Spatial Variation of The Impact of Salmonella Bacteria on The Soil of The Plateau (Najaf – Karbala) Using Modern Technologies

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KEYWORDS

Health, soil, Salmonella, Najaf district center, Al-Haidariya sub-district

ABSTRACT

The research concluded through field studies and laboratory work that there is spatial and temporal variation of soil contamination with Salmonella bacteria in the soil of the plateau (Najaf – Karbala) within the center of Najaf district and Al-Haydariyah sub-district by taking (36)sites and(144)models and by four seasons (summer, autumn, winter and spring) and then diagnosed and analyzed microbiologically and know their types and numbers and the effects caused by these pathological species on humans, animals and plants, as two types of Salmonella bacteria were discovered in the soil of the study area and these two types were (Salmonella enteritidis, Salmonella typhi) was also known to have spatial variation for all the previous two species, as it was found that there are sites that record the highest presence of Salmonella bacteria in the soil of the study area, on the contrary, there are sites that did not record any presence of this bacteria , and the temporal variation between the seasons was also known, as autumn and spring recorded the highest presence and then winter ranked third and finally recorded the summer in terms of the total number of Salmonella bacteria in the soil of the study area, and finally the research concluded that the study area poses an environmental threat to the population in particular and the population of Najaf Governorate In general, what these types of bacteria leave on the environment .

1. Introduction

The soil is a natural product of rocks, so it is a suitable environment for the growth of the roots of plants and living organisms that are represented by beneficial and pathological microorganisms and organisms that are also beneficial and harmful to the naked eye. The soil, including living organisms, was in a state of natural equilibrium as is the natural environment, but due to the increase in population and agricultural production at the expense of the soil and the lack of human awareness and the lack of preservation of the natural environment in general and the soil in particular, this led to its natural imbalance as a result of its pollution. One of the types of soil pollution was microbiological pollution represented by (pathological bacteria, pathological fungi and pathological viruses). In this research, soil contamination with Salmonella bacteria presents in the study area (Najaf-Karbala plateau between the center of Najaf district and the Al-Haidariya sub-district using modern technologies) will be studied to obtain the most accurate scientific results.

The problem of the study: The problem of the research was the following question:

Is there a spatial and temporal variation of soil contamination with Salmonella bacteria in the plateau (Najaf – Karbala) within the center of Najaf district and Al-Haidariya sub-district?

The hypothesis of the study: In order to answer the research problem, the following hypothesis came up:

There is a spatial and temporal variation in soil contamination with Salmonella bacteria, depending on the types and numbers of these bacteria from place to place and from season to season during the study seasons.

The objective of the study: There are many and varied objectives that seek to study the impact of soil contamination with Salmonella bacteria in the Najaf-Karbala plateau within the center of Najaf district and Al-Haidariya sub-district. The researcher believes that this study has immediate objectives and long-term objectives. The most important objectives can be summarized, which is to know the spatial

and temporal variation of soil contamination with Salmonella bacteria and its effects on human, animal and plant health in the study area, by determining the presence of Salmonella bacteria based on the results of laboratory analyses. Microbiological characteristics of the soil of the study area. The importance of the study was represented by two main points: first, the importance of the study lies in the importance of the plateau (Najaf–Karbala), where the plateau is an environment with heavy human weight within Najaf Governorate, as well as a good source of food for the population of Najaf Governorate and neighboring governorates, and second, the absence of previous studies on the level of soil contamination of the plateau (Najaf – Karbala) with Salmonella bacteria in particular and microbiological contamination in general.

2. Methodology

Boundaries of the study area: The center of Najaf District is located north of Najaf Governorate, and its borders extend between two longitudes (43 48. 2844E) and latitudes (4843. 44,28 N) forming a shape closer to the triangle, as for the geographical location, the area is bordered from the north by Al-Haidariya, from the south by the network, from the east by the center of Kufa district, from the southeast by Manathira district, and from the west by the administrative borders of Karbala governorate (Fig. 1).

