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Assessment of Foods Safety: Heavy Metal and Microbial Contamination in Husseini Processions in Wasit Province

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Abstract:

The safety of food and drinks in Hussein processions and their availability to meet the needs of visitors on this major religious occasion is of particular importance because it is one of the most important requirements that accompanies the visitor regardless of his geographical destinations. The study was conducted in the field during the forty models' period of 2023 in Wasit Province to determine the degree of microbial and metal contamination of the foods and drinks most consumed among visitors in Hussein processions and to provide recommendations for developing the design of nutritional evaluation monitoring. A total of 270 samples were collected randomly from 30 procession from 5 different regions. These samples consisted of 45 water samples, 120 samples of ready-to-eat foods (beef hamburger, falafel, boiled rice, boiled beans), and 105 samples of drinks (yogurt, orange juice, lemon juice and Noomi Basra juice). Some bacterial species were detected in the studied samples, as they were found after culturing the samples on different culture media to investigate microbial contamination. The results showed that the total number of aerobic bacteria (TBC), Escherichia coli, and Staphylococcus aureus exceeded the Iraqi standard specifications and international standards for some types of samples studied, while they were free of Salmonella spp. As for investigating metal contamination, lead and cadmium was analyzed using atomic absorption spectrometer technology (Model Phoenix-986 AAS). The results showed accumulations of lead and cadmium slightly exceeding the permissible limits locally and internationally. The data derived from this study show that the methods followed by most Hussein procession owners in preparing food are effective and therefore safe to use, but making more effort is better to protect visitors. The microbial and mineral quality of foods and drinks was satisfactory in most of the samples studied. The Iraqi authorities must establish health and preventive guidelines that provide for the safety of visitors and protect them from diseases transmitted through water and food, and cases of food poisoning.

Keywords*: Food safety, bacterial contamination, metal contamination, public health, Husseini processions*

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تقييم سلامة الأغذية: التلوث بالمعادن الثقيلة والميكروبات في مواكب الحسينيات في محافظة واسط

وسام ثامر المياحي

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الخلاصة:

إن سلامة الأطعمة والمشروبات في المواكب الحسينية ومدى توفرها لسد أحتياجات الزائرين في هذه المناسبة الدينية الكبيرة لها أهمية خاصة لكونها تعد من اهم المتطلبات التي ترافق الزائر بأختلاف وجهاته الجغرافية. أجريت الدراسة ميدانياً في فترة زيارة الاربعين لعام ٢٠٢٣ في محافظة واسط، لمعرفة درجة التلوث الميكروبي والمعدني للمأكولات والمشروبات الأكثر استهلاكًا بين الزائرين في المواكب الحسينية وتقديم توصيات لتطوير تصميم مراقبة التقييم الغذائي. تم جمع إجمالي ٢٧٠عينة بشكل عشوائي من ٣٠ موكب من ٥ مناطق مختلفة. وكانت هذه العينات عبارة عن ٤٥عينة ماء، و ١٢٠ عينة من الأطعمة الجاهزة للأكل (همبركر بقري، فلافل، تمن مسلوق، فول مسلوق) ، و١٠٥ عينة من المشروبات (للبن عراقي، عصير برتقال، عصير الليمون، عصير نومي بصره). تم التحري عن بعض الأنواع البكتيرية في العينات المدروسة إذ وجد بعد زرع العينات على أوساط زرعية مختلفة للتحري عن التلوث الميكروبي، واظهرت النتائج ان العدد الكلي للبكتريا الهوائية (TBC) وبكتريا القولون (Escherichia coli) وبكتريا المكورات العنقودية (Staphylococcus aureus) قد تجاوز الحدود المسموح بها في المواصفة القياسية العراقية والعالمية لبعض انواع العينات المدروسة ، مع خلوها من بكتريا (Salmonella spp). أما بالنسبة لتحري عن التلوث المعدني تم تحليل عنصري الرصاص، والكاديوم باستخدام تقنية جهاز مطياف الامتصاص الذري atomic absorption spectrometer (Model Phoenix-986 AAS) ، وأظهرت النتائج وجود تراكمات لعنصر الرصاص والكاديوم تفوق قليلاً الحدود المسموح فيها محلياً وعالمياً. تظهر البيانات المستمدة من هذه الدراسة أن الطرق التي يتبعها اغلب اصحاب المواكب الحسينية في تجهيز الأغذية فعالة وبالتالي فأنها كانت آمنة للاستخدام ولكن بذل المزيد من الجهد هو الأفضل لحماية الزائرين. كانت الجودة الميكروبية والمعدنية للمأكولات والمشروبات مرضية في اغلب العينات المدروسة. يجب ان تضع السلطات العراقية الارشادات الصحية والوقائية التي تنص على سلامة الزائرين وحمايتهم من الامراض المنقولة عن طريق الماء والغذاء وحالات التسمم الغذائي.

