Introduction

Street foods are popular all over the world including both developed and developing countries because of faster population growth and rapid urbanization (FAO, 1996; Rane, 2011). Both are affecting food systems around the globe due to changes in demography, modernization, increasing incomes, foreign investment and market liberalization. Thus, street foods business has become increasingly important as an income generating sector and as a fast and economical meal option specially in developing countries. Since entry into the street food entrepreneurship is largely unregulated and does not cost much upfront investment, it has become an increasingly popular way for families, and specifically women, to earn a living (Levin *et al*., 1999). Street foods have been defined as: 'ready-to-eat foods and beverages prepared and/or sold by vendors and hawkers especially in streets and other similar places' (Nago *et al*., 2009). Street food vending classified into three general groups. These include: (i) an operation where the vendor prepares food at home and brings it to the food stall to sell; (ii) foods prepared and sold at the food stall; and (iii) foods prepared in a cottage type of factory and brought to the stall for sale (Chakravarty and Canet, 1996).

Street food is part of the culture in south Asia (Albuquerque *et al*., 2019). Like other countries, street foods also very much lucrative in Bangladesh specially in largest and densely populated cities and towns. Millions of people eat streets food daily with a wide selection of foods that are relatively cheap and easily accessible (Kasem, 2014). There are more than 53 types of street foods available in Chattogram city (personal observation). Although nourishing food can be found, unhealthier options are becoming increasingly popular – a marker of nutrition transition. This transition is ongoing in south Asia and specifically, in Bangladesh where consumption of street foods gradually increasing day by day, although the nutritional composition of street food in Bangladesh is largely unknown. Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO, 1996). In Thailand street foods provided around 40%, 39% and 44% of total energy, protein and iron intake, respectively (Proietti *et al*., 2014). The nutritional importance is greater in children 4–6 years old, who obtained 80% of their energy, protein, fat and iron intake from street foods (Codjia, 2000).

In Bangladesh, like other low-income countries, street food is still a lucrative and better options of food among the young generations. The cost of street food is cheaper than that of larger food establishments like restaurants, fast food outlets, which make it more popular to the consumers. In Bangladesh the demand of street food is increasing day by day among the people. This business has been undergone in various studies, but the buying behavior and preference study of the street food consumer specially the younger generation has not been focused in those researches (Kasem, 2014). Therefore, the scenario of street food consumers, the buying behavior and preferences, especially among the people in Chattogram city were not studied yet. Although proximate components and some types of microbial loads of a number of selective street foods are studied in earlier studies (Ngoc and Thanh, 2015). Information on the nutritive value of street foods especially micro nutrients, food borne microbes, and the preference levels of people regarding the street food choices are very much limited. Though, some misconceptions related to hygiene, and ingredients are existing, the consumers are satisfied with the choices. The present study would be elucidated the useful guidelines for the business people, consumers and fellow researcher to explore this sector more extensively (Draper, 1996).

The contribution of the street food sector in socio-economic growth is considerable; therefore, the requirement of safety in this sector needs to be emphasized especially in developing countries (Von Holy and Makhoane, 2006). Otherwise, street food consumption of a large population may increase the burden for public health. Many studies on the microbiological quality of street foods have identified high levels of coliforms and the presence of various pathogens such as *Escherichia coli*, *Salmonella* spp., *Staphylococcus aureus*, *Bacillus cereus*, *Clostridium perfringens* and *Vibrio cholerae* (Choudhury *et al*., 2011). Moreover, street foods have been reported to be an appropriate medium for the transmission of antimicrobial-resistant pathogenic bacteria including *Salmonella* spp., *E. coli*, and *S. aureus* to people (Guven *et al*., 2010). Considering the above backgrounds, the present study was undertaken with the following objectives:

Objectives:

- To know the socio-economic status of the street food vendors and consumers.,
- To find out the different types of street food in Chattogram and their price.,
- To determine the most preferred street foods and main reasons for buying street foods.,
- To assess and compare the proximate components, minerals and vitamins of street and frozen food.,
- To detect the microbial quality in selective street and frozen foods.

Review of Literature

Street foods are very much popular all over the world to fulfill the food demands of the urban dwellers especially in developing countries. Food security means adequate quantity and quality of foods to lead an active and healthy life. Food and Agriculture Organization (FAO) reports that street foods have significant nutritional implications (providing nutritionally balanced diets, sufficient in quantity and presenting options for variety and choice) for consumers, particularly from middle and low-income sectors of the population who depend heavily on them (Mwangi, 2002). Some street foods are regional, but many have spread beyond their region of origin. Most street foods are classified as both finger food and fast food, and are typically cheaper than restaurant meals. Finger foods means a food that is to be held with the fingers for eating such as easy sweet & sour meatballs, chicken roll ups with ham and cheese and chicken enchilada cups (Bipasha and Goon, 2013). Fast foods are characterized as quick, easily accessible and cheap alternatives to home-cooked meals such as sandwich, noodles, fried chicken and hamburger. The types of street food varies among regions and cultures in different countries around the world (Wanjek, 2005). Today, people may purchase street food for a number of reasons, such as convenience, to get flavourful food for a reasonable price in a sociable setting, prompt service, to try ethnic cuisines, or for nostalgia (Smith, 2007).

2.1 Features of street foods

To distinguish street food from other types of food, we must look at its characteristics and meanings. In this clarification, the main aspect of street foods is their retail location, which is on the street. Characteristics of street foods include: (i) Ready food- Ready-to-eat foods are convenient for people on the go; (ii) Cheap- Important for low-income customers who might not be able to afford a balanced meal elsewhere; (iii) Tasty- As opposed to eating the same fast food from food chains with outlets around the world; (iv) Authentic and culturally enriching- Street food is historically produced and run in various parts of the world; (v) Low capital business- These are low-capital business. This is a simple form of business that anyone can launch. Women work as street vendors to supplement their family's income; (vi) Popular- Street food is highly common. This is a type of food that everyone enjoys; (vii) Easily available food- Street foods can be found almost anywhere. People can easily obtain food (Kasem, 2014).

2.2 Introduction to some street foods of Bangladesh

2.2.1 Samosa

A samosa is a south asian fried or baked pastry with a savory filling like spiced potatoes, onions, peas, chicken and other meats, or lentils. It may take different forms, including triangular, cone, or half-moon shapes, depending on the region.

2.2.2 Singara

Both flat-shaped and full-shaped samosas are popular snacks in Bangladesh. The Bengali version of the full-shaped samosa is called a 'singara' and is normally much smaller than the standard Indian variety. The singara is usually filled with pieced potatoes and vegetables, and other types of singaras which filled with beef liver, are very popular in some parts of the country.

2.2.3 Piaju

Piaju, also known as lentil fritters, has become a popular snack in Bangladesh over the years. It is generally made with different types of lentils , onion and coriander leaves but nowadays, many people also use vegetables such as potatoes and carrots. Piaju is also a popular iftar item that pairs well with chola and beguni.

2.2.4 Beguni

Beguni is a common Bengali snack originating from the Bengal region. It is made of eggplant (also known as aubergine or brinjal) which is sliced and dipped in gram flour batter before being either fried or deep fried in oil. A similar European dish is known as aubergine fritters.

2.2.5 Paratha

Paratha is popular bread in Bangladesh which is made with baking flour. It is layered with the oil on a frying pan. In particular, paratha is eaten in breakfast with vaji, lentil or fried eggs and it is very common in Bangladesh.

2.2.6 Biriani

Biriani is very delicious and featured food as the main dishes. It is made with special kinds of rice, meat, and potatoes. In general, the rice and meat are cooked with combination rather than cooking it separately. It is being served with the salad and sometimes with the chutney.

2.2.7 Fuchka

Fuchka is very common, traditional and tasty food in Bangladesh. It is prepared with the fried crisp and hollow puri. It is mixed with round and the particular type of flavored water. It is served in a plate. The food is very affordable and can be found on the street side of Chattogram city.

2.2.8 Alu chop

Alu chop a snack originating from the Indian sub continent; in West Bengal and Bangladeshi preparation also widely available in Odisha, it is made out of boiled potatoes and various spices. "Alu" means potato, and the word "chop" means a small cutlet fritters or croquette in Bengali.

2.2.9 Chona-muri

Chona (chola bhuna) is a special way to have chick peas during Ramadan. Usually brown chick peas are used for this recipe.Some of us loves to add tomato in this recipe. For adding tomato, dice it and add with spices. It is served hot and warm along with muri (puffed rice), green chilies,and sometimes sauce and salads.

2.2.10 Dal puri

Dal puri is basically flat bread stuffed with lentil and spices. It is a very popular snack in Bangladesh and India. Usually red lentil is used for this recipe.

2.2.11 Chotpoti

Chotpoti, which literally means spicy or as we say in Hindi 'chatpata', is a quintessential Bengali street food, made with sprouts, boiled potato, tamarind and some spices.

2.2.12 Roll

Roll is a cylindrical casing of rice paper, or sometimes wheat and egg dough, filled with a shredded mixture of vegetables and often meat or seafood, served fresh or deep-fried.

Figure 1: Bangladeshi street foods

Table 2.1: List of street foods around the world

Name of the country	Street food category
Ethiopia	Injera, tibswat
Ghana	Fufu, kenkey, banku, fried yams and bush meat
Nigeria	Suya (barbecued meat), roasted plantain, fried yam and fish, roasted corn, akara and moi-moi (beans cake)
South Africa	Gatsby, abaguette filled with meat (often bologna sausage), salad, cheese and chips
China	Lanzhou (gansu) halal beef noodles, chongqing (sichuan) mala bunch and xian (shaanxi) cold noodles
Hong Kong	Skewered bee , curry fish balls, stuffed peppers and mushrooms, dim sum
India	Chaat , lassi, panipuri, alootikki, chaap , poori-subzie , chai-faen, vada pav, thattu , dosa , putu mayam
Indonesia	Mixed rice, fried rice, soups, satay, cakes, tempeh or beverages
Japan	Nikuman and castella, taiyaki and imagawayaki
Korea (South)	Tteokbokki , sundae, oden, mandu, gimbap, boiled silkworm pupa and river snail
Philippines	Fried squidballs, fishballs, kikiamtaho, palamig calamare
Taiwan	Fried stinky tofu, oyster omelette, zongzi (especially intainan), rice cakes made with pork blood
Switzerland	Grilled panini, pretzels, grilled chicken, hot dogs

(**Source**: Kasem, 2014)

2.3 Street foods diversity

The diversity of street foods is extensive, as they vary widely not only from country to country, but also from vendor to vendor (Modarressi and Thong, 2010). Street food ingredients are country-specific and mostly undocumented.he type of meals, consumption frequency and regularity, therefore, vary from country to country and are influenced by the national and/or regional food cultures (Ohiokpehai, 2003). The ingredients and means of preparation are also diverse and mainly include meat, poultry, fish, seafood, eggs, cereal products, soya products, fruits and vegetables (Draper, 1996). Most meals are based on combinations of staple foods, and are sold and consumed either as one-dish meals or as snacks (Proietti *et al*., 2014). Street foods are prepared in many ways: they can be fried, roasted, boiled, baked, steamed or eaten raw, depending on different cultures (FAO and WHO, 2005). In a study carried out in Burkina Faso, it was found that the basic ingredients consumed in most street foods were cereals (48.5%) and meat (33.9%), with a much lower contribution from milk (9.6%) and fruits (4.4%) (Drabo *et al*., 2009). Street foods can be grouped in various ways: by meal (meals, constituents of meals, snacks and drinks), by number and type of ingredients (simple and complex foods that contain more than one main ingredient), and by level and type of processing (minimally processed foods such as fruits which may only have been peeled or sliced; traditionally processed foods made by the vendor or another informal sector operative, and centrally processed commercial foods) (Choudhury *et al*., 2011).

2.4 Profile of vendors

Street food vendors are a self-employed category of small entrepreneurs who are not dependent on any institutional structures to find their livelihoods. Their enterprises evolve exclusively around their own individual strengths and the support extended to them by their immediate social networks such as family members and other close associates. The earnings from their business enterprises are a means of living for the vendors themselves and their dependent family members. As such, these economic activities of the street food vendors have not only provided a source of livelihood to the vendors and their dependent family members but also have reduced the plight of their becoming an economic and social burden on the state. Both males and females and married and unmarried operate as street food vendors. Many street food vendors and their families have their origin in rural backgrounds or have moved to urban centers at a

later stage or else live in rural areas and travel daily to the city for their business operations . The level of education achieved by the street food vendors is comparatively low and in the case of a majority, education levels varied between grades 5 and 8 (Khairuzzaman *et al*., 2014). Many street food vendors are constrained by the unstable socio-economic backgrounds in their families. Employment history of the street food vendors shows their previous involvement in several urban-based, irregular, and low-paid income generating activities, which required hard manual labor, prior to their involvement in the street food business. Their engagement in such activities was not sufficient for their sustenance (Muzaffar *et al*., 2009).

2.5 Consumers of street food

Consumers are the key driving force of the street food business. On the basis of field observation it has been found that the poor working class people are the main customers of various types of street foods. In Dhaka Metropolitan area, there are roughly 750,000 rickshaw pullers and 300,000 street vendors live and work (Islam, 2005). Majority of these people are mainly depended on such foodstuffs provided by the food vendors. Along with them, students of different ages like various types of street foods. The cheaper price and availability of such foodstuffs attracts people mostly the poor class to consume these. Besides, most of the consumers are poor and are not conscious of hygiene and the quality of food does not bother its customers (Rahman and Kabir, 2013). It is quite difficult to identify the accurate number of customers who take street foods regularly. In the years between 2018 and 2020 the total population of Chattogram city have increased from 4,816,000 to 5,020,000. On the basis of this rapid growth of population, it can be surmised that the present number of consumers of street foods must have increased than that of the year 2018 (WPP, 2019).

2.6 Criteria for choice of vendor

It was observed that consumer were introduced to vendors by a friend, parents, sister/brother and other relatives. For those consumer who were introduced to vendors by others, the main reasons for introducing them were cleanliness, good taste of the food and good food preparation or well cooked food. For consumer that chose the vendors themselves, the most important criterion for the choice of vendor was hygiene (48.7%), and size of the food was important for only 2.2% of the consumer. Other

criteria included type of food (19.7%), price (14.1%) and nice vendor (11.3%) (Nyaruhucha *et al*., 2007).

Table 2.2: Main criteria for choice of vendor (multiple responses possible)

Criteria	N	%
Hygiene	977	48.7
Type of food	396	19.7
Price	284	14.1
Vendor is nice	226	11.3
Known to the family	81	4.0
Large portion size	44	2.2
Total	2008	100

(**Source**: Nyaruhucha *et al*., 2007)

2.7 Street food buying behavior

Sometimes in different parts of the world, people tend to consume street food categorized as impulsive buying behavior. An impulse purchase or impulse buy is an unplanned decision to buy a product or service, made just before purchase (Tausif and Gupta, 2013). In 1962 Stern has researched and found that people tend to buy cheap goods in impulse buying, and street foods are cheap. Some research suggests that people buy impulsively due to the attraction and point of purchase stimuli (Abratt and Goodey, 1990). Consumers find street food attractive and consume it impulsively. Youn and Faber (2000) suggest that consumers can have either positive or negative feeling about the product that they buy impulsively; in this case street food has both the aspects. Other research suggests that consumers found enjoyment therefore they chose impulsive buying as their sensors stimulates that (Kaur and Singh, 2007). From these various aspects we can term the buying behavior of street food as an impulsive one as consumers find it cheaper, lucrative and enjoyable (Kasem, 2014).

2.8 Advantages of the street food trade

Street foods are usually economical, socially and culturally appropriate food items or meals. With many adults working long hours the use of street foods saves time in preparation of foods. People often do not have adequate cooking facilities and space, hence purchasing ready-to-eat food is an advantage (Mwangi *et al*., 2001). Another important advantage of the street food trade is that of income generation. Many illiterate and unemployed people, frequently women, find this a simple way to earn some money with little capital investment required (Bendech *et al*., 2000). Among

lower-income groups in many developing countries 50–70% of house-hold earnings are spent on street foods (Dawson and Canet, 1991). Hence, street foods also potentially contribute significantly to the diet of school children. It appears that cooked foods (cuisines, in particular) have become tourist attractions in certain countries and are often hailed as being authentic and unique dimensions of culture, lifestyle and even heritage. For example, in a study in Singapore, 65% of tourists agreed that street food centres had an appealing uniqueness and cultural significance (Henderson *et al*., 2012).

2.9 Social and economic importance

The sale of street foods represents a good living for families involved in food vending, however, as it is considered part of the informal sector, the contribution of street food to the economies of developing countries has been considerably underestimated and even ignored (FAO, 1991; Simon, 2007). In Africa street food enables 80% of urban populations to feed themselves easily and at low prices, representing around 40% of food expenditure in urban settings (IFPRI, 2000). The trade of street food generates income and employment. In Mexico generate around 12.7% of the Gross National Product and employ 28.5% of the national labor force. In Zambia in 2003 street food sales had an annual turnover of US$100 million and employed around 16,000 people, mostly women with minimal education, to whom this sector offers a unique possibility of working and earning (FAO and WHO, 2005). The social value of street food sale is important particularly for women. Female heads of households account for the majority of street vendors in many countries, e.g., women are involved in 90% of street-food business in the Philippines, 81% in Zimbabwe, 67% in Nigeria and 53% in Senegal (Chukuezi, 2010).

2.10 Association of socio-economic status with street food consumption

It appears that food vendors prepared their food items according to demand of the people. For example, vendors sold more foods from different food groups in the industrial area (53% of Energy Intake) than in the slum area of Nairobi (43% EI) (Mwangi *et al*., 2002). In Mali, 95.4% of children ate street foods at least once daily (Bendech *et al*., 1998). The practice was highest in poorest and middle income groups (Oguntona and Tella, 1999). A national study on street foods in South Africa indicated that moderate street food intake was highest in the middle

income groups (29.7%) and in the frequent eaters (at least twice weekly) it was 14.2%. These data suggest that street foods are sold in all socio-economic status areas although the type of items may vary according to the disposable income of the consumers (Steyn and Labadario, 2011).

2.11 Nutritional contribution of street foods

The majority of studies demonstrated that street foods contributed significantly to the diet of children and adults in developing countries, both in terms of energy, protein and micronutrient intakes and in terms of food groups consumed (Webb and Hyatt, 1988). In terms of nutrient contributions from street foods, the highest contributions of street foods to daily energy intakes in adults were found in Abeokuta in Nigeria (50.3% EI in males; 48.3% EI in females). In Nigerian adults, street foods contributed 53.2% of males' and 50.7% of females' total daily protein intake. In Nigerian adults street foods provided 37.9% of total daily intake of fat. A few studies have provided limited data on the intakes of micronutrients. Among adults in Abeokuta, street foods contributed 35.2% of Fe intake, 46.2% of Ca, 55.3% of vitamin A, 57.3% of vitamin C and 47.5% of thiamine intake (total daily intakes) (Oguntona *et al*., 1998).

2.11.1 Nutritional composition

Industrial foods are more energy dense than street food due to their high fat and sugar content (Moodie *et al*., 2013). In contrast, street food presented a higher energy content per serving (Steyn *et al*., 2014). Street food is not only present a higher energy but also present higher protein content and higher lipid profile content such as (Saturated fatty acids, Trans Fatty Acids , Monounsaturated fatty acids, Polyunsaturated fatty acids, Omega-3 fatty acids and Omega-6 fatty acids) (Albuqunerque *et al*., 2019).

Table 2.3: Nutritional composition (energy and macronutrients) of the street foods evaluated by proximate analysis, per serving in Dushanbe, Tajikistan

Food product	n	Serving size (g)	Energy (kcal/serving)	Protein (g/serving)	Carbohydrates (g/serving)	Fat (g/serving)	Water (g/serving)
Industrial food							
Biscuit rolls	3	57	220	3.6	39.2	5.5	8.0
Bread	3	50	130	4·3	27·2	0·4	17·1
Chips	3	20	104	1·0	11·7	5·8	0·7
Chocolate	4	54	260	3·2	36·6	11·2	1·8
Cookies	4	33	153	1·9	22·2	6·3	1·9
Maize snacks	4	38	170	1·4	29·0	5·4	2·2
Croutons	3	39	153	4·4	28·1	2·5	1·9
Sunflower seeds	4	53	275	7·6	21·4	17·6	1·4
Sweet pastries	4	51	229	3·6	31·1	10·0	6·3
wafers	3	107	562	4·2	71·1	29·0	2·0
Street food							
Baklava	4	88	381	11·0	49·9	15·2	10·7
Belyashi	4	81	217	5·9	31·5	7·5	34·8
Bread (chapoti)	4	120	345	12·1	73·6	0·2	31·6
Bun	4	60	183	5·2	35·6	2·2	16·5
Chebureki	4	91	189	5·0	24·2	8·0	52·0
Hamburger	4	204	423	16·1	57·6	14·3	112·4
Hot dog	4	186	354	13·1	48·3	12·1	109·2
Kurut	4	18	57	6·0	3·6	2·1	4·2
Piroshky	4	59	177	4·2	25·1	6·7	22·3
Sambusa	4	94	222	8·2	35·1	5·4	43·3
Shawarma	4	277	517	30·5	49·2	32·6	159·8

(**Source**: Albuquerque *et al*., 2019)

Table 2.4: Nutritional composition (fatty acid profile) of the street foods evaluated by proximate analysis, per serving(mean values) in Dushanbe, Tajikistan

Food product	n	Serving size(g)	SFA (g/serving)	MUFA (g/serving)	PUFA (g/serving)	n-6 Fatty acids (g/serving)	n-3 Fatty acids (g/serving)	TFA (g/serving)
Industrial food								
Biscuit rolls	3	57	2.2	1.8	1.0	0.9	0.1	0.4
Bread	3	50	0·1	0·1	0·2	0·2	0·0	0·0
Chips	3	20	1·2	1·8	2·7	2·7	0·0	0·1
Chocolate	4	54	5·8	4·0	0·56	0·5	0·0	0·0
Cookies	4	33	2·6	2·0	1·3	1·2	0·0	0·3
Maize snacks	4	38	0·7	1·0	3·5	3·5	0·0	0·0
Croutons	3	39	0·4	0·6	1·5	1·5	0·0	0·0
Sunflower seeds	4	53	2·2	4·3	11·0	10·9	0·0	0·0
Sweet pastries	4	51	3·1	3·0	3·1	3·0	0·0	0·8
wafers	3	107	12.9	9.7	3.5	3.5	0.0	2.5
Street food								
Baklava	4	88	4·5	5·5	4·7	4·4	0·2	0·3
Belyashi	4	81	2·1	2·4	2·8	2·7	0·1	0·1
Bread (chapoti)	4	120	0·0	0·0	0·1	0·1	0·0	0·0
Bun	4	60	0·9	0·7	0·5	0·4	0·0	0·0
Chebureki	4	91	2·9	2·3	2·6	2·6	0·0	0·1
Hamburger	4	204	3·4	3·9	6·6	6·4	0·1	0·1
Hot dog	4	186	2·4	3·0	6·5	6·3	0·1	0·1
Kurut	4	18	1·2	0·6	0·1	0·0	0·0	0·1
Piroshky	4	59	1·9	1·7	3·0	2·9	0·0	0·1
Sambusa	4	94	2·2	1·4	1·5	1·5	0·0	0·1
Shawarma	4	277	7.4	10.8	13.9	13.6	0.2	0.1

(**Source**: Albuquerque *et al*., 2019)

Table 2.5: Average mineral and vitamin contents of typical street food dishes in uganda, kampala and jinja districts

Food product	Serving(g)	Fe(mg)	Retinol(µg)	Ca(mg)	Thiamin(mg)	Ascorbic acid(mg)	Niacin(mg)	Zn(mg)
Boiled rice	158	4.3	0.0	22.4	0.5	0.0	13.4	0.0
Steamed bananas	358	0.9	0.0	17.9	0.1	22.1	2.4	0.5
Steamed sweet potatoes	58	1.6	0.0	20.5	0.0	0.0	0.0	0.0
Steamed cassava	33	0.4	0.0	21.5	0.1	27.7	1.2	4.5
Posho	142	1.3	0.0	2.8	0.1	0.0	3.8	0.5
Millet bread	450	9.3	0.0	164	1.8	189	18.5	6.9
Steamed yams	175	1.4	1.4	89.3	17.5	175	175	0.0
Beef stew	185	12.2	18.8	7.2	0.02	6.5	0.2	0.4
Fish stew	252	0.7	18.8	6.3	0.1	6.5	5.4	0.04
Bean sauce	458	32.7	18.6	487	1.5	10.4	9.6	10.9
Groundnut sauce	208	17.0	469	855	1.7	58.8	13.3	5.3
Boiled amaranthus	17.5	0.1	0.0	13.5	0.03	0.0	0.0	0.1
Fried cabbage	29.6	0.1	0.0	12.5	0.03	0.0	0.08	0.05

(**Source**: Namugumya and Muyanja, 2011)

2.12 Negative connotations of the street food trade

Unfortunately the use of street foods has many negative connotations with regard to hygienic and safety issues, and in many countries this trade is not regulated, which means that bacterial contamination of such foods is of concern to many who buy these products. Numerous studies have documented these effects and certainly one would need to pay attention to addressing these issues before encouraging the sale of street foods (Draper, 1996).

