



Identification of microbiological hazards and safety of ready-to-eat food vended in streets of Amravati City, India

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ABSTRACT

Objectives: There are reports of food borne illnesses associated with the consumption of street vended foods in several places in India. A rapid review of street vended food was undertaken to assess its safety for human consumption and as potential sources of bacterial pathogens.

Methodology and results: A total of 55 samples were analyzed. The bacterial pathogens identified were *P. aeruginosa* (39%), *E.coli* (21%), *S. aureus* (16%), *Salmonella* sp. (12%) and *Proteus* sp. (12%). The highest frequencies of occurrence of bacterial pathogens were *P. aeruginosa* in samosa (25%), *E. coli* in kachori (32%), *S. aureus* in kachori (27%), *Proteus* sp. in palakwada (45%) and 36% *Salmonella* sp. in samosa.

Conclusion and application of findings: Food contamination in Amravati City streets is mainly due to poor water quality and hygiene during food preparation, washing of utensils, poor personal and domestic hygiene, peeling of fruits long before consumption, and crowded, dusty and poorly maintained shopping areas. The location of shops alongside busy roads with heavy vehicular traffic, which increase airborne particles, or beside waste disposal sites and over crowded dwellings, adds to the contamination. These findings demonstrate that the ready-to-eat food vended in Amravati City constitute an important potential hazard to human health. Provision of health education to the vendors and enforcing implementation of appropriate hygienic practices would improve food quality.

Key words: Street vended foods, bacterial contamination, food safety, *Escherichia coli*, *Pseudomonas aeruginosa*.

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INTRODUCTION

The street food industry plays an important role in meeting the food requirements of urban dwellers in many cities and towns of developing countries. The industry feeds millions of people daily with a wide variety of foods that are relatively cheap and easily accessible. However, food borne illnesses of microbial origin are a major health problem associated with street foods (WHO, 2002).

The traditional processing methods that are used in preparation, inappropriate holding temperatures and poor personal hygiene of food

handlers are some of the main causes of contamination of street-vended food. Consumers who depend on such food are more interested in its convenience and usually pay little attention to its safety, quality, and hygiene (Mensah *et al.*, 2002; Muinde & Kuria, 2005; Barro *et al.*, 2006).

Food borne illness associated with the consumption of street vended foods has been reported in several places in India and elsewhere (FAO, 1988; Estrada Garcia *et al.*, 2004; Chumber *et al.*, 2007; Ghosh *et al.*, 2007). Street foods are frequently associated with diarrhoeal

diseases which occur due to improper use of additives, the presence of pathogenic bacteria, environmental contaminants and disregard of good manufacturing practices (GMPs) and good hygiene practices (GHPs). Vendors are often poorly educated, unlicensed, untrained in food hygiene, and they work under crude unsanitary conditions with little or no knowledge about the causes of food borne disease (Barro *et al.*, 2007). Most of the foods are not well protected from flies, which may carry food borne pathogens. Safe food storage temperatures are rarely applied to street foods. Potential health risks are associated with contamination of food by *E.coli*, *Salmonella typhi*, *Pseudomonas sp.*, *Staphylococcus aureus* or *Proteus sp* during

preparation, post cooking and other handling stages (Hanoshiro, *et al.*, 2004; Ghosh, *et al.*, 2007).

Even though people are aware that food borne diseases could occur due to consumption of street food, the majority disregards these health hazards (Bryan, 1998). Therefore, the conditions under which street food preparation and vending occurs raise many concerns related to consumers' health. In view of the high demand and over crowding of food shops in many streets within Amravati City in India, a rapid review of the ready-to-eat food vended on the streets was undertaken during June–December 2007. The main objective was to assess the microbial hazards and threats to human health that are associated with consumption of these foods.

MATERIALS AND METHODS

Sample collection: Eight locations in Amravati City, catering to different age groups and communities were chosen for collection of samples. A total of 55 samples were analysed which included sambarwadi (3), palakwada (9), samosa (11), pakode (5), kochori (14), batatawada (7), pohe (2), dahiwada (1), gelabi (1), bread pakoda (1) and balushahi (1) (Table 1). The samples were put in a sterilized container and transported to the laboratory within 1h.

