Chapter 2

REVIEW OF LITERATURE

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The review of literature pertaining to the study “Safety of Street Vended Foods in Kochi” is presented under the following heads:-

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2.1 Street food vending – An overview

The population of the developing world is projected to double from 1.7 billion in 1995 to 3.4 billion by 2020 and rising deprivation in urban areas including poverty, food insecurity, and malnutrition are
increasing faster than in rural areas. Urban growth now presents a serious challenge in developing countries (Maxwell, 2000). It has been postulated by Anjan and Upasona (2012) that urbanization is a process in which an increasing proportion of the entire population lives in cities and the suburbs of cities.

With the surge in urban population there has been an increase in the demand for convenient Ready To Eat (RTE) foods (Schelin et al., 2011). In many developing countries the main source of this type of food is the informal sector, especially street food vendors (Mensah et al., 2012). Thus urbanization and the associated social and structural changes have caused the demand for street foods to increase (FAO, 2012).

Street foods are defined as ready-to-eat foods and beverages prepared and/or sold by vendors and hawkers especially in streets and other similar public places (FAO, 1989). Bhowmik (2005) reported that street food vendors can be broadly defined as those who offer goods for sale to the public without having a permanent built-up structure. The author also indicated that the total number of street vendors in the country is estimated to be around 10 million and the number of street food vendors in Indian cities has increased sharply during the past few years.

Street foods are mass consumer foods that include beverages intended for immediate consumption or at a later time, without further processing or preparation (Ekanem, 1998; Mosupye and Von Holy, 2000).
According to Gadaga et al. (2008) street foods also include foods prepared in the market and/or work premises without further processing.

Dawson and Canet (1991), Martins (2006), and FAO (2012) indicated the distinguishing characteristics of street vended foods as follows-

- Foods sold on the streets
- Foods prepared in small or cottage scale factories and brought to the street food stall for sale.
- Foods prepared at home by the vendor and brought to the street food stall for sale and
- Foods prepared and sold at the street food stalls and several other public places such as lorry stations, parks, schools and construction sites.

According to Ekanem (1998) street vended foods include a variety of products using meats, fish, fruits, vegetables, grains, cereals as well as frozen products and beverages. An array of traditional and homemade products, modern factory products like biscuits, bread, confectionaries, soft drinks, fruit juices and ice creams also form part of the street vended foods. Operating from all strategic locations at all hours of day and night, street food vendors serve customers with spicy foods and colourful beverages at reasonable and affordable prices (Johnson and Yawson, 2000). Similarly Tedd et al. (2003) reported that street food vendors exhibit a vibrant diversity which is reflected in the type of food they prepare or sell, the scale of their business, the mode in which they
are operating, the locations in which they prepare and sell food and the type of clients to whom they sell food. The authors also indicated that the types of preparation in the street food sector include foods without any preparation, ready-to-eat foods and foods cooked on site. According to Zobida and Mutabazi (2012) the final preparation of street foods occurs when the customer orders the meal which can be consumed where it is purchased or taken away.

Dawson and Canet (1991) reported that street foods provided variety to different ethnic groups and thus improved their popularity. According to Badrie et al. (2011), the popularity of street foods could be attributed to the availability near the places they are consumed such as factories, schools and universities, transit points and market places. Rane (2011), indicated the unique flavour of street vended foods as a reason for their popularity. Street vended foods also played a role in the cultural and social heritage of societies (FAO, 2012).

According to a baseline survey conducted in Sri Lanka by Tedd et al. (2003), street food vendors are gaining significance because of their self-employed nature without any support from formal institutional set up either to improve their business or to protect them from undue external forces. Moreover, the author also indicated that street foods satisfy the food consumption needs of a significant section of the population. Kok and Balkaran (2014), considered street food vending as an informal sector since most of them conducted their business without any registration.
The informal sector of street food vending employs millions of semiskilled and unskilled workers (Dawson and Canet, 1991). Armar-Klemesu (2000), indicated that street food vending is especially suitable for men and women with limited education and skills, mainly because of its low initial investment and basic skills. In Ghana a study conducted by Codjia (2000), among street vendors revealed that street food sector employed over 60,000 people. Worldwide, the informal food markets are recognised as role players in the creation of employment and income generation (Martins, 2006). Participatory appraisal studies conducted by Lues et al. (2006) showed that street food business is both economically viable and a good source of income. Chukuezi (2010a), indicated the socio-economic role of street food vending in terms of employment potential, providing special income particularly for women and provision of food at affordable costs to the lower income groups in the cities. Choudhary et al. (2011a) also indicated that street food vending is a large source of employment in many cities and towns of developing countries.

