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DETERMINATION OF BACTERIAL POLLUTION LEVEL IN EUPHRATES RIVER WITHIN Al-ANBAR PROVINCE, IRAQ

A. M. A. Taha[1] S. M. Shratooh[2] A. H. Jasim[3] B.

E-mail: brrnxn525@gmail.com

ABSTRACT

The biological properties of water are important in determining the suitability of water for various uses on the hand in addition to knowing the level of environmental pollution of this water on the other hand. This study aims to reveal the level of pollution occurring in the waters of the Euphrates River through these characteristics, and to identify the sources of this pollution. During the period from April 2022 to March 2023, the water quality of the Euphrates River was examined between Al-Qaim and Ramadi cities. The examined parameters include dissolved oxygen (DO), Biochemical oxygen demand (BOD), Fecal Coliform (FC), Total coliform Bactria (TC), Total plate count (TPC). The obtained values of such parameters were compared with the standard values of the World Health Organization (WHO). While most of the measurements were within the allowable range such as DO and BOD values in Hit and Ramadi cities which reached 8.31±0.41 mg/l, and 4.41±0.93 mg/l respectively, some values exceeded the limits of WHO regulations such as FC and TC values in Al-Qaim district which reached to 82.39±30.35 cell/100ml and 203.94±77.74 cell/100ml respectively. However, the correlation coefficient between the involved parameters was examined related to location and time. In conclusion, river pollution levels varied from one region to another area through the under-study parameters, as river water is generally suitable for irrigation but not for drinking without pretreatment processes.

Keywords: Euphrates River, coliform, Fecal Coliform.

INTRODUCTION

Water is of primary importance in human life, stability, and the continuation of duties and behavioral manifestations [3]. Surface water is at the top of the

[1] **Ministry of Education, Anbar Education Directorate, Ramadi, Iraq.**
[2] **Collage of Science, University of Anbar, Ramadi, Iraq.**
[3] **Ministry of Higher Education and Scientific Research, Baghdad, Iraq.**
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ladder of importance, because of the possibility of investing it directly without much trouble, and because water occupies the center stage in global problems, so the issue of water has now become one of the hot topics in international politics and the relations of countries with each other [6]. One of the most important problems with regard to water is the problem of bacterial pollution and the dangers resulting from it, as water is a major source of infection with many diseases because it is a vector and carrier of many microorganisms that have a negative impact on life in various fields [5].

River water is the main source of freshwater used to meet human, animal and plant needs [7]. And the irrational exploitation of this vital resource led to its deterioration in quantity and quality, and many rivers became a dumping ground for liquid and solid waste, which led to a change in the quality of its water chemically, physically and biologically [9], and this in turn led to pollution of the water of river so that it became unfit for various daily human uses [10]. The problem of water pollution has increased with the increase in the proportion of the population in the world, as the daily consumption of water by the population presents with it large amounts of human pollutants that reach the water through untreated sewage water, in addition to animal and agricultural pollutants that reach the water of rivers, which makes this water a source of many fecal coliform bacteria that are indicative of fecal contamination in water [27].

The world is now witnessing an increasing interest in water resources and how to confront the dangers that threaten them, such as an increasing shortage and a deterioration in their quality [31]. Water covers an area estimated at about 71% of the surface of the globe, oceans constitute about 98% of this area, fresh water constitutes about 2% of it, and this small percentage is invested for various human purposes and at the same time exposed to pollution as a result of these human uses. The objectives of the current study are based on the study of the bacteriological, physical and chemical properties of the water of the Euphrates River through selected districts namely Al-Qaim, Anah, Haditha, Hit and Al-Ramadi, which the river flows through them and an attempt to diagnose some pathological bacteria endemic or entering the river water, and conducting vital tests to include the total count of bacteria (TPC) Toal Plate Count, counting Total Coliform, Total Fecal Coliform [2].