Sample analysis: For analysis 1g of food was diluted with 10 mL sterile distilled water. From this diluted sample 0.5 ml was taken and put in 4.5 ml MacConkey broth and incubated for 4 - 5 h. The growing microorganisms, observed as turbidity in the broth, were then subcultured on Cysteine Lactose Electrolyte Deficient agar (CLED) and incubated at 37°C for 24h. Tentative identification of isolates was done by Gram staining, motility, oxidase test and cultural characteristics on CLED such as yellow colored colonies of lactose fermenting *E.coli*, greenish colour colonies of *Proteus sp.*, greenish blue or blue colonies of *P. aeruginosa*, mucoid yellow to whitish blue colonies of *Klebsiella sp.* and deep yellow opaque colonies of *S. aureus* (Hi-Media Manual, 2003).

Confirmatory identification of the bacterial pathogens was done by subculturing on Xylose Lysine Deoxycholate agar (XLD agar; M1108, Himedia, Mumbai), *Salmonella-Shigella*-agar (S-S agar M108, Himedia, Mumbai) for *Salmonella spp.*, Mannitol salt agar for *Staphylococcus aureus*, Cetrimide Agar for *Pseudomonas sp.*, MacConkey agar for other enteric pathogens and other biochemical tests (Collee *et al.*, 1996). Further confirmation was done by inoculating typical colonies into Rapid Microbial Limit Test (MLT) kits, which combine media in liquid and solid phase in a single bottle for simultaneous enrichment, isolation, and confirmation of pathogen identity. The MLT kits enable accurate identification of pathogens (Himedia Labs Ltd., Mumbai, India).

Together with the food samples, information/ and data on season, place and site of shop, time of collection, hygienic status of vendor and their servants, number of servants and their clothes, methods of food preparation and hygiene conditions of vending site were recorded and correlated to bacterial contamination of food. All data were analysed with the Statistical Package for Social Sciences software, Version 15 for Windows (SPSS Inc.; Chicago, IL, USA).



A: Food exposed to dust and other foreign matter that attract flies and cockroaches.



B: Samosas that have been prepared early and thus exposed for too long before consumption.



C: Handling food items unhygienically with bare hands.



D: Handling food unhygienically with only one hand covered.



E: Unhygienic washing of hands, glasses and utensils in the same bucket and without soap.



F: Hygienically preparing/-serving food items to prevent dirt and bacterial contamination.

Photo 1: Conditions of storage, handling and serving of ready-to-eat food vended on streets of Amravati city, India.

RESULTS AND DISCUSSION

In developing countries, drinks, meals and snacks sold by street food vendors are widely consumed by millions of people. These street foods provide an affordable source of nutrients to most of the lower income sectors of the population who appreciate the food due to its taste, low price, and availability at the right time (FAO, 1988). However, street foods are

frequently associated with diarrhoeal diseases due to improper handling and serving practices (WHO, 2002; Bhaskar *et al.*, 2004; Barro *et al.*, 2006).

Therefore, the condition under which street food is prepared and vended raises many concerns for consumers' health. In most cases running water is not available at vending sites, and thus hand and

dish washing are usually done in buckets and sometimes without soap. Wastewater and garbage are discarded nearby, providing nutrients for insects and rodents. Some of the foods are not well protected from flies or other organisms, which may

carry food borne pathogens. Food and its ingredients are also exposed to contamination from unwashed hands and the materials used for wrapping such as leaves, old newspapers, and re-used polythene bags.

Table 1: Types of street-vended food sampled and extent of contamination in Amravati City, India.