Dawson and Canet (1991) and Codjia (2000), considered street food vending as a significant ‘economic crisis buffer’ due to the high income received from this informal sector and also due to the employment opportunities provided by this sector. FAO (2012), also indicated that majority of the vendors who operated at night received an income more than the salary of a secondary school teacher.

The typical socio-economic organization of a street food unit is that of a household enterprise in which the entire family members are
involved in the procurement of raw materials, preparation, cooking and sale of foods. In a study conducted by Chukeuzi (2010a), in Nigeria, it was seen that women made up more than half of the vendors in the country, while men made up only a third. Hiemstra et al. (2006), also noticed that food preparation and sales in street food sector are often done by the same person or by members of the same household.

Dawson and Canet (1991), indicated the impact of street food sector on the nutritional status of urban population by feeding millions with ready to eat food. Ekanem (1998), also revealed the important role played by street food industry in meeting the food requirements of urban dwellers of developing countries by feeding them with a wide variety of cheap and easily accessible foods. FAO (2007), indicated that nearly 2.5 billion people across the globe eat street food every day.

Johnson and Yawson (2000) indicated the significance of street foods in contributing to the food and nutrition security of workers residing away from home in small towns and cities. Mwangi (2002) opined that street food addresses two increasing problems of urban poverty and under nutrition in developing countries. Apart from being an important means of income generation street food is well appreciated by consumers because of the taste, affordability, nutritive value, ready availability and unique flavour (Kibret and Tadesse, 2013).

Life style changes and accompanying urbanisation together with rising affluence are responsible for increased consumption of fast foods (Howden et al., 1993). In Calcutta, a study conducted by Chakravarty
(1996) indicated that about 80 per cent of the street food consumers were men in the age group of 19 to 48 years. The author also indicated that 33 per cent purchased street foods on a daily basis while 23 per cent patronized stalls one to four times in a week. In Africa all age groups consumed street foods (FAO, 2012).

Though children under five are usually fed from home, Mensah et al. (2002) observed that many mothers working at the markets in Accra bought some food items from street food vendors to feed their babies which led to serious health implications. In a report published by FAO/WHO (2005) it was seen that majority of street food consumers were men from variety of ethnic groups with diverse educational levels. In a study conducted by Rheinlander et al. (2008), it was observed that the typical street food customers were young unskilled workers, petty traders who bought street food on a daily basis and students who did not have cooking facilities or school children who used to get money from their parents to buy foods during school days.

Maxwell (2000) and Mwangi (2002) observed that low income people spent more money on street foods since they are forced to buy foods in small portions on a daily basis which is in fact more expensive than buying larger amounts of raw materials for cooking. Van’t Riet (2003) also indicated that low-income urban populations depended more on street foods as a source of relatively inexpensive foods and the food insecure households spent up to 41 per cent of the budget on street foods compared to 28 per cent of the secure households.
In Mali, it was seen that street vended foods were consumed on a daily basis (Bendech et al., 1998). In a study conducted by Oguntona and Tella (1999) in Nigeria the authors indicated that street foods provided 60 per cent of the daily food intake. In urban Kenya Gewa et al. (2007) reported high consumption of street foods especially among school children and indicated that they consumed street foods twice daily. A national study in Africa reported that Africans were the most frequent consumers of street foods and 19 per cent consumed street foods at least twice a week (Steyn and Labadarios, 2011).

Despite the recognized benefits of street food vending which included food security for the urban poor; meeting the socioeconomic and cultural needs of the community and its contribution to local economies; the street food sector had public health risks (Dawson and Canet, 1991; Rane 2011). The major contributing factors of food borne disease associated with street vended foods included contamination from raw food, infected food handlers and inadequately cleaned equipment as well as time temperature abuse (Martins, 2006; Mensah et al., 2012).

