Pollutionary effect of the Medical city waste water on the Tigris river bacterial indicators on Baghdad city

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Abstract
Bacteriological characteristics of Tigris river water were assessed monthly to monitor the impact of pollutants of Medical City waste water for the period from January to June-2013. Four stations were selected for the study, the first station placed before the Medical City Complex (500 meters). The second station represent Medical City sewage discharge into the river, where represents the study area. The third station placed (500 meters) after the second station, and the forth station is located on (2000 meters) after the second station.
Samples collected monthly to monitor the changes of water indicators showed that: Total Bacterial Count (10000 to 2700000 cells/1 ml), Total Coliform (200-3700 cells/100 ml), Fecal Coliform (100-2400 cell/100 ml), Total Streptococci (200-2800 cells/100 ml), Fecal Streptococci (0-2000 cells/100 ml) and the FC: FS ratio is (0-8).
Keyword: Tigris River, Medical waste, Bacterial pollution.

التأثيرات التلوثية لمياه الصرف الصحي لمدينة الطب على المؤشرات البكتيرية لنهر دجلة في مدينة بغداد

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الخلاصة:
درست التغيرات الشهرية للخصائص البكتريلوجية للمياه لتقييم نوعية مياه نهر دجلة و قياس تأثير ملوثات مستشفيات مدينة الطب على النهر للمدة من كانون الثاني الى حزيران 2013. اختيرت اربع محطات للدراسة ، تقع المحطة الأولى قبل مجمع مدينة الطب ب (500 متر)، وتمثل المحطة الثانية تفريغ ملوثات مدينة الطب الى النهر، حيث تمثل منطقة الدراسة، تقع المحطة الثالثة على بعد (500 متر) من المحطة الثانية، أما المحطة الرابعة فتقع على بعد (2000 متر) من المحطة الثانية.
أخذت العينات شهريا وبواقع نموذج لكل شهر. شملت العينات قياس قيم وتراكيز مؤشرات المياة وتراوحت التراكيز الشهرية كالأتي: العدد الكلي للبكتريا (10000-2700000 خلية/1 مل)، العد الكلي لبكتريا القولون (200-3700 خلية/100 مل)، والعد الكلي لبكتريا القولون البرازية (100-2400 خلية/100 مل)، العد الكلي لبكتريا المكورات المسبحية (200-2800 خلية/100 مل)، العد الكلي لبكتريا الكورات المسبحية البرازية (0-2000 خلية/100 مل) والنسبة بين بكتريا القولون البرازية والمكورات المسبحية البرازية (0-8).

1. Introduction
Tigris is the biggest river in Iraq and the main source of drinking water for Baghdad [1], any pollution of Tigris River may cause a direct pollution to Euphrates River and the related water sources

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since both rivers connected through Al Tharthar Lake [2]. According to UNICEF report, about 800 million people in Asia and Africa are living without access to safe drinking water. Consequently this has caused many people to suffer from various diseases. Contamination of water has been frequently found associated with transmission of diseases causing bacteria, *Vibrio, Salmonella*, bacterial and parasitic dysentery, and acute infectious diarrhea caused by *E.coli* [3]. Wastewater generated from hospitals usually contain pathogens, human tissues and fluids, pharmaceuticals, substances with genotoxic properties, chemical substances, heavy metals, and radio-active wastes, which may endanger public health, and contribute to oxygen demand and nutrient loading of the water bodies and in the process promote toxic algal blooms and leading to a destabilized aquatic ecosystem, if discharged without treatments into water bodies [4]. One of the main environmental problems putting by the hospital effluents is their discharge, in the same way as the urban classic effluents, towards the urban sewer network without preliminary treatment [5].

There is a similarity between hospitals and household wastewater, but it is characterized by containing hazardous many compounds and microorganism and include bacteria, viruses, worms, hazardous materials and chemicals sterilized in addition to radiation development laboratory waste, which is characterized by the presence of chemicals toxic, so the hospital put large amounts of liquid wastewater change their quantity and quality from one hour to another and from one season to another, where the discharge (300-1000 liters/person/day) hence the urgent need for waste water treatment issued by the hospital to reduce the dangers that may be caused these pollutants to civilian sources without treatment [6].

