# Coliform bacteria as a tool for assessing water quality of Shatt Al-Arab River in southern Iraq

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**Abstract:** *The total coliform count is widely used to assess drinking and swimming waters contamination in particular with pathogenic bacteria of intestinal origin. The common sources of coliform bacteria in the Shatt Al-Arab River include raw sewage, combined sewer overflows, effluents from wastewater treatment plants, industrial and agricultural sources, and urban run-off. In this study, total coliform bacteria were counted using multi-tube fermentation technique with lactose broth, eosine methylene-blue agar medium, and brilliant green bile broth. All samples taken from the Shatt Al-Arab River were positive for the appearance of coliform bacteria, although the count was variable from 4-399 MPN/100 ml. The highest percentage of coliform bacteria was found in the river samples obtained from the Basrah Center station. The results of current study indicate that all water samples of the studied stations were not suitable for drinking because of the high numbers of coliform bacteria. However, most of the water samples (90 %) obtained from the river can be used with good quality for bathing and swimming. These data have a significant impact on the local population who use the water of Shatt Al-Arab River for different purposes.*

**Keyword:** *Shatt Al-Arab river, coliform bacteria, water quality, microbial contamination*

## I. INTRODUCTION

Aquatic environments function as natural habitat for a variety of microorganisms, with both useful and pathogenic properties. It is known that pathogenic bacteria cause infectious diseases of human and marine animals (Cabral, 2010). Microbial indicators are used to determine whether water is safe to use or not. Recently, concerns have been raised about the appropriate use of microbial indicators to regulate the use of water bodies (Tallon *et al*., 2005).

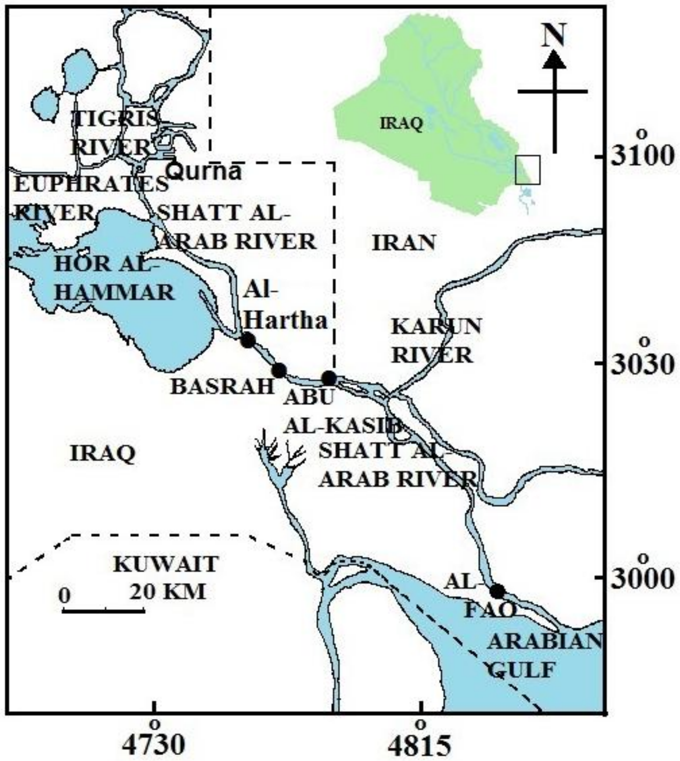
Microorganisms are widely spread in nature, and their diversity and density can be used as an indicator of water suitability (Staradumskyte *et al*., 2012). Bacteria can be used as indicators of water quality in two ways. First, the presence of such bacteria can be considered an indicator of contamination of faecal water; second, it can be considered as an indicator of potential health risks posed by faecal contamination (Simpson *et al*., 2004; Derriena *et al*., 2012). The higher the level of indicator bacteria, the higher the level of faecal contamination and the increased risk of water-borne diseases (Saxena *et al*., 2015). It is necessary to identify the source of faecal contamination in aquatic environments to assess the health risks associated with pollution, and to identify possible measures to treat contaminated waters (Tallon *et al*., 2005).

