Evaluation of microbial quality of street food in Karachi City, Pakistan: An epidemiological study

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Abstract

The purpose of this research was to evaluate the microbial quality of famous street foods vended in Karachi city and find out the potential sources implicated in food contamination. To proceed with this study, dry and wet procedures were used via closed system questionnaire and gold standard techniques respectively. According to the questionnaire survey, majority of people have basic knowledge of food borne sickness *i.e.* 67% and health risks associated with poor eating habits *i.e.* 87%, nonetheless most individuals do not mind their cleanliness before eating on spot. A large number of people had come across different food borne infections subsequent to eating street foods. Total mean aerobic count was 7.18 ± 1.26 CFU/ml that was not under the acceptable microbial limits. The highest total viable count 9.15 ± 0.01 CFU/ml and the lowest total viable count 4.67 ± 4.04 CFU/ml recorded were of grilled chicken and fried fish respectively. Poor post handling and personal cleanliness of food vendors were ascribed to high bacterial count in completely cooked street foods.

Introduction

Street food can be described as the food consumed or eaten on spot or as takeaway.¹ Street food is quite common and well accepted all around the globe. Different parts of the world are represented by their typical street foods that are not only palatable and presentable but also reasonably priced thereby attracting local inhabitants and tourists.²⁻⁵ Besides, street food is enjoyed by all age groups and classes of people. Street food is ready to consume food and is promptly served while both raw and cooked items are catered to the buyers. Health risks are more associated with the raw foods, especially vegetables, as these inherently harbor high number of microorganisms which are further worsened by

improper handling and use of tarnished utensils.¹ As defined by the US Division of Health and Human Services website, food poisoning also referred to as foodborne illness or foodborne disease is any sickness that results from consuming food contaminated with microbes or their toxins. Many of such foodborne diseases are known to cause serious health related disturbances.⁶ Health issues are the real concern with respect to street vended food. The way the food is prepared, processed and presented consequently affects its microbiological quality.^{7,8} Adulteration can be introduced in food through several courses; nature of water utilized for cooking is one of the major causes contributing to food poisoning.⁹ Nonetheless, being the essential feeding source of large number of people including travelers, labors, shopkeepers and students at reasonably low prices and easy access, the importance of street food cannot be questioned.¹⁰ In recent years major cities of Pakistan have suffered significant raise in urbanization largely due to migrations from rural areas. This pressure of increased population has caused street food vending business to grow extensively as these food hawkers earn their livelihood by catering to the needs of large number of migrant workers far away from their home places.¹¹ There are number of culinary dishes which are quite popular amongst the inhabitants of Karachi city including Biryani, Haleem, Nehari, Barbeque items and Junk foods. Mobile food sellers are the real public health safety concern as they prepare and dispense their finished products in carts and vans where they are bound to face difficulties like unavailability of clean water, inferior grade raw materials, lack of appropriate equipment and layouts, poor sanitation conditions, improper food processing and packaging techniques and absence of suitable storage facilities and waste disposal places.^{4,5,12,13} Correspondingly imprudent treatment of such foods is the chief source of food contamination. Food is an excellent medium for microbes to flourish and expand their number quickly.⁹ Ready to eat food especially made up of protein sources such as poultry and meat provides a potential vehicle for food borne microorganisms.^{5,14-16} It was reported that food products from animal origin and fresh produce from plants like salads play a crucial role in spreading antimicrobial resistant bacteria. Roughly 10 to 20% of food borne illness are caused by food handlers either by mishandling of food or their poor personal hygiene.¹⁷⁻¹⁹ Similarly noncompliance with the requirements of Good Hygiene Practice (GHP) and Good Sanitation Practice (GSP) is the main reason behind food borne dis-

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eases throughout the world.²⁰⁻²³ Careless attitude of food vendors results in bacterial pathogens becoming more stubborn and resistant to numerous antibiotics. Many hospitalization cases are associated with foodborne diseases therefore treatments turn out to be more challenging and frustrating.²⁴⁻²⁷ Therefore the aim of this study was to find out various food handling factors on street that might lead to causing bacterial diseases to the users. For this various factors have been assessed like personal hygiene of hawkers and vendors, and intrinsic and extrinsic environment (pH, temperature and humidity), which ultimately affect the quality of foods.

Materials and Methods

Selection of study site and questionnaire design

Karachi city is the most populous city in Pakistan and the 6th most populous metropolitan city in the world. Karachi is divided into six districts namely East, West, Central, South, Malir and Korangi. North Nazimabad town and Gulberg town areas of

Central district Karachi were taken under consideration for research purpose (Figure 1). Closed ended questionnaire was designed to analyze the knowledge of public regarding food related health risks. Survey was comprised of basic questions including awareness about foodborne diseases and incidences of diarrhea, dysentery, hepatitis after consuming street foods.

