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Bacterial contamination of fast food shawarma sandwiches in local restaurants in Benghazi city, Libya

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Highlights

- **Chicked shawarma sandwiches that sailed in Benghazi city restaurants are contaminated with pathogenic bacteria within the unsatisfactory microbiological quality levels.**
- **The pathogens isolated from chicken shawarma sandwiches are relatively resistant to the commonly used antibiotics.**

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ABSTRACT

Sandwiches are widely consumed as part of the international food culture, therefore, the investigation of microbiological quality and hygienists are essential steps for risk factor determination of food-borne illnesses. This study investigated the bacterial contamination in 151 chicken shawarma sandwiches randomly selected from 19 restaurants located in four different regions in the city of Benghazi, including North, South, East, and the City center. The results showed that 89.4% of chicken shawarma sandwiches samples were contaminated with bacteria. The bacterial diversity showed that *Klebsiella pneumoniae* was the predominant bacterial species isolated from the sandwiches (24.5%), thus, it has been suggested to represent the highest source of bacterial contamination in the screened samples. The latter bacteria was followed by *Escherichia coli* (19.9%), *Citrobacter freundii* (18.8%), *Bacillus sp.* (9.9%), *Proteus mirabilis*(8.6%), *Enterobactercloacae* (7.9%), *Pseudomonas aeruginosa* (6%), *Enterobacter aeruginosa* (4%) and *Staphylococcus aureus* (0.7%).Quantification of the bacterial contamination using total plate count has revealed that *Bacillus sp* 1.9×10^5 cfu/g, *E. cloacae*1.8×10^5cfu/g, *C. freundii* 1.4×10^5 cfu/g, *K.* 7.3×10^4 cfu/g, *E. coli* 4.5×10^4 cfu/g and *E. aerogenes* 4.2×10^3 cfu/g. The bacterial sensitivity to the antibiotics showed that all tested pathogens were mostly resistant to Cloxacillin, Amoxicillin, Metronidazole and Cephalothin (86.7% to 100% of resistant). Only *P. aeruginosa*, *Enterobacter sp.,* and *P. mirabilis* showed complete resistanceto Cefoxitin. *Bacillus sp.* was mostly resistant to the tested antibiotics compare to *S. aureus*. The results of this study demonstrated that the bacterial contamination in the tested sandwiches were relatively high and were produced under low hygienic conditions. This was supported by the finding that the increased bacterial count in the sandwiches and the high resistant level to antibiotic have indicated a high risk factor for acquiring food-borne illnesses.

1. Introduction

Food is a chemically complex matrix, which contains plenty of nutrients sufficient to support microbial growth (ICMSF, 1996 and Jarallah, 2014). Fast food is the term given to food that can be prepared and served very quickly. In other words, it is typically referering to food sold in restaurants or a store with low quality preparation and served to the customer in a packed form for take-out/takeaway (Ibrahim *et al.,* 2014). In general, harmful bacteria are the most common causes of food-borne illnesses, in a viewpoint of that, many bacteria may be present on fast food including meat when purchased (non-sterile food) leading to contaminate meat and poultry during slaughter or in butchery stores (Hassan, 2006; Mohamed 2010), therefore, food contamination with pathogens take place at any steps during food processing, preparation, storage, handling, distribution, and retail marketing. Thus the infection can occur by any of the following pathogens including *Citrobacter freundii*, *Enterobacter aerogenes, Enterobactercloacae*, *Klebsiella , Klebsiella ozaenae, Proteus mirabilis* (Ibrahim *et al*., 2014), as well as *Bacillus spp* such as *Clostridium perfringens*, *Escherichia coli, Pseudomonas aeruginosa, Staphylococcus aureus* and *Compylobacter jejuni* (Easa *et al*., 2010). The sandwiches ingredients and fillings like bread, chicken, salad, and sauce have been related to food-borne illness outbreaks (Jang *et al*., 2013). The ability of bacteria to grow or multiply in food is determined by the food environment in which food is stored which considered as the intrinsic and extrinsic environment of foods (Ray, 2005). In more detail, the extrinsic environment includes the temperature of storage, humidity of the environment, presence, and concentration of gases in the environment (Jay *et al*., 2005); while the intrinsic environment including PH, moisture content, nutrient content, antimicrobial constituents (Jay, 2000).

