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Evaluating Water Safety: A Study of Microbial Contaminants in Mobile Tanks in Basrah City/Iraq

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Abstract - This study assessed the microbial and physico-chemical quality of water stored in mobile tanks across Basrah governorate, Iraq, to evaluate possible health threats associated with their use for drinking and domestic purposes. Twenty water samples were gathered and tested for total plate count, total coliforms, fecal coliforms, total dissolved solids (TDS), electrical conductivity (EC), and pH. The findings exposed significant microbial contamination, with total plate counts reaching up to 103 CFU/100 mL, average total coliforms of 27.4 CFU/100 mL, and fecal coliforms averaging 2.3 CFU/100 mL, demonstrating fecal contamination and paired with health risks. Physico-chemical parameters showed mild ionic content (mean TDS 61.5 mg/L, EC 92.3 µS/cm) and slightly alkaline pH (7.0–7.6), conditions favorable to microbial survival. Higher contamination correlated with infrequent tank cleaning and environmental factors such as sunlight exposure and temperature. These outcomes highlight the urgent requirement for regular water quality monitoring, enhanced tank maintenance, effective disinfection, and public education to conserve health in societies that adopt on mobile tank water supplies in Basrah as a drinking source.

تقييم سلامة الماء: دراسة الملوثات الميكروبية في الخزانات المتنقلة في محافظة البصرة/ العراق.

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المستخلص: قيّمت هذه الدراسة الجودة الميكروبية والفيزيائية والكيميائية للمياه المخزنة في خزانات متنقلة في محافظة البصرة بالعراق، وذلك لتقييم المخاطر الصحية المحتملة المرتبطة باستخدامها للشرب والأغراض المنزلية. جُمعت عشرون عينة مياه وفُحصت لتحديد العد الكلي للأطباق، والبكتريا القولونية الكلية، والبكتريا القولونية البرازية، المواد الصلبة الذائبة الكلية (TDS)، والتوصيلية الكهربائية (EC)، ودرجة الحموضة (pH). تم الكشف عن تلوث ميكروبي كبير واضح، حيث وصل العدد الكلي للبكتريا في الاطباق حوالي 103 CFU/100 ml ، ومتوسط عدد البكتريا القولونية الكلية الى 27.4 CFU/100ml ، ومتوسط عدد القولونيات البرازية حوالي 2.3 CFU/100 ml ، مما يُظهر تلوثًا برازيًا ومخاطر صحية. أظهرت المعايير الفيزيائية والكيميائية محتوى أيوني معتدل (متوسط المواد الصلبة الذائبة الكلية 61.5 ملجم/لتر، و92.3 EC ميكروسيمنز/سم) ودرجة حموضة قلوية قليلاً (7.0 – 7.6)، وهي ظروف مواتية لبقاء الميكروبات. ارتبط ارتفاع التلوث بقلة تنظيف الخزانات وعوامل بيئية كالتعرض لأشعة الشمس ودرجة الحرارة. تُبرز هذه النتائج الحاجة المُلحة لمراقبة جودة المياه بانتظام، وتحسين صيانة الخزانات، والتطهير الفعال، والتوعية العامة للحفاظ على الصحة في المجتمعات التي تعتمد على إمدادات مياه الخزانات المتنقلة في البصرة كمصدر للشرب.

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كلمات مفتاحية: خزانات متنقلة، تلوث، بكتيريا القولون البرازية، بكتيريا القولون الكلية، سلامة مياه الشرب.

Introduction

Water is one of the most vital components of life on our planet and the key factor for its permanence. It is essential for all forms of life and is directly or indirectly connected to every aspect of human activity. The world, especially developing republics, faces one of the most serious challenges humanity has encountered the provision of hygienic drinking water (Bănăduc *et al.*, 2022; Kristanti *et al.*, 2022). Increased population density and the industrial revolution have undesirably impacted water quality and its suitability for several uses, touching human health. So, it is important to address the problems and threats caused by water pollution, which can give rise to a shortage of potable water supply. City residents consume an average of 265 liters of water per person per day, with approximately 190 liters lost to wastewater (Lin *et al.*, 2022; Babuji *et al.*, 2023).

