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Detection of Biological and Physicochemical Contaminants in Drinking Water in Al-Samawa City

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Abstract

This study investigates drinking water quality in Al-Samawa City by analyzing data from four filtration stations in Al-Muthanna Governorate over the period 2019-2021. Findings reveal significant contamination, including bacterial pollutants from sewage in the Euphrates River, high turbidity, elevated dissolved salts, and excessive chloride levels beyond permissible limits. These contaminants rendered the water unfit for human consumption. The study highlights the critical need for enhanced sanitation measures, stringent water quality controls, and effective management to ensure safe drinking water for the local population.

Introduction

Water is the most vital natural resource on Earth, serving as the cornerstone of life and supporting both human and aquatic ecosystems. It is indispensable for all living organisms; while some, like anaerobic microbes, can survive without air or dissolved oxygen, no life form can exist without water. Access to clean and safe water is crucial for human health and the well-being of communities. In many regions, including Al-Samawa City, water quality is a pressing concern due to various contamination sources. This study focuses on evaluating the drinking water quality in Al-Samawa City by examining biological and physicochemical contaminants. Over the period 2019-2021, data from four filtration stations in Al-Muthanna Governorate were analyzed, revealing significant pollution levels. Addressing these contamination issues is essential to ensure the provision of safe drinking water and to protect public health in the region.

The biological properties of contamination of water

The biological characteristics of water are very important in determining the suitability of water for various uses on the one hand, in addition to knowing the level of environmental

pollution of this water on the other hand. The level of pollution that occurs in the water of the Euphrates River through these characteristics is very dangerous to the lives of people. (Taha et al., 2023) Statistical results showed contamination of water sources with pathogenic microorganisms such as bacteria, pathogenic viruses, fungi, and parasites (Mohemmad et al., 2021), as the bacteria contents in both tap water and bottled water were within standard limits (AL-Dulaimi and youns., 2017).

Drug-resistant bacteria (DRB) can be found in the river near hospital sewage plants because some types of bacteria separated using vascular methods can be recognized and tested using the excellent diffusion test to assess their antibiotic resistance (Alsaad et al., 2022).

The range of bacteriological parameters, such as *E. coli* and total coliforms, was reported to be (30–1600 MPN/100 ml) and (500–1600 MPN/100 ml) in earlier research. Iraq's state drinking water regulations were frequently surpassed in terms of turbidity, SO₄, BOD₅, TC, and *E. coli* (Hussein et al., 2019).

All samples taken for drinking water and bottled drinking water were certified as potable because these samples were within the Iraqi standard, with the exception of Al-Rahman area water and Salem bottled water. They were contaminated with bacteria, 67 colonies for M.P.N and 89 colonies for A.P.C, respectively, but no salmonella and cholera bacteria were found. In all previous samples(Al-garawyi, 2019).

Bacteriological tests showed increasing in TPC, TC, FC, *E. coli* and FS bacteria as compared to those of the other months for water plant raw and drinking water and the FS values was less than other bacterial types for water plant (Al-Tmemy et al., 2020).

There is a relationship between drinking water and human health, so it must be of high quality and free of any components harmful to human health, such as harmful microorganisms, metals, and organic materials, which lead to the spread of disease due to sewage pollution (Ali et al., 2023).

Such as Staphylococcus bacteria (aureus and dermatophytes), Escherichia coli, Klebsiella pneumoniae, Proteus mirabilis and Pseudomonas aeruginosa. Staphylococcus aureus is the most pathogenic and abundant bacterial species in all types of samples, followed by Staphylococcus epidermidis and Escherichia coli (Hussain et al., 2017). Sources of bacterial contamination were among human and animal sources drinking water (Mohamed and altaee, 2022).

The physicochemical properties contamination of water

There are some physical and chemical properties, such as pH, total dissolved solids, calcium, magnesium, chlorides, and sulfates in mg/L. Tests of all samples and all physical and chemical properties were acceptable within the Iraqi and international specifications for drinking water (Al-Tameemi et al., 2020).

To evaluate the quality of groundwater in Kirkuk, a geographic information system (GIS) was adopted, which measures its suitability for drinking, irrigation, aquatic and recreational purposes, and livestock uses. The result was according to the global groundwater quality index. The previously collected groundwater samples were classified as marginal during the years 2017 and 2018, while it was observed Poor efficiency of groundwater as drinking water in 2019 (Hussein et al., 2017).

When measuring some physical factors, such as water temperature and turbidity, and chemical factors such as pH, total hardness (TH), phosphate (PO₄), nitrite (NO₂), and nitrate (NO₃), and measuring biological factors such as bacterial contamination, it became clear that some of the physicochemical values were not within the acceptable value for the drink. Iraq and the World Health Organization. It was found that the concentration of phosphate was (0.001-0.004) mg/L, while the level of nitrite was about (0.001-0.006) mg/L

and nitrates were (0.131-0.302) mg/L in Iraqi drinking water over the previous years (Mohamed and altaee, 2022).

