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Street Foods: Risk and Safety

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Street foods are defined as ready-to-eat foods and beverages prepared and sold by vendors and hawkers, especially in streets and public place (Hanashiro *et al.*, 2005). The street food industry plays an important role in the developing countries (Canet and N'Diaye, 1996). More than 30% of street vendors sell foods in different cities in India (Sudershan *et al.*, 2009). Street vendors are appreciated for their unique flavour and convenience, as well as for maintaining the nutritional nature of traditional preparations for the population. They also assure food security for low-income group urban population on one hand, and provide livelihood for a portion of the population in many developing countries (WHO, 1996). The consumers who depend on such food are more interested in their convenience and low cost, rather than on aspects related to its safety, quality and hygiene (Barro *et al.*, 2002b; Collins, 1997; Mensah *et al.*, 2002). Street vendors generally use stands and carts which are often of crude and inappropriate design; frequently running water is not accessible to them, and they are forced to use the same and limited water for hand and dish washing using the same bucket, sometimes even without using any detergent or soap. The waste water is usually discarded in the street, and the waste material or garbage is disposed at the nearest point. This provides ready food for street animals and also attracts insects and rodents. In areas where public toilets are not available, the vendors are frequently forced to get rid of even their body wastes in nearby places and return to the vending sites without properly washing their hands (Bryan *et al.*, 1988; Ekanem, 1998). Usually the pieces of paper used for serving the food items are newsprint materials. Even dried leaves are often used for serving the food which point towards the clear possibility of the existence of microflora on leaves and newsprints (Mensah *et al.*, 2002). Vendors are often with no formal education without a license, untrained in food hygiene and work under crude and unsanitary conditions. They have no or very little knowledge about the cause of food borne diseases (Barro *et al.*, 2007). Inadequate storage, processing and cooking facilities also contribute to contamination (Dawson and Canet, 1991).

The microbiological safety of street foods is a major concern (Moron, 1992). Biological contaminants such as bacteria, viruses, fungi, protozoa and helminthes, etc. are the major causative agents of food-borne diseases with varying severity, ranging from mild indisposition to chronic or life threatening illness, or both (Edema *et al.*, 2005). In some cases street-vended foods have been implicated in outbreaks of food borne diseases (Dawson and Canet, 1991). For instance, in Perak of Malayasia, 14 people died as a result of eating rice noodles brought from street vendors (Bryan *et al.*, 1992b). A cholera epidemic in Pune was related to street-vended sugarcane juice containing ice that was contaminated with *Vibrio cholerae* (Bryan *et al.*, 1992b). Food borne illness caused by the consumption of street vended foods has been reported in several places in India and elsewhere (FAO, 1989; Estrada Gracia *et al.*, 2004; Chumber *et al.*, 2007; Ghosh *et al.*, 2007). It has also been reported that street foods even contain pathogens and have been implicated in food borne epidemics, particularly in developing countries (King *et al.*, 2000; Kubheka, *et al.*, 2001; Azanza and Ortega, 2004). *Staphylococcus aureus* causes illness ranging from minor skin infection resulting

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in pimples, boils, cellulites, toxic shocks syndrome, impetigo, and abscesses to fatal infections as pneumonia, meningitis, endocarditis, and septicemia (Soomro *et al.*, 2003; Masud *et al.*, 1988). *Listeria monocytogenes* is recognized as a food borne pathogen (Kaclikova *et al.*, 2001) and can cause serious diseases called listeriosis, particularly to pregnant women, newborns, very old and in people who are immune compromised (Fleming *et al.*, 1985). Contamination of food products with pathogenic bacteria can aid in the spread of certain harmful diseases like tuberculosis, gastroenteritis brucellosis, salmonellosis, and staphylococcal food poisoning (Jay, 1987; George, 1981).

Food borne bacterial pathogens commonly detected in street-vended foods are *Bacillus cereus*, *Clostridium perfringens*, *Staphylococcus aureus* and *Salmonella* spp. (Bryan *et al.*, 1988; Bryan *et al.*, 1992a,b,c; Bryan *et al.*, 1997; Mosupye and von Holy, 1999; Umoh and Odoba, 1999). *Bacillus cereus* and *Staphylococcus aureus* are major pathogens found in poultry street foods like chicken noodles, chicken fried rice etc. in Hyderabad (Sudershan *et al.*, 2009). The foods sampled from street shops that had close proximity to heavy human or vehicular traffic were more contaminated than shops housed further away from roads (Tambekar *et al.*, 2008). Other studies showing some emerging food and water borne pathogens detected in food were *Listeria monocytogenes, Campylobacter jejuni, Yersinia eneterocolytica, Salmonella, E. coli, Vibrio cholera* (Daga *et al.*, 2003).

