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Seasonal variation of some contamination indicators in Euphrates river water in Al- Nasiriyah city

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ABSTRACT

This study was aimed to evaluated the bacterial contamination of the Euphrates river flowing through the city of Nasiriyah , the study was included done some bacteriological tests on river water, and the samples were collected from three stations , included three indicators , total coliform (TC) bacteria , Fecal coliform (FC) and Fecal Streptococci (FS). The sampling performed monthly for monitoring of water river in 2016 , it was expressed seasonally , It was appeared that TC , FC and FS was registered higher rates for all stations in autumn in range (2900-4400) (2000- 3500), (11000 - 14000) cell / 100 ml respectively and the smallest rates was in summer season in ranged between (1500- 2600), (1800- 2200) and (3000 - 4200) cell / 100 ml respectively . The second station was appeared higher numbers of all indicators bacteria for all seasons in range (2600-4400), (2200-3500)and (1400-9200) cell / 100 ml respectively ,while The first station was registered smallest numbers of them for all seasons in ranges (1500-2900), (1500-2000)and (3000 - 13000) cell/ 100 ml respectively . According to parameters of water quality Interpretation and Standards of European Communities, 1989 and Environmental Protection Agency ,2001 **,** all numbers of TC were less the numbers of A1 category(<5000 cell / 100ml), FC bacteria were more than numbers of A1 (>1000 cell / 100ml) and less than numbers of A2 group (<5000 cell / 100ml) . In regarded of FS , they were larger than numbers of A2 group(>2000 cell / 100ml) and larger than numbers of A3 group (>10,000 cell / 100 ml).The results of the study were found when studying the source of fecal contamination by using the proportion of FC to FS , all proportions to all stations in all seasons were less than 0.7,this indicate to contamination source was animal feces , except in station number 1 in spring the ratio was 1.88 which indicate to mixed contamination .

Key words : TC,FC,FS, river water, contamination indicators.

INTRODUCTION

Water is an essential natural resource for human life. Furthermore, it is an important resource in developing economics and society in terms of agriculture, industry and various facilities. Rivers not only supply water for human consumption but also receive wastewaters discharged from all human activities (ICMM, 2007).

The internal water in Iraq covers about (24000) km² which consist more than (5%) of Iraq area including, marshes, lakes, Tigris, Euphrates, their tributaries and branches (Jerry & Webb, 2004).

Most of Iraqi industries and all the Iraqi cities and highways are located on the banks of the main rivers without or with insufficient waste treatment stations causing microbial, organic and inorganic pollution; the Iraqi climate may be increasing the effects of these pollutants, when the temperature in summer reaches the highest value (Mousa *et. al.*, 1986).

Total coliform , the coliform were defined as gram negative , facultative anaerobic bacilli , non spore – forming that ferment lactose and production acid and gas (Mack , 1977).Total coliform were regarded as belonging to the genera *Escherichia* , *Enterobacter* , *Citrobacter* and *Klebsiella* , the group is heterogeneous , it includes many species such as *Enterobacter*

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cloacae and Citrobacterfreundii, which can be found in both feces and the environment nutrient – rich waters , soil and decaying plant material as well as in drinking water (OECD&WHO, 2003) .Total coliform bacteria (excluding *E.coli*)occur in both natural waters and sewage . Some of these bacteria are founded in the feces of animals and humans(WHO,2004). Coliform bacteria are of use as indicators of general microbial quality , and are also no longer regarded as indicators of fecal contamination . this acknowledges that some coliform bacteria may be part of the natural bacterial flora in water and proliferate in biolfilms.

Theromtolerant coliforms are defined as the group of total coliforms that are able to ferment lactose at 44-45 C , this group including the genus Escherichia coli and to a lesser extent *Klebsiella spp. CitrobacterEnterobacter* (Fujoka *et. al* ., 1999).

The principle of bacteriological testing is to identify a fecal indicator organism that is always excreted by warm – blooded animals , both health and an health , and to the degree of its presence as an indication of the degree of fecal contamination.

Bacteria from the thermotolerant(fecal) coliform group are nearly always present in feces, their presence in water is a strong indication of fecal contamination ;fecal streptococci , chain forming gram positive cocci used to be placed in the genus streptococcus and fecal streptococci were those streptococci generally present in the feces of humans and animals (OECD& WHO , 2003), Fs or enterococci that normally occur in fecal matter , which include *E. faecalis* . *E. faecium* , *S. bovis* , *E.avium* , *S. equinos* , *S. mitis* , *S. salivarius* (Leclerc *et al*., 1996). Fecal streptococci are more resistant to stress and chlorination than *E. coli* and the other coliform bacteria .these bacteria use as the parameter of choice as they are clearly of fecal origin from blooded animals (Gleeson & Gray , 1997).