Stages of work: This stage was represented by several aspects in order to obtain the scientific objectives, which are as follows:

1- Field work stage: It is the first stage in which the sample sites are collected in a random manner intended to rely on the GPS program to know the exact location of the samples, as (144) samples were collected from the soil of the study area, and taken from (36) sites with (4) samples from each site , representing the first season during the month of August (summer), specifically in (17/8/2023) ,while the second semester was in November (autumn), specifically in (9/11/2023) , the third semester was in January (winter), specifically in (11/1/2023), and the fourth semester was represented in(spring). The samples were taken on the date of (4/3/2023), as the microbiological models were analyzed in order to diagnose and know the types and numbers of Salmonella bacteria in the soil of the study area.

Laboratory work phase: This phase begins by transferring the samples to the laboratory by a controlled method to preserve soil samples from damage, and then the method of developing pathological bacteria cultures begins by taking (1g) soil from a model of the soil of the study area (for example sample No. 14). After that, a series of decimal dilutions was prepared (1) for the sample to be examined, taking four clean and single-use plastic tubes to maintain the absence of pollution, it was placed in the first tube (10ml) of distilled water with one gram of the soil is well mixed. The rest of the tubes are placed (9ml) of distilled water and mixed well. Then (1ml) of the first tube mixture is transferred by a clean syringe(syringe) (it does not need to be sterilized because it is used only once) to the second tube. The process of mixing and transporting continues like this until it is diluted 10^{-3}, where it is mixed and transferred (1ml) to a dry and clean petri dish andby three repetitions of the sample. The second step comes by adding the agricultural medium (Nutrient agar) or (Macconkey agar) sterilized by the buffer and mix the model well with the cultivated medium (Shake No. (8) in English) and leave to harden. The step comes before the diagnostic stage, which is the placement of dishes in the incubator (Incubator) in an inverted form (2) with a temperature of (37) for a period of 24. As for the last stage, it is the stage of calculating the total number of developing colonies in the dish through the BioCote device.

2- Isolation and Biological Diagnosis Phase: Microscopy Properties and Biochemical Properties were relied upon in order to reach the best results of accurate biological diagnosis, namely:

A. The traditional method (Stains), which is a method used to color the components of cells or tissues in order to distinguish them from each other, which facilitates the study of tissues and cells microscopically, as this method is one of the classic traditional methods for diagnosing

microorganisms, and this method was used primitively to identify types of microorganisms, as a set of dyes were used (Simple Stain, Differential Stain).

B. The modern method (the use of the Vitek-2 device) is one of the modern and advanced biological diagnostic methods. The device is characterized by its ability to determine the level of diagnosis of the organism through its test map and is compared to the classification qualities of the device. It gives the organism a probability ratio between 96-99% and an excellent level of confidence. The Vaitic2 device is used as an image (3) through the first step of greening the bacterial suspension (according to the instructions of the equipped company) by preparing sterile plastic tubes and placing in them (3 ml) of saline solution. Then a number of pure colonies are transferred from the agricultural dish to the tube by (Loop). The second step is vaccinating the Cards card or the so-called Cassettes, which contain (64) holes or pits, each one of which represents the base or medium material and is placed in the designated place in the device. The results are expected to appear on the device for a period of (24) hours after which the results show your Vait2 device on the program (Densi Chek) through which the information can be entered and taken out.

A. Spatial analysis of the distribution of Salmonella bacteria in the soil of the study area:

They are enterobacilli form bacteria that are negative for gram dye and move with whips on the entire cell. They prefer to grow and multiply in the presence of oxygen, but they also grow without it. The optimum temperature for their growth is 37 degrees Celsius, while the optimum pH for their growth is equal to seven (1). Salmonella bacteria are found in both warm and cold-blooded animals. People often become infected when they eat contaminated foods of animal origin such as meat or eggs. They can also become infected by eating salmonella in the waste of animals that pollute food or water, and perhaps by direct contact with infected animals. Animals may also get infected from contaminated feed or drinking water or direct contact with infected animals (including humans) (2).

There is a disease that affects animals called salmonella infection, which is caused by various types of salmonella germs. The causative agent is transmitted through feces, urine and nasal gonorrhea. It pollutes the surrounding environment, feed, soil and water. The symptoms appear in cows and calves with lethargy, fever, rapid pulse and breathing. Pneumonia is also observed in addition to the lack of desire to breastfeed in cows and the occurrence of mild diarrhea. In sheep, the symptoms are high temperatures up to 41 ADS, lack of appetite or abstinence from breastfeeding, thirst and diarrhea in the form of watery yellow foam, general weakness, arching of the back and abortions of pregnant females. The death rate is high in sheep infected with salmonella infection (3).

