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"A Study on the Biological Characteristics of Water in the Unified Tuz-Khurmato Project within Salah Al-Din Governorate"

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Abstract:

The current study was conducted in the Life Sciences Department laboratories at the College of Education for Girls, Tikrit University. The purpose was to identify some qualitative characteristics of the water at the unified Tuz-Khurmato water station, located in Salah Al-Din Governorate, and to demonstrate the suitability of water at the selected station. Monthly and locational variations were observed during the six-month study period, starting from August 2022to the end of October .2023

The study included measuring some biological characteristics of the water, which encompassed indicators of bacterial pollution. Throughout the study, variations in organic pollution indicators were observed based on the total bacterial count. The values ranged from high to low, according to Iraqi and global standards for drinking water.

Pathogenic bacteria were identified from some water samples. This study focused on pathogenic bacteria that have detrimental health effects on humans, especially those causing severe diarrhea, which is commonly waterborne. The following strains were isolated: *Escherichia coli, Shigella spp, Klebsiella spp, Salmonella spp,* and *Enterobacter aerogenes*.

Keywords: Water pollution, Drinking water, Bacteria.

Introduction:

Water is the lifeblood of existence and its most critical component. Life for all living organisms cannot persist without water. Water forms the structure of plant compounds and different tissues in human and animal bodies. Furthermore, no absorption, digestion, or metabolic processes occur except in an aqueous environment [1]. With civilizational advancement in various aspects of life, there is a need for different stations to purify and filter water, ensuring its quality and preserving its natural physical and chemical characteristics free from pollutants, thereby providing excellent quality and high-grade water [2]. Water is a unique chemical compound, composed of two hydrogen atoms and one oxygen atom. It is the only substance available in three physical states: solid, liquid, and gas. These physical properties of water grant it significant importance for life, and water scarcity is more dangerous than an energy crisis [3].

Seas and oceans are the primary repositories of water, containing about %97.2of the total aquatic volume in the form of saline water. Freshwater only accounts for about %2.8of the universe's total water, %75of which is frozen in the form of ice in the polar regions and some cold areas, representing about %2.2of the world's total freshwater. Thus, the percentage of available liquid freshwater for human use in daily life is estimated at only. %0.8of the total water on Earth [4].

Rivers are the most crucial sources of freshwater for humans. Political, economic, and social development is largely tied to the distribution and availability of freshwater in river systems. River systems can be considered the arteries of the Earth that sustain life and provide an abundance of living organisms [5].

The existence of pure water in nature is impossible, even river water, which is considered the purest type of natural water, contains some gases and dirt present in the air [6]. Therefore, pollution can be defined as changes in the physical, chemical, and biological attributes of the aquatic and atmospheric environment.[7].

Water pollution can be defined as degradation in the quality of water in environmental systems due to human interventions, making the water unsuitable for life and industrial uses [4]. This pollution results from an increase in disease-causing microorganisms, such as bacteria, viruses, and parasites in water. These pollutants often originate from human and animal waste contaminating water, either directly by being discharged into fresh or saline water bodies or indirectly through mixing with sewage or agricultural water. The presence of this type of pollution leads to many diseases. Therefore, this water should not be used for washing or drinking without first being exposed to various disinfectants like chlorine and mechanical filter filtration [1].

The aim of this study is to estimate the extent of bacterial pollution in the studied water samples and their compliance with Iraqi and international standards. This is accomplished by monitoring the changes in the number of bacteria contaminating the water at the studied station during the research period.

Materials and Methods:

This study covered the Tuz Khurmatu Unified Water Station in Salah al-Din province, which was established in 1986with a production capacity of 4000m 3 per hour and is located at coordinates (N34.5029.E44.3753). Some bacteriological factors of the Tuz desalination plant's drinking water were examined. The study site within this region was chosen due to the importance of drinking water in general and for the study area specifically, given its impact on the region's economic, social, and health aspects.

•Study Station

The drinking water project is located in the Tuz Khurmatu area of Salah al-Din province, about 186km from Baghdad. The water source for this project is the Little Zab River. Water is drawn from the source using pumps and is then pushed to reach the project site. Here, water is treated through sedimentation, filtration, and disinfection using sand and chlorine. The project supplies some parts of Tuz Khurmatu district, and the water is used for drinking and various other purposes .

