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Research Article

ASSESSMENT OF THE MICROBIOLOGICAL QUALITY OF PUBLIC RESTAURANTS AND STREET VENDED READY-TO-EAT "KOSHARI" MEALS

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Abstract

Ninety ″Koshari″ meals samples were collected from some restaurants and street vendors located in six public quarters in central Cairo, to determine the microbiological quality of them directly after cooking and preparing and after 4 & 8 hrs of storage at room temperature. These samples examined for aerobic bacteria, *Esherichia coli* and coagulase positive Staphylococci to conduct a preliminary microbial risk assessment for them in" koshari "meals. According to the CDPH (2009) only 53 samples (59%) were of satisfactory microbiological quality for Aerobic plate count (APC) and 81 samples (90%) were positive for *E. coli* cells and 58% of them (47 samples) are acceptable quality. About coagulase positive *S. aureus*, 28 samples (31.1 %) were positive and only 60.7% of them (17 samples) of satisfactory microbiological quality.Moreover, the percentage of unacceptable microbiological quality samples tested (potentially hazardous) reached to 36 samples (40%), 29 samples (32.2%), and 17 samples (18.9%) for APC, *E. coli* and *S. aureus* respectively, after 8 hrs of storage at room temperature. This study reveals that "Koshari" meals sold on the public areas are unwholesome and could be a potential source of food-borne bacteria pathogens if not properly handled. Option might be to suggest that the product should be consumed within short time of purchase in these places. Improvements in processing and handling are required and the need of food-borne bacteria disease surveillance indicated. In addition, it was evident that the Egyptian Food Code needed new legal revisions.

Key words: Ready -to-eat meal; street-vended foods; public restaurants; *E. coli*; *S. aureus*

Introduction

"koshari" meal is the most popular ready-to-eat meal in Egypt. It is made of various foods (e.g. macaroni, lentil, chick-peas, fried onion, tomato-salad, spices) surrounded by rice. Because "koshari" is usually prepared by poor handling in public places and restaurants, after all the ingredients have been cooked, it can be contaminated with Entero-bacteriaceae and *S. aureus* in these public places, especially, if the scoops, vessels, and dishes uses were cleaned and sanitized badly. Street-vendors usually congregate in overcrowded areas where there are high numbers of potential customers.

Major "koshari" ingredients were cooked in aluminum or stainless steel pots, and subsequently mixed and stored in uncovered container. Other ingredients included salads, spices, salt and vinegar, were stored in small glass/plastic containers which were usually left uncovered on tables. As far as could be ascertained, "koshari" meal was generally displayed for periods exceeding 8 hours. Also, "koshari" meal can be eaten promptly after preparation and purchase, but it is typically consumed later. Many laboures and students, enjoy partaking of this product as a work lunch or picnic lunch, which means it is consumed several hours after preparation. It is considered a potentially hazardous food (Institute of Food Nutrition, 2013) and requires time temperature control. However, people usually store it at room temperature to avoid retro-gradation of the rice starch. This makes the rice hard and is considered unacceptable by consumers.

Park et al., (2005) tested 32 samples of "kimbab" (the most popular ready-to-eat food in Korea) from several restaurants and found that 20 were contaminated with *S. aureus*, therefore the Korean Food Code stipulates that pathogens should not be detected in "kimbab" and the Korea Food and Drug Administration reports that "kimbab" has been implicated in many food-borne disease outbreaks.

Woo (2005) has determined that, for the year 2004," lunch box" (an assortment of Korean foods commonly served in a plastic box) and kimbab together are the primary cause of food-borne illness outbreaks in Korea.

In Senegal, more than 200 cases of food poisoning were reported and street foods made from dairy products were incriminated (Dawson and Canet, 1991).

Food and beverages sold by street vendors in Piura, Peru and orange juice sold by street vendors in Guayaquil, Ecuador, were associated with the transmission of *V. cholerae* in 1991 (Javier *et al*., 2012).