2.13 Hygiene and safety of street foods

In general, vendors tend to place their foods where there are a lot of human activities, irrespective of the poor conditions of the surroundings. In addition to lack of appropriate shelter to display and sell the foods, general sanitary condition of the surroundings and utensils used were poor. In most location, vendors displayed foods in uncovered, (plastic containers) and placed directly on dusty and unpaved ground. Overcrowding is usually accompanied with increased dust around the vending area, of which eventually gets onto the uncovered food and on vendors themselves, who continue with serving the customers using their bare hands. In very few location were vendors seen using special serving utensils (spoons, forks, etc). Most commonly, food is picked up by hand and placed in old newspaper wrapping, some vendors allowed consumer to pick out the food items themselves with their bare hands, a practice which could easily lead to microbial contamination of the food (Simon, 2007). With the increasing pace of globalization and tourism, the safety of street food has become one of the major concerns of public health, and a focus for governments and scientists to raise public awareness (Lues *et al*., 2006). However, despite concerns about contamination at street food vendors, the incidence of such is low, with studies showing rates comparable to restaurants (Etkin, 2009).

Table 2.6: Reasons for the foods to be unsafe

Reasons	N	%
Prepared under unhygienic conditions	186	34.6
Displayed uncovered	120	22.3
Place of preparation not known	85	15.8
Placed in unsafe plastic bags	45	8.4
Water is not boiled	32	5.9
Prepared from low quality ingredients	28	5.2
Vendor not clean	22	4.1
Uncooked	14	2.6
Not washed properly	3	0.6
Served un-hygienically (bare hands)	2	0.4
Mixed with colours	1	0.2
Total	538	100

(**Source**: Nyaruhucha *et al*., 2007)

2.14 Occupational hazards of street food vendors

Street vendors face unique kinds of livelihood risks because of the legal, physical, and socio-cultural environment in which they work. The most pressing and ongoing risk for many street vendors is the possibility that local government authorities will forcibly remove them from the streets or confiscate their merchandise. This risk of displacement often increases in the context of elections, mega events, or efforts to beautify historic city centers. Just like formal business operators, street vendors are less productive in unstable institutional environments where rules are irregular and unpredictable (Bhowmik, 2012).

2.15 Contamination of street food

Ready-to-eat street foods are also subjected to cross-contamination from various sources such as utensils, knives, raw foodstuffs, flies that sporadically landing on the foods, vendors bare hand serving and occasional food handling by consumers (Nicolas *et al*., 2007; Tambekar *et al*., 2009). In most cases, tap water is not available for washing hands and utensils at vending sites; hand and utensil washing are usually done in one or more buckets-sometimes without soap. Toilets, waste disposal and refrigeration facilities are rarely available. Wastewater and garbage are therefore discarded nearby, providing nutrients for insects and other household rodents, which may carry food borne pathogens (Tambekar *et al*., 2009). In Bangladesh, street foods are mostly prepared and processed manually and sold to the public at various lot terminals, by the roadside or by itinerant vendors (Mamun *et al*., 2013). The vendors in

Bangladesh lack of education regarding the basic food safety issues. Vendors generally use carts and stands, where they do not have easy access to running water, furthermore dish and hand washing is done using the same bucket, sometimes even without soap. Garbage and waste water are typically discarded in the streets nearby and thus attracting and providing food for rodents and insects (Bryan *et al*., 1988). Foodborne bacterial agents are the leading cause of severe and fatal foodborne illnesses. Of the many thousands' different bacterial species more than 90% of food-poisoning illnesses are caused by species of *Staphylococcus*, *Salmonella*, *Clostridium*, *Campylobacter*, *Listeria, Vibrio, Bacillus* and *Escherichia coli* (Schmidt *et al*., 2003).

2.16 Presence of microorganisms in different street food of Dhaka, Bangladesh

However, no such databases are available for Bangladesh as well as other developing countries. Therefore, from October Department of Microbiology and Biotechnology, Jagannath University, Dhaka conducted a series of experiments to assess the microbial quality of street foods of Bangladesh (Tabashsum *et al*., 2013). More than 100 street foods samples of 20 kinds including singara, jhal-muri, chotpoti, chetoi pitha, chola/bengal gram, jilapi, jar drinking water, pickles, amra, tehari, vegetable rolls, sugarcane juice, raw cucumber slices, milk, other juices, beverages, and bread were analyzed for major foodborne pathogens including, *Salmonella* spp., *Escherichia coli* O157, O111, O26, and other *E. coli*, other coliforms, *Listeria* spp. and *Staphylococcus* spp. (Khairuzzaman *et al*., 2014).

Table 2.7: Presence of different pathogens in the street food samples of Dhaka city

Food Items	N	*E.coli*	*E.coli* 0157, 0111, 026	*Salmonella*	*Staphylococus* Spp.	*Listeria monocytogenes*
Singara	9	ND	ND	ND	9	ND
Muri	9	ND	ND	3	9	ND
Chatpati	9	ND	ND	6	9	ND
Chitoi pitha	9	3	ND	3	9	ND
Chola	9	3	2	2	2	9
Jilapi	9	3	ND	3	3	ND
Jar water	18	8	2	2	6	ND
Achar	9	ND	ND	ND	3	ND
Amra	9	3	ND	ND	3	ND
Tehari	9	4	3	ND	2	ND
Vegetable roll	6	2	1	ND	5	ND
Sugarcane juice	3	ND	ND	2	1	ND
Slice cucumber	9	6	4	3	6	ND
Homemade bread	3	ND	ND	ND	1	ND
Milk	3	3	1	ND	3	ND
Juice	3	3	ND	ND	2	ND

(**Source** : Khairuzzaman *et al*., 2014), ND: Not Detected.

2.17 Conclusions

Street foods contribute significantly to the diet of many living in developing countries. Furthermore, street foods are convenient, cheap, easily accessible and a source of income to many poor people who would otherwise not find employment. Periodic health screening, ensuring compulsory treatment, and guidance on personnel and workplace hygiene may result in the decrease of microbial infections. Health policy makers and educators should encourage and promote the sale of healthy, traditional street foods and ensure that regulation efforts are in place to prevent health problems arising.

Materials and Methods

The study was conducted at the "Research Laboratory" under the department of Physiology, Biochemistry and Pharmacology and Poultry Research and Traning Centre (PRTC) in Chattogram Veterinary and Animal Sciences University (CVASU), Chattogram, Bangladesh in order to determine the nutritive value and isolation of food borne microorganisms from different street foods in Chattogram Metropolitan Area.

3.1 Study area

The study was conducted among different street foods in the Chattogram city, Bangladesh. The Chattogram city is located at a distance of 264.99 km. from Dhaka, Bangladesh. This is 2nd largest city in Bangladesh, and it is also known as commercial capital of Bangladesh. There are 5,133,000 inhabitants in this city (WPP, 2019). The current survey was conducted in nine popular places in Chattogram, namely Pahartali college, Tiger pass, Station road, New market, General Post Office (GPO), Kotwali, Chawk bazar, GEC more and Bahaddarhat. The list of reasons behind choosing the place are given in Annex 1 .

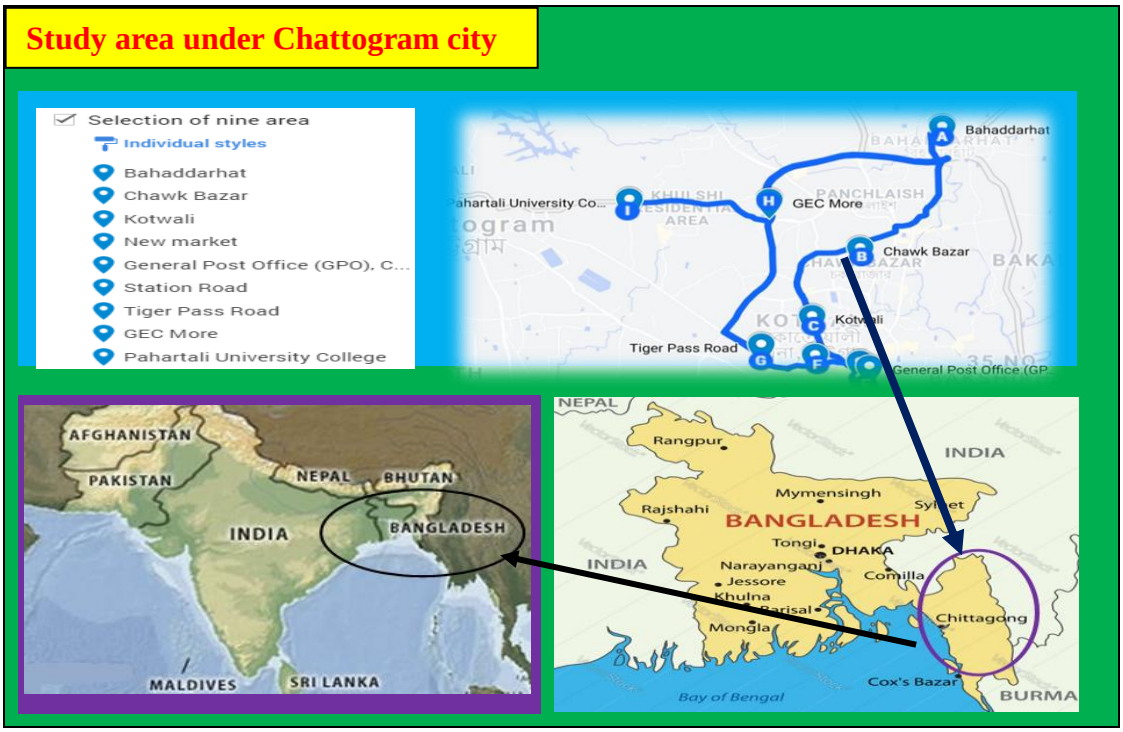

Figure 2: Geographical distribution of the study area

3.2 Study period

The study was conducted for a period of 18 months from January, 2019 to June, 2020.

3.3 Participants of the study

Street food vendors and the consumers of street food in the Chattogram city were the source population. Forty street food vendors and forty consumers in Chattogram city were the respondents of the study.

3.4 Sample size

Samples of the most commonly available food were collected for proximate analysis and assess the presence of microorganisms. Three street foods and three frozen foods such as Singara (Si) , Roll (Ro) and Samosa (Sa) were identified. Three samples of each of these street foods were collected from different vending sites and three samples of each of these frozen foods were collected from different commercial food brand. A total of 18 samples (nine street foods and nine frozen foods) were collected. Selection of food samples from different location and different brands are given in Annex 2.

3.5 Study design

We used the descriptive, quantitative and qualitative approaches. Descriptive research includes surveys, customers and vendors questionnaires that help small firms to improve their products and services by enabling them to make informed decisions. Quantitative approach is used to analyze the nutritional composition of the street food and commercial frozen food. Qualitative approach is used to identify the *Salmonella* spp. and *E.coli* from street food sample. Study planning is given in figure 3.

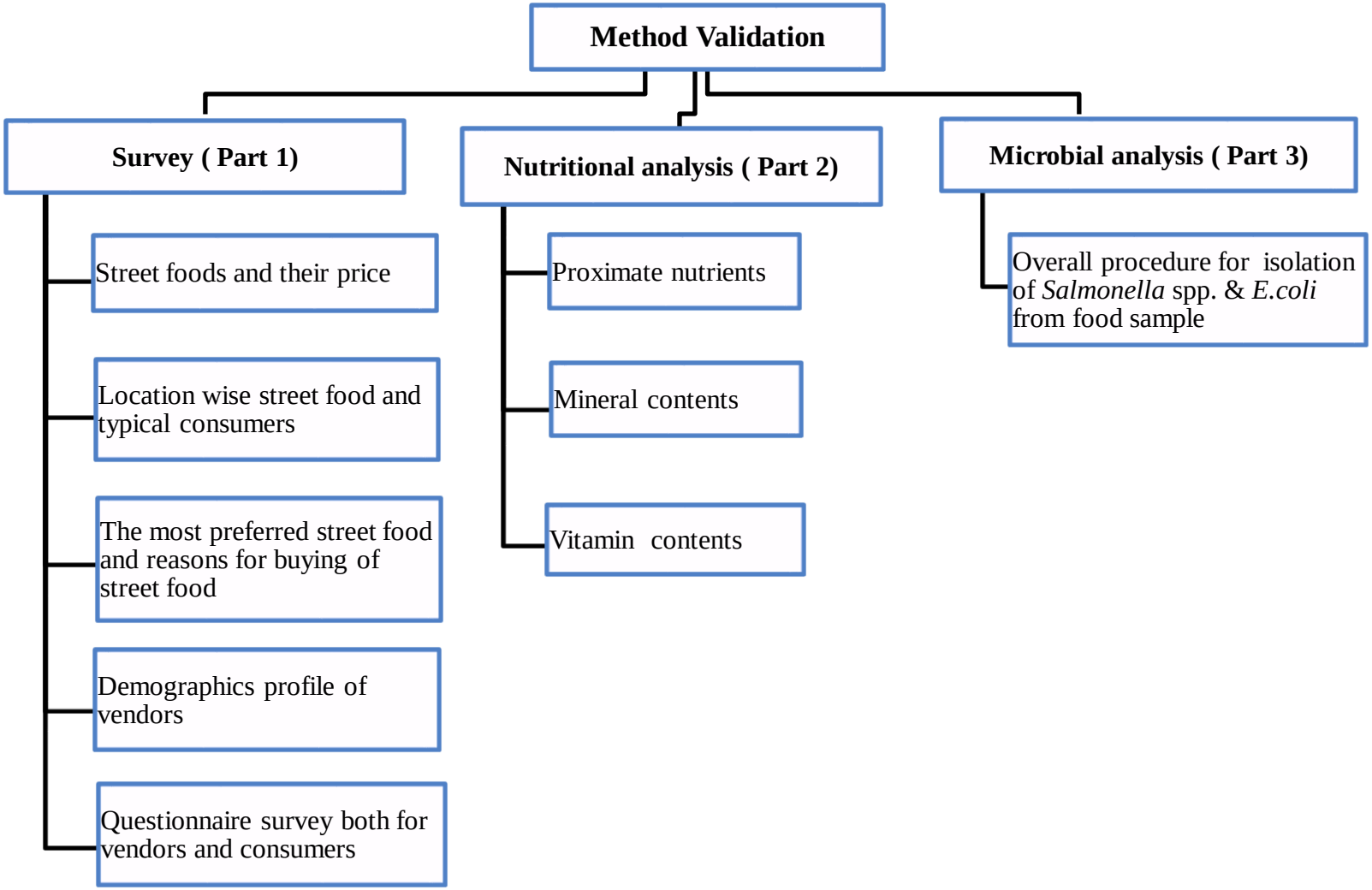

Figure 3: Study planning

3.6 Survey (Part 1)

3.6.1 Surveys tools

Surveys involve collecting informations, usually from fairly large groups of people. There are different types of survey. The most straight forward type (the "one shot survey") is administered to a sample of people at a set point in time. Another type is the "before and after survey" which people complete before a major event or experience and then again afterwards.In this study,we used one shot survey method. Descriptive data was collected from January, 2019 to june, 2020 in different region of Chattogram city among street food vendors and customers using various data collections methods (interviews, observations, photography and questionnaire). Data was compiled in handwritten field notes, pictures and recordings during field activities, and was indexed, transcribed and entered in MS Excell-2007 as quickly as possible during the field study.

3.6.1.1 Interview

A total of 80 vendors (n= 40) and consumers (n= 40) were selected randomly for an in-depth interview. All interviews were conducted using semi-structured interview guides and focused on: perceptions and attitudes towards food vending, food hygiene, and food safety but also sought general descriptions of the life of a street vendor, challenges and problems for the street food business,consumers preference, customer relationships and cooking knowledge, education and experience. Date of interview list is given in Annex 3.

3.6.1.2 Observations

Observations were conducted working or sitting inside or near kitchens and vending stands and included all cooking and vending procedures as well as interactions with customers. A set of observation notes were compiled for each vendor with exact descriptions of events, discussions, observation atmosphere, practices observed etc. Not all information was obtained from the questionnaire. Some aspects pertaining to vendors required observation. An observation form was developed that made provision for observing and recording the following aspects of vendors: status of nails and hands, smoking and taking care not to cough over food, wearing jewellery and/or bangles on arms, and handling of food and money without washing hands in between.

3.6.1.3 Photography

The method provided a rich, detailed set of data, but also brought a number of noticeable benefits to the data collection process. The photo-survey is not only effectively captured and documented life in the city but also acted as an 'agent for change', evoking thoughts and feelings which ultimately encouraged participants to reflect on their existing perceptions and urban experiences. The study also raises some important considerations for future work undertaken with this method and with using photographs as a set of data, and proposes techniques for minimising potential problems. Pictures are given in appendices (Figure 11 and 12).

3.6.1.4 Questionnaire survey pattern

The target of the survey was to assess the food safety knowledge, hygiene and attitudes of both consumers and street food vendors. Questionnaire consists of multiple choice question and few open ended questions. In our topics, we had to deal with in the street food vendors, customers and observe the vendors activity. Participants were interviewed through a structured questionnaire in Bangla language and data were analyzed. Questionnaire are given in appendices.

3.6.1.4.1 Questionnaire for vendors

Vendors questionnaires were developed as the major means of data collection on personal characteristics and social and cultural characteristics of the street food vendors. The following main issues were dealt with in the street food vendors questionnaire: features of street food outlets, toilet and water facilities, vendor hygiene, handling of utensils, waste disposal, food preparation, and financial affairs of vendors. Particular attention was paid to food handling and identification of potential sources of microbial contamination that would affect the quality and safety of street foods sold in the selective area of Chattogram city.

3.6.1.4.2 Questionnaire for consumers

Procedures for development and testing of the consumers questionnaire were similar to those used for the vendor questionnaire. However, different types of questions were used to cover the following topics: facilities of street food, favourite street food place, frequency of buying street food, opinion on prices and reason for choice of vendor, quality of food, stomach aches because of consumption of street food, monthly amount

spent on street food, and the main reasons (in order of importance) for buying street foods.

3.6.2 Types of street foods in Chattogram city

In this study, 53 items of street foods were identified in the selected areas. After analyzing the collected data some of the major food items had identified those were commonly sold over the streets in this city. Among these, the most widespread food items that were snacks and drinks. Besides, fruit items, lunch and other items are also countable. For example, roll, fuchka, singara, samosa, jhalmuri, piaju and sugarcane juice etc. are very popular food items here. The root factor lying behind the popularity of street food is its cheaper price. Most of the food items are available in Tk. 2-5 and about 98.1% of the street foods are sold in less than Tk. 25. Such small amount of money is easily affordable by all and so these are preferred by the all aged people. List of street foods and their price are given in Annex 4 and street food list on different locations and typical consumers of street foods are given in Annex 5.

3.6.3 Street food preferences

The participants were asked to indicate their favorite three ones from the list of 53 street foods mostly consumed in Chattogram. The consumers preferred the street food on the basis of variety, availability, to replace lunch, entertain friends and for the cost. However the hygiene factor, good ingredients factor, does not influence their preference level. Though some of the young adults feel that this type of food is not hygienic and should be banned, nevertheless most of the consumers feels that they are satisfied with the quality of street food in Chattogram city. The most preferred street food list is given in Annex 6.

3.6.4 Demographics profile of vendors-respondents

The demographic information consists of gender, age, income, deposit, educational level and food safety training. The knowledge section was designed to evaluate the food safety knowledge of vendors and economic condition of vendors. The list of demographics profile is given in Annex 7.

3.7 Nutritional analysis (Part 2)

3.7.1 Collection of food sample

Samples of foods in different locations were collected to assess their nutritive value. 18 samples (9 street foods and 9 frozen foods) of three popular types of foods (singara, samosa, roll) were collected. The samples were collected over two different days during the course of a week. The food samples were collected from vendors selected using the same random sampling method. Samples were collected aseptically in pre-sterile zipper bag, kept in ice-boxes, and were labelled.

3.7.2 Preservation of food sample

At the "Research Laboratory" under the department of Physiology, Biochemistry and Pharmacology, Chattogram Veterinary and Animal Sciences University, the samples were stored in the refrigerator at -18^0C to -22^0C. Before drying, the samples were thawed by transferring them from the freezer to a refrigerator at 4^0C for 24 hours. After thawing, samples were taken out from refrigerator and were processed each sample when the temperature of the samples were at room temperature.

3.7.3 Weight of food and detect the ingredients used in street and commercial frozen foods

Either a data sheet with sample numbers should be used or sometimes the weight can be written directly on the sample. Take zipper bag; then aseptically and accurately weigh unthawed food (street & frozen) into bag. Once the initial raw weight is taken (only for frozen food) and the sample begins to fry and dry. The frying and drying weight is taken, there is no going back so it's important to keep a good record. Many menu items contain street and frozen food. Ingredients find out from street and frozen food are more complicated. If we had to identify the ingredients of singara, samosa and roll, we might list the ingredients use for wrappping, stuffing and filling. Wrappping: Food wraps made from dough are used to keep the contents enclosed and together as they bake and as they are consumed; Stuffing: An edible food mixture, often composed of herbs and spices, used to fill a cavity in another food item; Filling: Material that is used to fill something, it may be legumes or boiled vegetables. The weight and ingredients list is given in Annex 8 and 9.