Applying this methodology, a geographic information system was developed. The researchers were provided with laboratory data for the physicochemical properties of 16 parameters for the year 2021, and linked this data to their spatial locations, through the use of radar images and seasonal satellite images. It was found that climate changes have affected some properties such as water temperature, pH, turbidity, and total hardness. The study showed that the concentration of sulphates (SO₄) exceeded the permissible limits in Iraqi river water. It was found that the values of hardness and alkalinity were within the permissible limits, although they were relatively high, and most of the environmental results used in the laboratory were within the permissible limit for Iraqi water, except for sulphates. The reason for conducting this study was to help government agencies adopt a correct vision for development projects, and it is also considered the first time that the environmental characteristics of the Hilla River in Babil Governorate have been studied using geographic information applications (Maarroof et al., 2023).

Drinking water in the city of Baghdad, especially tap water, contains certain levels of heavy metals, but most of these levels fall within international standards, although there are some indicators of chemical and biological pollution (Ghafil et al., 2022). Each step of the drinking water treatment plants determines the efficiency of each process in removing polycyclic aromatic hydrocarbons, which are considered harmful to human health, as the lowest values were recorded in the treated water. This indicates the efficiency of the treatment processes by removing polycyclic aromatic hydrocarbons from the water source (Mohammed et al., 2010).

It was found that it is possible to reduce organic matter in highly polluted water samples by changing the pH of the processor without fear of a slight increase in the resulting turbidity because the turbidity and alkalinity of the samples were very high from the original sources. Changing the pH has a very important effect because adding high doses of coagulant to increase coagulation at ambient pH may not be an operationally sound or cost-effective decision (Ghawi,2000). The developed water quality index will be followed by four main steps in order to develop a water quality index, these are selecting water quality criteria, assigning weights, making sub-indicators and finding the final index score. The governorate is divided in to four districts: Al-Samawa, Al-Khidhir, Al-Rumaitha and AlSalman.

The following processes represent a simplification of the drinking water treatment processes used globally:

Coagulation

Coagulation is often the first step in water treatment. During coagulation, chemicals with a positive charge are added to the

water. The positive charge neutralizes the negative charge of dirt and other dissolved particles in the water.

Flocculation

Coagulation is then followed by flocculation. The process of carefully mixing water to generate larger, heavier particles called flocs is known as flocculation. In order to aid in the creation of flocs, water treatment facilities frequently add more chemicals during this phase.

Sedimentation

One method used by water treatment facilities for clearing the particles from the water is sedimentation. While flocs are heavier than water, they float to the bottom of the water during sedimentation.

Filtration

The clear water on top of the flocs is filtered for removing any unwanted solids from the water after they have settled to the bottom. Clear water performs filtering by passing through filters consisting of various materials (such as sand, gravel, and charcoal) and with varying pore sizes. Dust, chemicals, parasites, bacteria, viruses, and other dissolved particles and microbes are extracted by these filters. Negative scents are also eliminated using activated carbon filters.

Disinfection

Water treatment facilities may add one or more chemical disinfectants (such chlorine dioxide, chloramine, or chlorine) to the water after it has been filtered to eliminate residual bacteria, viruses, or parasites. Water purification facilities will ensure that the water leaves the facility with minimal concentrations of chemical disinfectant to help keep it safe as it goes to residences and workplaces (Hassan and Mussa, 2022).

Indicators were assessed in 2019 for the drinking water network in the Muthanna Governorate, the water of the Euphrates River, and the water of the purification station. The findings indicated that the pH of the network, the rivers, and the purification stations tended to be neutral. The water has no color, taste, or odor, and when compared to the river's raw water, the purification station's and the network's water have far lower levels of turbidity and total and dissolved solids (Abed and Khudair, 2022).

River water's sulphate content dropped for network and station water, respectively. There was a difference in the concentration values of calcium, magnesium, chloride, and total hardness between the river water, the station, and the network. In the network water, free chlorine concentrations varied from 2.3 to 1.3 mg/L. While the measurements of electrical conductivity, total hardness, free chlorine, and biochemical oxygen were within the normal parameters

permitted by the World Health Organization, the pH values, solids, turbidity, calcium, magnesium, chloride, sulphate, and phosphate were outside of those ranges. Both the plant and network water had a somewhat higher oxygen demand. Both Iraqi guidelines and the World Health Organization classify BOD values as being under the domestic uses and drinking water commodity classification (Mansor,2022).

Conclusion

After collecting data from several government stations to purify drinking water in Muthanna Governorate over a period of three years (2019 to 2021) from the stations at Al-Hussein, Al-Majd, Al-Malha, and Al-Gharbiy District, several factors were identified that rendered the water unfit for drinking during this period.

The primary issue identified was microbial contamination, including the presence of aerobic bacteria such as *E. coli* and *Salmonella*. These bacteria originate from river water contaminated with sewage, leading to the pollution of drinking water. Additionally, factors such as the geology of the soil, excavation activities, erosion conditions, high turbidity, dissolved salts, and elevated levels of chloride salts beyond acceptable limits have also contributed to making the water unfit for human consumption over the past three years.

In conclusion, the tap and household water were heavily contaminated with bacteria, posing a significant health risk. The coliform count exceeded both international and national recommended limits. Contributing factors included poor sanitation, inadequate cleanliness, and lack of control over key parameters. To prevent further contamination, strict control and proper management of the water distribution system are recommended. Additionally, education programs should be developed focusing on water, sanitation, and public hygiene. Ensuring the cleanliness of filters in water filtration plants is also essential.

Conflict of Interest

The author hereby declares no conflict of interest.

Consent for publication

The author declares that the work has consent for publication.

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