In a study Chabuk et al. [11] of the effect of sugar and tanning factories' wastes and population wastes on the water quality of the Tigris River, they found an increase in the concentrations of the biochemical oxygen demand (BOD_5) and a decrease in the dissolved oxygen concentration of the waters of these wastes, so its effect was negative on the waters of the Tigris River. Tigris, especially the areas near these wastes. While it found that the water characteristics of the Tigris River changed in the wastes of the modern tanning factory in Mosul, the results show that these wastes negatively impacted the water wealth due to decreased dissolved oxygen concentration. Long distances from the river.

Al-Jahsani et al. [4] explained the effect of the civil and industrial waste water of the district of Mosul on the water quality of the Tigris River, where it was found that there was an increase in the electrical conductivity values of the river water sites close to the waste water. The river water is affected by the effect of waste water and with the increase in the values of the biochemical oxygen demand BOD_5, and it was also mentioned that the quality of the river water exceeds the permissible limits for water sources used for human consumption due to the high

total number of bacteria and the total number of coliform bacteria as a result of the disposal of municipal industrial and agricultural waste of the district.

Bacteria in water consume large amounts of dissolved oxygen, and dissolved oxygen levels can decrease during over-fertilization of aquatic plants by floods or flows from agricultural fields that contain phosphates and nitrates as fertilizer components [26].

If the BOD value ranges between (1-3) mg/l, this water is considered poor, while the value of (5) mg/l is considered critical between contaminated and poor water [11]. In their study of some bacterial pollutants in the waters of the Euphrates River and the Habbaniyah and Tharthar lakes, they were able to isolate and diagnose several bacterial species, including *Enterobacter, Klebsiellp ssp,* bacteria as evidence of organic and icrobial pollution of the water. Among the most important of these organisms, which are an indicator of biological contamination, are coliform bacteria, which are found naturally in the human intestine, in addition to other types of pathogenic bacteria such as *Sterptococcus, Proteus Psedomonas, Vibrio cholera, Shigella,* and *Salmonella* [27].

Description Study Sites

Water samples were taken from the following study stations, with three samples and three replications. The first sample is before the river enters the district, the second sample is through the river's flow the district, and the third sample is after the river passes the district. The sample is representative of each section of the river within the district, randomly.

The first location: Al-Qaim district 292 km from Al-Ramadi city center. The river flow through the center of the district. The water is flowing and has a fast current, the river section is narrow due to intensive agricultural activities, and different animals such as sheep, cows and aquatic plants are observed.

The second location: Anah district is 94 km away from the first station (Al-Qaim district), and the water flow is sparse. Human activities such as fishing were observed. The water is not clear, which reflects the quality of the water, such as turbidity, and the water level is low.

The third location: Haditha district is 63 km away from the district of Anah (the second site), and the water is fast-flowing. The liquid household waste passes through the district center and is directly discharged into the river, as well as the springs of Wadi Hajlan (the sulfur springs), which affects the water quality.

The fourth location: the district of Hit is (85) km away from Haditha. Where intensive agricultural activities abound before entering the district of Hit, as well as some untreated sewage and municipal sewage pipes, were discharged directly into the river. And the water has currents running and fast.

The fifth location: is the district of Ramadi (61) km from the district of Hit. The water is running and has a fast current when the dam gates are raised. The river passes through the center of the district, where the wastewater of the Ramadi General Hospital was noticed, which throws it directly into the river without treatment, as well as car washing stations and household sewage outfalls, as well as the presence of sand washing plants on the banks of the river.

