

Original Article

Microbial Load of Chicken Shawerma and the Handlers' Compliance with Food Safety Practices in Jordan

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Abstract

Background: *Shawerma* is a popular traditional food in the Eastern Mediterranean region.

Aim: The aim of this study was to assess the *shawerma* handlers' compliance with food safety practices and determine the microbial load and pathogenic organisms in the ready-to-eat chicken *shawerma* sandwiches in the restaurants of Amman, Jordan.

Methods: This cross-sectional study used mixed methods including observational checklists to determine the compliance of food safety practices by 120 chicken *shawerma* handlers from 40 randomly selected restaurants in Amman. Additionally, pathogenic microorganisms were assessed by laboratory analysis in the ready-to-eat chicken *shawerma* sandwiches.

Results: Only 2.5% and 10% complied, respectively, with separating knives and boards used for chicken from the ones used for vegetables. The compliance for maintaining proper temperatures for freezers and chillers were only 62% and 67%, respectively. As for hand-washing techniques and using disposable drying papers, the adherence was 5% and 7.5%, respectively. Laboratory analysis showed that 27.5% of the ready-to-eat *shawerma* had unacceptable levels of microorganisms.

Conclusion: Our findings showed poor compliance of food safety practices in chicken *shawerma* restaurants of Amman. There is a need for capacity building and periodic evaluations of food handlers' knowledge and practices within a comprehensive food safety program, carried out by qualified trainers.

Keywords: chicken *shawerma*, food safety, Jordan

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1. Introduction

The World Health Organization (WHO) describes food-borne illnesses as an illness that is usually infectious or toxic in nature and caused by bacteria, viruses, parasites or chemical substances entering the body through contaminated food or water [1]. Consuming safe and suitable food is a basic human right [2]. However, statistics published by the WHO express that this right is not warranted in many countries; it was estimated that worldwide, 2.2 million people die of food-borne diarrheal diseases, including 1.9 million children [1]. Furthermore, according to the Center for Disease Control (CDC), it is estimated that each year in the United States of America (USA), 48,000,000 Americans get sick, 128,000 are hospitalized and 3000 die due to food-borne diseases [3].

The Eastern Mediterranean region, including Jordan, enjoys a wide variety of traditional foods. Over the years, *shawerma* has become one of the most common and popular traditional dishes among all ages in the Jordanian society. Chicken *shawerma* is prepared by marinating sliced chicken with many ingredients overnight in a refrigerator. The chicken may be mixed with lemon juice, minced garlic, hot pepper sauce, vinegar, salt, tomato paste, cardamom, minced onion, spices and black pepper. The marinated chicken slices are then assembled around a large skewer and roasted slowly as the skewer rotates in front of or over a flame for hours. The cooked chicken is sliced and dropped on to a tray, to be retrieved then wrapped in bread. A variety of vegetables can be found in shawerma sandwiches, such as cucumbers, lettuce, fresh tomatoes and onions. Sauces and mayonnaise can also be served, according to the customers' demands [4].

Food safety is an increasingly important public health issue due to rising number of food safety problems coupled with recurring consumer concerns [1]. Food-borne diseases can occur at any stage in the long process of food preparation, from purchasing food products from unsafe sources to improper storage of food ingredients, preparation, processing, cooking, packaging and poor personal hygiene of food handlers [5–8].

The WHO manual for traditional foods in the Eastern Mediterranean region displayed the main critical control points (CCP) and their risk assessments in *shawerma* as follows: the thawing process, marinating, grilling, as well as the water and salt quality [9]. Food-borne diseases can create an enormous burden on the economy; they increase consumer costs, which include medical, legal and other expenses, as well as absenteeism from work and school. For many consumers who live at a subsistence level, the loss of income due to food-borne illness can perpetuate the cycle of poverty [10].

Since *shawerma* is a popular meal in the region, this study was conducted to assess the *shawerma* handlers' compliance with food safety practices, determine the microbial

load and pathogenic organisms in chicken *shawerma* sandwiches prepared in the restaurants of Amman, and compare the results we obtained with the regulations for microbial limits of ready-to-eat food set by the Jordan Food and Drug Administration [11–13].

2. Methods

2.1. Setting

Jordan has 12 governorates, and Amman, the capital of Jordan, is the largest governorate in terms of the number of inhabitants. There are 22 districts in Amman that have an estimated 3070 restaurants [14]. Of these, nearly 400 are specialized in chicken and meat *shawerma*.