Sample collection

For the research, 54 ready to eat food samples were collected from local stalls, shops and street vending sites at different locations in Karachi city from April 2015 to August 2016. Some food samples were proceeded on time as soon as the sample was collected while the others were examined after 10-12 hours. To avoid any exogenous contamination, food samples were aseptically collected, maintained and stored at 4°C in refrigerator until analyzed.

Isolation and enumeration of total viable count

1 gm/mL of food sample was homogenized in 99ml of maximum recovery diluent and the beaker was let to stand for 15-20 minutes. Ten folds serial dilutions were prepared by adding 1 mL homogenized sample in 9 ml blank (distilled water) up to 10^{-6} dilution. From the last three dilutions (10^{-4} , 10^{-5} , 10^{-6}), Miles and Misra technique²⁸ was performed in triplicate to determine the total

number of bacterial count. From each dilution, six drops of 20 μ l were positioned on Mueller Hinton agar plates. Inoculated plates were left undisturbed until the drops were properly absorbed. Then plates were incubated overnight at 37°C. Colonies were counted and tabulated after incubation period.

Enrichment and identification of bacteria

Enrichment technique was used for the isolation of bacteria belonging to Enterobacteriaceae family for which Lactose

broth and Mossel's broth were used. Subsequent to selective enrichment, inoculation was done from Lactose and Mossel's broth to selective media including MacConkey's agar, *Salmonella Shigella* agar, Deoxycholate Citrate agar, and Eosin Methylene Blue agar. Discrete colonies on selective media after incubation were inspected macroscopically and microscopically then biochemical tests were performed for further identification according to Bergey's manual of determinative biology²⁹ as shown in Table 1.

Figure 1. Map of Central district Karachi highlighted the research areas. Source: Official web portal of Karachi Metropolitan Corporation (<http://www.kmc.gos.pk/>).

Table 1. Biochemical characteristics of bacteria recovered from street foods.

Biochemical tests	<i>E.aerogenes</i>	<i>S.fonticola</i>	<i>E.coli</i>	<i>S.liquefaciens</i>	<i>C.freundii</i>	<i>S.grimesii</i>	<i>Pseudomonas</i> spp	<i>S.fecalis</i>	<i>S.aureus</i>	<i>L.adecarboxytaca</i>
IND	-	-	+	-	-	-	-	+	-	+
MR	-	+	+	+	+	+	+	-	-	+
VP	+	-	-	-	-	-	-	+	-	-
CIT	+	+	-	+	+	+	+	-	-	-
NIT	+	+	+	-	+	+	+	-	+	+
TSI	A/Ag+	A/Ag	A/Ag+	K/A	K/Kg H ₂ S	A/A	K/Kg	A/K	A/A	A/Ag+
SIM	--+	-+-	-+-	-+-	++-	--+	--+	-	-	-++
Oxi/Cat	-/+	-/+	-/+	-/+	-/+	-/+	+/+	-/+	-/+	-/+
URE	-	-	-	-	-	-	-	-	-	-
Glu	AG	AG	AG	A	AG	AG	A	A	A	AG
Lac	A	A	AG	-	AG	-	a	A	A	AG
Suc	A	AG	A	-	a	AG	a	A	A	AG
Mal	A	AG	AG	A	AG	AG	a	A	A	AG
Mani	A	AG	AG	-	AG	AG	-	A	A	AG
Man	A	AG	AG	A	AG	AG	-	A	A	AG
Xyl	A	AG	AG	A	-	AG	a	a	A	AG
Sor	A	AG	AG	-	AG	AG	-	A	A	-
Raf	A	AG	-	-	-	AG	-	-	-	AG
Dul	-	AG	AG	-	-	-	-	-	-	AG
Fru	A	AG	AG	-	AG	AG	a	A	A	AG

(-), negative; (+), positive; AG, acid and gas production; A, acid production only; a, weak acid production.

Statistical analysis

All experimental analyses were done in triplicates and interpretations were presented as Mean $\pm$ SD by Minitab software version 17.