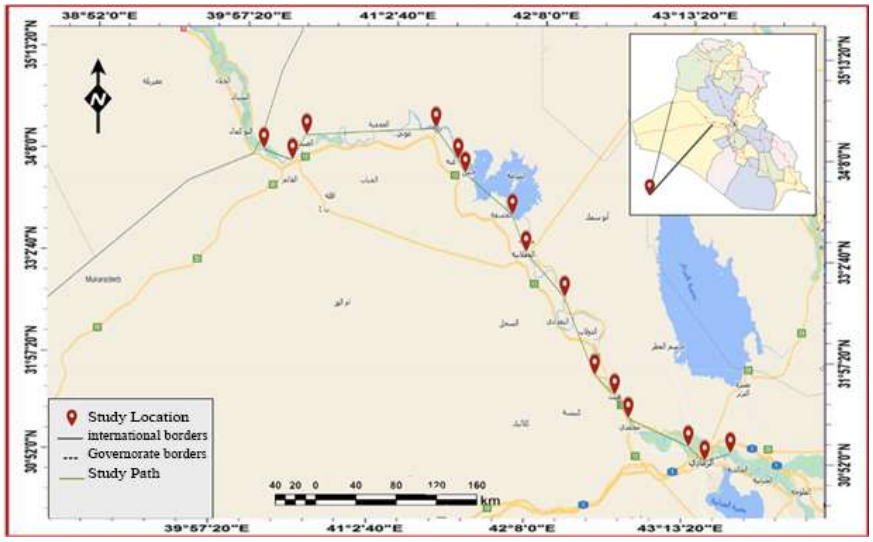

Figure (1) The study sites on the Euphrates River.

The study was conducted from April 2022 to March 2023, one sample was taken per month for each site. The samples were collected within one site in three patterns (before the district, at the district, after the district) and for all locations. Five sites were selected on the Euphrates River. The first site is in the Al-Qaim, then the district of Anah, then the district of Haditha, then the district of Hit, and the last site is the district of Ramadi. It included sample collection and field work on the same day and as soon as possible to measure the required physical and chemical properties. Then return to the laboratory to conduct a laboratory analysis in the coming days.

Samples were generally collected as follows:

Water samples were collected for physical and chemical tests using clean 5-liter polyethylene containers [12]. And Water samples were collected using transparent 250 ml Winkler bottles to determine dissolved oxygen DO and 250 ml dark Winkler bottles to determine (BOD_5). Then Water samples were collected for bacterial examinations using glass bottles of 250 ml, after they were sterilized with an Autoclave device. The samples were kept at an appropriate temperature until they arrived in the laboratory [15].

MATERIALS AND METHODS

The samples are measured immediately after being them, and when they cannot be measured, they are kept away from direct sunlight, but after fixing the dissolved oxygen in it by adding manganese sulfate and alkali iodide azide, then concentrated sulfuric acid to it and trying to measure it as soon as possible. When the sample is taken directly from a river, the bottle is held at its base, and its neck is inserted with water in an oblique manner, provided that the nozzle is towards the top and towards the current, filling the bottle.

The bacteriological examination of the water bottle must be conducted immediately after collection, provided that the time after collecting the sample and conducting the examination does not exceed (6) hours [11].

Fieldwork

Dissolved Oxygen and Biochemical Oxygen Demand (BOD_5). The Azide modification method of Winkler's method was used (Azide modification [14] and the product was expressed in mg/l units while BOD_5 was determined as follows:

-Dissolved oxygen was fixed in the vial by adding manganese sulfate and alkali iodide azide, then concentrated sulfuric acid to be measured in the laboratory later.

Biological tests of water

Biological water tests are wind and varied, and most are directly related to changing the environmental balance and determining the type and quantity of pollution. The most comprehensive and most important of these tests is in determining the suitability of water for different uses. These tests include:

Bacteriological examination of water, including determination of:

a- The total number of bacteria in the water.

b- The most probable number of coliform bacteria.

Bacteriological examination of water:

Water is generally a good medium for bacteria to live and grow. Bacteria live suspended in the water column or settled in the bottom mud or above aquatic plants, animals and may be inside them.

A- The total number of bacteria in the water: Total Plate Count (TPC).

Method of Work

Sterile Petri dishes are placed in the presence of fire, taking into account the preparation of two dishes for each sample and its accurate numbering. The lid of the dish is lifted on one side to the lowest possible opening and one milliliter of sample or any dilution is transferred with a sterile pipette. Lift the lid of the dish again from the side, and pour in it about (10-15) milliliters of sterilized food medium, which has a temperature of about (44-46) C°. Mix the contents of the plate well by gently moving the plate. Dishes must be poured in the same manner within a period not exceeding (15) minutes, taking into account accuracy to avoid external contamination. The dishes were left to freeze quickly, then the crops were incubated by placing them upside down in the incubator at a temperature of (35 ± 0.5) C° for a period of (48 ± 3) hours. After the end of the incubation period, count the number of colonies in each plate and calculate the average number of colonies per milliliter of each sample. Multiply the number of bacterial colonies by the reciprocal of the dilution ratio of the diluted samples.