In Johannesburg city street vendors typically sell maize porridge served with either chicken stew or beef stew, and gravy or salad. Salads and gravies consist of cut onion and tomato mixtures and reportedly have higher bacterial counts than chicken or beef stews (Mosupye and Von Holy, 1999).

Recent studies have detected high levels of *S. aureus* in foods typically served in Turkish dining facilities, such as Russian salad, vegetable salad and meatballs. Coagulase positive staphylococci were isolated in 18 of 20 (90%) Russian salad samples at the level of 3.1-3.4 Log CFU/g and 15 of 20 (75%) meatball samples, 4 of 20 (20%) of vegetable salad (Hassan *et al*., 2005).

Staphylococci grow in the temperature range of 7-48^{o}C and produce entero-toxin from 10 to 48 ^{o}C, with optimum entero-toxin production at 40-45 ^{o}C (ICMSF, 1998). Although growth usually is constrained by the presence of competing organisms, staphylococci thrive in environments relatively free of competition from other bacteria, such as foods with high concentrations of salt and sugar that impede the growth of other organisms, and its entero-toxins are highly resistant to heat (ICMSF, 1998).

Several food-borne outbreaks have been reported in healthcare settings (Javier *et al.*, 2012) associated to *E. coli* O157:H7 in salads, sandwiches, cheeses and deli meats.

Contamination of working surfaces, equipment or deficient handling practices can contribute to increase the presence of microbial indicators such as *E. coli* or *S. aureus* in ready-to- eat foods (*Collins and Thato* , 2011; *Mohd et al*., 2014).

Kubheke *et al*. (2001) studied the microbiological survey of street-vended salad and gravy in Johannesburg city and they, concluded that short holding times of the prepared foods were instrumental in reducing the growth of bacterial populations and the incidence of common gram-positive food-born pathogens were found due to the observed unhygienic food handling practice and unsanitary environmental-conditions under which the vendors operated.

Over the past 10 years, these is an increasing demand for ready - to- eat meals since people changed their eating habits because of healthier life style interest. Nevertheless ready-to-eat meals may be recognized as a source of food poisoning outbreaks in developed countries. However, this increased proportion of outbreaks cannot be completely explained by increased consumption and enhanced surveillance of them.

Thus, this study undertaken, 1- To determine the microbial quality of "Koshari" meals prepared in the public places and restaurants in Cairo suburbs and based on these data to consider some risk factors during food preparation and handling that could contribute to contamination or growth of *E. coli* and *S. aureus*, 2- To conduct a preliminary microbial risk assessment for Aerobic bacteria, *E. coli* and *S. aureus* in "koshari" meals using Guidelines for the microbiological examination of ready-to-eat foods samples at the point of sale from Communicable Disease and Public Health (CDPH,2009).This guidelines has been illustrated in the Table 1.

Materials and Methods

Sampling Procedure, Sample Processing and Analysis

A total of 90 samples were collected over a period of one month (from the beginning of May to the last of it, 2014) from 15 different public restaurants and street -vendors located in six quarters of a town in central Cairo. These restaurants and vendors were selected because they operated under perceived high-risk conditions with respect to meal preparation, holding and serving practices and exhibited a noticeable lack of personal hygiene.

Approximately 250 gm of each sample was collected using the vendors own utensils and placed into sterile isolate container during transportation to the laboratory for analysis directly within 1 hr and after 4 & 8 hrs of cooking and preparing. Twenty gm of each sample were mixed with 180 ml. peptone saline (0.1% peptone + 0.85% NaCl) and homogenized for 2 min (10^{-1}dilution). Serial dilutions were prepared and the spread plate technique was used.

Table 1: Guidelines used for permissible bacterial load (CFU/g)

Microbiological quality (CFU/g)				
Test	**Satisfactory**	**Acceptable**	**Unsatisfactory**	**potential hazard (unacceptable)**
Aerobic bacteria	$<10^6$	$<10^7$	$\geq 10^7$	not applicable
E. coli	<3	3-100	$\geq$ 100	not applicable
Coagulase positive staphylococci	$<10^2$	10^2-10^3	10^3-10^4	$\geq 10^4$

Microbiological analysis

Aerobic plate counts (APC) were done by the pour plating method on plate count agar (PCA), followed by incubation at 30 ºC for 48 hrs; colonies were recorded as CFU/g (Wehr and Frank, 2004; Basil *et al*., 2012).

