Estimation of validity Tigris River Water for Swimming in Baghdad City

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Abstract

This study was conducted during 2012 utilizing selected four swim areas on the Tigris river in Baghdad city. Twenty water samples from four swim areas during swim season were collected for quality analyses using chemical, physical and bacterial parameters. The result revealed that the temperature, pH and means dissolved solid in the Tigris river water in all swim areas were within limit recommended by environmental protection Agency standards. While mean of the total dissolved solid, turbidity, chlorophyll and blue green algae were ranged from 0.69-0.89 g/l, 10.15-1248 NTU, 1.85-222.82 µg/l and 338-7999 cells/ml respectively. The total viable counts (TVCs) of bacteria were ranged from 128 to 10000 cells/ml. The total Coliforms (TCs) and fecal Coliforms (FCs) were ranged from 300-1600ml and126-1600 /100ml respectively. During the study 77 isolates of enteric bacteria were isolated and identified. *Escherichia coli* isolated from all water samples (20 isolates) which it represents 100%, *Enterobacter spp*. were 70%, *Klebsiella spp*. were 60%, *Protus mirabilis* were 65%, *Protus vulgaris* were 15%, *Vibrio spp*. were 30%, *Morganella morgani* were 10%, *Pseudomonas aeruginosa* was 5%, *Salmonella Sp*. was 5% and *Staphylococcus spp*. were 25%.

Key word: Tigris river, swimming, bacteria

2. Introduction

Fresh water of rivers always considered as the main source of drinking, bathing and relevant human uses for maintenance of life. These natural water usually exposed to environmental pollution including chemical, physical and biological aspects that might alter the natural of these water to be risky for human users (1).

The Tigris river crosses the Baghdad city and divided it into two areas, the eastern area called Rusafa and the western called Karkh. Generally it may be stated that the main sources of pollution of Tigris river water in Baghdad city are due to the agricultural, industrial and housing sectors   (2). It is found that domestic discharges are among the important sources of pollution of the Tigris within Mosul area (3). Sanitary waters are often discharged untreated into the Tigris. There are more than forty pumps installed along both sides of the Tigris river disposing sewage water directly into the river without any treatment (2).

The water microbiological examination is used worldwide to monitor and control the quality and safety of various water types. These include potable water such as water for drinking or use in food preparation, treated recreational waters such as swimming pools, spa pools, hydrotherapy pools, and untreated   waters used for recreational purposes such as sea, river and lake waters (4). The common water microbiological indicators are used as markers of risk to human health includes total coliform, *Escherichia coli*, enterococci. *Clostridum perfringens*, *Pseudomonas aeruginosa* (5,4).

