Methodology refers to the plan and procedure adopted for the conduct of a research. It forms the philosophy on which the research is based and aims to obtain knowledge, based on empirical observations and logical reasoning. The methodology adopted for the present study entitled ‘Safety of Street Vended Foods in Kochi’ is detailed in this chapter.

The methodology pertaining to the study is discussed under the following heads:

3.1 Selection of area
3.2 Selection of sample
3.3 Design of the study
3.4 Tool and techniques for data collection
3.5 SWOT analysis
3.6 Data analysis and interpretation
3.1 Selection of area

Figure 3.1: Study Area in Kochi Corporation

SELECTED WARDS
1. Fort Cochin
5. Ammanavathy
11. Mamanakudy
15. Manammalam
16. Palarivattom
18. Vytilla
20. Ponnani
24. South
25. Gandhi Nagar
26. Kaloor South
31. Vytilla Irutha
34. Thoppumpady
39. Vavachery EESTV
46. Thirumullaivoyal
49. Ponnani
52. Pocharam
54. Koottathoor
56. Perumavoor
61. Elankulam
71. Kacheripady
The state of Kerala has fourteen districts and Kochi is the largest metropolitan region of the state and the commercial capital of Kerala. This financial and commercial hub of Kerala has seen the emergence of diverse food culture. Although, street food is common all over Kerala, in Kochi it forms a major resource for daily nutrition among all strata and a source of livelihood for many. There are 74 wards within Kochi corporation limits. From this, twenty wards were randomly selected by adopting area sampling procedure for the conduct of the present study. The area selected for the present study is depicted in Figure 3.1.

### 3.2 Selection of sample

The sample is a subset or portion of the total population (Singh, 2001). Sampling is done as the process of learning about a population on the basis of the sample drawn from it (Gupta, 2003). A representative sample is a small group of the universe from which results can be drawn and is a practical method to conduct an investigation (Kothari, 2001). In the present study a multi stage random sampling procedure was adopted to select representative samples of street outlets/ vendors, street food consumers and street vended foods. Multistage sampling refers to sampling in two or more stages were appropriate random sampling method is adopted at each stage of sampling (Krishnaswami and Ranganathan, 2010).

#### 3.2.1 Street food outlets / vendors

The pilot survey conducted in the study locale revealed that the number of street food outlets in a ward ranged from eight to twelve. A
power analysis based on the findings of the pilot survey with five per cent significance and 90 per cent power using a software Sigma plot 11 estimated a sample size of 186 or more. Hence, ten outlets each were randomly selected from the selected twenty wards. These 200 outlets constituted the primary sample for the study. A sub sample of five outlets were selected from each of the ten wards to get a sample size of 50 for detailed observation of vending services and quality evaluation of food served at the outlets.

3.2.2 Street food consumers

The consumers are important stakeholders in the street food sector. One hundred consumers who frequently visited the street food outlets were randomly approached and asked to voluntarily participate in the study. Five consumers were selected from each of the twenty wards for this purpose comprising a total sample size of one hundred consumers.

3.2.3 Street vended foods

A list of street vended foods comprising different categories like main dishes, side dishes, snacks and beverages were collected from the selected vendors. The quality evaluation with respect to nutrient composition, sensory attributes and microbial characteristics of the selected street vended foods from each category and the presence of adulterants in the ingredients used for the preparation of selected foods were conducted. The details pertaining to the number of foods and ingredients selected for quality evaluation are depicted in Figure 3.2.
3.3 Design of the study

A mixed study design was followed for the conduct of the study. The study was conducted in three phases, the first phase comprised the field survey, the second phase the laboratory techniques for quality evaluation of street foods and the third phase the education intervention for the street food vendors. The study design is presented under the following heads:-

3.3.1. Survey among street food vendors

3.3.2. Rapid Assessment Survey among consumers of street vended foods

3.3.3. Quality evaluation of street foods/ingredients
   3.3.3.1. Computation of nutrients and sensory evaluation
   3.3.3.2. Detection of adulterants in ingredients
   3.3.3.3. Microbiological assay of street vended foods

3.3.4. Microbiological assay of ice and water

3.3.5. Microbiological assay of swabs
3.3.6. Hazard analysis of selected foods
3.3.7. Development of food safety education module
3.3.8. Food safety education of the street food vendors
3.3.9. SWOT analysis of street food vending sector
3.3.10. Data analysis and interpretation

3.4 Tools and Techniques of data collection

3.4.1 Survey among street food vendors

A field survey was conducted among the street food vendors to collect information on the types of vending units, hygiene of food handlers, garbage disposal practices and general information on the type of food sold by them. Interview method was used for the data collection.

