coliform bacteria commonly found in the intestines of human and animals. Diarrhea caused by pathogenic *E.coli* is one of the main diseases associated with contaminated water supply and poor sanitation (Rathi, et al., 2010). *Salmonella* is one of the pathogenic bacteria commonly present in water and wastewater. Salmonella is a bacterium that causes infection known as salmonellosis. Salmonellosis has become a major problem in developed and developing countries, which represents a serious threat to public health resulting in considerable economic consequences in many parts of the world (Abatcha, et al., 2014). CDC (2014) reported that *Salmonella spp.* contributes 380 deaths, 19,000 hospitalization and over 1 million illnesses in United States, yearly.

As well as Salmonellosis, Shigellosis is an intestinal infection caused by bacteria which is one of the global issues. *Shigella spp*. is the third most common bacteria agent responsible for childhood diarrhoea (Singh, et al., 2011). For bacterial gastroenteritis, the most important causative agent is non-typhoidal *Salmonella*, followed by *Campylobacter, Shigella* and *E.coli* (Lee and Puthucheary, 2002).

## 3.0 Research Methodology

### a. Water Samples

Three litres of each water samples were collected in sterile glass bottles from five sites namely SP1 (River), SP2 (River), SP3 (Waterfall), SP4 (Lake) and SP5 (Coastal). Samples were kept in ice (approximately 4$^{o}$C) and transported to the laboratory for immediate testing.

### b. Water Quality Testing

In-situ tests had been done using portable probe (HORIBA). The parameter tested in this study including Dissolved Oxygen (DO), Turbidity, pH, Temperature and Total Dissolved Solid (TDS). For each sampling points, there are three points where measurements have been made to obtain the average results.

### c. Bacterial Testing

Bacteria counts were determined using the surface spread plate technique on SS agar and MacConkey agar. Serial of dilutions were prepared and 0.5 mL samples were poured on the agar. Detailed testing as described in Basri, et al. (2017). Pink with black centered and colorless colonies in SS agar were indicated as *Salmonella spp.* and *Shigella spp.*, respectively. While *E.coli* formed on MacConkey agar as pink colour.

## 4.0 Findings And Discussion

### a. Water Quality

Average water quality for TDS, Turbidity and DO is shown in Figure 1.