Many potential pathogens are associated with swimming in polluted water, monitoring usually done for *E. coli* which indicates to fecal contamination. The most common illness associated with swimming in water polluted by sewage is gastroenteritis. Other minor illnesses associated with swimming include ear, eye, nose, skin and throat infection. Swimmers may occasionally be exposed to more serious diseases like dysentery, hepatitis, cholera and typhoid fever. Most of these diseases require ingestion of the infected water, although some can transmit through wounds exposed to water (6). In recent study included five sites along the Tigris river in Baghdad area showed that the total coliform counts ranged from 190 to 1500 cfu / 100 ml filtered (7). The United States Environmental Protection Agency recommended recreational water (such as swimming water) quality standard for *E. coli* is 235 organisms /100ml for any single water sample (8). The present study is the first study in Iraq to determine the validity water of the Tigris river for swimming.
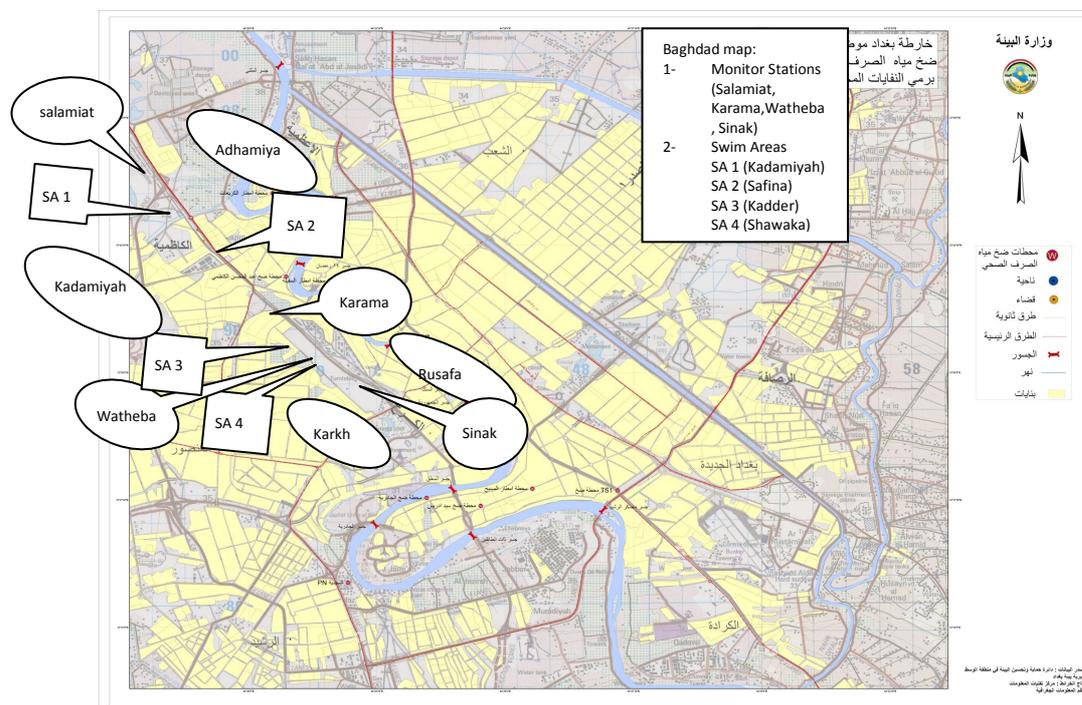
Figure 1. Map of the study area

2. Materials and Methods

2.1 Study Area

In the present study four swims areas were chosen on the Tigris river to cover Baghdad city (Figure 1). These were, area 1 (Kadamiyah) and area 2 (Safina) located north Baghdad, area 3 (Kadder) and area 4 (Shawaka) located in the center of Baghdad city (Table 1).

Table1: *Characterization municipalities bordering the Tigris river.

Municipality	○Area Km^2	Population	Dwelling units	Quantity wastewater discharge (liter/Sec.)into the river
Kadamiyah	56	520000	24	9000
Aadhamiyah	32	500000	28	4098
Karkh	24	66000	26	-------
Rusafa	45	500000	45	3777.7

* Environmental Protection and Improvement Directorate in Centric Region, 2012.

2.2 Collection of Water Samples

Twenty water samples were obtained from selected four swim areas along the Tigris river in Baghdad city during May, June, July, August and September (swim season), 2012. The samples were collected from the water surface in duplicate into sterile 1L glass bottles at 8:00 am and transported to the laboratory in ice box for bacterial analysis within two hours of collection.

2.3 Chemical and Physical Analysis

2.3.1 pH of Water: Water pH of each sample was measured by using a digital pH – meter (HANNA lnsturments).

2.3.2 Temperature of Water: The water temperature of each swim area was measured by using a mercury thermometer at the time of sample collection.

2.3.3 Monitor Stations: Data with respect to the dissolved solid, dissolved oxygen, turbidity, chlorophyll and blue green algae were obtained by the monitor stations (9) installed near swimming areas. These stations are Salamiat, Karama, Watheba and Sink as shown in figure (1).

2.4 Microbiological Analysis

2.4.1 Total Viable Count: The total viable count was conducted by pouring plate technique on Nutrient agar and counting the colonies developed after the incubation at 37^0C for 24 hours (10).

2.4.2 Total Coliform and Fecal Coliform Counts: Coliform count was obtained using five tubes Most Probable Number (MPN) technique. The presumptive coliform test was performed using MacConkey broth (Oxoid). The tubes were incubated at 37^0C for 24 h for estimation of total coliform and at 45^0C for estimation fecal coliform and examined for acid and gas production (11).

2.4.3. Isolation of Enteric Bacteria

2.4.3.1. Membrane Filter Technique: A known volume (30ml) of water samples was filtered through sterile 47 mm diameter grid-marked membrane filters with 0.45 μm pores (12). The membrane filters placed on the surfaces Mannitol Salt (MS) agar plates for isolation staphylococci, Eosin Methylene Blue (EMB) agar plates for isolation enteric bacteria and MacConkey agar plates for lactose and non lactose fermenting bacteria isolates.

