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RISK OF FOOD BORNE AILMENTS THROUGH READY TO EAT FOOD SOLD AT VENDING STALLS IN PUBLIC SECTOR HEALTH CARE ESTABLISHMENTS IN KARACHI, PAKISTAN

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ABSTRACT

Street food vending is a pertinent public health issue in developing countries including Pakistan. It is one of the principal cause of FBD (Food borne diseases) due to overwhelming growth of street food vendors due to the affordability and availability of ready to eat food. The matter of concern is that the food vendors lack an inadequate understanding of the food safety issues. One hundred forty two (142) samples of commonly available street food items (bankabab, samosa, chaat, roll and pakora) were collected from the vicinity of 10 public sector hospitals in Karachi. The samples were analyzed for their public health quality. The predominant Gram –ve microbial flora identified in the food samples were *Escherichia coli, Pseudomonas, Salmonella* and *Enterobacter*. Among Gram +ve *Staphylococcus aureus, Enterococcus faecalis and Bacillus subtilis* were the predominant microbial flora. The study disclosed that the street food samples were also faecally contaminated. The microbial contamination is likely to occur during preparation, storage, handling and serving of food items. The study further revels that the personnel hygienic and sanitation condition of street food vendors were highly deplorable. Moreover, environmental sanitation condition of the city is highly dreadful that further contributes to microbial contamination of street food.

Key words: Food borne diseases, ready to eat food, hospitals, vending stalls,

INTRODUCTION

Consumption of unhygienic and contaminated food often results in Food borne diseases (FBDs) that is a consistent global health issue. FBDs are known to have adverse health and economic affects claiming the life of around 2.2 million people annually Under acute conditions, the onset of FBDs mainly cause gastrointestinal symptoms while in chronic cases it may results in kidneys dysfunction, liver failure, neural disorders, reactive arthritis, cancer and even death (WHO, 2015). Socioeconomically, FBD causes increased health care cost and loss of total man working hours (NIAID, 2015). Research evidences from developed countries indicate that almost quarter of a population showed greater susceptibility to FBDs due to compromised immune systems (Lund and O'Brien, 2011). The situation is more alarming in developing countries including Pakistan, where diarrhea remains the primary cause of child mortalities and causes serious health risks among general population (NIPS, 2013).

The term street vended food (SVF) relates to ready-to-eat foods prepared and sold by sellers and venders particularly on public places and streets (FAO, 1989). The street food industry contributes widely to the economy of developing countries (Muinde and Kuria, 2005). Millions of people rely on ready to eat food, which is easily affordable and conveniently available therefore, the people hardly question about its quality (Barro *et al*., 2006). Street vended foods generally perceived as one of the major contributors of FBDs in developing countries mainly because of poor infrastructure, dilapidated environmental conditions, dearth of legal control on food vending processes, diversification and arrangements of temporary nature (Sousa, 2008).

Salmonella species, Staphylococcus aureus, Bacillus cereus and Clostridium perfringens are the common pathogens often found in SVF (Bryan *et al*., 1997; Bryan *et al*., 1992a, 1992b; Mosupye and von Holy, 1999; Muleta and Ashenafi, 2001; Umoh and Odoba, 1999). Several studies conducted on street foods, but none of the report presented a complete representative diagram of contamination mechanisms (Nicolas *et al*., 2007).

Karachi, a metropolitan city is the capital of Sindh province, Pakistan having an overall area of 3,527 km^2. The estimated population of 16.21 million as declared by 2017 census. The Population density is >6,000 people/ km^2. It is 7th largest city in the world and the hub of financial and industrial activities in the country.

Although Karachi contributes approximately 70% revenue of the country's economy but the basic infrastructure is in highly deplorable, with dreadful hygienic and sanitation conditions. Heaps of solid waste including hazardous waste, overflowing sewage, exhaust emissions are chronic environmental problems faced by the city dwellers. This situation is responsible for overcrowding of all public and private sector hospitals and other health care establishments. The quality of health care services in government owned health care facilities is often substandard although affordable therefore, the poor people have no choice except to rely on it.