Water quality is a critical determinant of public health, particularly in regions where access to clean drinking water is insufficient. In Basrah governorate, Iraq, the dependence on mobile tanks for water supply has become progressively common due to ongoing infrastructural challenges and deteriorating water quality from common sources. The microbial contamination of drinking water poses critical health risks, as evidenced by the high incidence of waterborne diseases in the country (Manetu *et al.*, 2021; Al-Jaberi *et al.*, 2023).

Microbial contamination in drinking water is primarily indicated by the occurrence of fecal indicator bacteria, such as total coliforms and *E. coli*. These indicators are crucial for assessing the safety of water for human consumption, as their presence suggests possible contamination with pathogenic microbes that can cause diarrhea and other serious related illnesses (Organization, 2022). As the World Health Organization (WHO), any detection of *E. coli* in drinking water is considered impermissible highlighting the importance of rigorous observation, monitoring and management (Fardowsa, 2024). Various surveys in Iraq have indicated that water in mobile tanks can become contaminated due to many factors such as inadequate and bad tank maintenance, improper cleaning strategies, and environmental exposure (Fardowsa, 2024; Najeeb *et al.*, 2024). Exposure to direct sunlight and high ambient temperatures can amplify the growth of pathogens in the tank's water. Furthermore, the lack of regular water quality monitoring is worsening the issue, leading to broad health risks for people's dependence on these water sources (Furst *et al.*, 2024; LeChevallier *et al.*, 2024) .

Despite the recognized risks associated with microbial contamination in Basrah, there is a lack of comprehensive data on the microbial quality of water from mobile tanks. This study aims to address this gap by evaluating the microbial contamination of water stored in mobile tanks throughout the Basrah governorate. The objectives are to assess the prevalence of fecal indicator bacteria in water samples, identify factors contributing to contamination, and recommend strategies for improving water safety in the region.

Materials and Methods:

This study was conducted in Basrah governorate, Iraq. Water samples were collected from December to March 2023. A total of 20 water samples were collected from mobile tanks used for drinking and domestic purposes. Presterilized 500 ml glass containers with screw caps were used for collecting water samples, which were kept at 4°C until the analysis was performed. Sampling locations included various residential areas, selected based on accessibility and the frequency of water deliveries as shown in Table (1) and Figure (1).

Table 1. Coordination of sampling stations

Sampling stations	Latitude	Longitude
1	30°32'32.88"N	47°45'28.91"E
2	30°29'40.85"N	47°50'43.40"E
3	30°33'26.88"N	47°46'53.50"E
4	30°26'49.22"N	47°52'39.29"E
5	30°26'50.88"N	47°46'46.24"E
6	30°30'11.80"N	47°46'23.38"E
7	30°35'41.96"N	47°47'20.30"E
8	30°22'36.15"N	47°42'7.50"E
9	29°58'46.91"N	48°28'0.75"E
10	30°19'19.82"N	48°15'12.15"E
11	30° 2'11.29"N	47°55'22.41"E
12	30°13'53.73"N	47°45'58.09"E
13	31° 1'7.93"N	47°25'31.26"E
14	30°41'33.53"N	47°44'16.55"E
15	30°51'23.61"N	47°32'0.44"E
16	30° 6'37.44"N	47°43'7.47"E
17	30°31'40.06"N	47°48'52.70"E
18	30°31'39.83"N	47°51'14.48"E
19	30°34'51.54"N	47°47'40.15"E
20	30°35'11.16"N	47°45'25.18"E