2.4.3.2. Spread Method: Water samples were serially diluted using normal saline. Aliquots of 0.1ml of undiluted water samples and water at dilutions of 10^{-1} and 10^{-2} were spreading on MS agar plates, EMB agar plates and MacConkey agar plates. The plates were incubated at 37^0C for 24 hours (13).

2.4.4. Detection of *Salmonella*: Detection of *Salmonella spp*. was done by the enrichment of water samples on Tetrathionate broth, followed by isolation of typical *Salmonella* colonies on selective medium salmonella Shigella (SS) agar (14).

2.4.5. Detection of *Vibrio*: Detection of *Vibrio spp.* Was done with enrichment sample in 1% alkaline peptone water (pH 8-9) for 6 to 8 hours followed by isolation on Thiosulphate Citrate Bile sucrose (TBCS) agar and red ring test for alkaline peptone was done using H_2SO_4 indicator (14).
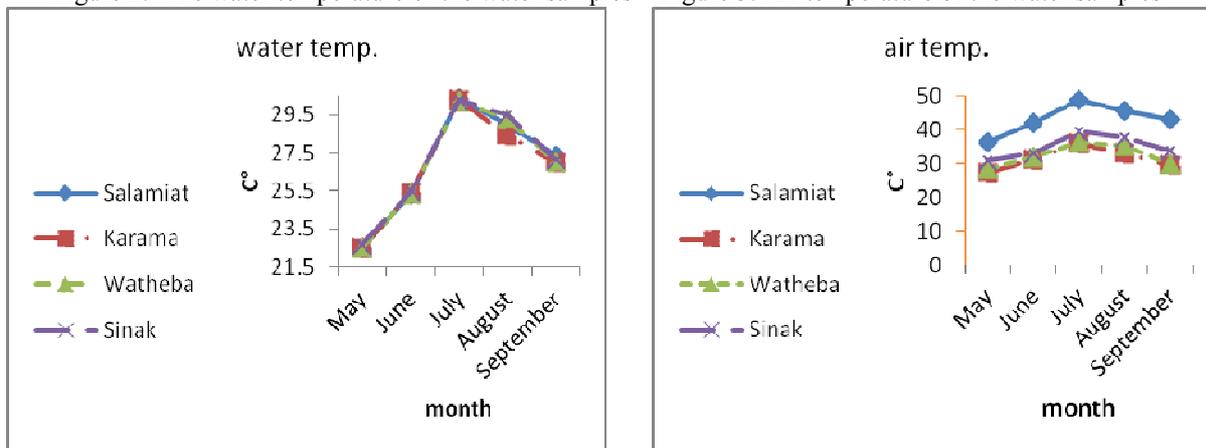
2.6. Biochemical test: Enteric bacteria isolated on respective selective and differential media were identified on the basis of colonial, morphological, Gram stain and biochemical tests which include: IMViC, Urea and Kligler Iron Agar (13).

3. Result

3.1. Water Temperature at Swim Areas Studied : The present results showed that the lowest and highest water temperature were 22.5^0C and 30.25^0C recorded at Kadder swim area during May and July respectively (fig. 2).

3.2. Air Temperature: The result indicated that the highest mean air temperature was 48.79^0C at 8:00 am during July (Fig. 3).

Figure 2. The water temperature of the water samples   Figure 3. Air temperature of the water samples

3.3. pH-values of Water Samples: The present results reveaed that the lowest and the highest pH of water samples was 7.27 and 8.08 recorded at Safina swim area during May and August respectively (fig. 4).

3.4. Total Dissolved Salts (TDS): The present results showed that the lowest mean TDS of water were 0.43 g/l recorded at Kadder swim area during May while the highest value was 0.89 g/l recorded at Kadamiyah swim area in September (Fig. 5).