Interview as the method of data collection provides ample opportunity to interact with the subjects and offers benefit of collecting additional information by personal observation. Kothari (2001) stated that interview method is suitable to collect required data and to record information systematically. The scope of clarification of any ambiguous data is possible in the interview method. A pre-tested interview schedule was used for gathering the data from the street food vendors.

Prior to administration of the schedule the investigator established rapport with the respondents and assurances were given to them on the confidentiality of the data to ensure their co-operation in data collection and to elicit accurate and reliable data from them. A mixed approach i.e. quantitative and qualitative methodologies were adopted to collect the
data. Data on food preparation; handling and storage practices were collected by observation and responsive enquiries. The food safety practices related to cleanliness and hygiene of the vendors, vending outlets and food preparation and service were observed by the investigator and recorded on the site using a five point rating scale with scores ranging from excellent to very poor. Rating scale involves a qualitative description of a limited number of aspects. An object is judged in absolute terms against specific criteria. In practice, three to seven point rating scales are used as they provide more sensitivity for measurement (Kothari, 2001).

Observational approach was adopted to assess the hygienic practices of vendors and hygiene status of the vending site. Observation may be defined as the systematic viewing of a specific phenomenon in the proper setting for the specific purpose of gathering data for a particular study (Kothari, 2001). Hygiene status of the food vending units and handlers was assessed using uncontrolled observation in the natural setting of the street vending units. An on the spot observation was conducted for a subsample of fifty vendors using a check list. The interview schedule for the field survey and observation checklist is appended (Appendix I and II).

3.4.2 Rapid Assessment Survey among consumers of street vended foods

Selected consumers were subjected to a rapid assessment survey using a questionnaire. The demographic information of the consumers, characteristics of street food consumed, street food consumption pattern
and perception regarding cleanliness of the outlets and hygiene of vendors were collected. To find out the nutrient contribution from street foods, the quantity of foods consumed by 80 adult men and 15 women were recorded and the quantity of ingredients used for the preparation of these items were collected from the street food vendors. The nutritive values of the foods were computed using the food composition table suggested by Gopalan et al. (1989). The mean nutrient contribution from street food was computed separately for both men and women consumers and per cent RDA met through street foods was calculated for a reference man and woman. The schedule used for the rapid assessment survey is given in Appendix III.

3.4.3 Quality evaluation of street foods/ ingredients

3.4.3.1 Computation of nutrients and sensory evaluation

In order to compute the nutritive value of common street foods, selected vendors were interrogated and proportions of various raw materials used for the preparation of fifty popular and frequently available food items were selected which comprised deep fried snacks (17 items) steamed snacks (3 items) main dishes (11 items), vegetarian side dishes (9 items), non vegetarian side dishes (7 items) and chaats (3 items). The quantity of raw ingredients used to prepare the selected foods and the yield in terms of total quantity, numbers or number of portions were also collected from the vendors. The nutritive value of these foods with respect to proteins, fat, carbohydrates, energy, calcium and iron was computed using the food composition tables suggested by ICMR (Gopalan et al., 1989). The nutritive value of eight main meals
along with side dishes was computed. The schedule to elicit this information is given in Appendix IV.

Sensory evaluation is a scientific discipline used to evoke measure, analyze and interpret reactions to food as perceived by the senses of sight, smell, taste, touch and hearing. It provides information about the sensory properties of foods. A subsample of ten foods belonging to five categories main dishes (2), snacks(2), side dish vegetarian and non vegetarian (2 each) and chaats (2) were prepared in the laboratory as per the proportions suggested by the vendors. Sensory evaluation was conducted using a score card with a five point hedonic scale by a panel of ten selected judges. Sensory attributes like appearance, flavour, taste, texture and acceptability of the foods were evaluated. The mean scores of sensory attributes and overall per cent acceptability were computed. The acceptability of street vended and laboratory prepared foods was compared. The score card used for the sensory evaluation is given in Appendix V.

