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Evaluate the bacteriological characteristics of certain water treatment facilities in Kirkuk city

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Abstract

The present study aims to evaluation the bacteriological characteristics of several water treatment plants in Kirkuk City. Four plant water treatments were chosen in different regions of Kirkuk City. The water samples were attained from the distributed network. 1L of water samples was collected monthly (6 months) from August 2020 until January 2021. The results showed that the total Coliform and faecal coli form values ranged between 0-51 X103 cell/100ml in Al-Kadhimiya, Al Shajarah, AL Basal and Abu al-Jess, where the highest value was recorded in October for Al-Kadhimiya, while the lowest value in August for Al Shajarah. The faecal Streptococcus values ranged between 0-25 X103 cell/100ml in Al-Kadhimiya, Al Shajarah, AL Basal and Abu al-Jess, where the highest value was recorded in August for AL Basal, while the lowest value in January for Al- Kadhimiya. It concluded that the bacteria parameters exceeded the international and Iraqi national standards and limits of water quality. These parameters include several total Coliform, faecal coli form and faecal Streptococcus. It concluded that the water in some areas of Kirkuk suffers from high bacterial pollution, which makes the water unfit for drinking, and that there is pollution with sewage water and raw water.

Keywords: Microbial contamination; Water quality; Water treatment plants; Bacteriological characteristics

1. Introduction

Climate change induces persistent droughts that exacerbate water scarcity and elevate water demand for industrial processes, agricultural irrigation, and other uses. This exerts pressure on water resources due to pollution, eutrophication, overexploitation, or drought, leading to a deterioration in both the quantity and quality of freshwater resources. Indeed, according to UN estimates, fifty percent of the global population experiences severe water scarcity at least once a year. [1,2]. Most people in developing nations still get their water primarily from surface waters, which they also use to dispose of their garbage. Most members of this group rely on unprotected or contaminated water sources for their drinking water, which can lead to waterborne disease outbreaks. Because many people in developing nations—mainly in Africa—do not have access to potable water, they are forced to use untreated water from other sources, for example rivers, reservoirs, springs, streams, and groundwater, for drinking and other household needs [3,4]. Industrial and agricultural pollutants and the residues of anthropogenic activities (such as filling and building bridges, canals, dams, highways, and deforestation) are released into aquatic habitats [5, 6]. Wastes and leaks, including detergents, heavy metals, chemicals originating from plastic or non-plastic, microfibers, etc., are mainly present in freshwater bodies [7, 8]. Microbial water pollution, which happens even in wealthy nations, is regarded as one of the most significant hazards to human health worldwide, in addition to these chemicals and hazardous residues affecting aquatic ecosystems [9, 10]. According to WHO, tainted water and inadequate sanitation cause about 600 million cases of diarrhea and dysentery annually and 46,000 newborn deaths [11,12]. Surface water bodies that come into contact with nearby sewage or household wastes could be dangerous ecosystems because they harbour harmful microbes [9,

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13]. Microbiologic water quality monitoring is essential to identify, detect, and measure the microorganisms that cause waterborne illnesses [1]. Quantitative microbial risk assessment of possible pathogen contamination uses various molecular and microbiologic techniques, including monitoring, detection, analysis, and decision-making [14]. Therefore, the current work aims to assess the bacteriological features of a few Kirkuk City water treatment facilities.

2. Material and methods

2.1. Area of study

Four water treatment plants were selected in different regions of Kirkuk city. The water samples were attained from a distributed network, as shown in Table (1).

Table 1 Name and sit of water treatment plants in current study

Name	Site
Al- Kadhimiya	E=43^{o}46'20"
	N=35^{o}22'55"
Al Shajarah	E=43^{o}24'49''
	N=35^{o}12'17''
AL Basal	E=43^{o}39' 07"
	N=35^{o}17'53"
Abu al-Jess	E=43^{o}50'50''
	N=35^{o}17'46''

2.2. Sample collection

Using specialized containers employed by health authorities, 1L of water samples were taken from four water treatment plants each month (for six months) beginning in August 2020 and ending in January 2021.

2.3. Bacteriological examinations

According to the method of [8], various tests were used to undertake bacteriological investigations, including determining the most likely number of total Coliform and detecting faecal Streptococcus and coli form.

2.4. Total bacteria count

The pour plate method estimated the total number of live bacteria. Each sample was diluted up to dilution 103. Then, 1 ml of each of the remaining dilutions was put in a Petri plate to count the number of colonies of aerobic bacteria developing. The dish was then filled with nutritional agar medium, sterilized and promptly chilled. In order to homogenise the medium with the water sample, number eight stirred the plate. The plates were incubated upside down at 37 °C for 24 to 48 hours after the nutrient agar solidified. The number of colonies growing on the medium was estimated, and the result was multiplied by the reciprocal of the dilution ratio and written as (cell. 1 ml -1) [15].