E .coli was enumerated using trypton bile X-glucouronide (TBX) agar following incubation at 30 ºC and 44 ºC. Only blue/green colonies were included in the calculations (Oxoid, 2002).

S. aureus was enumerated using Baird Parker Agar containing egg yolk tellurite-emulsions (selective supplement). Inverted Petri dishes were incubated at 35 ºC and counts were made after 24 hr. Dark colonies with clear zone were identified as methicillin resistant *S. aureus* according to the proposed method by Horwitz (2000).

Microbiological results were interpreted in accordance with microbiological criteria previously described by CDPH (2009).These criteria use the presence or level of bacterial contamination as an indicator of food safety.

Results and Discussion

Aerobic plate counts "APC" and percentage in 90 samples collected from six areas directly and after 4 & 8 hrs of "Koshari" meals preparing are given in Table 2 and Fig 1. Within each of the "Koshari" meals studied, only 53 (58.9% of 90 samples examined) were of satisfactory microbiological quality ($<10^6$ CFU/g). Furthermore, the percentage was decreased to 27.8% and 6.7% after 4&8 hrs of storage respectively.

At the same time, the unacceptable or potentially hazardous samples ($>10^7$ CFU/g) increased from zero% directly after preparation to 30 % (27/90) and 40% (36/90) after 4 & 8 hrs of storage respectively.

The APC high values was expected due to food preparation and holding practices and exhibited poor personal hygiene, which probably accounted for the observed differences as well as the high ranges in bacterial counts.

Table 2: Contamination level of Aerobic bacteria in "koshari" meals collected from public Cafeterias and "koshari" street - vendors of the town suburbs directly after preparation and after 4 and 8 hrs storage at room Temperature .

Place & No. of samples	**Time of Analysis**	**No. of Positive Samples and percentage**		**Confine the positive samples on classification of guidelines of microbiological Quality (CFU/g)**							
				Satisfactory $<10^6$		**Acceptable $<10^7$**		**Unsatisfactory $\geq 10^7$**		**Unacceptable not applicable**	
Bab – El shaaria	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
(15)	I		15	100	10	66.7	3	20.0	2	13.3	0	0.0
	II		15	"	5	33.3	3	20.0	2	13.3	5	33.3
	III		15	"	3	20.0	4	26.7	2	13.3	6	40.0
Gamalia	I		15	100	8	53.3	4	26.7	3	20.0	0	0.0
	II		15	"	4	26.7	4	26.7	3	20.0	4	26.7
(15)	III		15	"	1	6.7	5	33.3	4	26.7	5	33.3
El-saied Zeinab	I		15	100	8	53.3	3	20.0	4	26.7	0	0.0
	II		15	"	5	33.3	3	20.0	3	20.0	4	26.7
(15)	III		15	"	1	6.7	5	33.3	3	20.0	6	40.0
El-Basatin	I		15	100	9	60.0	5	33.3	1	6.7	0	0.0
	II		15	"	6	40.0	2	13.3	2	13.3	5	33.3
(15)	III		15	"	0	0.0	5	33.3	3	20.0	7	46.7
Bolak Abo El-ela	I		15	100	10	66.7	4	26.7	1	6.7	0	0.0
(15)	II		15	"	3	20.0	5	33.3	1	6.7	6	40.0
	III		15	"	0	0.0	6	40.0	2	13.3	7	46.7
El- Ataba	I		15	100	8	53.3	3	20.0	4	26.7	0	0.0
	II		15	"	2	13.3	6	40.0	4	26.7	3	20.0
(15)	III		15	"	1	6.7	4	26.7	5	33.3	5	33.0

I: Microbiological analysis done after koshari preparation directly.
II: Microbiological analysis done after storing 4hrs at room temperature.
III: Microbiological analysis done after storing 8hrs at room temperature.

