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Microbiological Monitoring of Drinking Water in Public Areas of the City of Turkestan

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Abstract

Water is an essential resource that directly affects public health. In the context of global change and population growth, water resources face increasing threats of pollution and reduced availability. This issue is particularly relevant for the city of Turkestan in Kazakhstan, where the quality of drinking water is under continuous monitoring. This study focuses on assessing the microbiological parameters of water from public sources in the city, with an emphasis on identifying contamination levels and potential health risks. Special attention is given to detecting microorganisms such as Escherichia coli and Coliform bacteria, which serve as indicators of fecal contamination. The importance of this research lies in the need for effective methods of analysis and monitoring of drinking water quality to ensure compliance with sanitary and hygiene standards and to protect public health. The results highlight the necessity for strengthened water quality control in public areas and for implementing measures to prevent contamination and improve the overall state of water supply.

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INTRODUCTION

Water is one of the most essential substances required for life. As the world's population continues to grow, the demand for water increases accordingly. However, under the influence of various factors particularly human activities water resources are being depleted, polluted, and used unsustainably. Numerous diseases exist in different communities around the world that can spread through water and cause devastating epidemics (Emad et al., 2023).

Ensuring access to safe drinking water for people around the globe is one of the most urgent issues of our time. The environmental crisis, exacerbated by human activity, highlights the critical need to protect our natural environment and resources, especially access to drinking water. To ensure sustainable and rational use of these vital resources, it is essential to address emerging problems quickly and effectively (El-Sorogy et al., 2023).

The most common and serious threat to health associated with drinking water is microbial contamination, and monitoring this process must always remain a priority. Ensuring the microbial safety of drinking water is based on the use of multiple barriers along the path from

water collection to consumption, in order to prevent contamination or reduce it to levels that are not hazardous to human health. Testing the microbiological quality of drinking water involves checking for the presence of *Escherichia coli (E. coli)* as an indicator of fecal contamination. The presence of *E. coli* is strong evidence of recent fecal pollution and should not be found in drinking water. Microbiological contamination can occur due to the growth of bacteria in poor-quality building materials that come into contact with water, such as sealants, pipe coatings, and plastic components (Nurtazin et al., 2020).

Bacteria such as *E. coli* or fecal streptococci are known indicators of contamination of drinking and recreational waters by sewage. In sanitary microbiology, specific groups of bacteria are widely used as indicators to assess water contamination. One of the most useful indicators of water pollution is the total number of coliform bacteria. The coliform group includes several species of organisms from the *Enterobacteriaceae* family *E. coli* and *E. aerogenes* are well-known representatives of rod-shaped bacteria and are commonly found in polluted water. As the predominant microorganism in human feces, *E. coli* serves as a reliable indicator of fecal contamination of water (Madni et al., 2022).

The task of providing the population with drinking water requires that its quality meets established hygienic standards aimed at preventing epidemics. The sanitary condition of water supply sources makes it important to develop and implement simple, reliable, understandable, and widely accessible methods for microbiological monitoring of water quality within laboratory practice (Irtaza et al., 2022).

Although the majority of the world's population lives in cities, ensuring that all urban residents have adequate quantity and quality of water, as well as access to it, lies at the intersection of environmental issues such as resource availability and related social, economic, and public health challenges (Silva et al., 2021).

According to the directive of the country's president, by the end of 2025 the population of the Turkestan region must be fully provided with drinking water. The issue of uninterrupted and high-quality water supply to settlements is under the strict control of the regional governor. During a meeting chaired by the head of the region, this important matter was discussed. The meeting was attended by the director of the Geological Committee of the Ministry of Industry and Infrastructure Development, heads of relevant services, and specialists engaged in drilling operations (Obiri-Danso et al., 2003).

In addition, the meeting thoroughly addressed the issue of ensuring drinking water supplies for the cities of Turkestan and Kentau from the groundwater reserves of the Myrgalym-sai deposit. The governor of the Turkestan region instructed responsible specialists, together with the Geological Committee, to develop concrete proposals to ensure drinking water supply to the settlements and to resolve existing problems promptly (Phiri et al., 2021).

According to the head of the Department of Energy and Public Utilities of the Turkestan region, the region has seven group water pipelines and local water supply systems. Most of the 608 settlements use drinking water from underground sources (wells). In 215 of the 720 settlements provided with water supply, water is supplied according to a schedule. The southern districts of the region experience a shortage of drinking water due to the decline in groundwater levels. As a result, water reserves are being depleted. The cities of Turkestan and Kentau receive water

through a trunk water pipeline from the groundwater reserves of the Myrgalym-sai deposit. In 2021, the company "Geotherm" carried out additional geological surveys and confirmed the groundwater reserves. As part of the project to reduce water abstraction and subsequently replenish the Koskorgan reservoir, 11 additional wells with vertical drainage systems were drilled in the Myrgalym-sai area of Kentau. Thus, it is planned to extract 40 million cubic meters of water per year. Drinking water is supplied through four pumps installed at depths of up to 130 meters. Additionally, the water is planned to be used for landscaping and irrigation of green areas in the city of Turkestan (Semerjian et al., 2020).