River waters are susceptible to a variety of sources of microbial contamination, which can contain infectious organisms to the digestive system, upper respiratory tract, ears, eyes, nasal cavity and skin (NRC, 2004). The potential public health threats of waterborne microbial pathogens have attracted renewed interest within the scientific community and among the public (Maal-Bared *et al*., 2008). What was previously thought to be under control, now referred to as emerging or re-emerging pathogens. The source of microbial contamination is often treated inappropriately because of factors such as human sewage, runoff from animal husbandry in streams or rivers, as well as other factors including waste from wild animals, changes in water turbidity or chemistry, and the proliferation of algae that increase abundance bacteria in water bodies (Isobe *et al*., 2004; Sauer *et al*., 2011). In the absence of sound management, serious problems may arise in the availability and quality of water [6]. Shatt Al-Arab River, though an important source of water for the population, provides facilities for navigation, transport, fisheries, harvesting of economically useful plants, sightseeing, tourism and recreation. Its water is contaminated by various types of contaminants resulting from disposal of domestic and municipal waste, causing undesirable change (Al-Salman, 2017). Human-induced stress has greatly affected river water quality, and monitoring the quality of river water using microbial indicators has been a key focus in the fight against public health problems.

The aim of this study was to study the use of coliform bacteria as an indicator of the level of contamination in the Shatt Al-Arab ecosystem.

## II. MATERIALS AND METHODS

Shatt Al-Arab River (Figure 1) originates from the confluence of the two major rivers of Iraq (Tigris and Euphrates) at Qurna. Karun river, the only tributary of the Shatt Al-Arab River, joins its eastern bank south of Basrah city. The length of the Shatt Al-Arab river from Qurna i.e. its place of origin, to its mouth in Arabian Gulf, extends about 175 km. It's width varies at different points, ranging from 0.4 km at Basrah city to 1.5 km at its mouth. The water depth increases in general towards the Gulf with a maximum of 12.2 m. The water level is, however, affected by the high and low tides of the Arabian Gulf where the average tidal range is about 1.7 m. Shatt Al-Arab river water characterized as being well mixed with limited vertical stratification of temperature and chlorinities. The water of river mouth may be traced as far as 5 km into the Arabian Gulf. The discharge of this river reaches the waters of Kuwait bay during the flood season. Shatt Al-Arab River provides important commercial waterway to the Arabian gulf. It's water has also been used for various purposes in the region including potable water supply, irrigation, fisheries, tourism navigation and industrial uses. Thus, the river is severely impacted by pollution from agricultural, industrial and domestic sources.




Four different stations were selected across Shatt Al-Arab River for water collection. The first station is commercial port (Al-Fao) (29°58'28.6" N, 48°29'09.5" E) and its water were heavily influenced by oil exportation. The second station is industrial location (Al-Hartha) (30°48'10.6" N, 47°45'03.8" E). These sites are specific to anthropogenic activities. The third station is urban area (Basrah center) (30°33'00.0"N, 47°47'10.0"E). The water of this area is generally subject to a variety of activities in a different degrees such as traffic, houses and workshops (mechanics, carpentry etc), sale of goods of all kinds and petroleum products handling facilities. The last station is rural area (Abu Al-Khasib) (30°27'44.5" N, 48°00'06.0" E) and their water considered low contaminated and is sometimes covered with vegetation. Water samples were monthly collected from selected stations from January to December, 2018 in 100 ml glass bottles that were carefully cleaned and rinsed with distilled water. During sampling, extreme caution was exercised to avoid contamination.

The quality of the water (coliform count) was determined by the standard multi-tube fermentation technique. Coliform bacteria were detected by inoculation of samples in tubes of lactose broth. The three-tube procedure using lactose broth was utilized to detect coliform bacteria and determine the Most Probable Number (MPN) of the bacteria. Water samples, 10 ml, 1 ml and 0.1 ml were piped into tubes with 10 ml of lactose broth and incubated at 37 ± 1 °C. Gas formation after 24 hours of inoculation indicates a positive presumptive test. The gas production (the bubble that fills the durum tube concavity) has been considered as an apparent positive growth of coliform bacteria. Cultures that show no gas production in 48 hours were considered negative. The tubes showing the gas were inoculated on eosine-methylene-blue agar. One or more typical colonies are selected and picked off into brilliant green bile broth and studied microscopically to see if organisms contained the morphological and coloring properties of coliform bacteria (Coyne and Howell, 1994; Bakare *et al*., 2003).