2. Material and Methods

2.1. Study area:

Baghdad Medical City is a complex of several hospitals in the area of Bab Al-Moatham, Baghdad. It's on the right bank of the Tigris River (Rusafa side) and extends between Sarafiya Bridge in the west and Bab al-Moatham Bridge in the east. These Medical centers and hospitals dispose liquid pollutants directly into River without treatment, once to twice daily (7 a.m. and 7 p.m.). These disposal places contain much of trees, dirty and algal growth - but no medical, offensive material like (Syringe, needle, blades ... etc.). Four stations were selected for sampling are: **Station 1**: 500 Meters before medical city (Station 2) – represent control. **Station 2**: Discharge pollution medical city. **Station 3**: 500 Meters after Station 2. **Station 4**: 2000 Meters after Station 2.

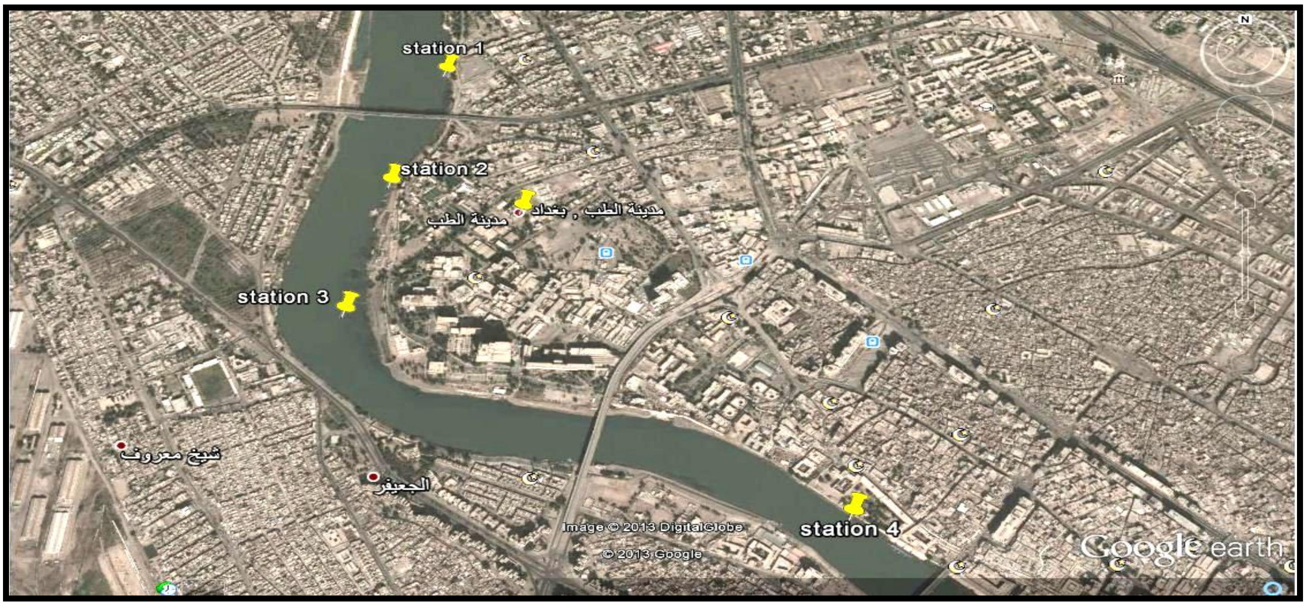

Figure 1- Sampling stations on Tigris River: Map from (Google Earth Pro).

2.2. Samples Collection and Procedures:

Samples were collected monthly during period extended from the January to June 2013 from the four stations at depth (10-15) cm surface water approximately, Sterilized glass bottles 250 ml use for bacteriological analysis and save them in cool box until reach to Laboratory at time not reach 3 hours[7].

The studies bacteriology tests:

Total Bacterial Count (T.B.C): The Pour plate method was used, one ml of diluted sample transferred to a sterilized petri dish by repeating each dilution, then 10-15 ml of the nutrient dissolved media cooled to a temperature of 44-46 °C and poured to each plate , the dish was moving in a circular motion several times to ensure homogeneity of the sample with the medium, the plates were left until the hardening of the medium, then they were incubated upside down in the incubator at a temperature of 37°C for 48 hrs., after the period of incubation the total number of each replicates of the sample was counted, the range was extracted and multiplied by the inverse of dilution to calculated the bacteria total number in 1 ml of the sample and recorded the result by the unit of (cell/1ml). [8] [9].