B- The most probable number of coliform bacteria (MPN)

1- Total Coliforms Bacteria (TC)

2- Fecal Coliform (FC)

This test is done by inoculating a group of fermentation tubes containing liquid MacConkie medium with appropriate, (5) tubes were used for each test with a concentration (10 ml, 1 ml, 0.1 ml) of the water sample, amounts of the sample and incubation at a temperature of (35 ± 0.5) C for a period of (24) hours or (48) hours. The coliform bacteria can ferment the sugar lactose, and this protection of carbon dioxide gas accompanies this fermentation. In light of determining the number of tubes in fermentation gas formation result appeared, the most likely number of coliform bacteria can be determined. This examination is called the presumptive test [1].

Method of Work:

(10) milliliters of McConkey Broth double concentration should be placed in each of the five fermentation tubes. (10) milliliters of McConkey Broth monoconcentrate should be placed in each of the ten fermentation tubes. A tube of one dirham is placed upside down in each fermentation tube, and the air inside the tube dirham, if any, is removed by turning the fermentation tube several times after covering it. Each fermentation tube is closed with a piece of cotton and sterilized using autoclave at (121) C for (15) minutes, then quickly cooled to avoid the decomposition of sugar in slow cooling. Feed each of the five fermentation tubes containing McConkey Broth with double concentration (10) milliliters of the water sample. Feed each of the five fermentation tubes containing McConkey Broth monoconcentrated with one milliliter of the water sample. Feed each of the last five fermentation tubes containing Macconkey Broth monoconcentrate (0.1) milliliters of water sample. Each tube is covered with a piece of cotton, and the tubes are arranged (according to the amount of the sample) into three groups, then incubated at a temperature of (35 ± 0.5) C for a period of (24 + 2) hours, and when no gas appears after this period, the incubation period can be increased for a period of (24) another hour. In the event that gas is present at a percentage of (10%) of the volume of the AED pipes, the result is considered positive (+ve), and in the event that no gas is formed in the AED pipes, the result is considered negative (-ve). The most probable MPN number of coliform bacteria in (100) milliliters of the sample is determined by comparing the results of the positive combination with approved standard values. As for the Fecal Coliform (F.C) count, the same previous steps are followed by inoculating the tubes with positive samples, but the incubation is at a temperature of (44.5) Celsius to reveal the pathological pattern of the bacteria.

Statistical Analysis:

The Average and Standard Deviation and chart were used. An analysis of variance table (ANOVA) and the LSD test were used to compare significant differences at the 0.05 level of probability to find out the differences between the averages of the study variables by months and by regions. Employing the Pearson correlation coefficient to determine the relationship directly between physical, chemical, and biological variables, all the studied statistical values were obtained using the statistical analysis of the (SPSS) version (25).

RESULT AND DISCUSSION

Differences were shown in the values of dissolved oxygen in the waters of the Euphrates River, where the highest mean value was in the district of Hit and reached (8.31 mg/l), and the lowest mean value was in the district of Anah and amounted to (7.9 mg/l). The results of the statistical analysis showed that there is a significant difference in the results obtained between the study cities or locations and below the probability level($P \leq 0.05$). The obtained results showed that the highest mean value (BOD_5) was in the city of Al- Ramadi and amounted to (4.41 mg/l), while the district of Haditha recorded the lowest mean value and amounted to (3.68 mg/l). The results of the statistical analysis showed that there is a significant difference in the results obtained between the cities of Hit and Ramadi, and below the probability level($P \leq 0.05$). The results obtained indicate the values of the number of fecal coliform bacteria (FC) and the total number of coliform bacteria (TC) in the waters of the Euphrates River, where the highest

mean value of bacteria rates was recorded in the district of Al-Qaim, which amounted to (82.39 cell/100ml) and (203.94 cell/100ml), respectively. While Haditha District recorded the lowest mean value (68.03 cell/100ml) and (165.39 cell/100ml), respectively. The obtained results showed the values of the total bacterial count (TPC) in the water of the Euphrates River, where the highest mean value of bacteria was recorded in the district of Anah and amounted to (295.11 x 10^3 cell/ml), while the district of Haditha recorded the lowest mean value and amounted to (253.11 x 10^3 cell/ml). The results of the statistical analysis showed that there is a significant difference in the results obtained between the study cities or locations under the probability level($P \leq 0.05$), Table (1).

