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The Biological Characteristics of the Drinking Water Purification Plant in Al-Hawija District

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Abstract:

The current research includes conducting a biological study in the study stations, which diagnosed some indicators of bacterial contamination of water and included (the total number of plate count total bacteria, the total number of total coliform bacteria and fecal coliform bacteria) Faecal, (Coliform, and the study began in October 2020 until March 2021). Six stations were chosen and distributed as follows: the first station on the course of the Zab River, and the other stations on the Hawija water purification project (the drawing area, collection basins, sedimentation basins and purified water tap water) The water samples were taken with the aim of analyzing them in the laboratory and determining some of their biological characteristics, in addition to that some readings were taken in real time The results of the current study showed that the project water in general is contaminated with bacteria (EPA, 2002) The total numbers of bacteria were not in conformity with the standard specifications for drinking water. Iraqi (Standard No. 417 for drinking water for the year 2001) and amounting to 10 cells/ml.

Introduction:

Water covers seven tenths of the globe, and its quantity is about (1.45) billion liters. The seas and oceans are the main reservoir, because they contain about 97.2% of the total water ocean, while the percentage of fresh water is only about 2.8% of the entirety of the water in the universe. About 75% is frozen in the form of ice at the poles and some other cold areas. Therefore, the proportion of fresh liquid water available to humans for living uses is estimated at only 0.8% of the total water on the globe, and this percentage is very small. However, this water, despite its scarcity, plays a major role in creating the conditions suitable for life, as it constitutes 60-70% of the bodies of high-level organisms, including humans. The adult human body contains about 58-65% of its weight in water, and this percentage reaches 90% in some other

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organisms such as primitives (Al-Saud, 2012). Water is the most vulnerable environmental component to pollution due to its characteristics that qualified it. The negative effects of water pollution extend not only to humans but to animals, trees and forests around the world, and the problem of water pollution increases with the increasing proportion of the population.

The daily consumption of water by the population raises with it large quantities of waste that reach the water through untreated wastewater, as well as animal, agricultural and industrial pollutants, and air and soil pollutants are their final destination to water bodies, whether directly or indirectly. (Al-Hajj, 2010)It was noted that the water pollution rates of the Hawija irrigation project increased with solid waste dumped on both sides of the watercourse, and sewage waste dumped in its water, which negatively affects the biological concentrations (Al-Tikriti, 2019). The current study aims to diagnose bacterial contamination and the suitability of water for drinking.

Material & Methods:

Description of the study area:

The Hawija irrigation project is located in the Hawija district of the Kirkuk governorate, located 60 km southwest of the city of Kirkuk, on the left side of the Lower Zab River. 38.55° and (51,30°35°) in the north, and longitudes (43,56.30°) and (38.30,43°) in the east. The Hawija irrigation project is one of the main surface water resources in Hawija district (Bassem and Ahmed, 2009). The study stations were chosen based on several reasons, including the lack of environmental studies and research on the area, and the lack of data. It shows the environmental nature of the project water and the extent of the environmental pollution in it, as well as the nature of the area and the possibility of choosing the best sites that are suitable as study stations, taking into account the direct effects of the population centers in these stations.

Map (1) represents descriptive scheme for Hawija Irrigation

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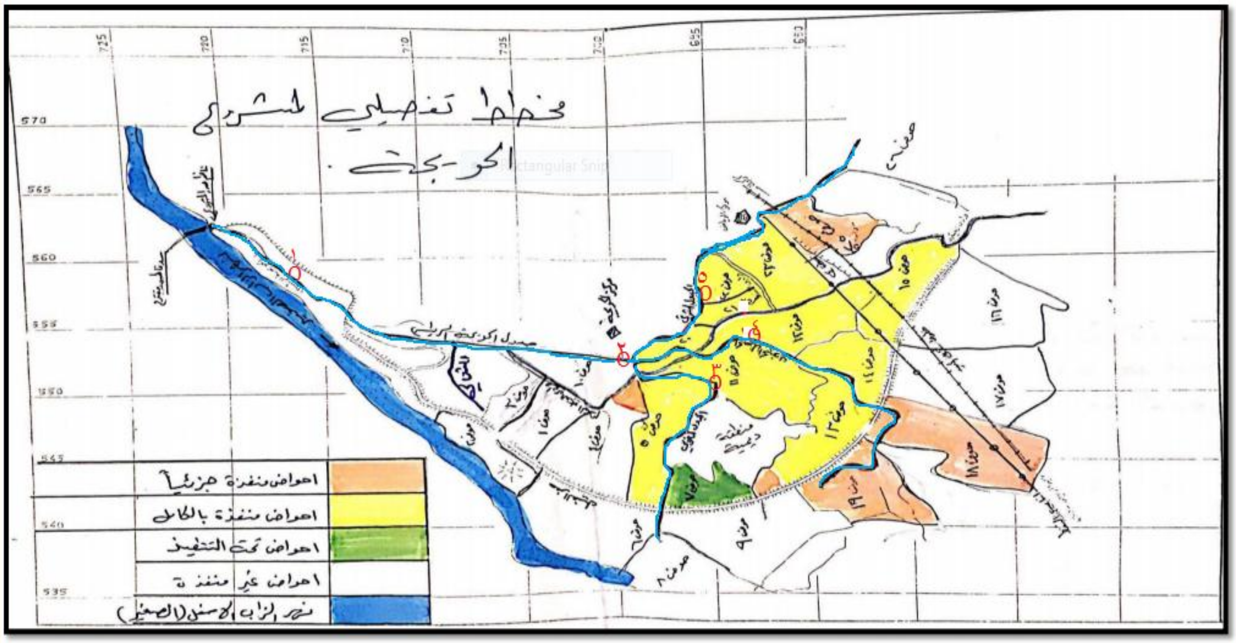
خريطة (١) تمثل مخطط تفصيلي لمشروع ري الحويجة



