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Environmental Assessment of Surface Water Contamination with Pathogenic Bacteria in the Manathira District Center

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KEYWORDS
Water Contamination, Bacteriological Characteristics, Manathira, Environmental Assessment

ABSTRACT:
The study is titled "Bacteriological Characteristics and Their Impact on Water Contamination in the Manathira District Center." Twenty surface water samples were collected and analyzed in the laboratory to detect pathogenic bacteria types. The study found that all the identified bacteria species are opportunistic pathogens that can cause various diseases in humans, animals, and plants. Additionally, the study identified new bacterial species that were not previously documented, including Acinetobacter baemolyticus and Enterobacter cloacae complex. The study observed spatial and temporal variations in bacteria distribution, with higher concentrations in locations with increased human activity and lower concentrations in areas more distant from human pollution sources. Furthermore, bacterial concentrations were found to vary across seasons, with higher counts in the spring and fall, and lower counts in the summer and winter, influenced by both natural and human-related factors.

Introduction

The bacteriological characteristics in the Manathira District Center have a clear impact on the contamination of surface water and the surrounding natural environment, affecting humans, animals, and plants by causing dangerous diseases. This is due to the nature of surface water in the region and the activities carried out by humans, as well as the resulting waste, which creates a suitable environment for bacterial growth in the study area. This leads to changes in the water's properties and its suitability for other uses, ultimately causing pollution and negatively impacting the growth of living organisms and the ecosystem. In light of this, the study focuses on bacteriological characteristics and their impact on environmental pollution in the Manathira District Center.

Research Problem:

What is the impact of bacteriological characteristics on the contamination of surface water in the Manathira District Center?

Research Hypothesis:

Bacteriological characteristics have a clear impact on surface water in the region, leading to diseases in humans, animals, and plants.

Research Objective:

The study aims to uncover environmental pollution in the Manathira District Center by highlighting the influence of bacteriological characteristics on surface water pollution. It also seeks to identify the types of diseases caused by these characteristics in living organisms.

Research Boundaries:

The Manathira District Center is located in the northern part of Najaf province, with geographic coordinates between latitudes (28° 44' - 28° 43') north and longitudes (48° 44' - 48° 43') east. The research duration extends from August 28, 2021, to August 22, 2022. The study relies on climatic, demographic, agricultural, satellite imagery, and map data for the year 2021. The study's objective is to conduct a spatial analysis of environmental pollution in the Manathira District Center by examining the natural and human characteristics affecting environmental pollution in the study area, with a focus on physical, chemical, and biological

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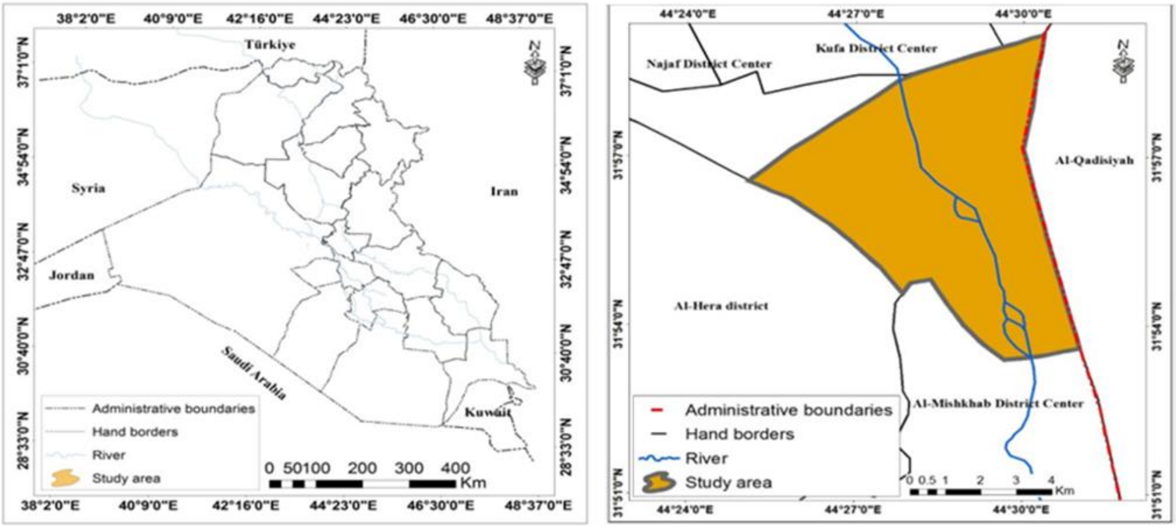
characteristics. These characteristics will be assessed for their suitability for various uses according to local and international standards (Map 1).



Map (1) Location of the area in Iraq [1]

Structural Framework: The study's structural framework consists of the theoretical framework, the research problem, the hypothesis, the research objective, the study area boundaries, the types of pathogenic bacteria, the results, and the sources.

Types of Water-Polluting Bacteria in the Study Area:

1-Acinetobacter baemolyticus

This bacterium is found widely in nature, including freshwater and sewage water, fresh meat, contaminated milk, poultry, and frozen foods. It is an opportunistic pathogenic bacterium that causes respiratory infections in individuals with weakened immune systems. It also leads to infections in the blood, urinary tract, and pneumonia.