Results

Epidemiological survey

Data with respect to the food and health awareness was gathered through structured based survey from public (Table 2). Survey was based on basic inquiries regarding individuals' dietary patterns, cleanliness practices and awareness on food related health risks. According to the survey, deliciousness 68.57% and convenience 42.85% are the primary explanations for the street food popularity. These foods are so scrumptious that individuals cannot get enough of it and due to this reason people tend to eat out 3-4 times *i.e.* 64% in a week. As indicated by the collected information, eating street foods is more prevalent in the age group of 20-29 years and majority of the food lovers are female *i.e.* 61.4%. According to the survey, 54% of the public prefer to eat on spot and 89.4% of these people do not wash or sanitize hands before having a meal. This study showed that 46% of the general population encountered malaise (nausea, vomiting, and stomach ache) after devouring street food in the past. It was likewise noticed that 14% of participants do not have the information about foodborne diseases and in addition, 13% of the public do not comprehend the significant health hazard related with poor dietary habits. Ready-to-eat foods samples were collected from various street vending sites at different locations of Karachi city. The most favorite food items to which public are attracted are fries 71.4%, Barbeque items 45.71%, Chaat 34.28%, Nehari 27.14% followed by Fried chicken 15% as shown in Figure 2. The types of street foods analyzed in this study were Nehari 10%, Haleem 10%, biryani 10%, Barbeque items 10%, Salad 2%, Fish 4% *etc.* as presented in Figure 3. Out of 70 volunteers, 29 contracted diarrhea, 25 reported to have suffered food poisoning, 10 experienced constipation, while 7 of them faced dysentery after consuming street food in past as shown in Figure 4.

Microbial quality of street foods

An aggregate of 54 food items were microbiologically examined and all samples were positive for microbial growth. Both Gram-positive and Gram-negative bacteria were recovered from the food samples (Table 3). Of the bacteria isolated,

Pseudomonas spp 20% and *Bacillus* spp 18% were predominant followed by *S. aureus* 6%, *S. epidermidis* 6% and *S. fecalis* 2% as shown in Figure 5. Among Enterobacteriaceae, *E. coli* 14% and *E. aerogenes* 10%, both notoriously known to cause food poisoning, diarrhea and dysentery cases, were also isolated. Similarly,

S. fonticola, *S. liquefaciens*, *S. grimesii* considered as opportunistic organisms were also isolated from food samples.

Total viable count

The mean bacterial count of the isolates was expressed as log CFU/gm (mL). Food was classified as acceptable if the bacterial

Table 2. Evaluation of basic knowledge of public through closed system questionnaire based survey.

Parameters	Frequency n=70
Age (years)	
<20	4 (5.7%)
20-29	42 (60%)
30-39	6 (8.5%)
40-49	4 (5.7%)
50-59	1 (1.4%)
60-69	1 (1.4%)
Gender	
Male	27 (38.5%)
Female	43 (61.4%)
Knowledge about food borne diseases	
Yes	47 (67%)
No	10 (14%)
Kind of	13 (19%)
Awareness regarding the major health risks with poor eating habits	
Yes	61 (87%)
No	9 (13%)
Preference of eating	
On spot	38 (54%)
Takeaway	36 (74%)
If on spot, do you wash your hands before eating?	
Yes	36 (51.4%)
No	34 (49%)
Junk foods make you eat more?	
Agree	48 (69%)
Disagree	22 (31%)
Are junk foods healthy?	
Yes	4 (5.7%)
No	66 (94%)
How many times do you eat out a week?	
None	2 (3%)
1-2	45 (64%)
3-4	11 (16%)
5-6	4 (5.7%)
7-8	1 (1.4%)
>8	4 (5.7%)
Instant nausea, vomiting, stomach ache after consuming street foods?	
Yes	12 (17%)
No	28 (40%)
Sometimes	32 (46%)
Reason for consuming street food	
Convenient	30 (42.85%)
Delicious	48 (68.57%)
Pleasant appearance	11 (15.71%)
Peer influence	6 (8.57%)
Healthy	6 (8.57%)
Habit	12 (17.14%)
Discount	2 (2.85%)
Nice odor	12 (17.14%)
Inexpensive	15 (21.42%)
Curiosity	1 (1.42%)

count was less than or equal to 5 log CFU/gm (mL).³⁰⁻⁴⁰ The cumulative aerobic count of all tested street food samples was 7.18 ± 1.26 CFU/gm (Table 4). TVC of grilled chicken 9.15 ± 0.01 CFU/gm was the highest and TVC for fried fish 4.46 ± 3.86 CFU/gm was the lowest among all food samples. Tested food items were not found to be within the acceptable microbial quality limits and were potential source of food-borne diseases. The presence of high bacterial load in tested samples was attributed to post cook handling like serving with bare hands and use of untidy utensils. Table 5 demonstrated that how the tested street foods are typically prepared, cooked, handled, and served.