In the cities of Turkestan and Kentau, located in Kazakhstan, the issue of drinking water availability may vary depending on the season as well as the condition of the water supply systems (Adhikari et al., 2022).

In recent years, the authorities of Turkestan have been actively working to improve water supply and upgrade water and sewage infrastructure. However, as in many regions of the country, some parts of the city may face water quality issues, such as elevated salt content or other impurities. Household water can be filtered and disinfected, but the use of additional filters is recommended to improve water quality (Albanus et al., 2022).

Identifying microorganisms in drinking water is a key process in ensuring its safety and quality. Water may contain various microorganisms, including bacteria, viruses, fungi, or protozoa. Their presence can indicate contamination of the water source or violations of sanitary norms (Liguori et al., 2010). Different countries have established standards defining the maximum permissible levels of microorganisms in drinking water. Regular monitoring of microorganisms is essential to prevent waterborne diseases such as cholera, dysentery, and salmonellosis (Nural & Seyhun, 2024).

The aim of this study is to assess the quality of drinking water in public areas of the city of Turkestan based on bacteriological indicators.

MATERIALS AND METHODS

This study is dedicated to assessing the quality of drinking water from public sources in the city of Turkestan. Water quality is determined by a range of indicators physical, chemical, and microbiological. The main focus is on microbiological analysis, particularly the presence of Escherichia coli and Coliform microorganisms, which serve as indicators of fecal contamination. The study covered 17 sampling points located in areas with high public attendance, such as near schools, mosques, markets, and parks. Their locations are shown on the map (Fig. 1).

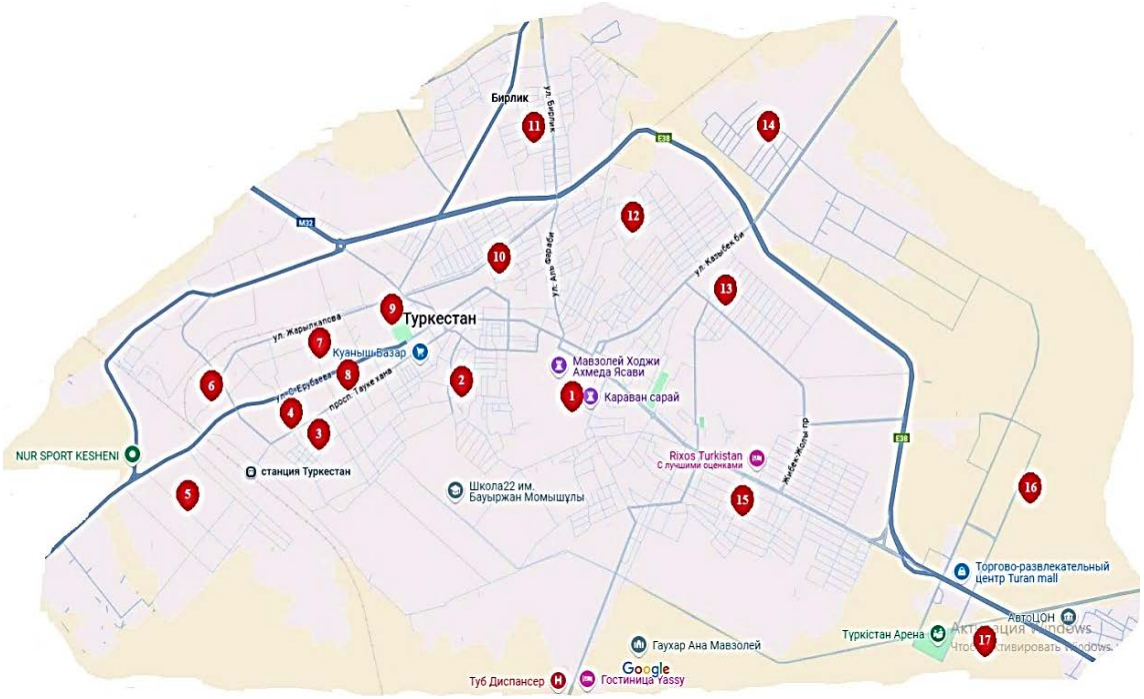

Fig. 1. *Map showing the locations of the examined drinking water sources (numbers highlighted in red) in public areas of the city of Turkestan*

The research methodology included the collection and analysis of water samples in accordance with sanitary standards. Samples were collected in the spring of 2025 using sterilized glass bottles after preliminary disinfection of faucets and flushing of the water. The samples were stored and transported to the laboratory in refrigerated containers at a temperature of 4 to 10 °C, and the time between sampling and analysis did not exceed 6 hours. All bacteriological studies were carried out in the laboratory of the Research Institute "Ecology" in accordance with GOST 18963-73 standards.