Food poisoning caused by bacterial toxins in contaminated food in general and fast food, in particular, has been considered as an important risk factor in immunocompromised individuals. For instance, some strains of *S. aureus* have been reported to contaminate fast food. They release antioxidant carotenoid pigments called staphyloxanthin, which allow the pathogen to escape killing by the innate immunity via the oxidative burst (oxygen-dependent killing

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pathway), (Clouditz *et al*., 2006). In addition, infection with *Yersinia pestis* can be less frequently caused by the consumption of meat and vegetables contaminated with rodent urine. This bacteria is the etiological agent for plaque, besides its association with autoimmunity in the gut (Ryan and Ray, 2004; Easa, 2010). This study was conducted to investigate the level of bacterial contamination in chicken shawarma sandwiches in four different areas in Benghazi/Libya as such contamination would represent a series threat to individuals in the investigated regions and a considerable public health issue in general.

2. Materials and methods

2.1 Samples collection

The experimental samples were collected randomly from 19 local restaurants from different areas in Benghazi city during the period of time from 1st of April 2017 to the 30th of July 2017. Sandwiches were collected designated as prepared ready to serve. As soon as the samples were received from (Cold or worm), they were placed into sterile bags and transferred to the laboratory for microbiological investigations within less than one hour from the collection.

2.2 Bacterial growth conditions

In order to investigate the bacterial typing, initial microbial enrichment for all samples was carried out. The sandwiches were placed into sterile plastic bags and were smashed to make homogenized mixture content. One gram from the mixture of each sample was inoculated into 10 ml of sterile lactose broth and sterile selenite broth, and the samples were mixed thoroughly and then incubated aerobically at 37°C for 24 hours. The next day, 10 µl of from all overnight cultures were subcultured on selective and non-selective agar plates using the streak plate method and incubated aerobically at 37°C for overnight. The mixed cultures were processed for further microbial culture purification.

2.3 Bacterial Identification

From the pure fresh overnight cultures, the identification of bacterial contamination in the sandwiches samples was initiated according to morphological characterization culture growth and Gram stain technique. In order to determine the bacterial biochemical characteristics, all relevant Gram-positive and Gram-negative bacteria were cultivated on several types of culture media including Triple sugar iron agar, MacConkey agar, Simmons citrate agar, Salmonella Shigella agar, Eosin methylene blue agar, and Blood agar. In addition, enzymatic chemical reactions including oxidase test, catalase test, and coagulase test were used to promote the identification. The identification of the isolated pathogens was confirmed using a BD Phoenix Automated Microbiology System (Phoenix 100).

2.4 Colony-forming unit count per gram

The determination of the level of sandwiches contamination was achieved by using the most probable number method (MPN) per gram. In a sterile test tube, one gram from each smashed sandwich sample was introduced into 9 ml of sterile normal saline and mixed thoroughly. Spread plates of one ml of serial 10-time fold diluted samples were carried out, and then the plates were aerobically incubated at 37°C for overnight. Colonies were enumerated and contamination was assessed as CFU/g.

2.5 Evaluation of the sensitivity of shawarma sandwiches isolated pathogen to the antibiotics

The identified bacterial isolates were tested for antibiotic sensitivity using the Kirby-Bauer test. Bacterial suspensions obtained from each pure overnight culture were prepared using normal saline and the bacterial cell count on the plate was adjusted according to 0.5 McFarland compared to a reference. The bacterial suspensions were spread on Mueller-Hinton agar plates using sterile cotton swabs. Several types of antibiotics including Ciprofloxacin (5 mg), Azithromycin (15 mg), Oxacillin (5 mg), Ceftriaxone (30 mg), Metronidazole (5 mg), Cephalothin (30 mg), Cloxacillin (5 mg), Amoxicillin (10 mg), Cefoxitin (30 mg), Tetracycline (10 mg), Erythromycin (15 mg) and Sulfamethoxazole (25 mg) were placed onto the plates and then incubated aerobically overnight at 37°C. The next day, the inhibition zones were determined in millimeters based on zone size interpretative and compared to zone size interpretative chart of Himedia Laboratories Pvt. Limited catalogue 2013 – 2014.

3. Results

3.1 Diversity of bacterial contamination in chicken shawarma sandwiches

Our study was undertaken to identify food-borne contamination in pre-prepared chicken shawarma sandwiches in Benghazi, Libya. We collected 151 sandwiches from 19 restaurants distributed across the city. The areas covered by this survey were the North, South, and East of the city along with the City center. Each area was sampled four or five times, with six to eight sandwiches collected from each restaurant. The results have presented that 134 (89.7%) samples from 12 restaurants had positive bacterial growth in their sandwiches, whereas 16 (10.3%) samples from seven restaurants had negative bacterial growth, these seven restaurants are located in different areas of the city. It was observed in some samples that more than one bacteria was a major contaminant. Overall, 151 bacterial isolates were collected and tested. The diversity of bacterial contamination in our samples is listed in Table (1).