In developing countries, the sources of food like those selling from the vending stalls within close proximity of hospitals are one of the major contributors of FBD among the general population. These vending stalls do not comply with, and are not under any strict food safety compliance regulations, and thus may serve as an important factor of FBDs (Vollaard *et al*., 2004) primarily to patients and their attendants who prefer to consume street vended food owing to its availability and affordability.

The health care system in Karachi comprises of public and private sector hospitals. Public sector hospitals in Karachi are governed by Federal government (11 hospitals), Provincial (Sindh 17 hospitals) government and Karachi City District Administration (13 hospitals).

The people of low income areas when suffer from any disease prefer to avail low-cost health care facilities available in public sector hospitals. The patient and their attendants while staying in the hospital prefer to rely on the substandard food items normally available at the vendor shops in the close proximity of the hospitals. The vendors selling out the food items remain in deplorable hygienic conditions. The raw material used in such food items are also substandard which makes the food items generally unfit for human consumption. Other possible reason of FBDs is the health status and personnel hygienic condition of food handlers that is highly appalling.

It is with this aim the present investigation was undertaken to determine the quality of ready to eat food selling at the vendor shops around the public sector hospitals in Karachi. As such to the best of our knowledge, no such study is available from the present perspective.

MATERIALS AND METHODS

Sampling

Various food samples were obtained during September 2015 to May 2016 from the vending stalls around the public sector hospitals in a radius of 0.5 km. Most common and readily available food items were collected including Bun kebab (local form of burger having a beef, chicken and a patty of potatoes, offered with raw vegetables and locally prepared sauces), Chaat (a spicy combination of boiled chick peas and potatoes, offered with yoghurt and spicy locally prepared sauces), Samosa (a deep fried flour triangular shell stuffed with filling of spiced mashed boiled potato, green chilies, and spices), chicken roll (stuffed with fried vegetable and chicken) and Pakoray (a fried snack, made from gram flour, fritter, served with spicy uncooked sauces). In all, 142 food samples were collected (Table 1). These samples were collected following a stratified random sampling design.

Sample Processing

The samples were transferred to the Institute of Environmental Studies, University of Karachi at low temperature using an icebox and stored at 4^0C until analysis. The sample was serially diluted using sterile saline blank. Serial dilutions were made aseptically by using 10 g of food sample mixed with 90 ml of saline and diluted up to 10^{-3}.

Microbiological Analysis

Food samples were analyzed through Most Probable Number (MPN) technique in laminar flow hood using sterilized culture media to detect the presence of TAC (Total aerobic count), TCC (Total coliform count),TFC (Total fecal coliform) and TFS (Total fecal streptococci) (APHA, 2005). The TAC and TCC were determined through single and double strength of nutrient broth and lactose broth (Merck, Germany), respectively. TFC was ascertained by EC broth (Merck, Germany) using the positive lactose broth tubes. TFS was monitored through sodium azide broth of single and double strength (Merck, Germany).

Predominant microbial flora was also isolated through standardized procedures. For the isolation of Gram negative bacteria a loop full was taken from the positive double strength lactose broth tube and was streaked on MackConkeys and EMB (Merck) agar plates followed by subsequent incubation at 37^oC in an incubator. Tryptic Soy agar (TSA; Merck, Germany) was used for the isolation of predominant Gram positive microbial

flora. TSA agar plates were streaked from the loop full of positive nutrient broth tubes used for the characterization of TAC. The plates were than incubated at 37^{o}C.

Table 1. Characteristics of health care establishments and frequency of sample collection.