- **Sample Collection:**

The sample collection process started in the morning, beginning from the raw water phase until the desalination stage, at a rate of twice a month. The process commenced from August 2022until the end of January 2023. After pumping a quantity of the sample water for ten minutes to get rid of stagnant contaminated water, we used narrow-necked, airtight glass bottles, each with a capacity of 250-200ml. These were pre-sterilized in the laboratory, and all samples were transferred to the lab to conduct bacteriological examinations directly. All glassware used in the analyses was thoroughly washed at the outset with distilled water and dried using an electric oven. The analyses were conducted in the postgraduate studies lab / Life Sciences Department / College of Education for Girls / Tikrit University / Salah al-Din Water Department / Quality Control Department.

- **Sterilization:**

Cultivation mediums and solutions were sterilized using moist sterilization, employing an autoclave at a temperature of 121degrees and pressure of 15 pounds/inch for 15minutes. As for the loop, test tubes, and flasks, they were dry-sterilized using the flame from a Bunsen burner.

- **Bacteriological Analysis:**

Total Plat Coliform (TPC) count:

The pour plate count method was used to estimate the total live bacteria count. A water sample was vigorously shaken about 25times, then a series of dilutions were prepared using sterilized distilled water. 1ml was transferred using a clean, sterilized pipette from each dilution and from the original sample to sterilized Petri dishes. Then, the nutrient agar medium was poured after it had reached a temperature of 50-45degrees Celsius. The medium was gently stirred

by rotating the dish in a circular manner and allowed to solidify. After that, the dishes were incubated upside down at a temperature of 37degrees Celsius for 48-24hours. The growing colonies were then counted using a colony counter in dishes that had between 300-30colonies.

- **Identification of Isolated Bacteria:**

This included chemotrophic tests such as the oxidase test, catalase test, urea hydrolysis test, indole test, methyl red test, Voges-Proskauer test, and citrate utilization test.

- **Statistical Analysis:**

This was carried out using the ready statistical software Special Program for Statistical System (SPSS version .(23

Results:

** •Total Bacterial Count (TPC)**: The bacteriological examination results, as shown in Figure 1, indicate that the total bacterial count, in the case of an increase, ranged between (200-32) x 10^ 6cells/mL. In contrast, during a decrease, the total bacterial count ranged between (190-30) x 10^ 6cells/mL, as shown in Figure 2. All studied samples contained bacteria, with %97of the examined water samples not conforming to the standard specifications [10].