2.2. Study design

This cross-sectional study was conducted in Amman, Jordan using a mixed-methods approach; the method included observational checklists to determine the compliance of food handlers with the JFDA food safety practices while preparing chicken *shawerma* sandwiches. In addition, we assessed the microbiological safety of the ready-to-eat restaurant-prepared chicken *shawerma* sandwiches through laboratory microbial analysis to determine the pathogenic microorganisms' and microbial load.

Our target population was chicken *shawerma* handlers at the restaurants in Amman governorate that are specialized in chicken and meat *shawerma*. In total, 40 restaurants were selected depending on their geographical location. This was done by applying geographical stratification for the 400 restaurants, and a simple random sample of 40 restaurants was then selected from each geographical area. Next, a sample of 120 food handlers was randomly selected from the shortlisted 40 restaurants (three from each restaurant). Finally, 40 samples of ready-to-eat chicken *shawerma* sandwiches (one from each restaurant) were taken for laboratory analysis in order to generate prevalence estimates.

2.3. Study instruments

The study instruments were observational checklists and laboratory analysis. The observation checklists were thoroughly investigated and examined for appropriateness by local professors from renowned universities. Furthermore, Cronbach alpha coefficient

was used for the reliability of the food safety observational checklists. The observational checklist used “comply/did not comply” to note the actual food safety practices of chicken *shawerma* food handlers. The laboratory assessment included collection of *shawerma* samples from these restaurants to assess their immediate microbial quality in JFDA laboratories.

2.4. Data collection

Informed consent was obtained from all participants and their confidentiality and autonomy were ensured. They were also informed about the purpose of the study, the voluntary nature of their participation, and their right to access findings. Before proceeding with the field work, the ethical approval was issued by the University of Jordan Research Ethics Committee and the JFDA.

Data collection was split into a field survey and laboratory assessment of the microbial status of the ready-to-eat *shawerma* samples collected from the selected restaurants. The first phase of data collection was filling structured observational checklists by the first author after the approval of the owners of the restaurants. Additionally, 40 ready-to-eat chicken *shawerma* sandwiches were redeemed from our study sample and instantly delivered in an ice box under ultimate hygienic condition to the JFDA Laboratories. Upon the arrival of the samples, they were subjected to the microbial testing. They were tested for *Salmonella species*, *Staphylococcus aureus*, *Listeria monocytogenes*, *Escherichia coli* and *Campylobacter jejuni*. The latter mentioned organisms were tested using approved conventional methods by the International Organization for Standardization (ISO), except for *C. jejuni* which was tested using the polymerase chain reaction (PCR) technique. Based on the estimates of Osaili *et al.* [15], the anticipated prevalence of *Salmonella spp* in chicken *shawerma* sandwiches in Jordan is 1% and the prevalence of *L. monocytogenes* is 4%. However, the prevalence of *Campylobacter spp*, *S. aureus* and *E. coli* in chicken *shawerma* sandwiches could not be estimated due to the lack of studies. Thereafter, the identified microorganisms were compared to the standard values of microbiological counts.

2.5. Statistical analysis

The collected data were analyzed using the Statistical Package for Social Sciences (SPSS) v.20.0. In addition, independent *t*-tests, one-way analysis of variance (ANOVA) and Pearson’s correlation test were used to measure the association between variables

and descriptive statistics (means, frequencies and standard deviations). P -value < 0.05 was considered as statistically significant.

3. Results

3.1. Study participants

The majority of our participants were in the age group 30–39 years; 53% of them were Egyptian, 26% Jordanian and 19% Syrian. While most of them (56%) had an experience of one to three years in their current job, 11% had a longer experience of up to seven years and more. The majority of the respondents had a diploma, and 90% of them had not received training on food safety. Table 1 shows the sociodemographic characteristics of the respondents.

3.2. Analysis of observational checklist

Table 2 shows that the majority of the restaurants complied with the restaurant's external ambience cleanliness. Outside waste container was available in 57.5% of the cases. Almost 62.5% did not adhere to the availability of a front glass face that isolates the restaurant from the outside. The analysis of compliance level of restaurants practice in the direct sales area showed that 97.5% of the restaurants did not have any expired food, 57.5% had no uncovered foods and 92.5% used a high mayonnaise quality. Packing material, benches and floors, and sandwich preparation area were clean in 67.5%, 37.5% and 45% of the restaurants, respectively. Moreover, only 20% showed good refrigerator display cleanness. More to that, only 15% had proper packing material covers. However, the highest incompliance of 97.5% was noted for the suitability of sharpening places for knives. The second highest incompliance of 92.5% was seen in the method of knife cleaning after each sharpening process.