Hospital code	Name of hospital	Jurisdiction of	Number of permanent street vendors	Type of sample	Number of sample
S-1	Civil hospital	Sindh govt.	24	Samosa	9
				Pakora	5
				Chat	4
				Bun kabab	6
				Roll	2
S-2	Jinnah	Federal govt.	22	Samosa	6
				Pakora	3
				Chat	4
				Bun kabab	6
				Roll	3
S-3	Abbasi Shaheed	CDGK	15	Samosa	5
				Pakora	3
				Chat	2
				Bun kabab	3
				Roll	2
S-4	Qatar Hospital	CDGK	6	Samosa	2
				Pakora	1
				Chat	1
				Bun kabab	2
				Roll	00
S-5	Sindh govt hospital	Sindh govt	17	Samosa	7
				Pakora	3
				Chat	4
				Bun kabab	2
				Roll	1
S-6	Lyari General Hospital	Sindh. Govt.	11	Samosa	3
				Pakora	3
				Chat	2
				Bun kabab	2
				Roll	1
S-7	Sindh Govt Hospital U.P. Mour	Sindh.govt.	10	Samosa	2
				Pakora	1
				Chat	2
				Bun kabab	2
				Roll	3
S-8	Landhi Medical complex	CDGK	14	Samosa	4
				Pakora	2
				Chat	3
				Bun kabab	3
				Roll	2
S-9	Social Security Hospital	Sindh.govt.	14	Samosa	4
				Pakora	2
				Chat	3
				Bun kabab	3
				Roll	2
S-10	OJHA	Federal	09	Samosa	2
				Pakora	1
				Chat	2
				Bun kabab	3
				Roll	1

The predominant microbial flora appeared on the plates were than subjected to morphological, cultural and biochemical characteristics. Bacterial isolates were identified according to the "Bergey's Manual of Determinative Bacteriology" (1994) (Buchanan *et al.*, 1994). Following morphological and biochemical test were performed for the characterization of predominant microbial flora.

i. Gram reactions ii. Oxidase test iii.Catalase test iv. Indole test v. MR test vi. VP test vii. Urease activity viii. Starch hydrolysis

Ethical considerations

All food vendors were informed about the intent and nature of the study. They were assured that anonymity of the vendors will be maintained, and food samples were obtained after obtaining their verbal consent to participate in the study.

RESULTS AND DISCUSSION

The data regarding the health care establishments and the number of samples collected from each hospital is given in Table 1. The results of public health quality of assorted food samples are presented in Table 2. From Table 2, it can be seen that the number of TAC was as high as > 2400 MPN /10 gm in Bun Kabab excluding the one collected from Landhi Medical Complex (LMC). In chaat and samosa samples the number of TAC was >2400 MPN/10 g. Similarly, in the samples of roll the number of TAC was again as high as >2400 /10 g except the sample collected from LMC.

TCC was present in all Bun Kababs excluding the samples obtained from S-7 and S-8. All the chaat and samosa samples were contaminated with TCC except the samples of samosa obtained from S-7 (39MPN/10 g). The samples of pakora and rolls have reached maximum limit (>2400) except the roll sample collected from S-8.

The lowest numbers of TFC in Bun Kabab samples was from the Qatar hospital (S-4) (210MPN/10g) whereas highest number (>2400MPN/10g) was found in all the samples excluding the one obtained from Civil hospital (S-1). Likewise, the number of TFC in chaat samples were in the range of 460 (S-5) to >2400 MPN/10 g. TFC count of 1100MPN/10g was found in the samples collected from S-3 and S-6. The minimum count of TFC in samosa was found in the samples collected from S-3. Whereas the samples collected from S-4 (460MPN/10g), S-1 and S-2 (1100MPN/10g) have relatively low count while rest of the samples have maximum value of TFC. The samples of roll samples collected from S-8 had the minimum value of TFC (<3.0 MPN/10gms). The samples of rolls collected from S-5 (93) and S-6 (460) MPN/10 gms had relatively low values of TFC. Maximum value of TFC in pakora samples were attained in all the food samples excepting the one that were obtained from S-7 (<3), S-2 (93), S-4 and S-6 (1100 MPN/10g).

The minimum value (<3) of TFS in Bun Kabab samples were found in S-7 and S-8. The maximum value of TFS was 210MPN/10g and was found in the samples of S-3 and S-10. The minimum count of TFS was found in chaat samples collected from S-6 (7 MPN/10gms). The maximum TFS count was found in S-4 chaat samples (210 MPN/10g). The minimum TFS count in samosa was reported in S-7 while the maximum value of TFS(210) was found in the S-8 samples. The samples of rolls collected from different location contained TFS ranged between <3 (S-8) to 460 (S-1) MPN/10g. The TFC count in pakora samples were minimum (<3) at S-7 and S-8 samples, while the maximum count (64MPN/10g) was obtained from S-1, S-3 and S-9. The number of TFC count was low as compared to TCC and TFC. Table 3 represents morphological, biochemical and cultural characteristics of predominant microbial flora isolated from the samples.