Table 1: Mean values of biological properties for the studied sites on the Euphrates River

Properties	Al-Qaim district Mean± SD	Anah district Mean± SD	Haditha district Mean± SD	Hit District Mean± SD	Al - Ramidi Mean± SD	Total
T.colif (TC) cell/100ml	203.94± 77.74	203.56± 88.92	165.39± 40.82	182.56± 70.93	200.61± 64.08	191.21± 71.21
FC cell/100ml	82.39± 30.35	81.56± 32.10	68.03± 17.54	74.36± 25.72	81.39± 25.95	77.54± 27.09
T.P.C. × 10^3 cell/ml	292.17± 83.89	295.11± 100.61	253.11± 44.53	273.11± 72.65	291.78± 63.94	281.06± 76.37
DO mg/l	8.05± 0.27	7.9± 0.38	8.22± 0.55	8.31± 0.41	8.24± 0.41	8.14± 0.47
BOD mg/l	4.01± 1.05	4.02± 1.08	3.68± 0.92	4.37± 0.92	4.41± 0.93	4.10± 1.01

Measuring biological properties of the Euphrates River by months

The results of DO showed that there is a significant difference in the mean DO for the month of April with the rest of the months at the level of 0.05, and there is a significant difference in the mean DO for the month of May with the rest of the months at the same level, as well as for the months of September, October, the second and December with the rest of the months at the same level, as higher mean results showed The value of DO was 8.54 mg/l in January and the lowest mean value of DO was 7.34 mg/l in July.

The obtained results showed that the highest mean values of (BOD_5) were recorded during the months of (September, October) and reached (4.38 mg/l) and (4.37 mg/l), respectively. The lowest mean was during the months (March, June), when it reached (3.55 mg/l) and (3.82 mg/l), respectively. The results of the statistical analysis showed that there are significant differences with the months (September, October, December) and below the probability level($P \leq 0.05$), while the results obtained for the values of the number of fecal coliform bacteria (FC) and the total number of coliform bacteria (TC) in the Euphrates River water showed that the lowest mean number of bacteria was in January, when it reached (46.2 cell/100ml) and (122.53 cell/100ml), respectively. While the highest mean number of bacteria was in July, when it reached (88.33 cell/100ml) and (216 cell/100ml), respectively. While the results obtained for the total bacterial count (TPC) values showed that the lowest mean number of bacteria was in January, when the mean number of bacteria was (206.4 x 10^3 cell/ml), while the highest mean numbers were in July, when the mean was (323.2 x 10^3 cell/ml). ml). The results of the statistical analysis showed that there are significant differences with all months of the year except for the month of March. Significant differences with the months of the year as show in table (2).

Table 2: Mean of the biological properties of the Euphrates River according to the months of the year

Properties	April Mean± SD	May Mean± SD	June Mean± SD	July Mean± SD	Aug Mean± SD	September Mean ± SD	October Mean± SD	November Mean± SD	December Mean± SD	January Mean± SD	February Mean± SD	March Mean± SD	Total
T.P.C. × 10^3 cell/ml	272.80 66.63	285.33 78.01	270.40 44.15	323.20 68.14	274.40 62.31	291.07 83.55	290.13 74.03	312.00 112.89	299.20 91.05	206.40 36.69	302.40 63.57	245.33 55.81	281.06 76.37
T.colif(TC) cell/100ml	184.00 64.45	194.00 73.17	184.67 44.38	216.00 63.67	187.20 62.46	200.27 79.88	198.53 64.84	212.80 97.79	211.60 96.15	122.53 39.75	215.33 63.90	167.60 46.82	191.21 71.21
FC cell/100ml	71.67 26.52	77.53 25.96	84.67 20.46	88.33 22.01	76.60 23.93	81.93 27.25	79.00 24.70	83.40 33.17	86.27 34.92	46.20 15.07	85.80 24.59	69.13 21.59	77.54 27.09
BOD mg/l	4.04 1.12	3.89 1.20	3.82 0.91	4.17 0.95	4.19 1.10	4.38 1.02	4.37 0.85	4.27 1.00	4.28 1.00	4.06 0.77	4.17 0.98	3.55 1.15	4.10 1.01
DO mg/l	8.06 0.25	8.19 0.28	8.15 0.19	7.34 0.36	8.01 0.50	8.40 0.21	8.46 0.34	8.20 0.54	8.45 0.43	8.54 0.50	7.94 0.22	7.98 0.30	8.14 8.14