The present study aim to evaluate the water quality status by measurement the percentage of microbial contamination in the Euphrates River near the center Nasiriya city, and this is done through: measurement the rates of total coliform counts, (TC) fecal coliforms (FC) , fecal Streptococci, in River water .

MATERIAL AND METHODS

Study Area :

The completion of the current study was chosen three stations Euphrates River (Figure 1) as follows:

1- **The First Station**: Sit before entering the river the city center, about 3 km^2 from city center.
2- **The Second Station** : Sit at near the city center.
3- **The Third Station:** Sit after the exit of the river from the center of the city, , about 3 km^2 from city center .

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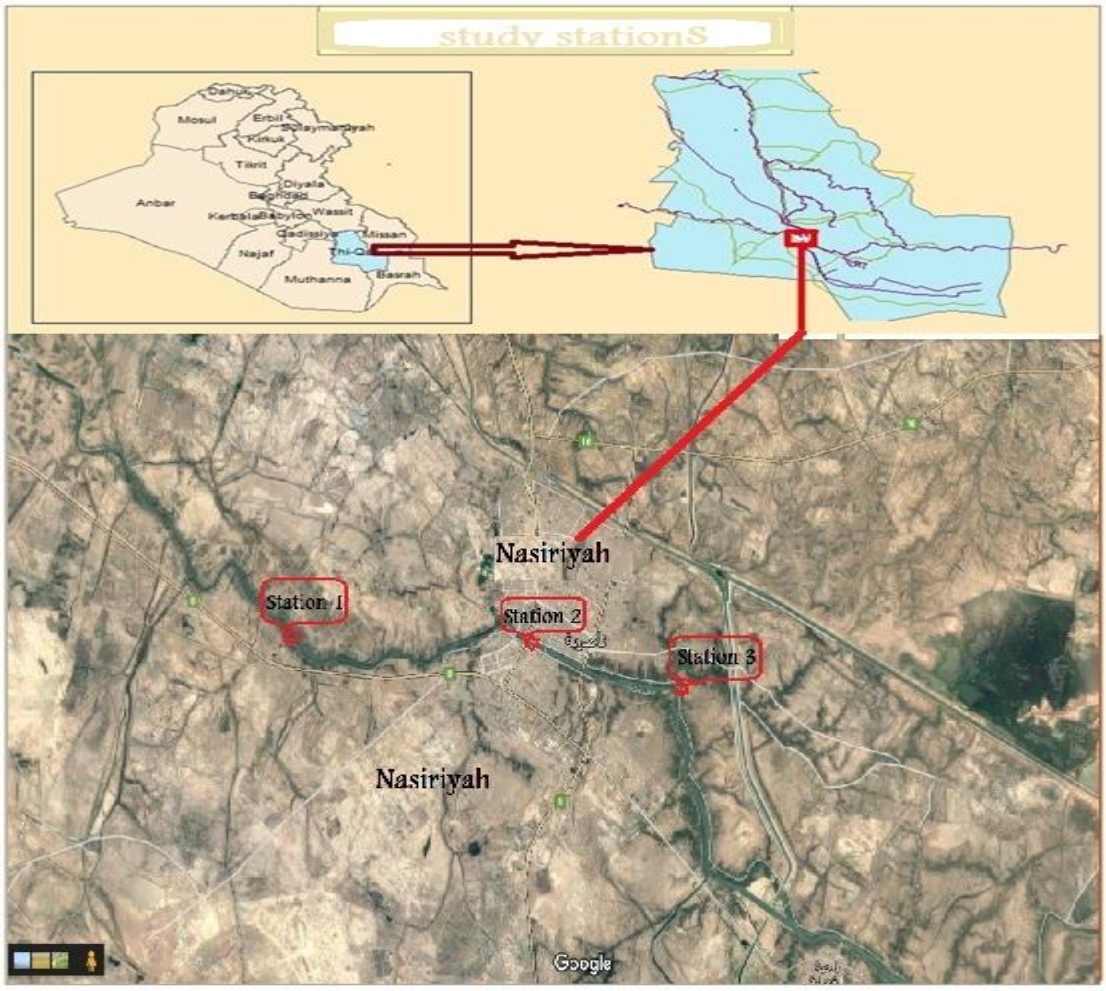

Figure 1: Stations studied in Euphrates river

Sample collection : The sampling performed monthly for monitoring of water / 2016 , it was expressed seasonally , triplicate samples were taken from each station , by polyethylene bottles volume (3) per liter for the purpose of the required tests.

