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Spatial Variation of Salmonella Bacteria for Plants in the Environment of Mishkab District Center

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Abstract

This research included the detection of knowledge of the numbers of salmonella bacteria species in the plants of the Mishkab district environment for four seasons and the knowledge of the variation in their numbers for each season and the salmonella of the genus Bacillus negative color in the Gram dye belonging to the family Enterobacteriaceae. They are strong bacteria that are found everywhere and can survive for several weeks in a dry environment and several months in water and moist soil and then move to the plant from the soil and water polluted by many sources. The main reason for the growth and spread of these bacteria is the feces of humans and animals. When the appropriate conditions for these bacteria are available, they help them spread and move to other places in the environment. Four maps were drawn for spatial modeling of salmonella bacteria in plants. Samples were taken for 30 important sites where most of the plants on which the population depends depend on food in the first place, such as vegetables, fruits and grain crops, in addition to natural plants that are spread in most parts and conduct analysis in various scientific laboratories.

Keywords:

Salmonella bacteria, Al-Mashkhab environment, seasonal variation, contaminated soil and water, spatial modeling.

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Introduction

Salmonella intestinalis is a Gram-negative bacterium responsible for a wide range of diseases in humans and animals, primarily transmitted through contaminated food and water (Almudhafar, 2020; Abdil-Ameer Noor et al., 2022; Abyss et al., 2022). This poses a significant threat to public health in various regions, including the Mishkab district center. The bacterium can survive in diverse environments, from dry conditions to moist soil and water, facilitating its transfer to plants through contaminated soil and water sources (Vij & Prashant, 2024; Kadhim et al., 2023; Abdil-Ameer et al., 2023; Wahhab et al., 2023). The Mishkab district, characterized by its agricultural significance, provides an ideal setting for studying the prevalence and spatial distribution of Salmonella bacteria in plants (Almudhafar et al., 2024; Almudhafar et al., 2023; Almudhafar et al., 2023). The district's dependence on agriculture, coupled with practices such as irrigation with potentially contaminated water, increases the risk of Salmonella spread (Almudhafar et al., 2023; Hassan et al., 2023). This study aims to investigate the spatial variation of Salmonella bacteria in plants across different seasons, identifying the factors contributing to their proliferation and understanding the implications for public health and agricultural productivity (Paul et al., 2020). The research focuses on seasonal variations in the presence of Salmonella bacteria in various plants, including fruit trees, cereal crops, and natural vegetation. By conducting detailed laboratory analyses and spatial modeling, the study seeks to map the distribution of Salmonella bacteria and determine the primary sources of contamination. Additionally, the study evaluates the impact of environmental factors, such as soil pH and agricultural practices, on the growth and spread of these bacteria (Gladkov & Gladkova, 2021). This investigation is crucial as it addresses the significant health risks posed by Salmonella contamination in a major agricultural region. By understanding the factors influencing the spread of these bacteria, effective measures can be implemented to mitigate their impact, ensuring the safety of food supplies and protecting public health (Almudhafar et al., 2024; Al-Jashaami et al., 2024; Al-Jashaami et al., 2024).

First: Research Problem

- Does the study area suffer from the presence of salmonella bacteria in plants?
- What is the main factor in the spread and concentration of Salmonella bacteria in plants?

Second: Research Hypothesis

- Through laboratory tests, there is a high concentration of salmonella bacteria in most parts of the plants.
- The main factor in the spread of these bacteria is the faeces of humans and animals with the interaction of temperature in the region.

Third: Objective of the Study

- The study aims to find out the most important reasons that led to the spread of salmonella bacteria in the plants of the study area.
- Detection of sources of environmental plant contamination with Salmonella bacteria and their temporal and spatial variation in the study area.
- Studying the impact of the determinants of the growth and increase of alkaline bacteria in the environment of the study area.

Fourth: Importance of the Study

The importance of studying Salmonella bacteria is one of the most important topics that studies are concerned with because it affects human health directly, as it causes various types of disorders to the human body as well as affects various types of agricultural crops, especially since the study area is one of the most important agricultural cities in the country.