The problems encountered by street food vendors that influenced the safety of foods included lack of infrastructure and lack of awareness on the basic principles of food hygiene (Muleta and Ashenafi, 2001; Estrada-Garcia et al., 2004). Mensah et al. (2002) also indicated lack of formal education and lack of knowledge on proper food handling among street food vendors. Mwangi (2002) reported that neither the sex of vendors nor vendors’ knowledge about health and hygiene were closely related to safe food practices. The author also indicated that the wider
social, cultural, and everyday context had a greater influence on handling of food risks and hygiene. Rheinlander et al. (2008) reported that educational level influenced vendors’ level of knowledge on food safety. The authors reported that vendors with formal education expressed more exact and elaborate knowledge on hygiene compared to vendors without any formal education. However, the author indicated that there was no correlation between education and actual safer food handling practices.

The salient features observed with regard to the unhygienic practices among street food vendors included washing of hands and utensils in one or more pans sometimes without soap, discarding of waste water and garbage on the street which provided food harborage for flies and rodents and lack of protection of foods from dust and flies (Dawson and Canet, 1991; Mosupye and Von Holy, 2000). Muinde and Kuria (2005), observed that street food vendors washed and rinsed their utensils only once and this water was used repeatedly and replaced only after a dirty appearance. Similarly, Abdalla et al. (2008) also indicated unhygienic practices of street food vendors like the washing of hands, utensils and dishes in buckets or bowls.

Muinde and Kuria (2005) noticed keeping of street foods at improper temperature and selling of foods in dirty surroundings. Sheth et al. (2005a) in a study conducted at Vadodara among street food vendors observed the unclean appearance of vendors and use of dirty napkins for wiping utensils. The authors also observed a poor picture with respect to environmental hygiene around the stalls with 80 per cent
stalls having garbage dumped near the stalls and 52 per cent of the stalls having stagnant pools.

A study on street food vendors in Coimbatore by Chandrasekhar et al. (2003) reported that nearly 90 per cent of the vendors kept food uncovered and 40 per cent of the vendors disposed the waste around the stall. Tambekar et al. (2011) noticed contamination of serving utensils with *Staphylococcus aureus* due to cross contamination from dish clothes and water used for dish and hand washing leading to major health risk to the consumers.

Water and ice used by the street food vendors were also found to be a source of contamination (Mahale et al., 2008). In a study conducted by Rao et al. (2012) in Hyderabad, it was seen that 41 per cent of the street food vendors used unclean and unpeeled vegetables. Nurudeen et al. (2014) studied the hygiene and sanitary practices of street food vendors in Nigeria and reported that vendors lacked basic training on hygiene. The authors indicated that nearly 45 per cent of the vendors blew air with their mouth to open plastic bags before packing foods and 60 per cent prepared foods in a dirty environment with flies around the foods, portending a danger for food borne diseases.

Mosupye and Von Holy (2000) observed that the food served from mobile street food vendors was prepared much in advance before serving and stored under unfavourable conditions without any temperature control to prevent microbial growth. It was also seen that the foods were kept without any protection from flies or cross-contamination. Gordon-
Davis (2011), indicated limited infrastructure facilities in the vending stalls with restricted access to potable water, toilets, refrigeration, washing and waste disposal facilities.

According to Muyanja et al. (2011) vendors sold foods from basic facilities like wheel barrows, trays, mats and make shift stalls which increased the risk of food contamination. It was observed that in Cameroon, Africa, the stalls and carts of street food vendors were built at the least possible cost using a minimum of construction technology, and the food products sold were prepared, handled and processed according to traditional methods without observing even minimal sanitary standards. The authors also indicated the lack of toilets and lavatory facilities near the stalls which forced the vendors as well as consumers to use the available nearby area, without washing their hands properly afterwards (Assob et al., 2012).

Street food vendors were found to be carriers of a variety of bacterial enteropathogens, including Salmonella typhi (Mensah et al., 2002). The authors indicated defective personal hygiene of vendors facilitating the transmission of these pathogens via food to humans. It was also seen that the use of leaves and newspapers for serving and handling of food increased the chances of food contamination. Garode and Waghode (2012) postulated that lack of protection from insects and flies increased the risk of microbial contamination of street foods.