الكلمات المفتاحية: سلامة الأغذية، التلوث البكتري، التلوث المعدني، الصحة العامة، المواكب الحسينية.

Introduction

The interest of researchers and specialists in environmental pollutants has increased in recent years due to the development the world is witnessing in many fields, especially the food industry and the increase in sources of pollution that may be a major cause of contamination of food and drinks, which has prompted the establishment of many governmental and private bodies and organizations to enact laws and monitor food safety It identifies food contaminants and determines their quantities (FAO, 2022 and IFPA,2023).

There is no doubt that human health and safety are among the most important basic points for achieving growth and progress, and healthy food free of pollution in all its forms from heavy elements, microorganisms and toxins is one of the important goals for achieving this goal (Jasim *et al.*,2024).

The study of heavy metals is crucial because they have a potentially serious impact not only on biological compounds but on human health as well. Due to the toxic effects of metals, their accumulation throughout the food chain leads to a serious environmental and health problem (Mohammed and Abdul-Rezzak, 2021).

United States Environmental Protection Agency (US EPA), microbiological contamination of food is no less important than chemical contamination. Microbiologically contaminated food is one of the most dangerous sources of diseases that can spread through the handling and consumption of food and drink (US EPA,2015).

The aims of this study were to assess the level of microbial and mineral contamination of common foods and drinks consumed by visitors of Husseini Processions in located Wasit Province, Iraq, in order to provide recommendations for ways to development of health procedures for assessing and monitoring dietary.

Material and methods

Study area and sampling

The study was applied during a period of visit forty of 2023, in Wasit province. A total number of 270 samples were collected from 30 procession from 5 different regions (6 processions in each). The investigated areas were Al Kut, Al Hayy, Al Numaniyah, Badara and Sheak Saad as presented in Figure (1). Samples were randomly collected as follow: 45 water, 120 ready-to-eat foods, and 105 drinks. The water samples were collected in sterile polyethylene containers described by APHA (2020). The food samples were collected in sterile bags and were cooked foods as beef hamburger, falafel, boiled rice, boiled beans. Moreover, the drinks samples were collected in sterile polyethylene bottles and were ready-to-drink beverages as yogurt, orange juice, lemon juice and Noomi Basra juice. The samples were coded, numbered, and transported to the laboratory, where they were all examined.