Species of *Salmonella* and *Proteus* can occur through poor quality water, sewage and soil, and improper handling by the workers (Adams and Moss, 2002). Assessment of the microbiological safety of salad vegetables and sauces from *kebab* take-away restaurants in the United Kingdom has revealed high bacterial counts and a high incidence of food borne pathogens. About 4.7% of 1213 salad vegetable samples were of unsatisfactory quality due to the presence of *Escherichia coli* and *Staphylococcus aureus* levels at $\geq 10^2$ cfu/g, 0.3% of salad samples were of unacceptable quality due to *S.aureus* at $\geq 10^4$ cfu/g. Cucumber was the most contaminated salad vegetable with regards to unsatisfactory levels of *E.coli* (6.0%) or *S.aureus* (4.5%). The 5%) of sauce samples were of unsatisfactory levels due to *E.coli*, *S. aureus* at $\geq 10^2$ cfu/g and *Bacillus cereus* and other *Bacillus* spp. at $\geq 10^4$ cfu/g; 0.6% of sauce samples were of unacceptable quality due to *Bacillus* spp. at $\geq 10^5$ cfu/g (Meldrum *et al.*, 2009). Microbiological studies of street vended foods in America, Asia and Africa have revealed high bacterial counts and a high incidence of food borne pathogens (Bryan *et al.*, 1988, 1992a, b, 1997; Ekanem, 1998). *Aspergillus* and *Rhizopus* spp. were found in street foods of Africa like *kokoro* and *kunu tsamiya* (Adegoke *et al.*, 2008). *Aspergillus niger* has been found to produce protecathenic and oxalic acids which are toxic metabolites in *kokoro* (Avdesh and Prakash, 1968). A large proportion of main dishes are contaminated with unacceptable levels of bacteria (Mensah *et al.*, 2002). The hygienic aspects of street food processing and vending operations are a major source of concern for the authorities connected with food safety and control. *E. coli*, *S. aureus* and *L. monocytogenes* have been isolated from milk products, such as curd and cottage cheese, sold at shops in the unorganized sector of Agra (Singh and Prakash, 2008). *E. coli* frequently contaminates food items and is a good indicator of fecal pollution (Soomro *et al.*, 2002; Benkerroum *et al.*, 2004).

Studies carried out in food safety in various part of India focused on various pathogenic organisms that were detected in a variety of foodstuffs which revealed the presence of *E. coli, Enterobacter* spp, *Shigella* spp in milk and milk products (Bhat and Rao, 1987; Bhat *et al.*, 1995, 1996), faecal coliforms and *E. coli* in vegetables (Bhat *et al.*, 1997; Bhat and Vasanthi, 1998), *Staphylococcus aureus, E. coli, Enterobacter* spp, *Salmonella typhi* in salad vegetables, fruit and sprouts and *Bacillus cereus* in cooked food (Bhat and Vasanthi, 2000). In street foods of India, the highest frequency of the occurrence of bacterial pathogens, such as *Pseudomonas aeruginosa* in *samosa* (25%), *E. coli* (32%) and *S. aureus* in *kachori* (27%), *Salmonella* spp. in *samosa (36%), batatawada* (12%) and *pakode* (7%) has been recorded (Tambekar *et al.*, 2008). There was report of high incidence of *E. coli* in food items from the city of Amravati, which might be occurring through the use of contaminated water or through the poor practice of hand washing and/or on account of contaminated utensils (Tambekar *et al.*, 2006). This was followed by contamination with *Staphylococcus aureus*, which might be occurring through infected wounds, running hands through hair or scratching the scalp, cuts, burns and dirty clothing of the vendors (Muleta and Ashenafi, 2001; Ghosh

et al., 2007). *E. coli, S. aureus, coliforms* and *Enterococci* were isolated from street foods of Karnataka (Gautami *et al.*, 1995; Girish *et al.*, 2002). Sudershan *et al.* (2009) pointed out that the critical control points of contamination of both street foods and water samples are poor during handling and prolonged storage conditions. In various parts of Tamil Nadu street foods such as fried fish, sugarcane juice, *gulab jamoon* (traditional sweet preparation made of cereal flour and dipped in sugar syrup) and *athirasai* (Indian traditional sweet preparation made of rice flour and sugar) contained *Vibrio* spp and *E. Coli* (Gugnani, 1999). In Madurai, street foods had highest total aerobic plate counts of bacteria showing that the food was not safe for consumption (Jacob, 1976; Sudershan *et al.*, 2009). In Coimbatore street foods showed high coliform count during the handling procedures (Sudershan *et al.*, 2009). Pineapple juice sold in Hyderabad showed *E. coli* indicating fecal contamination in the water used to make the juice (Kannan *et al.*, 1997; Kalra *et* al., 1999). Bacterial profile of street foods in Mangalore eg., *bhelpuri, masalapuri, panipuri, sevpuri*, noodles, fried rice and lime rice were examined, the same were shown to be contaminated with bacteria (Bhat *et al.*, 2004). A study carried out to examine the quality and safety of street vended fruit juice in Vishakhapatman city revealed to be hygienically poor (Lewis *et al.*, 2006).