Sample Location	Food Type											No. of bacterial pathogen isolated	
	Palakwada	Samosa	Batawada	Pakode	Kachori	Sambarwadi	Bread pakoda	Jalebi	Balushahi	Dahiwada	Pohe		Total samples
Bus Stand	1	2	-	1	3	1	-	-	-	-	-	8	9 (10%)
Camp road	1	2	1	-	3	-	-	-	-	-	-	8	14 (15%)
Prabhat square	2	2	2	1	4	-	-	-	-	-	-	11	22 (24%)
Irwin Square	2	-	1	1	-	1	-	-	-	-	-	5	7 (8%)
Gadge Nagar	1	1	1	1	1	-	1	1	-	-	1	8	15 (16%)
Rajkamal	-	1	1	1	1	-	-	-	1	-	1	6	9 (10%)
Gandhi Square	1	1	1	-	1	-	-	-	-	1	-	5	10 (11%)
Rajapeth	1	2	-	-	1	-	-	-	-	-	-	4	6 (6%)
Total	9	11	7	5	14	3	1	1	1	1	2	55	92 (100%)

Note: Palakwada, Samosa, Batawada, Kachori, Dahiwada, Pakode, Bread pakode are all Indian dishes mainly fried, prepared from gram powder mixed the either vegetable or mixed vegetable or Potato or curd or Bread and usually consumed in the evening on roadsides. The Jalebi and Balushahi are sweet fried dishes, prepared from starchy food items long before eating. The pohe are beaten fried rice and prepared usually just prior to eating in morning.

Table 2: Bacterial pathogens isolated from various foods sampled in streets of Amravati City, India

Type of food	Bacterial pathogen					Total
	<i>E. coli</i>	<i>Proteus spp.</i>	<i>Ps. aeruginosa</i>	<i>Salmonella sp.</i>	<i>S. aureus</i>	
Balushahi	0	0	1(3%)	0	0	1 (1%)
Batawada	1(5%)	1(9%)	6(17%)	1(9%)	2 (13)	11 (12%)
Pakode	1(5%)	0	3 (8%)	1 (9%)	1 (7%)	6 (7%)
Breadpakoda	0	0	0	0	1	1 (1%)
Dahiwada	0	0	1(3%)	0	1 (7%)	2 (2%)
Jalebi	0	0	1(3%)	1 (9%)	1 (7%)	3 (3%)
Kachori	6(32%)	2(18%)	7(19%)	2 (18%)	4 (27%)	21 (23%)
Palakwada	3(16%)	5(45%)	5(14%)	1 (9%)	3 (20%)	17 (18%)
Pohe	2(11%)	1(9%)	2(6%)	0	0	5 (5%)
Sambarwadi	2(11%)	0	1(3%)	1 (9%)	0	4 (4%)
Samosa	4(21%)	2(18%)	9(25%)	4 (36)	2 (13%)	21 (23%)
Total	19 (21%)	11 (12%)	36 (39%)	11 (12%)	15 (16%)	92 (100%)

The highest bacterial contamination was 24%, found in food vended at Prabhat Square followed by Gadge Nagar (16%) and Camp road (15%) (Table 1). The highest frequencies of occurrence of bacterial pathogens were *P. aeruginosa* in samosa (25%), *E. coli* in kachori (32%). *S. aureus* in kachori (27%), *Proteus sp.* in palakwada (45%) and 36% *Salmonella sp.* in samosa (Table 2). All food samples were contaminated with bacterial pathogens, with a total of 92 enteric isolates identified. The most frequently

isolated pathogens were *P. aeruginosa* (39%), *E.coli* (21%), *S. aureus* (16%), *Salmonella sp.* (12%) and *Proteus sp.* (12%) (Table 2). Burt *et al.* (2003) has previously observed a high incidence of *Pseudomonas sp.* (69%) in street food samples. In our study, *Pseudomonas sp.* constituted 33 and 43% of the isolates from kachori and samosa, respectively, which might be due to poor personal hygiene of vendors and a slime layer (biofilm) on poorly cleaned utensils. Often, the same utensils are

used alternately to hold cooked and raw food materials without proper cleaning, which promotes cross contamination. The clothes used to clean dishes also present hazards to food safety (Hanoshiro *et al.*, 2004). Our findings also show a

high incidence of *E.coli* (21%), which might be occurring through contaminated water supplies or through poor hand washing and contamination of utensils (Tambekar *et al.*, 2006, 2007).

Table 3: Distribution of bacterial pathogens in street food according to sampling location, season and hygiene conditions at the vending site in Amravati City, India.