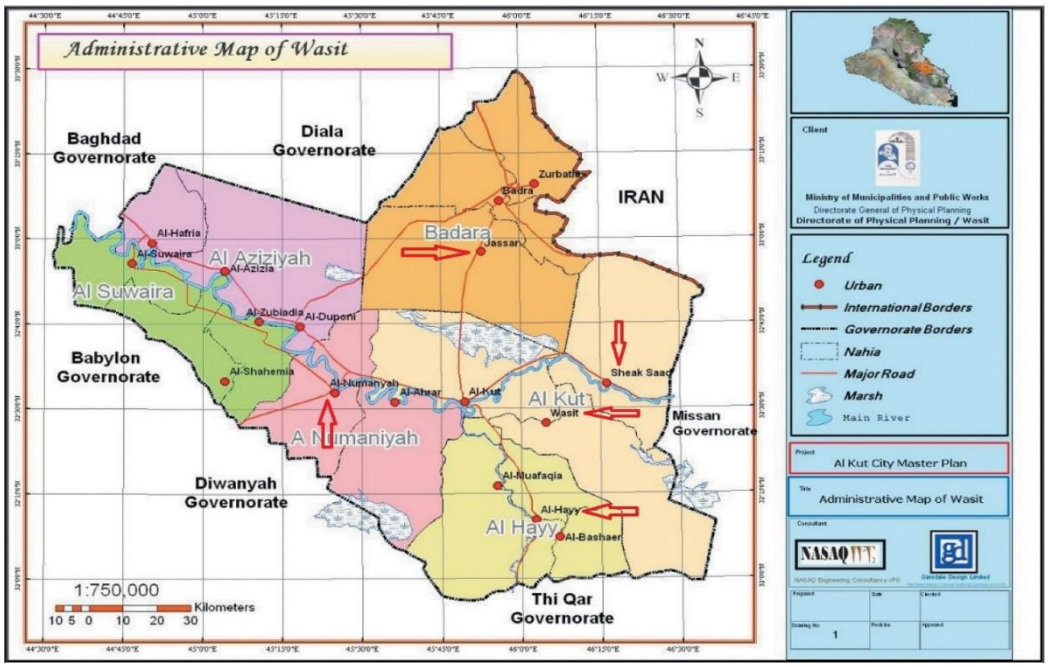

Figure 1. Map showing sampling locations in Wasit Province, Iraq

Laboratory Procedures

Detections of bacterial contaminations of food, drinks and water samples.

Microbial examinations of the study samples were conducted based on the methods mentioned in (WHO,2017), including examination of Total Bacterial Count (TBC), *Eschericia coli*, *Staphylococcus aureus* and *Salmonella spp.* The culture media was prepared in the public health laboratory in the Wasit Health Department, and after adjusting its pH, it was sterilized in an autoclave at temperature of 121°C and a pressure of 15 lb/in2 for 15 minutes, and the dishes were incubated at the temperatures approved for each test.

Estimations heavy metals contaminations of food, drinks and water samples.

Heavy metal samples were prepared according to the method of Zhang *et al.* (2021) and were measured in food, beverages and water by atomic absorption spectrometry (Model Phoenix-986 AAS).

Statistical Analyses

All analyses of the data obtained were performed using SPSS version 23 to generate descriptive statistics, and one-way analysis of variance (ANOVA) was used to test statistically significant differences (SAS, 2001).

Results and Discussion

Detections of bacterial contaminations

The results in Table (1) and Figure (2) showed that some samples of water, foods and drinks contain microbial contamination, as it was observed that the total bacteria count (TBC) ranged between (6 to 15) cfu/ml in the water samples, (0 to 11) in the foods samples, and (2 to 12) cfu/ml in the drinks samples. This contamination may be due to poor storage and preparation methods or through the machines used by workers.

As for the *Escherichia coli,* contamination was observed in two of the samples studied, the water sample which ranged between (1 to 3) cfu/ml , and the yogurt sample which ranged from (0 to 2) cfu/ml , while the other samples did not exceed the Iraqi and international permissible limits, which It indicated that the number of *Escherichia coli* should not exceed 1 colony-forming unit/ml at a temperature of 37°C for 24 hours (ICS,2011 and WHO,2020).

Table 1. Descriptive statistics results of Bacterial contamination in food, drinks and water samples selected of Husseini Processions during study period.

Food and Drinks samples	Descriptive Statistics	TBC cfu/ml	*Escherichia coli* cfu/ml	*Staphylococcus aureus* cfu/ml	*Salmonella spp.* cfu/ml
	Mean	8.5	0.5	1.5	0
	SD	2.17	0.5	0.829	0
	Min.	5	0	1	0
Beef hamburger	Max.	11	1	3	0
Falafel	Mean	2.5	0	0.5	0
	SD	1.803	0.433	0.5	0
	Min.	0	0	0	0
	Max.	5	1	1	0
Boiled beans	Mean	6.5	0.5	0.5	0
	SD	2.74	0.5	0.83	0
	Min.	4	0	0	0
	Max.	11	1	2	0
Boiled rice	Mean	2.5	0	1.5	0
	SD	1.803	0.433	0.5	0
	Min.	0	0	1	0
	Max.	5	1	2	0
Tap water	Mean	10	1.5	0.5	0
	SD	2.59	0.829	0.5	0
	Min.	6	1	0	0
	Max.	15	3	1	0
Yogurt	Mean	9.5	0.5	0	0
	SD	1.803	0.829	0.433	0
	Min.	7	0	0	0
	Max.	12	2	1	0
Noomi Basra juice	Mean	6	0.5	1	0
	SD	3.27	0.5	0.707	0
	Min.	2	0	0	0
	Max.	11	1	2	0
Lemon juice	Mean	8	0	0.5	0
	SD	1.5	0.433	0.829	0
	Min.	5	0	0	0
	Max.	9	1	2	0