The predominant microbial flora found in all the food samples is reported in Table 4 and 5. From the Table 4, it revealed that the *E. coli* was present in all the samples. The highest occurrence of Enterobacter was in chat samples (60%) followed by Bunkabab and roll (50%), samosa (40%) and pakora (30%). The percentage occurrence of *salmonella* was in the order of Chat (70%) <, Bankabab , samosa and roll (50%) < pakora (40%).

Table 5 indicates percentage occurrence of Gram positive organism in the food samples. *Bacillus subtilis*, *Staph aureus* and *Enterococcus faecalis* were the predominant microbial flora. *Bacillus subtilis* found in all the samples except in two chaat samples collected from S-7 and S-8. *Staph.aureus*was present in the following order, chat (60%) > Ban kabab (50%) > roll (30%)> samosa (20%). *Satphaurues* was not detected in pakora samples. The *Enterococcus faecalis*was found only in Ban kabab (30%) and Chat samples (40%).

Table 2. Microbiological assessment of street vended food items, sold near secondary and tertiary care setups of Karachi, Pakistan.

Hospital Code	Sample	MPN/gm				Remarks
		TAC	TCC	TFC	TFS	
S-1	Bun kebab	≥2400	≥2400	1100	9	UFHC
	Chaat	≥2400	≥2400	≥2400	11	UFHC
	Samosa	≥2400	≥2400	1100	210	UFHC
	Roll	≥2400	≥2400	≥2400	460	UFHC
	Pakoray	≥2400	≥2400	≥2400	64	UFHC
S-2	Bun kebab	≥2400	≥2400	1100	210	UFHC
	Chaat	≥2400	≥2400	≥2400	93	UFHC
	Samosa	≥2400	≥2400	1100	460	UFHC
	Roll	≥2400	≥2400	≥2400	64	UFHC
	Pakoray	460	≥2400	93	11	UFHC
S-3	Bun kebab	≥2400	≥2400	≥2400	210	UFHC
	Chaat	460	≥2400	1100	64	UFHC
	Samosa	≥2400	≥2400	≥2400	93	UFHC
	Roll	≥2400	≥2400	460	11	UFHC
	Pakoray	≥2400	≥2400	≥2400	64	UFHC
S-4	Bun kebab	≥2400	≥2400	210	9	UFHC
	Chaat	≥2400	≥2400	≥2400	210	UFHC
	Samosa	≥2400	≥2400	460	93	UFHC
	Roll	≥2400	≥2400	≥2400	64	UFHC
	Pakoray	≥2400	≥2400	1100	28	UFHC
S-5	Bun kebab	≥2400	≥2400	≥2400	210	UFHC
	Chaat	≥2400	≥2400	460	21	UFHC
	Samosa	≥2400	≥2400	210	9	UFHC
	Roll	≥2400	≥2400	93	11	UFHC
	Pakoray	≥2400	≥2400	≥2400	64	UFHC
S-6	Bun kebab	≥2400	≥2400	≥2400	28	UFHC
	Chaat	≥2400	≥2400	1100	7	UFHC
	Samosa	≥2400	≥2400	≥2400	93	UFHC
	Roll	≥2400	≥2400	460	4	UFHC
	Pakoray	≥2400	≥2400	1100	21	UFHC
S=7	Bun kebab	1100	75	15	<3	UFHC
	Chaat	≥2400	≥2400	≥2400	28	UFHC
	Samosa	1100	39	9	<3	UFHC
	Roll	≥2400	≥2400	≥2400	64	UFHC
	Pakoray	240	<3	<3	<3	UFHC
S-8	Bun kebab	410	<3	<3	<3	UFHC
	Chaat	≥2400	≥2400	≥2400	93	UFHC
	Samosa	≥2400	≥2400	≥2400	210	UFHC
	Roll	210	28	<3	<3	UFHC
	Pakoray	≥2400	≥2400	≥2400	64	UFHC
S-9	Bun kebab	≥2400	≥2400	≥2400	28	UFHC
	Chat	≥2400	≥2400	≥2400	93	UFHC
	Samoosa	≥2400	≥2400	≥2400	11	UFHC
	Roll	≥2400	≥2400	≥2400	28	UFHC
	Pakoray	≥2400	≥2400	≥2400	64	UFHC
S-10	Bun kebab	≥2400	≥2400	≥2400	210	UFHC
	Chat	≥2400	≥2400	≥2400	93	UFHC
	Samoosa	≥2400	≥2400	≥2400	11	UFHC
	Roll	≥2400	≥2400	≥2400	21	UFHC
	Pakoray	≥2400	≥2400	≥2400	7	UFHC

Table 3. Morphological, colonial and biochemical characteristics of predominant microbial flora.