Figure 4. pH value of the water samples
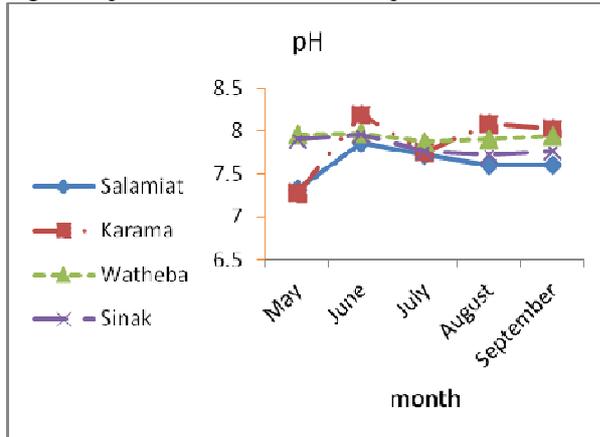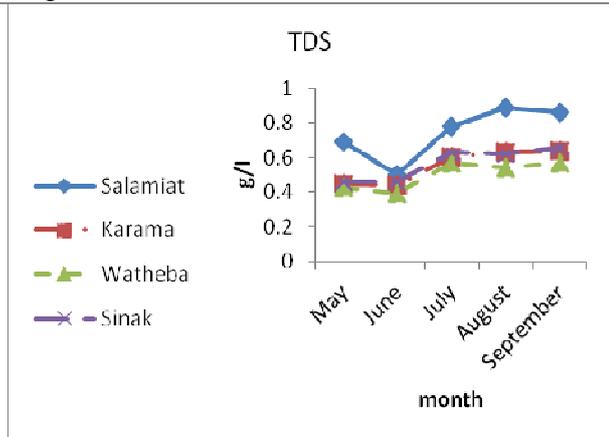
Figure 5. Mean total dissolved solid

3.5. Dissolved Oxygen (DO): The present results showed that the lowest mean DO of water samples was 5.15 mg/l recorded at Kadamiyah swim area during May but the highest value was 8.15 mg/l recorded at Kadder swim area in June (fig. 6).

3.6. Turbidity of Water: The present results indicited that the lowest mean turbidity of water was 10.15 UNT recorded at Kadamiyah swim area in May but the highest value was 1248 UNT recorded at Shawaka swim area during August (Fig. 7).
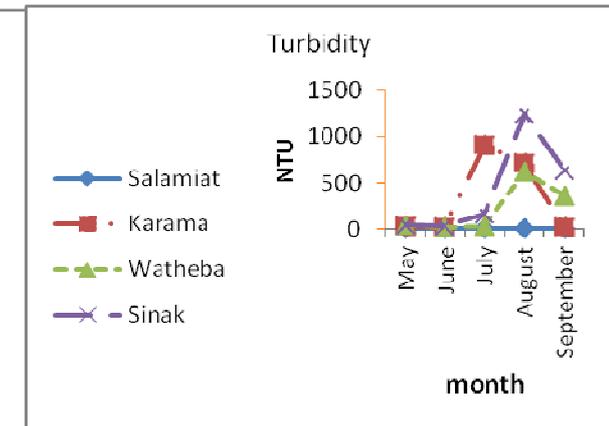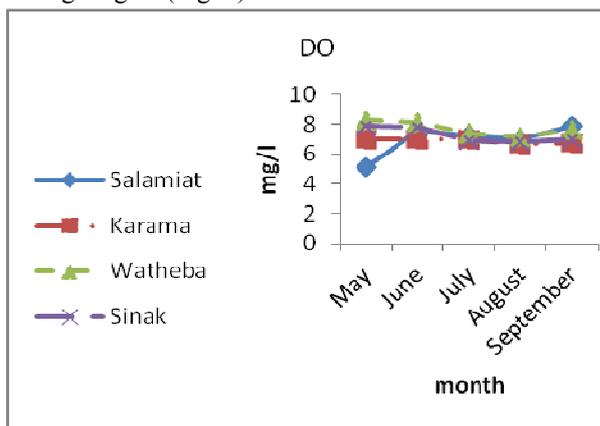
Figure 6. Mean dissolved oxygen

Figure 7. Mean turbidity of the water samples

3.7. Chlorophyll of Water Samples: It is found that the mean of lowest and highest chlorophyll quantities of water were 1.85 and 222.82 μg/l recorded at Kadamiyah and at Kadder swim areas respectively during September (Fig. 8).