The study indicates spatial and temporal variations in the contamination of surface water by Acinetobacter baemolyticus. The spatial variations are observed from one location to another. In the map for the month of July, two regions can be identified: one with low distribution (W1, W2, W3, W4, W5, W6, W8, W9, W10, W12, W13, W14, W15, W16, W17, W18, W19, W20) with colonies ranging from 2-12 colonies/1 ml out of a total of 154 colonies. This region extends from the north to the south and from the east to the west.

The second region (medium distribution) for this bacterium is found in two sites (W7, W11) with colonies ranging from 15-22 colonies/1 ml. This region extends to the northern and eastern parts. For the fall season, the distribution of Acinetobacter baemolyticus is observed in three regions: low, medium, and very high. The low region is found in 11 locations (W4, W8, W9, W10, W12, W13, W14, W16, W17, W18, W20) with colonies ranging from 5-13 colonies/1 ml out of a total of 327 colonies. It is scattered in different parts, including the north, east, and southern areas [2].

The medium region for this bacterium is observed in 8 locations (W1, W2, W5, W6, W7, W11, W15, W19) with colonies ranging from 17-29 colonies/1 ml. This region extends to the eastern and southern parts of the study area (Maps 2a, b).

As for the third region (high) for this type of bacteria, it appeared at one location, which is (W3). The number of colonies in it reached (55 colonies/mL for each). Its spatial distribution is evident in the northern part (Maps 3a, b).

Journal of Chemical Health Risks
www.jchr.org
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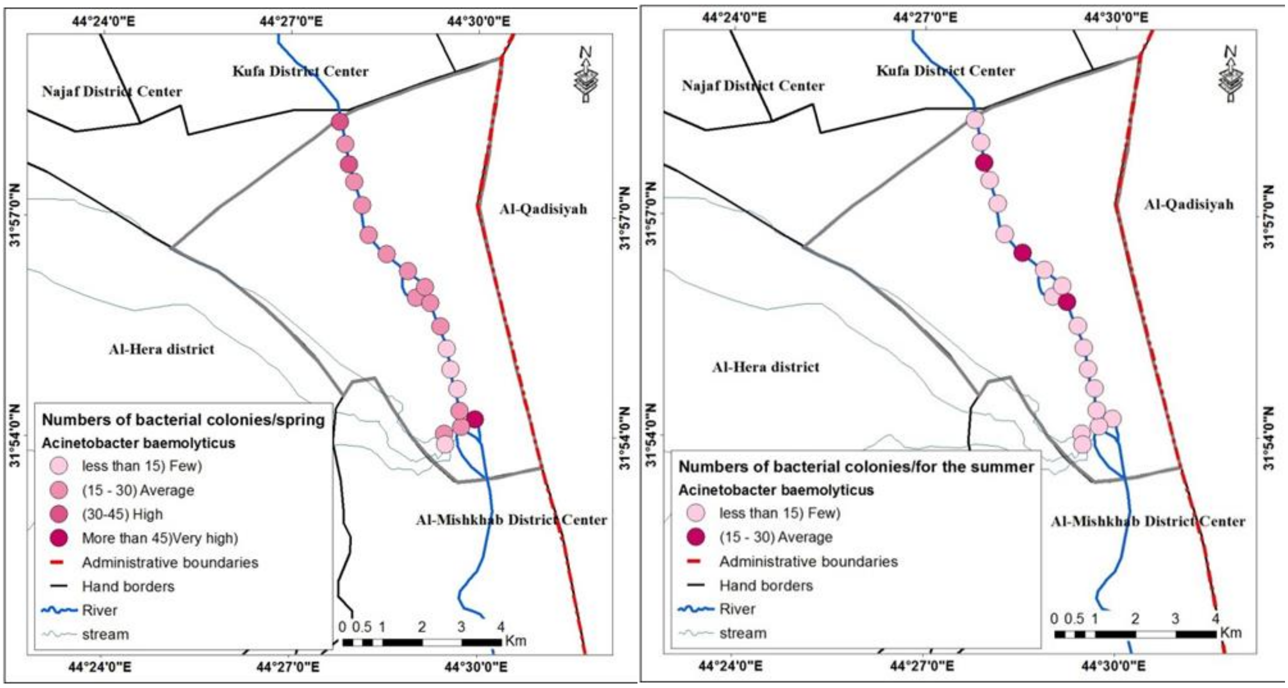
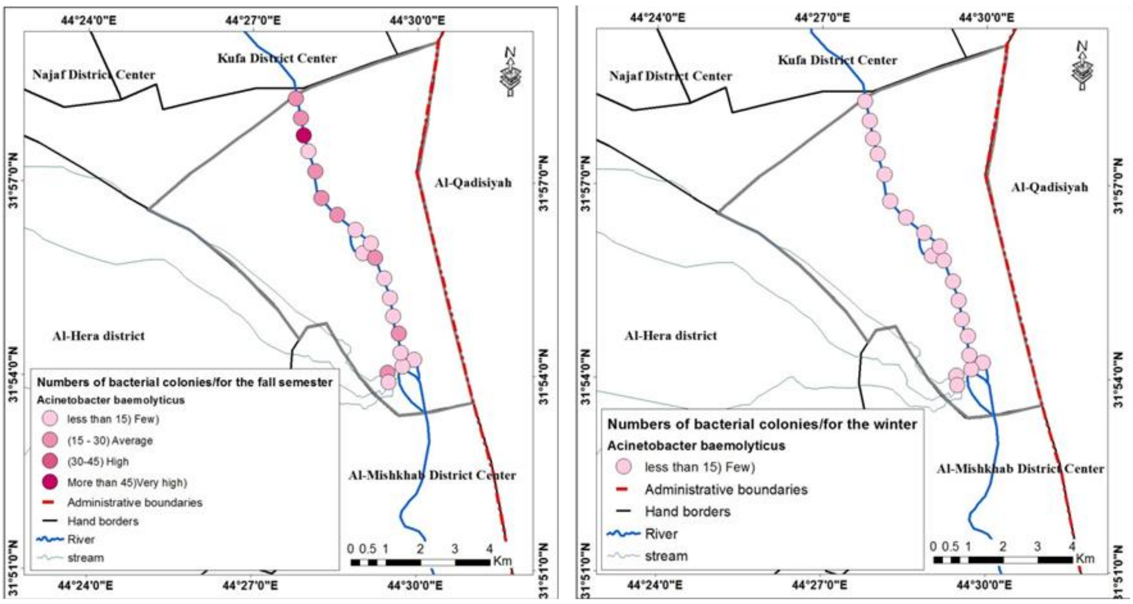