Laboratory Measurements

Total coliform bacteria and thermotolerant (fecal)coliform were identified according the method Most Probable Number (MPN)that description in(WHO, 1997).Fecal streptococci were isolated by MPN method that mention in (Bartram and Ballance ,1996).The number of indicators bacteria of river water were evaluated according to (European Communities, 1989 ; Environmental Protection Agency , 2001) as follows:

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Surface Water Quality Standards

Parameters	Unit of measurement	Standards for Categories		
		A1	A2	A3
- Total coliforms 37°C	/100 ml	5,000	25,000	100,000
- Faecal coliforms	/100 ml	1,000	5,000	40,000
- Faecal streptococci	/100 ml	200	2,000	10,000

Definition of the standard method of treatment for transforming surface water of categories A1 ,A2,and A3 into drinking water .

Category A1

Simple physical treatment and disinfection, e.g. rapid filtration and disinfection.

Category A2

Normal physical treatment, chemical treatment and disinfection, e.g. prechlorination, coagulation, flocculation, decantation, filtration, disinfection (final chlorination).

Category A3

Intensive physical and chemical treatment, extended treatment and disinfection, e.g. chlorination to break-point, coagulation, flocculation, decantation, filtration, adsorption (activated carbon), disinfection (ozone, final chlorination).

Statistical Analysis

Analysis of Variance ANOVA test were done to know the Least significant difference among the numbers of bacterial indicators through the seasons and through the stations . Correlation factor between bacterial indicators (Al – Rawi , 2000).

THE RESULTS

It was appeared that TC was registered higher rates for all stations in autumn in range (2900-4400)cell / 100 ml and the smallest rates was in summer season in ranged between (1500-2600)cell / 100 ml . the higher numbers of TC was appeared in second station for all seasons in range (2600-4400)cell / 100 ml . The first station was registered smallest numbers for all seasons in ranges (1500-2900)cell/ 100 ml table (1). All the numbers of TC were less than the numbers of TC of A1(<5000cell/100ml) category according to European Communities ,1989 and Environmental Protection Agency, 2001.

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Table(1): Quarterly rates of total coliform counts (TC) in water (cell / 100 ml)

Season	**The Station**	**NO .of TC) Cell / 100ml(**
The Autumn	ST.1	2900
	ST.2	4400
	ST.3	3200
Winter The	ST.1	2300
	ST.2	3800
	ST.3	2700
The Spring	ST.1	2000
	ST.2	3000
	ST.3	2200
The Summer	ST.1	1500
	ST.2	2600
	ST.3	2100

The results revealed that the higher of FC numbers in water were detected in autumn season for all station in range (2000- 3500) cell/ 100 ml , and the smallest rates was in summer season in ranged between (1800- 2200)cell / 100 ml, the higher numbers of FC was appeared in second station for all seasons in range (2200-3500)cell / 100 ml ,and the results indicate the smallest numbers of FC was appeared in first station in range (1500-2000)cell / 100 ml. All numbers of FC were above from 1000cell/ 100ml (A1 category) and less 5000cell /100ml (A2 category) according to European Communities, 1989 and Environmental Protection Agency ,2001 (Table 2) .

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Table (2): Quarterly rates of fecal coliforms (FC) in water (cell / 100 ml)

Season	**The Station**	**NO .of FC)Cell / 100ml(**
The Autumn	ST.1	2000
	ST.2	3500
	ST.3	2400
Winter The	ST.1	2000
	ST.2	2600
	ST.3	2200
The Spring	ST.1	1700
	ST.2	3300
	ST.3	1900
The Summer	ST.1	1500
	ST.2	2200
	ST.3	1800

In table (3), the results was appeared the higher numbers of FS were in autumn for all stations under the study , it was ranged between (11000 - 14000) cell/ 100 ml , while the lower number of FS was appeared in summer in range (3000 - 4200)cell / 100 ml . The second station was revealed higher number of FS through all seasons in range (1400-9200)cell/ 100 ml and the lower numbers were registered in first station , it was between (3000 - 13000)cell / 100 ml. It was appeared the numbers of FS were ranged > A2(2000cell/100ml) - >A3(10000 cell/100ml) category according to European Communities, 1989 and Environmental Protection Agency, 2001 .