Nicolas et al. (2007) reported commotion due to congestion and littering on streets as some of the disadvantages of street foods in
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Africa. Muyanja et al. (2011) indicated improper waste disposal facilities and uncovered trash receptacles attracting flies and insects in and around the street vending outlets. Gawande et al. (2013) noticed that location of vending sites alongside busy roads with heavy vehicular traffic or beside waste disposal sites also lead to contamination of street foods.

Food handling personnel play an important role in ensuring food safety throughout the chain of food production and storage. Mishandling and disregard of hygienic measures on the part of the street vendors may enable pathogenic bacteria to come into contact with food and carry illness to the consumers (WHO, 1989). Handling personnel also play a significant role in spread of bacterial infections and food poisoning (Abdalla et al., 2009). Sabbithi et al. (2014) noticed cross contamination of salads sold by the street food vendors in Hyderabad with Salmonella present in the hand washings of the vendors.

A study at Abeokuta, Nigeria by Idowu and Rowland (2006) revealed infection with one or more faecal-orally transmissible parasites among 97 per cent of the street food vendors. The authors also noticed improper toilet facilities in the vending sites. A study conducted by Thakur et al. (2013) assessed the food safety and hygienic practices of street food vendors in Delhi and indicated that none of the vendors had registration or license. Seventy two per cent disposed garbage in open bins, and 16 per cent threw it on the road. Only three per cent of the vendors used gloves, and only two per cent washed hands before and
after handling raw or cooked food. Flies and mosquitoes were observed in 45 per cent of the vending sites.

Informal street foods contaminated with pathogens had a negative impact on the health of a large segment of the urban population (Legnani et al., 2004). Rane (2011), also indicated serious health problems related to the preparation and handling of street foods by both chemical and microbial contamination. According to Fahrion et al. (2014) food that is contaminated irrespective of whether it has unacceptable levels of pathogens or chemical contaminants or other hazards imposes substantial health risks to consumers and severe burdens on individual communities and nations.

Available epidemiological evidence confirms association between street vended foods and sickness among consumers (Dawson and Canet (1991); Ekanem, (1998); Barro et al. (2006)). Food borne bacterial pathogens commonly detected in street vended foods included Bacillus cereus, Clostridium perfringens, Staphylococcus aureus and Salmonella sp (Muleta and Ashenafi, 2001).

Lianghui et al. (1993) reported that in Shandong province of China, street foods were responsible for 691 food poisoning outbreaks and 49 deaths during 1983 to 1992. A study conducted by Bhat (2004) in Hyderabad reported 42 outbreaks of food borne diseases affecting 1008 people during September 2002 to August 2003 through contamination of kheer, lemon rice and khoa with Staphylococcus aureus and Bacillus cereus.
2.2 Quality characteristics of street foods

2.2.1 Nutrient composition and contribution to diet

In 2011, Feeley et al. postulated that street foods would probably make a significant contribution to total dietary intake since many items were substantial meals in terms of energy value. This conclusion was made based on the high frequency of consumption of street foods among the youth. Street foods thus have significant nutritional implications for consumers, particularly from middle and low-income section of the population. Studies conducted by the authors to analyze the nutritional quality of street vended foods revealed that an average street food meal meets around half the RDA for protein, carbohydrate and energy. Thus, street foods were considered to be the least expensive means of obtaining a nutritionally balanced meal outside the home, provided the consumer selects a proper combination of foods. The nutrient composition and contribution of street foods to the diet of consumers has not received much attention.