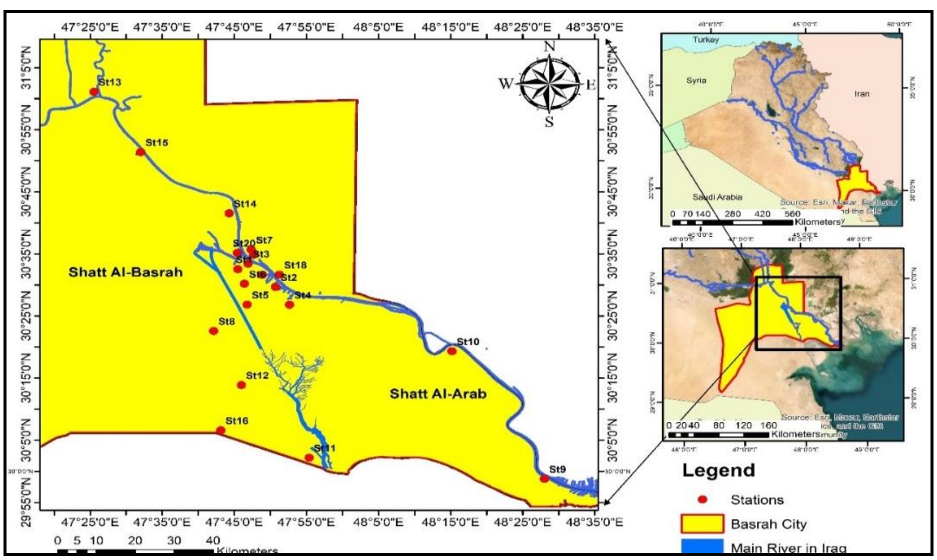

Figure 1.Map of sampling stations from Basrah governorate

The samples were subjected to a serial dilution ranging from 10^{-1} to 10^{-3} using sterile distilled water, then analyzed for total plate count; total coliforms and fecal coliforms using the filtration method (STM 9222B) (Lipps *et al.*, 2023), as outlined in the standard methods for the examination of water (Rice *et al.*, 2012). Each sample was processed within 24 hours of collection to ensure accuracy.

According to ASTM standard various parameters were identified in the water samples, including pH (ASTM-D1293), Conductivity (ASTM-D1125) and Total dissolved salts (HACH METHOD).

Results and Discussion:

The analysis of water samples from mobile tanks in Basrah city detects significant microbial contamination alongside moderate ionic content and slightly alkaline conditions. The data presented in the Table 2 and Figure 2 present an analysis of the results of microbial contamination and physicochemical parameters in collected water samples, which is critical for evaluating water quality and public health risks. Compared with Iraqi Drinking Water Quality Standards (ICSD, 2009; Abbas, 2025) ,the total plate count (TPC), with values reaching up to 103 CFU/100ml, indicates significant microbial presence. High TPC levels are often linked to organic pollution and can indicate the possibility of pathogen presence, requiring regular monitoring and management of water sources (Baird *et al.*, 2017; Organization, 2022).

Table 2. Results of bacterial and physiochemical tests

Sample	Total Plate Count (CFU/100ml)	Total Coliforms (CFU/100ml)	Fecal Coliforms (CFU/100ml)	TDS (mg/L)	EC µs/cm	pH
1	32	20	1	45	70	7.1
2	76	35	3	65	102	7.3
3	58	25	2	80	125	7
4	13	4	0	50	78	7.4
5	89	40	4	90	141	7.2
6	67	15	1	30	47	7.5
7	23	7	0	75	117	7
8	39	28	2	60	94	7.3
9	82	36	5	100	156	7.6
10	9	3	0	25	39	7.1
11	73	45	6	85	133	7.2
12	48	27	3	40	63	7.4
13	60	33	2	70	109	7
14	36	21	1	55	86	7.3
15	84	44	4	95	148	7.6
16	103	44	7	50	78	7.1
17	62	26	3	80	125	7.5
18	55	39	5	65	102	7.2
19	77	32	2	90	141	7.4
20	20	7	0	30	47	7