Table 3 shows the worst practices in *shawerma* preparation area with very little compliance observed in separating knives used for chicken from the ones used for vegetables as only 2.5% complied to it, and only 10% complied with separating the cutting boards used for chicken from the ones used for vegetables.

Moreover, the compliance in maintaining proper temperature for freezers and chillers were 62% and 67%, respectively.

Among the surveyed restaurants, 50% compliance and 50% noncompliance were seen regarding the isolation of raw food from other foods. While not exceeding the above-limit storage compliance was 70%, covering food properly was 42.5% and no

TABLE 1: Frequency and percentage of sociodemographic and personal characteristics of the respondents

Characteristics	Frequency	Percentage
Educational level		
Read and write	3	2.6
Elementary	3	2.6
Preparatory	19	16.2
Secondary	30	25.6
Diploma	50	42.7
Bachelor	12	10.3
Total	117	100
Age (yr)		
<30	39	33.3
30–39	57	48.7
≥40	21	17.9
Total	117	100
Nationality		
Jordanian	30	25.6
Egyptian	62	53
Syrian	22	18.8
Other	3	2.6
Total	117	100
Experience in current job (yr)		
1–3	65	55.6
4–6	39	33.3
≥7	13	11.1
Total	117	100
Scope of past experience		
In <i>shawerma</i> restaurants	44	37.6
In restaurants in general	51	43.5
Other	22	18.8
Total	117	100
Years of past experience in food handling		
≤5	69	59
6–10	38	32.5
≥11	10	8.5
Total	117	100
Training in food safety		
Has training	12	10.3
No training	105	89.7
Total	117	100

TABLE 2: Frequency and percentage of compliance of food handler's practices and restaurants in direct sales area

Items	Comply		Did not comply	
	Frequency	Percentage	Frequency	Percentage
Suitability of fire grill	13	32.5	27	67.5
Availability of grease filter on the skewer	33	82.5	7	17.5
Ventilation efficiency	30	75	10	25
Proper packing material covers	6	15	34	85
Cleanness of packing material	8	20	32	80
Nonavailability of uncovered foods	23	57.5	17	42.5
Absence of expired food	39	97.5	1	2.5
Availability of sufficient insect killers that are effective	17	42.5	23	57.5
Proper insect killer distribution location	8	20	32	80
Bench and floor cleanness	27	67.5	13	32.5
Cleanness of walls	33	82.5	7	17.5
Refrigerator display cleanness	18	45	22	55
Cleanness of sandwich preparation area	15	37.5	25	62.5
Suitability of knife-sharpening place	1	2.5	39	97.5
Method of knife cleaning after sharpening	3	7.5	37	92.5
Suitability of temperature-measuring method for <i>shawerma</i> skewer on the grill	3	7.5	37	92.5
Suitability of knowing that <i>shawerma</i> is well-done	3	7.5	37	92.5
Discarding burned <i>shawerma</i> pieces	17	42.5	23	57.5
Mayonnaise quality used in sandwiches	37	92.5	3	7.5
Mode of receiving money and tips	11	27.5	29	72.5
Place of keeping presliced <i>shawerma</i>	4	10	36	90
Using <i>shawerma</i> prepared a day before	36	90	4	10
Mean %		44%		56%

chemical materials storing with food was 75%. The compliance to the absence of expired food was the highest being approximately 88%.

In terms of general appearance and personal hygiene, most workers did not follow the regulations of proper general appearance and personal hygiene as >82.5% did not

TABLE 3: Frequency and percentage of compliance of food handler's practices in restaurants preparation area.

