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Microbial contamination of drinking water on some areas of Thi Qar Governorate

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Abstract:

A total of twenty-four drinking water samples were collected from several areas at northern Thi-Qar Governorate: Al-Fajr, Al-Qalaa, Al-Rifai, Al-Nasr, Al-Shatra, and Al-Gharraf. Four replicates were taken from each area to study microbial contamination. The efficiency of water treatment plants in the study areas was assessed according to the World Health Organization (WHO) standards and Iraqi Standard 417 of 2001. The results showed that the sampled areas were contaminated with Total coliform and Fecal coliform bacteria at very high levels in most of them. The presence of these bacteria indicates a malfunction in the water treatment plants serving these areas, either in their filtration and purification processes or in the contamination of the water source supplying these plants, thus negatively impacting consumer health.

Keywords: Pollutants, filtration plants, bacteria

Introduction:

Water is the treasure of life and its lifeblood. Since the beginning of creation, water has been an integral part of society's various purposes, from agriculture and industry to numerous domestic uses, and more. A significant portion of health problems in all developing countries stem from the lack of safe drinking water (Gray, 2005; De, 2012; Bylund et al., 2017). Water has unique and distinctive properties that increase its high susceptibility to absorbing pollutants from the surrounding environment. Its composition and state change due to these acquired pollutants, whether directly or indirectly (Hamoudi et al., 2018). Iraq possesses considerable quantities of water, being the land of the Tigris and Euphrates rivers, yet it suffers from high levels of pollution, like many other countries worldwide. The reasons for this are numerous, including climatic, demographic, agricultural, and industrial factors that exacerbate the scarcity of fresh water, increase pollution levels, and render it unfit for drinking (Abdul-Razzaq, 2017). This violates the standards adopted by the World Health Organization (WHO) for drinking water, and has a direct and rapid impact on consumers due to this high level of pollution on the one hand, and the inefficiency of water treatment plants and those responsible for the process on the other.

Iraq possesses considerable quantities of water. However, like other countries around the world, it suffers from high levels of pollution. The reasons for this are numerous, including climatic, population-related, industrial, and agricultural factors. All of these contribute to the scarcity of fresh water, the concentration of pollutants, and its unsuitability for drinking. This pollution violates the international standards adopted by the World Health Organization (WHO) for drinking water. It has a direct and rapid impact on consumers due to the inefficiency of water treatment plants and those responsible for the process (Abdul-Razzaq, 2017).

Microbial contamination is very dangerous when drinking, swimming, or bathing water comes into contact with human waste or sewage from surrounding areas (Denchak, 2021), in addition to disrupting the oxygen balance and threatening the lives of aquatic plants and animals (Sharma, 2001). .the presence of fecal coliforms suggests the presence of wastewater from treatment plants. In both cases, water must be disinfected before human use or before being given to animals. This is due to the serious health risks it poses to living organisms and the dangerous diseases it causes, which kill thousands of people—more than wars. Chlorination processes are another risk added to the dangers of other pollutants. This is because these purification processes produce harmful byproducts and contain certain types of bacteria, such as *Pseudomonas aeruginosa*, *Escherichia coli*, and chlorine-resistant *Escherichia coli*. This process also enhances the ability of some species to exchange antibiotic-resistant genes (Jin *et al.*, 2020).

Water contaminated with microbes is dangerous as a carrier of pathogenic microorganisms wherever it comes into contact with human waste or sewage from surrounding areas (Denchak, 2021). Water contaminated with microbes becomes extremely dangerous for drinking, swimming, bathing, and other uses. Sewage in water primarily disrupts the oxygen balance, which is detrimental to aquatic plants and animals (Sharma, 2001). The presence of fecal coliform bacteria in a water body indicates contamination by the feces of warm-blooded animals. Coliform bacterial counts are crucial for basic and applied research in aquatic microbial ecology and its development. Coliform bacteria, belonging to the *Enterobacteriaeae* family, are prominent water pollutants and pathogens to humans (Ashbolt and Grabow, 2001). They have a greater ability to survive for longer periods than other organisms (USEPA, 2005).

Total coliform bacteria (TCB): It is one of the most suitable and important indicators of water pollution due to its ease of detection and counting. Total coliform bacteria are facultative anaerobic, Gram-negative rod-shaped organisms that do not form spores and have a high capacity for fermentation (lactose), producing gas, acid, and aldehydes when incubated at 35-37°C for 24-48 hours. These bacteria are widespread in nature, such as in soil and water. (Hamilton *et al*., 2003). The term coliform refers to a group of intestinal bacteria. (Feng *et al*., 2002).