A study conducted by Chakravarty and Canet (1996), in Calcutta reported that an average street food meal contained about 30 grams of protein, 15 g. of fat and 180 g. of carbohydrates providing nutritious, inexpensive and tasty food to millions of working women, men, children and students. In a study from Nigeria, Oguntuna and Tella (1999) observed that street foods supplied 59 per cent of energy and protein, 80 per cent of calcium, 57 per cent of iron and 50 per cent of vitamins in the daily diet. In Nairobi, Van’t Riet et al. (2001) indicated that the male consumers obtained a higher energy from street food consumption when compared to women.
Street foods were mostly consumed at breakfast and as afternoon snacks in Cotonou, Benin (Nago et al., 2010). Cereals and cereal products were the most commonly consumed items followed by sweet foods, other beverages, fruits and vegetables, eggs and dairy, meat, fish and legumes. The authors also indicated that street food contributed 40 per cent of energy, fat, protein, carbohydrate and fibre to the diet of consumers.

It has been reported that up to 30 per cent of household food expenditures were devoted to prepared foods purchased outside the household and street foods had significant nutritional implications (FAO, 2000). In Varanasi majority of the street food consumers were found to be working persons who patronized the food outlets during lunch hours (Mishra, 2007).

### 2.2.2 Adulterants in street vended foods

Dixit et al. (1995) observed non permitted colours and non food grade dyes in eatables sold in the rural markets of Uttar Pradesh. Chakravarty and Canet (1996) detected non permitted colours like metanil yellow in sherbet, jalebi, laddu and fresh fruit juices available in the streets of Calcutta. Presence of banned colours like metanil yellow, orange II in popular sweets like jalebi and bundi laddu and rhodamine B, auramine orange G in sugar candy and coconut burfi sold by the street vendors of Bangladesh was reported by Rajprem et al. (2000).

Heber and Bowerman (2001) indicated the presence of non permitted food colours in many food samples from the street food outlets.
in India. Similarly, in 72 different samples of sweet meat and confectionaries collected from large and small shops of Rawalpindi street of Uttar Pradesh, Ashfaq and Masud (2002) observed 18 to 220 ppm of permitted as well as non permitted colours. The authors noticed increased use of non permitted food colours in street vended foods.

Chandrasekhar et al. (2001) indicated the presence of non permitted colour orange RN in stick ice samples and saccharine in candies sold at street food outlets in Coimbatore. Presence of non-permitted colours in amounts exceeding the statutory limits was reported by Rao and Bhat (2003). Ohikpehai (2003) observed high amounts of azodyes in margarine and fruit juices sold in various outlets in Botswana. Rao et al. (2004) also observed high amount of food colours in most of the ready to eat foods available at the street food outlets of Hyderabad. Tartrazine and sunset yellow were observed in sweets, sweet meat and fruit beverages sold in the stalls of Hyderabad in amounts exceeding the required limits (Rao et al., 2005).

In a study carried out in Accra by Tomlins (2002) it was observed that street food samples had higher levels of lead, cadmium, arsenic, mercury and copper than average food samples, mainly due to the leaching of the metals from the utensils. Adekunle and Akinyemi (2004) reported elevated levels of lead in street vended smoked fish samples of Nigerian markets. A study on the physicochemical and microbial assessment of street foods in Nigeria by Opeolu et al. (2010) also reported chemical pollutants like lead and cadmium in samples. The
highest pollutant levels were observed in the high traffic density areas. The evaluation of street vended foods in Egypt by Soliman et al. (2011) revealed significant levels of heavy metals like lead and cadmium. The authors also indicated elevated levels of lead in plant foods while the animal foods had high level of cadmium. Abdulmajid et al. (2014) conducted an assessment of street vended foods for the presence of heavy metals and indicated the presence of lead in all street foods assayed while cadmium was present below the detection limits of 0.02 µg/g.

In a study conducted in Hyderabad by Waghray et al. (2010) for the presence of adulterants in street foods, the authors noticed the presence of metanil yellow, saw dust and added colours in 8 to 92 per cent of the chilli powder samples assayed. The authors also noticed the presence of non permitted colours in dry ginger, coconut burfi and cotton seed candy as well as aluminium in some sweet samples. Nath et al. (2015) also observed the presence of metanil yellow in 21 per cent of the samples of turmeric powder and ladoo sold by the unorganised sector in West Bengal, India.