Many food products are highly perishable. They are easily contaminated when produced in an unhealthy and unclean environment. In fact, food is a very good indicator of environmental pollution and is quite often used to monitor the state of the environment (Francis, 1979). Enterotoxin producing *Staphylococcus aureus* is most dangerous and harmful for human health. About 50% strains of *S. aureus* are able to produce enterotoxin associated with food poisoning (Payne and Wood, 1974). Salmonellosis accounts for the greatest proportion of food borne disease outbreaks in industrialized countries, and is mostly due to *Salmonella enteritidis*, which is transmitted mainly through contaminated eggs and food containing eggs and poultry, and due to *Salmonella typhimurium* (Fisher, 1997). An analysis of data from the WHO covering 21 European countries during 1992-1993, indicated that, whenever the agent for the food borne disease outbreak was identified, *Salmonella* caused 84.5% of investigated outbreaks. In other cases, *S. enteritidis* (50.9%), *Staphylococcus aureus* (3.5%), *C. perfringens* (3.0%), *C. botulinum* (1.1%), *Trichinella* (1.5%), mushroom intoxication (1.3%), and *B. cereus* (1.0%) were attributed to all outbreaks (Todd, 1997). Infection with *E. coli* serotype O157:H7 was first described in 1982, which mainly causes bloody diarrhea and acute renal failure that can be fatal (Potter *et al.*, 1997). Outbreaks of severe food borne intoxications involving some hundreds of school children have repeatedly been reported in some African countries (FAO, 1989). Street food has also been recognized as an important vehicle for the transmission of cholera and other food borne diseases in Asia and Latin America (El-Sherbeeny *et al.*, 1985a). Foods though heated sufficiently to kill the microbes; spore-forming bacteria can be a major concern because ordinary cooking does not kill all spores (Bryan *et al.*, 1992a). Instead, anaerobiosis is enhanced, and spores are heat activated which stimulates them to germinate when environmental conditions become favorable for pathogenic growth (Bryan *et al.*, 1992a). Haryani *et al.* (2008) reported that in Malaysia the risk of disease transmission caused by *E. cloacae* through street foods is possible. Use of raw materials, temperature abuse during vending, inadequate cooking and use of leftovers are responsible for high microbial counts found in ready to eat foods sold in the Philippines (Azanza, 2005).

The growing concern about food safety by public health authorities and consumers based on media reports of food borne outbreaks (Board and Tranter, 1986) has provided the impetus for the application of a system of Hazard Analyses and Critical Control Points (HACCP). The HACCP system is defined by the Codex Alimentarius Commission (CAC) as a system which identifies, evaluates, and controls hazards which are significant for food safety (Motarjemi, 2001). Street food safety management needs a system of Hazard Analysis Critical Control Points (HACCP) to instill professional face to the street food operators (Bryan *et al.*, 1988). CAC (2004) formulated a concept of Food Safety Objective (FSO) proposed by (Gorris, 2005), and applicable to all food preparations for the production of safe food (Barro *et al.*, 2007). HACCP is a continuous, comprehensive food safety monitoring system that is designed to prevent hazards from developing and thus ensures a high degree of food safety (NACMCF, 1992). The HACCP system was initially developed in 1960 as a system for

use by foods processors for preventing food-borne hazards. Nowadays it is been promoted international as a standard for food trade. It is an action oriented programme to identify and reduce food-borne diseases. The HACCP system consists of the following seven principles: (i) Conduct a hazard analysis; (ii) Determine the Critical Control Points (CCPs); (iii) Establish critical limits; (iv) Establish a system to monitor control of the CCP; (v) Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control; (vi) Establish procedure for verification to confirm that the HACCP system is working effectively; and (vii) Establish documentation concerning all procedures and records appropriate to these principles and their application (Gupta *et al.*, 2010). The HACCP-approach would be a good tool to gain more knowledge about the causes of high microbial counts (Freese *et al.*, 1998). Studies that use the HACCP system to detect possible ways for contamination showed that holding food more than 4-6 h was one of the main contributing factors of high contamination (Bryan *et al.*, 1988a, b; Bryan *et al.*, 1992a, b, c, d; El-Sherbeeny *et al.*, 1985a, b., Michanie *et al.*, 1987; Michanie *et al.*, 1988a, b). Often temperature below 54.4^{o} C can lead to growth of pathogens, and high microbial load can be detected if consumed without reheating (Bryan *et al.*, 1992a, b).

