

Street Vended Food in Developing World: Hazard Analyses

Sharmila Rane

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Abstract Street food vending has become an important public health issue and a great concern to everybody. This is due to widespread food borne diseases, due to the mushrooming of wayside food vendors who lack an adequate understanding of the basic food safety issues. Major sources contributing to microbial contamination are the place of preparation, utensils for cooking and serving, raw materials, time and temperature abuse of cooked foods and the personal hygiene of vendors. Various studies have identified the sources of food safety issues involved in street foods to be microorganism belonging to the genus *Bacillus*, *Staphylococcus*, *Clostridium*, *Vibrio*, *Campylobacter*, *Listeria*, *Salmonella*. Application of sound risk analysis policies is being advocated to provide a scientific base to the host of risk management option which India may need to explore to ensure public health and safety.

Keywords Street foods · Food safety risks · Hazard analysis · Control measures · Initiatives

Street Foods

With the grip of sudden and unprecedented urban growth, and an increase in the size of the labour force, the demand for non-traditional services has gained momentum. The street food trade has shed its disorganized, lower class image and is becoming a viable, important informal-sector industry.

“Street foods are ready-to-eat foods and beverages prepared and/or sold by vendors and hawkers especially in streets and other similar public places” [1].

Street vended foods are not only appreciated for their unique flavors, convenience and the role which they play in the cultural and social heritage of societies, they have also become important and essential for maintaining the nutritional status of the populations [2, 3]. Besides offering business opportunities for developing entrepreneurs, the sale of street foods can make a sizeable contribution to the economies of developing countries. In India, the National Policy for Urban Street Vendors/Hawkers stated that street vendors constitute approximately 2% of the population of a metropolis [4].

Street foods are perceived to be a major public health risk due to lack of basic infrastructure and services, difficulty in controlling the large numbers of street food vending operations because of their diversity, mobility and temporary nature [5, 6]. A general lack of factual knowledge about the epidemiological significance of many street vended foods, poor knowledge of street vendors in basic food safety measures and inadequate public awareness of hazards posed by certain foods has severely hampered the deployment of a precise scientific approach to this very serious issue of public health and safety.

The epidemiological studies to suggest that street foods contribute to a significant number of food poisonings are inadequate, due to paucity of data deficiencies in knowledge about important parameters in the food chain and host pathogen interactions; however, there have been several documented cases of food poisoning outbreaks due to street foods. Street foods were responsible for 691 food poisoning outbreaks and 49 deaths from 1983 to 1992 in Shangdong Province (China) [7].

S. Rane (✉)
Foods Technology Centre, ITC R&D Centre,
Peenya Industrial Area, Bangalore 560058, India
e-mail: sharmila.rane@itc.in

Foodborne bacterial pathogens commonly detected in street vended foods are *Bacillus cereus*, *Clostridium perfringens*, *Staphylococcus aureus* and *Salmonella* spp. [8–14]. People who patronize street food, have been reported to suffer from food borne diseases like diarrhea, cholera, typhoid fever and food poisoning [15–19].

This study was undertaken to develop an understanding of the microbiological problems associated with street vended foods with particular reference to sources of risk and to identify the behavior and practices that may be hazardous and microbial risk assessment was used as tool for the purpose [20–23].

Hazard Analysis of Street Vended Foods

From the initial contamination of raw foods with pathogenic bacteria to subsequent contamination by vendors during preparation [24–26], the factors that should be considered for the analyzing the hazards due to street foods are many (Table 1).

Vending Location: Food Handling and Waste Disposal

The conditions under which some street vendors operate are reported to be unsuitable for the preparation and selling of food [27, 28]. The food is prepared either at home or at stalls, which are located on the street side and are made up of wood, polythene bags, tin, etc. The place of preparation is not always clean, well lit and not far from source of contamination. Preparation surfaces used by some vendors have remains of foods prepared earlier that can promote cross contamination. Most of these foods are not covered and are exposed to flies and dust, which may harbor foodborne pathogens. In 70–90% of the cases, presence of

animals, insects and liquid wastes in food preparation areas have been reported [29]. The two major sources from where the contaminants can enter the preparation area are: Improper food handling and waste disposal.