a b

Map (2) The number of colonies of a. Acinetobacter baemolyticus for the autumn season, b. Acinetobacter baemolyticus for the summer season



a b

Map (3) for the number of colonies of a. (Acinetobacter baemolyticus) for Summer, b. (Acinetobacter baemolyticus) for winter

During the winter season, it appears from Map (2) that the distribution of this type of bacteria in one region is represented as "low." The "low" region for this type of bacteria appears in 20 locations, which are (W1, W2,

W3, W4, W5, W6, W7, W8, W9, W10, W11, W12, W13, W14, W15, W16, W17, W18, W19, W20). The number of colonies varies from 2 to 12 colonies per 1 ml, out of a total of 110 colonies in these locations. The distribution extends across all parts of the study area, from north to south and from east to west.

During the spring season, we notice from Map (3) that the distribution of this type of bacteria is represented in four regions: "low," "medium," "high," and "very high." The first region, "low," for this type of bacteria appears in 4 locations (W13, W14, W15, W20), with the number of colonies ranging from 11 to 14 colonies per 1 ml, out of a total of 505 colonies during the spring, which recorded the highest number of colonies for Acinetobacter baemolyticus bacteria compared to other seasons. The distribution extends to the southern part of the study area [3].

The second region, "medium," for this type of bacteria appears in 12 locations (W2, W4, W6, W7, W8, W9, W10, W11, W12, W16, W17, W18), with the number of colonies ranging from 17 to 28 colonies per 1 ml. The distribution extends to various parts of the region, including the northern, western, and southern parts.

The third region, "high," for this type of bacteria appears in 3 locations (W1, W3, W5) with the number of colonies ranging from 30 to 35 colonies per 1 ml. The distribution extends to the northern part. The fourth region, "very high," for this type of bacteria appears in one location (W17) with the number of colonies reaching 95 colonies per 1 ml. The distribution extends to the southern part of the region.

From the provided information, it becomes clear that this type of bacteria appears in all studied locations within the study area. This aligns with the global reality of the region. The highest number of colonies is recorded during the autumn and spring seasons, which provide suitable environmental conditions for growth and reproduction due to optimal temperatures and humidity levels. Additionally, this area is affected by agricultural waste, including the use of organic fertilizers and pesticides, which reach surface water through runoff, along with sewage water. These conditions create an integrated environment for the growth and reproduction of bacteria [4].

In the second position comes the summer season, which recorded the lowest number of colonies for this type of bacteria. The reason for this is the high temperatures, low humidity, and elevated salt concentrations in the water, which kill the bacteria.

During the winter season, which comes in fourth place in terms of the lowest number of colonies for the bacteria, the area has the least influence from agricultural and civilian activities. The presence of this type of bacteria in the locations of the study area poses a danger to rural residents when dealing with water contaminated with sewage waste containing these bacteria, leading to respiratory and urinary tract infections when consuming contaminated meat and milk.

2- Citrobacter Bacteria:

These bacteria are part of the Gram-negative bacteria, and they are opportunistic pathogenic intestinal bacteria. They cause various diseases in humans and animals, including urinary tract infections, respiratory system infections, septicemia in immunocompromised individuals, meningitis, and pulmonary infections in newborns and young children. Maps (5), (6), (7), and (8) show spatial and temporal variations in surface water contamination with Citrobacter bacteria, varying in location and time.