Total Coliform (TC), Fecal Coliform (FC), Total Streptococci (TS) and Fecal Streptococci (FS) by Most Probable Number (MPN) procedure, after make serious dilution of samples. Using MacConkey broth as cultivated medium with Durham tube for gas detection. Tubes incubated at 37 ± 0.5^{o}C and 44.5 ± 0.25^{o}C for 24 hrs. for TC and FC respectively. Using Azide Dextrose broth for both Streptococci and Faecal Streptococci bacteria as cultivated medium. Tubes incubated at 37 ± 0.5^{o}C for 24-72 hrs. and 44.5 ± 0.25^{o}C for 24-48 hrs. [10,11].

Diagnosis depending on culture, microscope and API system (API 20 E and API staph).

FC: FS Ratio [12].

3. Results and discussions:

Total Bacterial Count is an important test in the microbial water tests which gives an estimate of the total number of bacteria in the water sample, but it does not provide evidence of health risk or fecal pollution [13], Figure: 2 shows monthly changes in T.B.C for the four selected stations. Values ranged between 10000 cell/1ml in station-1 during April to 2700000 cell/1ml in station-2 during March. The statistical analysis revealed significant differences at ($P<0.05$) in T.B.C among months and stations (Table, 1). The highest number appears in winter, which might be the consequence of the high level of suspended solid and nutrients in the waste water which affected the survival of aquatic microflora [14]. While low number of bacteria during spring may be due to flood period which dilutes the organic matter which used as food for the bacteria, as well as high temperature that caused kill of large number from the bacteria [15], other workers concluded almost the same fluctuation of Abtc in Iraqi rivers [16-18].

Table 1- Minimum and maximum (First Line), mean and standard deviation (Second Line), for Bacteriological characteristics at study stations.

Stations **Parameters**	**St.1**	**St.2**	**St. 3**	**St.4**
Total bacteria count cell/1ml	10000 - 40000 190000 ± 57.3 d	300000 - 2700000 1166667 ± 483.9 a	100000 - 2000000 866667 ± 367.2 b	100000 – 1130000 521667 ± 278.4 c
Total Coliform cell/100ml	200 - 1200 476.67 ± 160.34 C	680 - 3700 2196.67 ± 447.22 a	400 - 2800 976.67 ± 385.19 b	200 - 1700 543.33 ± 234.40 C
Faecal Coliform cell/100ml	100 - 930 346.67 ± 126.01 C	200 - 2400 1076.67 ± 321.62 a	180 - 1100 413.33 ± 143.45 b	100 - 610 235 ± 77.62 d
Total Streptococcus cell/100	200 - 2000 596.67 ± 296.21 c	610 - 2800 1855 ± 376.49 a	200 - 2800 933.33 ± 475.16 b	200 - 2800 833.33 ± 439.44 b
Faeal Streptococcus cell/100	0 ± 0 c	180 - 400 310.00 ± 44.04 a	180 - 200 193.33 ± 4.21 b	180 - 200 186.67 ± 4.21 b

***Station that carrying similar character have no any significant difference between them.**

Total Coliform is considered as a general contamination indicator of water which can become from nature or from the feces [19]. Coliform bacteria are a group of bacteria present in great quantities in human feces [20]. Total coliforms have long been utilized as a microbial measure of drinking water quality and largely because they are easy to detect and enumerate in water [21]. Figure: 3 shows monthly changes in TC values ranged between 200 cell/100ml in January, May and June in station-1, and in January and March in station-4 to 3700 cell/100 ml in station-2 during April 2013. The statistical analysis revealed a significant differences at ($P<0.05$) in TC between months and stations (Table, 1). Hot months are associated with increased TC because of temperature, human and micro organism activities increased [18]. This result was similar to previous studies in Lower Al-Zab-Tigris River done by Al-Jebouri & Edham [22]. The TC results were allowable but not desirable except station-2 not allowable, table -4.