The correlation coefficient of the measured variables of the Euphrates River.

The results indicate that there is a direct correlation between the total count of bacteria, the total count of coliform bacteria, the fecal coliform bacteria, the biological requirement for oxygen and the temperature. This correlation is statistically significant at the probability level (0.01) and (0.05). Also, these variables (TPC), (TC), (TFC) and (BOD) showed an inverse correlation with dissolved oxygen (DO) Table (3).

Table 3: Correlation Coefficient of the measured variables of the Euphrates River

		T.P.C. × 103	T.colif	Colif .B	DO	BOD
T.P.C. × 103 cell/ml	Pearson Correlation	1	.982**	.956**	-.589**	.537**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	180	180	180	180	180
T.colif cell/100ml	Pearson Correlation	.982**	1	.973**	-.557**	.519**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	180	180	180	180	180
Colif .B cell/100ml	Pearson Correlation	.956**	.973**	1	-.548**	.514**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	180	180	180	180	180
DO mg/l	Pearson Correlation	-.589**	-.557**	-.548**	1	-.297**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	180	180	180	180	180
BOD mg/l	Pearson Correlation	.537**	.519**	.514**	-.297**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	180	180	180	180	180

Biological properties

Total Plate count of Bacteria (TPC)

Bacteria are found in water naturally and are part of the living components of the ecosystem, but their numbers increase and their types differ when there is a source of organic pollution [18]. The presence of bacteria in river water often reflects the degree of nutrition of that water body. The number of bacteria increases in water containing high concentrations of nutrients [23]. The highest rate of total bacteria was in the month of July, and this is due to the population activity represented in the villages built near the site, whose wastes are discharged into the river water directly, and the presence of animals whose waste or decaying remains reach the river directly or indirectly, in addition to the professionalism of the villagers. Fishing, and thus the direct arrival of fishermen's droppings and dead fish remains into the river water, which may be attributed to the relatively high temperature as well as the availability of oxygen required for the oxidation of organic matter [25], while the lowest rate was In the month of January, the reason for this may be due to the decrease in temperature, which works to reduce

the activity of bacteria, as well as the reason may be due to the lack of organic materials in sufficient quantity (23).

The results of this study were consistent with what was stated by Payment [22], as this study showed that the largest number of bacteria in the waters of the Euphrates River was in the summer. As well as a study [14]. The reason for the clear increase in the numbers of bacteria during the month of July is attributed to the increase in the density of sewage water for this month on the one hand, and on the other hand to the change in temperatures mainly.

The results of our current study are close to the findings of Hanif et.al. [12] where showed that the waters of the Euphrates River are polluted with sewage water in the Ramadi region, and were consistent with what was reached by Rodrigues and Cunha [23] when he studied the pollution of the waters of the Tigris River with wastewater. The presence of coliform bacteria in the water is a general indicator of contamination, which could be from nature or faeces [20] confirmed that the number of total coliform bacteria increases with the onset of rain, and this number is also attributed to the population activity by some fishermen in the region, in addition to the presence of some villages in the region whose excrement reaches directly or indirectly to the water.

Although intestinal bacteria can survive in water for a limited period of time only, they often multiply in polluted water without losing their ability to cause infection [25]. The current results agreed with what was stated in the study conducted by Payment [22] on the Euphrates River.