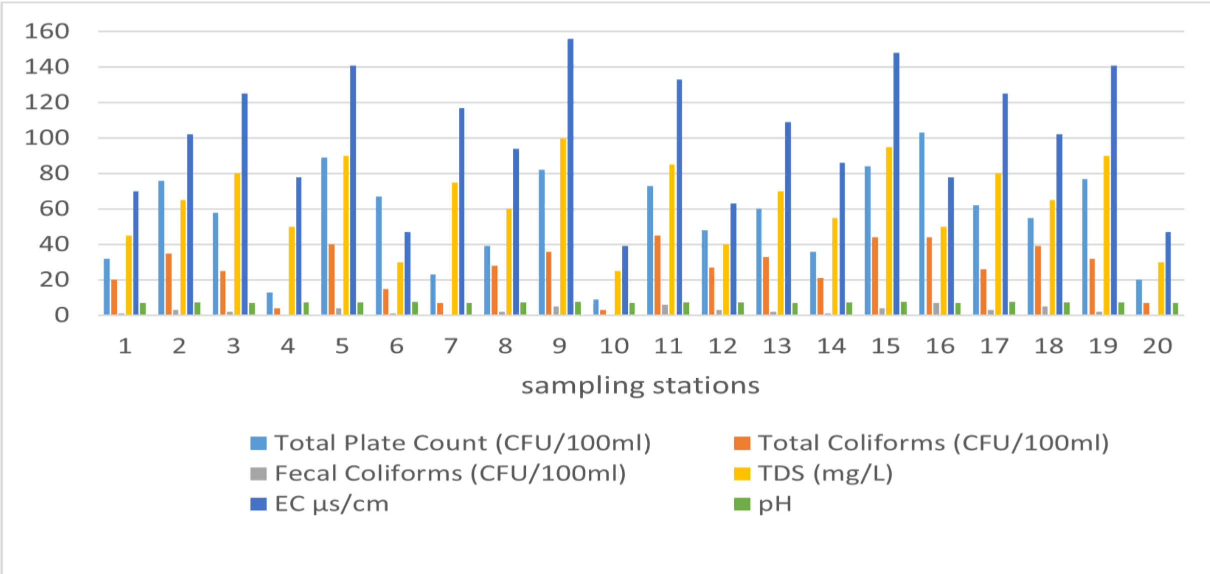

Figure 2. Bacterial and physiochemical test results chart

The total coliform counts, averaging 27.4 CFU/100ml, reflect moderate contamination levels. Coliform bacteria serve as indicators of water quality, as their presence suggests possible fecal contamination, which can introduce harmful pathogens (Wen *et al.*, 2020). Notably, the fecal coliform levels, with a mean of 2.3 CFU/100ml, highlight specific risks associated with fecal contamination. Fecal coliforms are dangerous indicators of hygiene efficacy and public health risk, commonly related to gastrointestinal infections such as *E. coli* and Salmonella *sp.* (Holcomb *et al.*, 2020; Humudat *et al.*, 2020).The occurrence of fecal indicator bacteria at levels surpassing the (WHO) allowable limit, is defined as zero for *Escherichia coli* (Organization, 2024). These findings align with regional studies in Iraq and Egypt, where mobile tanks and household storage systems exhibited similar contamination patterns due to infrequent cleaning and environmental exposure (Aldhamin, 2023; Abdulbaqi *et al.*, 2024).

The main water source for mobile tanks in the Basrah governorate is the reverse osmosis system of water treatment plants (WTPs), which is distributed throughout the city. Most of these plants are located nearby the Shatt Al-Arab River, which serves as the raw water source for them. Recent rises in salinity levels have directly impacted the efficiency of the reverse osmosis membranes, resulting in elevated salinity levels in the mobile tanks (Almuktar *et al.*, 2020). Total Dissolved Solids (TDS) and electrical conductivity (EC) measurements provide insights into the ionic concentration of the water. The mean TDS of 61.5 mg/L and EC of 92.3 µS/cm propose a reasonable level of dissolved ions, which can influence microbial survival and growth by shifting osmotic balance and nutrient availability (Shaheen *et al.*, 2019). Elevated TDS and EC are often correlated with increased salinity, which can affect the ecological stability of aquatic systems and the behavior of microbial communities (DeVilbiss, 2021). pH values ranging from 7.0 to 7.6, indicate slightly alkaline conditions. pH is a significant factor influencing microbial activity and nutrient availability in water. Microbial communities typically thrive within specific pH ranges, and variations can affect their metabolic processes and survival (Quatrini *et al.*, 2018; Naz *et al.*, 2022).