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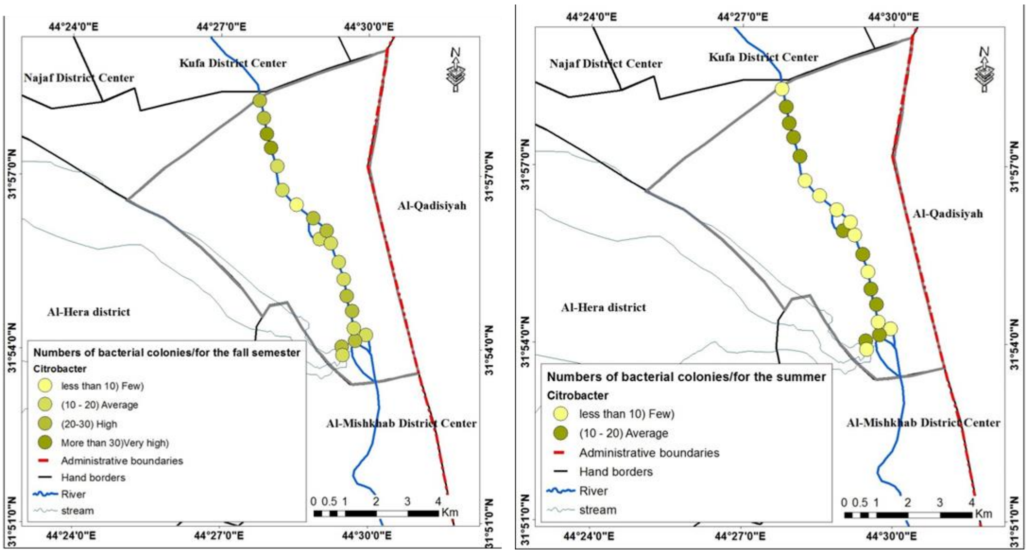
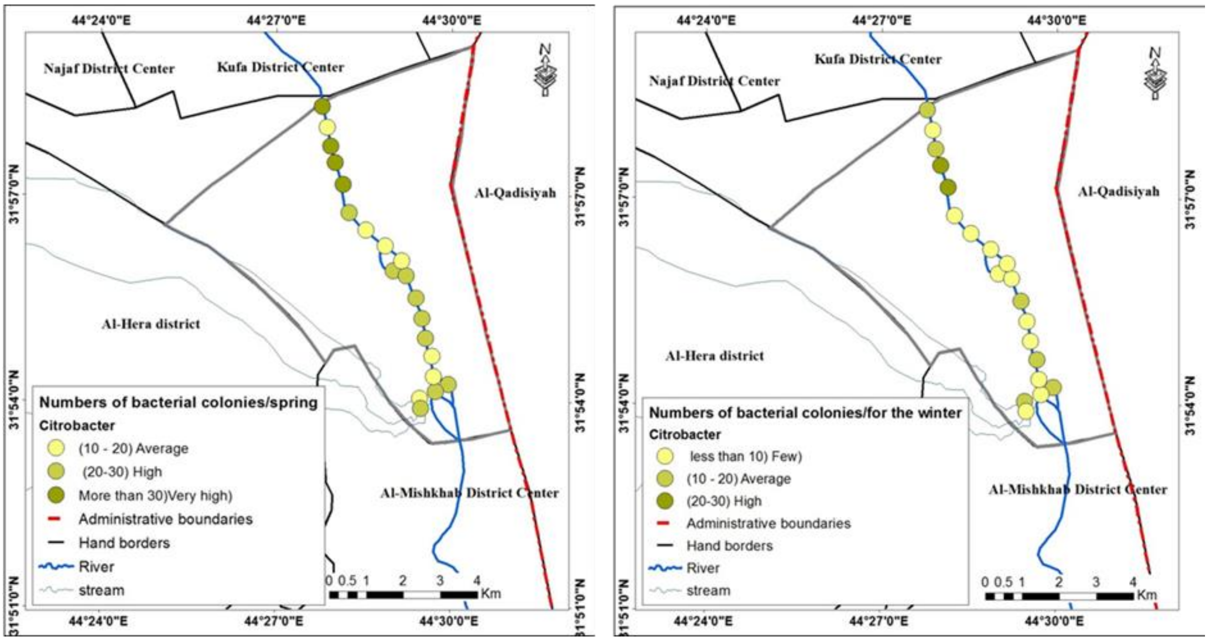


Map (4) for the number of colonies of a. Citrobacter for the autumn season., b. Citrobacter for the summer season.



Maps (5) for the number of colonies of a. Citrobacter for the winter season, b. Citrobacter for the spring season.

From one place to another and seasonally throughout the year, it is evident from Map (4) for the month of July that the distribution of this type of bacteria is represented in two regions, namely (Low, Medium). The first region (Low) appears in 8 locations, namely (W6, W7, W8, W9, W11, W13, W16, W20), with the number of colonies ranging from (2-9) colonies/1 ml, out of a total of (211) colonies in these locations. This season records the lowest number of colonies for this type of bacteria, and its spatial extension is observed in all parts of the study area, extending from the north to the south and from the east to the west.

The second region (Medium) for this type of bacteria appears in 12 locations (W1, W2, W3, W4, W5, W10, W12, W14, W15, W17, W18, W19), with the number of colonies ranging from (15-19) colonies/1 ml for each. Its spatial extension is observed in all parts of the study area. On the other hand, data from Map (5) for the autumn season show that the distribution of this type of bacteria is represented in four regions (Low, Medium, High, Very High). The first region (Low) for this type of bacteria appears in one location (W7) with a number of colonies totaling (7) colonies/1 ml out of a total of (462) colonies in these locations, and its spatial extension is observed in the center of the study area.