Discussion

Epidemiological studies are of great importance in researching the links between foodborne sickness and its causes. Being an ignored area of study in a developing country like Pakistan, there is no significant epidemiological data to infer relationship between consumption of different street foods and the resultant foodborne diseases. Several food poisoning outbreaks due to street foods were reported in China from 1983 to 1992 in Shandong province in which street foods were found to cause 691 food poisoning cases and 49 resulting deaths.³⁰ Other studies also supported the high risk of consuming street foods culminating in foodborne diseases.³¹⁻³⁴ It was reported in previous studies that more or less similar food borne pathogens including *E. coli*, *S. aureus*, *S. fecalis*, *S. typhi* and *Bacillus* spp were isolated from various street foods.³⁵⁻³⁹

The extrinsic and intrinsic environment under which the street foods prepared, processed and sold by vendors and hawkers were not suitable and did not fulfill the standards of GHP and GSP.⁴⁰⁻⁴² pH of all the food samples and the temperature of environment where foods were prepared, examined in this research were more or less similar and respectively classified under the range in between (6.5-7.0) and (30-37°C). This investigation described the impact of seasonal variation on the type of bacteria recovered from street vended foods. As sample collection was performed between the periods April 2015 to August 2016. It was observed that the food items acquired and handled in winter season had lower bacterial count showing decrease in the total aerobic count of microorganisms while marked intensification in TVC was noticed in summer season. Correspondingly, from November to February, only gram positive

Table 3. Quantity of food items analyzed and microbes recovered from famous street foods in Karachi.

Street Foods	Bacteria isolated
Nehari (n=5)	<i>E. coli</i> , <i>S. fonticola</i> , <i>S. aureus</i>
Biryani (n=5)	<i>S. grimesii</i> , <i>P. cholerae</i> , <i>E. adecarboxytaca</i> , <i>S. fonticola</i> , <i>E. coli</i>
Korma (n=5)	<i>E. coli</i> , <i>E. aerogenes</i> ,
Haleem (n=5)	<i>S. liquefaciens</i> <i>Bacillus</i> spp, gram negative rods
BBQ items (n=5)	<i>Pseudomonas</i> spp <i>Bacillus</i> spp
Beef items (n=4)	<i>Pseudomonas</i> spp <i>E. coli</i> , <i>E. aerogenes</i> ,
Salad (n=1)	<i>Bacillus</i> spp
Sandwich (n=4)	<i>C. freundii</i> , <i>Pseudomonas</i> spp, <i>E. coli</i> , <i>S. fonticola</i>
Finger fish & sauce (n=1)	<i>S. aureus</i> , <i>S. epidermidis</i> , <i>Bacillus</i> spp
Samosa (n=4)	<i>E. coli</i> , <i>Bacillus</i> spp, <i>E. aerogenes</i>
Pani puri (n=1)	<i>E. coli</i> , <i>E. aerogenes</i>
French fries (n=2)	<i>Pseudomonas</i> spp, gram negative rods
Fried chicken items	
Grilled chicken (n=1)	<i>S. fonticola</i> , <i>S. epidermidis</i> , <i>C. freundii</i>
Stuffed chicken (n=1)	<i>Pseudomonas</i> spp, gram negative rods
Mayo garlic roll (n=1)	<i>S. fecalis</i> , <i>C. freundii</i>
Chicken roll (n=1)	<i>E. aerogenes</i>
Chicken Manchurian (n=1)	<i>S. fecalis</i>
Chicken shashlik (n=1)	<i>Pseudomonas</i> spp
Chicken tikka roll (n=1)	<i>S. fonticola</i> , <i>P. fluorescens</i>
Wonton (n=1)	<i>Pseudomonas</i> spp, <i>C. freundii</i>
Zinger burger (n=4)	<i>Bacillus</i> spp, <i>S. fonticola</i> , <i>Pseudomonas</i> spp

Table 4. Total bacterial counts [Mean log₁₀ CFU/g (ml) ± standard deviation for foods with at least 2 samples & log₁₀ CFU/g (ml) for 1 food sample].