المصدر:– وزارة الموارد المائية، الهيأة العامة لتشغيل مشاريع الري والبزل، مديرية الموارد المائية في كركوك، دائرة ري الحويجة، قسم التصاميم، سنة٢٠١٩،(بيانات غير منشورة).

Resource – Ministry of Water Resources. The General Board for Operating Irrigation and Drainage Projects in the Directorate of Water Resources in Kirkuk. Hawija Irrigation Department. Design department

Study stations:-

Six stations were elected within the study area in Kirkuk governorate. These stations were distributed to each of the lower Zab tributary (within Hawija district). Hawija water purification project and drinking water taps, and they were as follows:-

Table (1) describes the study stations within Kirkuk governorate

Notes	No. station	Name of station	No
Represents the left side of the river	**1**	The lower Zab tributary	1
intake tubes	**2**	Drinking water purification project in Hawija district	2
collection basins	**3**		
sedimentation basins	**4**		
pumping tubes	**5**		

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Inside Hawija District	**6**	drinking water taps	3

Collecting models

Water samples (river - basin - drinking) were collected for bacteriological examinations from the study area on a monthly basis, starting from October to March of 2021, as samples were collected from the treatment stages in the Hawija liquefaction project in Kirkuk governorate. This is as follows:-

1. River water intake.

2. Sedimentation basins.

3. Drinking water.

Collecting samples

Capacity for field examinations Filling in sterile glass containers

Air and water temperature ml for biological tests (400)

Bacteriological examinations:

Default stage

Using Lauryl trypose (LTP) medium

Work is carried out in a sterile atmosphere near a fire and shakes the water sample 25 times before starting the examination to ensure that the microorganisms are distributed as evenly as possible.

1- Drinking water with chlorine content.

Use ten or five fermentation tubes inoculate 10 mL of sample water for each fermentation tube.

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2- Drinking water if the percentage of chloride is 0.

Use 15 fermentation tubes and the tubes are inoculated by fermentation as follows

• Inoculation of the first five fermentation tubes with 10 mm with the model.

• Inoculate five second fermentation tubes with one model water.

.Inoculate five third fermentation tubes with one of the sample water.

3- Raw water

Use 30 fermentation tubes and the tubes are inoculated as follows:

• Inoculation of the first five fermentation tubes with ten milliliters of water of the model.

• Inoculate five second fermentation tubes with one model water.

.Inoculation of five third fermentation tubes with 1 ml of sample water.

Results and discussion:

Biological study

Water is a good medium for the livelihood and growth of bacteria and an important source for the transfer of latent intestinal pathogens (Aubaid, 1998). Therefore, most natural waters contain different types of bacterial organisms that can come from eroded soil into water bodies, or which are Its source is sewage water more, and the most important source of pollution by human excreta is untreated sewage, as well as human waste and many animals are the most polluting in water. The lower part of the alimentary canal in humans and animals contains a very large number of Microbes are different genera, and bacteria in natural conditions account for 40% of the weight of the waste (Tartera and Jofer, 1987), and these bacteria are either suspended in the water column or settled in the bottom mud, and may be in the form of spores that are the cause of Its stability is high and for a long time in the water. It can be found above plants and aquatic animals and attached to the crumbs of suspended matter. The use of inorganic compounds contains iron or sulfur, for example (EPA, 2004).