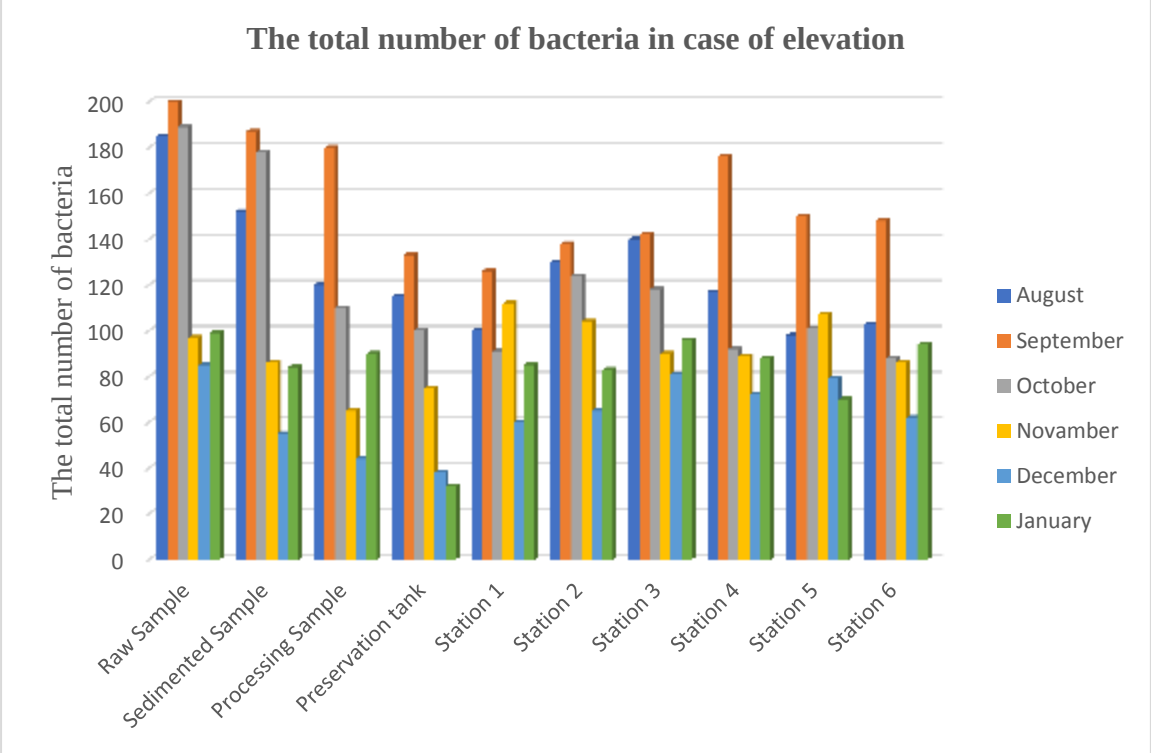

Figure 1: Illustrates the monthly and locational variations of the total bacterial count (10^ 6cells/mL) during an increase in the water throughout the duration of the study.

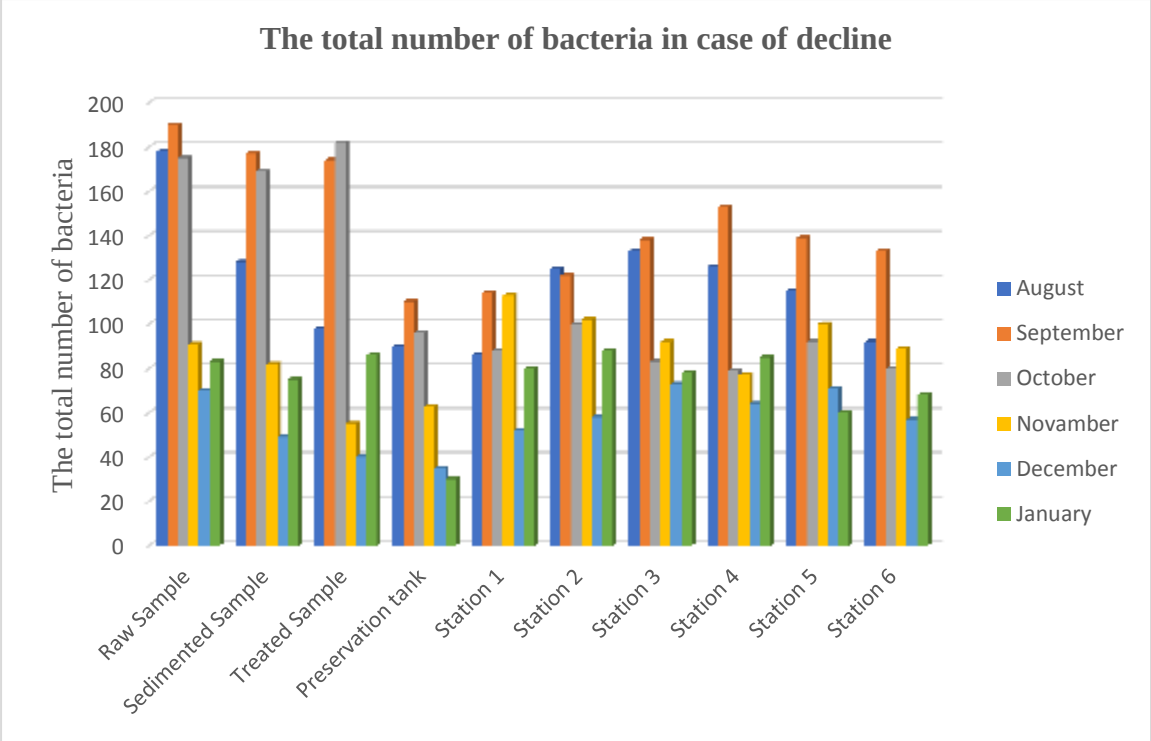

Figure 2: Illustrates the monthly and locational variations of the total bacterial count (10^ 6cells/mL) during a decrease in the water throughout the duration of the study.