The second region (Medium) for this type of bacteria appears in 6 locations (W6, W11, W13, W16, W17, W20), with the number of colonies ranging from (15-19) colonies/1 ml. Its spatial extension is observed in the eastern and southern parts of the study area. The third region (High) for this type of bacteria appears in 11 locations (W1, W2, W5, W8, W9, W10, W12, W14, W15, W18, W19) with the number of colonies ranging between (20-30) colonies/1 ml, and its spatial extension is observed in various parts, including the northern, western, and southern parts [5].

The fourth region (Very High) for this type of bacteria appears in two locations (W3, W4) with concentrations ranging from (24-47) colonies/1 ml for each, and its spatial extension is observed in the southern part.

However, during the winter season, it is evident from Map (5) that the distribution of this type of bacteria is represented in three regions (Low, Medium, High). The first region (Low) for this type of bacteria appears in 10 locations (W2, W6, W7, W8, W9, W10, W11, W13, W14, W18) with the number of colonies ranging from (0-9) colonies/1 ml, out of a total of (213) colonies in these locations, and its spatial extension is observed in various parts, including the northern, western, and southern parts [6].

The second region (Medium) for this type of bacteria appears in 7 locations (W1, W2, W5, W8, W9, W10, W12, W14, W15, W18, W19), with the number of colonies ranging from (20-30) colonies/1 ml, and its spatial extension is observed in the northern and southern parts.

The third region (High) for this type of bacteria appears in two locations (W4, W5) with a number of colonies ranging from (35-45) colonies/1 ml, and its spatial extension is observed in the northern part of the region.

During the spring season, it is evident from Map (5) that the distribution of this type of bacteria is represented in three regions (Medium, High, Very High). The first region (Medium) for this type of bacteria appears in 7 locations (W2, W6, W7, W8, W9, W15, W16) with the number of colonies ranging from (10-18) colonies/1 ml, with a total of (503) colonies in these locations. This season records the highest number of colonies for Citrobacter bacteria compared to other seasons due to the ideal environmental conditions. Its spatial extension is observed in various parts of the study area, including the northern, western, and southern parts.

The second region (High) for this type of bacteria appears in 10 locations (W6, W10, W11, W12, W13, W14, W17, W18, W19, W20), with the number of colonies ranging between (21-29) colonies/1 ml, and its spatial extension is observed in various parts, including the eastern, western, and southern parts.

The third region (Very High) for this type of bacteria appears in 4 locations (W1, W3, W4, W5) with the number of colonies ranging from (35-45) colonies/1 ml, and its spatial extension is observed in the northern part of the region.

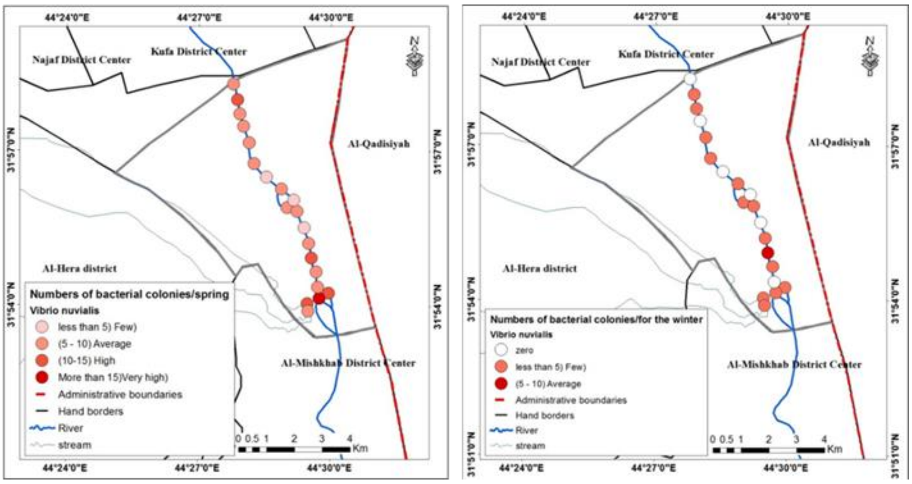
In conclusion, it is clear that this type of bacteria does not appear in all the studied locations of the study area, which aligns with the global reality of the region. It records the highest number of colonies during the autumn and spring seasons, thanks to the suitable environmental conditions, including optimal temperatures and high humidity, as well as the increased agricultural waste resulting from fertilizers and pesticides that are carried by surface water runoff and soil washing into surface waters. Additionally, commercial activities such as painting workshops also contribute to the growth of this type of bacteria. On the other hand, the winter season records the second-highest number of colonies due to the limited agricultural areas and reduced waste from industrial and civilian activities. The summer season, which has the highest temperatures and increased salt concentrations in surface waters, records the lowest number of colonies. The presence of this type of bacteria in the waters of the study area poses a risk to farmers when dealing with contaminated water containing these bacteria, potentially leading to respiratory infections and urinary tract infections when consuming contaminated meat and milk [7].