Hossain and Anawar [14] indicated in a study of the effects of wastewater in the Tigris River that the highest number of coliform bacteria was in the month of April, depending on the location from which the sample was taken, for study Hanif et.al. [12]. It was found that the number of total colonic bacteria varied from one month to another, as it decreased in the winter months except for February, when it recorded a significant increase, while it was high in most of the summer months, especially July and August) in their study of the pollution of the waters of the Lower Zab River, which may be attributed to the difference in the nature of the two rivers and their discharge, and thus the difference in the dilution factor of the waste discharged, as well as the difference in the quantity and quality of the waste discharged to it. The current study agreed with the study of Romeo and Gupta [25] about the pollution of the waters of the Tigris River with wastes. It detects fecal coliform bacteria to investigate other pathogenic bacteria such as typhoid, dysentery, and cholera bacteria, where the fecal coliform bacteria accompany these bacteria in the intestines because their number is greater and their survival in the water is longer and detection is easier and considered as evidence of the presence of enteric pathogenic bacteria in the water, although The detection of fecal coliform bacteria is universally applicable in all laboratories as evidence of water contamination and unfitness for drinking, it should be noted that it does not necessarily come from the human intestine, as it is also present in the intestines of warm-blooded animals [28], and the reason for this is due to the population activity represented by the villages adjacent to the site, the presence of fishermen, and thus the arrival of waste to the river water, causing pollution and increasing the number of bacteria. The reason for this is due to the little unnoticed human activity at this site.

This study agreed with Jahan et al. [15] on bacterial contamination in the Euphrates River basin, study WHO [29] on bacterial species found in springs in Hawaii, and study Rodrigues and Cunha [24] on fecal evidence in tropical waters.

in Uganda. On the other hand, the presence of this bacteria in the water indicates the possibility of its contamination with fecal pollutants that may have been reached by activities adjacent to the water surface, such as from some farming villages near the river, or the arrival of various animal waste to the river. It also indicates the dangers of using this water for drinking [30].The presence of a single cell is evidence of contamination of river water by human and animal excrement [26].

Biochemical Oxygen Demand (BOD)

In the flowing ecosystem such as rivers and streams, due to its relatively shallow nature and abundant microbial life in addition to the river's self-purification, the amount of organic matter decreases, which leads to a decrease in BOD [13]. Low BOD values were recorded in different Iraqi waters [21].

The results of the current study showed high levels of BOD_5 in some sites (4.41 mg/L), and this mean value does not exceed the permissible limits (5 mg/l) recommended by the World Health Organization, 1996. This may be related to the large loads of organic matter that are discharged. In the river in the area near sewage and agricultural land, similar results were obtained by other authors [23].

The high values of (BOD_5) in the cities of Ramadi and Hit are attributed to the different population activities on the outskirts of the cities of Ramadi and Hit, which are represented by villages that throw their waste into the river water directly without treatment, in addition to what is washed away by the rainwater of various residues and waste such as carcasses and feces of animals that reach the water directly. Directly or indirectly, thus causing pollution of this water and an increase in the number of bacteria that work to raise the values of (BOD_5), and this result is identical to previous studies Romeo and Gupta [25]. The results of the statistical analysis indicate that there is a significant positive relationship between (BOD_5) and salinity and a significant negative relationship between (BOD_5) and dissolved oxygen, which indicates a decrease in (BOD_5) values when the concentration of dissolved oxygen increases as an indication of the purity of the water and the lack of microorganisms in it. When comparing the results of our study with previous studies, we found a match with the study of Mallongi et al. [18], where it was found that the concentration of (BOD_5) in the water of the Euphrates River in the district of Ramadi is (4 ml / L), and this was attributed to the effect of sewage that was discharged into the river without treatment. This is consistent with the findings of Mahamat et al. [18].