3.4.3.2 Detection of adulterants in ingredients

Food adulteration is defined as lowering the quality of food by intentional or unintentional substitution of food with some inferior foreign particle or by removal of some value added constituents from the main food item. Food Safety and Standards Act of India (FSSAI, 2012a) has defined adulterant as any material which is or could be employed for making the food unsafe or sub-standard or misbranded or containing extraneous matter. The ingredients used for the preparation of street foods were categorised according to the major food groups. Two common ingredients from each of
the food groups such as cereals, pulses, spices and miscellaneous items and one ingredient each from the milk and milk products and fats and oil group were collected from each of the 15 outlets and tested for the presence of adulterants. The details pertaining to the ingredients selected to detect adulterants is given in Table 3.1. Thus a total of 150 ingredient samples were tested for the presence of adulterants. The methods employed for the detection of adulterants are adopted from the FSSAI (2012a) manual and are detailed in Appendix VI.

Table 3.1: Ingredients selected from each food group for detection of adulterants and the adulterants tested.

<table>
<thead>
<tr>
<th>Food groups</th>
<th>Ingredients selected (n=150)</th>
<th>Adulterants tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereals</td>
<td>Rice</td>
<td>Damaged grains, weevil infested grains, insects and rodent hair and excreta, dust and pebbles</td>
</tr>
<tr>
<td></td>
<td>Refined flour</td>
<td>Iron filings, stone gravel, webs and chalk powder and resultant flour</td>
</tr>
<tr>
<td>Pulses</td>
<td>Red gram dal</td>
<td>Clay, stone and gravel, Rodent hair, excreta, Damaged dals, Kesari dal</td>
</tr>
<tr>
<td></td>
<td>Bengal gram flour</td>
<td>Kesari dal flour, metanil yellow</td>
</tr>
<tr>
<td>Spices</td>
<td>Red chilli powder</td>
<td>Brick powder, sudan III, water soluble coal tar colour, oil soluble coal tar colour and Rhodamine B</td>
</tr>
<tr>
<td></td>
<td>Turmeric powder</td>
<td>Metanil yellow, chalk powder and Lead chromate</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>Salt</td>
<td>Chalk powder, iron filings</td>
</tr>
<tr>
<td></td>
<td>Sugar</td>
<td>Chalk powder, iron filings</td>
</tr>
<tr>
<td>Fats and oils</td>
<td>Cooking oil</td>
<td>Rancid oil, Mineral oil and Argemone oil</td>
</tr>
<tr>
<td>Milk and milk products</td>
<td>Milk</td>
<td>Presence of starch, addition of sugar, Removal of fat</td>
</tr>
</tbody>
</table>
3.4.3.3 Microbiological assay of street vended foods

The detection and enumeration of microorganisms in food is an important component in ensuring the safety of foods. Microbiological analysis of foods is effective in monitoring the contamination and analysing trends for detecting emerging risks. Microbiological analysis of foods is based on the detection of microorganisms in foods by quantitative or enumerative methods as well as qualitative methods also known as presence/absence tests. Traditional culture methods for detecting microorganisms in foods are based on the incorporation of the food sample into a nutrient medium in which the microorganisms can multiply, thus providing visual confirmation of their growth.

Routine examination of foods for the complete range of pathogenic organisms is impractical. In order to assess the microbiological safety of food borne pathogens, indicator organisms are used which indicate the presence of pathogens of intestinal origin as a result of direct or indirect faecal contaminations and they are usually used to assess food hygiene (Chandi and Patra, 2012).

To evaluate the microbiological quality of street foods the samples were collected in two phases. In the first phase eighteen frequently consumed foods were identified on the basis of the cooking methods and evaluated for Total Plate Count, total coliforms, faecal coliforms in cfu/g and the presence or absence of *E.coli*. In the second phase, six popular foods belonging to four categories namely beverages,
chaats, chutney and snacks were tested for Total coliforms, *E.coli*, *Staphylococcus aureus*, *Salmonella* and *Vibrio* in cfu/g.