2.2.3 Microbiological quality of street vended foods

Safe food is a basic human right. Despite this, many foods are frequently contaminated with naturally occurring pathogenic microorganisms. Microorganisms contaminate food in many ways, and it is not always possible to recognize the spoilage by sight, smell or taste. Such pathogens cannot be detected organoleptically, but can cause diseases of varying severity, including death.
Food borne illnesses of microbial origin are a major health problem associated with street foods and are an important cause of death in developing countries (WHO, 2002). Various studies indicated that ready-to-eat foods and food preparation surfaces are reservoirs for microbial contamination (Mankee et al., 2005; Ghosh et al., 2007). According to Angelidis et al. (2006), although the initial microbiological load on ready to eat food ingredients is important, factors like handling, processing, storage and display may also influence the microbiological load of ready to eat foods at the point of sale. Ghosh et al. (2007) stated that potential health risks are associated with contamination of foods with *E. coli*, *Salmonella typhi*, *Pseudomonas* species, *Staphylococcus aureus* and *Proteus* species during preparation, post cooking and other handling stages. The authors indicated a variety of intrinsic and extrinsic factors determine whether microbial growth will preserve or spoil the food. The intrinsic or related factors include pH, moisture content, water activity or availability, oxidation-reduction potential, physical structure of the food, available nutrients, and the possible presence of natural antimicrobial agents. Extrinsic or environmental factors include temperature, relative humidity, gases (CO₂, O₂) present and types and numbers of microorganism present in food (Frazier et al., 2011).

The microbiological quality of food indicates the amount of microbial contaminants in foods and a high level of contamination indicates low quality of food handling and storage. According to Colombari et al. (2007) microbiological contamination is particularly marked in foods undergoing little or no processing since these foods are
often prepared by hand and this direct contact may lead to an increased incidence of contamination with potential food borne pathogens, such as *Staphylococcus*. Microbial studies on street vended foods in American, Asian and African countries have revealed that increased bacterial pathogens in food is related to documented outbreaks of illnesses in human community (Mahale *et al.*, 2008).

Street foods in some African countries have been tested for various microorganisms of public health concern including faecal coliforms. Presence of *Escherichia coli*, *Staphylococcus aureus*, *Salmonella* and *Bacillus cereus* were noticed in foods, water, hand and surface swabs collected from street food vendors in Harare, Zimbabwe. (FAO/WHO, 2005) Research conducted to analyze the microbiological safety of street vended fruit chaats in Patiala city by Kumar *et al.* (2006) also indicated the presence of high counts of total coliforms, faecal coliforms, enterotoxigenic *S. aureus and Salmonella*. The researchers attributed the presence of *S. aureus* to unhygienic handling by street vendors. Presence of *Salmonella* was attributed to transmission through hands of vendors or from those vendors who sold egg products in the vicinity. A study in south east Nigeria indicated the presence of *Salmonella*, *Shigella* and *E.coli* in ready-to-eat foods, indicating poor sanitary control and practices in the preparation of the foods (Oranusi and Braide, 2012).

Vasanthakalaam (1996) indicated aerobic microbial load of $5.3 \times 10^2$ cfu/g in street vended breakfast foods like idli, dosa and chapathi. The author noticed a count of $11 \times 10^3$ cfu/g in preparations like tomato rice, curd rice and fried rice. Higher aerobic bacterial count
was also observed in apple juice, banana milk shake and water melon juice.

The microbiological assay of samosa and pani puri sold in Allahabad indicated the presence of *Salmonella* in 60 to 75 per cent of the samples (Gawande et al., 2013). The study also indicated the presence of yeast and mold in 36 to 81 per cent of the samples. Sharma and Mazumdar (2014) examined a total of 37 street vended food samples in Silchar city of Assam comprising pani puri, chaat and egg rolls for bacteria and noticed counts in the range of $4.5 \times 10^5$ to $1.12 \times 10^6$ cfu/g. The isolates identified were *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Salmonella* sp., *Klebsiella* sp., *Shigella* sp. and *Enterobacter* sp. causing potential hazard to human health.

A study on the bacteriological quality of street vended ice cream sold in Thrissur, Kerala by Ambily and Beena (2012), reported higher levels of coliform and staphylococcal counts in 30 per cent of the samples. The authors also isolated *E.coli* and *Salmonella* from the samples of ice cream. A study on the microbiological quality of popular street food namely chhole matar sold in Allahabad city, indicated the presence of *Escherichia coli*, *Proteus mirabilis*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Enterococcus faecalis* in different samples (Kushwaha and Mustafa, 2012).