Salmonella bacteria were studied and diagnosed in the study area, which affects the plant's infection with diseases and is transmitted to humans and animals directly or indirectly and then infected with various diseases. Two types of Salmonella bacteria that are already present in the soil of the study area were diagnosed for (36) sites and by (4) models for four seasons of the year, and these two types are as follows:

Salmonella enteritidis: This genus causes Salmonella bacteria (food poisoning), and the source of infection for humans and ways of transmitting it to them are animals such as birds, fish, insects, dogs, cats, frogs and monkeys, whether through eating or dealing directly, as well as the infection is transmitted through sewage and water contaminated with liquid or solid waste, as well as microbe-contaminated vegetables (4). The symptoms of the disease appear in humans in the form of nausea, vomiting, abdominal pain, diarrhea with high temperature, feeling cold and shivering as well as headache, anxiety and dizziness, as well as muscle weakness and a feeling of fatigue, and the stool smells like chicks and its color is green, and these symptoms last between two to three days (5).

Table (1) shows that there is a spatial and temporal variation in soil contamination of Salmonella enteritidis bacteria, as the highest presence in the spring and autumn is recorded in (20 and 21) sites, each of them, respectively, out of (36) sites in the study area. The spring and autumn contributed to

making the highest presence of these bacteria during these two seasons through the availability of natural factors represented by the appropriate temperatures and humidity and human factors represented by human activity represented by household waste and the use of animal and organic fertilizers in agriculture, which are frequent during the two mentioned seasons, but the spring season is higher than the autumn season in terms of the total number of colonies of (227) colony grams of soil 10^{-3}.

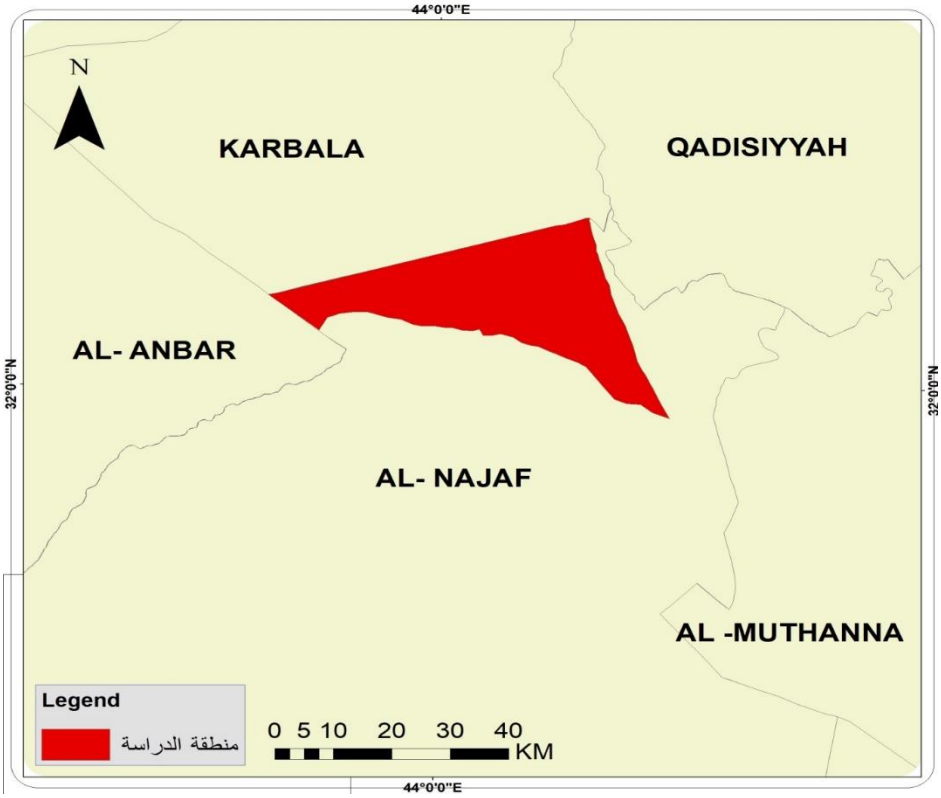

Figure (1) Administrative boundaries of the study area

3. Results and discussion

Table (1) The total numerical distribution of the bacteria enteritidis Salmonella in the soil of the study area 2023 AD