Characteristics Morphological characteristics	Tentative cultures *Bacillus subtilis*	Tentative cultures *Staph. aureus*	Tentative cultures *Enter. faecalis*	Tentative cultures *E. coli*	Tentative cultures *Salmonella*	Tentative cultures *Enterobacter*	Tentative culture *Pseudomonas*
Grams reaction	Gram +	Gram +	Gram +	Gram -	Gram -	Gram -	Gram -
Morphology	Rod like arranged in chain	Cocci in bunches (grape-like clusters)	Cocci appeared in chains	Rod like arranged in short chains	Straight rods, scattered	Rod like	Rod like, scattered
Colonial characteristics	Colonies were dry, flat having irregular margin, lobate on nutrient agar on TSA	Colonies were circular, having entire margin, convex, yellow in colour on TSA	Colonies were white or creamy entire margin	Pink coloured colonies on MacConkeys Agar; Dark blue to black colonies with metallic green sheen	Transparent and colourless colonies on MacConkeys agar: Grey mucoid colonies on EMB agar	Brown, dark-centered, mucoid colonies on EMB; Mucoid pink colonies on MacConkeys agar	Irregular, colorless to pink colonies on MacConkeys agar; Pinkish small colonies on EMB agar
Oxidase	-ve	-ve	-ve	-ve	-ve	-ve	+ve
Catalase	+ve	+ve	-ve	+ve	+ve	+ve	+ve
Indole	-ve	+ve	-ve	+ve	-ve	-ve	-ve
MR test	+ve	-ve	-	+ve	+ve	+ve	-ve
VP test	+ve	-ve	+ve	-ve	-ve	-ve	-ve
Urease activity	-ve	+ ve	-ve	-ve	-ve	+ve	-ve
Starch hydrolysis	+ve	-ve	-	-ve	+ve	-ve	-ve

Table 4. Percentage occurrence of gram negative bacteria collected from street vended ready to eat food.

Type of sample	Type of organisms	Location	% occurrence in sample
Ban kabab	*E.coli*	All sampling sites	100
	Enterobacter	S-1, S-4, S-8, S-9, S-10	50
	Pseudomonas	S-1, S-5, S-6	30
	Salmonella	S-1, S-2, S-5, S-7, S-9	50
Chat	*E.coli*	All sampling sites	100
	Enterobacter	S-1, S-2, S-4, S-7, S-8, S-10	60
	seudomonas	S-1, S-5	20
	Salmonella	S-1, S-2, S-3,S-5, S-6, S-7, S-9	70
Samosa	*E.coli*	All sampling sites	100
	Enterobacter	S-1, S-2, S-4, S-7	40
	Pseudomonas	Nil	-
	Salmonella	S-1, S-2, S-3,S-5, S-8	50
Roll	*E.coli*	All sampling sites	100
	Enterobacter	S-1, S-2, S-3, S-6, S-8	50
	Pseudomonas	S-1	10
	Salmonella	S-1, S-2, S-3,S-5, S-8	50
Pakora	*E.coli*	All sampling sites	100
	Enterobacter	S-1, S-4, S-8	30
	Pseudomonas	Nil	-
	Salmonella	S-1, S-3, S-6, S-9	40

Table 5. Percentage occurrence of gram positive bacteria collected from street vended ready to eat food.