2.5. Faecal coliform

These indicators can be found using various techniques, some of which rely on culture media, such as immunological and molecular techniques. The multiple-tube fermentation method is one of the most significant culture media-based techniques. Specialized organizations like the US Environmental Protection Agency have used this technique to identify faecal streptococci, E. coli, and total and faecal coliform bacteria. By employing the most likely number method by the worldwide standards of American health, this approach estimates the number of contaminated bacteria, the type of pollution, and the extent of water contamination [15].

3. Results and discussion

3.1. Total coliform

The total coliform values ranged between 0 and 51 X103 cells/100ml in Al-Kadhimiya, Al Shajarah, AL Basal, and Abu al-Jess. The highest value was recorded in October for Al-Kadhimiya, while the lowest was in August for Al-Shajarah, as shown in Tables (2-5).

3.2. Fecal coli form

The faecal coli form values ranged between 0 and 51 X103 cells/100ml in Al-Kadhimiya, Al Shajarah, AL Basal, and Abu al-Jess. The highest value was recorded in October for Al-Kadhimiya, while the lowest value was recorded in August for Al-Shajarah, as shown in Tables (2-5).

3.3. Fecal Streptococcus

The faecal Streptococcus values ranged between 0 and 25 X103 cells/100ml in Al-Kadhimiya, Al Shajarah, AL Basal, and Abu al-Jess. As shown in tables (2-5), AL Basal recorded the highest value in August, while Al-Kadhimiya recorded the lowest value in January.

Table 2 Bacteriological examinations of Al- Kadhimiya

Months / Bacteria	2020					January 2021
	August	**September**	**October**	**November**	**December**	
total Coliform X 103	2	6	51	48	41	16
Fecal coli form X 103	2	6	51	48	41	16
fecal Streptococcus	19	13	18	6.8	8.1	1.5

Table 3 Bacteriological examinations of Al Shajarah

Months / Bacteria	2020					January 2021
	August	**September**	**October**	**November**	**December**	
total Coliform X 103	1	6	49	42	37	15
Fecal coli form X 103	1	6	49	42	37	15
fecal Streptococcus	22	19	12	8.7	4.3	2.8

Table 4 Bacteriological examinations of AL Basal

Months / Bacteria	2020					January 2021
	August	**September**	**October**	**November**	**December**	
total Coliform X 10^3	4	8	40	38	39	18
Fecal coli form X 10^3	4	8	40	38	39	18
fecal Streptococcus	25	13	11	19	4.2	1.9

Table 5 Bacteriological examinations of Abu al-Jess

Months / Bacteria	2020					January 2021
	August	September	October	November	December	
total Coliform X 10^3	2	5	31	33	29	11
Fecal coli form X 10^3	2	5	31	33	29	11
fecal Streptococcus	21	17	16	18	5.7	2.1

The present study's findings contradicted a study that found that bacteriological tests, including total coliform, had the highest values in December, March, and April. The study also found that sedimentation in the basins, neglect of their cleanliness of mud and microorganisms, and variations in the percentages of chlorine added and its quality, precipitating microorganisms, were the leading causes of the pollution [16,17]. Several samples above the Iraqi standard determinants 2001 for drinking water, established at zero cells/100 ml, can be seen by comparing the current study's results with those determinants [17–18]. High bacterial concentrations in raw river water are standard, and the fluctuation in coliform bacterial counts during some months may be caused by the low temperatures that help the bacteria survive longer, as well as the rise in coliform bacterial populations brought on by the rainy season. Numerous organic contaminants and nutrients teeming with bacteria wash it away [19]. Their presence in aquatic ecosystems indicates the water's contamination and shows it is unfit for human consumption [20]. It was observed that the coliform bacterial count in the river water increased significantly in October, reaching its highest at the Al-Kadhimiya station with 51 X103 cells/100 ml. The coliform bacterial count decreased in August, with the Al Shajarah stations recording the lowest count at 1X103 cells/100 ml. These findings are consistent with the findings of [21,22] regarding the Tigris River water. The appropriate temperature for microbic growth may cause their increased growth throughout the summer [23]. This is consistent with other studies [24,25,26], where the faecal coliform bacterial count ranged between 0 to 51 X103 cells/100 ml. The faecal coliform bacterial count has shown a discernible increase in October and a drop in August.

4. Conclusion

The results of the present study showed that the water in some areas of Kirkuk suffers from high bacterial pollution, which makes the water unfit for drinking, and that there is pollution with sewage water and raw water.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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