		Comply		Did not comply	
		Frequency	Percentage	Frequency	Percentage
1.	Suitability of temperature during the preparation of chicken <i>shawerma</i>	10	25	30	75
2.	Suitability of chicken <i>shawerma</i> temperature during preparation	12	30	28	70
3.	Availability of thermometers inside preparation area	8	20	32	80
4.	Availability of thermometer inside refrigerators	16	40	24	60
5.	Method of distinguishing knives	1	2.5	39	97.5
6.	Method of distinguishing cutting boards	4	10	36	90
7.	Isolation of <i>shawerma</i> preparation tables from those used for the preparation of other food items	19	47.5	21	52.5
8.	Salad preparation place isolated from <i>shawerma</i> preparation place	30	75	10	25
9.	Availability of insect killers that work properly and sufficiently, and are distributed properly	8	20	32	80
10.	Cleanness of surfaces and floors	19	47.5	21	52.5
11.	Refrigerator cleanliness	17	42.5	23	57.5
12.	Ventilation of preparation area	21	52.5	19	47.5
13.	Suitability of temperature for chilling storage	27	67.5	13	32.5
14.	Suitability of temperature for freezing storage	25	62.5	15	37.5
15.	Procedure of thawing frozen chicken	17	42.5	23	57.5
16.	Suitability of tools used for marinating and <i>shawerma</i> spicing	30	75	10	25
17.	Covering dishes inside the refrigerators	12	30	28	70
18.	Suitability of weight and diameters of <i>shawerma</i> skewer	23	57.5	17	42.5
19.	Suitability of the place for storing and filtration area of the <i>shawerma</i> skewer	17	42.5	23	57.5
20.	Good storage condition compliance inside refrigerators	12	30	28	70

TABLE 4: Frequency and percentage of food handlers' general appearance and personal hygiene

Item	Comply		Did not comply	
	Frequency	Percentage	Frequency	Percentage
Workers wear gloves during preparation	5	12.5	35	87.5
Workers use spoons for dealing with ready food	6	15	34	85
Wearing proper hair cover	7	17.5	33	82.5
Beard shaving	17	42.5	23	57.5
Wearing a suitable uniform	29	72.5	11	27.5
Wearing clean working uniform	9	22.5	31	77.5
Proper shoes for working	5	12.5	35	87.5
Nails were clipped and clean	4	10	36	90
Hand-washing method	2	5	38	95
Hand-washing duration	3	7.5	37	92.5
Hand-drying method after washing	3	7.5	37	92.5
Workers' bad practices during preparation (i.e., smoking)	22	55	18	45
Removing rings and jewelry while preparing food	4	10	36	90
Presence of hand wounds	25	62.5	15	37.5

comply, despite the fact that 72.5% were wearing suitable uniforms as presented in Table 4.

Table 5 shows that the food handlers' practices regarding restaurants' sanitary facilities were in accordance with the JFDA regulations on keeping sanitary facilities properly isolated from food preparation places and dish-washing areas (95%). However, when it comes to proper hand-washing techniques, whether it is the use of sterilizing material or disposable drying papers, the adherence was noted to be low since only 5% followed those techniques.

Although the compliance to practices regarding pest control should be very high, yet 80% of the restaurants failed to keep the inside of their restaurants free from flies; however, 77.5% of them managed to keep it free of cockroaches and/or rodents.

3.3. Statistical analysis of the laboratory results

Microbial laboratory analysis of the collected *shawerma* chicken sandwiches was done in order to ascertain the eligibility of the sandwiches compared with the microbial limits of ready-to-eat food set by JFDA. As can be observed in Table 6, a total of 40 samples were analyzed and a total of 11 samples corresponding to 27.5% were found to have unacceptable levels of microorganisms.

TABLE 5: Frequency and percentage of food handlers' practices regarding restaurants' sanitary facilities

Item	Comply		Did not comply	
	Frequency	Percentage	Frequency	Percentage
Sanitary facilities are isolated properly from food-preparation and dish-washing areas	38	95	2	5
Hand-washing sinks are clean	38	95	2	5
Use of warm water for hand washing	6	15	34	85
Use of liquid soap for hand washing	17	42.5	23	57.5
Use of proper sterilizing material in hand-washing sinks	2	5	38	95
Use of disposable drying papers on hand-washing sinks	2	5	38	95
Good ventilation that works properly	13	32.5	27	67.5

4. Discussion

Several studies have reported that chicken *shawerma* sandwiches are responsible for most outbreaks of food-borne diseases [8, 17]. In Jordan, most outbreaks of food poisoning have been attributed to the *Salmonella* spp. isolated from chicken *shawerma* sandwiches [16], consumed on a large scale by all classes of society [11, 15].

In this study, we aimed to determine the microbial load in chicken *shawerma* samples collected from restaurants in Jordan. The microbial analysis revealed that 11 out of 40 (27.5%) samples had unacceptable levels of food-contaminating microorganisms according to the JFDA microbial limit for pre-prepared food. *Escherichia coli* was most commonly found: it was isolated from four samples (10%), *Salmonella* species were isolated from four samples (10%) and *S. aureus* was isolated from three (7.5%). *Listeria monocytogenes* and *C. jejuni* were not found in any of the samples. Our results were inconsistent with those obtained in a study conducted by Osaili *et al.* also in Jordan; they isolated *Salmonella serovars* from 3 out of 301 chicken *shawerma* samples (1%), while *L. monocytogenes* was isolated from 12 out of 301 samples (4%). No *E. coli* O157:H7 was isolated [15].