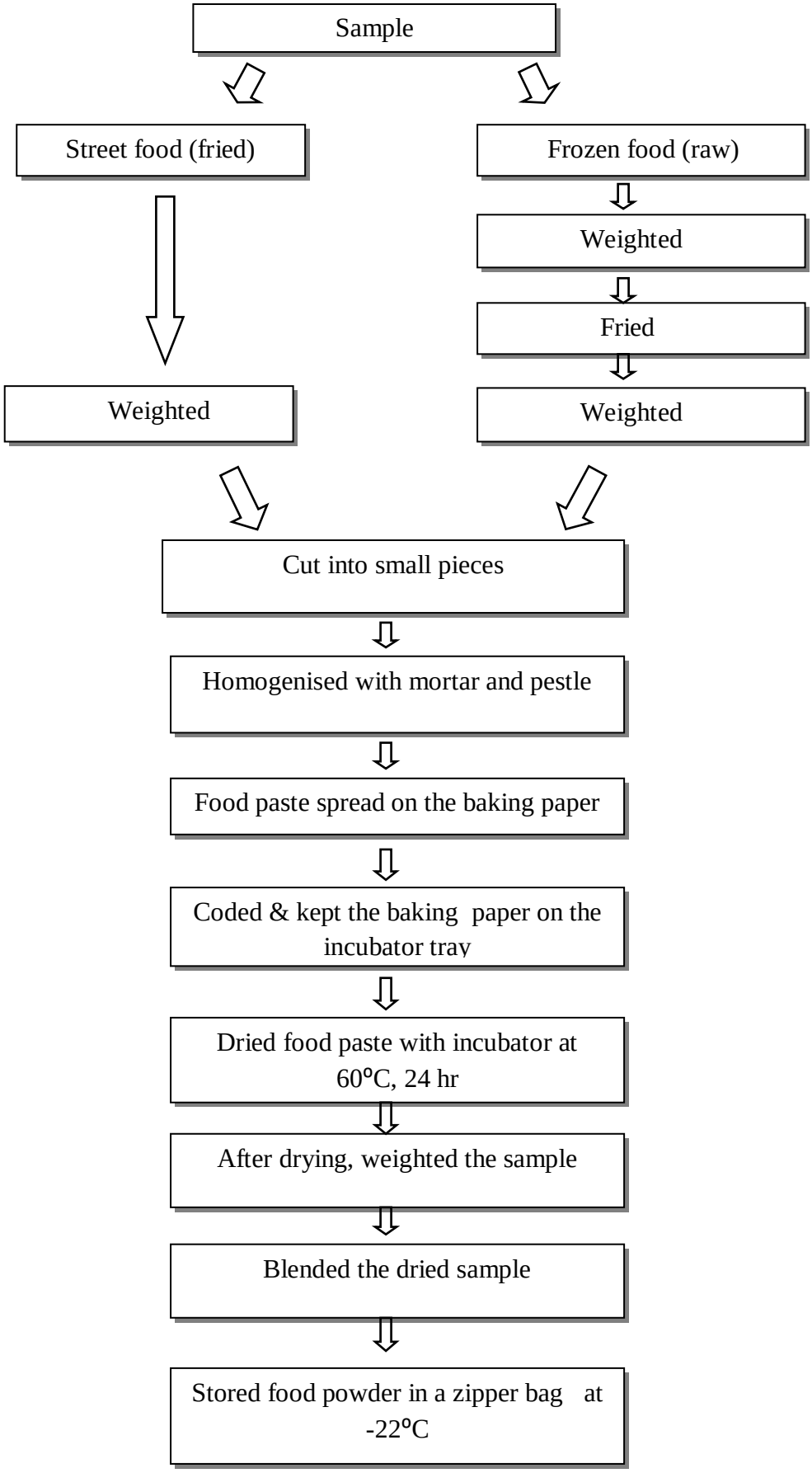

Figure 4: Flow sheet for food sample preparation

3.7.4 Proximate analysis of food sample

The assessment of the nutritional composition included the analysis of (a) moisture by oven drying at 105°C until constant weight, (b) protein by Kjeldahl's method, (c) fat by Soxhlet's method, (d) ash was measured gravimetrically in a muffle furnace (DB33F-Witeg) by heating at 550^0C to constant weight, (e) crude fiber was determined gravimetrically after chemical digestion, (d) carbohydrates was estimated by difference. Proximate analysis of food components (moisture, protein, fat, carbohydrate, ash and crude fiber), performed in accordance with standard methods, as recommended by the Association of Official Analytical Chemists (AOAC, 2005). All determinations were done in double and the result was expressed as the average value.

3.7.4.1 Determination of moisture content

Principle: The method is based on the drying of food sample under controlled temperature until constant weight is obtained. Moisture content is required to express the nutrient content per dry weight basis. In some foods, moisture is used to indicate their quality. Standard values of moisture are indicated in food notification or regulation.

Procedure: Moisture is always present in food staffs. Estimation of moisture is done simply by heating at 104-105°C for 3-4 hours in the oven and is cooled in a desiccator to absorb moisture. The process is repeated for several times until the constant weight shows by the sample.

Calculation:

$$\text{Moisture \%} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Sample weight}} \times 100$$

3.7.4.2 Determination of ash content

Principle: The principle of ashing is to burn off the organic matter and to determine the inorganic matter remained. Heating is carried out in two stages:- firstly to remove the water present and to char the sample thoroughly; and finally ashing at 550°C in a muffle furnace.

Procedure: The ash fraction contains all the mineral elements jumbled together. This method performs oxidization of all organic matter by incineration and determines the weight of remaining ash. At first weighed the empty crucible. About 5 gm of dried samples was ignited in the crucible with the help of a suitable burner for about an hour. Completed the ignition by keeping in a muffle furnace at 550-600^{0}C for about 3 hours until grey color ash was obtained. Then the crucible was taken from muffle furnace and cooled in desiccators. Later on the crucible was weighted.

Calculation:

$$\text{Ash \% of Sample} = \frac{\text{Amount of ash of supplied sample}}{\text{Sample wt}} \times 100$$

3.7.4.3 Crude protein determination

Principle: The method is based on the digestion of proteins and other organic food components in the sample with sulfuric acid in the presence of catalyst e.g. sodium or potassium sulfate to release nitrogen from protein and retain it as ammonium salt. Ammonia gas is liberated upon addition of excess alkali (concentrated sodium hydroxide) and is distilled into a boric acid solution to form ammonium-borate complex. The ammonia liberated from the complex is titrated with standardised hydrochloric acid. The amount of nitrogen in the sample is determined from the milligram equivalent of the acid used. Crude protein is determined by multiplying the nitrogen content with a conversion factor 6.25 (equivalent to 0.16 g nitrogen per gram of protein).

Reagents required: (i) Concentrated sulphuric acid (0.2%); (ii) Digestion mixture (K_2SO_4 & $CuSO_4$); (iii) Boric acid solution (2%); (iv) Sodium hydroxide solution (40%); (v) Mixed indicator solution (methyl red and methylene blue); (vi) Standard HCl (0.2 N)

Procedure: The Kjeldahl method can conveniently be divided into three steps: digestion, distillation and titration.

Digestion

The digestion step was done to break down the intricate structure and chemical bonds of feed substance to simple ionic structure. In digestion procedure, proteins and other forms of nitrogen were broken down and converted to ammonia.

0.3g sample was weighed accurately. Then 4g digestion mixture was added. Further 5ml of conc. H_2SO_4 was added to the mixture. After that the digestion flask was placed on Kjeldahl digestion set. After digestion removed the flask from the chamber and cooled at room temperature.

Distillation

In Distillation steps, ammonia-nitrogen was separated from the digested end product. It involved the conversion of ammonium (NH_4^+) ion to ammonia (NH_3). Distilling the ammonia, nitrogen was separated, and collected the distillate in a suitable trapping medium. Collection of ammonia is usually done by absorption into a solution of 2% boric acid. The ammonia is bound to the boric acid in the form of ammonia borate.

At first 25 ml distilled water was added. Then content was transferred to distillation flask. After that 10 ml 40% NaOH solution was added and set the condenser 10 ml 2% Boric acid solution and mixed indicator were added in conical flask. Heat the distillation flask and continue up to collection of app. 100ml of distillate.

Titration

Determination of the amount of nitrogen on the condensate flask can be accomplished by several methods. The most common method is titration of the ammonia with a standard solution of N/10 HCl in the presence of mixed indicator. The receiving solution was titrated with 0.2N HCl solution until turn into grey color.

Calculation:

$$\text{Protein \%} = \frac{\text{Titration value} \times \text{Normality of HCl} \times 0.014}{\text{Sample wt}} \times 6.25 \times 100$$

3.7.4.4 Crude fat determination

Principle: Lipid in food present in various forms like monoglycerides, diglycerides, triglycerides and sterol and free fatty acid and phospholipid and carotenoids and fat-soluble vitamins. Lipid is soluble in organic solvent and insoluble in water, because of this, organic solvents like hexane, petroleum ether have the ability to solubilize fat and fat is extracted from food in combination with the solvent. Later the fat is collected by evaporating the solvent. Almost all the solvent is distilled off and can be reused.

Procedure: The dried sample was taken in a thimble and plugged the top of the thimble with a wood of fat free cotton. The thimble was dropped into the fat extraction tube attached to a Soxhlet apparatus. The anhydrous petroleum ether was poured through the sample in the tube into the flask. Top of the fat extraction tube was attached to the condenser. The sample was extracted for 16 hours or longer on a water bath at 70-80°C.

At the end of the extraction period, the thimble from the apparatus was removed and distilled of the petroleum ether by allowing it or collected in Soxhlet tube. The ether was poured off when the tube was nearly full. When the ether was reached a small volume, it was poured into a small, dry (previously weighed) beaker through a small funnel containing plug cotton. The flask was rinsed and filtered thoroughly using ether. The ether was evaporated on a steam bath at low heat, it was then dried at 100°C for 1 hour, cooled and weighed. The difference in the weights was the ether-soluble material present in the sample.

Calculation:

$$\text{Fat \% of sample} = \frac{\text{Wt of extract}}{\text{Sample wt}} \times 100$$

3.7.4.5 Crude fiber determination

Principle: Crude fiber is determined gravimetrically after chemical digestion and solubilization of other materials present. The fiber residue weight is then corrected for ash content after ignition.

Reagents required: (i) Sulphuric acid solution (0.255N,1.25%); (ii) Sodium hydroxide solution (0.313 N ,1.25%)

Procedure: Crude fiber is the water insoluble fraction of carbohydrate consists mainly of cellulose, hemicellulose and lignin. It was estimated through digestion of fat free known amount of food sample by boiling it in a weak solution of acid (1.25% H_2SO_4) for 30 minutes followed by boiling in weak solution of alkali (1.25% NaOH) for 30 minutes at constant volume and then deducting ash from the residue obtained.

About 2-5ml of moisture and fat free sample were weighed into 500ml beaker and 200ml of boiling 0.255 N (1.25% w/v) sulfuric acid is added .the mixture was boiled for 30 minutes keeping the volume constant by the addition of water at frequent intervals.

At the end of this period, the mixture was filtered through a muslin cloth and the residue washed with hot water till free from acid. The material was then transferred to the same beaker and 200ml of boiling 0.313 N (1.25%) NAOH added. After boiling for 30 min, the mixture was filtered through muslin cloth. The residue was washed with hot water till free from alkaline followed by washing with some alcohol and other. It was then transferred to a crucible, dried overnight at 105^0C and weighed. The crucible is heated in a muffle furnace at 600^0C for 2-3 hrs. Cooled and weighed again. The difference in the weight represents the weight of crude fiber.

Calculation:

$$\text{Crude fiber \%} = \frac{\text{Weight of residue with crucible} - \text{Weight of ash with crucible}}{\text{Sample weight}} \times 100$$

3.7.4.6 Determination of carbohydrate

Principle: Carbohydrate values are calculated by subtraction methods. This means that when a food is chemically analyzed in a lab, the grams of protein, fat, crude fiber, water, and ash are subtracted from the total gram weight of the sample, and the amount left over is considered the carbohydrate value.

Procedure: The carbohydrate content of a food can be determined by calculating the percent remaining after all the other components have been measured. It was given as the difference between 100 and a sum total of the other proximate components.

Calculation:

% CHO = 100% - % (Protein + Fat + Fibre + Ash + Moisture content)

3.7.5 Determination of mineral contents

Principle: The method involves the separation of minerals from the food matrix by destruction of the organic matter of the sample through dry ashing or wet digestion. The mineral content in diluted acid is then determined either by spectrophotometer (Humalyzer 3000®) or colorimeter (Labtronics).

Reagents required: Nitric acid ($HNO_{3)}$ and Perchloric acid ($HClO_4$)

Procedure: One (01) g of dry sample was weighted in a conical flask. For dry sample, add 5 mL conc. HNO_3 and 1mL conc.$HClO_4$. For wet sample, add 5-10 mL HNO_3 and 1-2 mL $HClO_4$ (HNO_3: $HClO_4$ = 5:1). Then the flask was placed in a hot plate at 200W for

1-2 hours until full digestion. After digestion, it was cooled to room temperature. Then transferred the digested samples into 100 mL volumetric flask and diluted up to 100 mark with Deionized water and mixed well. Later, the solution was filtered through Whatman® filter paper No. 1 and transfer to eppendorf tube for mineral determination.

3.7. 5.1 Determination of sodium (Na^+)

Principle: Sodium is precipitated as a triple salt with magnesium and uranyl acetate. The excess of uranyl ions are reacted with ferrocyanide in an acidic medium to develop a brownish colour. The intensity of the colour produced is inversely proportional to the concentration of sodium in the sample. The absorbance is measured at 540 nm.

Procedure:

Table 3.1: Sodium (Na^+) determination

Step 1: Precipitation

Pipette into cuvette		
	Blank	**Standard**
Precipitating Reagent(L1)	1.0 ml	1.0 ml
Sodium Standard	20 µl	-
Sample	-	20 µl

Trade name : ELYTE 3 KIT. Batch number : 1103060015. Manufacturer name : Coral clinical systems, tulip diagnostics (p) Ltd.

Mix well and let stand at R.T. for 5 mins. With shaking well intermittently. Centrifuge at 2500 to 3000 RPM to obtain a clear supernatant.

Step 2: Colour development

Pipette into cuvette			
	Blank	**Standard**	**Sample**
Acid Reagent(L2)	1.0 ml	1.0 ml	1.0 ml
Supernatant from step 1.	-	20 µl	20 µl
Precipitating Reagent(L1)	20 µl	-	-
Colour Reagent(L3)	100 µl	100 µl	100 µl

Trade name : ELYTE 3 KIT. Batch number : 1103060015. Manufacturer name : Coral clinical systems, tulip diagnostics (p) Ltd.

Calculations:

$$\text{Sodium (mmol/L)} = \frac{(A)\text{blank} - (A)\text{sample}}{(A)\text{blank} - (A)\text{standard}} \times \text{Standard conc. (mmol/L)}$$

3.7.5.2 Determination of chloride ion (Cl^-)

Principle: Chloride ions combine with free mercuric ions and release thiocyanate from mercuric thiocyanate. The thiocyanate released combines with the ferric ions to form a red brown ferric thiocyanate complex. Intensity of the color formed is directly proportional to the amount of chloride present in the sample. The absorbance is measured at 505 nm.

Procedure:

Table 3.2: Chloride ion (Cl^-) determination

Pipette into cuvette			
	Blank	**Standard**	**Sample**
Sample	-	-	10 µl
Deionized water	10 µl	-	
Standard	-	10 µl	-
Reagent	1.0 ml	1.0 ml	1.0 ml

Trade name : ELYTE 3 KIT. Batch number : 1103060015. Manufacturer name : Coral clinical systems,tulip diagnostics (p) Ltd.

Calculation :

$$\text{Chloride (mmol/L)} = \frac{\text{(A)sample}}{\text{(A)standard}} \times \text{Standard conc. (mmol/L)}$$

3.7.5.3 Determination of calcium (Ca^{2+})

Principle: Calcium ions form a violet complex with O-Cresolphthalein complexone in an alkaline medium. The absorbance is measured at 570 nm.

Procedure:

Table 3.3: Calcium (Ca^{2+}) determination

Pipette into cuvette			
	Blank	**Standard**	**Sample**
Sample	-	-	25 µl
Distilled water	25 µl	-	
Standard	-	25 µl	-
Working Reagent	1.0 ml	1.0 ml	1.0 ml

Trade name : Calcium (Ca). Batch number : 1070CA. Manufacturer name : Randox Laboratories Ltd.

Calculation:

$$\text{Calcium (mg/dl)} = \frac{\text{(A)sample}}{\text{(A)standard}} \times \text{Standard conc. (mg/dl)}$$

3.7.5.4 Determination of magnesium (Mg^{2+})

Principle: The method is based on the specific binding of calmagite, a metallochromic indicator and magnesium at alkaline pH with the resulting shift in the absorption wavelength of the complex. The intensity of the cromophore formed is proportional to the concentration of magnesium in the sample. The absorbance is measured at 520 nm.

Procedure:

Table 3.4: Magnesium (Mg^{2+}) determination

Pipette into cuvette			
	Blank	**Standard**	**Sample**
Sample	-	-	10 µl
Standard	-	10 µl	-
R1. Reagent	1.0 ml	1.0 ml	1.0 ml

Trade name : Magnesium MR. Batch number : 1980005. Manufacturer name : Linear Chemicals, S.L.U.

Calculation :

$$\text{Magnesium (mg/dl)} = \frac{(A)\text{sample}}{(A)\text{standard}} \times \text{Standard conc. (mg/dl)}$$

3.7.5.5 Determination of phosphorus (P^{3-})

Principle: Inorganic phosphate reacts with ammonium molybdate in the presence of sulfuric acid to form a phosphomolybdic complex which is measured at 340 nm.

Procedure:

Table 3.5: Phosphorus (P^{3-}) determination

Pipette into cuvette			
	Blank	**Standard**	**Sample**
Sample	-	-	10 µl
Standard	-	10 µl	-
R1. Reagent	1.0 ml	1.0 ml	1.0 ml

Trade name : Phosphorus UV. Batch number : 1149005. Manufacturer name : Linear Chemicals, S.L.U.

Calculation:

$$\text{Phosphorus (mg/dl)} = \frac{(A)\text{sample}}{(A)\ \text{Standard}} \times \text{Standard conc. (mg/dl)}$$

3.7.5.6 Determination of potassium (K^+)

Principle: Sodium tetraphenyl boron reacts with potassium to produce a fine turbidity of potassium tetrapheny boron. The intensity of turbidity is directly proportional to the concentration of potassium in the sample. The absorbance is measured at 630 nm.

Procedure:

Table 3.6: Potassium (K^+) determination

Pipette into cuvette			
	Blank	**Standard**	**Sample**
Sample	-	-	20 µl
Deionized water	20 µl	-	-
Standard	-	20 µl	-
K^+ Reagent	1.0 ml	1.0 ml	1.0 ml

Trade name : ELYTE 3 KIT. Batch number : 1103060015. Manufacturer name : Coral clinical systems, tulip diagnostics (p) Ltd.

Calculation:

$$\text{Potassium (mmol/L)} = \frac{(A)\text{sample}}{(A)\text{standard}} \times \text{Standard conc. (mmol/L)}$$

3.7.5.7 Determination of iron (Fe^{2+})

Principle: The iron is dissociated from transferring-iron complex in weakly acid medium. Liberated iron is reduced into the bivalent form by means of ascorbic acid. Ferrous ions give with FerroZine a colored complex. The intensity of the color formed is proportional to the iron concentration in the sample. The absorbance is measured at 562 nm.

Procedure:

Table 3.7: Iron (Fe^{2+}) determination

Pipette into cuvette			
	Blank	**Standard**	**Sample**
Sample	-	-	200 µl
Standard	-	200 µl	-
Reagent	1.0 ml	1.0 ml	1.0 ml

Trade name : Iron FerroZine. Batch number : IRO-023. Manufacturer name : Bio-Science Medical S.L.

Calculations:

$$\text{Iron } (\mu g/dl) = \frac{(A)\text{sample} - (A)\text{sample blank}}{(A)\text{standard}} \times \text{Standard conc. } (\mu g/dl)$$

3.7.5.8 Determination of zinc (Zn^{2+})

Principle: Zinc in an alkaline medium reacts with Nitro-PAPS to form a purple coloured complex. Intensity of the complex formed is directly proportional to the amount of zinc present in the sample. The absorbance is measured at 570 nm.

Procedure:

Table 3.8: Zinc (Zn^{2+}) determination

Pipette into cuvette			
	Blank	**Standard**	**Sample**
Working Reagent	1.0 ml	1.0 ml	1.0 ml
Distilled Water	50 µl	-	-
Standard	-	50 µl	-
Sample	-	-	50 µl

Trade name : Zinc kit. Batch number : 1103130025. Manufacturer name : Coral clinical systems, tulip diagnostics (p) Ltd.

Calculations:

$$\text{Zinc (µg/dl)} = \frac{\text{Abs of Sample}}{\text{Abs of standard}} \times \text{Standard conc. (µg/dl)}$$

3.7.5.9 Determination of copper (Cu^{+})

Principle: Copper, reacts with Di-Br-PAESA to from a coloured complex. Intensity of the complex formed is directly proportional to the amount of Copper present in the sample. The absorbance is measured at 580 nm.

Procedure:

Table 3.9: Copper (Cu^{+}) determination

Pipette into cuvette			
	Blank	**Standard**	**Sample**
Buffer Reagent (L1)	500 µl	500 µl	500 µl
Colour Reagent(L2)	500 µl	500 µl	500 µl
Distilled Water	50 µl	-	-
Standard	-	50 µl	-
Sample	-	-	50 µl

Trade name : Copper kit. Batch number : 1103040025. Manufacturer name : Coral clinical systems, tulip diagnostics (p) Ltd.

Calculations:

$$\text{Copper (µg/dl)} = \frac{\text{Abs of Sample}}{\text{Abs of standard}} \times \text{Standard conc. (µg/dl)}$$

3.7.5.10 Determination of manganese (Mn^{2+})

Principle: Manganese solution in sodium hydroxide when mixed with brucine followed by HCl produces pink color and the absorbance is measured at 480 nm. This color reaction has been developed for the colorimetric determination of manganese (Hashmi *et al.*, 1969).

Procedure:

Table 3.10: Manganese (Mn^{2+}) determination

Pipette into cuvette (Step- 1)			
	Blank	**Standard**	**Sample**
Sample	-	-	2.0 ml
Methanol	10 ml	-	-
Standard	-	2.0 ml	-
S1	-	2.0 ml	2.0 ml
S2	-	2.0 ml	2.0 ml
S3	-	4.0 ml	4.0 ml
Final volume(S4)	10 ml	10 ml	10 ml

Trade name : Manganese standard solution. Catalogue number : 119789. Manufacturer name : Merck KGaA ,Germany.

Shake, heat at 60-65°C for 2 mins in water bath until formation of orange yellow color and cool under tap water and take 5 ml standard and sample from S4 and blank will be untouch.

Pipette into cuvette (Step- 2)			
	Blank	**Standard**	**Sample**
S4	10 ml	5.0 ml	5.0 ml
Add S3	-	5.0 ml	5.0 ml

Calculation:

$$\text{Manganese (µg/2ml)} = \frac{Y}{0.0002}$$

Where, 0.0002 = slope, Y=Absorbance

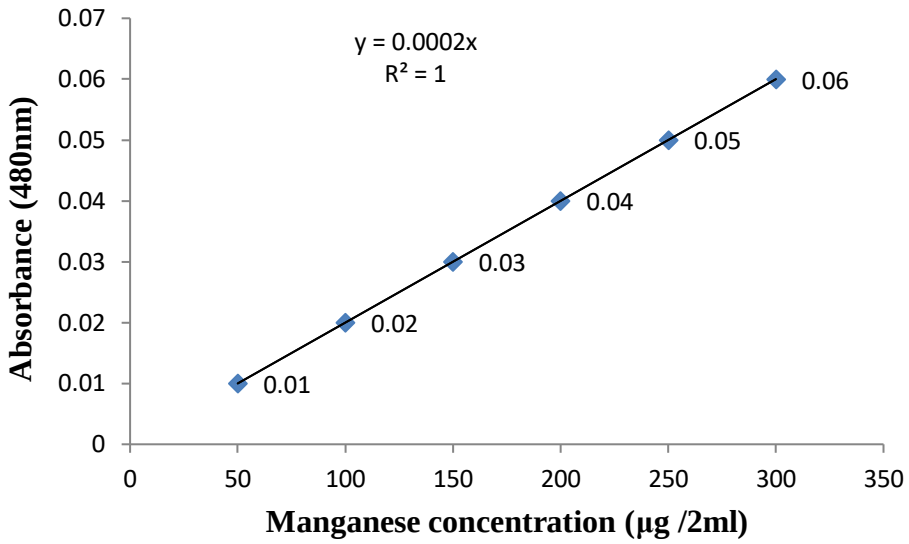

Figure 5: Calibration curve for the determination of manganese

3.7.5.11 Determination of selenium (Se^{2-})

Principle: The reaction of selenium with potassium iodide in acidic medium liberate iodine. The liberated iodine bleaches the violet colour of azure B to colourless leucoform and the absorbance is measured at 630 nm (Narayana and Mathew, 2006).

Procedure:

Table 3.11: Selenium (Se^{2-}) determination

Pipette into cuvette			
	Blank	**Standard**	**Sample**
Sample	-	-	1.0 ml
Distilled water	1.0 ml	-	-
Standard	-	1.0 ml	-
S1	1.0 ml	1.0 ml	1.0 ml
S2	1.0 ml	1.0 ml	1.0 ml
S3	500 µl	500 µl	500 µl

Trade name : Sodium Biselenite. Batch number : M0M091209. Manufacturer name : Qualikems fine chem. Pvt Ltd.