## III. RESULTS

All water samples obtained during the study from Shatt Al-Arab River stations were positive in relation to the appearance of coliform bacteria well above the permissible limits, although their counts were variable (Table 1). The data also showed that the highest percentage of these bacteria is located in the third station (Basrah Center). The distribution of coliform bacteria was very variable with significant differences between sampling stations and ranged from 5 to 572 MPN/100 ml.

The maximum coliform count in first (Al-Fao), second (Al-Hartha), third (Basrah Center), and fourth stations (Abu Al-Khasib) were observed in July (143, 270, 399 and 213 MPN/100 ml respectively), followed by August (93, 212, 368 and 143 MPN/100 ml), June (56, 120, 272 and 85 MPN/100 ml) (Summer), May (50, 100, 168 and 82 MPN/100 ml), April (33, 62, 122 and 45 MPN/100 ml), March (29, 51, 77 and 40 MPN/100 ml) (Spring), September (14, 28, 46 and 19 MPN/100 ml), October (7, 18, 33 and 12 MPN/100 ml), November (5, 10, 24 and 8 MPN/100 ml) (Autumn), December (4, 8, 18 and 5 MPN/100 ml), January (4, 5, 14 and 4 MPN/100 ml), and February (4, 4, 10 and 4 MPN/100 ml) (Winter) (Figure 2).

The wise distribution of the coliform bacteria (Table 2) shows that most of the water samples (62.5 %) are in the second category, followed by 32.5 % of the samples in the third category, 5 % of the samples in the fourth category, and 0 % of the sample in the first category. The current study indicates that none of the samples are suitable for drinking. Most of the water samples (90 %) obtained from the Shatt al-Arab River were suitable for bathing and swimming in good or fair quality. However, some of the river's spots were of poor quality and therefore unsuitable for any use.

**Table 1: Total coliform bacteria count (MPN/100 ml) in four stations of Shatt Al-Arab River**

| Season | Month | Al-Fao | Al-Hartha | Basrah Center | Abu Al-Khasib |
|---|---|---|---|---|---|
| Winter | January | 4 | 5 | 14 | 4 |
| | February | 4 | 4 | 10 | 4 |
| | March | 29 | 51 | 77 | 40 |
| Spring | April | 33 | 62 | 112 | 45 |
| | May | 50 | 100 | 168 | 82 |
| | June | 56 | 120 | 272 | 85 |
| Summer | July | 143 | 270 | 399 | 213 |
| | August | 93 | 212 | 368 | 143 |
| | September | 14 | 28 | 46 | 19 |
| Autumn | October | 7 | 18 | 33 | 12 |
| | November | 5 | 10 | 24 | 8 |
| Winter | December | 4 | 8 | 18 | 5 |