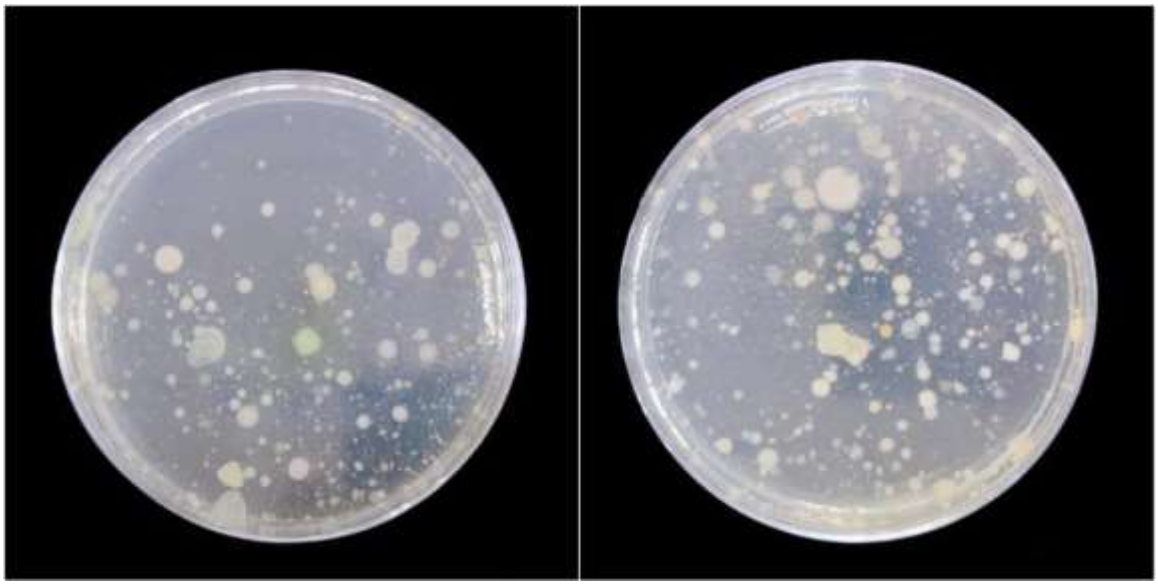

Figure 1-4: Bacterial colonies of raw river water

Biochemical tests:

The tests included indole production test, methyl red test, oxidase test, Voges-Proskauer test, catalase test, and urease enzyme test, as shown in Table 1. Some of the most important results obtained were the recurring presence of Shigella bacteria in the months from August to January, causing watery diarrhea or dysentery, and Aeruginosa, which causes urinary tract infections and is found in

sewage water contaminated with fecal matter and heavy metal pollutants. Some types of bacteria are resistant to certain heavy metals [11].

Table 1-4: Results of Biochemical Test Examination

Isolated bacteria	Indole Test	Methyl Red Test	Voges-Proskauer Test	Citrate Utilization Test	Urease Test	Oxidase Test	Catalase Test
Escherichia coli	+	+	−	−	−	−	+
Shigella	−	+	−	−	−	−	+
Salmonella	+	+	−	+	−	−	+
Klebsiella	−	−	+	+	+	−	+
Enterobacteria aerogenes	−	−	+	+	−	−	+

"+"denotes a positive test result, indicating the presence of the trait, reaction, or substance tested for.

"-"denotes a negative test result, indicating the absence of the trait, reaction, or substance tested for.

Discussion:

Biological pollution is defined as the presence of disease-causing microorganisms such as bacteria and viruses in water intended for use [12]. Surface water is known to be the best type for the growth of microorganisms due to its high content of organic matter, which serves as the primary food source for most microorganisms, and its temperature is more conducive to the growth of these organisms [13]. There is also what is called bacterial pollution of urban networks, which may facilitate the widespread transmission of diseases among the consumers of such water and cause unpredictable damage [14]. Total bacterial count tests are a general indicator of germ contamination, an important standard for the purity of water and its freedom from transmissible diseases [15] .