Gently shaken each cuvette after adding S2 solution to yield yellow color. Again shaking well 2 mins after adding S3 solution. Centrifuge at 3000 RPM for 15 min to obtain a clear supernatant.

Calculation:

Selenium (µg/ml) = 8.654x + 1.830

Where, 8.654= slope, 1.830= intercept, x= absorbance

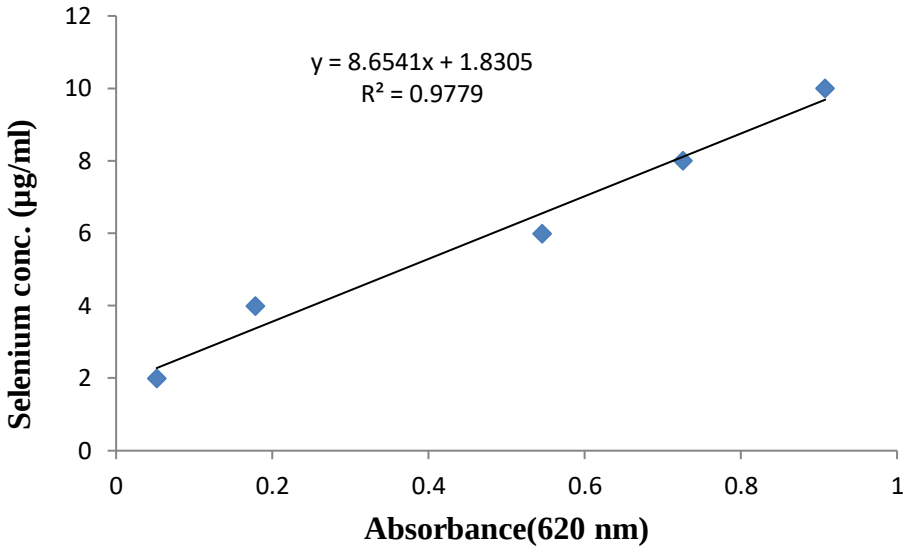

Figure 6: Calibration curve for the determination of selenium

3.7.6 Determination of Vitamin content

3.7.6.1 Determination of riboflavin (Vit -B2)

Principle: After oxidising interfering substances with permanganate, riboflavin is extracted into acetic acid-pyridine-butanol mixture and measured colorimetrically (Morell and Slater, 1946).

Procedure:

Table 3.12: Riboflavin (Vit-B2) determination

Pipette into cuvette			
	Blank	**Standard**	**Sample**
Sample	-	-	500 µl
Distilled water	500 µl	-	-
Standard	-	500 µl	-
S1	500 µl	500 µl	500 µl
S2	1 drop	1 drop	1 drop
S3	2 drop	2 drop	2 drop
Shake gently for 1min. If the purple color is not destroyed within 10 sec, add a further drop of S3 and warm to 21˚C.			
S4	1.5 ml	1.5 ml	1.5 ml
Shake vigorously up and down 25 times over 1 min and Stand to allow the layers to separate. Add a small amount of S5, rotate between the hands until the alcohol layer clears and Stand for a min or two for the layers to separate fully.			
Alcohol extracts	1.0 ml	1.0 ml	1.0 ml
Absorbance read at 540nm in colorimeter using excitation at 480 nm, zeroing against the blank. The alcohol extracts are stable for at least 2 hr. To get an improved riboflavin reading, expose the alcohol extract to strong ultraviolet light for 60 min after taking the initial reading. Then read the final absorbance at 540nm and the difference is due to riboflavin.			
Trade name : Riboflavin standard. Manufacturer name : Koch-Light Laboratories Ltd.			

Calculation:

$$\text{Riboflavin (mg/l)} = \frac{\text{Difference of sample Abs}}{\text{Difference of standard Abs}} \times \text{Standard conc. (mg/l)}$$

3.7.6.2 Determination of retinol and beta carotene (Vit-A) using TFA

Principle: Proteins are precipitated with alcohol and retinol and carotenes extracted into light petroleum. After reading the intensity of the yellow colour due to carotenes,the light petroleum is evaporated and the residue dissolved in chloroform before carrying out the colour reaction. Allowance is made for the carotene contribution to the reaction (Bradley and Hornback, 1973). Retinol present in sample reacts with trifluoroacetic acid (TFA). During the reaction of sample and TFA, a blue color is observed indicating the presence of retinol in the sample. The blue color is transient, so if the color develops, it must be observed within 2 seconds after adding the reagent (Makhumula *et al*., 2007).

Procedure:

Table 3.13: Beta carotene determination

Pipette into cuvette			
	Blank	**Standard**	**Sample**
Sample	-	-	1.0 ml
S1	-	-	2.0 ml
S2	6.0 ml	-	3.0 ml
Standard	-	6.0 ml	-
Total volume (S3)	6.0 ml	6.0 ml	6.0 ml

Trade name: Beta carotene. Batch number: 9899207. Manufacturer name: Sisco research laboratories.

Mix well with a vortex mixer, mechanical shaking for 10 min, centrifuge the tubes for 10 min at 3000 RPM. Finally take 2ml blank and standard and collect 2ml supernatent from sample. Read the absorbance at 420 nm against the blank. Do this without delay to prevent solvent evaporation and destruction of carotenoids by light.

Table 3.14: Retinol determination

Pipette into cuvette			
	Blank	**Standard**	**Sample**
Sample (from S3)	-	-	2.0 ml
Evaporate the contents of the sample cuvette to dryness in a 50 ℃ water bath.			
S4	100 µl	-	100 µl
Standard	-	100 µl	-
S5	1.0 ml	1.0 ml	1.0 ml

Trade name: Retinol acetate. Batch number: G05Y/1305/1006/62. Manufacturer name: S.D. fine- chem. Limited, Mumbai 400025.

Mix well with a vortex mixer. Recording the absorbance (A_{620}) at exactly 2s after adding the reagent. Because S5 reagent is a strong acid with an irritant vapour.

Calculation:

$$\text{Carotene (mg/l)} = \frac{Y-0.0041}{0.0133}$$

Where, 0.0133= slope, 0.0041= intercept, Y= absorbance

$$\text{Retinol (mg/l)} = \frac{Y-0.01}{0.013}$$

Where, 0.013= slope, 0.01= intercept, Y= absorbance

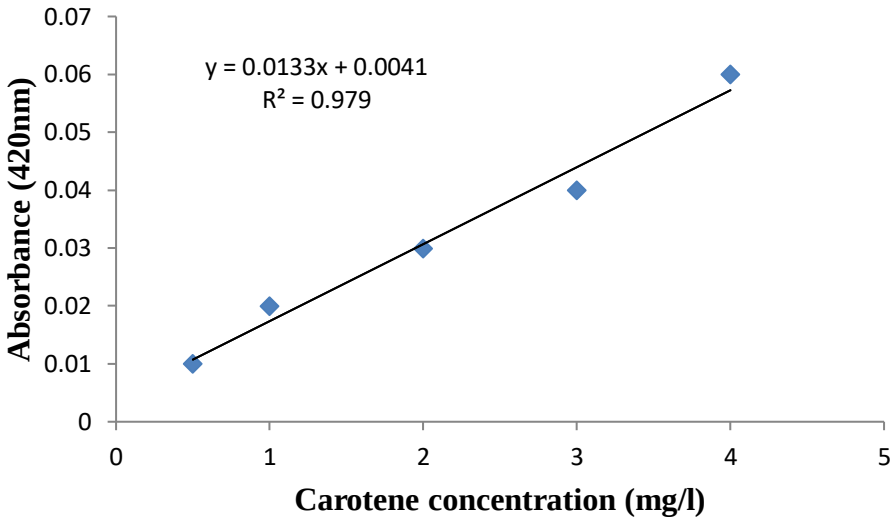

Figure 7: Calibration curve for the determination of beta carotene

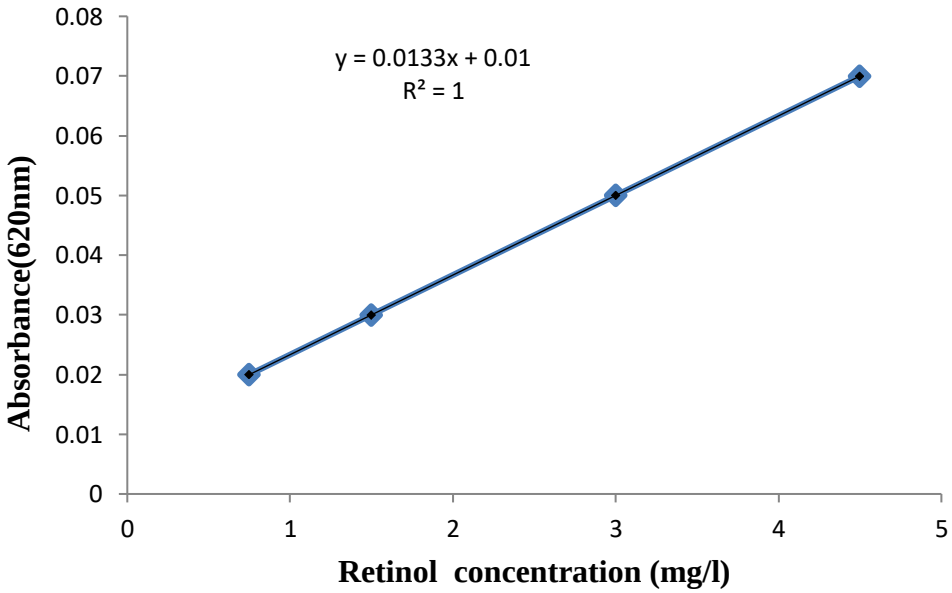

Figure 8: Calibration curve for the determination of retinol

3.7.6.3 Determination of α - tocopherol (Vit-E)

Principle: Tocopherols can be measured by their reduction of ferric to ferrous ions which then form a red complex with α,α′- dipyridyl. Tocopherols is first extracted into xylene and the absorbance is read at 480 nm to measure the tocopherols. A correction for the tocopherols is made after adding ferric chloride and reading at 520 nm (Baker and Frank, 1968).

Procedure:

Table 3.15: α - tocopherol (Vit-E) determination

Pipette into cuvette			
	Blank	**Standard**	**Sample**
Sample	-	-	1.5 ml
S2	1.5 ml	-	-
Standard	-	1.5 ml	-
S1	1.5 ml	-	1.5 ml
S2	-	1.5 ml	-
S3	1.5 ml	1.5 ml	1.5 ml
Mix well and centrifuge			
Supernatant	1.0 ml	1.0 ml	1.0 ml
S4	1.0 ml	1.0 ml	1.0 ml

Trade name: DL-α-Tocopherol. Batch number: L225501707. Manufacturer name : Loba Chemical Pvt.Ltd.

Pipette 1.5ml of the mixture into colorimeter cuvettes and read the absorbance (A_{480}) of the sample and standard against the blank at 480 nm. Then, in turn, beginning with the blank add 0.33 ml ferric chloride solution, mix, set the wavelength to 520 nm and 1.5 min after mixing read the absorbance (A_{520}) of the sample and standard against the blank.

Calculation:

$$\text{Alpha tocopherols (mg/l)} = \frac{A'(\text{absorbance) of unknown}}{A'(\text{absorbance)of standard}} \times 10$$

$$\text{Where } A' = A_{520} - 0.29 \times A_{480}$$

3.8 Microbial analysis (Part 3)

3.8.1 Total procedure for identify the *Salmonella* spp. and *E.coli*

3.8.1.1 Collection and preservation of sample

Freshly prepared street food samples were collected from Tiger pass, Station road, New market, GPO, Kotwali and Chawk bazar and frozen food samples were collected from super shop (Basket®) situated in Khulshi, Chattogram. Samples of the most commonly available food (singara, samosa, roll) were collected for microbial analysis. A total of 36 samples (eighteen street foods and eighteen commercial frozen foods) were collected. Six samples of each of these street food were collected from different vending sites and six samples of each of these frozen food were collected from different three commercial food brand. Samples were collected by wearing a disinfected hand gloves and placed into sterile zipper bags. The sterile bags were sealed and labelled (place and date of sample collection) and then kept chilled in a cooler box packed with dry ice for a maximum of six hours. Thereafter, the samples were frozen (-18°C) until they were analysed at the Research Laboratory in the department of Physiology, Biochemistry and Pharmacology. Before performing microbial analysis, the samples were thawed by transferring them from the freezer to a refrigerator at 4^0C for 24 hours.

Table 3.16: Requirement for *Salmonella* spp. and *E.coli* isolation

General equipment	Machanical equipment	Chemical required
Hand gloves, mask	Hot water bath	Sample
Conical flask	Dryer	Buffered peptone water
Volumetric cylinder	Autoclave	Mac conkey agar
Petri dish	Weight machine	Brilliant green agar
Spoon	Refrigerator (-18°C)	Brain heart infusion broth
Inoculating loop	Electric heater	50% glycerine
Test tube	Biological safety cabinet	Distill water
Spirit lamp	Incubator	70% ethanol

Table 3.17: Composition of growth media and culture media

Buffered peptone water	
Ingredients	**Amount (g/l)**
Proteose peptone	10.0
Sodium chloride	5.0
Disodium hydrogen phosphate	3.50
Potassium dihydrogen phosphate	1.50
Final pH (at 25°C)	7.2 ± 0.2
Batch number : 0000356909. Manufacturer name : Himedia laboratories pvt.Ltd.	

Mac conkey agar	
Ingredients	**Amount (g/l)**
Peptic digest of animal tissue	20.0
Sodium chloride	5.0
Lactose monohydrate	10.0
Bile salts	5.0
Neutral red	0.07
Agar- agar	15.0
Final pH (at 25°C)	7.5 ± 0.2
Batch number : 61935605001730. Manufacturer name : Merck specialities pvt.Ltd.	

Brain heart infusion broth	
Ingredients	**Amount (g/l)**
Calf brain, infusion from	200
Beef heart, infusion from	250
Proteose peptone	10.0
Dextrose	2.0
Sodium chloride	5.0
Disodium phosphate	5.0
Final pH (at 25°C)	7.4 ± 0.2
Batch number : 0000220782. Manufacturer name : Himedia laboratories pvt.Ltd.	

Brilliant green agar	
Ingredients	**Amount (g/l)**
Proteose peptone	10.0
Yeast extract	3.0
Lactose	10.0
Sucrose	10.0
Sodium chloride	5.0
Phenol red	0.080
Brilliant green	0.0125
Agar	20.0
Final pH (at 25°C)	6.9 ± 0.2
Batch number : 0000161360. Manufacturer name : Himedia laboratories pvt.Ltd.	

3.8.1.2 Preparation of growth media

3.8.1.2.1 Buffered peptone water (BPW)

Suspend 20.0 g of the powder in 1 liter of distilled or deionized water. Mix well. Heat to boil shacking frequently until completely dissolved. Sterilize in autoclave at 121°C for 15 min.

3.8.1.2.2 Brain heart infusion (BHI) broth (used for prepare stock solution)

37gm media dissolve in 1 liter distilled water. Heat to dissolve the media if necessary. Dispense into bottles or tubes as desired. Sterilize by autoclaving at 15 lbs (121°C) for 15 min.

3.8.1.3 Preparation of culture media for isolation of bacteria

3.8.1.3.1 Macconkey agar

49.53 grams of dehydrated medium suspend in 1000ml purified / distilled water and heated to boiling to dissolve the medium completely. Sterilization was done at 121°C (15 lbs pressure) for 15 minutes by autoclaving followed by Cooling to 45-50°C. Mixed well before pouring it into sterile petri-plates.

3.8.1.3.2 Brilliant green agar (BGA)

58.09 gm agar media suspend in 1000ml purified / distilled water and heated to boiling to dissolve the medium completely. Sterilization was done at 121°C (15lbs pressure) for 15 minutes by autoclaving. Avoid overheating. Cooled to 45-50°C. Mixed well and pour it into sterile petri plates.

3.8.1.4 Isolation of associated bacteria from collected samples

After thawing, a sterile spoon was used to aseptically collect 1g of each sample and transfer it into 9 ml buffered peptone water and incubated at 37°C for overnight. From the peptone water, subcultures were also made on MacConkey agar and BGA agar and incubated at 37°C for overnight. After 18 hours culture in buffered peptone water, the clear transparent Peptone were changed to turbid, which indicates bacterial growth. Both BGA and MacConkey agar plates streaked with the organism and incubated at 37°C for overnight. The growth of *E. coli* was indicated by large pink color in MacConkey agar and the growth of *Salmonella* spp. was indicated by reddish /pinkish white colonies in BGA agar. *E. coli* can ferment all the five basic sugars (dextrose, sucrose, lactose, maltose, and mannitol). Furthermore, *Salmonella* spp. ferment three

basic sugars (dextrose, maltose, and mannitol) but does not ferment sucrose. On the basis of colony and staining characteristics, the organisms were isolated.

3.8.1.5 Long-term storage of associated bacteria

For bacterial stock, was used 50% of glycerol and as broth Brain Heart Infusion (BHI). Prepared and sterilized tubes with 5 ml BHI, from the plates with microorganisms taken two or three colony and resuspend it in BHI. After overnight incubation added 700 µL of the overnight culture to 300µL of 50% glycerol in a 2 mL eppendorf tube and gently vortex for homogenization. The 50% glycerol was prepared with distillate water and autoclave too.

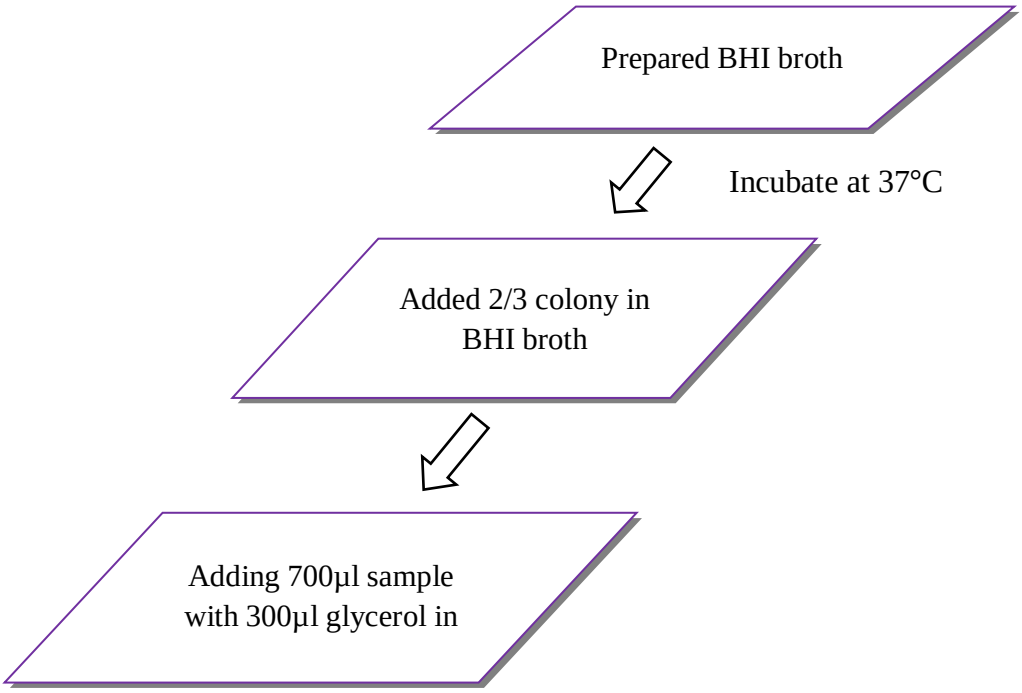

Figure 9: Flow chart of preparation of bacterial stock

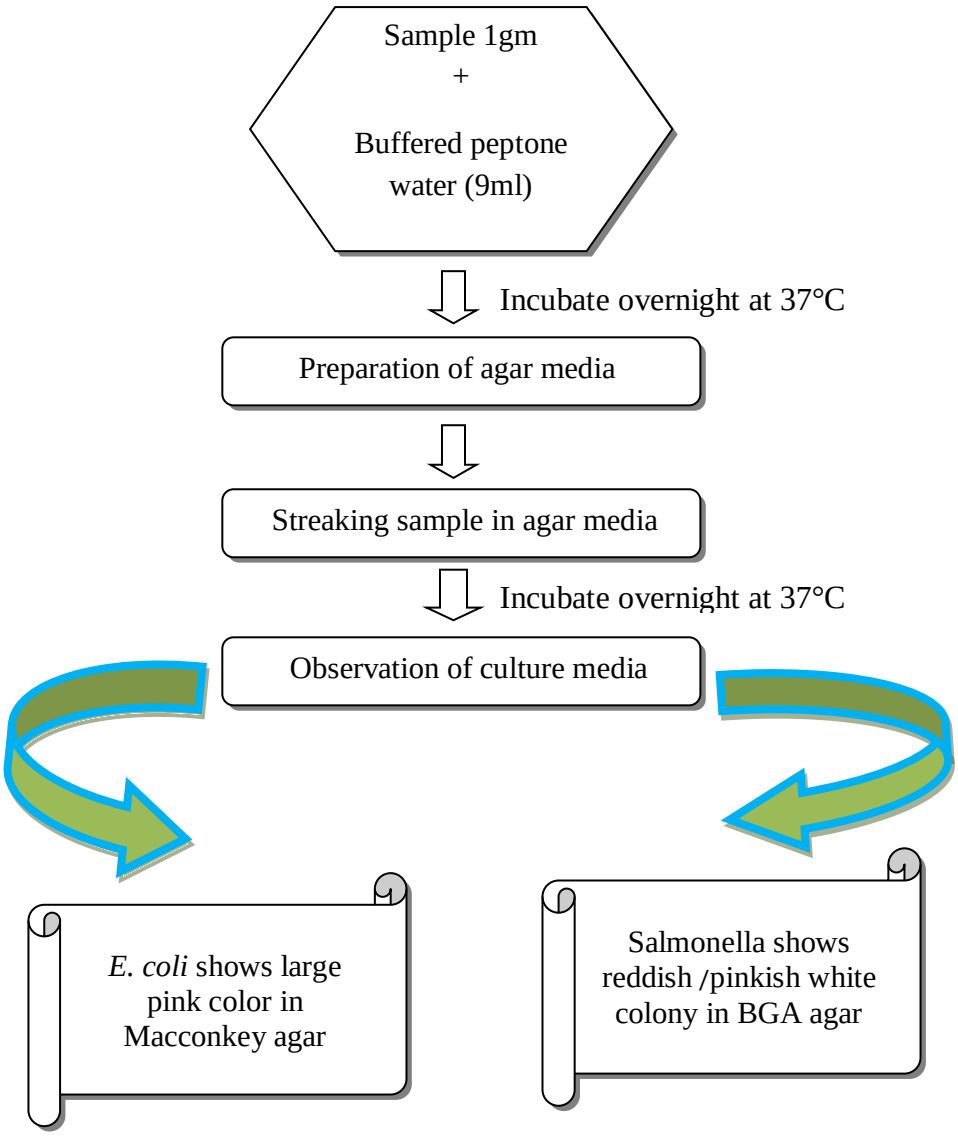

Figure 10: Flow chart of isolation process of bacteria

3.8.1.6 Statistical analysis

Recorded data on socio-economic survey, proximate composition, mineral contents, vitamin contents and microbial quality evaluation were entered into Microsoft Excel 2007., sorted out and exported to Statistical Package for the Social Sciences 26.0. Descriptive statistics were performed including percentage, mean, standard deviation. Comparison of proximate components, mineral contents and Vitamin contents among different types of foods (street and frozen) were analyzed by using analysis of variance (ANOVA) and Independent t test. The statistical analysis was conducted at 5% level of significant($P<0.05$).