Das et al. (2010) indicated high loads of bacterial pathogens like *Streptococcus faecalis*, *E.coli*, *Staphylococcus aureus*, *Bacillus* sp., *Klebsiella* sp. and *Pseudomonas* sp. in street vended chaat sold in
Yeast and fungi were also encountered in the samples assayed. Samples of panipuri and bhelpuri assayed by Garode and Waghode (2012) were found to be contaminated with *Salmonella typhi*, *Pseudomonas* sp., *Staphylococcus aureus*, *Proteus* sp. and *E.coli*. The authors postulated that the high microbial contamination of street foods is due to the presence of flies and insects which carried food borne pathogens.

A study conducted in Jaipur to analyse the bacterial load on street vended salads revealed the presence of gram positive as well as gram negative bacteria; however, the population of the latter was higher (Rajvanshi, 2010). The author isolated *Bacillus*, *E.coli*, *Pseudomonas*, *Staphylococcus*, *Enterobacter*, *Streptococcus*, *Klebsiella*, and *Citrobacter* from the foods. Wadhai and Khoragade (2012), identified *E.coli*, *S.aureus*, *Bacillus* sp. and *Salmonella typhi* in chutney samples sold in Chandrapur city of India.

Mahale *et al.* (2008), reported high microbial load in 70 per cent of ice samples in street food vendors used to prepare fruit juices. Pandove and Sahota (2014) assayed water from street food outlets and indicated the presence of *E.coli*, *Aeromonas hydrophilia*, *Listeria* and *Yersinia enterocolitica* in 24 to 57 per cent of the samples.

Lewis *et al.* (2006) reported abnormally high viable counts, total and faecal coliform counts in street vended fruit juices of Vishakapatnam. The samples assayed indicated the presence of pathogenic *E.coli*, *Streptococcus faecalis* and *Salmonella typhimurium*. Tambekar *et al.*
(2009) conducted a rapid review of street vended fruit juices in Amravati city of India. Of the 52 samples assayed, *E. coli* was the dominant bacterial pathogen followed by *Pseudomonas aeruginosa*, *Salmonella*, *Proteus* sp., *S. aureus*, *Klebsiella* and *Enterobacter* sp. The highest bacterial contamination was observed in juices prepared with sweet lemon, pineapple and pomegranate, apple and orange. Reddi et al. (2015) assayed 150 samples of fruit juices in Hyderabad and reported that 96.6 per cent of the juices were contaminated with faecal coliforms, 77.3 per cent with *S. aureus*, 73.3 per cent with *Shigella* sp. and 42.6 per cent with *E. coli*.

### 2.3 HACCP as a food safety management system

A hazard is unacceptable contamination, survival, persistence, growth or increase of a microbiological, chemical or physical nature. Hazard analysis conducted at street food outlets could detect on site hazards and assess related risks (Bryan, 1995). Unlike the traditional food safety assurance systems that rely on end product testing, the HACCP system integrates end product testing into the design of the process of food safety control, providing a preventive and cost effective approach (Motorjemi *et al.*, 1996). The system seeks to identify the hazards associated with all stages of food production, processing or preparation, assesses the related risks and determines the operation where control procedures will be effective (Peter *et al.*, 2000). For each step of the production process the fault tree analysis makes it possible to identify the hazard and define whether that stage will be or not be a Critical Control Point (CCP) (Bertolini *et al.*, 2007). While end product
sampling to determine compliance has its place in determining the safety of foods, HACCP is a preventive measure to ensure food safety (Schelin et al., 2011).

Chakravarty (1996) studied the hazards in the preparation of sandesh and identified water and the cheese cloth that was used in the preparation of sandesh were the significant hazards. The author also identified the critical points of contamination of food and water samples and indicated that the contamination occurred during handling, poor and prolonged storage conditions. Sabbithi et al. (2014) assayed the microbiological quality of salads served along with street foods of Hyderabad. It was found that 58 per cent of carrots and 45 per cent of onion samples contained *Salmonella* and 68 per cent of carrots and 24 per cent onions had *Yersinia*. The HACCP study revealed that the food handlers with poor personal hygiene and food handling practices were responsible for the *Salmonella* contamination. The management of street food safety can be ensured with the right HACCP measures and the pre-requisite system as Good Manufacturing Practices (GMPs) and Good Hygienic Practices (GHPs).