The interrelationship among these parameters highlights the importance of a comprehensive approach to water quality management. For instance, elevated TPC and coliform counts often correlate with specific physicochemical conditions; thus, understanding this relationship is crucial for developing effective treatment strategies. Future studies should focus on identifying the specific sources of contamination and evaluating the effectiveness of water treatment processes (Holcomb and Stewart, 2020). The high rates of contamination are concerning, particularly given the reliance on mobile tanks for drinking water in the region. By enhancing our understanding of these interactions, we can develop targeted strategies to improve water quality and ensure public health safety. Further investigation showed that tanks that were cleaned less frequently exhibited higher microbial contamination levels. This result aligns with prior studies highlighting the significance of regular maintenance in mitigating microbial growth (Clasen *et al.*, 2003).

Environmental factors, such as exposure to direct sunlight and temperature variations, were also found to correlate with increased bacterial counts in stored water (Hong *et al.*, 2010; Furst *et al.*, 2024). To reduce the risks of pathogenic microbial contamination in mobile tanks, it is essential to implement several management strategies and arrange the adoption of standardized protocols for tank hygiene in Basrah. For instance, establishing periodic cleaning schedules and utilizing UV-resistant materials for the tanks could help reduce biofilm formation. On the other side, upon physically inspecting the inner surface of the mobile tank contaminated with fecal coliforms, we detected a thin layer of slime. The presence of a slime layer or biofilm is a significant concern in water quality management. Biofilms are complex groups of microorganisms embedded in an extracellular polymeric substance (EPS), which they produce. This defending layer facilitates the survival of bacteria in harsh environments, allowing pathogenic organisms, such as fecal coliforms, to persist and reproduce (Gaihre *et al.*, 2024). Additionally, community-led chlorination initiatives may lower the risks of fecal contamination. Additionally, public awareness campaigns should be initiated to educate residents about the importance of maintaining safe water practices and the health risks associated with contaminated water.

The test results data were entered into the XLSTAT 2018 statistical program, and the outcomes are presented in Table 3.

Table 3.Statistical analysis of the results

Statistic	Total Plate Count (CFU/100ml)	Total Coliforms (CFU/100ml)	Fecal Coliforms (CFU/100ml)	TDS (mg/L)	EC µs/cm	pH
No. of Samples	20	20	20	20	20	20
Minimum	9.0	3.0	0.0	25.0	39.0	7.0
Maximum	103.0	45.0	7.0	100.0	156.0	7.6
1st Quartile	35.0	18.8	1.0	48.8	76.0	7.1
Median	59.0	27.5	2.0	65.0	102.0	7.3
3rd Quartile	76.3	36.8	4.0	81.3	127.0	7.4
Mean	55.3	26.6	2.6	64.0	100.1	7.3
Variance (n-1)	727.8	187.2	4.4	525.3	1280.4	0.0
Standard deviation (n-1)	27.0	13.7	2.1	22.9	35.8	0.2

The statistical analysis from the current study provides a comprehensive overview of the water quality provided by mobile tanks in the city of Basrah. The results detect that while most physiochemical parameters including pH, total dissolved solids (TDS) and EC are generally located within the permissible limits of the World Health Organization (WHO) (Organization, 2024) and Iraqi national standards (Abbas, 2025); there are notable exceptions. Some water samples displayed high levels of TDS, suggesting the presence of dissolved substances that could compromise water taste. More seriously, the study revealed significant microbial contamination, with a considerable ratio of samples testing positive for total coliforms and fecal coliforms. The detection of these microbial indicators in drinking water is particularly alarming, as their presence signifies potential fecal contamination and a direct risk to public health, increasing the hazards of waterborne diseases such as gastroenteritis, especially among weak groups like children, the elderly, and those with weakened immune systems.

Conclusions:

The microbial evaluation of mobile tanks water in Basrah governorate reveals an urgent public health issue that needs immediate attention. Addressing the factors contributing to microbial contamination is essential for protecting community health and ensuring access to safe drinking water. The study highlights the crucial necessity for enhanced regulatory oversight, including regular and systematic monitoring of both physio-chemical and microbial water quality in mobile tanks. It also underscores the importance of public education on hygiene practices related to water storage and handling strategies, as well as the imperative for improved infrastructure to ensure proper tank maintenance and water filtration. These conclusions point to systemic issues in water sourcing, reservoir sanitation, and distribution methods, despite the general compliance with chemical standards.

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