No Sample	Location	Setup Bacteria in summer g of soil/x10^{-3}	Prepared by: Bacteria in autumn g of soil/x10^{-3}	Bacteria count in winter g of soil/x10^{-3}	Preparation of bacteria in spring g of soil/x10^{-3}
1W	Cultivated Soil (Najaf / Karbala) Street, Pillar 95	0	0	0	0
2W	Soil planted in the marginal area between Sahliya and the plateau column 298	0	19	0	28
3W	Soil planted in marginal area column 542	1	21	1	30
	Soil planted in marginal area	1	39	1	43
5W	Soil planted in the marginal area (Al-Haidariya border area with Karbala)	0	2	0	1
6W	Cultivated Gypsum Desert Soil	0	9	0	8
7W	Desert soil planted in Al-Haidariya area	0	0	0	0
4-8w	Hydrian cultivated desert soil (20km) from Najaf / Karbala Street	0	0	0	0
9W	Cultivated desert soil (2km) from the main street of Karbala	0	0	0	0
SAE 10W	Cultivated soil (10km) from the main Karbala Street	0	2	0	0

9-11w	Soil affected by the residues of the Najaf refinery.	0	0	0	0
12W	Desert soil in the Najaf Plateau near the Kifl checkpoint	0	0	0	0
13W	Cultivated soil (340 meters) away from (Najaf/Karbala) Street	0	0	0	0
14W	Planted soil near the strategic line	0	1	0	1
15W-40	Planted soil near Al-Attar depression	0	0	0	0
16W	Soil affected by sewage landfill/Al-Qaws Street.	0	0	0	0
17W	Soil from Wadi Al-Salam Cemetery Model 1	2	26	4	11
18W	Soil from Wadi Al-Salam Cemetery Model 2	3	9	5	8
19W	Soil from Wadi Al-Salam Cemetery Model 3	1	15		21
20w	Soil from Wadi Al-Salam Cemetery Model 4	1	11	3	8
21W	Soil from Wadi Al-Salam Cemetery Model 5	2	4	1	13
22W	Soil planted near the top of the sheep	0	1	0	1
W23	Planted soil near Hawalli Karbala Abu Sakhir Road	0	8	0	5
W24	Cultivated soil (1km) from Hawalli Karbala Abu Sakhir Road	0	1	0	1
W25	Cultivated soil near Najaf Gate Complex	0	2	0	1
2018-W26	Uncultivated soil Hawalli Karbala Abu Sakhir Road.	0	0	0	0
W27	Cultivated soil affected by the waste of the power station/ near the Najaf gas power station	0	0	0	0
W28	Uncultivated soil near Najaf International Airport	0	0	0	0
W29	Uncultivated soil Al-Hawli Airport Highway	0	0	0	0
F-W30	Cultivated soil affected by medical waste/ near the University of Kufa (Portal of the Faculty of Science)	0	3	1	10
W31	Cultivated soil affected by medical waste/near the center of the Middle Euphrates tumors	0	6	1	7
W32	Planted soil, Al-Hizam Al-Akhdar Street	0	0	0	0
L34/W33	Cultivated soil affected by household waste/Al-Askari Street	0	0	0	0
W34	Uncultivated soil affected by household waste/Al-Sawq neighborhood	8	20	9	14
W35	Uncultivated Soil Affected by Household Waste/Assembly Neighborhood	1	15	2	11
W36	Uncultivated soil affected by the waste of medical clinics/doctors' neighborhood	0	4	0	5
Total		**20**	**218**	**28**	**227**

Ranked second in terms of the number of sites of (20) sites, and these sites were represented in the spring (March) in Petrib (W2, W3, W4, W5, W6, W14, W17, W18, W19, W20, W21, W22, W23, W24, W25, W30, W31, W34,5 W3, W36). The number of colonies in those sites ranged between (43-1) colony gm of soil $x10^{-3}$. The autumn season comes second in terms of the number of developing colonies, as it reached (218) colony gm of soil $x10^{-3}$, but ranked first in terms of the number of sites of (21) sites, these sites were represented in autumn (November) by (W2, W3, W4, W5, W6, W10, W14, W17, W18, W19, W20, W21, W22, W23, W24, W25, W30, W31, W34, W35, W36). The number of colonies in those sites ranged between (39-1) colonies gms of soil $\times10^{-3}$. The winter (January)represented the third place in terms of spatial distribution by (10) sites contaminated with bacteria. These sites totaled the number of colonies (28)colonies gms of soil $\times10^{-3}$ (W3, W4, W17, W18, W20, W21, W30,W31, W34, W35) and the number of colonies in those sites ranged between(1-9) colony grams of soil $\times10^{-3}$, while the least season in which the soil in the study area was contaminated with bacteria is the summer(AB) despite the presence of human pollution, but it can be said that the temperatures led to the killing of these pathological bacteria in the soil. The sites were (9) sites are (W3, W4, W17, W18, W19, W20, W21, W34, W35). The number of colonies ranged between