4- Bacteriological Characteristics

A number of biological factors were selected, including the study of the total number of aerobic bacteria TPC (Total plate count), as well as the number and detection of total coliform

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bacteria TC (Total coliform bacteria) and the number of fecal coliform bacteria. Faecal Coliform bacteria (FC) grow at (44) AD, because it is a bacteria that is used as one of the biological indicators in determining the validity of water in its various uses.

4 Total bacterial count

Most natural waters contain different types of bacteria that can be sourced from the soil drifting into water bodies or which can be sourced from sewage water to a greater extent. They may be pathogenic or non-pathogenic, and they are either suspended in the water column or settled in bottom mud, which may be found in the form of spheres, is the reason for its high stability and for a long time in water. It can be found on aquatic plants and animals and attached to the crumbs of suspended matter, it is either aerobic or anaerobic depending on its need for oxygen and is fed inside the water either by oxidation of organic compounds or the use of inorganic compounds containing iron or sulfur, for example (Annachatre and Jeganaesan, 2001).

The importance of examining the total number of bacteria lies in knowing the general bacterial content in the water, not all bacterial species, but only those that have the ability to grow on the culture medium and form visible colonies under certain conditions of temperature and time (OECD & WHO, 2003)). The results shown in Table (1) indicate that the total number of bacteria ranged between (0-400) cells/ml, as the highest value was recorded in the first and third stations (the river outlet and the collection basin) which amounted to (400) Cells/ml during February, December and January. While the lowest value was recorded in the fifth and sixth stations (processed water and liquefied water), which amounted to (0) cells/ml during October, November and December, as the first and third stations coincided in recording the highest values during the aforementioned months due to the appropriate temperature for growth. The high water levels and the resulting torrents loaded with organic matter and bacteria as a result of the dredging and washing of agricultural lands where animal fertilizers are often used, in addition to the presence of large numbers of livestock and cows that graze close to the project at that station, which is a major source of access for the living Microscopy and bacteria to the river (Al-Tamimi, 2004). As for the decrease in the number of bacteria in the fifth and sixth stations, respectively, in October, November and December, it is due to the use of chlorine in good quantities, which leads to the killing of bacteria.

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The Pearson correlation coefficient recorded a positive significant relationship between the total number of bacteria and between suspended solids, coliform group and fecal coliform bacteria, which amounted to (686.-0.831-851 r=0.) at the level of significance P≤0.01 Table (6) and with turbidity and magnesium ion, which amounted to (0.419-387 r = 0.) at a significant level P≤0.05. The correlation coefficient recorded negative significant values with the air temperature, which reached (387.0) at a significant level of P≤0.05. The results of the statistical analysis according to the variance test showed that there were significant differences between the stations (spatial) and no significant differences between the months (temporal) at the level of P≤0.05. Table (4,5). The US Environmental Protection Agency has determined that the highest permissible concentration is (50) cells/ml, which indicates that the project water is generally contaminated with bacteria (EPA, 2002). The total numbers of bacteria did not conform to the standard specifications of Iraqi drinking water (Specification No. 417 for drinking water for the year 2001), which amounted to 10 cells/ml.

Table (1) Results of the tests for the number of colonies of colon bacteria (Plate count 37c/1ml).

Average of stations	S-6	S-5	S-4	S-3	S-2	S-1	stations / months
207.5	0	0	200	351	344	350	October
149.5	0	0	152	230	265	250	November
200	0	0	175	400	325	300	December
238.3	120	110	175	400	325	300	January
254.6	113	95	210	324	386	400	February
164.3	124	100	155	222	185	200	March
	59.5	50.8	177.8	321	305	300	the average

Total Coliform

Coliform bacteria express the health status of the water and provide basic information about the quality of the water source and are used as an indicator of the efficiency of drinking water treatment processes (OECD & WHO, 2003). The results shown in Table (2) indicate that

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the values of the total number of colon bacteria in the current study ranged between (0-16) cells/100 ml. The lowest value was recorded in the fifth and sixth stations (processed water and liquefied water) in October, November and December, while the highest value was recorded in the first, second, third and fourth stations in all months of the study. The results of the current study were consistent with a study (Al-Khalidi, 2003; Al-Sadani, 2009). Recording high values in the studied stations is due to the quality of the nutritious organic materials, and one of the reasons for the increase in the number of colon bacteria is also the appropriate temperature, in addition to the use of chlorine in small or no quantities during some months of the study, which showed the presence of contamination in the prepared and liquefied water.