In the present study "Koshari" meals were left after preparation uncovered on the vessels at the vending sites during purchase (which allowed for dust to settle) would be expected to contain large numbers of vegetative bacteria and spores leading to further contamination

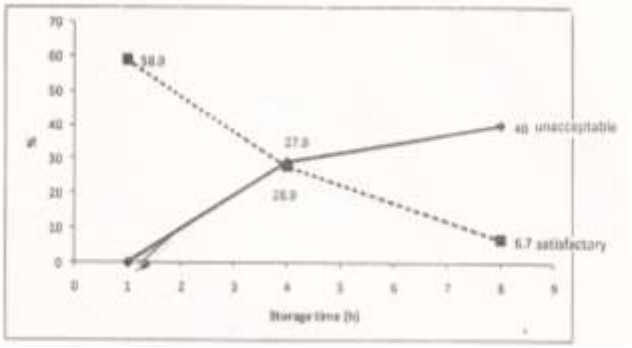

Fig 1: Percentage of number positive satisfactory and unacceptable APC samples

Dirty dishes, scoops and spoons uses to mix and dish out food to customers were likely to provide possible sources of additional bacterial contamination (ICMSF, 1998), furthermore, these foods were left at ambient temperatures, which may have led to the proliferation of contaminating bacteria resulting in increased bacterial counts (Bryan *et al.*, 1997).

E. coli detected in the samples are given in Table 3 and the percentage of acceptable and unacceptable "Koshari" samples directly and after 4 and 8 hrs of preparing are shown in Fig 2.

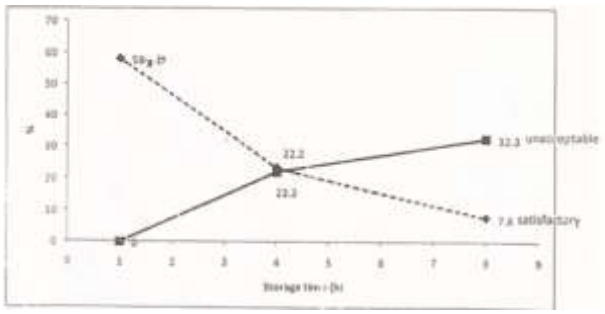

Fig 2: Percentage of number positive satisfactory and unacceptable E. coli samples

Table 3: Contamination level of *E. coli* in "Koshari" meals collected from public cafteries and "Koshari" street-vendors of the town suburbs directly after preparation and after 4 and 8 hrs storage at room temperature.

Place & No. of Samples	Time of analysis	No. of Positive Samples and percentage		Confine the positive samples on classification of guidelines of microbiological Quality (CFU/g)							
				Satisfactory < 3		Acceptable 3-100		Unsatisfactory ≥ 100		Unacceptable not applicable	
Bab - El shaaria (15)		No.	%	No.	%	No.	%	No.	%	No.	%
	I	12	80	0	0	7	46.7	5	33.3	0	0.0
	II	15	100	0	0	3	20.0	8	53.3	4	26.7
	III	15	100	0	0	1	6.7	9	60.0	5	33.3
Gamalia (15)	I	13	86.7	0	0	8	53.3	5	33.3	0	0.0
	II	15	100	0	0	4	26.7	8	53.3	3	20.0
	III	15	100	0	0	2	13.3	9	60.0	4	26.7
El-saieda Zeinab (15)	I	15	100	0	0	9	60.0	6	40.0	0	0.0
	II	15	"	0	0	4	26.7	8	53.3	3	20.0
	III	15	"	0	0	3	20.0	7	46.7	5	33.3
El–Basatin (15)	I	13	86.7	0	0	8	53.3	5	33.3	0	0.0
	II	15	100	0	0	3	20.0	8	53.3	4	26.7
	III	15	100	0	0	0	0.0	10	66.7	5	33.3
Bolak Abo El–ela (15)	I	14	93.3	0	0	8	53.3	6	40.0	0	0.0
	II	15	100	0	0	3	20.0	9	60.0	3	20.0
	III	15	100	0	0	1	6.7	10	66.7	4	26.7
El- Ataba (15)	I	14	93.3	0	0	7	46.7	7	46.7	0	0.0
	II	15	100	0	0	3	20.0	8	53.3	4	26.7
	III	15	100	0	0	0	0.0	9	60.0	6	40.0