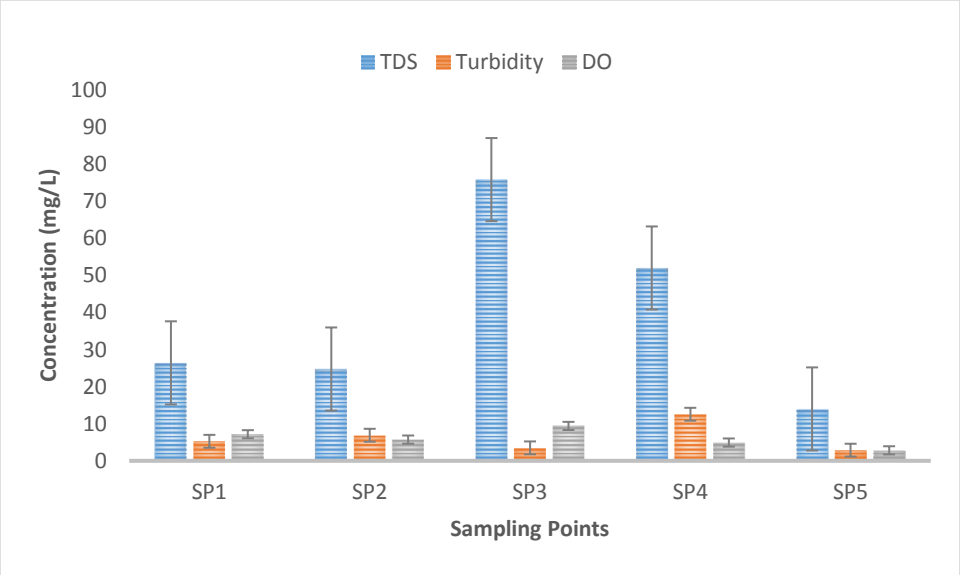


**Figure 1:** TDS, Turbidity and DO for all sampling points.

Solids are found in two forms, suspended and dissolved. Dissolved solid usually comes from urban runoff, hard water ions and acidic rainfall. Mean of TDS in SP1, Sp2, Sp3, Sp4 and SP5 are 26.43, 24.77, 75.87, 52.03, and 14.00 mg/L, respectively. The mean value of TDS in the SP3 and SP4 are similar to TDS levels in lakes and stream which typically found in the range of 50 to 250 mg/L. Turbidity is a measure of the water's lack of clarity. Water with high turbidity is cloudy, while water with low turbidity is clear. The mean for SP1, SP2, SP3, Sp4 and SP5 are 5.27, 6.90, 3.50, 12.57, and 2.87 NTU, respectively. Overall, the highest reading was recorded in lake water sample. The causes of high turbidity in the sample may come from several factors including urban runoff and organic matter resulting from microorganisms, decaying plants and animals, or oil from roads. For that reasons, it may reduce the water clarity and aesthetically unpleasant.

The amount of gaseous oxygen ($O_2$) dissolved in water could be measured by the dissolved oxygen analysis. It can be seen that the mean in SP1, SP2, SP3, Sp4 and SP5 are 7.17 mg/L, 5.73 mg/L, 9.41 mg/L, 4.93 mg/L , and 2.83 mg/L respectively. According to Mohd-Aizat, et al. (2013), low flowing at the effluent (upstream) tends to have less concentration of DO compared to high flowing in the influent (downstream). Among the important of water quality indicator is pH. PH is a measure of how acidic / basic water is. The range goes from 0 – 14, with 7 being natural. PH of less than 7 indicate acidity, whereas a pH of greater than 7 indicates a base. Figure 2 shows the mean of pH in all sampling points.

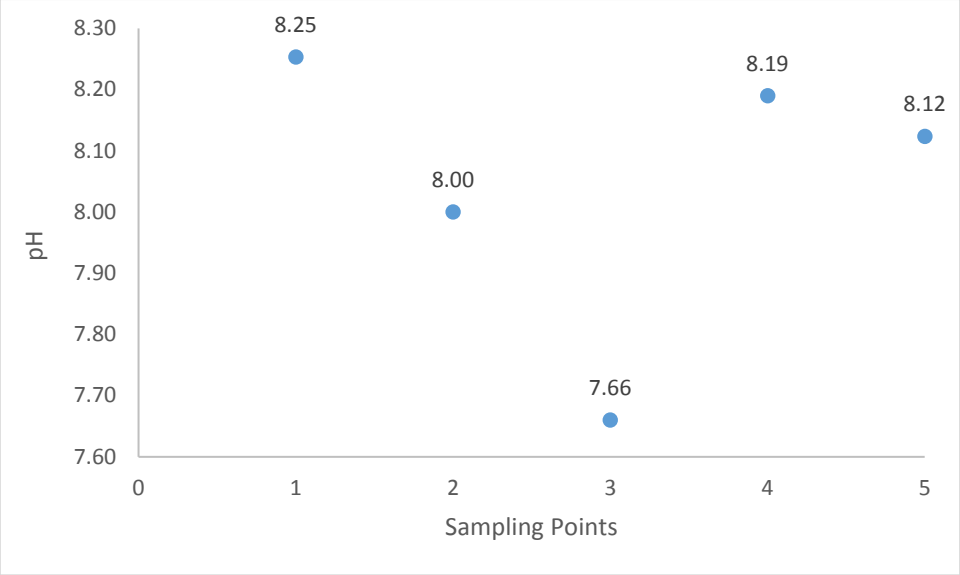


**Figure 2:** pH for all sampling points.

From the results, the water quality at the sampled location are with pH mean ranging from 7.66 to 8.25. Waterfall stated the lowest pH while SP1 (River) recorded as highest pH. However, the average value of the pH expressed is safe because it is in a neutral range. Water sampling was conducted in the morning on fine day. In this research, the temperature mean concentration ranges are 25.77°C to 31.03°C in all sampling points as shown in Figure 3.