### 3.4.3.3.1 Microbiological assay of foods prepared by different methods of cooking

The methods of cooking adopted by the vendors were enumerated and foods cooked by different methods were selected for microbiological assay. The main and side dishes sold at the street food outlets were classified on the basis of methods of cooking. Main dishes prepared by steaming (n=4) and shallow frying (n=2), vegetarian side dishes (n=3) and non vegetarian side dishes (n=3) prepared by combination of cooking methods were selected. From snacks vegetarian (n=3) and non vegetarian (n=3) foods prepared by deep frying were selected. A total of 18 food samples were selected for microbiological assay and two samples of the food in each category were assayed for enumeration of Total Plate Count, total coliform, faecal coliform count and presence or absence of *Escherichia coli*. Thus a total of 36 food samples were assayed and the details pertaining to the number of foods selected for microbiological assay in each category are given in Figure 3.3. Total Plate Count is the most widely used method for determining the number of viable cells or Colony Forming Units (CFU) in a food product. The term coliform is used to describe a group of enteric bacteria that can ferment lactose and are similar to *E.coli* in phenotypic characteristics.
Faecal coliforms are a group of the total coliforms that are present in large numbers in the intestinal flora of human and other warm-blooded animals, and are thus commonly found in faecal material. Estimation of *E. coli* is an important part of microbiological analysis of foods for quality assurance. Its presence signifies the occurrence of faecal contamination through lack of hygiene and sanitation.

The plate count method is based on culturing dilutions of sample suspensions in the interior or on the surface of an agar layer in a petri dish. Individual microorganisms or small groups of microorganisms will grow to form individual colonies that can be counted visually. Enumeration and detection of the total colonies, total coliforms, faecal coliforms and *E. coli* was conducted using standard methods suggested by Agarwal and Hasija (1986) and Harrigan (1998) and are detailed in Appendix VII.

*Figure 3.3: Selection of food samples for microbiological assay on the basis of cooking methods*
3.4.3.3.2 Microbiological assay of specific foods for food borne pathogens

For the detection of food borne pathogens, the street vended foods were broadly classified into four categories namely beverages, chaats, chutneys and snacks. Two beverages, one sample each of chaat and chutney and two snacks were microbiologically assayed to detect the presence of food borne pathogens. The beverages included one fruit and one vegetable based beverage. The snacks comprised a deep fried and steamed snack. Nine samples of each of the food items were purchased from nine different locations selected for this purpose by random sampling. The details are depicted in Figure 3.4.

![Figure 3.4: Selection of food samples for the detection of pathogens.](image)

Thus, a total of fifty four food samples were assayed to detect the pathogens in the four categories of foods. A systematic review of existing published literature from other parts of the country indicated *E.coli, Staphylococcus aureus, Vibrio* and *Salmonella* to be the most commonly assayed pathogens in street vended foods. Thus, the samples were assayed for total coliforms, *E.coli, Staphylococcus aureus, Vibrio*
and *Salmonella* in cfu/g. The mean number of colonies was expressed as log colony forming units in terms of cfu/g of the sample assayed.

Coliforms are a group of bacteria employed to assess the microbiological quality of water and/or food. The presence of coliform bacteria in ready-to-eat foods indicates unhygienic conditions during processing, handling and distribution or post processing contamination. Staphylococci are a common type of bacteria that live on the skin and mucous membranes (e.g. in nose) of humans. *Staphylococcus aureus* is the most important of these bacteria in human diseases. Most food intoxications caused by *S. aureus* are the result of bad hygienic practices in kitchens. *Salmonella* is a genus of rod-shaped, gram-negative, non-spore-forming, predominantly motile enterobacteria. *Salmonella* is a major cause of food borne illness throughout the world. If present in food, it does not usually affect the taste, smell, or appearance of the food. The bacteria live in the intestinal tract of infected animals and humans. *Vibrio* is a gram-negative, comma-shaped bacterium. Some strains of *Vibrio cholerae* cause the disease cholera. It is associated with a rapid onset of severe diarrhoea.