Food Handling

Unsanitary handling of street foods by the some of the vendor has been commonly found to be the source of contamination [30, 31]. The vendors can be carriers of pathogens like *Escherichia coli*, *Salmonella*, *Shigella*, *Campylobacter* and *S. aureus* who eventually transfer these food borne hazards to the consumers. The hands of the food handlers are the most important vehicle for the transfer of organisms from faeces, nose, skin to the food [32]. The finding that *Salmonella*, non-typhi salmonellae, *Campylobacter* and *E. coli* can survive on finger tips and other surfaces for varying periods of time [33] and in some cases even after washing, supports the reports of contamination of street vended food with toxigenic *S. aureus*, the major being suppurative lesions of human beings and the environment [34, 35].

Waste Disposal

Few vendors congregate in overcrowded areas where there are high numbers of potential customers, which usually provide limited access to basic sanitary facilities. Hence, the contamination of street foods is often linked to the waste generated by food processing, that is usually dumped near the vending site. The lack of facilities for liquid drainage and wastewater and garbage disposal encourages wastes to be thrown into nearby streets and gutters. Such areas act as habitats for rodents, breeding points for flies and media for growth of microorganisms. A study done

Table 1 Source and type of hazard and the microbial risk involved

S.No.	Source	Hazard	Risk involved
1	Vendor location	Improper food handling	Transfer of pathogens like <i>Salmonella</i> and <i>E. coli</i> , <i>S. aureus</i> from human body and environment into foods
		Improper waste disposal	Transmission of enteric pathogens like <i>Salmonella</i> , <i>Shigella</i> and <i>E. coli</i> via vectors
2	Raw materials	Water	Passage of pathogens like <i>E. coli</i> , fecal streptococci, <i>Salmonella</i> and <i>Vibrio cholerae</i>
		Vegetables and spices	Introduction sporeformers like Bacilli and Clostridium and pathogens like <i>L. monocytogenes</i> , <i>Shigella</i> , <i>Salmonella</i> , etc.
3	Utensils and equipments	Chemical contaminants	Leaching of chemical leading to poisoning
		Microbial contaminants	Cross contamination of food with <i>Staphylococcus aureus</i> , <i>E. coli</i> and <i>Shigella</i> due to contaminated water, dish cloth, handler
4	Storage and reheating	Improper storage temperature and reheating of food	Likelihood of heat stable toxins produced by pathogens like <i>C. perfringens</i> and <i>B. cereus</i>
5	Personal hygiene of vendors	Biological hazards	Introduction of <i>Staphylococcus</i> , <i>Salmonella</i> and <i>Shigella</i> via carriers

[36] in Africa revealed that 85% of the vendors prepared foods like fish, fruit salads, roasted maize and chips in unhygienic conditions, given that garbage and dirty waste were conspicuously close to the stalls. In these areas large amounts of garbage accumulates which provide harborage for insects and animal pests that are linked to enteric disease transmission (*Shigella*, *Salmonella* and *E. coli*) [2, 12, 24, 27, 37–39].

Quality of Raw Materials: Water and Other Material

The quality of raw materials used in the preparation of street foods is very important as their contamination can persist through preparation and or cooking.

Water

Water is a critical raw material in many street-vended operations. Contaminated water can create a public health risk when it is used for drinking, washing of foods, incorporated in the food as an ingredient and used in the processing of food or used for washing equipment, utensils and hands. It is a well known vehicle for enteropathogens such as *E. coli*, *Salmonella* spp. and *Campylobacter* spp. amongst others [40–42]. Studies carried out in different regions of Asia, Africa and South America have frequently pointed the unavailability of potable water for various activities at the vending site as a major concern. Due to the shortage of clean potable water, many vendors tend to re-use the water, especially for cleaning utensils and used dishes [31].

Studies done to find out the bacteriological quality of the water used by some street vendors have revealed frequent contamination with coliforms and fecal coliforms [43]. When the street foods in Trinidad and Tobago were analyzed, it was reported found that 35% of foods were contaminated by *E. coli* while 57.5% of water used by vendors were contaminated by coliforms [26, 44–46]. These reports were similar to the findings that the stored water used by consumers and vendors, at the vending site, showed heavy bacteriological contamination of faecal origin [31]. Such heavily contaminated water is a primary source of diarrheal diseases to the street food consumers. When water samples from storage tanks used by some vendors were checked at different localities in Pune, India, it was revealed that 29.6% of the water samples were not conforming to the WHO standards of potability and had coliform counts of more than 16/100 ml, while fecal coliform counts were more than 16/100 ml in 15.5% of water samples, 4.5% of samples were positive for *E. coli* and 2.7% for enteropathogenic *E. coli* [47]. Similarly, pathogens like *Salmonella* and *Shigella* have been detected in the water used by vendors for dishwashing [27].