Parameter	Type	Bacterial isolate					Total (%)
		<i>E.coli</i>	<i>Proteus sp</i>	<i>Ps. aeruginosa</i>	<i>Salmonella sp.</i>	<i>S.aureus</i>	
Location of Shop	Crowded	15 (79%)	5 (45%)	24 (67%)	7 (64%)	14 (93%)	65 (71%)
	Less crowded	4 (21%)	6 (55%)	12 (33%)	4(36%)	1 (7%)	27 (29%)
Season of collection	Monsoon	12 (63%)	8 (73%)	16 (44%)	5 (45%)	10 (67%)	51 (56%)
	Post monsoon	7 (37%)	3 (27%)	20 (56%)	6 (55%)	5 (33%)	41 (44%)
Number of servant	One	8 (42%)	9 (82%)	15 (42%)	5 (45%)	5 (33%)	42 (47%)
	Two	11 (58%)	2 (18%)	21(58%)	6(55%)	10 (67%)	50 (53%)
Personal hygiene of servant	Poor	10 (53%)	4(36%)	16(44%)	3(27%)	8 (53%)	41 (47%)
	Fair	7(37%)	3(27%)	14(39%)	4(36%)	7(47%)	35 (35%)
	Good	2(11%)	4(36%)	6(17%)	4(36%)	0	16 (18%)
Hygiene condition of vending site	Poor	9(47%)	7(64%)	21(58%)	6(55%)	10(67%)	53 (56%)
	Fair	8(42%)	4(36%)	11(31%)	5(55%)	3(20%)	31 (35%)
	Good	2(11%)	0	4(11%)	0	2(13%)	8 (9%)
Time of food preparation	Long before eating	15(79%)	10(91%)	25(69%)	9(82%)	10(67%)	69 (75%)
	Just prior to eating	4(21%)	1(9%)	11(31%)	2(18%)	5(33%)	23 (25%)

Contamination of street food with *S. aureus* was also significant at 16% which might be occurring through infected wounds, running hands through hair or scratching the scalp, cuts, burns and dirty clothing of the vendors (Muleta & Ashenafi, 2001; Ghosh *et al.*, 2007). *Salmonella* and *Proteus sp.* could have contaminated the foods through contaminated water, sewage and soil, handling of food by infected workers, vendors, and consumers in the market place (Adams & Moss, 2002).

Kachori and samosa were highly contaminated (23%) followed by palakwada (19%), batatawada (12%) and pakode (7%). Foods that were prepared long before consumption had were more contaminated (75%) than food prepared just before consumption (25%). Demand for kachori and samosa was high; hence these were prepared in larger numbers well before serving. Most of these foods were prepared at home and often kept uncovered at the vending site, which exposed them to dust and soil contamination. Pohe (5%), breadpakoda, and balushahi (1%) showed minimal bacterial contamination, as these food items were prepared and consumed freshly, mainly in the

morning when there was less traffic and less crowding at the vending site.

The foods sampled from shops on streets that had heavy human or vehicular traffic were more contaminated (71%) than the shops housed further away from roads (29%). Out of 92 bacterial pathogens, 51 (56%) were more common in the monsoon season and 41 (44%) were frequently encountered in the post monsoon period. The dominant pathogen during the monsoon season was *E.coli* (63%), which may be due to increased exposure to human sewage or contaminated water as fecal material get mixed with water (Tambekar *et al.*, 2008).

In shops where food was sold by only one servant or only the owner, the extent of food contamination was less (47%) as compared to where there were two servants (53%). This indicates that personal hygiene plays an important role in spread of infection. Poor personal hygiene of vendor resulted in higher contamination (56%), reducing to 35 and 9% contamination where the hygiene was fair and good, respectively. *P. aeruginosa* (58%), *E.coli* (47%) and *S. aureus* (67%) were frequently isolated from shops

that were rated to have poor personal hygiene conditions (Table 3). This might be due to dirty clothing, improper cleaning of dishes, unhygienic handling and serving practices, contaminated hands of vendor, and lack of knowledge of hygienic practices and safety of food products (Tambekar *et al.*, 2006) (Photo 1). Unhygienic surroundings like sewage, improper waste disposal system, inadequate water supply attracts houseflies or fruit flies, which further increases food contamination (Chumber *et al.*, 2007).

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