Fifth: Boundaries of the Study Area

Spatial Boundaries

The city of Mishkab, which is the center of Mishkab district, is located between the meridians (-°44.32 44.28˚) east and two latitudes (˚31.52 – 31.44˚) north. On the banks of the Euphrates River, as in Figure (1).

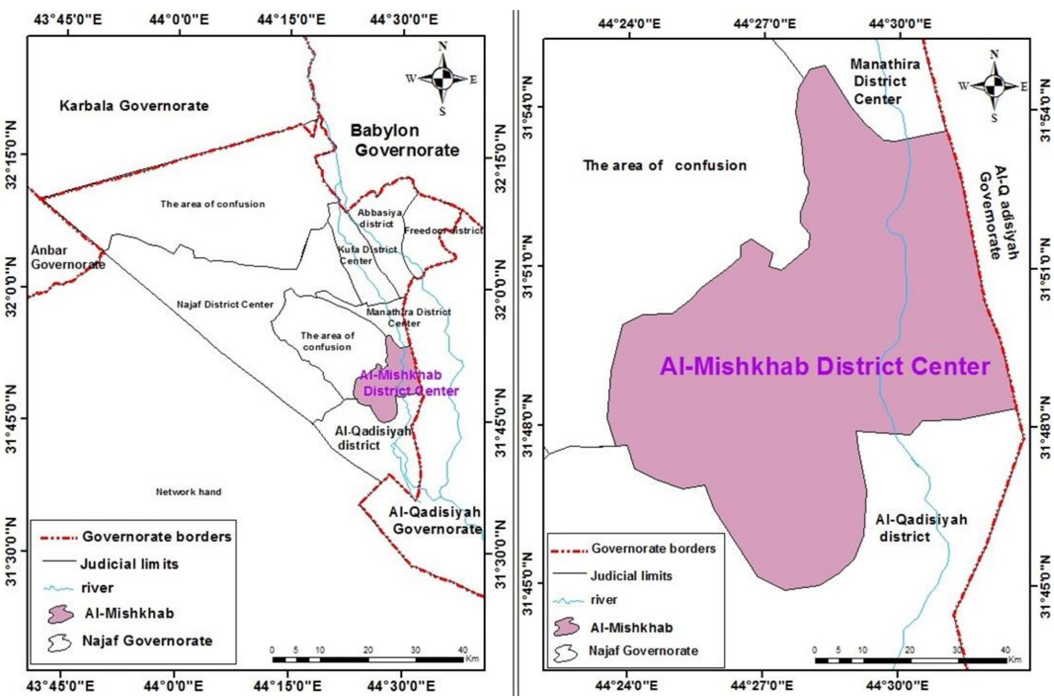


Figure 1. Spatial boundaries of the study area

Materials and Methods

Investigating the total number, not the types of Salmonella and Bacteria. After that, bacterial contamination was determined using evidence. Biological contamination, which included calculating the total number of aerobic bacteria (Total Salmonella Bacteria) using plant cutting technology (Veerasamy & Fredrik, 2023).

Sampling Site

- Washed with sterile water and cut into small parts.
- The parts of the plant were mashed and then distilled water was added to the samples.
- Implanted samples.

Figure (1a) show the form of Salmonella bacteria in the castor plant and Figure (1b) show the form of Salmonella bacteria in wheat crop.

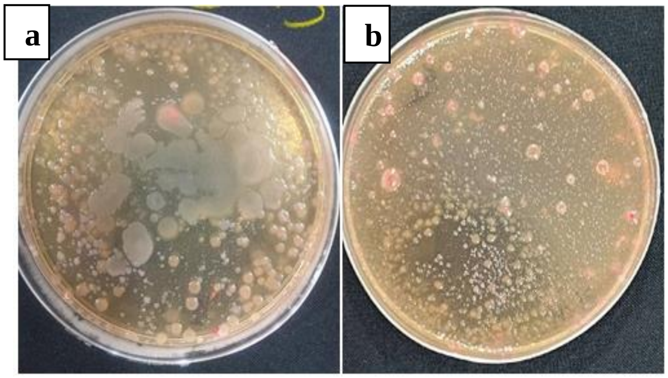


Figure 2 a. The form of Salmonella bacteria in the castor plant; b. The form of Salmonella bacteria in Wheat Crop

After twenty-four hours, the numbers are read and then we take a sample of these bacteria and grow them in a dish of vineyards to determine the type of bacteria accurately.