3- Vibrio Nuvialis Bacteria:

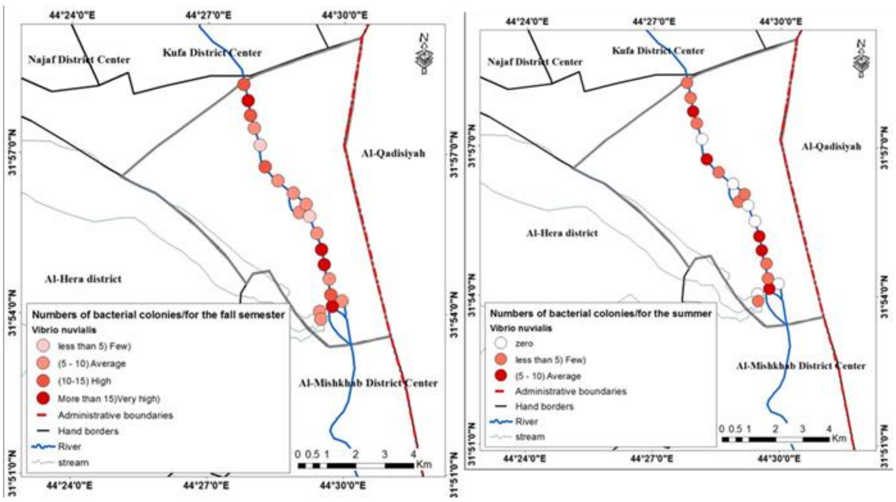
These bacteria are characterized as opportunistic pathogens that are found in water, especially saline water.

Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(3), 1067-1077 | ISSN:2251-6727

They cause many diseases, including acute diarrhea, and have the ability to infect humans with a variety of crustacean diseases.



Map (6) for the number of colonies of a. Vibrio nuvialis for the autumn season., b. Vibrio nuvialis for the summer season.



a b

Maps (7) for the number of colonies of a. Vibrionuvialis for the spring season., b. Vibrionuvialis for the winter season

There is spatial and temporal variation in the contamination of surface water with Vibrio nuvialis bacteria. This variation occurs from one place to another and during different seasons of the year. As shown in Map (6) for the month of July, the distribution of this type of bacteria is represented in two regions: low and medium. The first region (low) is observed in 14 locations (W2, W4, W5, W7, W8, W9, W10, W11, W12, W15, W16, W17, W19, W20), with the number of colonies ranging from 0 to 4 colonies/1 ml out of a total of 63 colonies in these locations. This season records the lowest number of colonies for this type of bacteria due to high temperatures, increased evaporation rates, and decreased humidity. Its spatial distribution is observed in various parts of the study area, extending from the northern part to the southern part [8].

The second region (medium) of this type of bacteria appears in 6 locations (W1, W3, W6, W13, W14, W18) with the number of colonies ranging from 5 to 9 colonies/1 ml in each. Its spatial distribution is in the northern part and the central part of the study area, extending to the southern part.

On the other hand, Map (7) for the autumn season show that the distribution of this type of bacteria is represented in four regions: low, medium, high, and very high. The first region (low) of this type of bacteria is observed in two locations (W5, W11) with the number of colonies reaching 4 colonies/1 ml for each, out of a total of 221 colonies in these locations. Its spatial distribution is in the central and southern parts of the study area.

The second region (medium) of this type of bacteria appears in 9 locations (W4, W7, W9, W10, W12, W15, W17, W19, W20) with the number of colonies ranging from 8 to 9 colonies/1 ml. Its spatial distribution is in the eastern part of the region, extending to the central and southern parts.

The third region (high) of this type of bacteria is observed in 5 locations (W1, W3, W6, W8, W16) with the number of colonies ranging from 10 to 14 colonies/1 ml. Its spatial distribution is in various locations across the study area, appearing in the northern and southern parts.

The fourth region (very high) for this type of bacteria is observed in 4 locations (W2, W13, W14, W18) with the number of colonies ranging from 14 to 22 colonies/1 ml for each. Its spatial distribution is in the northern and southern parts of the study area.

During the winter season, it is evident from Map (7) that the distribution of this type of bacteria is in two regions: low and medium. The first region (low) of this type of bacteria is observed in 17 locations (W1, W2, W3, W4, W5, W6, W7, W8, W9, W10, W11, W12, W15, W16, W17, W18, W20) with the number of colonies ranging from 0 to 4 colonies/1 ml out of a total of 44 colonies in these locations. Its spatial distribution covers all parts of the study area.

The second region (medium) of this type of bacteria is observed in 3 locations (W13, W14, W19) with the number of colonies ranging from 14 to 22 colonies/1 ml. Its spatial distribution is in the southern part of the study area [9].

During the spring season, spatial modeling (12) that the distribution of this type of bacteria is represented in four regions: low, medium, high, and very high. The first region (low) of this type of bacteria is observed in two locations (W7, W12) with the number of colonies reaching 4 colonies/1 ml for each, out of a total of 177 colonies in these locations. The spring season records the highest number of colonies for Vibrio nuvialis bacteria compared to other seasons due to favorable environmental conditions in terms of temperature and humidity. Its spatial distribution is observed in the central part of the study area.