A study was conducted by Gautam et al. (2014) to evaluate the hygienic practices of dairy based street food vendors in Allahabad City and to assess the bacteriological safety of water and dairy food items sold by street vendors with regard to coliforms, *Salmonella* and *E.coli*. Of the 40 dairy food items evaluated 40 per cent of the samples were found to be contaminated with *Salmonella* and 65 per cent were contaminated with *E.coli*. Highest *Salmonella* contamination was found
in milk shake followed by gulab jamun while highest E.coli contamination was observed in gulab jamun followed by milk shake. The contamination was reported to be due to unhygienic conditions, poor maintenance of premises, poor personal hygiene and the slime layer on poorly cleaned utensils. The authors also indicated that seventy two per cent of the water samples assayed were coliform positive and Critical Control Points identified included initial and storage contamination.

Poor personal hygiene often facilitates transmission of 60 pathogens via foods to humans (Mepba et al., 2007). Steyn et al. (2011) identified two critical points to ensure safety of foods which included cooking at temperatures over 65°C and having short holding times. Gadi et al. (2013) suggested that microbial hazards and their solution, critical points, practical control measures and monitoring procedures as well as principles of food microbiology and food safety need to be incorporated for safe street food preparation. The authors also stressed the importance of microbiological swab tests to identify hazards that occur at the street food outlets.

2.4 Food safety education for street food vendors

Training of food handlers could be taken up as an important strategy to improve food safety (Smith, 1994). A three day food safety workshop for the food providers from food service outlets conducted by Olumakaiye and Bakare (2013) revealed improvement in the hygiene practices and environmental conditions at the outlet. A systematic approach for the management and control of food safety for the street
food sector in Ghana with the help of nine education modules established that timely intervention is effective to manage the safety of street vended foods (Tortoe et al., 2013).

Donkor et al. (2009) conducted a study on street food vendors in Ghana and reported that the vendors constituted an important source of orofaecal transmission. Evidence based training on the application of the WHO five keys to safe food, had a significant impact on the knowledge gained by the vendors. The authors postulated a lack of food safety education as a major hindrance to behavioural change among vendors. A cross sectional study of 80 street food vendors, providing training with evaluation of knowledge, attitude and practice showed a significant positive change in the perception, knowledge and practices of the vendors. The overall performance rating of full adoption of Good Hygiene Practices (GHP) improved from 37.5 per cent to 50.8 per cent in the post training period (Choudhary et al., 2011).

FAO (2001) indicated that training programs for street vendors should deal with basic aspects which address the local situation and information on common food-borne diseases. In training vendors, the local language should be used in order to ensure the understanding of the trainees.

According to Medeiros et al. (2001), food safety education is most effective when messages are targeted towards changing behaviours to reduce food borne illness. The authors indicated to include aspects like personal hygiene, adequate cooking, avoiding cross-contamination,
keeping food at safe temperatures, and avoiding foods from unsafe sources in food safety education programme. However, Rheinlander et al. (2008) indicated that formal food safety education alone may not be adequate to secure safer street food hygiene. It is crucial to understand vendors’ and consumers’ social and normative perceptions of food safety.

It becomes apparent that there is a need to develop a training program for the purpose of achieving effective and permanent changes in the behaviour of street vendors who are entrusted with the responsibility of preparing and selling street foods. Through the training, an improvement in food and environmental hygiene should be evident in all those involved in the handling, preparation and sale of foods (FAO, 2000).

It is evident that there is a rapid proliferation of the street food sector, though the safety of street vended foods is often a cause for concern. It is mandatory to adopt a realistic approach to improve the safety of street vended foods. Assessment of the quality characteristics with food safety education for the vendors can mitigate the risks involved with consumption of street foods and will ensure safe, economical and nutritious food to the consumers.

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