- Autoclave device to sterilize the medium of Chrome Acre and Maconkey Acre.
- Deionizing water.
- Confirmatory diagnostic tests in dishes for plants.

Bacterial isolates were diagnosed using phenotypic and transplant diagnostic methods.

Types of Plants Analyzed for these Seasons

Plants vary between cultivated and natural plants, the most important of which are grapefruit, wheat, palm, and sidr leaves, as well as shafallah, castor, Kokalallah, and other plants (Table 1).

Table 1. The most important plants in the study area

Sample Code	Summer	Winter	Spring	Autumn
P1	Kurt	Kurt	Kurt	Kurt
P2	Kokalla	Kokalla	Kokalla	Kokalla
P3	Shilp	wheat, corn, grist	wheat, corn, grist	Al-Gharba Leaves
P4	Castor Oil Plant	Castor Oil Plant	Castor Oil Plant	Castor Oil Plant
P5	Sidr leaves	Sidr leaves	Sidr leaves	Sidr leaves
P6	Palm fronds	Palm fronds	Palm fronds	Palm fronds
P7	Drapery Leaves	Drapery Leaves	Drapery Leaves	Drapery Leaves
P8	Alkabaz	Alkabaz	Alkabaz	Alkabaz
P9	Fujaila	Fujaila	Fujaila	Fujaila
P10	Shilb	wheat, corn, grist	wheat, corn, grist	Palm fronds
P11	Curt	Curt	Curt	Curt
P12	Tartai	Tartai	Tartai	Tartai
P13	Curt	Curt	Curt	Curt
P14	Pomegranate leaves	Pomegranate leaves	Pomegranate leaves	Pomegranate leaves
P15	Apple leaves	Apple leaves	Apple leaves	Apple leaves
P16	Jet	Jet	Jet	Jet
P17	Taki Fruits	Tek Leaves	Tek Leaves	Tek Leaves
P18	Palm fronds	Palm fronds	Palm fronds	Palm fronds
P19	Sidr root	Sidr root	Sidr root	Sidr root
P20	Rose	Rose	Rose	Rose
P21	Bamba leaves	Bamba leaves	Bamba leaves	Bamba leaves
P22	Calbutose leaves	Calbutose leaves	Calbutose leaves	Calbutose leaves

P23	Mint	Mint	Mint	Mint
P24	Celery	Celery	Celery	Celery
P25	Sidr leaves	Sidr leaves	Sidr leaves	Sidr leaves
P26	Marsupial plant	Marsupial plant	Marsupial plant	Marsupial plant
P27	Dannan	Fajilah	Fajilah	Fajilah
P28	Yaas	Yaas	Yaas	Yaas
P29	Al-Gharba Leaves	Al-Gharba Leaves	Al-Gharba Leaves	Al-Gharba Leaves
P30	Sidr leaves	Sidr leaves	Sidr leaves	Sidr leaves

From Table (2) and Figure (2) for the summer, it was found that there were three sections between the high, medium and low levels of Salmonella bacteria in the plants of the study area, and it was found that the following sites were in high concentration (P28-P21-P27-P29-30). The concentrations ranged between (10-15) cells / 100 ml to dilute (3^{10}), while the sites with medium concentration, which were characterized by the following sites (P1-P3-P8-P14-P15-P17-P20-P22-P24-P25). The concentration of these sites ranged between (5-9) cells / 100 ml to dilute (3^{10}). There are concentrations in the environment of the study area that were characterized as few (P2-P5-P6-P7-P9-P11-P13-P16-P18-P19-P4-P23-P26).