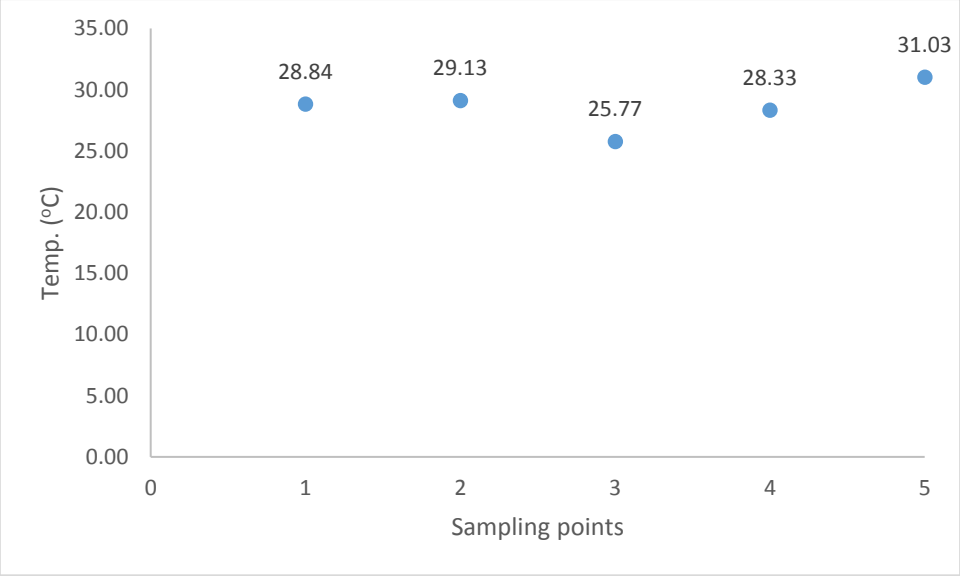


**Figure 3:** Temperature for all sampling points.

Normally, temperature of the air above the water body may affect water temperature depending on the depth of the water. Shallow water is more easily affected by the temperature on its surface. It can be said that, the higher the depth of water, the cooler the temperature in the water.

### b. Detection of Pathogenic Bacteria in Water Bodies

The detection of pathogenic bacteria from five sampling points was shown in Figure 4.