In India, quality control with regard to food products is being enforced through various regulatory mechanisms like the Prevention of Food Adulteration Act (PFA), Agriculture Grading and Marketing (AGMARK), Fruit Products Order (FPO), *etc.* The Bureau of Indian Standards (BIS) has recently launched a HACCP certification programme for the food industry. While efforts are being made to implement HACCP in the organised sector of the food industry, there is a need to implement HACCP in the unorganised sector also as it accounts for 70-80% of food produced and processed in India (Bhat *et al.*, 2000). A study on the application of HACCP in the unorganized sector of the food industry such as the production of *khoa* (partially desiccated milk), traditional Indian milk, *paneer* (a coagulated product of milk) and *mushroom* was carried out. Studies carried out in different parts of India indicated that *khoa* is often contaminated with pathogenic organisms such as *Staphylococcus aureus* and *Bacillus cereus* and has been implicated in many food-borne diseases. The critical Control Point for the detoriation of *paneer* was identified as contamination due to food handlers using bare hands to remove the excess water in *paneer* (Bhat *et al.*, 2000).

Various ethnic foods and alcoholic beverages constitute an important part of the local diet in Sikkim (Tamang, 2010). The urban population of Sikkim consumes a good amount of street foods. The vendors prepare food locally at their homes and the same is then sold on the streets, public places, busy market places, school areas, and near college campus and the taxi stand, etc. Table1 shows common street foods sold in Sikkim markets. The most common ready to eat foods are *momo, chowmein, alu-cheura, samosa, kachori, pyazi, alu- dum, jhaal-muri, faaley, selroti*, ice-creams, *pakoda, puchhka, chana-chola,* etc. Microbiological assessment, determination of risk factor and safety measures of street foods of Sikkim using HACCP system for quality assurance is being carried out (unpublished Kharel and Tamang).

Table 1. Street foods sold in markets, tourist spots and busy places in Sikkim

Food	Major Ingredients	Common Place
Alu cheura	Potato, beaten rice (*cheura*), spices	Market places, taxi stands, school and college areas
Jhalmuri	Puffed rice (*murai)*, spices, onion	Petrol pumps, taxi and bus stands, market places, tourist spots
Chana items	Different types of grams	Market places, taxi stands, school and college areas
Puchhka	Flour, potato, tamarind, rock salt, spices	Market places, taxi stands, bus stop
Vegetable *Momo*	Flour, cabbage, mono-sodium glutamate, onion, spices	Taxi stands, bus stop, market places, tourist spots, school and college areas
Pork *Momo*	Flour, pork meat, mono-sodium glutamate, onion, spices	Taxi stands, bus stop, market places, tourist spots, school and college areas, road sides
Beef *Momo*	Flour, beef, mono- sodium glutamate, onion, spices	Taxi stands, bus stop, market places, tourist spots, school and college areas
Samosa	Flour, potato, onion, spices, oil	Market places, tourist spots, school, college areas, road sides
Alu faaley	Flour, potato, onion, spices	School and college areas
Sya faaley	Flour, beef, onion, spices, oil	School and college areas, taxi stands, bus stop
Pyaazi	Gram flour, onion, chilli, oil	School and college areas, taxi stands, bus stop, market places
Beef *Kofta*	Gram flour, beef, onion, chilli, mono sodium glutamate, oil	School and college areas, taxi stands, bus stop, market places, tourist spots
Alu dum	Potato, onion, spices, oil	School and college areas, taxi stands, bus stop, market places, tourist spots
Ice candy	Water, sugar, different types of grams, potato, onion, spices, oil	School and college areas
Chola		School and college areas, taxi stands, bus stop, market places, tourist spots
Bread *chop*	Bread, potato, chilli, spices, oil	Taxi stands, bus stop, market places, tourist spots, school and college areas
Kachori	Flour, gram flour, spices, oil	Market places, tourist spots
Murai ko dalla	Puffed rice, jiggery	Market places, busy areas
Jalebi	Gram flour, sugar, oil	Market places, busy areas
Khurma	Flour, sugar, oil	Market places, busy areas
Nimki	Flour, salt, oil	Market places, busy areas, taxi stands, bus stop
Noodles	Flour, different types of vegetables, onion, salt, oil	School and college areas, taxi stands, bus stop, market places, tourist spots
Bhujia	Gram flour, oil, salt, spices	School and college areas, taxi stands, bus stop, market places, tourist spots
Selroti	Rice, sugar, oil	Taxi stands, Bus stop, market places, tourist spots
Egg *pakoda*	Egg, gram flour, oil, chilli, spices	School and college areas, taxi stands, bus stop
Nimbu pani	Lemon, water, rock salt	Market places, busy areas

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