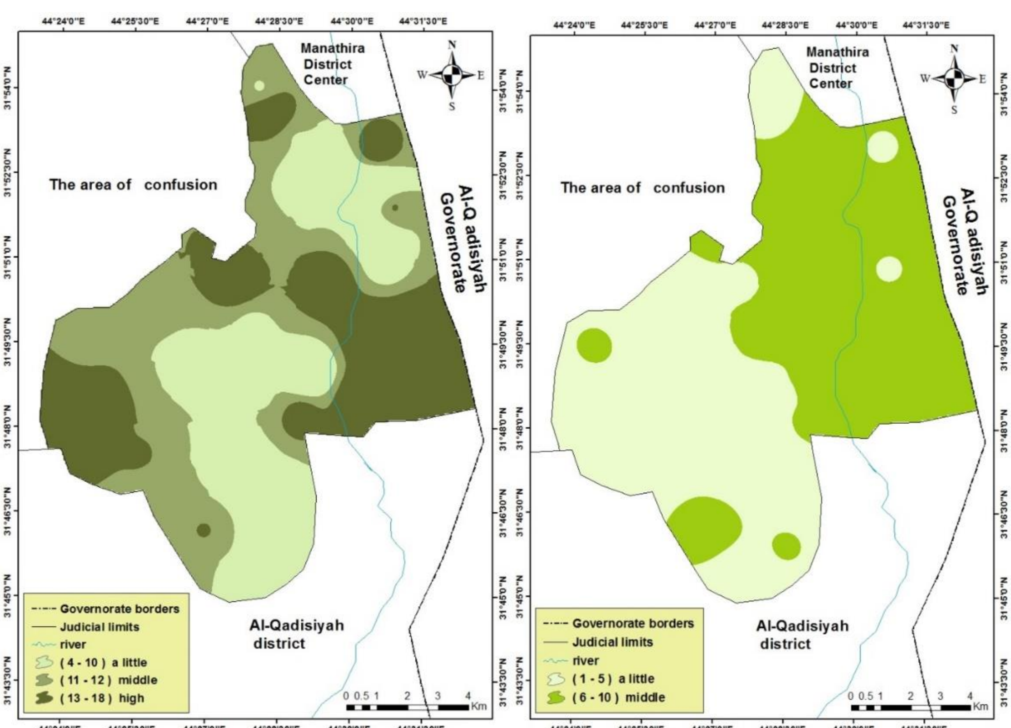
Table 2. Laboratory results of the numbers of salmonella bacteria in the plant

Sample Code	Summer	Winter	Spring	Autumn
P1	6	4	25	10
P2	2	10	20	4
P3	5	11	24	9
P4	2	16	22	8
P5	3	12	23	9
P6	2	11	25	7
P7	3	8	22	6
P8.	6	9	22	6
P9	4	15	18	2
P10	5	14	23	3
P11	2	8	25	2
P12	1	10	15	5
P13	8	12	18	2
P14	6	16	20	3
P15	1	8	17	1
P16	8	16	24	3
P17	2	15	17	2
P18	2	10	25	4
P19	9	10	23	1
P20	12	12	25	2
P21	5	16	16	5
P22	3	8	12	5
P23.	7	8	13	2
P24	6	18	22	3
P25	2	15	24	2
P26	12	5	22	4
P27	15	12	16	5
P28	11	10	18	6
P29	10	5	22	8
P30	11	4	3	2