Food items	Mean log CFU/g (ml)	SD (±)
Korma	7.63 – TNTC	0.73
Haleem	7.42– TNTC	0.61
Samosa	8.43 - TNTC	0.03
Zinger	7.33	0.90
Sandwich	6.80– TNTC	0.62
Biryani	7.18 – TNTC	0.25
Nehari	7.49 - TNTC	0.52
Pani puri	TNTC	-
Fish	4.46	3.86
Fish sauce	4.67	4.04
Salad	4.67	4.04
Grilled chicken	9.15	0.01
Fries	7.60 - TNTC	0.18
Shashlik	7.0	0.0
Chicken Manchurian	7.02	0.35
Wonton	7.31	0.15
Stuffed chicken	8.61	0.03
Mayo garlic roll	6.79	0.17
Tikka roll	7.44	0.08
Chicken roll	TNTC	-
Dhaga kabab	6.99	0.30
Bihari boti	8.68	0.09
Tikka	TNTC	-
Creamy tikka	8.21	0.02
Total	7.18	1.26

Figure 2. Main streams foods of Karachi.

Figure 3. Frequency of food items analyzed.

Table 5. Street foods encountered in Central district Karachi with a description of the major components.

Street foods	Ingredients	Nature of food	Handling after cooking	Source of contamination
Nehari	Meat, onion, spices	Entirely cooked	Served hot with spoon	Equipment, eating bowl
Wonton	Minced chicken, onion, spring onion, egg, spices dough, oil	Deep fried, snack	Served with hands or tong	Hands
Biryani	Chicken/beef, rice, spices, potato	Entirely cooked	Served hot with spoon	Equipment, eating bowl
Chicken shashlik	Chicken, onion, tomato, capsicum, lemon, yogurt, spices	Pan fried	Served hot	Equipment, eating bowl
Grilled chicken	Chicken, spices, butter yogurt	Grilled	Served hot with spoon	Under cooked
Stuffed chicken	Chicken, vegetables, mayo, cream, spices, egg	Deep fried	Served with spoon	
Pani puri	Flour, chana, onion, spices, potato,	Mixture of fried, cooked and raw ingredients; snack	Served with hands	Hands, serving bowls,
Haleem	Beef, onion, spices, pulses, oil, wheat, rice	Served hot with spoon	Equipment, eating bowl	
Chicken Manchurian	Boneless chicken, tomato sauce, onion, sugar, pineapple juice, spices, oil, soya sauce	Cooked	Served hot with spoon	Equipment, eating bowl
Chicken mayo garlic roll	Boneless chicken, mayo sauce, flour, spices, yogurt	Fried, cooked	Served with hands	Hands
Sandwich	Beef/chicken patty, egg, oil, tomato, onion, cucumber, ketchup, mint chitin, spices	Cooked	Served with hands	Hands
French fries	Potato, spices	Deep fried	Served with hands	Hands
BBQ items	Chicken/ beef, spices, oil, butter, cream, onion, yogurt	Cooked on coal	Served hot with hands	Hands
Zinger	Chicken, flour, pepper, chili sauce, ketchup, mayonnaise	Deep fried	Served hot with hands	Hands
Samosa	Boiled mashed potato, spices, dough	Deep fried, snack	Served with hands	Hands
Coleslaw salad	Cabbage, spring onion, carrot mayonnaise, pepper, lemon, sugar	No cooking	Served with spoon	Fresh vegetables, hands and equipment
Finger fish	Fish, spices, egg wash, bread crumbs	Deep fried	Served with hands	Prolong storage, hands

Figure 4. Incidence of food borne diseases consuming street vended food in Karachi.

Figure 5. Percentage dominance of microbes recovered from street vended foods in Karachi.

bacteria including *S. aureus* and *Bacillus* spp were seen. But on the other hand from the month of March-October, Gram negative as well as Gram positive bacteria were recovered from street food samples. The working site remain uncleaned after preparation of food that will increase the chance of cross contamination during the making of next meal. Other factors including food handling, waste disposal, using filthy utensils successively, reheating, storage problems, and open environment where food items are not fully covered might add up the chance of microbial load. Beside these factors, personal hygiene of most of the vendors were seriously compromised.^{41,43} Food borne illness is a very serious public issue which is left behind due to scientific deployment in this field. The rate of likelihood of street foods among public is directly proportional to health risks associated with street foods.

Conclusions

The results obtained in this study demonstrated that street foods sold in Central region Karachi constitutes a potential hazard to human health. The isolation of bacteria belonging to the family Enterobacteriaceae in street vended foods that were entirely cooked was a decent marker of post-handling defilement or deficient cooking. The results indicated the presence of potentially threatening strains in street foods that could serve as a critical vehicle for transmitting resistant organisms to consumers on daily basis. Accordingly, access to clean water and wellbeing instruction to the sellers on individual's cleanliness, food security, and legitimate transfer of waste would enhance the food quality and diminish food borne incidences in future.

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