3.2 Distribution of bacteria that contaminate chicken shawarma sandwiches isolated from different restaurants

The bacterial isolated in this study included 37 *Klebsiella pneumoniae* isolates(24.5 %), 30 *Escherichia coli* isolates (19.9 %) and 28 mixed *Citrobacter sp.* isolates (18.5 %), which represented the most predominant pathogens contaminating the sandwiches sampled. Bacterial pathogens less frequently isolated include *Bacillus sp*. (15 isolates, 9.9 %), *Proteus mirabilis* (13 isolates, 8.6 %), *Enterobacter cloacae* (12 isolates, 7.9 %), *Pseudomonas aeruginosa* (9 isolates, 6 %), *Enterobacter aeruginosa* (6 isolates, 4.08 %) and *Staphylococcus aureus* (1 isolate, 0.07 %), Table (1), Fig. 1. The incidence of bacterial contamination for each area and isolation points indicated the North district had the highest rate of contamination. The total bacterial count from the North of the city was 57 isolates (37.71 %). The City Centre and East showed similar levels of contamination with 42 isolates (27.81%) and 35 isolates (23.17 %) respectively. The south of the city had the lowest levels of bacterial contamination with 17 isolates (11.25 %) identified. In the North, the most frequently isolated pathogens were *Citrobacter sp.* (15 isolates, 26.31 %) and *Bacillus sp.* (13 isolates, 22.80%). While testing the City Centre, the most frequently isolated pathogen was *K. pneumoniae* (11 isolates, 26.19 %), *E. coli* (10 isolates, 23.80 %) and *Citrobacter sp.* (9 isolates, 21.42 %) and in the East, 10 *E. coli* isolates were observed (28.57 %). The results of samples taken from the South of the city showed *K. pneumoniae* (12 isolates, 70.58 %), Table (1). The results have shown the distribution of bacteria at a subset of restaurants in Benghazi city included *K. pneumoniae*, *E. coli* and *C. freundi*i in twelve restaurants, *E. cloacae* at six restaurants, *Proteus mirabilis* in five restaurants, *Bacillus sp* from four restaurants, *Enterobacter aerogenes* in three restaurants, *P. aeruginosa* at two restaurants, and *S. aureus* isolated from one restaurant.

Table 1

Distribution of bacteria contaminates isolated from chicken shawarma sandwiches from different restaurants.

Bacterial diversity	Collection area									
	City Center		North		South		East		Total isolates in all collection points	
	N.	%	No.	%	No.	%	No.	%	No.	%
Klebsiella pneumoniae	11	(26.19)	9	(15.7)	12	(70.58)	5	(14.28)	37	(24.5)
Escherichia coli	10	(23.80)	7	(12. 2)	3	(17.64)	10	(28.57)	30	(19.9)
Citrobacter sp.	9	(21.42)	15	(26.31)	0	(0.0)	4	(11.42)	28	(18.5)
Enterobacter aeruginosa	4	(9.52)	0	(0.0)	2	(11.76)	0	(0.0)	6	(4.00)
Enterobacter cloacae	1	(2.38)	6	(10.52)	0	(0.0)	5	(14.28)	12	(7.96)
Proteus mirabilis	6	(14.28)	3	(5.26)	0	(0.0)	4	(11.42)	13	(8.60)
Bacillus sp	0	(0.0)	13	(22.80)	0	(0.0)	2	(5.71)	15	(9.90)
Pseudomonas aeruginosa	0	(0.0)	4	(7.0)	0	(0.0)	5	(14.28)	9	(6.00)
Staphylococcus aureus	1	(2.38)	0	(0.0)	0	(0.0)	0	(0.0)	1	(0.70)
Total isolates / area	42	(100)	57	(100)	17	(100)	35	(100)	**151/151**	(100)
Percentage of total isolates *vs* total collections	(27.81)		(37.74)		(11.25)		(23.17)			(100)