3.8. Blue Green Algae Counts: Results showed that the mean of lowest and highest blue green algae count were 338 and 7999 cells/ml recorded at Safina and at Kadder swim areas respectively during September (Fig. 9).
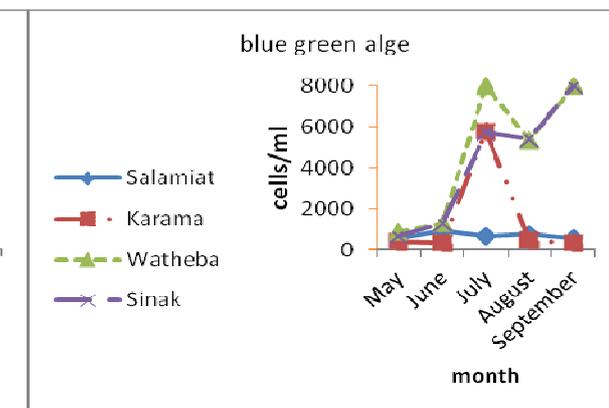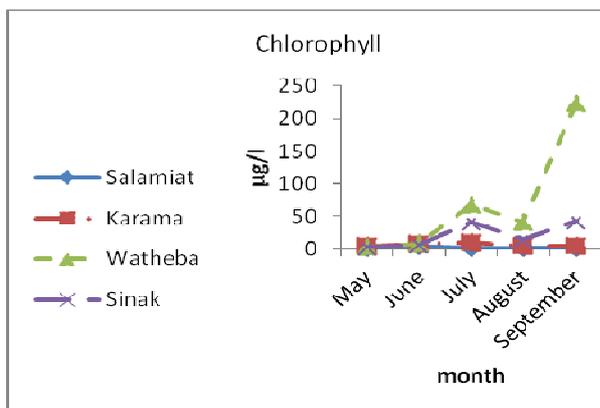
Figure 8. Mean chlorophyll concentration
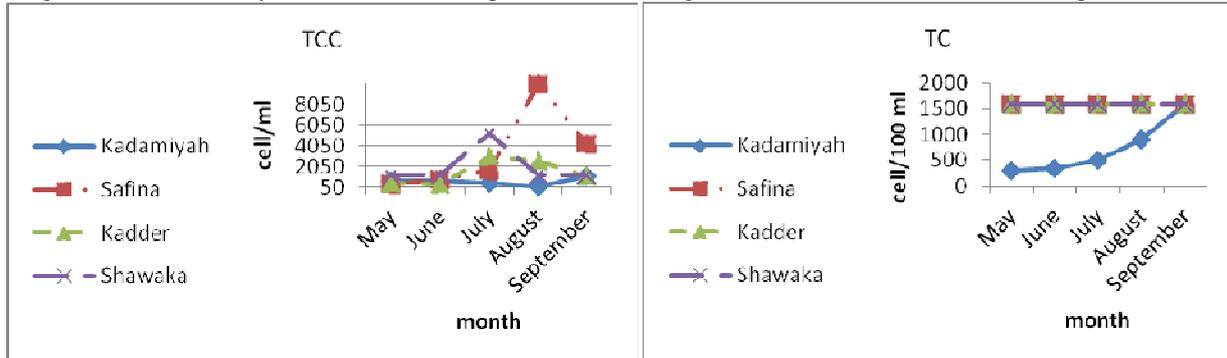
Figure 9. Mean blue green algae counts

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3.9. Total Viable Count (cells/ml): The present results indicated that the lowest TVC of water was 128 cells/ml recorded at Kadamaiyah swim area in August but the highest value was 10^4 cells/ml recorded in August too at Safina swim area (Fig. 10).

3.10. Total Coliform (TC) Counts: It is found that the total coliform count recorded at Kadamaiyah swim area were ranged from 300 to 1600 cells/100ml during May and September respectively. But Safina, Kadder and Shawaka swim areas had total coliform counts more than 1600 cells/100ml during the study period (Fig. 11).

Figure 10. Total colony count of water samples

Figure 11. Total coliform of water samples

3.11. Fecal coliform (FC) Counts: The present results showed that the lowest and highest total fecal coliform counts recorded at Kadamaiyah swim area were 160 and 500 cells/100ml during July and September respectively while Safina, Kadder and Shawaka swim areas had counted more than 1600/100ml during the study period (Fig. 12).