Where the FC is associated with bacteria in gut, because of their largest number, longer survive in water and easy in detection and considered as evidence of the presence of intestinal pathogenic bacteria in the water, Although detection of FC is use in all global laboratories to detect water suitability for drinking uses but it should be noted that it does not have to be sourced from the human intestine is also present in the intestines of warm-blooded animals [23]. FC has been shown to represent 93% - 99% of coliform bacteria in faeses from humans, poultry, cats, dogs and rodents [24]. FC is considered as an indicator for recent microbial pollution [25]. Figure: 4 shows monthly changes in FC, the lowest 100 cell/100 ml was encountered in Station-1 during February and in station-4 in April and May and the highest 2400 cell/100 ml was recorded in station-2 during May can be attributed to suitable environmental conditions for bacteria growth in this season and also returned to hospital and domestic waste waters and indiscriminate defecation along the river banks by both humans and other animals that graze along the river banks [17]. The statistical analysis revealed a significant differences at ($P<0.05$) in FC between months and stations, table -1. The FC results were allowable but not desirable, table -4.

Figure: 5- shows monthly changes in TS, the lowest 200 cell/100 ml was measured from station 1, 3, 4 during March, April, May and June and the highest 2800 cell/100 ml was observed in January in Stations 2, 3, 4 and in February in station-2, because humans and animals activity. The TS results were not allowable (Table, 4)

The Fecal streptococcus is intestinal bacteria, FS have been used as indicators of fecal contamination in water because presence in the intestines of humans and animals, as well as its presence in the soil and on plants and some insects [9]. Figure: 6 shows monthly changes in FS the lowest nil was observed in station-1 during the all study time, to the highest 400 cell/100 ml measured from station-2 in January, April and June 2013. In station-1 there are no factory, no discharge and no humans or animals activity so it’s nil, and the highest in station-2 because the hospital discharge and their bacterial activity.

In all months the TBC, TC, FC, TS, FS in the Station-2 significantly increased because the hospital discharge which is characterized by containing hazardous many compounds and microorganism and include bacteria, viruses, worms and hazardous chemicals and materials sterilized, so the hospital put large amounts of liquid wastewater change their quantity and quality from one hour to another and from one season to another [6].

Table 2- Selected bacteria genera and species isolated from four stations selected by API System.

Station 1	Station 2	Station 3	Station 4
E.coli *Onchrobactrium authropi* *Panteoa* *Sarcina maxima* *Burkholderia cepia* *Klebsellia oxytoca*	*E.coli,* *Onchrobactrium authropi* *Panteoa* *Sarcina maxima* *Staph(Micrococcus spp)* *Pseudomons aeruginosa* *Salmonella typhi*	*E.coli,* *Onchrobactrium authropi* *Panteoa* *Sarcina maxima* *Burkholderia cepia* *Staph(Micrococcus spp)* *Staph.hominis* *Klebsellia oxytoca*	*E.coli* *Onchrobactrium authropi* *Panteoa* *Sarcina maxima* *Burkholderia cepia,*

FC: FS Ratio: To determine the Pollution origin

FC: FS Ratio <1 is indicated for water pollution of animal source, whereas FC: FS Ratio ≥ 1 is indicated for water pollution of human source [12]. Table: 3 shows that the lowest value for this ratio is zero in Station-1 in all study time, and the highest is 8 in May 2013 Station-2. Station-1 is animal source, there are no factory, no human activities, and station-4 in April and May is animal source because hospital sewage diluted with river and reduces after this away. In station 2, 3 is humans source because hospital sewage, also in station-4 in January, February, March and June.

Table 3- FC: FS Ratio.

	Station 1	Station 2	Station 3	Station 4
Jan.	0	1.12	1	1.1
Feb.	0	1.11	1	1
March	0	6.6	6	1.1
April	0	3.5	2	0.5
May	0	8	2	0.5
June	0	2	1	3.3

Table 4- Bacteriological characteristics of the surface water [26].