Orange juice	Mean	8.5	0	0.5	0
	SD	2.69	0.433	0.829	0
	Min.	3	0	0	0
	Max.	10	1	2	0

The presence of *Staphylococcus aureus* was also observed in most foods and drinks samples, and the highest value (3) cfu/ml, was recorded in the beef hamburger. This result is close to the results of international research (Iraqi Standard,2001 and APHA,2020). *Staphylococcus aureus* is found in meat, penetrates inside it, and is transmitted from the surrounding environment with all its elements to humans. This indicates the necessity of reducing contamination with such microbes, and these bacteria are considered one of the factors causing food poisoning in humans. The study did not detect any presence of Salmonella spp. in all the samples studied, and this result was consistent with what was indicated by the Iraqi and international standards (COSQC, 2010 and IFPA, 2013), which indicated that foods and water should be free of *Salmonella spp.*

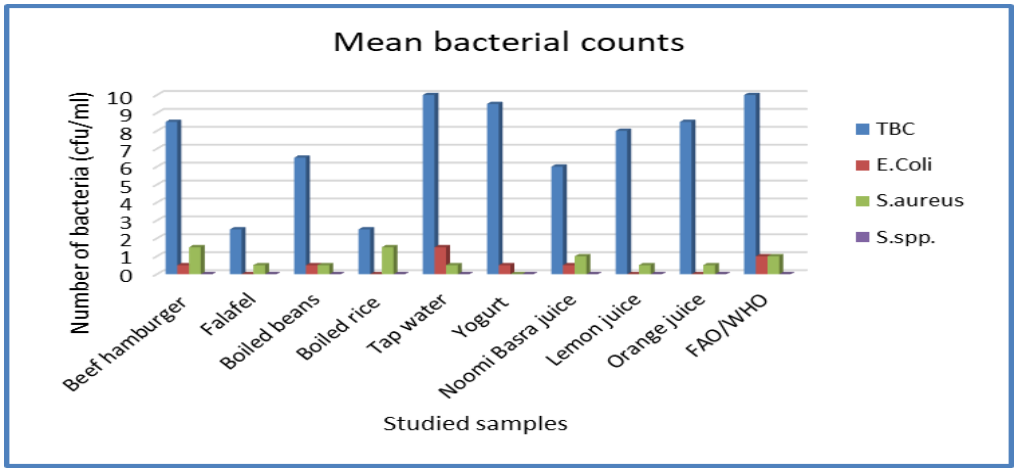

Figure 2. Mean bacterial counts in foods, drinks and water during study period.

Furthermore, this study showed that there is a significant difference in the number of bacteria between the studied areas Figure (3), the total bacteria count (TBC) was recorded to be the highest value (10) in Al Numaniyah city and the lowest value (6) was Al Hayy city, while the *Staphylococcus aureus* was recorded highest value (2) in Numaniyah city and lowest value (1) in Badara city. *Escherichia coli* was recorded highest value (2) in Kut city and the lowest value (1) in Al Hayy city. This difference in the number of bacteria between the studied sites is due to the movement of visitors within the Husseini processions, as processions that witness a large crowd of visitors may face an increase in pollution due to frequent touching and handling of surfaces, in addition to the fact that the Husseini processions that maintain good cleanliness of the places and apply public health standards are less susceptible to bacterial contamination.