This could be due to the inefficiency of disinfection processes at water stations, the inefficiency of the workers in these processes, as well as the potential for contamination through transport in the water pipelines. Neglect in properly sealing tank covers, or breakages that allow dust particles and their microbial content to enter the tank water, can exacerbate the problem due to a lack of chlorine with rising temperatures in the summer and the presence of dissolved nutrients in the water that encourage the reproduction of microorganisms [16] .

The increase in the total bacterial count can be attributed to the increase in nutrients from organic and inorganic matter and salts in large quantities, which create a suitable environment and means for bacterial growth, as well as an increase in water turbidity and a temperature suitable for the growth and activity of microorganisms [17] .

In a similar study in the province of Baghdad [18], total bacterial count rates for drinking water and tank water were between 9.3-2.6cfu/ml and 17.42-3.8 cfu/ml, respectively. The lowest total bacterial count values for drinking and tank water were recorded in February, while the highest values were registered in August. This study also highlighted the clear difference in total bacterial count rates between drinking water .

The current study agrees with the findings of [19] and [20], and is higher than the results obtained by [21] when evaluating the efficiency of the old and unified Shirqat water stations in the Shirqat district and their ability to purify drinking water, where total bacterial count values ranged from (51× 10-3) to (160× -3 10CFU/ml). The increase in total numbers is often due to the arrival of contaminated water containing many pollutants without treatment [22] .

Water samples in the studied areas were more polluted than the water inside the stations, and this was attributed to the old water distribution network pipes, their constant malfunctions, and the delay in their repair. Therefore, they often mix with soil components contaminated with various types of bacteria. The presence of biological pollution could be due to pollution occurring in the sedimentation basins of water projects and neglecting to clean them of algae and sediments, which protect bacteria from the lethal effects of chlorine. The statistical analysis results showed differences.

Statistical differences were found between the stations at a significant level of $0.05 \leq P$, and significant differences were also recorded between the months .

The presence of the bacteria Salmonella sp, which causes typhoid and paratyphoid fever, is dependent on the presence of animals in nature. One of the most significant factors contributing to the presence of this bacterial genus is the existence of poultry, cattle, rodents, and cats, which can also benefit from humans as a host .

The isolate Klebsiella pneumoiae demonstrated the ability to grow at varying temperatures ranging between 43-12degrees Celsius. It is found in the respiratory system and feces of about %5of healthy individuals, causing chronic infections including pneumonia. Its tolerance to variable temperatures ensures its presence during both summer and winter months.

Escherichia coli was isolated frequently throughout the study months and for all the samples studied. Escherichia coli is considered the only true indicator of recent fecal contamination. It belongs to the enteric family, which has similar effects to cholera bacteria and grows at a temperature of 37degrees Celsius as well as at 44degrees Celsius.

The increase in the number of coliform bacteria, especially in tank water, is perhaps due to the availability of suitable conditions for the growth and proliferation of bacteria when nutrients are available. There is no specific season for the increase in the number of coliform bacteria, but the increase and decrease in numbers are dependent on the environment they live in and the abundance of suitable nutrients for their growth. The presence of coliform bacteria in drinking water indicates that the water has not been treated properly, or that the operating system is of low quality, or due to the degradation of water quality from the water source due to chemical and microbial contamination along with increased salinity and heavy elements. Water contamination with coliform bacteria is a serious indicator, as drinking water should be free from any cell of coliform bacteria in 100ml.

Conclusions

Bacteriological examinations have shown that the total number of bacteria was present at high levels, exceeding both Iraqi and World Health Organization standards. It is essential to pay attention to the informational aspect to increase environmental awareness, specifically water pollution and the health damages resulting from using water without treatment, as well as the need for rational water consumption, the importance of maintaining its cleanliness, and avoiding the disposal of waste and sewage debris into the river without treatment. It's also crucial to conduct physical, chemical, and biological tests before treatment processes to determine the exact and scientific amount of chlorine to be added. Conducting these tests on the water inside the stations after every treatment process and the water exiting the stations ensures the effectiveness of the treatment processes and the suitability of drinking water.

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