Bacteria	Allowable concentration	Desirable concentration
Coliform group	1000/100 ml	< 100 / 100 ml
Faecal Coliform	2000/100 ml	< 100 / 100 ml
Streptococcus	2000/100 ml	< 100 / 100 ml

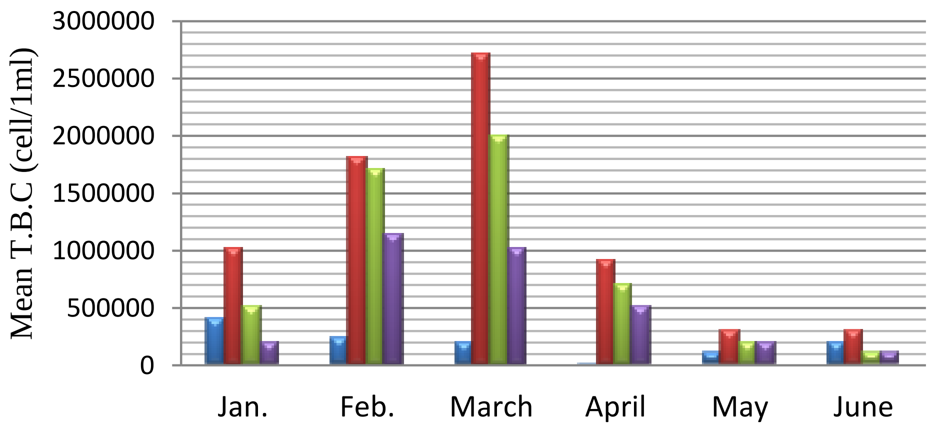

Figure 2- Monthly changes in T.B.C for the four selected stations

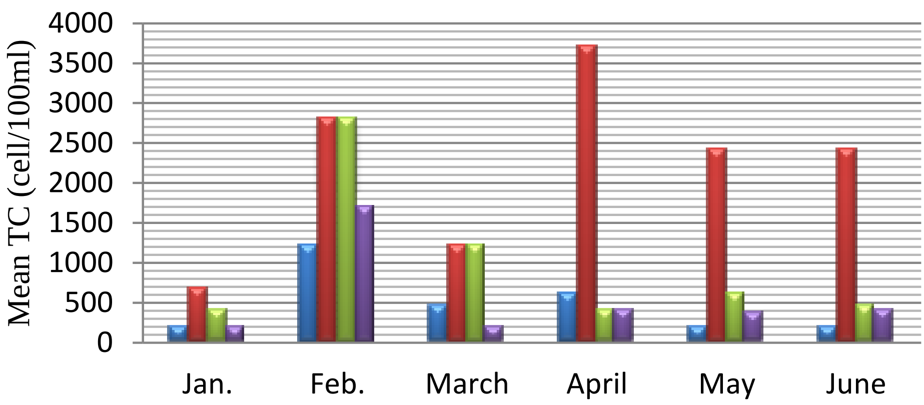

Figure 3- Monthly changes in TC for the four selected stations

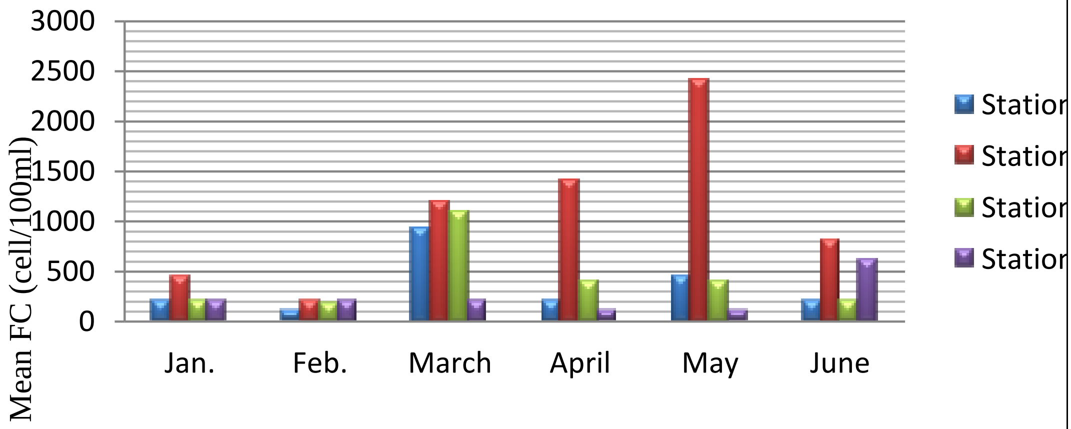

Figure 4- Monthly changes in FC for the four selected stations