Results

4.1 Results of socio-economic survey

4.1.1 Street foods price

Table 4.1 shows the selling price of street food. The root factor lying behind the popularity of street food is its cheaper price. About 54.7% of the food items are available in Tk. 2-5. Whereas 30.2%, 9.4%, 3.8% and 1.9% of the food items are available in Tk. (6-10), (16-20), (11-15) and (26-30), respectively.

Table 4.1: Price of street food (N=53)

Food items	Price (BDT)	n	%
Sompapri, achar, carrot and khira fruit with salt and chilli, butter bun, denise, peanut, jilapi, biscuit, piaju, beguni, guava with salt and chili, jhal muri, paratha, cake, sorboth, motor boot, jhal chanachur, singara, samosa, puri, chanachur vaji, alur chips, gola ice-cream, chitoi pitha, puli pitha, vapa pitha, mal poa, mowa, alu chop	2-5	29	54.7
Pineapple with salt and chili, chona muri, noodles, sugar cane juice, boiled egg, egg burger, roll, sandwich, dim chop, vhel puri, tea, papor vaji, hot pettics, jal pettics, kimapuri, mixer	6-10	16	30.2
Vot, vegetable burger	11-15	2	3.8
Chicken tikka, dim cake, chicken stick, fuchka, chotpoti	16-20	5	9.4
	21-25	0	0.0
Chicken biriani	26-30	1	1.9

4.1.2 Profile of street food vendors

Table 4.2 shows the demographic profile of the street food vendors interviewed in the study. Among the respondents, 90% were male. Most of the respondents were unmarried (60%). Fifty percent of the street food vendors were aged between 21 and 30 years. Almost 37.5% had a primary school qualification, but 32.5% had no formal schooling. More than half (55%) of the participants earned an average monthly income of 6000 to 10000 tk. About 35% of the respondents deposited an average 1001 to 2000 tk per month however, 45% had no deposit. 42.5% of them were experienced between 1-3 years while 42.5% were experienced between 4-6 years. 67.5% of the respondents had a family size of 5 or less and the rest 32.5% had a family size higher than 5. Hundred percent of the vendors replied that they had no training on food safety.

Table 4.2: Demographic profile of the vendors (N=40)

Variable	n	%
Sex		
Male	36	90.0
Female	4	10.0
Marital Status		
Married	16	40.0
Unmarried	24	60.0
Age(year)		
10 - 20	4	10.0
21 - 30	20	50.0
31 - 40	13	32.5
41 - 50	3	7.5
Eduction		
No education	13	32.5
Primary (1-5)	15	37.5
Secondary (6-10)	12	30.0
Monthly Income (tk)		
6000-10000	22	55.0
10001-15000	16	40.0
15001-20000	2	5.0
Monthly Deposit(tk)		
No deposit	18	45.0
≤ 1000	6	15.0
1001-2000	14	35.0
2001-3000	2	5.0
Experience (year)		
1-3	17	42.5
4-6	17	42.5
7-9	4	10.0
10-12	2	5.0
Family member		
1-5	27	67.5
6-10	13	32.5
Food safety training		
yes	-	0.0
no	40	100

Table 4. 3: The most preferred street foods of consumer (N=40)

Street food	n	(%)
Roll	14	35.0
Beguni	10	25.0
Piaju	9	22.5
Singara	9	22.5
Samosa	9	22.5
Alu Chop	8	20.0
Fuchka	6	15.0
Chona muri	5	12.5
Puri	5	12.5
Dim Chop	4	10.0
Chicken Stick	3	7.5
Chotpoti	3	7.5
Sorboth	3	7.5
Noodles	3	7.5
Achar	2	5.0
Alur Chips	2	5.0
Butter Bun	2	5.0
Chicken Tikka	2	5.0
Chicken Biriani	2	5.0
Denise	2	5.0
Paratha	2	5.0
Papor Vaji	2	5.0
Sugar Cane Juice	2	5.0
Vegetable Burger	2	5.0
Vot	2	5.0
Boiled Egg	1	2.5
Chicken Roll	1	2.5
Dim Cake	1	2.5
Jilapi	1	2.5
Jhal Chanachur	1	2.5
Sompapri	1	2.5
Sandwich	1	2.5

4.1.3 Consumer preferrence of street food

The most preferred street foods of consumer are shown in Table 4.3. A total of 40 consumers reported their preference for street food. In this study it was found that roll (35%), beguni (25%), piaju (22.5%), singara (22.5%), samosa (22.5%), alu chop (20%), and fuchka (15%) are the most preferred street foods among the consumers.

4.1.4 Customer satisfaction with street foods

The index of importance for reasons for buying street foods in Table 4.4 is highest for the inexpensive of street foods (45%), followed by like the taste (32.5%), quickly cook (15%) and like the environment (7.5%). In order of importance, the reasons for preferring street foods were cheap (45%), followed by tasty (30%), fast consumption (7.5%), easily accessible (5%), and varity (5%).

Table 4.4: Index of importance of main reasons for buying street foods and preference of street food (N=40)

Question	n	%
Reasons for buying street food		
Quickly cook	6	15.0
Inexpensive	18	45.0
Like the taste	13	32.5
Like the environment	3	7.5
Reasons for preference street food		
Cheap	18	45.0
Tasty	12	30.0
Easily accessible	2	5.0
Fast consumption	3	7.5
Varity	2	5.0
Satisfies hunger	1	2.5
Food preparation can be seen	1	2.5
More satisfying	1	2.5

4.1.5 Types of street food consumers

Table 4.5 shows the types of consumers at different location in Chattogram city. The surveyed information of 9 selected places of the Chattogram city does not represent the same characteristic appearance regarding the varity of street foods. There is variation in terms of the varity of food, concentration of vendors, types of institution in these places. Among the surveyed people almost 90% of students consumed street food at these places. It was found that 88.9% driver ate street food followed by 77.8% employee, 77.8% shopkeeper, 66.7% local people, 66.7% transport vehicle staff, 55.6%

passer-by, 44.4% passenger, 33.3% security gard, 22.2% traffic police and 11.1% city corporation worker ate street food respectively in these places.

Table 4.5: Types of street food consumers at different locations in chattogram city (N=9)

Consumers category	n	%
Student	8	88.9
Driver	8	88.9
Employee	7	77.8
Shopkeeper	7	77.8
Local people	6	66.7
Transport vehicle Staff	6	66.7
Passer-by	5	55.6
Passenger	4	44.4
Security guard	3	33.3
Traffic police	2	22.2
City corportion worker	1	11.1

4.1.6 General hygiene and health of the vendors

Table 4.6 shows the health and hygienic environmental condition of vendors. Results show that upto 62.5% of the vendors did not use plastic wraps, foils and covers when storage. 65% of those reported that, they did not work under bad health conditions. A large proportion (57.5%) of the vendors observed did not clean their utensils. 57.5% the vending stalls had no waste disposal facilities. 60% vendors did not seperate raw and cooked food. About 100% of the vendors were found to store cooked products before selling.

4.1.7 Inspection of vendors activity and nature of vending stalls

Table 4.7 shows the vendors observation checklist. During the survey it was revealed that 52.5% of the vending shops were located on the transport areas and the rest were located in all other possible areas (near residential area, commercial area, industrial area and hospital). One of the striking findings found in the survey was that 85% vendors did not take any measures for purification of drinking water, they used tap water. which implies a definite possibility of contamination. 15% of the vendors used filtered water or boiled water for food preparation purpose. Seventy percent of the vendors reported storing water in closed container whereas 30% vendors storing water in open pan. 80% vendors reported that there was no toilet facilities in work place. 55%

vendors washed their hands before preparing food whereas 45% washed their hands after direct contact with raw material. From those who washed their hands, 100% reported using water only. During observations, it was also identified that 37.5% of the vendors had dried their hand with paper whereas 32.5% vendors did not dry their hand. Most of the vendors (37.5%) changed their clothing every 2 days. 55% of the foods sold were made at vending shop, 37.5% home made and 7.5% whole industrial processed food (e.g. bun,butterbun etc). All food vendors cleaned their hand from bucket water. That bucket water which was reused by vendors.

4.1.8 Consumers opinion on street food

Table 4.8 shows the interview guide for consumers. During the survey 45% indicated that street foods are safe, 17.5% indicated that the foods sold by vendors are not safe to eat and 37.5% indicated that they do not know. Consumers were asked to indicate which option they would select about the rate of street food facilities. 60% of the consumers indicated that the facilities were good and remaining consumers indicated that the facilities were satisfactory (22.5%), outstanding (10%) and inadequate (7.5%) respectively. 40% consumers reported that the healthy water facilities were inadequate and remaining of the consumers indicated that the healthy water facilities were good (35%) and satisfactory (25%), respectively. Only 12.5% consumers reported consuming commercial food. The remaining 87.5 % of consumers who reported consuming street food. A five-point Likert scale, ranging from one (1) “strongly agree” to five (5) “strongly disagree” was also used to determine consumers attitudes towards influencing income for choosing street foods. 55% of those indicated that they agree and remaining 45% indicated that they strongly agree. It was noted that 85% consumers spent around 50tk per day on street food. The most favourite street food place chosen for street food consumption were Newmarket (50%), Pahartali (10%), Katwali (7.5%), Tiger pass (7.5%) and Bahaddarhat (7.5%) among the selected places. A total of 28 (70%) consumers mentioned that they consumed street food for everyday of the week where 30% reported to have street food for 1 day per week. More than 32% admitted to having street food between 10-12 am and one of the more popular times for consumption was lunch time (1-2 pm).

Table 4.6: Health and hygienic environmental condition of vendors (N=40)

Questions	Yes		No	
	n	%	n	%
Usage of plastic wraps, foils and covers when storage	15	37.5	25	62.5
Work under bad health conditions	14	35.0	26	65.0
Cleanliness of utensils	17	42.5	23	57.5
Waste disposal	17	42.5	23	57.5
Seperation of cooked foods and raw foods	16	40.0	24	60.0
Storing cooked products before selling	40	100	0	0.0
Prevention of smokers in the workplace	2	5.0	38	95.0
Work under bad environmental condition	19	47.5	21	52.5
Adequate lighting in the food preparation area	15	37.5	25	62.5
Suitable water storage container	6	15.0	34	85.0
Pre-prepared or ready-to-eat foods are handled with pertinent utensils, without manual contact	10	25.0	30	75.0
Appropriate uniform of vendors	0	0.0	40	100
Protection covering completely the hair	0	0.0	40	100
Short/clean nails	16	40.0	24	60.0
Hands free of sores	31	77.5	9	22.5
Smoking while working with food	25	62.5	15	37.5
Coughing over food	9	22.5	31	77.5
Handling food and money without washing hands in between	24	60.0	16	40.0

Table 4.7: Vendors observation checklist (N=40)

Question	n	%	Question	n	%
1. Location of vendors included in study			6. Product use for hand washing		
Residential area	14	35.0	Just water	40	100
Transport area (railway, bus stations)	21	52.5	Liquid hand Soap	0	0.0
Near hospital	0	0.0	Liquid Soap	0	0.0
Industrial area	1	2.5	Detergent	0	0.0
Commercial area	4	10.0	7. Hand drying		
2. Water to prepare food			Paper	15	37.5
Spring water	0	0.0	Towel	12	30.0
Boil or filter water	6	15.0	Do not dry	13	32.5
Tap water	34	85.0	8. Changing of attire		
3. Place to store the water to prepare food			Every day	14	35.0
Container (Closed)	28	70.0	Every 2 days	15	37.5
Other (Pan with Lid)	12	30.0	Every 3/4 days	11	27.5
4. Toilet facilities			Weekly	0	0.0
No toilet latrine	32	80.0	9. Pre-preparation of food		
Just pit latrine with slab	6	15.0	In vending shop	22	55.0
Just pit latrine without slab	2	5.0	At home	15	37.5
Ventilized improved pit (VIP) latrine	0	0.0	Factory (processed)	3	7.5
5. Frequency of hand washing			10. Location of hand washing		
Before preparing food	22	55.0	Tap on the street	0	0.0
After receiving Cash	0	0.0	Public washroom	0	0.0
After Direct Contact with raw material	18	45.0	From bucket	40	100

Table 4.8: Interview guide for consumers (N=40)

Question	n	%	Question	n	%
1. Do you think street food is important to choose healthy food?			6. How much money do you receive per day to spend on street food?		
I don't know	15	37.5	50 tk	34	85.0
No	7	17.5	100 tk	6	15.0
Yes	18	45.0	100 tk more	0	0.0
2. How do you rate the facilities of street food?			7. Which one is your favorite street food place?		
Outstanding	4	10.0	GEC	1	2.5
Good	24	60.0	Kotowali	3	7.5
Satisfactory	9	22.5	New market	20	50.0
Inadequate	3	7.5	Pahartoli	4	10.0
3. How do you rate the facilities in the healthy water?			Tiger pass	3	7.5
Outstanding	0	0.0	Station Road	2	5.0
Good	14	35.0	GPO	2	5.0
satisfactory	10	25.0	Chokbazar	2	5.0
Inadequate	16	40.0	Bahaddarhat	3	7.5
4. Do you consume commercial food ?			8. How often do you eat street food?		
Yes	5	12.5	Everyday	28	70.0
No	35	87.5	Once a week	12	30.0
5. Is income influencing the chosen street food?			Once a month	0	0.0
Strongly agree	18	45.0	9. What time of day do you eat street food?		
Agree	22	55.0	Before 10 AM	10	25.0
Neutral	0	0.0	Between 10-12 AM	13	32.5
Disagree	0	0.0	Between 1-2 PM	13	32.5
Strongly disagree	0	0.0	Between 4-5 PM	4	10.0

4.2 Results of nutritive value

4.2.1 Results of overall weight distribution (fried and dried weight) of different types of street and frozen food

Table 4.9 showed (Mean±SD) of overall weight (fried and dried weight) distribution of different street and frozen food sample such as singara, roll and samosa. In case of frying condition, the fried weight of street roll had the highest weight (72.52±4.45) g whereas the fried weight of street samosa had the lowest weight (39.16±2.84) g. On the other hand, in frozen food the fried weight was found the highest in singara (32.92±4.75) g whereas fried weight was found the lowest in frozen roll (19.52±1.07) g. In case of drying condition, the dried weight in street food was found the highest in roll (34.50±2.28) g whereas the lowest dried weight was found in street samosa (25.88±1.63) g. On the other hand, the highest drying weight was found in frozen singara (19.86±3.45) g while this was found lowest in frozen roll (9.54±0.90) g.

Table 4.9: Overall weight distribution of different types of street and frozen food such as singara, roll and samosa

Parameter (g)		Street Food			P Value	Frozen Food			P Value
		Singara(n=3)	Roll(n=3)	Samosa(n=3)		Singara(n=3)	Roll(n=3)	Samosa(n=3)	
Frying	Range	61.67-62.94	67.39-75.27	37.25-42.43	0.000	28.02-37.52	18.77-20.75	19.34-39.77	0.161
	Mean± SD	62.27±0.63	72.52±4.45	39.16±2.84		32.92±4.75	19.52±1.07	26.26±11.70	
Drying	Range	30.44-35.52	31.87-35.86	23.99-26.87	0.006	15.88-22.07	9.01-10.59	8.21-14.69	0.008
	Mean± SD	33.05±2.54	34.50±2.28	25.88±1.63		19.86±3.45	9.546±0.90	11.00±3.33	

The mean difference is significant at the 0.05 level.

4.2.2 Comparison of overall weight distribution between street and frozen food

Table 4.10 showed comparison of overall weight distribution (frying and drying weight) between street and frozen food sample such as singara, roll and samosa. The highest frying and drying weight were found in street singara (62.27±0.63) g and (33.05±2.54) g, respectively. Likewise, frying weight (72.52±4.45) g and drying weight (34.50±2.28) g were found higher in street roll. Similarly, street samosa contained higher frying weight (39.16±2.84) g and drying weight (25.88±1.63) g, respectively.

Table 4.10: Comparison of overall weight distribution (frying and drying weight) between street and frozen food

Parameter (g)	Singara		P Value	Roll		P Value	Samosa		P Value
	Street (n=3)	Frozen (n=3)		Street (n=3)	Frozen (n=3)		Street (n=3)	Frozen (n=3)	
Frying	62.27±0.63	32.92±4.75	0.000	72.52±4.45	19.52±1.07	0.001	39.16±2.84	26.26±11.70	0.191
Drying	33.05±2.54	19.86±3.45	0.006	34.50±2.28	9.54±0.90	0.000	25.88±1.63	11.00±3.33	0.002

The mean difference is significant at the 0.05 level.

4.2.3 Proximate value of selected street food and commertial frozen food

Table 4.11 shows the proximate composition of singara, samosa, roll in street and frozen foods. Both street food and frozen food usually available and consumed in Chattogram city were analysed for proximate composition. The crude protein, ash, moisture and fiber content of the street food samples (singara, samosa, roll) ranged between (10.15% - 10.85%), (1.89% - 2.80%), (4.74% - 6.77%) and (1.51% - 2.56 %) respectively. However, there were statistically no significant differences among the street food samples crude protein, ash, moisture and fiber content as determined by one-way ANOVA, ($p<0.05$). Samosa had the highest fat content (27.20%) followed by singara (21.75%) and roll (14.88%). Based on the ANOVA result, there were significant differences ($p<0.05$) in the percentage of total fat among the street food samples. Since there were very little difference in carbohydrate percentages. Carbohydrate were found higher in the roll (63.69%) than in the singara (56.39%) and roll (54.12%) samples. Besides these findings, there were statistically no significant differences among the frozen food samples crude protein, fat, ash, moisture, fiber and carbohydrate content as determined by one-way ANOVA, ($p<0.05$). The crude protein, fat, ash, moisture, fiber and carbohydrate content of the frozen food samples (singara, samosa, roll) ranged between (8.78% - 10.70%), (21.58% - 26.61%), (2.22% - 2.69%), (6.58% - 7.21%),(1.49% - 4.54%), and (50.20% - 57.04%), respectively.

Table 4.11: Proximate composition of singara, samosa, roll in street and frozen food

Parameter (%)		Street Food			P Value	Frozen Food			P Value
		Samosa(n=3)	Roll(n=3)	Singara(n=3)		Samosa(n=3)	Roll(n=3)	Singara(n=3)	
CP	Range	9.89 - 10.41	10.50 - 11.03	10.06 - 10.85	0.097	7.88 - 9.80	7.88 - 10.50	9.98 - 11.55	0.152
	Mean± SD	10.15 ± 0.26	10.85 ± 0.30	10.41± 0.40		8.98 ±.0.99	8.78 ±1.49	10.70±0.79	
FAT	Range	23.83 - 29.20	11.69 - 19.76	19.88 - 23.65	0.009	24.23-29.43	20.69-31.80	18.52-23.22	0.266
	Mean± SD	27.20 ± 2.93	14.88 ± 4.29	21.75 ± 1.88		26.61±2.62	26.54±5.57	21.58±2.65	
ASH	Range	1.25 - 2.56	2.04 - 2.57	2.44 - 3.31	0.150	2.12 - 3.08	2.18 - 3.15	1.65 - 2.52	0.563
	Mean± SD	1.89 ± 0.65	2.28 ± 0.26	2.80 ± 0.45		2.44 ± 0.54	2.69 ± 0.48	2.22±0.49	
MC	Range	4.53 - 4.94	5.37 - 7.65	4.10 - 7.96	0.242	6.29 - 8.31	6.27 - 6.79	6.42 - 7.56	0.570
	Mean± SD	4.74 ± 0.20	6.77 ± 1.23	6.07 ± 1.93		7.21 ± 1.02	6.58±0.27	6.96 ±0.57	
FIBER	Range	1.56 - 2.08	0.95 - 2.11	2.37 - 2.95	0.056	3.20 - 6.15	2.44 - 5.62	1.38 - 1.56	0.060
	Mean± SD	1.89 ± 0.28	1.51 ± 0.58	2.56 ± 0.33		4.54 ±1.49	3.81 ± 1.63	1.49 ±0.09	
CHO	Range	52.07 - 57.67	57.41 - 67.22	54.73 - 58.82	0.050	47.03 - 54.11	45.20- 56.83	55.96-58.29	0.172
	Mean± SD	54.12 ± 3.08	63.69 ± 5.45	56.39 ± 2.15		50.20 ± 3.59	51.57 ± 5.89	57.04 ±1.17	

The mean difference is significant at the 0.05 level. Note: CP, MC and CHO means Crude protein, Moisture content and Carbohydrate.

4.2.4 Comparison of proximate content between street and frozen food (singara, samosa, roll)

Difference between proximate composition of street and frozen food (singara, samosa, roll) are presented in Table 4.12. Results obtained from the present study indicated that street samosa contained lower amount of moisture and fiber than frozen samosa. The percentages of moisture and fiber in the samosa samples were significantly different at $p<0.05$. The highest amount of moisture (7.21%) and fiber (4.54%) were found in frozen samosa. Likewise, the ash level (2.44%) was found higher in frozen samosa. Whereas street samosa contained higher amount of crude protein (10.15%), fat (27.20%) and carbohydrate (54.12%). Street roll contained lower amount of fat than frozen roll. The percentages of fat in the roll samples were significantly different at $p<0.05$. The highest amount of fat (26.54%) was found in frozen roll. Similarly, the ash (2.69%) and fiber (3.81%) were found higher in frozen roll. On the contrary, street roll contained higher amount of crude protein (10.85%), moisture

(6.77%) and carbohydrate (63.69%). Frozen singara contained lower amount of fiber than street singara. The percentages of fiber in the singara samples were significantly different at $p<0.05$. The highest amount of fiber (2.56%) was found in street singara. Likewise, the fat (21.75%) and ash (2.80%) were found higher in street singara. Differently, Frozen singara contained higher amount of crude protein (10.70%), moisture (6.96%) and carbohydrate (57.04 %).

Table 4.12: Difference between proximate composition of street and frozen food (singara, samosa, roll)

Parameter (%)	Samosa		P Value	Roll		P Value	Singara		P Value
	Street (n=3)	Frozen (n=3)		Street (n=3)	Frozen (n=3)		Street (n=3)	Frozen (n=3)	
CP	10.15 ± 0.26	8.98 ±.0.99	0.121	10.85 ± 0.30	8.78 ±1.49	0.132	10.41± 0.40	10.70±0.79	0.598
FAT	27.20 ± 2.93	26.61±2.62	0.807	14.88 ± 4.29	26.54±5.57	0.045	21.75 ± 1.88	21.58±2.65	0.931
ASH	1.89 ± 0.65	2.44 ± 0.54	0.322	2.28 ± 0.26	2.69 ± 0.48	0.271	2.80 ± 0.45	2.22±0.49	0.212
MC	4.74 ± 0.20	7.21 ± 1.02	0.015	6.77 ± 1.23	6.58±0.27	0.807	6.07 ± 1.93	6.96 ±0.57	0.490
FIBER	1.89 ± 0.28	4.54 ±1.49	0.039	1.51 ± 0.58	3.81 ± 1.63	0.082	2.56 ± 0.33	1.49 ±0.09	0.006
CHO	54.12 ± 3.08	50.20 ± 3.59	0.226	63.69 ± 5.45	51.57 ± 5.89	0.059	56.39 ± 2.15	57.04 ±1.17	0.670

The mean difference is significant at the 0.05 level. Note: CP, MC and CHO means Crude protein, Moisture content and Carbohydrate.