3.12. Enteric bacterial isolates: In this study, 77 isolates were obtained and identified into 10 genus (9 Gram negative bacteria + one Gram positive bacteria). The *Escherichia coli* was isolated from all water samples (100 %) but *Pseudomonas aeruginosa* and *Salmonella Sp*. were isolated one time only (5%) (Fig.13).
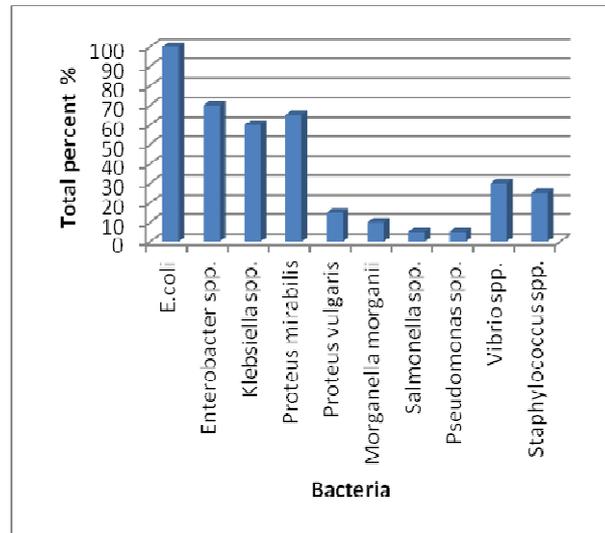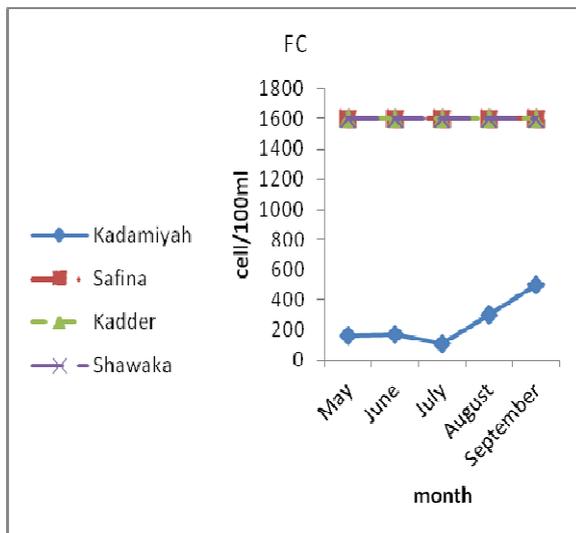
Figure 12. Fecal coliform of water samples

Figure 13. The total percentage of bacteria isolates

4. Discussion

Water quality affects the public health. Water resources consider one of the most important sources to determine the percent of mortality in the world. In Iraq in 2004, World Health Organization reported that the death percent result of water resources pollution was 383/100000 children under 5-years (15).

4.1. Temperature: Water temperature considered one of vital factor for water habitat as it affects the dissolving of salts and gases especially oxygen and carbon dioxide (16). The present study showed that the water temperature of the Tigris river ranged from 20.5-30 ^{0}C during swim season (between May and September in Iraq) as shown in figure (2). The temperature of the water under study was complied to the EPA, 1991 standard for recreational fresh water (17). The highest water temperature was recorded during July at Safina swim area whereas the lowest water temperature was recorded during May at Kadder swim area. On the other hand,

weather in Iraq is extreme in the summer. The highest mean air temperature at 8:00 am was 48.79 ^{0}C recorded during July but the lowest mean air temperature was 27.26^{0}C recorded during May (Fig. 3).

4.2. pH: The pH of the aquatic system is an important indicator of the water quality and the pollution in watershed areas (18). The pH value of the Tigris river water ranged from 7.27-8.08 during swim season (Fig. 4). The pH of the water samples under study were comply with the EPA standard for fresh water (17). The highest pH values were recorded during August and September but the lowest pH value was during May.

4.3. Total Dissolved Solid: Results showed that the mean total dissolved solid concentration of water samples during May and June were comply with the EPA guideline standard for freshwater supply (17) except one sample had concentration exceed the maximum allowed (500mg/l) was collected from Kadamiyah swim area during May. But other water samples had concentration exceed the recommended value during July, Agust and September (Fig. 5).