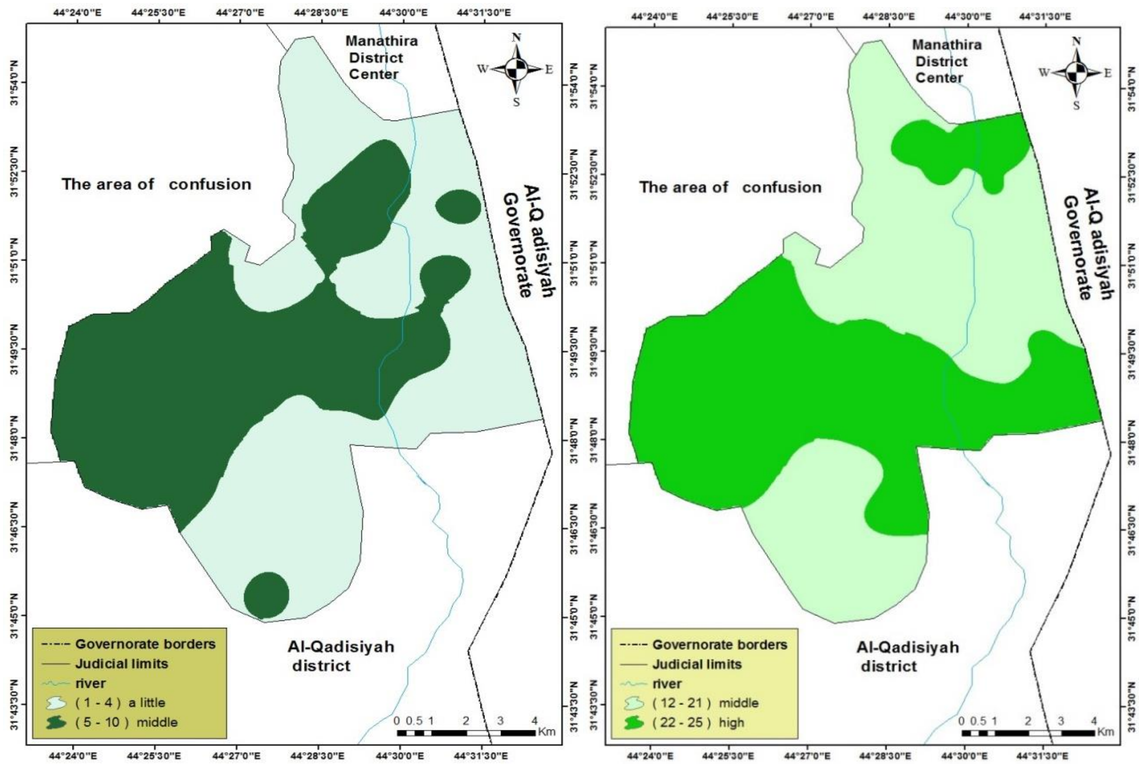
These concentrations ranged between (1-4) cells / 100 ml to reduce (3^{10}). When comparing these results with the winter season of Table (2) and the spatial modeling Figure (3a) of the sites, we note that there is a clear increase in the concentration of bacteria for most sites due to the continuous population activity and various crafts that contribute to the increase of salmonella bacteria, especially since the study area is from rural areas characterized by agricultural areas and breeding of various types of animals. We note that there are also three concentrations between the high, medium and low.

The high concentrations in the following sites (P2 - P3 - P4 - P5 - P6 - P9 - P10 - P13 - P14 - P15 - P17 - P18 - P21 - P22 - P25 - P26 - P28 - P29) and the concentrations ranged between (10– 18) between (1-4) cells / 100 ml to relieve (3^{10}). When comparing these results with the winter season of Table (2) and the spatial modeling Figure (3b) of the sites, we notice a clear increase in the concentration of bacteria for most sites due to continuous population activity and various crafts, which contribute to an increase in salmonella bacteria, especially since the study area is from rural areas characterized by agricultural areas and breeding various types of animals. We note that there are three regions also between the high, medium and small.

While the medium regions were concentrated in the sites (P2 - P8 – P11 - P16 - P23) and these concentrations ranged from (8- 9) for the third dilution ^{10}) and there are low concentration regions for salmonella bacteria, where they were represented in the following sites (P1 - P27 - P30) and these concentrations ranged from (4- 5) for the third dilution ^{10}) while the spring season was characterized by a high concentration of salmonella bacteria and for most sites of Table (2) and Figure (3c) and was divided into two regions between the high and medium and that the high region was concentrated in the following sites (P1 - P2 - P3 - P4 - P5 - P6 - P7 - P8 - P10 - P11 - P15 -P17-P19-P20-P21-P25-P26-P27-P30). The concentrations of these sites ranged from (20-25) (for the third mitigation ^{10}). The medium region was represented by each of the following sites (P9-P13-P14-P16-P18-P22-P23-P24-P28-P29). The concentrations of these sites ranged from (12-18) (for the third mitigation $^{10)}$. Finally, the autumn season, which is the least developed site for salmonella bacteria. The colonies were concentrated between two medium and small regions. The region of the sites with medium concentration was represented in each of the following sites (P3-P4-P5-P6-P7-P9-P29-P30). The concentrations ranged from This region of these sites ranged between (6-9) for the third mitigation ^{10}) and the other (18) sites represented the low concentration region, which ranged between (1-5) for the third mitigation ^{10}) according to Table (2) and Figure (3d).