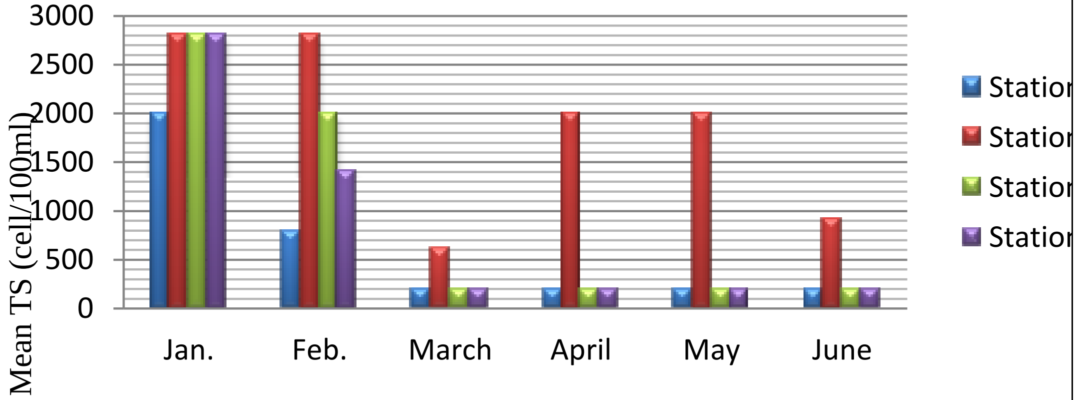

Figure 5- Monthly changes in TS for the four selected stations

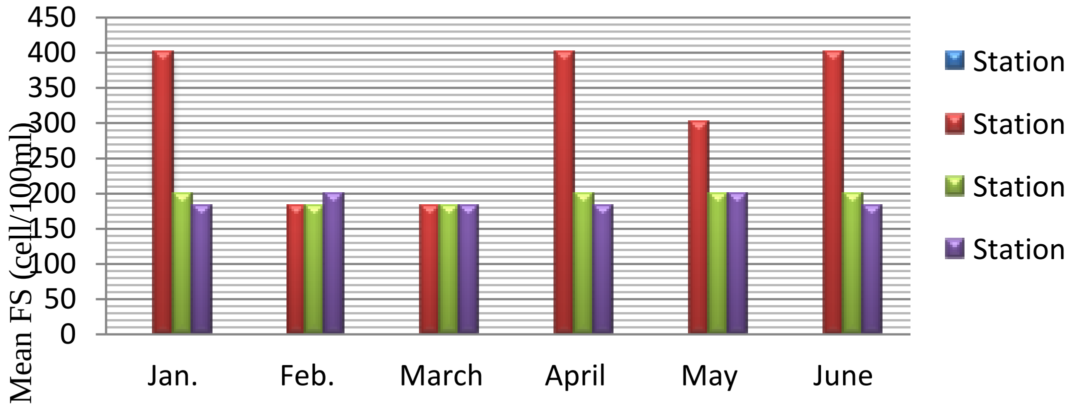

Figure.6- Monthly changes in FS for the four selected stations

4. Conclusions

I. The waste water of Medical city hospitals in Baghdad affected the bacteriological characteristics of Tigris River.

II. The results revealed that water parameters of bacteriology were allowable but not desirable in most studied locations and months.