4.4. Dissolved Oxygen: United States Environmental Protection Agency (EPA) standard for dissolved oxygen in fresh water is not less than 5mg/l (17). Therefore water samples under study were comply with the standard (Fig.6). But the highest mean dissolved oxygen of water under study was 8.15 mg/l during June.

4.5. Turbidity: Figure 7 shows the high mean turbidity was 1248 NTU recorded at Shawaka swim area during September. The turbidity of Tigris water during the investigated period was fluctuated among sampling months and swim areas.

4.6. Chlorophyll: Elevated concentrations of chlorophyll-a can reflect an increase in nutrient load and increasing trends can indicate eutrophicatiopn of aquatic ecosystems (19). Eutrophication can be detected by chlorophyll measurement which exceed the guidelines 2mg/l (20). Result showed mean chlorophyll concentration of 15/20 samples were less than 15μg/l comply with the EPA standard (40μg/l) for freshwater (17). While mean chlorophyll concentration of 3/20 samples were slightly higher than the recommended value (between 41-44μg). But 1/20 samples had mean chlorophyll concentration exceed 2mg/l recorded during September at Kadder swim area (Fig. 8). This result indicates the loss of eutrophication phenomenon in the Tigris river during the investigated period.

4.7. Blue Green Algae: Toxins produced by cyanobacteria have been implicated in human health problems ranging from skin irritation and gastrointestinal upset, to death from liver or respiratory failure (21). During the investigated period, blue green algae varied from 338 to 7999 cells/ml which recorded during September at Safina and Kadder swim areas respectively (Fig. 9).

4.8. Total Viable Count, Total Coliforms and Fecal Coliforms: The present study revealed variable total viable bacteria counts with respect to different swim areas and months of sampling collection. These values ranged from 128-10000 cells/ml (Fig. 10). The highest numbers were counted during August and September at Safina swim area and during July at Kadder swim area. But the lowest number was counted during August at Kadamiyah swim area. Previous study (1) revealed that the total bacteria counts of Tigris river water ranged between 110-3240 cells/ml during the investigated period. The highest numbers were counted during January, February and March whereas the lowest number was counted during September.

On the other hand, guide level standard of total coliforms for bathing beach water is 500/100ml (22). Therefore 3/20 water samples (15%) under study were comply with the standard (Fig. 11). The lowest coliform count was 300 cfu/100ml recorded during May at Kadamiyah swim area. 16/20 water samples had total coliforms exceed 1600 cfu/100ml. Furthermore total coliforms considered an indicator for longterm water pollution (23). The present study revealed that the fecal coliform counts ranged from 110 to more than 1600 cells/ml. 15/20 samples (75%) had high fecal coliform counts more than 1600 cells/100ml. The lowest fecal coliform count was recorded during July at Kadaiymah swim area (Fig.13). The EPA standard for recreational freshwater should not exceed *E. coil* 126 /100 ml (24). Therefor 1/20 samples were complied to the recommended value. In previous studies in Baghdad (7) reported that the fecal coliform counts varied among the sampling seasons. They count ranged from a minimum of 200 cfu/100 ml in spring to a maximum of 1320 cfu/100 ml in winter. The risk to health increases in proportion to the amount of pollution. The counts of fecal coliform in most swim areas indicate increased risk of infectious disease transmission. Furthermore the fecal coliforms (*E. coli*) was considered as an indicator for recent microbial pollution (25).

4.9. Enteric bacterial isolates: Fecal coliform showed positive significant correlation with presumptive *E. coli*, *Shigella*, *Salmonella* and *Proteus*/*Klebsiella*, total *Vibrio* and *P. aeroginosa* (27). Our study showed total coliform (*E. coli*, Enterobacter spp., Klebsiella spp. respctivelly) were found to be the most prevalent organism isolates. Furthermore, it was observed *Proteus spp.* 80% of the sample, these results show that stream water sources had more contamination with wastewater.

5. Conclusion

The Tigris river water in Baghdad city is polluted. The main source of pollution result of domestic discharges wastewater (table 1). The total irregular untreated water into the river, up to 16875.7 l/Sec. The highest polluted swim area was shawaka area but the lowest polluted swim area was kadamiyah area., Thus the bacterial quality of Tigris River water is bad and not valid for swimming.

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