The second region (medium) of this type of bacteria is observed in 12 locations (W1, W3, W4, W5, W6, W8, W9, W10, W11, W12, W13, W16) with the number of colonies ranging from 5 to 9 colonies/1 ml. Its spatial distribution covers all parts of the study area.

The third region (high) for this type of bacteria is observed in 5 locations (W2, W14, W17, W19, W20) with the number of colonies ranging from 10 to 13 colonies/1 ml. Its spatial distribution is in the northern and southern parts of the region [10].

The fourth region (very high) of this type of bacteria is observed in one location (W18) with the number of colonies reaching 24 colonies/1 ml. Its spatial distribution is in the southern part of the region.

Based on the data from Table (3), this type of bacteria is present in all the studied locations of the study area, which aligns with the global reality of the region. Autumn and spring seasons rank highest in terms of colony numbers for this bacterium due to moderate temperatures and suitable humidity conditions, facilitating its growth. This is in addition to the influence of sites by human waste resulting from urban activities, which directly contaminate the water. Furthermore, the growth of aquatic plants in waterways provides a suitable environment for its proliferation. In contrast, during the summer season, which ranks third, and the winter season, which ranks fourth, there are fewer colonies of this bacteria due to unfavorable climatic conditions such as high temperatures, increased evaporation rates, and elevated salinity levels that hinder its growth. During the winter season, the scarcity of human waste pollutants also contributes to the lack of a conducive environment for bacterial growth. The presence of these bacteria in surface waters in the region has led to infections among the population, especially farmers, transmitted through the use of water [11].

4- Enterobacter cloacae complex

These bacteria are facultative anaerobic, non-lactose fermenters belonging to the widely distributed

Journal of Chemical Health Risks
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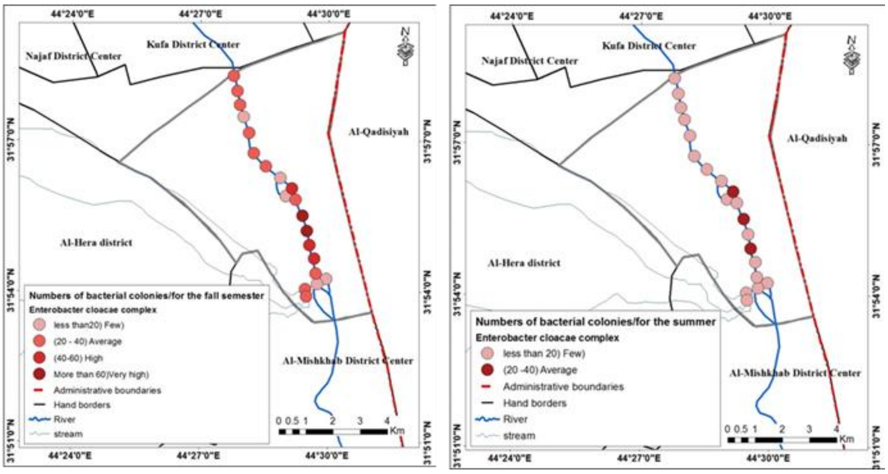
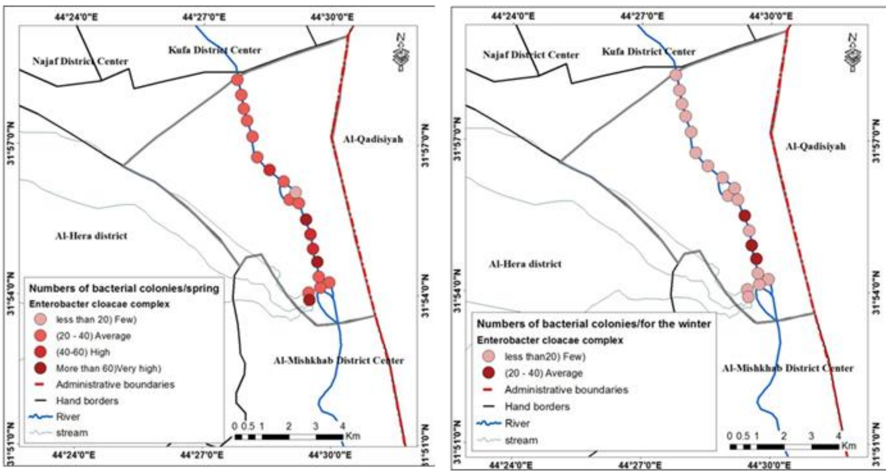
Enterobacteriaceae family. They can be found in wastewater, soil, and are part of the normal gut microbiota. They are opportunistic pathogens and can cause various diseases in humans, especially those with weakened immune systems. Transmission can occur through blood transfusions.



a **b**

Map (8) for the number of colonies of a. Enterobacter cloacae for the autumn season., b. Enterobacter cloacae for the summer season.



a **b**

Maps (9) for the number of colonies of a. Enterobacter cloacae for the spring season., b. Enterobacter cloacae for the winter season

The map (13)(14)(15)(16) shows spatial and temporal variations in the contamination of surface water with Enterobacter cloacae complex bacteria. These variations occur both in different locations and throughout the seasons. In the map for July (13), it is evident that the distribution of this type of bacteria represents two regions: low and medium contamination. The low contamination region is observed in 18 locations (W1, W2, W3, W4, W5, W6, W7, W8, W10, W11, W13, W15, W16, W17, W18, W19, W20), with colony counts ranging from 3-12 colonies per 1 ml, out of a total of 233 colonies in these locations. This season has the fewest colonies of this type of bacteria due to high temperatures, increased evaporation rates, and reduced humidity, which do not provide a suitable environment for their growth. The spatial distribution is observed across all parts of the study area, extending from north to south and from east to west. In the medium contamination region, there are 2 locations (W9, W14) with colony counts ranging from 22-27 colonies per 1 ml, and their spatial distribution is in the western part of the area.