The beverages were collected from the outlets in autoclaved sterile containers. The pH of the beverages was measured using a pH meter. All foods were purchased from the vendors and transported to the laboratory within one hour of collection in an ice box. Twenty five grams of the sample was weighed and transferred to 225 ml of sterile buffer. After homogenisation the diluents of the buffer were inoculated to the respective media. The methods adopted for microbiological assay are given in Appendix VII.
3.4.4 Microbiological assay of ice and water

Water is a critical raw material in many street vended operations. It is used for drinking, washing of ingredients and as an ingredient. Ice is often added to beverages after preparation and can be a potential source of contamination. One sample each of water and ice were collected from five street food outlets from where the beverages were procured. The samples of water and ice were collected in autoclaved sterile containers and assayed for total coliforms, *E.coli*, *Staphylococcus aureus* in cfu/ml/g and the presence or absence of two pathogens, namely *Vibrio* and *Salmonella*.

3.4.5 Microbiological assay of swabs

Microbial contamination in a food service establishment can occur from the food handler, the equipment and surfaces of the establishment. Swabs are an effective tool in the detection of such contamination. The swab usually consists of a breakable stick with cotton or synthetic material contained in a tube or an envelope. Using the swab method, a specified area to be examined is marked and then wiped. The swab sticks are broken into a tube or bottle containing a sterile dilution fluid or neutralising fluid and mixed. In the laboratory, the initial suspension and if necessary, further decimal dilution, are used to determine the number of microorganisms, using standard method of enumeration of microorganisms to be investigated. Food handlers, work surfaces and equipment used in the vending unit may cause cross contamination. A total of ten swabs were collected from ten street vending outlets from where the beverage and food samples were procured and assayed bacteriologically. Sterile cotton swabs were dipped in saline and
dispensed in to screw cap tubes. Two swabs were collected from five sites namely vendors hands, utensils, cutting board, knife and napkins. The swabs were assayed for the presence or absence of two pathogens namely *E. coli* and *Staphylococcus aureus*.

### 3.4.6 Hazard analysis of selected foods

The Hazard Analysis and Critical Control Point (HACCP) concept is a systematic approach for the identification, assessment and control of hazards. The system offers a rational approach to the control of microbiological hazards in foods. Hazard analysis consists of an evaluation of all procedures concerned with the production, distribution and use of raw materials and food products. A CCP is an operation (practice, procedure, location or process) at which control can be exercised over one or more factors to eliminate, prevent or minimize a hazard (Bryan *et al.*, 1992). The hazard analysis includes observing food preparation and practices to identify the sources and modes of contamination. Development of a process flow chart is a prerequisite for carrying out HACCP. The foods subjected to detailed microbiological assay were evaluated for hazards during preparation and HACCP flow diagrams were developed for the same. From the HACCP protocol, common hazards were identified and the Critical Control Points (CCPs) were established. In the present study, the hazard analysis includes observing food preparation and practices to identify the sources and modes of contamination, microbiological assay of water, ice and swabs from the vending units and preparation of the process flow diagram.
3.4.7 Development of food safety education module

It has been reported by FAO (2009), that handlers of street vended foods had a very limited knowledge and expertise in safe food handling. Among many other concerns of street food, the main concern is food safety. In order to improve the personal hygiene and handling techniques of the food handlers, a food safety educational module was developed. It consisted of a documentary on general aspects of street food vending in the city and a food safety kit for preventing contamination of food at the vending site.

3.4.7.1 Documentary on street foods

A documentary is defined as a film using pictures or interviews with people involved in real events to provide a factual report on a particular subject or event. It is intended to document some aspect of reality, primarily for the purpose of instruction. A documentary is often reported to be ‘a creative treatment of actuality’. The documentary for the purpose of this study was prepared on general aspects of street food vending in the city with segments from experts in the field of food safety. The experts provided their inputs on the street food sector. This was evaluated by a panel of five experts for specific criteria namely clarity, brevity, presentation, and appropriateness to target group, relevance to topic and overall attractiveness. A three point rating scale was used for the evaluation of the documentary. The score card for the evaluation of the documentary is included in the Appendix VIII.
3.4.7.2 Food safety kit for food handlers

The food safety kit consisted of a booklet on safe food handling practices for street food handlers, surface disinfectant and alcohol based hand-rub solution with allied accessories to assist safe food production.