I: Microbiological analysis done after Koshari preparation directly.
II: Microbiological analysis done after storing 4hrs at room temperature.
III: Microbiological analysis done after storing 8 hrs at room temperature.

The levels of *E. coli* for the "koshari" meals examined were significantly high, the presence of these potential human bacterial pathogens in our samples pose a very serious health hazard to the consuming public in our locality, because they can be a source of food-borne diseases, which there are hundreds of strains of this bacterium most are harmless, however *E. coli* O157:H7 produces a toxin that can cause severe food-borne illness. Symptoms typically develop within 2-5 days of infection and can include severe bloody diarrhea and stomach cramps. In young children, the elderly, and immune-compromised individuals, infection can lead to hemolytic uremic syndrome (HUS), causing destruction of the red blood cells and kidney failure (Abram, 1995)

This study showed that 81 samples (90% of 90 examined samples) from different six quarters directly after preparation were positive for *E. coli* contamination. Only 47 samples (58%) of these positive samples are of acceptable microbiological quality (3-100 CFU/g) and the rest (34 samples 41.9%) were of unsatisfactory microbiological quality (≥100 CFU/g). Furthermore, the percentage was decreased to 22.2% and 7.8% after 4 and 8 hrs of storage respectively. At the same time, the unacceptable or potentially hazardous samples increased from zero% directly after preparation to 23.3% (21/90) and 32.2% (29/90) after 4 and 8 hrs of storage respectively. It means that nearly the third-part of the samples became potentially hazardous after 8 hrs of storage at room temperature.

It is adjudged that "Koshari" meals prepared in public places and restaurants are unwholesome.

Enumeration of *S. aureus* is considered a more sensitive to measure food hygiene practices, it is one of the most important food-borne pathogens found in ready-to-eat products and *S. aureus* intoxication can result in debilitating illness (Gilbert, 1993). Ajogi *et al*., (2005) found that all coagulase positive *S. aureus* produce entero-toxins and counts of *S. aureus* in food above 100 CFU/g is considered unwholesome, the entero-toxins produced by this bacterium are heat stable and are not affected by processing temperatures. Anderson *et al. (2012)* reported that Staphylococcal food contamination is usually traced to workers who are carriers and/or to contact with inadequately cleaned equipment.

The results in Table 4 and Fig. 3 show the prevalence rate of *S. aureus* out of 90 samples examined from six quarters, 28 samples (31.1%) coagulase positive *S. aureus*, and only 17 samples of them (60.7%) were of satisfactory microbiological quality (<10^2 CFU/g). After 8 hrs of preparing, out of 90 samples examined, 65 samples (72.2 %) coagulase positive *S. aureus*, and only 26 samples of them (40%) were of satisfactory microbiological quality. At the same time, unacceptable samples (≥10^4 CFU/g), also increased from nothing (zero%) directly after preparation to 17 samples (26.2%) after the same period (about the fifth of the examined samples).

Finally, it should be noted that all initially contaminated "koshari" meals had hazardous concentration of *E. coli* and *S. aureus* after 8 hrs of purchase in these public sites

In conclusion, we found that "koshari" meals at the public areas and lanes in the quarters of a town is a potential source of food-borne bacterial pathogens and therefore poses a problem to public health.

Therefore, it is adjudged that "koshari" meals in these public areas are unwholesome. This emphasizes the need of authorities to enhance food-borne diseases surveillance and monitoring capacities, implement food safety regulations through an efficient inspection system and develop food safety education programs.