For the autumn season, as shown in map (8), the distribution of these bacteria is categorized into four regions: low, medium, high, and very high contamination. The low contamination region is observed in 5 locations (W4, W8, W10, W17, W18), with colony counts ranging from 15-19 colonies per 1 ml, out of a total of 594 colonies in these locations. The spatial distribution is in the western part, extending to the central and southern parts of the area.

In the medium contamination region, there are 10 locations (W1, W2, W3, W5, W6, W7, W11, W16, W19, W20) with colony counts ranging from 20-34 colonies per 1 ml. The spatial distribution extends from the northern to the eastern parts, reaching the southern part of the area. The high contamination region has 3 locations (W9, W14, W15) with colony counts ranging from 41-54 colonies per 1 ml. The spatial distribution is in the western and southern parts of the area [12].

The very high contamination region consists of 2 locations (W12, W13) with colony counts ranging from 61-74 colonies per 1 ml. The spatial distribution is in the southern part of the area. During the winter season, it is evident from map (9) that the distribution of these bacteria is categorized into two regions: low and medium contamination. The low contamination region is observed in 17 locations (W1, W2, W3, W4, W5, W6, W7, W8, W9, W10, W11, W13, W16, W17, W18, W19, W20), with colony counts ranging from 4-18 colonies per 1 ml, out of a total of 244 colonies in these locations. The spatial distribution covers all parts of the study area, extending from north to south and from east to west. In the medium contamination region, there are 3 locations (W12, W14, W15) with colony counts ranging from 21-27 colonies per 1 ml, and their spatial distribution is in the southern part of the area [14].

During the spring season, as shown in map (9), the distribution of these bacteria is categorized into four regions: low, medium, high, and very high contamination. The low contamination region is observed in one location (W9), with 14 colonies per 1 ml. The total number of colonies in this location is 784, which is the highest colony count for Enterobacter cloacae complex bacteria during the spring season, indicating the favorable environmental conditions with moderate temperatures and high humidity. The spatial distribution is in the central part of the study area [13]. In the medium contamination region, there are 13 locations (W1, W2, W3, W4, W5, W6, W8, W10, W11, W16, W17, W18, W19) with colony counts ranging from 22-39 colonies per 1 ml. The spatial distribution covers all parts of the study area. The high contamination region consists of 3 locations (W7, W13, W14) with colony counts ranging from 43-59 colonies per 1 ml. The spatial distribution is in the central part of the study area and the southern part. The very high contamination region consists of 3 locations (W12, W15, W20) with colony counts ranging from 63-82 colonies per 1 ml. The spatial distribution is in the southern part of the area. It's worth noting that this type of bacteria is present in all the studied locations in the study area. This is consistent with the global reality of the region. The spring and autumn seasons show the highest colony counts for this type of bacteria due to favorable environmental conditions, including moderate temperatures, high humidity, and human factors like agricultural runoff and sewage effluents that contribute to water pollution. This poses a health risk to farmers who come into direct contact with the soil and water in the region, leading to various respiratory diseases [15].

Conclusions

Spatial and Temporal Variations: The study reveals significant spatial and temporal variations in the contamination of surface water by Enterobacter cloacae complex bacteria. These variations are attributed to seasonal changes and environmental factors. Seasonal Trends: The spring and autumn seasons consistently show the highest levels of contamination. This pattern is driven by the favorable environmental conditions, including moderate temperatures and high humidity, which promote bacterial growth and proliferation. Human Factors: Human activities, such as agricultural runoff and sewage effluents, play a crucial role in surface water contamination. These activities contribute to the presence of bacteria in water sources and pose health risks, especially to individuals in direct contact with contaminated water. Geographical Distribution: The spatial distribution of contamination varies across different regions within the study area. The research identifies regions with low, medium, high, and very high contamination levels, each influenced by local environmental and human factors. Implications for Water Quality Management: The findings of this study have important implications for water quality management. Understanding the factors influencing contamination patterns allows for more targeted and effective strategies to mitigate water pollution and protect public health. Health Risks: The presence of Enterobacter cloacae complex bacteria in surface water sources poses health risks, particularly to farmers and individuals in direct contact with contaminated water. It is essential to raise awareness about these risks and implement measures to reduce exposure. In conclusion, this research contributes to our understanding of surface water contamination dynamics and highlights the need for proactive measures to address water quality issues, particularly in regions with high bacterial contamination. It underscores the importance of managing human activities and environmental conditions to safeguard public health and water resources.

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