Type of sample	Type of organisms	Location	% occurrence in sample
Ban kabab	*Bacillus subtilis*	All sampling sites	100
	Staph aureus	S-1, S-4, S-5, S-9, S-10	50
	Enterococcus faecalis	S-1, S-3, S-5	30
Chat	*Bacillus subtilis*	All sampling sites except S-7 and S-8	80
	Staph aureus	S-1, S-2, S-3, S-5 S-9, S-10	60
	Enterococcus faecalis	S-2, S-3, S-5, S-7,	40
Samosa	*Bacillus subtilis*	All sampling sites	100
	Staph aureus	S-2, S-5	20
	Enterococcus faecalis	Nil	-
Roll	*Bacillus subtilis*	All sampling sites	100
	Staph aureus	S-2, S-3, S-6	30
	Enterococcus faecalis	Nil	
Pakora	*Bacillus subtilis*	All sampling sites	100
	Staph aureus	Nil	-
	Enterococcus faecalis	Nil	-

Street foods are usually associated with diarrheal diseases due to improper hygienic conditions during handling, storage and serving (Barro *et al*., 2006; Bhaskar *et al.*, 2004). Because of its extensive consumption, street-vended foods are impending carriers of FBD.

The predominant Gram + and Gram - bacterial flora isolated from the samples were *E.coli, Enterobacter, Pseudomonas, Salmonella, Bacillus subtilis, Staph. aureus* and *Enterococcus faecalis.* These results corroborate the findings of Bryan *et al*., (1997); Bryan *et al*., (1992b); Muleta and Ashenafi, (2001); Umoh and Odoba, (1999).

E. coli was the most predominant organisms found in all the food samples. It is interesting to note that it was even present in samosa and roll samples that are fried at very high temperature. The presence of *E.coli* in the samples can be correlated with the ingredients used in the preparation of these foods and the way it was served. One of the critical raw materials is water which is used for washing hands, cleaning of utensils and other gears. The quality of water used by the vendors is not often of good quality and has of serious health concern. Contaminated water also acts as a carrier for the transmission of *E. coli* and *Salmonella* spp. Angulo *et al*., (1997) and Rane (2011) already pointed out that unavailability of potable water is of major concern for different operations at the vending site. In Karachi, the availability of potable water is of serious concern and due to unavailability of potable water the vendors have no choice except to reuse the washed water for cleaning utensils as has been observed at different vending sites which keeps on redistributing the microorganisms throughout the day. In Trinidad and Tobago the results of street food analysis revealed that the foods samples were contaminated with *E.coli* as the water used for preparation was already contaminated (Mankee *et al*., 2003).

These findings are in agreement with those of the present study as the water stored in deplorable conditions by the street vendors and have extensive bacteriological contamination of faecal origin (Dawson and Canet, 1991). It is anticipated that the use of contaminated water could be the principal cause of diarrheal sicknesses to the customers of street vended food. Barro *et al*. (2006) reported *Salmonella* and *Shigella* in the water used by the vendors for dishwashing.

The occurrence of above reported microorganism in food items other than those cooked at elevated temperature might be attributed to the use of substandard ingredients, personnel hygiene of the vendors, storage conditions and the supplementary food used with principal food such as savory prepared with vegetables and yogurt.

In Karachi, the raw materials used in the vended food is of inferior quality that also contributes to public health microorganisms. The meat used in Ban kabab and roll is commonly contaminated with the organisms of public health importance so are the vegetables used to prepare samosa, pakora, chat and roll. Such ingredients harbor a number of organisms including those, which were found in the present study such *as B. cereus, E. coli, Salmonella* and *S. aureus* (Hutabarat, 1994). In African countries the presence of diarrhoeagenic *E. coli* and *Salmonella* were reported in street-vended food (Barro *et al*., 2006; Muleta and Ashenafi, 2001). Similar results are also obtained in the present study. Moreover, the spices are also likely to contain those organisms which are reported in the present study and are reported elsewhere (Mosupye and von HOLY, 1999).

The shape and design of the cooking and storage utensils also plays a critical role in maintaining the hygienic quality of food. It has been noticed that food storage equipment are not properly covered thereby exposing the food to dust, flies and other vectors. It has been observed that some venders use a dirty cloth to cover the food. Once the food is consumed by the consumer the serving utensils are often cleaned with a dirty cloth or paper. During interview with the vendors it is revealed that once the business is over at the end of the day, the cooking and storage utensils are cleaned with water only, without using any detergent. It is reported that serving utensils like plates, bowls, spoons and glasses may get contaminated with Staphylococcus spp., Micrococcus spp. that may instigate particularly from the vendors during handling of food at different stages (Cardinale, *et al*., 2005).