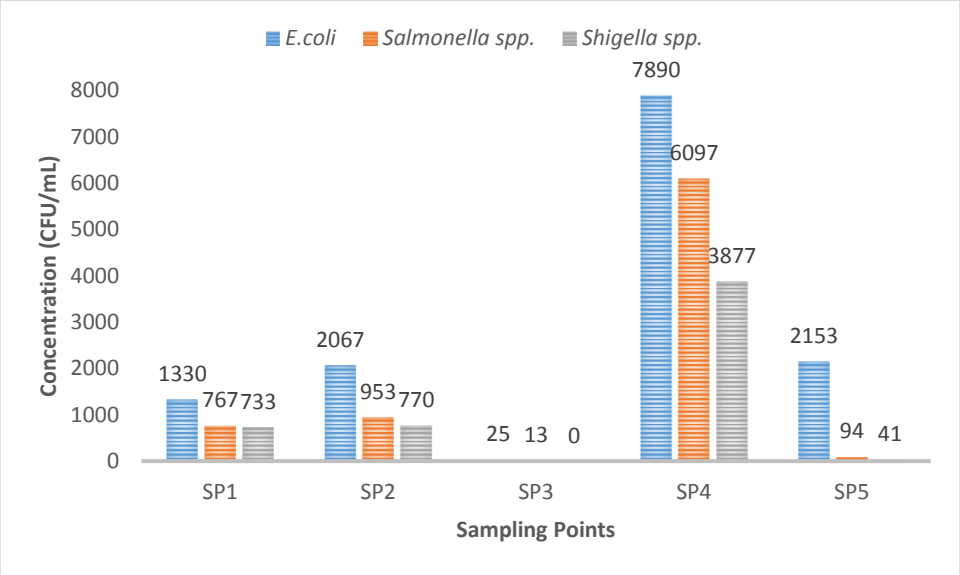


**Figure 4:** Bacterial detection in water bodies.

From the figure, it shows *E.coli*, *Salmonella spp.* and *Shigella spp.* were detected in all sampling points, except *Shigella* was not detected in waterfall (SP3). According to ADEQ (2010) and U.S EPA (2009), level of *E.coli* permitted for surface water full-body contact (swimming) and surface water partial-body contact are 235 CFU/100mL and 575 CFU/100mL, respectively. This indicates that all sampling points are insecure sources of water for either full-body contact or partial body contact. *E.coli* recorded higher average values in five sampling points, overcoming *Salmonella spp.* and *Shigella spp.* However, the average values of *Salmonella spp.* and *Shigella spp.* are are recorded high in SP1, SP2 and SP4, and are capable of risking general human health.

## 5.0 Conclusion

In conclusion, this study confirmed that water and wastewater might act as reservoir for *E.coli*, *Salmonella spp.* and *Shigella spp.* thereby serving as a source of human infection and a potential threat to human health. It can be concluded that pathogenic bacteria are most detected in lakes with high concentrations compared to other sampling points.

## 6.0 Future Research and Recommendations

It is recommended that the following investigations be undertaken in the future:

i. A study of gram-positive bacteria in water bodies and their movement.
ii. More types of pathogenic gram-negative bacteria exists in water environment.

## References

Abatcha, M.G., Zakaria, Z., Kaur, D.G., Thong, K.L. (2014). A trends if Salmonella and antibiotic resistance. Advances in Life Sciences and Technology, 17, 9-21.

Arizona Department of Environmental Quality. 2010 Water Quality. Retrived at http://www.azdeq.gov/environ/ water/index.html. on Dec, 22nd 2014.

Basri, Z. D. M., Chua, A. L. and Wahid, M. A. (2017). Occurrence of antibiotic-resistant bacteria in wastewater treatment plant. Advanced Science Letters, 23(5), 4649-4651.

Centers for Disease Control and Prevention 2014. Reports of selected Salmonella outbreaks investigation. Retrieved at http://www.cdc.gov/salmonellaoutbreaks on June, 1st 2018.

Lee WS, Puthucheary SD (2002). Bacterial enteropathogens isolated in children with acute gastroenteritis in Kuala Lumpur – a changing trend. Med J Malaysia, 57, 24-30.

Mohd-Aizat, A., Mohamad-Roslan, M.K., Wan Nor Azmin Sulaiman (2013). Water quality index of selected station at Rasau River, Ayer Hitam Forest Reserve, Puchong, Selangor. International Journal of Water Research, 1(2), 37-42.

Rathi, A., Thong Kwai Lin, Chong, V.C. (2010). Isolation, detection and genomic differentiation of Escherichia coli from aquatic environments in Kelantan, Malaysia. Malaysia Journal of Science, 29, 11-18.

Singh, K.B., Ojha, S.C., Deris, Z.Z., Rahman, R.A. (2011). A 9-year study of shigellosis in Northeast Malaysia: Antimicrobial susceptibility and shifting species dominance. Journal of Public Health, 19, 231-236.

U.S. Environmental Protection Agency. 2009 Water Quality Standards. Retrievedat http://www.epa.gov/waterscience/standards/wqslibrary/az/az9wqs.pdf on Dec, 22nd 2014.