The correlation coefficient recorded a positive significant relationship between the numbers of coliform bacteria, suspended solids, magnesium ion, sodium ion, and fecal coliform bacteria, and the total number of bacteria as (633-456-427- 891-831 r = 0) at a significant level. P≤0.01 (Table 3) and with turbidity, which is (372 r=0.) at a significant level P≤0.05. While the correlation coefficient recorded negative significant values with the air temperature, which amounted to (475 r = 0.) At a significant level P≤0.01. The results of the statistical analysis showed that there were no significant temporal differences with the presence of significant spatial differences at the level of P≤0.05, which means that the monthly rates of the numbers of coliform bacteria were affected by the spatial variables of the study area.

Table (2) results of tests for the total number of coliform bacteria (MPN of total coliform 37c / 100ml) for the withdrawn water samples.

Average of stations	**S-6**	**S-5**	**S-4**	**S-3**	**S-2**	**S-1**	**stations / months**
9.5	0	0	9.2	>16	>16	>16	October
10.6	0	0	16	>16	>16	>16	November
10.6	0	0	16	>16	>16	>16	December
13	5.1	9.2	16	>16	>16	>16	January
14.8	16	9.2	16	>16	>16	>16	February

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11.9	5.1	9.2	9.2	>16	>16	>16	March
	4.3	4.6	13.7	>16	>16	>16	the average

-3-2 Fecal Coliform Bacteria

Water is an important carrier medium for many diseases, where fecal coliform bacteria are referred to as a group of colon bacteria that can grow and ferment lactose sugar and produce gas and acid at a temperature of 44-45 ° C (WHO, 2004), and it represents colon bacteria Heat resistance, including Escherichia coli, are successful indicators of recent fecal contamination of water and the presence of health risks when using water for drinking. Its presence in water sources is evidence of fecal contamination of water from human and animal sources and the possibility of the presence of intestinal pathogenic bacteria in the water. The E. coli is as confirmatory evidence of fecal contamination of water (Al-Sardar, 2012). Any presence of fecal coliform bacteria in the prepared water indicates either insufficient treatment or contamination after the treatment process and its source must be investigated immediately (Twort et al., 2001).

Fecal coliform bacteria were observed in the raw water of the first, second, third and fourth stations and for all months in Table (3), where it was found that the river water is contaminated with bacteria and is directly unsuitable for drinking when studying the total number of bacteria, and Al-Nuaimi (2017) concluded: There were large numbers of fecal coliform bacteria during the 6 months of that study, and it indicated that the number of coliform bacteria was related to water temperature and rainfall, and this was confirmed by Al-Douri (2000), where he indicated a high coli bacteria in winter more than in summer months when studying the Tigris River within Salah El-Din Governorate.

The correlation coefficient recorded a positive significant relationship between fecal coliform bacteria, turbidity, suspended solids, magnesium ion, sodium ion, coliform group and the total number of bacteria, which amounted to (431-671-591-516-891-831 r=0.) at the level of Significant $P \leq 0.01$ Table (6) and with total basicity and sulfate, which amounted to (333-373 r=0.) at a significant level $P \leq 0.05$. While the correlation coefficient recorded negative significant values with the air temperature, which amounted to (456 r = 0.) at a significant level $P \leq 0.01$. The

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results of the statistical analysis showed that there were no significant temporal differences with the presence of spatial significant differences at the level of P≤0.05.

Average of stations	S-6	S-5	S-4	S-3	S-2	S-1	Stations / Months
8.8	0	0	5.1	>16	>16	>16	October
8.3	0	0	2.2	>16	>16	>16	November
9.5	0	0	9.2	>16	>16	>16	December
11.4	2.2	9.2	9.2	>16	>16	>16	January
13.7	16	9.2	9.2	>16	>16	>16	February
11.9	5.1	9.2	9.2	>16	>16	>16	March
	3.8	4.6	7.3	>16	>16	>16	Average

Table (3) The results of the tests for coliform bacteria (1ml/MPN of total E.Coli 44c) for samples of water withdrawn.

Conclusions:

1- Most of the factors studied were not in conformity with the Iraqi and international standards for drinking water

2- The monthly variables, especially with regard to rainfall and rising water levels, have a significant impact on the biological characteristics of the water of the drinking water purification project in Hawija district.

3- Through the results obtained, we found that drinking water was contaminated with types of bacteria such as coliform group and fecal coliform bacteria, due to the lack of chlorine use in filtering and sterilization processes.