Fecal coliform bacteria (F.C.): This type of bacteria is known for its resistance to heat and for fermenting lactose sugar at 44.5 degrees Celsius in the presence of bile salts. (Al-Fatlawi, 2008). It is one of the indicators used to determine water quality and suitability for use. (Hattit, 2009). Their presence indicates fecal contamination from human and animal waste. and of the presence of pathogenic intestinal bacteria. (Al-Douri, 2012). Fecal coliform bacteria constitute 60-90% of the total coliform bacteria population. (Al-Nasrawi and Al-Salman, 2014).

The study aimed to identify areas of drinking water pollution and the efficiency of the treatment and purification plants in a group of areas of Dhi Qar Governorate by comparing them with Iraqi standard specifications. (Standard Specification No. 417 (2001), And the international standards set by the World Health Organization (World Health Organization, 1997).

Materials and Methods:

The study samples were taken from six areas in the north of Dhi Qar Governorate, with four replicates for each area, so the total number of studied samples was 24. The samples were kept in tightly sealed plastic bottles in a plastic box containing ice to limit bacterial growth in them..

This study relied on the international standards followed in APHA;2015 for measuring bacterial contamination.

Table (1) World Standard Specifications for Drinking Water (WHO) 1997.

Water	microorganisms	Guiding value
Ready-to-drink water	*Escherichia coli* bacteria and heat-resistant *E. coli* bacteria.	It should be undetectable in any 100 ml of the sample. Zero in any 100 ml of water sample.

Iraqi Standard Specifications for Drinking Water (417) of 2001:

The Iraqi Standard Specifications of 1998 stipulated that the number of fecal bacteria must not exceed zero cells per (100) milliliters of drinking water. It also stipulated that the total number of coliform bacteria must not exceed (10) cells per (100) milliliters of water.

Results:

Table (2): Fecal coliform and Total coliform bacterial counts for the study areas.

Samples	Total coliform	International Standards + Iraqi Specifications	Fecal coliform	International Standards + Iraqi Specifications
S1	UC	Non-compliant	1.2×10^3	Non-compliant
S2	UC	Non-compliant	0.990	Non-compliant
S3	UC	Non-compliant	UC	Non-compliant
S4	UC	Non-compliant	UC	Non-compliant
S5	UC	Non-compliant	UC	Non-compliant
S6	UC	Non-compliant	UC	Non-compliant
S7	40	Non-compliant	Nil	compliant
S8	UC	Non-compliant	430	Non-compliant
S9	UC	Non-compliant	UC	Non-compliant
S10	UC	Non-compliant	UC	Non-compliant
S11	UC	Non-compliant	1.2×10^3	Non-compliant
S12	UC	Non-compliant	370	Non-compliant
S13	UC	Non-compliant	7×10^2	Non-compliant
S14	3.5×10^3	Non-compliant	30	Non-compliant
S15	730	Non-compliant	820	Non-compliant
S16	UC	Non-compliant	1.2×10^3	Non-compliant
S17	Nil	compliant	10	Non-compliant
S18	Nil	compliant	40	Non-compliant
S19	UC	Non-compliant	UC	Non-compliant
S20	UC	Non-compliant	UC	Non-compliant
S21	10	Compliant with Iraqi specifications only	Nil	compliant
S22	Nil	compliant	20	Non-compliant
S23	Nil	compliant	Nil	compliant
S24	10	Compliant with Iraqi specifications only	Nil	compliant

- UC: The number is uncountable.
- Nil: No Growth.
- CFU: Colony Forming unit.

Discussion of results:

Total Coliform:

The results of bacteriological testing of drinking water from several stations in Thi-Qar Governorate, which draw their water from the Al-Gharraf River, a tributary of the Tigris River, shown in Table (2), indicate the presence of bacterial growth in the drinking water of most stations. This growth is very high in Total Coliform counts and does not meet international drinking water standards. According to the World Health Organization (WHO), which has set the limit for bacterial growth at 0 CFU 100ml, it is also higher than the Iraqi limits set for drinking water in 2001, which stipulated that the total coliform count should not exceed 10 CFU 100ml. The reasons for this are numerous, including the availability of conditions and factors that promote bacterial growth, such as increased nutrients. There is no specific season for this increase; rather, the growth of coliform bacteria is related to the environment in which they grow (Al-Mayali and Abd, 2021). The presence of coliform bacteria in drinking water indicates inefficient water treatment or a result of poor water quality. (Source) The treatment plant) and its chemical and microbial contamination. Or due to the poor performance of the water treatment plants, or due to the high salinity of the river, or the high content of heavy metals (Sabri *et al.*, 2001). Despite the presence of chlorine in the filtration system used, this means that the coliform bacteria present are resistant to chlorine due to genetic mutations that enable them to resist chlorine (Zmirou *et al.*, 2007; Gagnon *et al.*, 2005).