In Canada, many food-borne outbreaks have been recorded due to the consumption of chicken *shawerma*. For example, in Windsor (2005), 18 cases of *Salmonella* were attributed to chicken *shawerma*, as were two cases of *Campylobacter* in Edmonton (2007) [17]. Another study conducted in Saudi Arabia investigated the presence of pathogenic bacteria, fungi and yeasts in fast foods [18]. They isolated *C. jejuni*, *E. coli*, *L. monocytogenes*, and *Salmonella* from chicken *shawerma* samples. They concluded

TABLE 6: Laboratory result of ready-to-eat chicken *shawerma* sandwiches

I.D. No.	Laboratory results					Final result
	S. aureus	E. coli	Salmonell	L. monocytogenes	Campylobacter spp.	
1	<10	<10	Abs	Abs	Abs	Pass
2	1.5×10^3 CFU	<10	Abs	Abs	Abs	Unaccepted
3	<10	<10	Abs	Abs	Abs	Pass
4	<10	<10	Pre	Abs	Abs	Unaccepted
5	<10	<10	Abs	Abs	Abs	Pass
6	<10	<10	Abs	Abs	Abs	Pass
7	<10	<10	Abs	Abs	Abs	Pass
8	<10	<10	Abs	Abs	Abs	Pass
9	<10	<10	Abs	Abs	Abs	Pass
10	<10	<10	Abs	Abs	Abs	Pass
11	<10	<10	Abs	Abs	Abs	Pass
12	<10	<10	Abs	Abs	Abs	Pass
13	<10	<10	Pre	Abs	Abs	Unaccepted
14	<10	<10	Abs	Abs	Abs	Pass
15	<10	<10	Abs	Abs	Abs	Pass
16	<10	<10	Abs	Abs	Abs	Pass
17	<10	<10	Abs	Abs	Abs	Pass
18	<10	1.6×10^2 CFU	Abs	Abs	Abs	Unaccepted
19	<10	1.8×10^2 CFU	Abs	Abs	Abs	Unaccepted
20	1.0×10^2 CFU	<10	Abs	Abs	Abs	Pass
21	<10	<10	Abs	Abs	Abs	Pass
22	<10	<10	Abs	Abs	Abs	Pass
23	<10	<10	Abs	Abs	Abs	Pass
24	<10	<10	Abs	Abs	Abs	Pass
25	1.5×10^2 CFU	<10	Abs	Abs	Abs	Pass
26	<10	<10	Abs	Abs	Abs	Pass
27	<10	<10	Abs	Abs	Abs	Pass
28	2.0×10^3 CFU	<10	Abs	Abs	Abs	Unaccepted
29	<10	<10	Abs	Abs	Abs	pass
30	<10	<10	Abs	Abs	Abs	Pass
31	<10	<10	Abs	Abs	Abs	Pass
32	<10	<10	Pre	Abs	Abs	Unaccepted
33	<10	80 CFU	Abs	Abs	Abs	Pass
34	<10	<10	Abs	Abs	Abs	Pass
35	<10	1.2×10^2 CFU	Abs	Abs	Abs	Unaccepted
36	1.3×10^3 CFU	<10	Abs	Abs	Abs	Unaccepted
37	1.9×10^3 CFU	<10	Abs	Abs	Abs	Unaccepted
38	<10	<10	Abs	Abs	Abs	Pass
39	<10	<10	Abs	Abs	Abs	Pass
40	<10	1.4×10^2 CFU	Pre	Abs	Abs	Unaccepted

CFU: colony forming units; Pre: present; Abs: absent

that poor hygienic practices, improper handling and bad storage of food in unclean environment and at unsafe refrigeration temperature are the main source of these pathogens.

As mentioned previously, there are many CCP during the preparation of food that may introduce food contamination. A study was conducted in Giza, Egypt which aimed to estimate the quantity of heavy metals in 25 chicken *shawerma* samples from different restaurants [19]. High levels of heavy metals were detected, and this is attributed to the method of chicken *shawerma* marination, which takes several hours prior to cooking in unsafe containers, leading to migration of dangerous heavy metals to the chicken meat. Also, the location of the *shawerma* skewer near the entrance of the restaurant leads to its exposure to different pollutants from gasoline motors, dust, and other air pollutants.