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Table (3): Quarterly rates of fecal Streptococci in water (cell / 100 ml)

Season	The Station	NO .of FS)Cell / 100ml(
The Autumn	ST.1	11000
	ST.2	14000
	ST.3	13000
Winter The	ST.1	7800
	ST.2	13500
	ST.3	9200
The Spring	ST.1	9000
	ST.2	12000
	ST.3	9400
The Summer	ST.1	3000
	ST.2	9200
	ST.3	4000

The statistical analysis was appeared the presence of significant differences (≤o.o5) among the numbers of TC through the studied seasons and through the stations .

When a correlation coefficient was found between the microbial indicators, a link was found between TC and FC. There was no association between TC and FS .

Table 4 was appeared The proportion of FC to FS , all proportions to all stations in all seasons were less than 0.7, except in station number 1 in spring the ratio was 1.88 .

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Table (4): Percentages between the numbers Fecal Coliform and Fecal Streptococci

Season	The Station	NO .of FC)Cell / 100ml(	NO .of FS)Cell / 100ml(	FC/FS	source of pollution
The Autumn	ST.1	2000	11000	0.18	Animal fecal
	ST.2	3500	14000	0.25	Animal fecal
	ST.3	2400	13000	0.184	Animal fecal
The Winter	ST.1	2000	7800	0.25	Animal fecal
	ST.2	2600	13500	0.192	Animal fecal
	ST.3	2200	9200	0.23	Animal fecal
The Spring	ST.1	1700	9000	1.88	Mix(predominant -Animal fecal)
	ST.2	3300	12000	0.275	Animal fecal
	ST.3	1900	9400	0.20	Animal fecal
The Summer	ST.1	1500	3000	0.5	Animal fecal
	ST.2	2200	9200	0.23	Animal fecal
	ST.3	1800	4000	0.45	Animal fecal

DISCUSSION

Bacterial indicators have been used to find out the health of surface waters and fitting for drinking and other uses for humans . total coliform , fecal coliform and fecal streptococci are used as indicators bacteria in determine the presence of pathogenic bacterial contamination (Onwumere , 2007) , our results were appeared , the highest level of TC, FC and FS in temperate seasons such as autumn in all stations under the study , this may be due to the temperate temperature in this season which appropriate to grow of these bacteria, while the lowest level of all types of bacterial indicators were in summer , this season have high temperature and sunshine that caused the death of high numbers of these bacteria (Rai& Hill , 1978) , and the low temperatures assist for the stay these bacteria for long time (Atlas & Bartha , 1986) , these results were agreement with local study by Noam (1998) who revealed that all indicators bacteria (TC, FC and FS) that isolated from water river in Baghdad were registered higher numbers in seasons which have lower temperatures and lowest numbers were in summer . This study was appeared the second station was registered the higher numbers of all bacterial indicators among the other stations under study , in this station , the river will have been put up across the city's waste – laden various contaminants that link to this site which makes the water of the river then loaded with new pollutants as well as contaminants in situ bacteria causing increasing rates of outlets . The results of this study show that the river water contains a high percentage of fecal indicators and this may indicate the presence of other intestinal pathogens in those waters, as pointed out by Wilkes *et al*., (2009) that bacterial

indicators are used as evidence of the presence of other pathogens. Our results showed ,all numbers of TC were less the numbers of A1 category(<5000 cell / 100ml), This means that the numbers of these bacteria are within the ranges allowed in the water of the river, Fecal coliform bacteria were more than A1 (>1000 cell / 100ml)and less than the A2 group (<5000 cell / 100ml), meaning that water is contamination ,and needed Simple physical treatment and disinfection. In regarded of FS , they were larger than the A2 group(>2000 cell / 100ml) and other numbers were larger than the A3 group (>10,000 cell / 100ml). This means increasing the number of these bacteria from the permissible limits. It is the most widely studied bacterial indicator, and the water was high contamination ,and need Intensive physical and chemical treatment, extended treatment and disinfection, when using this water to drink (European Communities ,1989 and Environmental Protection Agency , 2001) .The proportion of FC to FS was taken to know the source of the stools , when the ratio is more than 4 to be source of pollution is the man , either if the ratio between (2.0 -4.0) indicates that the predominant of human waste within the mixed pollution , while the proportion between (0.7-1.0) this indicates that predominant of animal waste in mixed pollution , either if the ration is less than 0.7 indicates that the source of the contamination is animal (APHA , 1989).Our results showed all proportions of FC to FS was indicates to the source of the stool is animal .

We conclude from our study, increased percentage of microbial contamination in the Euphrates River , and water is exposed to large-scale pollution and from various sources. We recommend treating wastewater before dumping it into the river, in addition do not throw of animal, industrial and agricultural waste in the water.

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