4.2.5 Mineral value of selected street foods and commertial frozen foods

Table 4.13 showed the mineral composition of singara, samosa, roll in street and frozen foods. Ca, Mg, P, K, Cl, Fe, Zn, Cu, Na, Mn and Se contents of singara, samosa, roll samples from street were ranged (37.67-60.67) mg/100g, (86.67-103.3) mg/100g, (46.67-70) mg/100g, (533-988) mg/100g, (82.83-343.2) mg/100g, (3.65-7.14) mg/100g, (2.34-3.23) mg/100g, (23.54-69.75) mg/100g, (743.7-881.7) mg/100g, (250-1083.3) mg/100g and (92.40-142.2) mg/100g, respectively. Whereas the same samples (frozen) from market stalls had Ca, Mg, P, K, Cl, Fe, Zn, Cu, Na, Mn and Se contents ranged (43-97.33) mg/100g, (76.67-90) mg/100g, (50-76.67) mg/100g, (130-689) mg/100g, (82.83-414.2) mg/100g, (1.33-3.43) mg/100g, (2.56-3.84) mg/100g, (33.67-62.18) mg/100g, (713-835.7) mg/100g, (416.7-666.7) mg/100g and (96.67-130.6) mg/100g, respectively. There were statistically significant differences among the frozen food samples potassium content as determined by one-way

ANOVA, ($p<0.05$). The highest amount of potassium (689 mg/100g) was found in frozen roll. Whereas frozen singara and samosa contained lower amount of potassium 494 mg/100g and 130 mg/100g, respectively. The amount of Phosphorus content in the street food samples were significantly different at $p<0.05$. The highest amount of Phosphorus (70 mg/100g) was found in street samosa. Whereas street singara and roll contained lower amount of Phosphorus 50 mg/100g and 46.67 mg/100g, respectively.

4.2.6 Comparison of mineral contents between street and frozen foods (singara, samosa, roll)

Table 4.14 showed the comparison of mineral contents between street and frozen foods. The highest amount of Mg (90 mg/100g), K(728 mg/100g), Cl (343.2 mg/100g), Fe (4.63 mg/100g), Cu (69.75 mg/100g), Na (881.7 mg/100g) and Se (132.9 mg/100g) were found in street singara. Conversely, frozen singara contained higher amount of Ca (97.33 mg/100g) and Mn (666.7 mg/100g). Since there were very little difference in Zn percentages. Zn were found higher in the frozen singara (3.27 mg/100g) than in street singara (3.22 mg/100g). No difference was found in P (50 mg/100g) content from singara both street and frozen sample. The highest amount of Fe (3.65 mg/100g), Mn(1083.3 mg/100g) and Se (142.2 mg/100g) were found in street roll. On the contrary, frozen roll contained higher amount of Ca (90 mg/100g), Mg (90 mg/100g), P (53.33 mg/100g), K(689 mg/100g), Cl (414.2 mg/100g), Zn (3.84 mg/100g), Cu (62.18 mg/100g) and Na (835.7 mg/100g). The highest amount of of Ca (50.33 mg/100g), Mg (103.3 mg/100g), K(988 mg/100g), Cl (130.2 mg/100g), Fe (7.14 mg/100g) and Zn (3.23 mg/100g) were found in street samosa. Frozen samosa contained higher amount of P (76.67 mg/100g) , Cu (33.67 mg/100g) and Na (820 mg/100g). Since there were very little difference in Se percentages. Se was found higher in the frozen samosa (96.67 mg/100g) than in street samosa (92.40 mg/100g). No difference was found in manganese (500 mg/100g) content from samosa both street and frozen sample.

Table 4.13: Mineral composition of singara, samosa, roll in street and frozen food

Parameter (mg/100g)		Street Food			P Value	Frozen Food			P Value
		Singara(n=3)	Roll(n=3)	Samosa(n=3)		Singara(n=3)	Roll(n=3)	Samosa(n=3)	
Calcium	Range	22-55	29-79	38-59	0.411	14-148	62-140	3- 87	0.464
	Mean± SD	37.67±16.56	60.67±27.53	50.33±10.97		97.33±72.73	90.00±43.40	43.00±42.14	
Magnesium	Range	70-100	80-100	80-130	0.552	70- 90	80-100	70-100	0.471
	Mean± SD	90.00±.17.32	86.67±11.55	103.3±25.17		76.67±11.55	90.00±10.00	83.33±15.27	
Phosphorus	Range	40-60	40-50	60-80	0.035	30-60	50-60	50-120	0.399
	Mean± SD	50.00±10.00	46.67±5.77	70.00±10.00		50.00±17.32	53.33±5.77	76.67±37.86	
Potassium	Range	585-975	507-585	780-1248	0.065	468-507	585-780	78-156	0.000
	Mean± SD	728.0±214.8	533.0±45.03	988.0±238.3		494.0±22.51	689.0±98.15	130.0±45.03	
Chloride	Range	177.5- 639	71-106.5	71-213	0.171	71.00-745.5	71.00-639.0	35.50-106.5	0.366
	Mean± SD	343.2±256.8	82.83±20.49	130.2±73.90		331.3±362.6	414.2±301.9	82.83±40.99	
Iron	Range	3.90-5.39	1.21-5.39	5.22-9.16	0.114	2.22-5.05	1.92-4.91	0.44-2.42	0.177.
	Mean± SD	4.63±0.74	3.65±2.17	7.14±1.97		3.43±1.46	3.33±1.50	1.33±1.00	
Zinc	Range	1.91-5.16	1.23-3.64	2.40-4.61	0.687	1.51-6.26	3.48-4.14	1.73-3.18	0.629
	Mean± SD	3.22±1.71	2.34±1.22	3.23±1.20		3.27±2.60	3.84±0.33	2.56±0.75	
Copper	Range	60.04-81.74	13.24-82.18	10.33-37.24	0.125	29.08-81.16	28.65-80.80	19.64-56.44	0.388
	Mean± SD	69.75±11.03	55.88±37.26	23.54±13.46		58.81±26.81	62.18±29.09	33.67±19.89	
Sodium	Range	805-943	644-897	483-897	0.577	575-851	736--966	667-943	0.507
	Mean± SD	881.7±70.27	789.7±130.8	743.7±226.9		713.0±138.0	835.7±118.02	820.0±140.5	
Manganese	Range	250-250	500-1500	250-750	0.054	250-1500	250-500	250-750	0.793
	Mean± SD	250.0± 0.00	1083.3±520.4	500.0±250.0		666.7±721.7	416.7±144.3	500.0±250.0	
Selenium	Range	124.1-139.3	109.1-193.9	70.90-114.8	0.169	118.1-139.6	96.70-188.6	87.10-101.5	0.368
	Mean± SD	132.9±7.86	142.2±45.33	92.40±21.96		128.47±10.77	130.6±50.49	96.67±8.28	

The mean difference is significant at the 0.05 level.

Table 4.14: Difference between mineral composition of street and frozen foods (singara, samosa, roll)

Parameter (mg/100g)	Singara		P Value	Roll		P Value	Samosa		P Value
	Street (n=3)	Frozen (n=3)		Street (n=3)	Frozen (n=3)		Street (n=3)	Frozen (n=3)	
Calcium	37.67±16.56	97.33±72.73	0.289	60.67±27.53	90.00±43.40	0.379	50.33±10.97	43.00±42.14	0.785
Magnesium	90.00±.17.32	76.67±11.55	0.329	86.67±11.55	90.00±10.00	0.725	103.3±25.17	83.33±15.27	0.305
Phosphorus	50.00±10.00	50.00±17.32	1.000	46.67±5.77	53.33±5.77	0.230	70.00±10.00	76.67±37.86	0.783
Potassium	728.0±.214.8	494.0±22.51	0.199	533.0±45.03	689.0±98.15	0.067	988.0±238.3	130.0±45.03	0.004
Chloride	343.2±256.8	331.3±362.6	0.965	82.83±20.49	414.2±301.9	0.197	130.2±73.90	82.83±40.99	0.387
Iron	4.63±.745	3.43±1.46	0.273	3.65±2.17	3.33±1.50	0.846	7.14±1.97	1.33±1.00	0.010
Zinc	3.22±1.71	3.27±2.60	0.978	2.34±1.22	3.84±.33	0.108	3.23±1.20	2.56±.75	0.456
Copper	69.75±11.03	58.81±26.81	0.549	55.88±37.26	62.18±29.09	0.829	23.54±13.46	33.67±19.89	0.505
Sodium	881.7±70.27	713.0±138.0	0.132	789.7±130.8	835.7±118.02	0.675	743.7±226.9	820.0±140.5	0.645
Manganese	250.0± 0.00	666.7±721.7	0.423	1083.3±520.4	416.7±144.3	0.099	500.0±250.0	500.0±250.0	1.000
Selenium	132.9±7.86	128.47±10.77	0.598	142.2±45.33	130.6±50.49	0.781	92.40±21.96	96.67±8.28	0.769

The mean difference is significant at the 0.05 level.

4.2.7 Contribution of different vitamin contents in street and frozen food

Table 4.15 showed the vitamin composition of different types of street and frozen food (singara, samosa, roll). Exception of proximate nutrient and mineral content, street foods also provided minimal amounts of vitamin content (Vit-E,Vit-B2, carotene and retinol). Vit-E content was found higher in street singara (7.60 mg/100g) whereas, street samosa (5.35 mg/100g) had the lower Vit-E content. Conversely, frozen roll (7.51 mg/100g) had the the higher Vit-E content whereas, frozen samosa (6.82 mg/100g) had the lower Vit-E content. Vit-B2 was found higher in street singara (6.30 mg/100g) whereas, street samosa (4.50 mg/100g) had the lower Vit-B2. There were very little difference of Vit-B2 in frozen food. Frozen singara, roll and samosa contained Vit-B2 4.93 mg/100g, 4.93 mg/100g and 4.05 mg/100g, respectively. Carotene content was found higher in street roll (10.00 mg/100g) whereas, street samosa (7.84 mg/100g) had the lower carotene. Frozen singara (10.42 mg/100g) had

the the higher carotene whereas, frozen samosa (2.00 mg/100g) had the lower carotene. Retinol content (3.00 mg/100g) was found same among the street food such as singara, samosa, roll. Frozen samosa (3.75 mg/100g) had the the higher retinol content whereas, frozen singara (2.25 mg/100g) had the lower retinol content.

Table 4.15: Vitamin composition of different types of street and frozen food (singara, samosa, roll)

Parameter (mg/100g)		Street Food			P Value	Frozen Food			P Value
		Singara(n=3)	Roll(n=3)	Samosa(n=3)		Singara(n=3)	Roll(n=3)	Samosa(n=3)	
Vit- E	Range	6.94-8.00	6.90-7.36	4.30-6.60	0.025	6.68-7.54	7.21-7.84	6.27-7.30	0.235
	Mean± SD	7.60±0.57	7.13±0.23	5.35±1.16		7.20±0.45	7.51±0.31	6.82±0.51	
Vit- B2	Range	2.70-8.10	5.40-6.70	1.35-6.75	0.616	2.70-6.70	2.70-6.70	2.70-5.40	0.801
	Mean± SD	6.30±3.12	6.27±0.75	4.50±2.81		4.93±2.04	4.93±2.04	4.05±1.35	
Carotene	Range	6.00-12.00	9.00-12.00	3.00-10.26	0.703	9.00-12.00	3.00-6.00	1.50-3.00	0.001
	Mean± SD	9.42±3.09	10.00±1.73	7.84±4.19		10.42±1.50	4.00±1.73	2.00±0.86	
Retinol	Range	2.25-4.50	2.25-4.50	2.25-4.50	1.000	2.25-2.25	2.25-4.50	2.25-6.75	0.579
	Mean± SD	3.00±1.30	3.00±1.29	3.00±1.30		2.25±0.00	3.00±1.29	3.75±2.59	

The mean difference is significant at the 0.05 level.

4.2.8 Comparison of different vitamin content between street and frozen food

Table 4.16 showed comparison of different vitamin contents between street and frozen food sample such as singara, roll and samosa. The highest amount of Vit-E (7.60 mg/100g), Vit-B2 (6.30 mg/100g) and retinol (3.00 mg/100g) were found in street singara. Frozen singara contained higher amount of carotene (10.42 mg/100g). Street roll had the highest Vit-B2 (6.27 mg/100g) and carotene (10.00 mg/100g) content. Whereas frozen roll had the highest Vit-E (7.51 mg/100g) content. No difference was found in retinol (3.00 mg/100g) content from roll sample both street and frozen food. Higher amount of vit-B2 (4.50 mg/100g) and carotene (7.84mg/100g) content were determined in street samosa.Conversely, higher amount of Vit-E (6.82 mg/100g) and retinol (3.75 mg/100g) content were found in frozen samosa sample.

Table 4.16: Comparison of different vitamin content between street and frozen food (singara,samosa,roll)

Parameter (mg/100g)	Singara		P Value	Roll		P Value	Samosa		P Value
	Street (n=3)	Frozen (n=3)		Street (n=3)	Frozen (n=3)		Street (n=3)	Frozen (n=3)	
Vit- E	7.60±0.57	7.20±0.45	0.397	7.13±0.23	7.51±0.31	0.168	5.35±1.16	6.82±0.51	0.116
Vit -B2	6.30±3.12	4.93±2.04	0.560	6.27±0.75	4.93±2.04	0.348	4.50±2.81	4.05±1.35	0.815
Carotene	9.42±3.09	10.42±1.50	0.641	10.00±1.73	4.00±1.73	0.013	7.84±4.19	2.00±0.86	0.132
Retinol	3.00±1.30	2.25±0.00	0.423	3.00±1.29	3.00±1.29	1.000	3.00±1.30	3.75±2.59	0.678

The mean difference is significant at the 0.05 level.

4.3 Results of microbiological quality

4.3.1 Isolation of bacteria from street vended and frozen foods

Table 4.17 shows the presence of *E. coli* & *Salmonella* percentage in street and frozen food. Two genera of bacteria such as *Escherichia coli* and *Salmonellas* were isolated from different street and frozen food (singara, roll and samosa) samples. A total 36 samples were collected from different street and frozen food. In case of 3/6 (50%), 2/6 (33.3%) and 4/6 (66.7%) street food samples of singara, roll and samosa, respectively, were positive for *Escherichia coli* whilst 4/6 (66.7%), 3/6 (50%) and 2/6 (33.3%) frozen food samples of singara, roll and samosa, respectively, were positive for *Escherichia coli* colonies on the Mac conkey agar plates. 2/6 (33.3%), 3/6(50%) and 1/6 (16.7%) street food samples of singara, roll and samosa, respectively, were determined to have *Salmonella* colonies whilst 1/6 (16.7%), 4/6 (66.7%) and 2/6 (33.3%) frozen food samples of singara, roll and samosa, respectively, were determined to have *Salmonella* colonies on the Brilliant green agar plates. Comparison of *E. coli* and *Salmonella* percentage between street and frozen food sample it was reveled that, 50% *Escherichia coli* was found in both street and frozen food samples whereas, 33.3% *Salmonella* was found in street foods and 38.8% *Salmonella* was found in frozen foods.

Table 4.17: Presence of *E.coli* & *Salmonella* spp. percentage in street and frozen food

Food Items	Presence of *E. coli*						Presence of *Salmonella*					
	Street food			Frozen food			Street food			Frozen food		
	n	(+) ve	%	n	(+) ve	%	N	(+) ve	%	n	(+) ve	%
Singara	6	3	50.0	6	4	66.7	6	2	33.3	6	1	16.7
Roll	6	2	33.3	6	3	50.0	6	3	50.0	6	4	66.7
Samosa	6	4	66.7	6	2	33.3	6	1	16.7	6	2	33.3
Total	18	9	50.0	18	9	50.0	18	6	33.3	18	7	38.8

Discussion

In Bangladesh especially at Chattogram city street food vending was evolved mainly during Pakistan period. At that time, food items were limited to various types of pitha, sharbat, ice cream, chanachur and chutneys (Nazmoon and Hafiza, 2015). At present there is a wide range of street foods found in the streets of the city such as singara, samosa, piaju, beguni, paratha, puri, roll, noodles, boiled egg, egg burger, fuchka, sandwich, dim chop etc. There is a possibility for street food sector to play an important role in providing food services, as they can provide the food at a lower price than the traditional food shops.

5.1 Socio-economic survey based discussion

5.1.1 Most preferred street food and their consumer and price

The root factor lying behind the popularity of street food is its cheaper price. About 54.7% of the food items are available in Tk. 2-5. Whereas 30.2%, 9.4%, 3.8% and 1.9% of the food items are available in Tk.(6-10), (16-20), (11-15) and (26-30), respectively. Such small amount of money is easily affordable by all and so these are preferred by the people especially by the low earned community. Street foods are widely consumed and produced in almost all countries around the world, as a result of nutritional trends in urban areas. Street food is preferred by consumers, especially students (88.9%), driver (88.9%), employee (77.8%), shopkeeper (77.8%), local people (66.7%), transport vehicle staff (66.7%), passer-by (55.6%), passenger (44.4%), security guard (33.3%), traffic police (22.2%) and city corportion worker (11.1%) because of its cheapness (45%), followed by delicious taste (30%), fast consumption (7.5%), accessibility (5%), varity (5%), satisfies hunger (2.5%), food preparation can be seen (2.5%) and more satisfying (2.5%). The main reasons for buying street foods is highest for the inexpensive of street foods (45%), followed by like the taste (32.5%), quickly cook (15%) and like the environment (7.5%). In the present study the most preferred foods were roll (35%), beguni (25%), piaju (22.5%), singara (22.5%), samosa (22.5%), alu chop (20%), fuchka (15%), chona muri (12.5%), puri (12.5%), dim chop (10%), chicken stick (7.5%), chotpoti (7.5%), sorboth (7.5%), noodles (7.5%), achar (5%), alur chips (5%) etc.

5.1.2 Demographic profile of vendors

In Chattogram city, street food vending is one of the most popular type of self employed businesses, which is for many people the only source of income. Students, employees, small business owners, office going people, rickshaw/cart pullers, and they like rely on these vendors for their morning breakfast, evening snacks, sometimes for a quick lunch. If we focus on the demographic situation of these vendors we see that most of these vendors are males (90%). Most of the vendors were unmarried (60%). Fifty percent of the street food vendors were aged between 21 and 30 years. In Uganda, the majority (87.6%) of the street food vendors were women. Seventy five per cent of the street food vendors were aged between 21 and 40 years (Namugumya and Muyanja, 2011). From this study, we have found that, about 67.5% vendors could write their names and 32.5% vendors do not have any formal education. Bangladesh, all citizens must undertake ten years of compulsory education which consists of five years at primary school level and five years at high school level. Primary and secondary education is financed by the state and free of charge in public schools (Choudhury and Rahaman, 2015). More than half (55%) of the vendors reported that, their monthly income range from Tk. 6000 to 10000. The Bangladesh minimum wage is 1,500 taka per month for all economic sectors not covered by industry-specific wages (in the garment industry the minimum wage is 5,300 taka per month) (van der Heijden *et al*., 2019). Around 35% of the vendors reported their deposit to be Tk. 1001 to 2000 on monthly basis. By enquiring the vendors of selected places it has been found that 42.5% of the total vendors have started their business within the last 1 to 3 years; while 42.5% vendors were experienced between 4 to 6 years. As those vendors who are related to street food business gained enough experience than others with little experience the experienced ones can easily deliver the order within very short time so that the consumers love to visit there shops frequently as a result the business and profit as well as popularity also rises rapidly. New customers also visits their shop frequently. 67.5% of the respondents had a family size of 5 or less. The study showed that street food vendors have a relatively low income and it is their main source. Most of the street food vendors were able to support their children in respect of their basic needs such as education, clothing and food. Hundred percent of the vendors replied that they had no training on food safety. In South Africa, 77% of the vendors had no food safety training (Nkosi and Tabit, 2021). In Vietnam, the vast majority of the vendors (95%) did not have any food

safety training (Ngoc and Thanh, 2015). As a result, these foods threaten consumers' health because of poor hygiene conditions. Because of cross-contamination risk and lack of legal regulations for safety precautions for consumers has a negative effect on public health. Therefore, legal obligations on street foods and vendors and self-controlled practice and behaviours of vendors are effective in prevention of consumers' health. Only training of the vendors can develop their knowledge of selection, preservation, storage of food, personal health hygiene, lapse time between preparation and dispensing of food items to the consumers.

5.1.3 Gross observation about hygiene

In order to be able to bring out the hazards associated with street foods in Chattogram city, it was necessary to evaluate the general hygiene practices of the vendors and also the raw materials used in the preparation of foods. The personal hygiene of the vendors is very important as this could serve as possible sources of contamination or hazards during the preparation and sale of street foods. Indeed, Tambekar *et al*. (2011) showed that a good personal hygiene can significantly reduce the level of microbiological contamination of street foods. In this respect, the survey showed that, 100% of street food vendors did not wear appropriate uniform during their vending activity. As a results, the vendors can be source of physical hazards if these get into the food being sold in the course of preparation or serving. Results also show that 100% of the vendors did not cover their heads. This mal practice could lead to the introduction of hair as well as microbiological hazards in food. Almost 22.5 % of the vendors did not cover their sores properly in cases of cuts, bruises and burns. They reported that when they are wounded, they simply fold the wound with a piece of cloth and continue with their activity. This attitude of the vendors could be a potential source of biological hazards as the food can be contaminated with the blood of the vendors. The observation of nails shows that up to 60% of the vendors kept dirty nails. These dirty nails could harbour microorganisms which could contaminate food. The wearing of clean clothing can significantly reduce the degree of contamination of food (Tambekar *et al*., 2011). Concerning unhygienic behaviour at the vending site, it was found that 77.5% of the vendors carried out certain mal practices such as coughing over food, 60% vendors handling food with their hands without washing them after touching money. About 62.5% of the vendors were found to frequently display their food without covering it, exposing the food at roadsides where vehicles pass by raising dust which

can be a source of all types of hazards, dangerous for the consumers health who eat the food. According to table 4.3 result, it could be found that most of the vendors were not aware of health and personal hygiene knowledge. During the survey it was revealed that 52.5% of the vending shops were located on the transport areas and the rest were located in all other possible areas (near residential area, commercial area, industrial area and hospital). In general, vendors tend to sale their foods where there are a lot of human activities, irrespective of the poor conditions of the surroundings. This situation was observed in the surveyed. Overcrowding is usually accompanied with increased dust around the vending area. To minimize this situation, the authority of city corporation should be taken necessery steps such as selection of specefic footpath for street food business and provide covered vending craft and dust bean. Water is one of the most important ingredients used by street food vendors. It is also used for the washing of equipment, and for drinking. However in some cases when vendors wash their hand frequently in the fixed bucket water then those water and along with the vendors hand also contaminated . Seventy percent of the vendors said they kept their water in a closed container, while 30% said they kept it in an open pan. The use of water storage containers that are difficult to clean which may lead to the growth of microorganisms on the walls of the containers and the blowing of air into a plastic paper to open and parcel food with it. Almost all of the respondents did not know that soap are required for washing hand and 70% vendors did not know that rinsing with hot water and hand drying with clean clothes should be done after washing the hand. Thus these can serve as sources of microbiological hazards in street vended food. Moreover, the vendors were questioned on whether or not they had toilets which they could use. 80% reportedly did not have proper toilet facilities at their vending sites. This was alarming as these vendors most likely used unauthorised places as toilets. From visual observation, the vendors were divided into two groups: those that wearing clean clothes and those wearing dirty clothes. The later represented 65%. Without wearing clean clothes, the vendors become likely vectors of food contaminants.

5.1.4 Consumers opinion

Consumers opinion on street food indicate that street foods are safe according to consumers (45%) reports. 60% of the consumers indicated that the facilities were good. 40% consumers reported that the healthy water facilities were inadequate. A total of 28 (70%) consumers mentioned that they consumed street food for everyday of the week

where 30% reported to have street food for 1 day per week. So we may say consumers are satisfied to eat street food due to cheapness of street food price.

Finally, according to strategies to enhance the safety of street vended foods (WHO, 1996), studies of local street food systems and consideration of education of consumers as well as training of food handlers are important. In addition, most of studies on street vended foods have concentrated on the knowledge of vendors regarding to food safety. However, the understanding and attitudes of consumers about street food safety also have an important role towards this problem through their purchasing decision, in other words, through their decisions of what to consume and from whom to purchase. Therefore, it is obvious that performing this study on food safety knowledge not only for street vendors but also for consumers at the same time in a certain location is necessary.