The presence of *Staph.* in all the samples except pakora is likely to be introduced from food preparation areas, cloth used for cleaning, food itself and the contaminated water. Bryan *et al*. (1992b) reported that Staphylococcal food poisoning positioned amongst the most widespread causes of gastroenteritis all over the world. Cardinale *et al.*, (2005) also reported similar sources of *Staph. aureus*. The issue of *S. aureus* contamination in food supply is still significant world wide particularly in developing countries (Ghosh *et al*., 2007). In the present study, its presence in the food items can be attributed during chopping, cutting or mixing of food next to cooking through contamination from food utensils as also reported by Lues *et al.* (2006). Bryan *et al*. (1992a) already reported *S. aureus* count 10^5 cfu/g in Pakistani street-vended foods. It was also found that the oil used for deep frying of pakora and roll is also re-used. The colour of the oil was dark having unpleasant odour and the vendors did not replace it with fresh oil even for days.

The study further disclosed that the street food vendors are untrained with respect to food hygiene and work under deplorable sanitary conditions. As far as personal hygiene of the sellers is concerned, they hardly use aprons or caps and handled food with their bare hands without using gloves. Most of the vendors either use polythene bags, newspaper or used paper to serve the food for take away.

Based on the current observation it was found that these vendors do not have standardized garbage receptacles, hence they disposed the food waste just near the stalls making the surroundings grubby. It was also observed that houseflies were present in most of the stalls that could be the potential sources of microorganism identified in the present study. This was similar to the conditions reported by Muinde and Kuria (2005) in Nairobi, Kenya.

Personnel hygienic condition of food handlers was also deplorable. They hardly bother to clean their hand with soaps after satisfying their physiological needs. The hands of food handlers can be a vector in the dissemination of food borne diseases because of poor personal hygiene or cross-contamination (Bryan *et al*., 1997).

The use of appropriate utensil helps in preventing the risk of cross contamination from raw materials (Kaul and Agarwal, 1988). The surface of utensils and contaminated knives could also be the sources of Salmonella in all the samples (Barro *et al*., 2006). It has been observed that during chopping of raw material the knives hardly clean and the food residues stick on the surface that attracts flies and responsible for cross contamination.

The presence of the heavy bacterial load in the food samples can also be correlated with the ambient temperature which facilitates their growth and multiplication. Karachi enjoys mild climate owing to its proximity to the Arabian Sea. The annual average temperature ranged between 19 to 31^{o}C. Mild climatological condition with high humidity favors the growth of microorganisms once the food is cooked and kept under unhygienic conditions. Since the refrigerating conditions are hardly available in these stalls the food often stored at ambient temperature once it is cooked. High bacterial count including *Salmonella typhimurium, Salmonella gallinarum, Shigella dysentriae, Pseudomonas fluorescens and Klebsiella pneumonia* were reported in fruit chaat sold in Chandigarh, India where the food was stored at room temperature (Kaul and Agarwal, 1988). In case of Bun Kabab meat petty is already cooked but stored at room temperature and then reheated when demanded by customers. However, this reheating is often

insufficient to destroy microorganism that are likely to be present during storage which survive post heating temperature and proliferate (Omemu and Aderoju, 2008). According to WHO (1996) the prepared foods should be kept at a temperature of at least 60^0C if kept for more than 4 to 5 hours. In the present study, it was observed that food is being stored even up to 8 to 10 hours. These sources could be major factors of food poisoning outbreaks (WHO, 1989). Bryan *et al*., (1992b) reported that the major factor that contributes to outbreaks of foodborne diseases in Pakistan is the storage of cooked foods at ambient temperature for several hours. Bryan *et al.,* (1992b) further reported that in chaat, chick peas, and gram flour products pose risks of illness caused by *B. cereus* and *C. perfringens*. This situation is likely to contribute food borne outbreaks in Pakistan.

Conclusions

The present study disclosed the potential hazards of popular street-vended foods available in Karachi. The likelihoods of foodborne diseases spreading through these contaminated foods to the local population cannot be unheeded.

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