3.4.7.2.1 Booklet on safe food handling practices

Street food handlers are generally seen to have a very poor understanding of basic food safety measures. Most of the handlers are not trained in food hygiene and sanitation. Personal hygiene of the food handler plays a vital role in food safety and prevention of food-borne illnesses. Keeping this in view, a booklet was developed to educate the vendors on basic food handling techniques. It aimed to improve the quality of the tasks performed by the street food vendors. This was evaluated by a panel of five experts for specific criteria namely clarity, brevity, presentation, and appropriateness to the target group, relevance to topic and overall attractiveness. A three point rating scale was used for the evaluation of the training booklet developed. The score card used for the evaluation of the booklet is given in Appendix VIII.

3.4.7.2.2 Surface disinfectant

Chlorine is by far the most commonly used disinfectant in all regions of the world. Chlorine eliminates slime bacteria, moulds and algae that commonly grow in water supply reservoirs, on the walls of water mains and in storage tanks. Chlorine bleach is a powerful, economical disinfectant that destroys bacteria, moulds, spores and viruses. It can be used at varied concentrations to clean work surfaces,
kitchen utensils, sponges, clothes and cutting board (FAO, 2009). Dilute mixtures of chlorine and water are a common and cost-effective method for sanitizing surfaces. When used properly, chlorine can be a very effective to kill undesirable microorganisms. The concept of surface disinfection with chlorine based agents was introduced to the vendors.

### 3.4.7.2.3 Alcohol based hand rub solution

Hygiene of hands has been acknowledged as an important measure to prevent and control infectious diseases and can significantly reduce the burden of disease. Street food vendors often have a limited supply of water at the stalls. A substitute to soap and water can be a desirable option for the street food vendors. Alcohols have an excellent germicidal activity against gram positive and gram negative vegetative bacteria and a variety of fungi. Quantitative studies on the effects of antiseptic hand rubs have established that alcohols effectively reduce bacterial counts on hands. An alcohol based hand rub was devised based on a WHO formulation for better hand hygiene, bottled and included in the kit. The formulation and method of preparation of the alcohol based hand rub solution is given in Appendix IX.

### 3.4.8 Food safety education of the street food vendors

Food safety remains a critical issue in the street food sector and the mishandling of food plays a significant role in the occurrence of food borne illness. Food handler’s training is one strategy where by food safety can be increased offering long term benefits to the food industry (Smith, 1994). Training refers to the systematic development of knowledge, skills and attitudes required to perform a task effectively. It helps to modify
attitude, knowledge and behaviour. A food safety training programme was conducted in order to educate street food handlers. A sub sample of hundred subjects who had enrolled for the study was informed of the food safety education programme. There was reluctance from the vendors to attend the training programme as it meant loss of a day’s income for them. Of the hundred vendors sixty two attended the programme, but only fifty filled up the checklist both before and after the sessions. The subjects were trained by veterans in the food service and safety sector. The importance of personal hygiene, cross contamination, environmental sanitation and other aspects of food safety were elaborated. The programme included an interactive session for the vendors, during which they were given opportunity to narrate their experiences and apprehensions about safe food services. The documentary was screened to the subjects and the food safety kits were distributed. They were briefed on the need and importance of the contents of the kit. Pre and post training knowledge were assessed with a checklist and the scores were statistically analysed to ascertain the impact of the training programme.

3.4.9 SWOT analysis of street food vending sector

SWOT analysis is defined as a tool that identifies the strengths, weaknesses, opportunities and threats in a sector. It provides a framework for identifying the internal and external factors that can have an impact on the viability of a sector. A SWOT analysis was performed for the street food sector in the study locale. The researcher identified the strengths, weaknesses, opportunities and threats in the street food sector based on the findings of the study.
3.4.10 Data analysis and Interpretation

Data were entered and statistically analysed using SPSS version 17. All the entries were cross checked for any possible key board error. Chi square test and paired ‘t’ test were used to assess the impact of the food safety education. Descriptive statistics such as means and percentages were used to describe the data. The data thus obtained were tabulated, analyzed and interpreted. The schematic representation of the study is given in Figure 3.5.

![Schematic Representation of the study]

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**Figure 3.5: Schematic Representation of the study**