(1-8) colony gms of soil $\times 10^{-3}$. The total number of colonies (20) colony gms of soil $\times 10^{-3}$. Through the above, it is noted that the highest presence of these bacteria during the spring and autumn seasons is due to the availability of moderate temperatures suitable for their growth and activity with the availability of other appropriate conditions. During the winter season, their numbers were significantly decreased due to the fact that these bacteria are less active when temperatures decrease as well during the summer season, their numbers decrease, as high temperatures during the summer season affect the growth and activity of these bacteria.

It is clear from Table (1) that the most contaminated sites with these bacteria are (W4) soil planted with the crop (dill, fry and radish) in the marginal area, (W3) soil planted with the crop (barley, clover and aspenagh) in the marginal area, (W2) soil planted (cress, radish, celery, leeks and dill) in the Hashemite region between Sahliya and the plateau, column 542. The reason for its high presence in these three sites may be due to the use of Human and chemical organic fertilizers in agriculture are excessive and also the use of chemical pesticides is irrational and excessive, which leads to providing a suitable environment for the growth of these pathological bacteria more than the rest of the other sites. This threatens the population of the study area in particular and the province of Najaf in general with the poisoning of Salmonella (food poisoning). The symptoms of the disease in humans appear in the form of nausea, vomiting, abdominal pain, diarrhea with high temperature, a feeling of cold and shivering as well as headache, anxiety and dizziness, as well as muscle weakness and a feeling of stress. The stool smells like chicks and its green color. These symptoms last between 2-3days, as well as the presence of these bacteria dangerously on animals through a disease called salmonella infection. The symptoms in cows and calves are inactivity, fever, rapid pulse and breathing, pneumonia is also observed, in addition to the lack of desire to breastfeed in cows and the occurrence of mild diarrhea. In sheep, the symptoms are high temperatures up to 41°C, lack of appetite or refraining from breastfeeding, thirst and diarrhea in a yellowish foamy watery form, general weakness, arching of the back and abortions of pregnant females. The death rate is high in sheep infected with salmonella infection, so the presence of these bacteria Salmonella enteritidis is a threat to the environment of the study area.

Salmonella typhi**:** This genus of Salmonella bacteria, known as Bacillus typhi, is responsible for an acute and infectious disease (typhoid fever). The ways of infection and infection are through food and drink contamination or direct exposure, as well as infection with wounds and bites of insects and other animals, as well as contaminated air (6). Typhoid disease or typhoid fever occurs when Salmonella typhi bacteria control the endothelial reticular system, multiplying within the cells, the gallbladder duct and the intestine, and then spreading with blood to all parts of the body. The danger is that it is a bump that collects in the lungs, gallbladder, spleen and marrow, and the symptoms of the disease appear on the host about two weeks after infection (7). Symptoms are enteritis, which is characterized by diarrhea, high temperatures and abdominal pain. The most serious symptom is fatal damage to the liver, spleen, respiratory system or nervous system, as well as sepsis, which is characterized by chills, intermittent high temperatures, loss of appetite for food and bacteremia (8).