(a) (b)



(c) (d)

Figure 3. Spatial Modeling of Salmonella Bacteria for: a. Summer, b. Winter, c. Spring, d. Autumn

We note the reason for the high concentration of salmonella bacteria in the plants of the study area for the spring and summer is the presence of large numbers of animals (sheep, livestock and poultry) in most of the farms of the study area. When the water of these barns is mixed with the water of the main river and the affiliated branches, they work to concentrate these bacteria resulting from the feces of these animals and their residues with the water of the river, which is the main source of irrigation for these farms, thus facilitating the transfer of these bacteria to the roots of the plant and the rest of the other parts of the plant. This bacterium is one of the main causes of food poisoning. Salmonellosis is an ongoing threat to human health in the study area environment. Salmonella has the ability to concentrate in the leaves of plants by sticking to the leaf gap and then being able to concentrate in the rest of the Leaves. It has also been laboratory proven that plants growing in soils whose P_H value ranges between 7-10, that is, between neutral and basic, can concentrate in these bacteria as in the results of Table (3), which shows the presence of ph value in the soil of the study area. Samples were taken from a wide range of agricultural and non-agricultural soils from (30) sites in the Mishkab district center to measure the saline elements and find out the extent of the impact of salmonella bacteria on the plants of the environment of the study area and from the Figure 4 For soil sites planted with these plants and Table (3), where the result of the element (ph) was that the following sites (S13-S15-S18-S20-S21-S25-S26-28), which ranged from (7.9-7.2-7.1-7.2-7.1-7.0-7.1-7.2), where these sequences were neutral to the element (PH) according to the standard of the American Salinity Laboratory Table (4), where these sites showed the growth of bacteria (Salmonella) and we note the role of (pH) is positive and important for the soil because these sites are neutral or close to the degree of (pH) The soil as it contributes to the decomposition of the soil Residues of organic materials useful in the growth of cultivated plants, while the other sites (S1-S2-S3-S4-S5-S9-S10-S11-S12-S14-S16-S17-S19-S22-S24-S25-S27-S29-S30) ranged between (8.0-8.19) (Table (3)) and it is clear from these sites that they are non-acidic alkaline according to the American Soil Laboratory standard as in Table (4). In other words, the salmonella bacteria present in these sites are harmful to the life of the cultivated plants and increase very significantly. They are not affected by alkaline soils, that is, they multiply like soils in contrast to acidic soils, in which the bacterial activity is less. Table (3) shows us that there is no site characterized by acidity according to the global standard of the American Salinity Laboratory as show in Table (4).

Table 3. pH concentrations in the soil of the study area

Sample Code	Soil type	pH
P1	River shoulder	8.1
P2	Gypsum	8.12
P3	River basin	8.1
P4	River basin	8.3
P5	River basin	8.12
P6	River basin	8.11
P7	River basin	8.10
P8.	River basin	8,9
P9	River basin	8.03
P10	River basin	8.00
P11	Gypsum soil	8.05
P12	River basin	8.18
P13	River basin	7.9
P14	River basin	8.04
P15	River shoulder soil	7.2
P16	River basin	8.19
P17	River shoulder soil	8.1
P18	Gypsum soil	7.1
P19	River Basin	8.0
P20	Gypsum soil	7.2
P21	River Basin / River Catchment	7.1
P22	River shoulder soil	8.1
P23.	River basin	7.0
P24	River basin	8.01
P25	River basin	8.2
P26	River shoulder	7.1
P27	River basin	8.1
P28	River basin	7.2
P29	River basin	8.2
P30	River shoulder	8.1

Table 4. The global standard of (pH) soil according to the American Salinity Laboratory standard (Miao & Wang, 2020)

Soil Interaction	Soil Characteristic
Less than 4.5	Ultra-acid
4.5-5.00	Very acidic
5-5.5	Extremely acidic
5.5.6	Medium acidity
6-7	Mildly acidic
7	Moderate
7-8	Moderate Basal
8–8.5	Medium Basal
8.5-9	Very basic
More than 9	Very basic