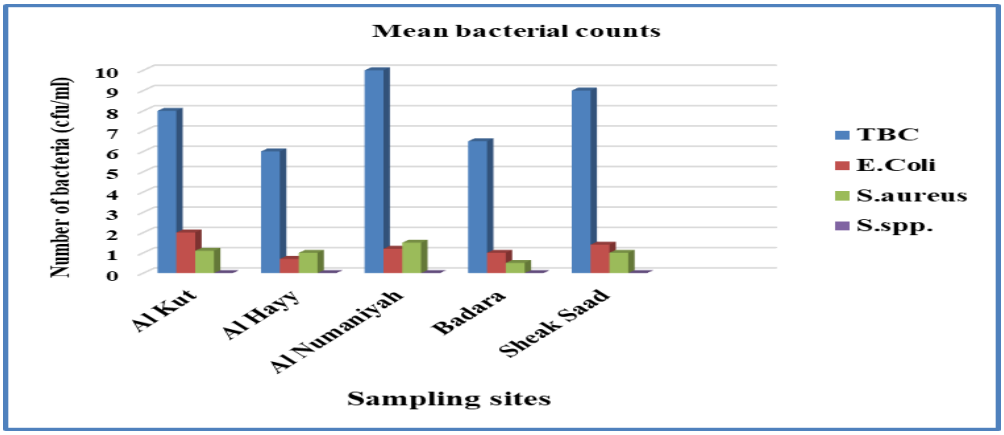

Figure 3. Regional detection of bacterial contaminations

Estimations heavy metals contaminations.

Many international and local studies have proven that there is significant contamination of foodstuffs with many heavy metals (Shadab and Afzal, 2021; Al-Mayah, 2022; Al-Mayah, 2025). The focus of this study was on the elements lead and cadmium due to their high contamination rates and their widespread use in many industrial and agricultural activities.

The results in Table (2) and Figure (4) showed that the concentration of lead and cadmium in some of the samples under study exceeded the Iraqi and international permitted limits (ICS,2011 and FAO/WHO, 2020), as their concentration in water was between (0.009-0.025) ppm and (0.0029-0.0047) ppm, and foods between (0.0851-0.479) ppm and (0.039-0.195) ppm, and in drinks (0.173-0.394) ppm and (0.073-0.217) ppm respectively.

Table 2. Descriptive statistics results of minerals contamination in food, drinks and water samples selected of Husseini Processions during study period.

Food and Drinks samples	Descriptive statistics	Lead ppm	Cadmium ppm
	Mean	0.258	0.1
	SD	0.142	0.057
	Min.	0.099	0.039
Beef hamburger	Max.	0.479	0.195
Falafel	Mean	0.2265	0.099
	SD	0.110	0.046
	Min.	0.105	0.048
	Max.	0.378	0.169
Boiled beans	Mean	0.2705	0.106
	SD	0.071	0.044
	Min.	0.179	0.073
	Max.	0.348	0.191
Boiled rice	Mean	0.2155	0.117
	SD	0.082	0.042
	Min.	0.0851	0.049
	Max.	0.301	0.158
Tap water	Mean	0.018	0.00395
	SD	0.006	0.001
	Min.	0.009	0.0029
	Max.	0.025	0.0047
Yogurt	Mean	0.29	0.121
	SD	0.086	0.049
	Min.	0.195	0.077
	Max.	0.394	0.198
Noomi Basra juice	Mean	0.274	0.103
	SD	0.100	0.047
	Min.	0.173	0.087
	Max.	0.425	0.204
Lemon juice	Mean	0.302	0.1295
	SD	0.091	0.056
	Min.	0.207	0.073

	Max.	0.413	0.209
Orange juice	Mean	0.331	0.1215
	SD	0.082	0.054
	Min.	0.221	0.081
	Max.	0.427	0.217

Lead recorded the highest concentration in beef hamburger (0.479) ppm and the lowest concentration in water (0.009) ppm, while cadmium recorded the highest concentration in orange juice (0.217) ppm and the lowest concentration in water (0.0029) ppm. The variation in the concentration of lead and cadmium within the study samples (food, drinks, and water) is due to different sources, as they can be transmitted from agricultural soil, polluted water, and polluted air, represented by harmful gases released by car exhausts, in addition to packaging materials and utensils used in preparation, which reach up to the food chain then.