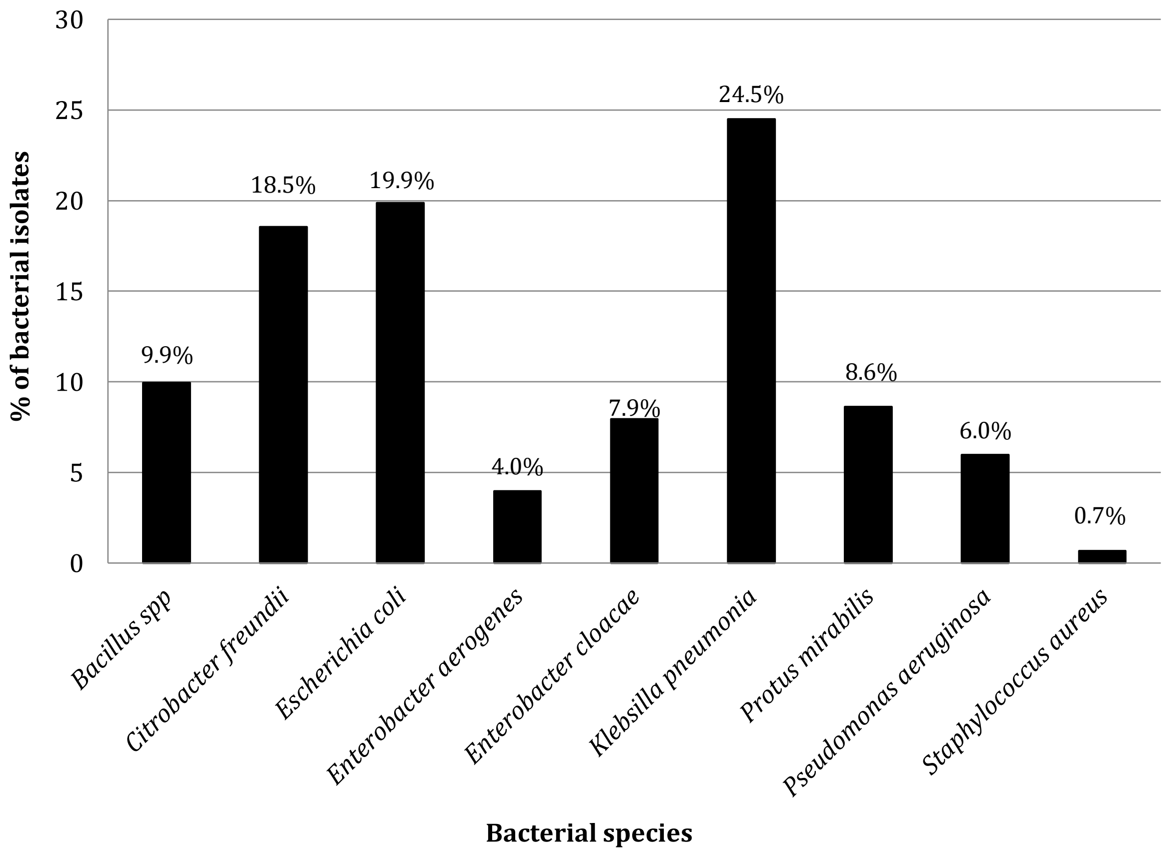

Fig. 1. Diversity of bacterial pathogens in chicken shawarma sandwiches

3.3 Frequency of bacterial species at different times of isolation

To determine the most frequent bacterial contaminant in the tested sandwiches, the microbial isolation was carried out as two isolations on two different days over 2-3 collection points in each region. The species of contaminants varied temporally in each area and amongst the collection points within each area, see Table (2). In this regard, variation was seen across 12 (63%) restaurants. The first bacteria isolated in the City Centre were *C. freundii, K. pneumoniae,* and *E. coli,* while *E. cloacae, C. freundii,* and *K. pneumoniae* were isolated during subsequent sampling. In the Northern region, the first isolation recovered *C. freundii, P. aeruginosa, K. pneumoniae,* and *E. coli*, whereas subsequent isolations found *E. cloacae, E. coli, K. pneumoniae, C. freundii, P. mirabilis* and *P. aeruginosa* as the major contaminant. The southern region had *Bacillus sp., E. cloacae, C. freundii,* and *E. coli* as contaminants after the initial isolation and the later isolations recovered *P. mirabilis* and *E. coli* as the most prevalent pathogens. In Eastern Benghazi, *E. cloacae, P. aeruginosa, E .coli, C. freundii*, *P. mirabilis,* and *K. pneumoniae* were isolated during the first sampling. During the second sampling, *K. pneumoniae*, *C. freundii, P. aeruginosa, E. cloacae, E. coli,* and *P. mirabilis* were isolated, Table (2).