Other Raw Materials

Besides water, other raw materials are also important to the safety of the street vended foods because of the biological, chemical and physical hazards that they might introduce. In order to keep prices down, some vendors purchase cheap or adulterated ingredients containing unpermitted chemical additives from unauthorized suppliers which may further increase the risks associated with the food so prepared. Raw meat, poultry and vegetables are commonly contaminated with large numbers of bacteria, including potential foodborne pathogens such as *B. cereus*, *C. perfringens*, *C. jejuni*, *E. coli*, *L. monocytogenes*, *Salmonella* and *S. aureus* [48, 49]. Spices are known to harbor a large number of microorganisms which include members of the genus *Bacillus*, anaerobic sporeformers, enterococci, members of Enterobacteriaceae, a variety of yeast and mould and pathogens like coagulase positive staphylococci. Contamination of foods by spices which act as spore carriers has been reported to lead to food spoilage and can even lead to food poisoning [23, 50]. Sporeformers in spices may lead to food spoilage, when they survive the cooking process and multiply under favorable conditions [50, 51].

In a study [43] done in Calcutta, samples that were suspected of adulteration were analysed and in 30 of the 50 samples, unauthorized food additives were detected. Similarly, pathogens like *B. cereus*, *S. aureus*, *C. perfringens*, *V. metschnikovii* and *E. coli* were reported [12] in raw chicken, salad and gravy raw materials. These organisms were probably present in these foods either prior to purchase by vendors or may have been introduced by cross contamination during food handling or during preparation.

Utensils and Equipments: Chemical and Microbial Contaminants

Use of proper utensils for cooking and storage of prepared food is often critical to the safety of street vended foods. Poor quality of material coupled with improper practices may lead to toxin formation, pathogen growth or recontamination. The design, construction and maintenance of equipments and utensils is very important to food safety, as their poor maintenance may lead to the inability to effectively clean and sanitize surfaces. This may then result in the build up of residues of food, facilitating microbial growth, leading to an increased likelihood of contamination. The appropriate use of equipment is also important to prevent the cross contamination from raw materials [17].

Chemical Contaminants

As some containers will leach hazardous chemicals like copper, lead and cadmium into food, use of equipment and

utensils incompatible with the food being handled, should be avoided. This has been observed particularly with acidic food and beverages [52].

Microbial Contaminants

The serving utensils used at the vending site are often contaminated with *Micrococcus* spp. and *Staphylococcus* spp. which may have originated from the vendors hands when they touched the food preparation areas, dishcloths, or the water during dish washing or hand washing which indicates cross contamination between dishwater, food preparation surfaces, and the food itself [53, 54].

It is reported that bacteria from dirty dish washing water and other sources adhere to the utensil surface and can constitute a risk during the food vending process. Microbiological analysis of utensils surface and knives have shown the presence of *Salmonella* and *Shigella* [27]. It is also reported that during the preparation of food, the raw material is cut and chopped using the same knife without in between cleaning and such knives are often invaded by flies [53].

Food Preparation: Storage and Reheating

An important issue influencing food contamination and contributing to further increase in contamination is food storage temperature. The preparation of food long before its consumption, storage at ambient temperature, inadequate cooling and reheating, contaminated processed food, and undercooking are identified as the key factors that contribute to food poisoning outbreaks [32].

Storage

Holding foods at high ambient temperatures for long periods of time have been reported to be a major contributor to the occurrence of food poisoning outbreaks [55]. Foods are often held for several hours after cooking and this includes overnight holding at ambient temperatures, until sold, and thus can harbor high microbial populations [7, 10, 11, 38, 39, 56]. Besides, some of the foods are held in the pans in which they are cooked, until sold or reheated, which results in longer holding time, hence creating favorable conditions for the growth of foodborne pathogens. In such foods, the counts of *Escherichia coli*, *Staphylococcus aureus*, *Bacillus cereus* and *Clostridium perfringens* are reported to be high [57, 58].

B. cereus was isolated from 42 (26.3%) samples of fried fish, tuwo, soup, boiled rice and moin moin suggesting that their spores survived the cooking process [14, 59]. The presence of this bacterium coupled with the storage of these foods at ambient temperatures for several hours under

high temperature and high relative humidity showed that the product could be hazardous. *B. cereus* has been responsible for outbreaks of foodborne illness because it produces heat stable (emetic) and heat sensitive (diarrheal) toxins when foods are held under conducive conditions for several hours [12, 53].