Table (2) shows that the number of Salmonella typhi bacteria in the study area varies temporally and spatially , as it is clear that the highest number of these bacteria was in the autumn (November) in terms of the total number of colonies of (160) g of soil $^{3-}10^{\times}$and in terms of the number of sites of (19) out of (36) sites, as those sites were (W2, W3, W4, W5, W6, W10, W14, W16, W17, W18, W19, W20, W21, W24, W25, W30, W31, W33, W36) and the number of colonies ranged between(1-42) g of soil $^{3-}10^{\times}$The total number of colonies in those sites reached (160) gms of soil $\times 10^{-3}$, then came the second place in the spring (March) in terms of the number of developing colonies that reached (150) gms of soil $\times 10^{-3}$distributed over (19) sites out of (36) sites. Those sites were (W2, W3, W4, W5, W6, W10, W14, W16, W17, W18, W19, W20, W21, W24, W25, W30, W31, W33, W36) and the number of colonies ranged between(1-30) gms of soil $^{3-}10^{\times}$, as for the separation Winter (January) recorded the third rank in terms of the number of developing colonies, which amounted to (31) colonies g of soil

$\times 10^{-3}$ recording (8) contaminated sites, namely (W2, W3, W4, W14, W18, W20, W21, W33) and the number of

Table (2) The total numerical distribution of Salmonella typhi bacteria in the soil of the study area 2023AD

No Sample	Location	Setup Bacteria in summer g of soil/x10^{-3}	Prepared by: Bacteria in autumn g of soil/x10^{-3}	Bacteria count in winter g of soil/x10^{-3}	Preparation of bacteria in spring g of soil/x10^{-3}
1W	Cultivated Soil (Najaf / Karbala) Street, Pillar 95	0	0	0	0
2W	Soil planted in the marginal area between Sahliya and the plateau column 298	2	10	1	8
3W	Soil planted in marginal area column 542	1	13	4	20
	Soil planted in marginal area	1	3	1	6
5W	Soil planted in the marginal area (Al-Haidariya border area with Karbala)	0	2	0	1
6W	Cultivated Gypsum Desert Soil	0	4	0	5
7W	Desert soil planted in Al-Haidariya area	0	0	0	0
4-8w	Hydrian cultivated desert soil (20km) from Najaf / Karbala Street	0	0	0	0
9W	Cultivated desert soil (2km) from the main street of Karbala	0	0	0	0
SAE 10W	Cultivated soil (10km) from the main Karbala Street	0	1	0	1
9-11w	Soil affected by the residues of the Najaf refinery.	0	0	0	0
12W	Desert soil in the Najaf Plateau near the Kifl checkpoint	0	0	0	0
13W	Cultivated soil (340meters) away from (Najaf/Karbala) Street	0	0	0	0
14W	Planted soil near the strategic line	1	6	1	7
15W-40	Planted soil near Al-Attar depression	0	0	0	0
16W	Soil affected by sewage landfill/Al-Qaws Street.	0	1	0	1
17W	Soil from Wadi Al-Salam Cemetery Model 1	0	2	0	1
18W	Soil from Wadi Al-Salam Cemetery Model 2	2	21	5	19
19W	Soil from Wadi Al-Salam Cemetery Model 3		42		26
20w	Soil from Wadi Al-Salam Cemetery Model 4	1	19	2	10
21W	Soil from Wadi Al-Salam Cemetery Model 5	4	25	7	30
22W	Soil planted near the top of the sheep	0	0	0	0
W23	Planted soil near Hawalli Karbala Abu Sakhir Road	0	0	0	0
W24	Cultivated soil (1km) from Hawalli Karbala Abu Sakhir Road	0	2	0	1
W25	Cultivated soil near Najaf Gate Complex	0	3	0	5
2018-W26	Uncultivated soil Hawalli Karbala Abu Sakhir Road.	0	0	0	0

W27	Cultivated soil affected by the waste of the power station/ near the Najaf gas power station	0	0	0	0
W28	Uncultivated soil near Najaf International Airport	0	0	0	0
W29	Uncultivated soil Al-Hawli Airport Highway	0	0	0	0
F-W30	Cultivated soil affected by medical waste/ near the University of Kufa (Portal of the Faculty of Science)	0	1	0	1
W31	Cultivated soil affected by medical waste/near the center of the Middle Euphrates tumors	0	1	0	1
W32	Planted soil, Al-Hizam Al-Akhdar Street	0	0	0	0
L34/W33	Cultivated soil affected by household waste/Al-Askari Street	1	2	10	3
W34	Uncultivated soil affected by household waste/Al-Sawq neighborhood	0	0	0	0
W35	Uncultivated Soil Affected by Household Waste/Assembly Neighborhood	0	0	0	0
W36	Uncultivated soil affected by the waste of medical clinics/doctors' neighborhood	0	2	0	4
Total		**13**	**160**	**31**	**150**

The colonies were between (1-10) colonies gms of soil $3^{-}10^{\times}$, and finally the summer season (AP) recorded the lowest seasons in terms of the total number of developing colonies, which amounted to (13) colonies gms of soil $3^{-}10^{\times}$ distributed over (8) sites are (W2, W3, W4, W14, W18, W20, W21, W33) and the number of colonies ranged between (1-4) colonies gms of soil $^{\times}10^{-3}$.