Table 2

Diversity of bacterial types at different times of isolation

Collection area	First isolation	Second isolation
City Center Point No. 1	*C. freundii K. pneumoniae*	*C. freundii K. pneumoniae*
City Center Point No. 2	*C. freundii E. coli*	*E. cloacae C. freundii*
North Point No. 1	*C. freundii P. aeruginosa K. pneumoniae E. coli*	*E. cloacae C. freundii P. aeruginosa*
North Point No. 2	*E. coli C. freundii K. pneumoniae*	*C. freundii P. mirabilis*
North Point No. 3	*C. freundii*	*E. cloacae E. coli K. pneumoniae*
South Point No. 1	*Bacillus spp. E. cloacae*	*E. coli*
South Point No. 2	*C. freundii E. coli*	*P. mirabilis*
East Point No. 1	*E. cloacae E. coli P. aeruginosa*	*K. pneumoniae C. freundii P. aeruginosa*
East Point No. 2	*E. coli C. freundii P. mirabilis*	*E. cloacae E. coli P. mirabilis*
East Point No. 3	*K. pneumoniae*	*P. mirabilis K. pneumoniae*

3.4 Bacterial counts (cfu/g) in the examined shawarma sandwiches samples

In order to investigate the microbial contamination levels, the most probable number method was carried out, the results showed that *Bacillus sp.* isolates counted from 1.35×10^4 cfu/g to 4.3×10^5 cfu/g with an average of 1.9×10^5cfu/g, *Citrobacter freundii* isolates counted from 1 $\times10^5$ cfu/g to 1.7×10^5 cfu/g with average 1.4×10^5 cfu/g. *Klebsiella* isolates counted from 3×10^3cfu/g to 1.2×10^5 cfu/g with average 7.3×10^4 cfu/g, *E. coli* isolates counted from 4×10^4cfu/g to 1.3×10^5 cfu/g with average 4.5×10^4 cfu/g, *Enterobacter cloacae* ranged from 8.5×10^4 cfu/g to 3.7×10^5 cfu/g with average 1.8×10^5 cfu/g and *Enterobacter aerogenes* isolates counted from 3×10^2 cfu/g to 1.2×10^3 cfu/g with average 4.2×10^3 cfu/g.

3.5 Sensitivity of the bacteria-contaminated shawarma sandwiches to the Antibiotics

In order to investigate the sensitivity of the isolated pathogens to the regular use of antibiotics, ten antibiotics have been illustrated. The antimicrobial susceptibility testing was carried out according to the Kirby-Bauer disc diffusion method. The results showed that several species have shown low resistance to Ciprofloxacin (7.4 -25%) with the highest rate of resistance was seen in 23.8 % of *E. coli* and 25% of *Enterobacter sp.*, likewise, all Gram-negative bacteria species investigated presented low resistance rate to Azithromycin (0-20%) with *Enterobacter sp*. displaying the highest percentage of resistant bacteria (20%). In addition, only half of *P. mirabilis* population demonstrated moderate resistance to ceftriaxone 54.5% while the rest of the experimented bacteria were sensitive to the same antibiotic (0-22.2%). The rate of resistance to Cefoxitin by the same category of bacteria from 40% to reach a complete resistance (100%). In the same manner, most of *C. freundii* and *E. coli* showed sensitivity to Sulfamethoxazole, whereas, other bacteria were barely affected by the antibiotic when applied to their bacterial culture (84.6-100% resistant). Although Gentamycin showed a suitable effect on some of the experimented pathogens (8.7% of *C. freundii* and 9.1% of *P. mirabilis*), however, it has failed to make a great effect on the rest of pathogens (41.7-75% of resistance). Noticeably the antibiotics Cloxacillin, Amoxicillin, Metronidazole, and Cephalothin were almost not powerful on all Gram-negative bacteria (88.9-100%), (86.7-100%), (90.9-100%) and (90.9-100%) respectively. The Antimicrobial resistance profiles of Gram-negative isolated pathogens from the shawarma sandwiches are shown in Table (3). The isolation results in the shawarma sandwiches have shown only two species of Gram-positive pathogens including *Staphylococcus aureus* and *Bacillus sp*). *S. aureus* showed a complete sensitivity to Ciprofloxacin, Azithromycin, Gentamicin, Erythromycin, and Amikacin, whereas the same pathogen showed moderate sensitivity to Tetracycline and Sulfamethoxazole by 40% and 46%, in that order. More to the point, *S. aureus* samples were resistant to Ceftriaxone 66.6% and Cefoxitin 80%. , whilst resistant by a rate of 100% to Cloxacillin, Amoxicillin, Metronidazole, and Oxacillin. The other Gram-positive pathogen was *Bacillus sp*., the isolated pathogen was sensitive to Ciprofloxacin, Tetracycline, and Erythromycin. However, the same pathogen showed complete resistance to the rest of the used antibiotics including Amoxicillin, Metronidazole, Oxacillin, Cefoxitin, Ceftriaxone, and Sulfamethoxazole (100% of resistant) except for Cloxacillin that showed 88.9% of the resistance. Antimicrobial resistance profiles of Gram-positive isolated pathogens from shawarma sandwiches are shown in Table (4).