Kaul and Agarwal [17] reported high microbial count in fruit chat sold by a street vendor in Chandigarh, India where the counts ranged between 10^6 and 10^8 cfu/g, and a further increase in count by 1–3 log cycles was observed after 16 and 24 h of storage at room temperature. A number of pathogens, such as *E. coli*, *Salmonella typhimurium*, *Salmonella gallinarum*, *Shigella dysenteriae*, *Pseudomonas fluorescens* and *Klebsiella pneumoniae* were also found to be present in these samples.

Reheating

Time–temperature exposures during reheating need to be sufficiently high or long to inactivate large quantities of infectious microorganisms that could develop during the lengthy holding process. Some food vendors often partially or fully cook some products ahead of time, store them and then reheat them when requested by customers [59]. However, this reheating is often inadequate to destroy bacteria that may be present as this would allow the foodborne pathogens that germinate from spores which survived cooking or that contaminate the food after cooking, to survive and proliferate.

Personal Hygiene of the Vendors or Food Handlers

According to WHO [32], food handling personnel play an important role in ensuring food safety throughout the chain of food production, processing, storage and preparation. Mishandling and disregard of hygienic measures on the part of the food vendors may enable pathogens to come into contact with food and in some cases to survive and multiply in sufficient numbers to cause illness in the consumer.

Some food handlers may introduce biological hazards by cross contamination after handling raw materials when they suffer from specific diseases [52, 53] and physical hazards by careless food handling practices. Most of the vendors pack the food in polythene bags for their customers. When packing these foods, they blow air into the polythene bags to open them, in this process a number of pathogens can be passed on to the consumer.

A study in Santa Fe de Bogota, Colombia revealed that over 30% of a group of food handlers examined were carriers of pathogenic microorganism including *Salmonella typhi*, *Staphylococcus aureus*, *Salmonella enteritidis*, and *Shigella* [22].

Control Measures and Initiatives to Improve Street Food Vending

A logical step towards reducing the risks of food borne illness from street foods would be controlling the steps in food preparation and sale that may contribute to the contamination, growth and survival of the microbes responsible for food borne illness. The efforts made should focus on (a) educating the food handlers (b) improving the environmental conditions under which the trade is carried out (c) providing essential services to the vendors to ensure safety of their commodities [60].

To enable official recognition and control of the street food industry as an integral part of the food supply, appropriate regulations should be prepared, and incorporated into existing food regulations. FAO has implemented and supported several projects which aimed at improving various aspects of the street food sector in countries like Bolivia, Colombia, Ecuador, India, Zaire, etc.

Malaysia, Philippines and India are the three countries which have regulations for protecting street vendors. Malaysia is the only country where licensed street vendors are provided facilities for conducting their trade. An initiative has been taken in Africa, where a coalition between local and national authorities, explored the food laws associated with street vending and developed strategies that could be used to control identified food hazards [61]. Another policy was framed in Durban, Africa, where the street vendors were allocated specific areas to operate, issued certificate of acceptability and were also given training on essential food hygiene practices [62]. In India, CII Institute of Quality's Food Safety and Quality (FSQ), has taken an initiative to create awareness among the consumers and street food vendors and it has issued a simple informative checklist of hygienic practices, called the "CII-14 point checklist on food safety for street vended food" which emphasizes on implementation of good hygiene standards by the street vendors [63]. The scheme to upgrade hygiene and quality of street food has also been undertaken by the Ministry of Food Processing Industries, India. Under the proposed programme, 10,000 street food vendors will be identified, and the majority of stake-holders will be upgraded in terms of quality and hygiene and efforts would be made to make it mandatory for the vendors to register with the local authorities [64].

Conclusions

Epidemiologic information about the diseases caused by street foods with respect to adverse health impact, severity and duration is not sufficient, as outbreaks of such type rarely get reported and investigated to its logical

conclusion. The dose response model for such street foods can be created only when, the precise numbers of organisms ingested (dose) on consumption of contaminated food leading to foodborne illness is available. Such type of data will help in completing the risk analysis studies, as such studies are valuable aids in orienting health and food safety interventions when food sold in the street is identified as a disease vehicle and in gauging the health impact of improvements. Hence, studies about the dose–response, hazard characterization and risk characterization are required to be undertaken to carry out science based Microbiological Risk Assessment of street vended foods, thereby ensuring that large street food consuming populations are protected against both possible as well as perceived risks associated with relishing their favorite flavors.

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