It is noteworthy from Table (2) that the highest presence of Salmonella typhi bacteria in the sites of (W19, W21, W18) and those sites have models of the soil of the Wadi Al-Salam cemetery. The reason for its presence may be that it can participate in the decomposition of the remains of the dead and provide the appropriate conditions of food and organic matter that help them grow and reproduce perfectly. The presence of these bacteria in large numbers in the soil of the Wadi al-Salam cemetery is a dangerous indicator of the infection of the residents of the study area in particular and the residents of the Wadi al-Salam cemetery in general with a group of diseases, including (typhoid fever). The methods of infection and infection are through food and drink contamination or direct exposure. The infection is also transmitted by wounds and bites of insects and other animals as well as polluted air. The symptoms appear in the arrivals in the form of enteritis, which is characterized by diarrhea, high temperatures and abdominal pain. The most serious symptoms are fatal damage to the liver, the spleen, respiratory system, or the nervous system.

The study proved through laboratory analysis of (144) samples taken from (36) studied sites for four seasons (summer, autumn, winter and spring), the following:

1- There is a temporal and spatial variation in the distribution of Salmonella bacteria in terms of the number of colonies that have grown, as the study showed that the highest total number of colonies was during the autumn (November) and the second spring (March). Winter (January) was the third place and finally summer (August) was the fourth place in terms of the total number of colonies growing Salmonella bacteria.

2- The study also concluded after field work for four seasons and conducting modern biological analyses of soil samples of the study area to two types. There are two types of Salmonella bacteria that are already present in the study area, and these two types were first (Salmonella enteritidis)

and second (Salmonella typhi) and each of them leaves a group of diseases on humans, animals and plants that directly affect the population of the study area and indirectly affect the population of Najaf Governorate.

3- It was discovered that the highest presence of Salmonella enteritidis bacteria in the following sites is (W4) soil planted with the crop (dill, fry and radish) in the marginal area and(W3) soil planted with the crop (barley, clover and aspenagh) in the marginal area (column and(W2) cultivated soil (cress, radish, celery, leek and dill) in the Hashemite region between Sahliya and the plateau (column 542). The reason for their high presence in these three sites may be due to geographical factors, and this threatens the population of the study area in particular and the province of Najaf in general with Salmonella poisoning (food poisoning), as well as the presence of these bacteria dangerously on animals by contracting a disease called Salmonella infection.

It was discovered that the highest presence of Salmonella typhi bacteria in the sites (W19, W21, W18) and those sites have samples of the soil of Wadi al-Salam cemetery. The reason for its presence may be that it can participate in the decomposition of the remains of the dead and provide the appropriate conditions of food and organic matter that help them grow and reproduce perfectly. The presence of these bacteria in large numbers in the soil of Wadi al-Salam cemetery is a serious indicator of the infection of the population of the study area in particular and the expatriate population of Wadi al-Salam cemetery in general with a group of diseases, including typhoid fever.

4. Conclusion and future scope

The research demonstrated that there is significant spatial and temporal variation in soil contamination with Salmonella bacteria in the Najaf-Karbala plateau. Through extensive field and laboratory analysis of 36 sites across four seasons, it was found that the presence of Salmonella bacteria varied by location and season. Two types of Salmonella, Salmonella enteritidis and Salmonella typhi, were identified in the soil samples. The study concluded that certain sites had high concentrations of Salmonella, while others had none. Temporally, autumn and spring recorded the highest presence of these bacteria, followed by winter, with summer showing the least contamination. This variation is attributed to natural factors like temperature and humidity, and human activities such as household waste disposal and the use of animal and organic fertilizers. Overall, the research highlights that the soil in the study area poses an environmental threat, especially to the local population, due to the presence of these pathogenic bacteria. This underscores the need for environmental management and public health measures to mitigate the impact of soil contamination in the region.

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