Table 3

Susceptibility of the Gram-negative bacteria to the antibiotics

Types of pathogens	*E. coli*		*P. aeruginosa*		*K. pneumoniae*		*C. freundii*		*Enterobacter*		*P. mirabilis*	
Antibiotics	R(T)	%	R(T)	%	R(T)	%	R(T)	%	R(T)	%	R(T)	%
Ciprofloxacin	5(21)	**23.8**	1(9)	**11.1**	4(31)	**12.9**	2(27)	**7.4**	3(12)	**25**	1(11)	**9.1**
Azithromycin	3(20)	**15**	1(9)	**11.1**	5(33)	**15.2**	3(27)	**11.1**	2(10)	**20**	0(5)	**0**
Gentamicin	12(16)	**75**	5(9)	**55.6**	10(16)	**62.5**	2(23)	**8.7**	5(12)	**41.7**	7(11)	**9.1**
Cloxacillin	16(16)	**100**	8(9)	**88.9**	16(16)	**100**	22(23)	**95.7**	10(10)	**100**	5(5)	**100**
Amoxicillin	19(20)	**95**	9(9)	**100**	13(15)	**86.7**	25(27)	**92.6**	12(12)	**100**	11(11)	**100**
Cefoxitin	14(20)	**70**	9(9)	**100**	27(33)	**81.8**	2(5)	**40**	12(12)	**100**	11(11)	**100**
Ceftriaxone	0(18)	**0**	2(9)	**22.2**	7(30)	**23.3**	0(25)	**20**	2(12)	**16.7**	6(11)	**54.5**
Sulfamethoxazole	7(20)	**35**	9(9)	**100**	27(30)	**90**	2(21)	**9.5**	12(12)	**100**	11(13)	**84.6**
Metronidazole	20(20)	**100**	9(9)	**100**	30(33)	**90.9**	28(28)	**100**	12(12)	**100**	10(11)	**90.9**
Cephalothin	19(20)	**95**	9(9)	**100**	30(33)	**90.9**	27(27)	**100**	10(10)	**100**	5(5)	**100**

Table 4

Susceptibility of Gram-positive bacteria to the antibiotics

Antibiotics	*S. aureus*		*Bacillus sp.*	
	R(T)	%	R(T)	%
Ciprofloxacin	0(15)	**0.0**	0(1)	**0.0**
Azithromycin	0(2)	**0.0**	-	-
Gentamicin	0(3)	**0.0**	-	-
Cloxacillin	16(16)	**100**	8(9)	**88.9**
Amoxicillin	15(15)	**100**	1(1)	**100**
Cefoxitin	12(15)	**80**	1(1)	**100**
Ceftriaxone	10(15)	**66.6**	1(1)	**100**
Sulfamethoxazole	7(15)	**46**	1(1)	**100**
Metronidazole	15(15)	**100**	1(1)	**100**
Tetracycline	6(15)	**40**	0(1)	**0.0**
Erythromycin	0(15)	**0.0**	0(1)	**0.0**
Oxacillin	15(15)	**100**	1(1)	**100**