5. References

1. Razzak, I.A. and Sulaymon, A.H. **2009**. Effects of Discharging Sewage of Baghdad to Tigris River on the Water Quality. *Eng. and Tech. Journal*. , pp:27:16.
2. Rahi, K.A. and Halihan, T. **2010**. Changes in the salinity of the Euphrates River system in Iraq. *Reg Environ Change* 10, pp:27–35.
3. Al-Bayatti, K.K.; Al-Arajy, K.H. and Al-Nuaemy, S.H. **2012**. Bacteriological and Physicochemical Studies on Tigris River Near the Water Purification Stations within Baghdad Province. *Journal of Environmental and Public Health*.8.
4. Ojo, O.A. and Adeniyi, I.F. **2012**. The Impacts of Hospital Effluent Discharges on the Physico-chemical Water Quality of a Receiving Stream at Ile Ife, Southwestern Nigeria. *Journal of Sustainable Development*.
5. Emmanuel, E.; Perrodin, Y.; Keck, G.; Blanchard, J.M. and Vermande, P. **2002**. Effects of hospital wastewater on aquatic ecosystem. *Congreso Int*., , pp :27-31.
6. Elia, N.H. **2010**. The Physicochemical treatment of waste water Mosul hospital complex. *J.Eng. Al-rafiden*.18(3):13-24.(in arabic).
7. APHA (American Public Health Association). **1998**. Standard method for examination of water and waste water, APHA press. 20TH ed.
8. AOAC. **2005**. Official Methods of Analysis, 18th ed. edited by Horwitz, W. and G. W. Latimer, *AOAC International*.
9. APHA, AWWA and WFF. **2005**. Standard Methods for the Examination of Water and wastewater, 21th ed., edited by Eaton, A. D. ; L. S. Clesceri; E. W. Rice, and A. E. Greenberg. *American Water Work Association and Water Environment Federation*, USA.
10. APHA (American Public Health Association). **1999**. Standard methods for the examination of water and waste water, *American Water Works Association, Water Environmental Federation*.
11. WHO (World Health Organization). **1971**. International standard for drinking water. 3rd edition. New York. USA.
12. Geldrich, E.E. **1967**. Fecal Coliform concepts in stream pollution. *Water and sewage works*. 114 Nov., pp:98-109.
13. WHO (World Health Organization). **2006**. Guidelines for drinking water quality. 3rd ed. first addendum. World Health *Organization*, Geneva. 1, pp: 515.
14. Hader, D.P.; Kumar, H.D.; Smith, R.C. and Dobler, W.I. **1998**. Effects on aquatic ecosystems. *J Photochem and Photobiol* 46, pp: 53-68.
15. Abdo, M. H.; Sabae, S. Z.; Haroon, B. M.; Refaat, B.M. and Mohammed, A. S. **2010**. Physico-chemical characteristics, microbial assessment and antibiotic susceptibility of pathogenic bacteria of Ismailia Canal Water, River Nile, Egypt. *J. American Science*. 6(5) , pp:243-250.
16. Al-Shwani, T.M.K.A. **2001**. An Ecological and Microbiological Study on Lower Al-Zab Waters from Al-ton Kobri to Al-Hawija District in Al-Taameem Governorate. M.Sc. Thesis. University of Tikrit, Iraq.
17. AL-Fatlawy, Y.F. **2007**. Study the Drinking Water Quality of Some Baghdad Drinking Water Treatment Stations. Ph.D. Thesis, University of Baghdad, Iraq.
18. Waite, W.M. **1985**. A Critical Appraisal of the Coliform Test. *Journal of the Institute of Water Engineers and Scientists*.39, pp:341-357.
19. Al-Rahbi, S.M. **2002**. Bacterial pollution in Al-Habania and Al-Tharthar reservoirs. M.Sc. Thesis. University of Baghdad. Iraq.
20. Alley, E. R. **2007**. *Water quality control handbook*. The McGraw-Hill Companies, New York.
21. Al-Zubaidi, A.N. **2011**.A study of Al-Kut and Al-Karama water treatment plants efficiency to purify the drinking water in Al-Kut city. M.Sc. Thesis, University of Baghdad, Iraq.
22. Al-Jebouri, M.M. and Edham M.H. **2011**. An Assessment of Biological Pollution in Certain Sector of Lower AL-Zab and River Tigris Waters Using Bacterial Indicators and Related Factors in Iraq. *Journal of Water Resource and Protection*. 4, pp:32-38.
23. Edberg, S.C. Rice, E.W. Karlin, R.J. & Allen, M.J. **2000**. *E.Coli*: the best biological drinking water indicator for public health protection. *Journal of applied microbiology*, 88, pp, pp:106-116.
24. WRC (Water Resources Commission), **2003**.Ghana Raw Water Criteria and Guidelines. Domestic Water, *CSIR-Water Research Institute*, Ghana: 1.
25. Al-Jebouri, M.M. and Trollope, D.R. **1981**.The Escherichia coli Content of Mytilus edulis from Analysis of Whole Tissue or Digestive Tract. *Journal of Applied Bacteriology*. 1(51), pp:135-142.
26. Mahmood, T. A. **1988**. Environmental science and technology, *Dar Al-Kotob for the printing and publishing* (9). University of Mosul.