5.2 Microbiological quality based discussion

5.2.1 Presence of *Escherichia coli* and *Salmonella* in street and frozen foods

The highest rate of *Salmonella* (33.8%) contamination was found in frozen foods whereas in street foods the rate of *Salmonella* (33.3%) contamination was low 50% *Escherichia coli* was found in both street and frozen food samples. This comparatively higher bacterium in street and frozen food samples suggests contamination from water, practice of inadequate hygienic measures such as mishandling, improper storage, inadequate cooking and above all unhygienic conditions. 50% of singara, 33.3% of roll, 66.7% of samosa street food samples taken from street vendors were contaminated with *E. coli*. On the other hand 66.7%, 50% and 33.3% frozen food samples of singara, roll and samosa, respectively were positive for *Escherichia coli*. The isolation of a higher rate of *Escherichia coli* emphasized the need for close supervision of food vendors at the workplace because asymptomatic carriers significantly contributed to the spread of various pathogens, which might have a significant impact on public health in the community. In this study, *Salmonella* was found also both in street and frozen food. 33.3%, 50% and 16.7% street food samples of singara, roll and samosa, respectively were determined to have *Salmonella* colonies whilst 16.7%, 66.7% and 33.3% frozen food samples of singara, roll and samosa, consecutively were determined to have *Salmonella* colonies on the Brilliant green agar plates. Necessery steps should be taken to control hygiene and enhance the microbial quality of food. As street foods are

consumed regularly, the necessity of educating both vendors and consumers about food hygiene ought to considered. Successful food hygiene education and knowledge about food hygiene practices due to this education are important in the prevention of foodborne diseases around the world. In a study conducted in India, it was determined that after educating 80 vendors about food safety and hygiene, the mean knowledge level was raised from 24.35% to 66.2% and that the adaptation of good hygiene practices was raised from 37.5% to 50.8% indicating that food hygiene education can affect consumers and vendors behaviour positively (Choudhury *et al.*, 2011).

Health and spoilage hazards arising from refrigerated and deep frozen foods may be due to - raw materials, improper processing. Recontamination which follows a heat process is much more important and occurs before, during and after application of cold (Sinell, 1989).

It was observed that most of the consumers were served with bare hands, which is potential source of contamination. In addition, various factors including the use of contaminated water during food processing, serving foods without wearing gloves and head coverings, use of unclean towels, dirty water for washing utensils, unhygienic equipment for processing are possible causes of bacterial contamination in street vended foods. Moreover, unclean bags or contaminated bags may also be an important source of contamination. Therefore, educating vendors in personal hygiene and good manufacture practice can minimize pathogen contamination risk for consumers.

5.3 Nutritional composition based discussion

5.3.1 Overall weight distribution

From the overall weight (fried and dried weight) distribution of different street and frozen foods samples (such as singara, roll and samosa) it was found that street food was more weight than frozen food. Since, street foods have a higher weight than frozen food, it will provide more nutrients than frozen food. Due to higher serving size of street food, the consumer number of street food increasing day by day.

5.3.2 Proximate profile

We observed no significant differences in crude protein, ash, moisture, fiber and carbohydrate content among samples of street food (singara, samosa, roll). Based on the ANOVA result, there were significant differences ($p<0.05$) in the percentage of

total fat among the street food samples. Samosa had the highest fat content (27.20%) followed by Singara (21.75%) and roll (14.88%). Conversely, frozen food items (singara, samosa, roll) showed no significant differences in proximate nutrient contents.

Difference between proximate composition of street and frozen foods (singara, samosa, roll) it was found that there was only significant differences in moisture ($p=0.015$) and fiber ($p=0.039$) content between street samosa and frozen samosa. The highest amount of moisture (7.21%) and fiber (4.54%) were found in frozen samosa. In contrast, there was only significant differences in fat ($p=0.045$) content between street roll and frozen roll. Street roll contained lower amount of fat than frozen roll. The percentages of fat in the roll samples were significantly different at $p<0.05$. The highest amount of fat (26.54%) was found in frozen roll. On the contrary, there was only significant differences in fiber ($p=0.006$) content between street singara and frozen singara. The percentages of fiber in the singara samples were significantly different at $p<0.05$. The highest amount of fiber (2.56%) was found in street singara. In the study of dhaka university (Institute of Nutrition and Food Science), singara (dry) contained carbohydrate (65.90%), protein (4.55%), lipid (24.24%), dietary fiber (2.93%), ash (2.38%) and fresh singara contained moisture 29.97%. Samosa (dry) contained carbohydrate (46.01%), protein (23.91%), lipid (25.55%), dietary fiber (2.91%), ash (1.63%) and fresh samosa contained moisture 32.82%. Vegetable roll (dry) contained carbohydrate (66.49%), protein (8.82%), lipid (19.19%), dietary fiber (4.26%), ash (1.23%) and fresh vegetable roll contained moisture 53.59%. These food samples were collected from fast food shops situated in two posh areas (Dhanmondi and Baily road) of Dhaka city (Rahim *et al*., 2002).

5.3.3 Minerals profile

We observed that there was only significant differences ($p=0.035$) in phosphorus content among the samples of street food (singara, samosa, roll). Cauliflower, potatoes, onion, mung bean contain phosphorus and these ingredients are present in samosa. However, mung bean is the higher source of phosphorus. Therefore, Samosa had the highest phosphorus content (70 mg/100g) followed by singara (50 mg/100g) and roll (46.67 mg/100g). Although, no significant differences was found in other mineral contents among the sample of street food. Conversely, there was only significant differences in potassium content ($p=0.000$) among the samples of frozen food (singara, samosa, roll). Cabbage, papaya, carrot, potatoes, onion chopped, green peas contain

potassium and these vegetables are present in roll. Whereas, papaya and green peas are the source of higher potassium. Therefore, roll had the highest potassium content (689.0 mg/100g) followed by Singara (494.0 mg/100g) and samosa (130.0 mg/100g). However, no significant differences was found in other mineral contents among the sample of frozen food.

Difference between mineral composition of street and frozen food (singara, samosa, roll) it was found that there was no significant differences in mineral contents between street singara and frozen singara. Similarly there was no significant differences in mineral contents between street roll and frozen roll. On the contrary, there was only significant differences in potassium ($p=0.004$) and iron contents ($p=0.010$) between the samples of street samosa and frozen samosa. Tomatoes, mung bean, onion, potatoes, cauliflower are the higher source of potassium and potatoes, mung bean are the higher source of iron. These vegetables are present in samosa. Therefore, Street samosa contained higher amount of potassium (988 mg/100g) and iron (7.14 mg/100g). No significant differences was found in other mineral contents between the sample of street singara and frozen singara.

5.3.4 Vitamin profile

Exception of proximate nutrient and mineral content, street foods also provided minimal amounts of vitamin content (Vit-E, Vit-B2, carotene and retinol). It was observed that there was only significant differences ($p=0.025$) in Vit-E content among the samples of street food (singara, samosa, roll). Cauliflower, potatoes, onion chopped, chick peas, green papaya slice, coriander leaf are the souce of Vit-E and these vegetable are present in street singara. Whereas, peanut and coriander leaf are the source of higher Vit-E. Vit-E content was found higher in street singara (7.60 mg/100g) followed by street roll (7.13 mg/100g) and street samosa (5.35 mg/100g). No significant differences was found in other vitamin contents among the sample of street food. On the contrary, there was only significant differences ($p=0.001$) in carotene content among the samples of frozen food (singara, samosa, roll). Carrot, green peas, coriander leaf, tomatoes are the higher carotene rich vegetables and these vegetables are present in frozen singara. Therefore, frozen singara (10.42 mg/100g) had the the higher carotene followed by frozen roll (4.00 mg/100g) and frozen samosa (2.00 mg/100g).

Although, no significant differences was found in other vitamin contents among the sample of frozen food.

Comparison of different vitamin content between street and frozen food (singara, samosa, roll) it was found that there was no significant differences in vitamin contents between street singara and frozen singara. Similarly there was no significant differences in vitamin contents between street samosa and frozen samosa. On the contrary, there was only significant differences ($p=0.013$) in carotene contents between street roll and frozen roll. Carrot, cabbage, cucumber, ladies fingers, green capsicum are the source of carotene and these vegetables are present in street roll. Whereas, carrot, cabbage and green capsicum are the higher source of carotene. Therefore, street roll had the higher carotene contents (10.00 mg/100g) whereas, frozen roll (4.00 mg/100g) had the lower carotene. Although, no significant differences was found in other vitamin contents between the sample of street roll and frozen roll.

Most street food vendors reported using fresh cooking oil daily rather than weekly, because the amount of oil they can afford to buy is usually very small. Common street food preparation methods have a considerable impact on the nutritional quality of the final product. For instance, the high fat content in deep-fried foods is mainly resulting from the fact that street food vendors fry at low temperature, which makes food items absorb more oil. Other preparation methods often used, like boiling food for too long or soaking the maize before milling and the discard of water afterwards or removal of the bran result in nutrient losses, mainly of vitamins and minerals. If we create consciousness among the vendors about the impact to use of more oil and nutrient loss during food prepartion then street food sector will be developed more day by day. The content of proximate nutrients, minerals and vitamin value of street food and frozen food resulted in this study is significant in a nutritional sense. Street food and frozen food, with heterogeneous nutritional value, were widely available in Chattogram city. But there is no more nutritional difference between street food and frozen food. However, some people imagine that street food is bad in all sense but it does mean that it is still possible to eat and to follow a nutritious diet. Hence, policies promoting the availability of street food should be encouraged. The data presented provide most needed information which will assist nutritionists and epidemiologists in the assessment of diet-health relationships in our population.

Conclusion

This study achieved the main objectives of assessment of nutritive value and microbial quality of street food as well as socioeconomic status of the street food vendors and consumers in chattogram city. Generally, student, driver, employee, shopkeeper, local people, transport vehicle staff, passer-by, passenger, security guard, traffic police and city corportion worker consume street food daily at different location in Chattogram city. Furthermore, street foods are convenient, cheap, easily accessible and a source of income to many poor people who would otherwise not find employment. The most important finding of this study is the correlation between the socio-economic results regarding the hygiene practices of street vendors and the findings of the microbiological survey.The highest rate of *E. coli* and *Salmonella* contamination was found both in street and frozen foods. The findings indicate that street food vendors in Chattogram city practiced minimal hygienic and sanitary practices. The hygienic practices in question included personal hygiene, food preparation, handling practices and care of equipment. This study recommends that every vendor, helper or food handler has to undergo proper training with regard to basic food hygiene, knowledge of preservation, storage of food, lapse time between preparation and dispensing of food items to the consumers. In order to maintain the benefits of street-vended food system while assuring the safety of the food sold authorities need to develop a policy aimed at assisting, controlling and maintaining the street food sector. The policy developed should be in response to an integrated consultation with vendors and consumers if it is to meet the needs of each of the partners in food safety (government, consumers and vendors). Street food vending still operates as an informal sector, thus receiving less attention from central government, whereas it greatly contributes to the nutrient needs of the people. The contribution of street foods to the nutrition of consumers depends upon the types of food offered by vendors, the nutritional content of the foods, the food preparation technique, the choices of the consumers and the place of street foods in the total diet of different types of consumers. Based on the information gained in the present study, street food provides a good target for improvement of the total diet of the urban poor in terms of variety, amount and nutritional quality.

This study is important in providing insights into the nutrient composition of singara, samosa, roll from street stalls and industrial frozen-food in Chattogram. The information may be useful for the public in choosing healthier singara, samosa and roll. Available data on nutrients (such as proximate nutrient, minerals & vitamins) composition of singara, samosa, roll also assist consumers to make a healthier choice for maintaining a healthy lifestyle. The results suggested that street foods contributed more nutrients, thus indicating a proper nutrient density of the street foods.

Lastly, this finding gives a better and clearer understanding of the socio-economic status of vendors, consumers preference and satisfaction, gross observation about hygiene, microbiological quality, nutritional composition (proximate nutrient, minerals & vitamins) of street and frozen foods (singara, samosa, roll) available in Chattogram city. Health policy makers and educators should encourage and promote the sale of healthy, traditional street foods and ensure that regulation efforts are in place to prevent health problems arising.

Strength & Limitation

Strength of the study

- We used common food sample for this study which are available in both commercially and local street shop.
- Compared the nutritional comparison between street food and commercial frozen foods.
- Compared the presence of bacteria (*E.coli* & *Salmonella* spp.) between street food and commercial frozen foods.
- For this study purpose we developed some protocol such as vitamin like Retinol & Beta carotene (Vit-A), Tocopherol (Vit-E) & Riboflavin (Vit-B2) and mineral like Manganese and Selenium.

Limitation of the study

Due to the impediment of time, the study was as it were carried out in nine places in Chattogram city. As a results, vendors and consumers number were little. Only forty vendors and forty consumers were taken part in this study where, more male clients than female clients were participated in this study. All seasons of the year were not covered through overview information collection. Only winter season was covered. Due to the restriction of budget, the types of the collected street foods was limited for both microbial investigation and nutritive value analysis.

Recommendations & Future perspectives

Recommendations

The researchers highly recommend that the city corporation authority of Chattogram responsible for controlling food stalls. However, street foods stalls are not well-controlled compared with the registered stationary food stalls.Vendors should be assigned specific spaces to undertake business. These places should be supplied with water, electricity, sewage systems, sanitary facilities.

The researchers suggest that the vendors should wear uniform or even just a clean shirt with a logo of their association. With that idea, at least they will establish camaraderie and uniformity. Having good procedures should be followed such as garbage bins should not be placed beside the cooking area. It should be at least five meters away.

The researchers also recommend starting a simple informative checklist of hygienic practices. This checklist will evaluate the food safety practices of the street food vendors to emphasize the implementation of good hygiene standards. This could also help them to map out a program for food safety. The checklist should include business skill (e.g. on financial management, quality of the services, business opportunity). This checklist should be provided to street food vendors so as to enable them to understand factors likely to affect their business performance and how to overcome them.

The researchers suggest that a food vending monitoring programme should be established and well enforced by the food safety officers. Routine quality and safety assessment of locally vended food and inspection of selling premises should be carried out. Food safety officers should ensure that street food undergo quality examination periodically and the records should be the basis for consumers satisfaction.The education and awereness level for food safety among the vendors should increase which may help to prevent food adulteration as well as disease transmission.

Future perspectives

Present study is conducted to investigate the quality evaluation of street food. This study suggests there is more future evaluation need for analysis of street food. The following suggestions:

- The street food sample need to be collected from more different location in Chattogram city with higher sample size.
- The other minerals parameter like Sulfur, Iodine, Fluoride, Chromium and Cobalt (which is part of the vitamin B12 / cobalamine) need to be analyzed.
- Vitamin like D, K, B1 and B3 need to be analyzed.
- Toxic chemical like PAHs (Polycylic aromatic hydrocarbons), Acrylamide and Mycotoxins in street foods need to be analyzed.
- Fatty acid profile (Saturated fatty acids, Monounsaturated fatty acids, Polyunsaturated fatty acids, Omega-3 fatty acids , Omega-6 fatty acids and Trans fatty acids) need to be analyzed.
- Heavy metal like Aluminium (Al), Cadmium (Cd), and Lead (Pb) etc in street food need to be analyzed.
- Presence of antioxident and flavonoids in street food need to be analyzed.
- To study antimicrobial sensitivity pattern of isolated *E.coli* & *Salmonella* spp.
- pH and Water Activity (a_w) of the street foods should be measured.
- Colourings may react with the food and change to poisons in the body, causing mutations cancer or other toxic effects.So,colour adulterent in street food need to be analyzed.
- Trans fats are unsaturated fats which are usually produced during the process of hydrogenation of oil and also while reusing the cooking oil. So, presence of trans fat in cooking oil need to be analyzed.

References

Abratt, R. and Goodey, S. D. 1990. Unplanned buying and in-store stimuli in supermarkets. Managerial and Decision Economics, 11(2): 111-121.

Albuquerque, G., Morais, I., Gelormini, M., Casal, S., Damasceno, A., Pinho, O., Moreira, P., Jewell, J., Breda, J., Lunet, N. and Padrao, P. 2019. Street food in Dushanbe, Tajikistan: availability and nutritional value. British Journal of Nutrition, 122(9): 1052-1061.

AOAC. 2005. Official Methods of Analysis. 18th Ed., AOAC International, Gaithersburg, MD, USA, Official Method 2005.08.

Baker, H. and Frank, O. 1968. Determination of vitamin E. In: Clinical vitaminology: methods and interpretation, (ed.). Baker, H. and Frank, O., New York, Wiley, 172-176 pp.

Bendech, A., Chauliac, M., Kante, N. and Malvy, D. J. 2000. Food consumption patterns in the urban milieu of Bamako. Sante Publique, 12(1): 45-63.

Bendech, M. A., Chauliac, M. and Malvy, D. J. M. 1998. Assessment of dietary intake at home and outside the home in Bamako (Mali). Ecology of Food and Nutrition, 37(2): 135-162.

Bhowmik, S. 2012. Street vendors in the global urban economy, 1st ed., Routledge India, London, 320 p.

Bipasha, M.S. and Goon, S. 2013. Fast food preferences and food habits among students of private universities in Bangladesh. South East Asia Journal of Public Health, 3(1): 61-64.

Bradley, D. W. and Hornbeck, C. L. 1973. A clinical evaluation of an improved TFA micromethod for plasma and serum vitamin A. Biochemical Medicine, 7(1): 78-86.

Bryan, F. L., Michanie, S. C., Alvarez, P. and Paniagua, A. 1988. Critical control points of street-vended foods in the Dominican Republic. Journal of Food Protection, 51(5): 373-383.

Chakravarty, I. and Canet, C. 1996. Street foods in Calcutta. Food Nutrition and Agriculture, 17(18): 30-37.

Choudhury, M., Mahanta, L., Goswami, J., Mazumder, M. and Pegoo, B. 2011. Socio-economic profile and food safety knowledge and practice of street food vendors in the city of Guwahati, Assam, India. Food Control, 22(2): 196-203.

Choudhury, R. K. and Rahaman, M., 2015. Education for all realities, achievements and challenges. The story of Bangladesh. ZEP - Journal of International Educational Research and Development Education, 38(2): 33-37.

Chukuezi, C. O. 2010. Food safety and hygienic practices of street food vendors in Owerri, Nigeria. Studies In Sociology of Science, 1(1): 50-57.

Codjia, G. 2000. FAO Technical Support for Improvement within the Street Food Sector. Unpublished report, Government Printer, Gauteng Province, Pretoria.

Dawson, R. J. and Canet, C. 1991. International activities in street foods. Food Control, 2(3): 135-139.

Drabo, K. M., Toe, L. P., Savadogo, L. G., Tarnagda, Z., Zeba, A. N., Zongo, I., Rouamba, J., Toe, A., Ouedraogo, D. and Ouedraogo, J. B. 2009. Main characteristics of the street food sector in Bobo-Dioulasso, Burkina Faso. Bulletin of The Society of Exotic Pathology, 102(1): 36-40.

Draper, A. 1996. Street foods in developing countries: the potential for micronutrient fortification. Omni Project, 2: 1-9.

Etkin, N. 2009. Foods of association: Biocultural perspectives on foods and beverages that mediate sociability. University of Arizona Press, 1: 264.

FAO. 1991. Street foods in developing countries: lessons from Asia. Food, Nutrition and Agriculture (FAO), 1(1): 11-18.

FAO. 1996. Rome Declaration on World Food Security and World Food Summit Plan of Action. Report of the World Food Summit, Food and Agriculture Organization of the United Nations, Rome, Italy.

FAO. and WHO. 2005. Informal food distribution sector in Africa. Proc. FAO/WHO Regional Conference on Food Safety for Africa, 3-6 October 2005, Harare, Zimbabwe, 1-11 pp.

Guven, K., Mutlu, M. B., Gulbandilar, A. and Cakir, P. 2010. Occurrence and characterization of *Staphylococcus aureus* isolated from meat and dairy products consumed in Turkey. Journal of Food safety, 30(1): 196-212.

Hashmi, M. H., Qureshi, T., Chughtai, F. R. and Saeed, M. 1969. Spectrophotometric determination of manganese. Microchimica Acta, 57(4): 782-785.

Henderson, J. C., Yun, O. S., Poon, P. and Biwei, X. 2012. Hawker centres as tourist attractions: The case of Singapore. International Journal of Hospitality Management, 31(3): 849-855.

IFPRI. 2000. Urban Livelihoods and Food and Nutrition Security in Greater Accra, Ghana. Research Report 112, International Food Policy Research Institute, Washington D.C , USA.

Islam, N. 2005. Dhaka Now: Contemporary Urban Development, 2nd end., Bangladesh Geographic Society, Dhaka, 87 p.

Kasem, N. 2014. Street Food Vending in Bangladesh: An Examination of Young Adults Preference in Dhaka City. Journal of Bangladesh University of Business & Technology, 6: 52-66.

Kaur, P. and Singh, R. 2007. Uncovering retail shopping motives of Indian youth. Journal of Young Consumers, 8(2): 128-138.

Khairuzzaman, M. D., Chowdhury, F. M., Zaman, S., Al Mamun, A. and Bari, M. 2014. Food safety challenges towards safe, healthy, and nutritious street foods in Bangladesh. International Journal of Food Science, 2014: 1-9.

Levin, C., Ruel, M., Morris, S., Maxwell, D., Armar-Klemesu, M. and Ahiadeke, C. 1999. Working Women in an Urban Setting: Traders, Vendors and Food Security in Accra. World Development Journal, 27(11): 1977-1991.

Lues, J. F., Rasephei, M. R., Venter, P. and Theron, M. M. 2006. Assessing food safety and associated food handling practices in street food vending. International Journal of Environmental Health Research, 16(5): 319-328.

Makhumula, P., Guamuch, M. and Dary, O. 2007. Manual of laboratory methods for fortified foods Part II. The USAID Micronutrient and Child Blindness Project (GHS-A-00-05-00012), East, central and southern africa health community, Arusha, Tanzania.

Mamun, M., Rahman, S. M. M. and Turin, T. C. 2013. Microbiological quality of selected street food items vended by school-based street food vendors in Dhaka, Bangladesh. International Journal of Food Microbiology, 166(3): 413-418.

Modarressi, S. and Thong, K. L. 2010. Isolation and molecular sub typing of *Salmonella enterica* from chicken, beef and street foods in Malaysia. Scientific Research and Essays, 5(18): 2713-2720.

Moodie, R., Stuckler, D., Monteiro, C., Sheron, N., Neal, B., Thamarangsi, T., Lincoln, P. and Casswell, S. 2013. Profits and pandemics: prevention of harmful effects of tobacco, alcohol, and ultra-processed food and drink industries. The Lancet, 381(9867): 670-679.

Morell, D. B. and Slater, E. C. 1946. The fluorimetric determination of riboflavin in urine. Biochemical Journal, 40(5-6): 652-657.

Muzaffar, A. T., Huq, I. and Mallik, B.A. 2009. Entrepreneurs of the streets: An analytical work on the street food vendors of Dhaka City. International Journal of Business and Management, 4(2): 80-88.

Mwangi, A. 2002. Nutritional, hygienic and social-economic dimensions of street foods in urban areas: the case of Nairobi. PhD thesis, Department of Food Science, Nutrition and Technology, University of Wageningen, Netherlands.

Mwangi, A. M., Hartog, D. P. A., Foeken, D. W., Van't Riet, H., Mwadime, R. K. and Van Staveren, W. A. 2001. The ecology of street foods in Nairobi. Ecology of Food and Nutrition, 40(5): 497-523.

Mwangi, A. M., Hartog, D. P. A., Mwadime, R. K., Van Staveren, W. A. and Foeken, D. W. 2002. Do street food vendors sell a sufficient variety of foods for a healthful diet: the case of Nairobi. Food and Nutrition Bulletin, 23(1): 48-56.

Nago, E., Lachat, C., Huybregts, L., Roberfroid, D., Dossa, R. and Kolsteren, P. 2009. Food, energy and macronutrient contribution of out-of-home foods in school-going adolescents in Cotonou, Benin. British Journal of Nutrition, 103(2): 281-288.

Namugumya, B. and Muyanja, C. 2011. Contribution of street foods to the dietary needs of street food vendors in Kampala, Jinja and Masaka districts, Uganda. Public Health Nutrition, 15(8): 1503-1511.

Narayana, B. and Mathew, M. 2006. An easy spectrophotometric determination of selenium using azure B as a chromogenic reagents. Indian J. Chem. Technol, 13: 455-458.