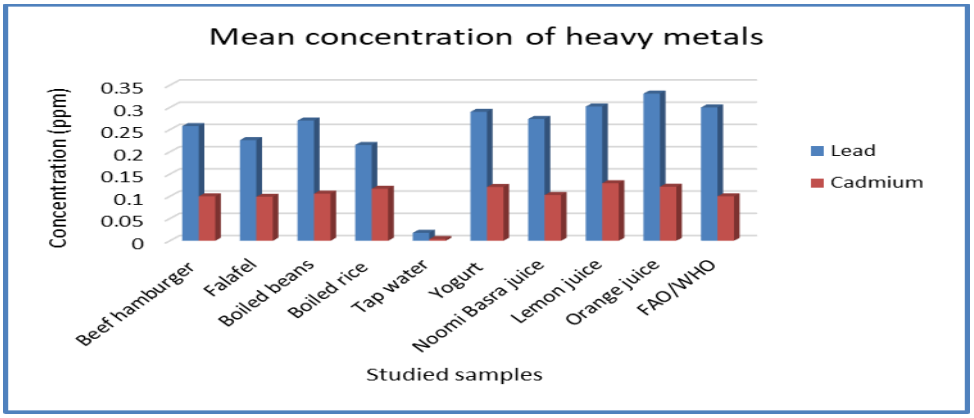

Figure 4. Mean concentration of heavy metals in foods, drinks and water during study period.

Figure (5) shows significant difference in heavy metal concentration between the studied areas, where lead recorded highest concentration (0.35) in Al Numaniyah city and lowest concentration (0.18) was observed in Badara city. The highest concentration of cadmium was observed in Husseini Processions at Al Kut, Numaniyah and Al Hayy, respectively, while lowest concentration Badara and Sheak Saad. These differences are attributed to proximity to pollution sources processions located near factories, stress, or industrial areas may be exposed to higher levels of heavy metal contamination, in addition to nearby agricultural activities, poor waste management and burning, and improper food storage methods.

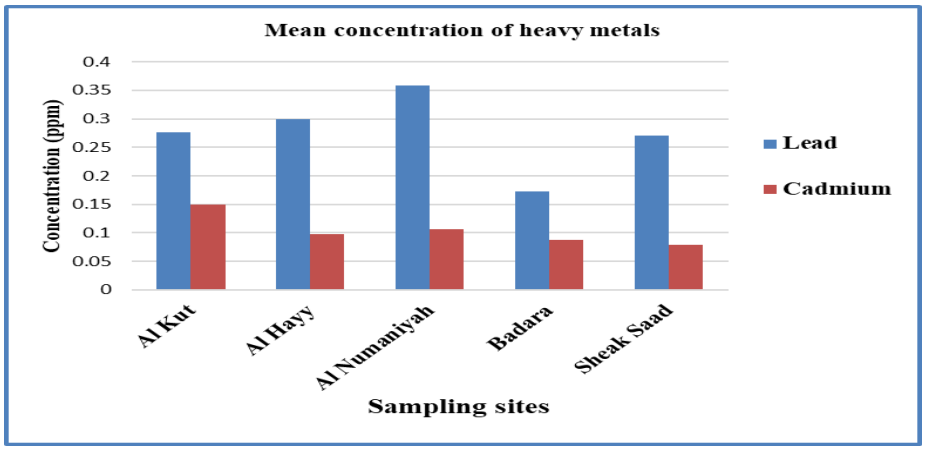

Figure 5. Regional detection of heavy metal contaminations

Conclusion and Recommendation

1. Although bacteria were detected in foods, drinks and water, its preparing methods practices in Hussein processions are effective, but making more effort is better to protect visitors.

2. The levels of heavy metals in some study sample slightly exceeded the permissible limits locally and internationally.

3. The microbial and mineral quality of foods and drinks and water was satisfactory in most of the samples.

4. This study was provided useful information about the microbial and mineral quality of common foods and drinks that prepared in some Husseini Processions in Wasit Province.

5. Tightening health control over all owners of Husseini Processions that preparing and equipping food and obligating them to fully implement the health conditions that must be available in the places of preparation, preparation and presentation.

6. The Iraqi authorities must establish health and preventive guidelines that provide for the safety of visitors and protect them from diseases transmitted through water and food, and cases of food poisoning.

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