It is indisputable that the practices of food handlers play a major role as indicated by the WHO 2008 manual [4]. However, only a few studies have been conducted in Jordan to estimate food handlers' knowledge and practices regarding safe food preparation. A study by Osaili *et al.* in 2013 revealed that food handlers had "fair" overall knowledge about food safety concepts and "poor" knowledge regarding food-borne pathogens and safe storage, thawing, cooking and reheating of the foods [15]. However, they displayed "good" knowledge about personal hygiene and symptoms of food-borne illnesses.

Food workers in restaurants are considered to be one of the most common factors that contribute to the occurrence of food-borne disease, through contaminating food by poor personal hygiene, cross-contaminating raw and processed food, and inadequately cooking and improperly storing foods [5, 6, 20]. Research on food-borne illnesses risk has indicated that most outbreaks in food service establishments can be attributed to food handlers due to improper food preparation practices. Moreover, Green *et al.* and McIntyre *et al.* revealed that the root causes of food poisoning outbreaks are poor food-handling practices such as cross-contamination of raw and cooked products, slow cooling and inadequate refrigeration of foods, as well as poor worker hygiene when handling ready-to-eat food [7, 21].

In Jordan, during the period from September 2006 to August 2007, about 2000 consumers were hospitalized due to consumption of chicken *shawerma* [22]. The epidemiological investigations carried out by JFDA during these outbreaks revealed that the source of the outbreaks was the mayonnaise prepared within the restaurants under unsanitary conditions, further indicating the major role played by food handlers in food-borne outbreaks [4]. In the aftermath of the outbreak, the JFDA set a new regulation of code of practices regarding handling *shawerma* [11], and in the same year, food safety training program were instituted and food handlers were compelled

to receive training, especially those preparing *shawerma*. However, this program was unfortunately terminated with no justifiable reason.

In 2010, through a comprehensive report of assessing food safety in Jordan, the WHO indicated that poor knowledge in food-handling practices as well as constraints to food safety (that include limited human resources, inadequate consumer awareness, overlapping of responsibilities across the food chain, lack of regulation of street foods and food handlers, lack of multidisciplinary inspection teams and limited laboratory services) were considered to be a great concern in health implications [1]. It is reasonable to assume that this poor knowledge and practice are due to the termination of training programs in food safety concepts, and this is supported by the study of Osaili *et al.* [15]. It is also safe to assume that poor knowledge regarding proper food handling and preparation plays a major role in the lack of compliance displayed by the food workers. For example, there was a high rate of noncompliance when it came to proper distribution of insect killers, method of knife cleaning after sharpening, suitability of temperature-measuring method for the *shawerma* skewer and several other practices. The knowledge of the proper way to perform the aforementioned activities can be acquired only through didactic workshops. On the other hand, there was a higher rate of compliance in other more intuitive practices, such as absence of expired food, wall cleanness and use of high-quality mayonnaise.

5. Limitations

This study has several limitations including the relatively small sample size, a larger sample size would have generated more accurate results, however, due to time and money constraints this was not feasible. Additionally, due to limited budget, we could not validate the *shawerma* sandwiches samples by taking more than one sample from each restaurant. To minimize bias, we used comply/did not comply design in the observational checklists. An independent researcher who is not involved in the observational studies was used to deliver the food samples and to hand them for microbial testing. By that, bias of knowledge gained about the level of compliance of food safety and hygiene in different restaurants was avoided.

6. Conclusion

This study aimed to assess food *shawerma* handlers' compliance with food safety practices and identify pathogenic bacterial strains found in chicken *shawerma* sandwiches. The results showed poor compliance of *shawerma* handlers and the pathogenic load

was unsatisfactory compared to the JFDA guidelines, which reflects poor food-handling practices and substandard vigilance and regulation by stakeholders.

Our findings help us predict that if such high levels of food-borne pathogens persist, future food-poisoning outbreaks might ensue. Therefore, we propose that the Ministry of Labor in Jordan reconsider the instructions and regulations related to food handlers. For example, the workers must receive training in food safety before they start working in restaurants. Furthermore, the JFDA should reactivate the training program which was provided for *shawerma* food handlers. Additionally, the JFDA should conduct periodic evaluations of food handlers' knowledge and practices in a comprehensive food safety program, carried out by qualified trainers.

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