It was thus concluded that the observed lack of hygiene was not a major determinant of the quality and safety of ready-to-eat street-vended ″koshari″. It is suggested that short holding times of the prepared meals were instrumental in reducing the growth of bacterial populations and the product might be consumed within 1hr of purchase.

This risk assessment points out that additional research on product formulation effects and doses of *S. aureus* toxin needed to cause illness, more data on concentration of *S. aureus* and *E. coli* in "koshari" meals at the point of sale, data on "koshari" serving sizes and number of servings consumed per day, may be useful in improving the safety of this popular Egyptian food.

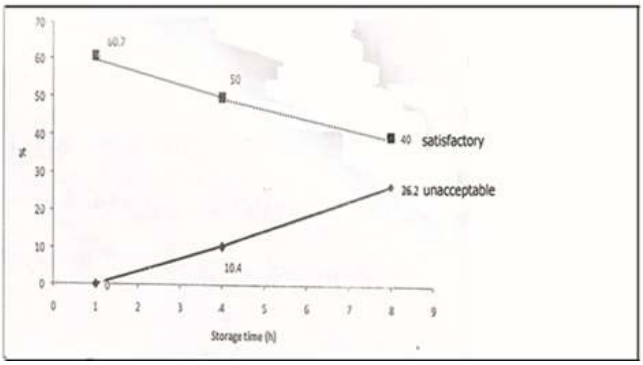

Fig 3: Percentage of number positive satisfactory and unacceptable *S. aureus* samples

Table 4: Contamination level of *S. aureus* in "Koshari" meals collected from public cafteries and "Koshari" street - vendors of the town suburbs after preparation and after 4 and 8 hrs storage at room temperature

Place & No. samples	Time of Analysis	No. of Positive Samples and percentage		Confine the positive samples on classification of guidelines of microbiological Quality (CFU/g)							
				Satisfactory ($<10^2$)		Acceptable (10^2 - 10^3)		Unsatisfactory (10^3 - 10^4)		Unacceptable not applicable ($\geq 10^4$)	
Bab -El shaaria		No.	%	No.	%	No.	%	No.	%	No.	%
(15)	I	7	46.7	5	33.3	2	13.3	0	0.0	0	0.0
	II	9	60.0	4	26.7	3	20.0	1	6.7	1	6.7
	III	12	80.0	6	40.0	1	6.7	2	13.3	3	20.0
Gamalia	I	6	40.0	4	26.7	1	6.7	1	6.7	0	0.0
(15)	II	10	66.7	5	33.3	2	13.3	2	13.3	1	6.7
	III	13	86.7	5	33.3	3	20.0	3	20.0	2	13.3
El -saida Zeinab	I	5	33.3	3	20.0	2	13.3	0	0.0	0	0.0
(15)	II	8	53.3	5	33.3	1	6.7	1	6.7	1	6.7
	III	11	73.3	6	40.0	1	6.7	1	6.7	3	20.0
El – Basatin	I	3	20.0	2	13.3	1	6.7	0	0.0	0	0.0
(15)	II	8	53.3	5	33.3	1	6.7	1	6.7	1	6.7
	III	11	73.3	3	20.0	2	13.3	2	13.3	4	26.7
Bolak Abo El-ela	I	2	13.3	2	13.3	0	0.0	0	0.0	0	0.0
	II	5	33.3	2	13.3	1	6.7	2	13.3	0	0.0
(15)	III	7	46.7	2	13.3	1	6.7	1	6.7	3	20.0
El – Ataba	I	5	33.3	1	6.7	1	6.7	3	20.0	0	0.0
(15)	II	8	53.3	3	20.0	2	13.3	2	13.3	1	6.7
	III	11	73.3	4	26.7	3	20.0	2	13.3	2	13.3

I: Microbiological analysis done after Koshari preparation directly.
II: Microbiological analysis after storing 4hrs at room temperature.
III: Microbiological analysis done after storing 8hrs at room temperature

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