For the analysis, inoculations were performed on nutrient media: the water was inoculated onto Endo agar and LPS medium, then incubated in a thermostat at 37 °C for 24 hours (Fig. 2). Bacterial colonies were counted using a specialized device, taking into account both surface and deep colonies. Coliform bacteria were identified based on their characteristic growth (dark-red colonies with a metallic sheen) and confirmed by Gram staining. The total microbial count (TMC) was also assessed as an indicator of the overall level of contamination.

a b c

Fig. 2. *Samples with Petri dishes: a – cultures for determining the total microbial count; b – cultures on LPS medium for identifying coliform bacteria; c – cultures for detecting the presence of total coliform bacteria in the examined water samples on Endo agar*

The results showed that the TMC levels in the samples ranged from 4 to 88 cells per 1 mL, which corresponds to the category of "contaminated waters." According to coliform bacteria (TCB) indicators, most sources were classified as moderately contaminated, contaminated, or heavily contaminated. The obtained data emphasize the need for regular monitoring of water quality in public areas and for implementing measures to improve the sanitary condition of the city's water supply system.

RESULTS AND DISCUSSION

The results of the study of water from urban drinking sources based on microbiological indicators are presented below. The research was conducted in the spring, in March 2025.

Table 1. Characteristics of the examined public drinking water sources in the city of Turkestan

Sampling points	Total mesophilic aerobic and facultative anaerobic microorganisms (TMC), colony-forming units	Total coliform bacteria (TCB)
1. Ortaq	31	not detected
2. Microdistrict	44	not detected
3. Samal	88	detected
4. Turkestan – Water	71	detected
5. Remzavod	7	not detected
6. Victory Park	27	not detected
7. Zholdyn Asty	5	not detected
8. Novostroika	4	not detected
9. Mausoleum	5	not detected
10. TGDZh	9	not detected
11. Birlik	11	not detected
12. Ishtikhat	56	detected
13. Zhukovsky	8	not detected
14. Oralman	19	not detected
15. Kommunizm	37	not detected

Sampling points	Total mesophilic aerobic and facultative anaerobic microorganisms (TMC), colony-forming units	Total coliform bacteria (TCB)
16. New City 1	55	not detected
17. New City 2	47	not detected
Standard requirements	number of CFU/mL not higher than 50	not detected in 100 mL
Test methods	GOST 18963-73 p.4.1	GOST 18963-73 p.4.2

Based on the microbiological analysis of water samples from the selected locations, most samples such as Ortaq, Microdistrict, Remzavod, Victory Park, Zholdyn Asty, Novostroika, Mausoleum, TGDZh, Birlik, Zhukovsky, Oralman, Kommunizm, New City 1, and New City 2 did not contain total coliform bacteria (TCB), and therefore comply with sanitary standards. These samples meet the requirements of GOST 18963-73 p.4.2, according to which TCB must not be detected in 100 mL of water.

However, in samples from Samal (88 CFU/mL) and Turkestan – Water (71 CFU/mL), the concentration of mesophilic aerobic and facultative anaerobic microorganisms (TMC) exceeds the established limit of 50 CFU/mL, which represents a deviation from the standards specified in GOST 18963-73 p.4.1. This may indicate reduced water quality in these locations and necessitates attention and possible purification measures.

The sample from Ishtikhat also showed the presence of coliform bacteria, indicating potential water contamination. The total number of mesophilic aerobic and facultative anaerobic microorganisms in this sample was 56 CFU/mL, which also exceeds the standard. Therefore, corrective measures are required for this location as well.

Overall, the study results show that water in most sampling points complies with sanitary standards regarding the presence of coliform bacteria and mesophilic aerobic microorganisms. However, deviations identified in the Samal, Turkestan – Water, and Ishtikhat samples require further monitoring and actions to improve water quality to ensure consumer safety.

Although the study demonstrated that the majority of drinking water sources in the city meet sanitation standards, certain sampling points require increased attention due to the identified deviations. The water quality issues found in several locations highlight the importance of regular monitoring and timely purification measures. Therefore, city authorities should enhance the system of water treatment and ensure regular maintenance of drinking water sources. It is also advisable to consider expanding the network of drinking sources in public areas especially in parks and playgrounds to improve access to clean water for residents and reduce the risk of waterborne diseases.

CONCLUSION

As a result of the study on the quality of drinking water in the city of Turkestan, both positive and negative aspects were identified. Most of the city's water sources comply with sanitary standards regarding the content of mesophilic aerobic and facultative anaerobic microorganisms, which indicates a high level of control over water quality. However, in certain districts, such as Samal, Voda–Turkestan, and Ishtikhat, deviations from the standards were recorded, associated with the presence of coliform bacteria and other microorganisms, indicating possible water contamination.

This poses a threat to public health, as microbial pollution can contribute to the spread of waterborne diseases.

To ensure further improvement in the quality of drinking water in Turkestan, it is necessary to implement regular inspections and effective methods of purification and disinfection of water sources. It is also important to strengthen control over the condition of water sources in public areas and improve water supply infrastructure. The implementation of these measures will not only ensure compliance with sanitary requirements but also significantly enhance the safety of drinking water, which is crucial for protecting public health.

AUTHOR CONTRIBUTIONS

Author Contributions: T.G.E. Conceptualization, Data curation, Formal analysis, Investigation. A.N.A. and Y.D.K. Conceptualization, Formal analysis, Investigation, Writing – review & editing. A.N.A. and Y.D.K. Writing – original draft. T.G.E.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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