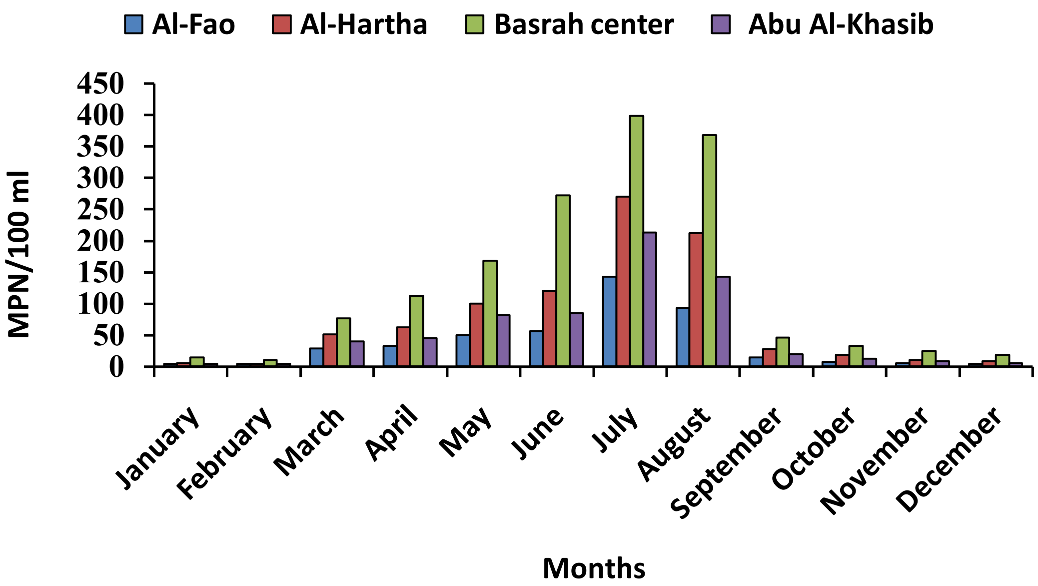



**Figure 2: Coliform bacteria count in the water of Shatt Al-Arab River stations, Al-Fao, Al-Hartha, Basrah Center, and Abu Al-Khasib**

**Table 2: Category wise distribution of coliform bacteria count (MPN/100 ml) in a rivers water in relation to its use and quality.**

| | First category | Second category | Third category | Fourth category |
|---|---|---|---|---|
| MPN range | 0 | 4-50 | 51-400 | 401-1100 |
| Percentage | 0 | 62.5 | 32.5 | 5 |
| Usage | Drinking | Bathing and Swimming | Bathing and Swimming | Unfit |
| Grade | Excellent | Good | Fair | Poor |

## IV. DISCUSSION

Shatt Al-Arab River water has shown a significant deterioration in quality in light of international standards. All samples were contaminated with coliform bacteria, which resulted mainly from human activities, in particular the disposal of domestic and agricultural wastes directly into the river. Recent studies have shown that coliform bacteria have a positive relationship with human activities [Leclerc *et al*., 2001, Getachew *et al*., 2018]. Odonkor and Ampofo (Odonkor and Ampofo, 2013) suggested that *Escherichia coli* is a bacteria found in the intestinal tract of humans and warm blood animals and discharged from the faeces. Ecotominogenic *E. coli* (ETEC) is a common cause of "traveler's diarrhea" in developing countries that affect humans only, and transmission occurs through water and food contaminated with human waste. The index of MPN observed for water samples showed that the maximum samples exceeded the WHO (2003) limit, indicating the massive pollution of the Shatt Al-Arab River and its transformation into eutrophication. The high MPN values in river water samples analyzed can be attributed to agricultural runoff and sewage drainage into the river from the watershed area across Basrah city. The results were consistent with Jamieson *et al*. (2003), which showed an increase in the total number of coliform bacteria from water bodies due to increased use of animal waste in agricultural fields. Lateef *et al*. (2003) documented the presence of large numbers of coliform bacteria in the spring water in the Kashmir valley as a result of agricultural operations. Intensive farming increased the concentration of animal waste, leading to increased pollution of rivers and streams (Jacinta and Adebayo, 2015). The results of this study are supported by the results of Culbertson *et al*. (2013) reported that places with greater human stress had a relatively higher bacterial load. Shatt Al-Arab River can be classified as the third category and classified as satisfactory for bathing purposes. Therefore, control measures should be implemented to limit the transfer of bacteria to the natural systems of the river.

## V. CONCLUSION

The total density of coliform bacteria in Shatt Al-Arab River indicates that water quality has deteriorated and is no longer suitable for drinking purposes. It is also clear that human activities have led to elevated levels of total coliform bacteria. The inadequacy of the health system and the poor use of land for direct collection and disposal of sewage continue to jeopardize the quality of river water for human use. Therefore, control should be implemented to reduce bacterial transport to such natural systems.

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