4. Discussion

Food contamination with pathogenic microorganisms is a leading cause of illnesses. Food contamination has become a global major public health concern, with many cases resulting in high morbidity and mortality rates worldwide. Infectious diarrhoea is reported globally at 3-5 billion cases annually, with nearly 1.8 million deaths mainly in young children (Thanigaivel and Anandhan, 2015). Bacteria are the most common causes of foodborne illness and some bacteria are present on foods when purchased. Contamination of meat during slaughter is also a major source of bacterial contamination for the consumer (Hassan, 2006 and Mohamed, 2010). Fast food contamination can occur at any point during its processing. Pathogens may be introduced during production, distribution, retail, handling, and presentation. Education for people involved in food-related industries to understand how their hygiene affect the safety of food and how they can help decrease the dissemination of foodborne illnesses. Many points of contamination are available during the preparation of chicken shawarma sandwiches, including the cooking, preparation, seasoning, and storage. The investigation of bacterial contamination of chicken shawarma sandwiches in this study identified Gram-negative bacteria were the most common bacterial contaminants (89.4%). The most prevalent bacteria was *Klebsiella* followed by *Escherichia coli* and *Citrobacter freundii*. The study carried out by Al_Mutairi (2011) has reported that contamination of shawarma sandwiches with Gram-negative bacteria was more frequent than Gram-positive. It was also reported that the most frequent pathogens were *Klebsiella*, *E. coli*, *Citrobacter* and *Proteus* sp., that was during bacteriological assessments of fast foods at restaurants, the bacterial contamination in the sandwiches was shown to be a highly diverse range of Gram-negative bacteria, (Kalantari *et al*., 2012; Hasan and Dimassi 2014; Ibrahim *et al*., 2014 and Asiegbu *et al*. 2015). However, a study has been carried out by El-Fakhrany *et al*. (2019) have revealed that *Enterobacter cloacae* is the most isolated Enterobacteriaceae species in to ready to eat sandwiches including burger, meat shawarma, sausage, and liver in a percentage of 69%, 44%, 42%, and 33% respectively, whereas chicken shawarma sandwiches represented *Klebsiella oxytoca* as the most predominant pathogen with percentage of infection (40 %). In our study, Gram-positive bacteria have recorded only (10.6%) of contamination including *Bacillus spp.* and *Staphylococcus aureus*. However, a study performed by Haddad *et al*., (2013) has reviled that Gram-positive bacteria were the most frequent bacteria isolated from sandwiches including *Staphylococcus aureus* and *Bacillus sp.* (48%). Similarly, other studies revealed that *S. aureus* was the second most frequent foodborne pathogen which was isolated from sandwich samples (Todd *et al*., 2008 and Kalantari *et al*., 2012). The bacterial strains which exhibited the highest level of contamination by count were *Bacillus sp.*, *E. cloacae* and *C. freundii*, respectively, *E. aerogenes* had the lowest bacterial count. The comparison of our results with the standards set by BC Centre for Disease Control expressed that the current results of contamination levels with these types of bacteria were within the unsatisfactory microbiological quality level (≥10^4 cfu/g). Al_Mutairi, (2011) revealed that the counts of *Enterobacteriaceae* in shawarma meals were in the average of 5×10^4 cfu/g. Ibrahim *et al*., (2014), also found the shawarma sandwiches were within the unsatisfactory microbiological quality levels, they have concluded that bacteria coliforms counts in shawarma sandwiches collected from different restaurants in Cairo city governorate were at the levels of 9.97×10^3 cfu/g. Similar results were demonstrated by (Hassanien *et al*., 2015 and Darwish 2018). The contamination level observed in this study was consistent with previously published studies, the microbial count levels of ≥10^4 cfu/g are considered as contributing risk factors in foodborne illness if present when consumed. However, a study conducted by El-Fakhrany *et al*., (2019) on some fast-food chicken sandwiches, where they showed the level of contamination is increasing significantly up to 2.36x10^{10} cfu/g. Notably, the current study has found that the sensitivity of screened bacteria to the applied antibiotics showed a worryingly high rate of resistance into several antibiotics (≥ 90%), which represents an interesting and imperative subject for further and more broad research. This is mainly because of the serious and harmful effect that such pathogenic bacteria, for example, *S. aureus, P. aeruginosa and K.* may have on individuals consuming in chicken shawarma sandwiches. The most affected individuals usually are immunocompromised individuals like those with immunodeficiency diseases, children, pregnant women, and senior citizens.

5. Conclusion

Our results have shown that chicken shawarma sandwiches are among the common sources of harmful bacteria, many of which have been proven to be antibiotic-resistant. Consequently, consumption of fast food (here chicken shawarma) may represent a risk factor of food-borne illnesses. However, the comparison of our results with the standardization conducted by the British Columbia (BC) Centre for Disease Control (CDC) representing that our contamination level with this bacteria places within the Cautionary level (10^5) (CDC, 2004). Compared to a study by Al haddad *et al*., (2013) that showed less *Bacillus* count at 6.5×10^3 cfu/g. Although not shown here, but it is well established that the most susceptible people for foodborne illnesses are immunocompromised individuals, therefore, good hygienic practices should be applied to ensure public health safety.

References

Alhadad, A. H., Abushaala, F. A. and Bahout, A. A. (2013) 'Bacterial contamination of ready to eat foods (Shawarma sandwiches) in Misurata city, Libya', International Conference on Environment, Agriculture and Food Sciences (*ICEAFS*), Kuala lampur, Malaysia, pp. 85-87.