Table (2) shows the absence of any coliform bacteria growth at some stations, namely S17, S18, S22, and S23. This is a good indicator of the efficiency of these water treatment plants, and the water quality is within international standards and according to the approved Iraqi standards for drinking water. However, stations S21 and S24, where the bacterial growth rate was 10 CFU/100 ml, are within the Iraqi limits set for drinking water but outside international standards.

We conclude from this that there are clear differences in the rates of coliform bacteria pollution between the stations under study, and the high pollution in most of them is due to the low level of the river (Al-Gharraf River), the main source for these stations, and the increase in the pollutants it carries, such as untreated sewage, and the high content of organic compounds, which are a food source for coliform bacteria, so their numbers increase in proportion to the pollutants in the river, which increase as the river continues its course.

Fecal coliform:

Table (2) shows the high growth rates of fecal coliform bacteria .The majority of stations had very high bacterial growth (UC). The growing fecal coliform cells could not be counted. These stations are S3, S4, S5, S6, S9, S10, S19, and S20. This indicates a malfunction in the operation of the treatment plants in these areas or a problem with the personnel working at these stations. It also indicates their failure to adhere to the standards set for safe drinking water. There is a very high level of pollution in the river water. Meanwhile, stations S7, S21, S23, and S24 showed no fecal coliform growth. This means that these stations conform to the approved international and Iraqi standards for drinking water. These standards define drinking water as the absence of any bacterial cells per 100 ml. This is an indicator of the stations' efficiency. These areas and the efficiency of the staff working there. As for the remaining stations, namely S1, S2, S8, S11, S12, S13, S14, S15, S16, S17, S18, and S22, the growth rates of fecal coliform bacteria ranged from 1200 CFU 100 ml to -10. These stations also exceed the limits set by the World Health Organization standard and are outside the Iraqi drinking water standards.

Most of the samples taken from the study stations did not meet international standards, as defined by the World Health Organization for drinking water, nor Iraqi standards (417) of 2001. This indicates the inefficiency of the treatment plants and the high level of pollution in the Al-Gharraf River, which feeds all these stations. This is a serious indicator of the deteriorating health of consumers of this water (Alexander, 2002). This is because all the study stations are located in agricultural areas where chemical fertilizers and pesticides are widely used. In addition, the river is polluted with animal waste and sewage. The presence of total coliform bacteria and fecal coliform bacteria, which are naturally present in the human intestine, in the water indicates fecal contamination (Atshan, 2025).

The increased number of fecal coliform bacteria may be due to damage and breakage in the network pipes, leading to the mixing of water with contaminated water resulting from leaks in the sewage network and surface water, in addition to some operational problems in certain water supply projects, such as improper filtration and sedimentation processes used to remove bacteria, these basins may not be clean enough, and there may be malfunctions in the chlorine and alum feed pumps, or inaccurate dosing (Alyousif et al., 2021).

There are other reasons for the increase in fecal coliform bacteria due to contamination resulting from their transmission through water supply pipes, particularly over the past two decades, due to the deterioration of services. This has led people to connect water pumps directly to the network to draw water and pump it to rooftop tanks. The potential health risks that result from this include a drop in pressure within the network in the event of any break or deterioration in the connecting pipes. (Al-Azawi et al., 2011).

This problem is exacerbated by the absence of chlorine in the water, coinciding with high temperatures during the summer and the presence of dissolved nutrients. The problem is exacerbated by the lack of chlorine in the water treatment plants, high summer temperatures, and the abundance of dissolved nutrients resulting from liquid waste dumped into the river, leading to an increase in microorganisms. (Yahya, 2002; Al-Saffawi *et al*., 2018). Many studies agree with this study regarding the amount of pollution in Iraqi rivers such as the Tigris, Euphrates, and Shatt al-Arab. (Al-Ta'ee *et al*., 2008; Al-Azawi *et al*., 2011). All of which confirm the presence of high levels of bacterial growth causing fecal coliform bacteria contamination.

Conclusions:

Laboratory results showed that the drinking water in these stations suffers from weakness and defects in its filtration and sterilization processes, and that it is unsafe and permanently unfit for drinking due to bacterial growth rates exceeding the standard limits set by the World Health Organization (WHO) and the Iraqi standard limit (417) for drinking water.

This is due to the high pollution levels in river water caused by the dumping of agricultural and human waste and sewage. Addressing this major health problem requires intensive and organized awareness campaigns for the residents of these agricultural areas, adherence to health regulations when using river water, and conducting regular and thorough monitoring of drinking water through bacteriological tests, as well as addressing and maintaining the problems affecting water pipes.

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