Dissolved Oxygen (DO)

Dissolved oxygen is one of the most important factors entering the aquatic ecosystem through the air-water interface and through photosynthesis and the activities of aquatic plants. Thus, the amount of dissolved oxygen in aquatic organisms depends on the rate of occurrence of these processes in the ecosystem [8]. The solubility of oxygen in running water is affected by several factors such as temperature, dissolved salts, partial pressure of gas, as well as inputs of organic matter. The amount of dissolved oxygen in water is affected by a number of chemical, physical, or biological factors, including wind (aeration), algae, water flow velocity, air pressure, salt content, temperature, organic compounds, and others Mallongi et al. [19], Payment [22].

The results indicated high concentrations of dissolved oxygen recorded in some locations due to air, high water levels, and phytoplankton density. Similar conclusions were reached by other authors Hossain and Anawar [14]. The low concentration may be due to the low water level and low organic matter [16].

Similar results have been reported by other authors Lenart-Boroń et al. [17]. The oxygen value increased during the winter season more than the rest of the seasons due to the decrease in temperature, which is an expected situation confirmed by the statistical relations.

Conclusions

The presence of Enterobacteriaceae, especially E. Coli, in all the sampling stations is an indication of bacterial contamination of the river water. The results of the current study indicate high levels of (BOD5) in some sites, but this value does not exceed the permissible limits during the study period. The multiplicity of sources of pollution in the study area, especially human ones, as these sources are loaded with high concentrations of pollutants and affect the quality of the river water. The water of the Euphrates River is exposed to pollution due to various wastes that are constantly dumped on the banks and course of the Euphrates River within the study area, especially the cities of Ramadi and Hit, as they are the largest and most densely populated cities.

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تحـديد مستوى التلوث البكتيري في نهــر الفــرات ضمن محافظة الانبار، العراق

عبد الرزاق محمد علي طه[1] سفيان محمد شرتوح[2] أوس هلال جاسم[3]
E-mail: brrnxn525@gmail.com

الملخص

تعتبر الخصائص البيولوجية للمياه مهمة في تحديد مدى ملائمة المياه للاستخدامات المختلفة من جهة ومعرفة مستوى التلوث البيئي لهذه المياه من جهة اخرى. تهدف هذه الدراسة الى الكشف عن مستوى التلوث الحاصل في مياه نهر الفرات من خلال هذه الخصائص، والتعرف على مصادر هذا التلوث. تم فحص المتغيرات حسب ما مقرر في الدراسة خلال الفترة من ابريل 2022 الى مارس 2023، تم فحص جودة مياه نهر الفرات بين مدينتي الرمادي والقائم، تشمل المتغيرات التي تم فحصها الاوكسجين المذاب (DO), المتطلب الحيوي للأوكسجين (BOD5), بكتريا القولون البرازية (FC)، العد الكلي لبكتريا القولون (TC) و العد الكلي للبكتريا (TPC). تمت مقارنة القيم التي تم الحصول عليها من هذه المتغيرات مع القيم القياسية لمنظمة الصحة العالمية (WHO). في حين ان معظم القيم كانت ضمن النطاق المسموح به مثل قيم الاوكسجين المذاب والمتطلب الحيوي للأوكسجين في مدينتي هيت والرمادي والتي وصلت الى 0.41±8.31 ملغم/لتر و 0.93±4.41 ملغم/ لتر على التوالي. فان بعض القيم تجاوزت الحدود المسموح بها من قبل منظمة الصحة العالمية مثل FC، TC وهذه القيم في مدينة القائم وبلغت 30.35±82.39 خلية / 100 مل و 77.74±203.94 خلية/100 مل على التوالي، ومع ذلك، تم فحص معامل الارتباط بين المتغيرات المعنية المتعلقة بالموقع والوقت. في النهاية، تفاوتت مستويات تلوث الانهار من منطقة الى اخرى داخل منطقة الدراسة من خلال المتغيرات قيد الدراسة، حيث ان مياه النهر مناسبة بشكل عام للري، ولكنها لا تشرب بدون عمليات المعالجة المسبقة.

الكلمات الدالة: نهر الفرات، القولونية، بكتريا القولون البرازية.

[1] مديرية التربية في محافظة الانبار، الرمادي، العراق.
[2] كلية العلوم، الانبار، العراق.
[3] وزارة التعليم العالي، بغداد، العراق.
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