Al-mutairi, M. F. (2011) 'The incidence of *Enterobacteriaceae* causing food poisoning in some meat products', *Advance Journal of food science and Technology*, 3(2), pp. 116-121.

Asiegbu, C., Lebelo, S. and Tabit, F. T. (2015) 'The food safety knowledge and microbial hazards awareness of consumers of ready-to-eat street-vended food', *Food Control*., 60, pp. 422-429.

CDC: Centre for Disease Control (2004) 'Diagnosis and Management of Foodborne Illnesses (A Primer for Physicians and Other Health Care Professionals)', *MMWR,* 53, pp. 1-33.

Clouditz, A., Resch, A. Weiland, K. P., Peschel, A. and Gotz, F. (2006) '*Staphylococcus* plays a role in the fitness of *Staphylococcus aureus* and its ability to cope with oxidative stress Infect', *Immun.*, 74(8), pp. 4950-4953.

Darwishm A. M. (2018) 'Foodborne pathogens of fast food and ready-to-eat Foods in Tabuk city and evaluating hazard for food quality', *International J. of Healthcare and Biomedical Research,* 6(2), pp. 149-158.

Easa, S. M. (2010) 'The Microbial Quality of Fast Food and Traditional Fast Food', *Nature and Science*, 8(10), pp. 117-133.

El-Fakhrany, A. M. A., Elewa, N. A. H., Moawad, A. A., and El-Saidi, N. H. (2019) 'Microbiological Evaluation of Some Fast Food Sandwiches in Fayoum', *Egypt. J. Food. Sci.*, 47(1), pp. 27-38.

Hassan, H and Dimassi, H. (2014) 'Food safety and handling knowledge and practices of Lebanese university students', *Food Control*., 40, pp. 127–133.

Hassan, N. A. (2006) Bacterial contamination of restaurant food in Khartoum state', Thesis M. D., University of Khartoum, Sudan.

Hassanien, F. S., El-Shater, M. A., Rabab R. and Abd El-Fatah, R. R. (2015) 'Bacteriological aspect of meat and poultry meat meals', *Benha Veterinary medical Journal*, 28(2), pp. 91-97.

Ibrahim, H. M., Amin, R. A. and Sobieh, A. S. (2014) 'Bacteriological evaluation of fast foods at restaurants level in Cairo governorate', *Benha Veterinary Medical Journal*, 26(1), pp. 34-42.

Jang, H. G., Kim, N. H, Choi, Y. M and Rhee, M. S. (2013) 'Microbiological quality and risk factors related to sandwiches served in bakeries, cafés, and sandwich bars in South Korea', *J. Food Prot*, 76(2), pp. 231-238.

Jarallh, E. M., Sahib, S. I. and Yassen, K. (2014) 'Isolation and Identification of some pathogenic bacterial species contaminated from meats in butchers shopes and kebab restaurants in al_kut city', *Euphrates Journal of Agriculture Science*, 6(4), pp. 30-37.

Jay, J. M. (2000) 'Modern food microbiology', 6th ed, Gaithersburg, Maryland; pp. 17-53.

Jay. J. M., Loessner, M. J. and Golden, D. A. (2005) 'Modern food Microbiology', 7th ed. 233 spring street, *New York NY. USA*., pp. 39-56.

Kalantari, S., Sepehri, G., Bahrampour, A. and Sepehri, E. (2012) 'Determination of bacterial contamination isolated from sandwiches in Kerman city and their resistance to commonly used Antimicrobials', *Scholars research Library*, 4(2), pp. 1100-1105.

Mohamed, A. M. (2010) 'Contamination of ready to eat vended food of meat origin with Aerobic bacteria in Khartoum state', *Master Thesis, University of Khartoum, department of microbiology. Faculty of veterinary medicine*, pp. 10-61.

Ray, B. (2005) 'Fundamental food microbiology', 3rd ed, *and francis e_library,Boca Raton London*, Washington D. C. New York. pp. 68-78.

Ryan, K. J. and Ray, C. G. (2004) 'Sherris medical microbiology: an introduction to infectious diseases', 4th ed. *McGraw Hill*, *New York*, NY.

Thanigaivel, G. and Anandhan, A. (2015) 'Isolation and Characterization of Microorganisms from Raw Meat Obtained from Different Market Places in and Around Chennai', *J Pharm Chem Biol Sci*, 3(2), pp. 295-301.

Todd, E. C. D., Greig, J. D. Bartleson, and Michaels, B. S. (2008) 'Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 5. Sources of contamination and pathogen excretion from infected persons', *J. Food Prot*. 71, pp. 2582–2595.