While these sites are neutral to the value of (pH), which is (S13-S15-S18-S20-S21-26-S28). These values ranged from (8.0-8.9). Basal saline soils usually contain low percentages of organic carbon in the soil, mainly due to the weak growth of the plant, which leads to a decrease in the organic matter in the soil, as it works to prevent the decomposition of residues Plants and benefit from them as a foodstuff and affect the non-delivery of organic and inorganic fertilizers for cultivated plants and benefit .Some of them therefore affect the quantities of agricultural production of all kinds in the study area, which negatively affects the income of the farmer there and that the presence of bacteria in the soil ecosystem is an integral part of it, but we cannot benefit from it in such cases (Figure 4).

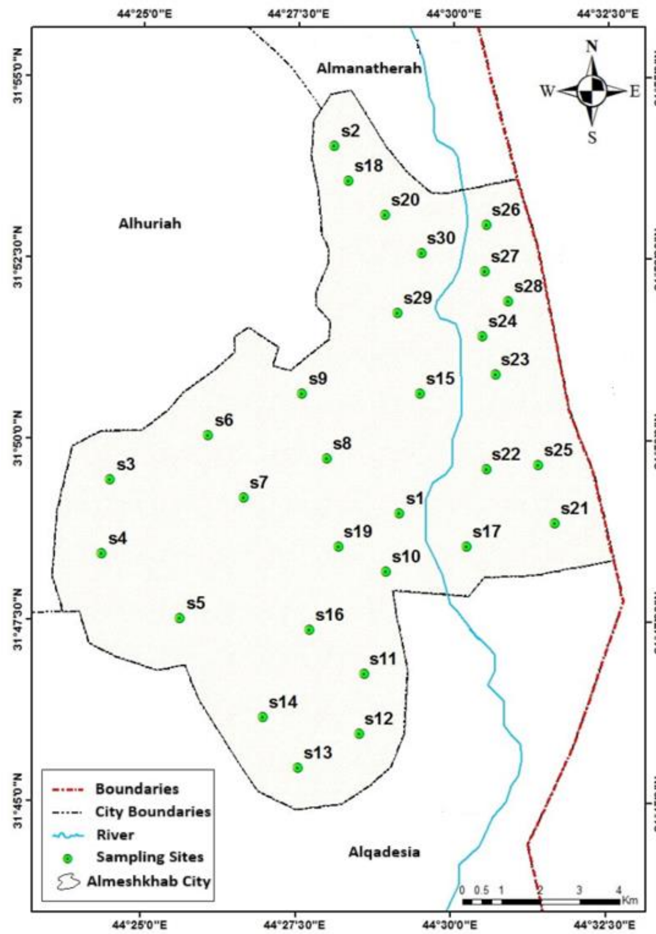


Figure 4. Locations of soil samples for the study area

The decline that occurred in the autumn and summer seasons is due to the scarcity of water that the study area was suffering from and the lack of delivery to agricultural lands, which led to the lack of agriculture and the lack of mixing of river water with plants. The reason for the low rate of water level in the rivers of the study area is due to the foreign policies of the state with neighboring countries as well as the lack of rainfall in the winter, which negatively affected the type of crops cultivated and the lack of agricultural production

Conclusions

The study revealed clear seasonal variations in bacterial concentrations. Laboratory results showed very high concentrations of Salmonella bacteria in plants from the study area. However, in the autumn, a marked decrease in these bacterial concentrations was observed in most plants. Salmonella bacteria thrive in soil with a pH range of 6 to 10, and the soil in the study area is predominantly neutral and non-acidic. The primary source of

Salmonella bacteria in the study area is human and animal feces. Most of the sewage is discharged into the Mishkab River, mixing with the river water and its branches. Farmers mainly rely on this river for irrigation, leading to contamination of crops with various bacteria, including Salmonella. Bacteria tend to concentrate in the lower parts of plants, which are directly exposed to irrigation. However, laboratory analyses of other plant parts, such as leaves and fruits, showed very high bacterial concentrations, as the bacteria adapt to these environments and adhere to other plant parts through straws and pores.

Author Contributions

All Authors contributed equally.

Conflict of Interest

The authors declared that no conflict of interest.

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