Table (4) Duncan test for the studied factors based on the months of the year (20-20-2021)

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March	February	January	December	November	October	Seasons / Stations
19.08b	12.15a	13.57a	12.92a	17.35b	27.03c	air temperature
13.7c	12.47c	7.98b	5.58a	8.5b	20.78 d	water temperature
11.92a	14.87a	13.05a	10.67a	10.67a	9.53a	Total Coliform
11.92a	13.73a	11.43a	9.53a	8.37a	8.85a	Total *E.coli*
164.33a	254.67a	238.33a	200a	149.5a	207.5a	The number of colonies of colon bacteria

Different letters indicate significant differences, P≤ 0.05, in Duncan's test.

As for similar letters, there are no moral differences

Table (5) Duncan test for the studied factors based on the studied stations during the study period (2020-2021)

S-6	**S-5**	**S-4**	**S-3**	**S-2**	**S-1**	**position / Factors**
20.16a	19.3a	17.26a	17.2a	15.06a	a13.1	air temperature
13.13a	12.7a	11.7a	11.01a	10.8a	9.5a	water temperature
4.3a	4.6a	13.7b	16b	16b	16b	**Total Coliform**
3.8b	4.6a	7.3a	16b	16b	16b	**Total *E.coli***
59.5a	50.8a	177.8b	321c	305c	300c	**The number of colonies of colon bacteria**

Different letters indicate a significant difference (P≤ 0.05) in Duncan's test.

As for similar letters, it means that there are no moral differences

Annex table (6) Pearson correlation coefficient for the studied factors (2020-2021)

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T.E.coli	T.C.	Mn	Cd	Pb	K^{+1}	Na^{+1}	SO_4	Cl^{-1}	T.Alka.	Mg^{+2}	Ca^{+2}	T.H	pH	TSS	TDS	Turb.	E.C	W.Tem	A.Tem.	Correlations / Correlation Pearson
																			.791**	W.Tem
																		-0.009	-0.197	E.C
												.					0.250	-0.231	-0.324	Turb.
																-0.241	.358*	-0.323	-.568**	TDS
															-0.075	.525**	0.273	-0.133	-0.294	TSS
														-.368*	0.327	-0.251	-0.190	-.580**	-.383*	pH
													0.062	0.007	.698**	-0.037	.633**	-0.065	-.416*	T.H
												.794**	0.224	0.052	.676**	-0.045	.532**	-0.259	-.455**	Ca^{+2}

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											.365*	.657**	-0.047	0.277	.460**	0.112	.469**	-0.048	-.357*	Mg^{+2}
										.567**	.743**	.817**	0.284	-0.073	.837**	-0.044	.455**	-0.274	-.569**	T.Alka
									.717**	.437**	.634**	.684**	.406*	-0.050	.588**	0.163	.544**	-.405*-	-.520**	Cl^{-1}
								.561**	.343*	.623**	.331*	.525**	-0.056	.348*	.334*	0.145	.650**	-0.101	-0.189	SO4
							.531**	.591**	.690**	.566**	.587**	.742**	0.003	0.226	.556**	0.186	.593**	-0.221	-.555**	Na^{+1}
						0.280	.343*	.336*	0.175	0.184	0.237	0.242	0.152	0.194	0.184	0.274	.510**	-0.279	-0.298	K^{+1}
					-0.182	-0.078	-0.167	-0.245	-0.302	-0.119	-0.184	-0.122	-0.453	0.124	-0.207	-0.104	-0.082	0.449	0.417	Pb
				0.041	0.017	0.480	-0.320	-0.247	-0.328	0.091	-0.395	-0.348	0.139	-0.351	-0.442	-0.307	-0.437	0.098	0.167	Cd
			0.006	-0.042	-0.010	0.311	0.132	.498*	.533*	0.153	0.024	0.266	0.358	-.541*	0.238	0.033	-0.268	-0.366	-0.357	Mn
		-0.	-0.	0.0	0.0	.42	0.2	0.0	0.29	.45	0.2	0.1	-0.	.63	0.2	.37	0.2	-0.	-.4	T.C.

		245	120	85	68	7**	67	71	0	6**	01	64	155	3**	32	2*	40	260	75**	
	.891**	-0.176	-0.098	0.120	0.130	.516**	.373*	0.189	.333*	.591**	0.240	0.288	-0.258	.671**	0.270	.431**	0.329	-0.194	-.456**	**T.E. coli**
.851**	.831**	-0.184	0.010	0.156	-0.049	0.197	0.188	-0.058	0.116	.387*	0.024	0.019	-0.306	.686**	0.079	.419*	0.064	-0.168	-.387*	**T.Plate count**

* Means that there is a significant correlation at 0.05 P ≤

** Means that there is a significant correlation at P ≤ 0.01

A negative sign means that there is a negative correlation.

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