Nazmoon, S. and Hafiza, K. 2015. Spatial Pattern of Street Food in Dhaka City. Oriental Geographer, 56: 97-112.

Ngoc, T. and Thanh, C. 2015. Food safety behavior, attitudes and practices of street food vendors and consumers in Vietnam. PhD and MS thesis, Faculty of Bioscience Engineering, Universiteit Gent, Belgica.

Nicolas, B., Razack, B. A., Yollande, I., Aly, S., Tidiane, O. C. A., Philippe, N. A., De Souza, C. and Sababenedjo, T. A. 2007. Street-vended foods improvement: Contamination mechanisms and application of Food Safety Objective Strategy: Critical review. Pakistan Journal of Nutrition, 6(1): 1-10.

Nkosi, N. V. and Tabit, F. T. 2021. The food safety knowledge of street food vendors and the sanitary conditions of their street food vending environment in the Zululand District, South Africa. Heliyon, 7(7): 1-8.

Nyaruhucha, C., Kinabo, J., Kulwa, K., John, J., George, V. and Sillo, L. 2007. Improving the nutritional quality of street foods to better meet the micronutrient needs of schoolchildren in urban areas. Report, Food and Agriculture Organization and Sokoine University, Rome, Italy.

Oguntona, C. R. and Tella, T. O. 1999. Street foods and dietary intakes of Nigerian urban market women. International journal of food sciences and nutrition, 50(6): 383-390.

Oguntona, C. R., Razaq, M. A. and Akintola, T. T. 1998. Pattern of dietary intake and consumption of street foods among Nigerian students. Nutrition and Health, 12(4): 247-256.

Ohiokpehai, O. 2003. Nutritional aspects of street foods in Botswana. Pakistan Journal of Nutrition, 2(2): 76-81.

Proietti, I., Frazzoli, C. and Mantovani, A. 2014. Identification and management of toxicological hazards of street foods in developing countries. Food and Chemical Toxicology, 63: 143-152.

Rahim, A. T. M. A., Islam, M., Ara, G., Nessa, M. U. and Shaheen, N. 2002. Commercial Fast Food and Traditional Snack Food of Bangladesh: II. Content of Proximate Nutrients, Sodium, Potassium, Dietary Fiber and Energy. Bangladesh Journal of Nutrition, 15: 79-89.

Rahman, M. M. and Kabir, S. L. 2013. Veterinary education on fostering food safety and governance achieving a healthy nation in Bangladesh. Veterinary Science Development, 3(1): 1-4.

Rane, S. 2011. Street Vended Food in Developing World: Hazard Analyses. Indian Journal of Microbiology, 51(1): 100-106.

Schmidt, R. H., Goodrich, R. M., Archer, D. L. and Schneider, K. R. 2003. General overview of the causative agents of foodborne illness. Emily Dickinson International Society (EDIS), 2003(6): 1-5.

Simon, S. 2007. Promises and challenges of the informal food sector in developing countries, 1st ed., Food and Agriculture Organization of the United Nations (FAO), Rome, Italy, 1-34 pp.

Sinell H.J. 1989. The hygiene of refrigerated and frozen foods. Zentralbl Bakteriol Mikrobiol Hyg B. Journal, 187(4-6): 533-545.

Smith, A.F. ed. 2007. The Oxford companion to American food and drink, 1st ed., Oxford University Press, New York, 693 p.

Steyn, N. P. and Labadarios, D. 2011. Street foods and fast foods: How much do South Africans of different ethnic groups consume?. Ethnicity and Disease, 21(4): 462.

Steyn, N. P., Mchiza, Z., Hill, J., Davids, Y. D., Venter, I., Hinrichsen, E., Opperman, M., Rumbelow, J. and Jacobs, P. 2014. Nutritional contribution of street foods to the diet of people in developing countries: a systematic review. Public Health Nutrition, 17(6): 1363-1374.

Tabashsum, Z., Khalil, I., Nazimuddin, M. D., Mollah, A. K. M., Inatsu, Y. and Bari, M. L. 2013. Prevalence of foodborne pathogens and spoilage microorganisms and their drug resistant status in different street foods of Dhaka city. Agriculture Food and Analytical Bacteriology, 3(4): 281-292.

Tambekar, D. H., Jaiswal, V. J., Dhanorkar, D. V., Gulhane, P. B. and Dudhane, M. N. 2009. Microbial quality and safety of street vended fruit juices: a case study of Amravati city. Internet Journal of Food Safety, 10(7): 72-76.

Tambekar, D. H., Kulkarni R. V., Shirsat S. D and Bhadange D. G. 2011. Bacteriological quality of street vended food panipuri: a case study of Amravati City, India. Bioscience Discovery, 2(3): 350-354.

Taushif, M. and Gupta, M. 2013. A study of factors affecting impulse buying behaviour of consumers at Malls (Delhi). International Journal of Research and Development, 2(2): 2319-5479.

van der Heijden, J., Gray, N., Stringer, B., Rahman, A., Akhter, S., Kalon, S., Dada, M. and Biswas, A. 2019. 'Working to stay healthy', health-seeking behaviour in Bangladesh's urban slums: a qualitative study. BioMed Central (BMC) Public Health, 19(1): 1-13.

Von Holy, A. and Makhoane, F. 2006. Improving street food vending in South Africa: achievements and lessons learned. International Journal of Food Microbiology, 111(2): 89-92.

Wanjek, C. 2005. Food at work: Workplace solutions for malnutrition, obesity and chronic diseases., 1st ed., International Labour Organization (ILO), Geneva, 446 p.

Webb, R. E. and Hyatt, S. A. 1988. Haitian street foods and their nutritional contribution to dietary intake. Ecology of Food and Nutrition, 21(3): 199-209.

WHO. 1996. Essential safety requirements for street-vended foods. Documents, Division of Food and Nutrition World Health Organization, Geneva, Switzerland.

World Population Prospect (WPP) of United Nations. Chittagong, Metropolitan Area Population (https://www.macrotrends.net/cities/20115/chittagong/population), geneva, 2019. Accessed 19 september 2021.

Youn, S. and Faber, R. J. 2000. Impulse buying: its relation to personality traits and cues. Advances In Consumer Research, 27: 179-185.

Appendices

Annex 1: Reasons behind choosing the place

Location	Reasons behind choosing the place
Pahartali college	Gathering of youths everyday as there are more than 1,000 students in this college.
Tiger pass	The meeting place of some roads. So, a large number of people of varied occupation gather here daily.
Station road	The railway terminal was constructed during the British era. The busiest parts of the city is station road, very crowed place with full of life.
New market	Popular commercial shopping market. People from all parts of the city come here for shopping; most of them are of middle income group.
GPO	Government post office commonly known as GPO. Agglomeration of some private and public bank. So, it is an overcrowded street of chattogram city.
Kotwali	It is the famous thana of chattogram city and characterized by the rapid increase of residential population.
Chawk bazar	A large number of coaching centres and private institutions generate heavy flow of population here.
GEC more	There are more spacious restaurent near GEC more. It is one of the commercial centres of the city.
Bahaddarhat	The main business and commercial hub of chattogram city. It is also known as the city centre. That is why the largest gathering of all type of population and activities is seen here during day time.

Annex 2: Selection of food samples

Street food		ID	Location	Frozen food		ID	Brand name
	Singara	Si 1	GPO		Singara	Si 4	Mafco
		Si 2	New Market			Si 5	ATR
		Si 3	Pahartali College			Si 6	Eon foods limited
	Roll	Ro 1	GPO		Roll	Ro 4	Mafco
		Ro 2	New Market			Ro 5	Eon foods limited
		Ro 3	Pahartali College			Ro 6	AG food
	Samosa	Sa 1	GPO		Samosa	Sa 4	Kazi farms
		Sa 2	New Market			Sa 5	Mafco
		Sa 3	Pahartali College			Sa 6	AG food

Annex 3: Date of interview

SL.NO	Location	Date of interview
1	Pahartali College, Chattogram	1/1/2019
		5/1/2019
		8/1/2019
2	Tiger pass	12/1/2019
		15/1/2019
		19/1/2019
3	Station Road	21/1/2019
		24/1/2019
		27/1/2019
4	New market	1/2/2019
		4/2/2019
		9/2/2019
5	GPO	13/2/2019
		17/2/2019
		22/2/2019
6	Kotwali	25/2/2019
		1/3/2019
		5/3/2019
7	Chawk bazar	8/3/2019
		11/3/2019
		15/3/2019
8	GEC more	20/3/2019
		25/3/2019
		2/4/2019
9	Bahaddarhat	6/4/2019
		12/4/2019
		15/4/2019

Annex 4: List of Street foods and their price

SL. NO	Name of street food	Price in TK
1	Sompapri	5
2	Achar	5
3	Carrot and khira fruit with salt and chilli	5
4	Butter bun	5
5	Denise	5
6	Chicken biriani	30 per plate
7	Peanut	5
8	Chicken tikka	20
9	Pineapple with salt and chili	10
10	Jilapi	5
11	Chona muri	8
12	Biscuit	2
13	Noodles	10
14	Piaju	2
15	Beguni	3
16	Guava with salt and chili	5
17	Sugar cane juice	10
18	Jhal muri	5
19	Paratha	5
20	cake	5
21	Boiled egg	10
22	Dim cake	20
23	Sorboth	5
24	Motor boot	5
25	Jhal chanachur	5
26	Egg burger	10
27	Vot	15
28	Roll	10
29	Sandwich	10
30	Chicken stick	20
31	Vegetable burger	15
32	Singara	5
33	Samosa	5
34	Dim chop	8
35	Puri	5
36	Vhel puri	6
37	Chotpoti	20
38	Fuchka	20
39	Tea	6
40	Chanachur vaji	5
41	Papor vaji	10
42	Alur chips	5
43	Hot pettics	6
44	Jal pettics	8
45	Kimapuri	10
46	Gola ice cream	5
47	Chitoi pitha	5
48	Puli pitha	5
49	Vapa pitha	5
50	Mal poa	5
51	Mowa	2
52	Mixer	10
53	Alu chop	5

Annex 5: Street food list on different locations and typical consumers of street foods

Location	Location wise street food	Consumer
Pahartali College Chittagong	Sombappi	Student
	Achar	Student
	Singara	Student
	Samosa	Local people
	Piaju	Local people
	Alu chop	Transport vehicle staff
	Roll	Local people
Tiger pass	Carrot and khira fruit with salt and chilli	Driver, transport vehicle Staff, shopkeeper
	Butter ban	Student
	Dynise	Transport vehicle Staff
	Chicken biriani	Employee
	Peanut	Passer-by
	Chicken tikka	Passer-by, employee
	Pineapple with salt and chili	Employee, student
	Singara	Transport vehicle Staff
	Samosa	Employee
	Piaju	Student
Station Road	Jilapi	Shopkeeper
	Chana muri	Shopkeeper
	Biscuit	City corporation worker
	Noodles	City corporation worker
	Piaju	Driver
	Beguni	Employee, passenger
	Guava with salt and chili	Passenger, shopkeeper
	Sugar cane juice	Driver, student
	Jhal muri	Student
	Singara	Passenger
New market	Paratha	Local people
	Jhal muri	Shopkeeper
	Boiled egg	Driver
	Dim cake	Student
	Sorboth	Employee
	Motor boot	Employee
	Jhal chanachur	Security guards
	Egg burger	Security guards
	Vot	Driver
	Roll	Student
	Sandwich	Local people
	Chicken stick	Local people
	Vegetable burger	Traffic police
	Beguni	Traffic police
	Piaju	Driver
	Singara	Passer-by
	Samosa	Passer-by
GPO	Singara	Student
	Samosa	Student
	Dim chop	Driver
	Chicken stick	Employee
	Puri	Employee

	Vhel puri	Shopkeeper
	Chotpoti	Local people
	Fuchka	Local people
	Tea	Shopkeeper
	Chanachur vaja	Driver
	Papor vaji	Employee
	Alur chips	Employee
	Hot pettics	Local people
	Jal pettics	Local people
	Kimapuri	Employee
	Roll	Local people
	Egg burger	Local people
	Gola ice cream	Student
Kotwali	Chitoi pitha	Student
	Puli pitha	Driver
	Vapa pitha	Passer-by
	Mal poa	Transport vehicle Staff
	Mowa	Transport vehicle Staff
	Mixer	Local people
	Alu chop	Passenger
	Singara	Employee, traffic police
	Samosa	Local people
	Puri	Driver
	Piaju	Local people
	Chotpoti	Driver
	Noodles	Shopkeeper
Chawk bazar	Singara	Driver
	Samosa	Passer-by
	Piaju	Driver
	Beguni	Passer-by
	Noodles	Employee
	Roll	Driver
	Alu chop	Driver
	Mixer	Transport vehicle Staff
	Puri	Employee
	Boiled egg	Driver, transport vehicle Staff, shopkeeper
	Fuchka	Local people, student
	Chotpoti	Local people
GEC more	Sandwich	Driver
	Chicken stick	Student
	Vegetable burger	Employee, passenger
	Beguni	Employee
	Piaju	Shopkeeper
	Singara	Shopkeeper
	Samosa	Driver, security gard
Bahaddarhat	Butter ban	Passer-by, passenger
	Chicken biriani	Passer-by
	Dim cake	Driver, local people
	Sorboth	Local people
	Roll	Security gard
	Sandwich	Employee
	Singara	Transport vehicle Staff
	Samosa	Transport vehicle Staff
	Piaju	Transport vehicle Staff

Annex 6: The most preferred street food

Consumers name	Age (year)	Prefer foods of consumer
Nahid	22	Singara, samosa , sorboth
Raju	27	Roll, singara, puri
Badsha	21	Vegetable burger , roll , singara
Ajoy	24	Puri , samosa, fuchka
Rashed	21	Chicken stick, roll, alu chop
Sumi Akter	32	Boiled egg , samosa, dim chop
Anju	17	Piaju, chona muri, beguni
Manik	30	Noodles, singara, dim chop
Mamun	25	Paratha, samosa, alu chop
Akbor	19	Achar , fuchka, chotpoti
Soma Das	16	Jilapi, chona muri , roll
Sunny	40	Sorboth, roll, alu chop
Abdulla	15	Papor vaji, alur chips, fuchka
Jiku	20	Dim cake, dim chop, paratha
Ripon	22	Jhal chanachur, achar, singara
Linkon	15	Sombappi, papor vaji, alur chips
Kisar	35	Dynise, butter bun, noodles
Mojammal	32	Beguni, roll, alu chop
Akter	27	Piaju, beguni ,singara
Rubel	29	Chicken tikka, chicken roll , chicken biriani
Etu	21	Chotpoti, roll, samosa
Ovi	26	Piaju, beguni, roll
Aka	17	Chicken stick, chicken tikka, vot
Mumu	22	Beguni, sandwich, vegetable burger
Amrit	29	Piaju, puri, beguni
Sontu	34	Roll, alu chop, fuchka
Novel	35	Samosa, chona muri, piaju
Akbor	31	Fuchka, noodles, dim chop
Bivu	32	Chona muri, alu chop, sugar cane juice
Rocky	18	Chicken biriani, vot, chicken stick
Babu	35	Roll, alu chop, piaju
Monu	40	Sorboth, sugar cane juice, singara
Habib	38	Piaju, beguni, roll
Nokul	42	Beguni , singara, samosa
Riku	33	Piaju, chona muri, beguni
Moti	45	Roll, chotpot, samosa
Rajdip	17	Puri , samosa, fuchka
Priyom	21	Roll, singara, puri
Aditto	36	Dynise ,butter bun, piaju
Koilas	18	Beguni, roll, alu chop

Annex7: Demographics profile of vendors

SL.NO	Name	Sex (male/ female)	Marital status (married/ unmarried)	Age (year)	Education (class)	Income (tk/month) K=thousand	Deposit (tk/month) K=thousand	Experience (year)	Family member	Food safety training
1	Mannan	Male	Unmarried	16	5	18 k	2k	3	12	no
2	kamal	Male	Married	47	None	11 k	1k	5	8	no
3	Rony	Male	Unmarried	15	4	9 k	1.5k	1	5	no
4	Lokman	Male	Unmarried	21	2	6 k	None	2	6	no
5	Rifat	Male	Unmarried	19	7	7k	None	3	4	no
6	Anis	Male	Unmarried	22	None	10k	2k	4	3	no
7	Hakim	Male	Married	40	None	12k	3k	8	5	no
8	Nazma	Female	Unmarried	35	2	10k	None	4	5	no
9	Hider	Male	Unmarried	25	3	13k	2k	2	5	no
10	Emon	Male	Unmarried	23	None	15k	3k	3	7	no
11	Aiysa	Female	Unmarried	25	None	13k	1k	4	4	no
12	Nazu	Male	Married	30	8	12k	None	5	5	no
13	Saju	Male	Married	34	10	10k	2k	6	3	no
14	Sonjoy	Male	Unmarried	29	3	14k	1k	2	4	no
15	Rahit	Male	Married	32	None	17k	1.5k	3	5	no
16	Bokkor	Male	Married	29	None	12k	None	3	3	no
17	Fathema	Female	Married	28	1	7k	None	4	3	no
18	Anik	Male	Unmarried	23	6	10k	1.5k	2	6	no

19	Jashmine	Female	Unmarried	22	None	12k	1k	3	5	no
20	Hasan	Male	Unmarried	28	4	8k	None	3	3	no
21	Raju	Male	Unmarried	25	8	10k	None	4	7	no
22	Amit	Male	Married	28	10	12k	1.5k	7	3	no
23	Sohel	Male	Unmarried	23	6	10k	1k	5	5	no
24	Tuktuk	Male	Unmarried	16	7	8k	None	1	4	no
25	Rijve	Male	Married	30	2	13k	None	4	6	no
26	Maruf	Male	Unmarried	31	3	9k	None	6	5	no
27	Nobin	Male	Married	35	9	7k	None	3	3	no
28	Jahed	Male	Unmarried	26	5	8k	None	6	7	no
29	Anju	Male	Unmarried	25	None	10k	1k	4	8	no
30	Farid	Male	Married	43	None	11k	2k	10	5	no
31	Sopon	Male	Married	40	5	6k	None	12	4	no
32	Roman	Male	Unmarried	29	7	8k	None	6	6	no
33	Tiklu	Male	Unmarried	33	9	11k	2k	5	7	no
34	Bappu	Male	Unmarried	25	10	9k	None	3	4	no
35	Manik	Male	Unmarried	31	None	10k	1k	5	3	no
36	Akter	Male	Married	39	5	12k	2k	7	5	no
37	Jony	Male	Married	33	None	13k	1.5k	2	7	no
38	Niyaj	Male	Married	36	2	15k	2k	6	3	no
39	Faruk	Male	Married	42	None	10k	None	8	8	no
40	Basu	Male	Unmarried	31	3	7k	None	6	4	no

Annex 8: Weight of street food and frozen food sample

Sample	Raw weight for frozen food (g)	After frying weight (g)	After drying weight (g)	Wet basis moisture loss (frying wt- drying wt) (g)
Si 1		62.94	35.52	27.42
Si 2		62.20	30.44	31.76
Si 3		61.67	33.19	28.48
Si 4	40.92	37.52	22.07	15.45
Si 5	34.95	33.23	21.65	11.58
Si 6	31.81	28.02	15.88	12.14
Ro 1		74.92	35.79	39.13
Ro 2		67.39	31.87	35.52
Ro 3		75.27	35.86	39.41
Ro 4	19.92	18.77	9.04	9.73
Ro 5	23.07	20.75	10.59	10.16
Ro 6	21.44	19.04	9.01	10.03
Sa 1		42.43	26.78	15.65
Sa 2		37.82	23.99	13.83
Sa 3		37.25	26.87	10.38
Sa 4	41.41	39.77	14.69	25.08
Sa 5	21.14	19.34	10.1	9.24
Sa 6	20.97	19.67	8.21	11.46

Annex 9: Ingredients and methods of preparation for street food & frozen food

Food Items	Ingredients			Method of preparation
	For the dough (wrapping)	For Roasted spice (stuffing)	Boiled/fried vegetable/legume (filling)	
Samosa (street)	Flour, salt, sugar, oil, water	Oil, panch phoron, dried red chiilies, onion paste, ginger paste, bayleaves, turmeric powder, chilli powder, coriander powder, cumin powder, salt, garam masala powder, water	Cauliflower, potatoes, onion chopped, tomatoes, mung dal (fry)	Deep fry
Samosa (frozen)	Flour, salt, sugar, oil, water	Oil, panch phoron, dried red chiilies, onion paste, ginger paste,bayleaves, turmeric powder, chilli powder, coriander powder, cumin powder, salt, garam masala powder, water	Cabbage, carrot, potatoes, onion chopped, green peas	Deep fry (before freezing) & shallow fry (before eating)
Roll (street)	Flour, corn flour, baking powder, egg, sugar, salt, oil, water	Oil, garlic paste, ginger paste, onion paste, soya sauce red chili powder, turmeric powder, cumin powder, cinnamon sticks, cardamon, salt, water	Carrot, potatoes, cabbage, onion chopped,cucumber, ladies fingers, green capsicum	Deep fry
Roll (frozen)	Flour, corn flour, baking powder , egg, sugar, salt, oil, water	Oil, garlic paste, ginger paste, onion paste, soya sauce red chili powder, turmeric powder, cumin powder, cinnamon sticks, cardamon, salt, water	Cabbage, papaya, carrot, potatoes, onion chopped, green peas	Deep fry (before freezing) & shallow fry (before eating)
Singara (street)	Flour, salt, oil, water, black berries, master seed paste	Oil, panch phoron, dried red chiilies, onion paste , garlic paste, ginger paste, turmeric powder, chilli powder, coriander powder, cumin powder, garam masala powder, slice green chilli, salt, water	Cauliflower, potatoes, onion chopped, chick peas, peanut, green papaya, slice coriander leaf	Deep fry
Singara (frozen)	Flour, salt, oil, water	Oil, panch phoron, dried red chiilies, onion paste , garlic paste, ginger paste, turmeric powder, chilli powder, coriander powder, cumin powder, garam masala powder, slice green chilli, salt, water	Potatoes, onion chopped, ,carrot, green peas, coriander leaf, tomatoes	Deep fry (before freezing) & shallow fry (before eating)

Figure 11: Different types of street food in Chattogram

Figure 12: Socio-economic survey of vendors and consumers

Figure 13: Nutritional value analysis of food

Figure 13: Microbial quality analysis

Questionnaire

Assessment of the health and hygienic condition of vendors and consumers

Department of Physiology, Biochemistry and Pharmacology
Faculty of Veterinary Medicine
Chattogram Veterinary and Animal Sciences University
Conducted by: Srijan das
MS Fellow (Biochemistry)
Session: 2019-2020

Vendors Questionnaire:

A. Location of vendors included in study

1. Residential area
2. Transport area (Taxi, railway, bus stations)
3. Near hospital
4. Industrial area
5. Commercial area

B. Profile of vendors level of education

1. No education
2. Primary (1-5)
3. Secondary (6-10)

C. Gender

1. Male
2. Female

D. Age group

1. 10-20
2. 21-30
3. 31-40
4. 41-50

E. Years of experience as a street food vendor

1. 1-3 year
2. 4-6 year
3. 7-9 year
4. 10-12 year

F. Pre-preparation of food

1. In vending shop
2. At home
3. Factory (processed)

G. Toilet and water facilities

1. Water to prepare food
    a. Spring water
    b. Boil or filter water
    c. Tap water
2. Place to store the water to prepare food
    a. Container (Closed)
    b. Other (Pan with Lid)
3. Frequency of sanitizing
    a. No toilet latrine
    b. Just pit latrine with slab
    c. Just pit latrine without slab
    d. Ventilized improved pit (VIP) latrine
4. Frequency of hand washing
    a. Before preparing food
    b. After receiving Cash
    c. After Direct Contact with raw material
5. Location of hand washing
    a. Tap on the street
    b. Public washroom
    c. From bucket
6. Product use for hand washing
    a. Just water
    b. Liquid hand Soap
    c. Liquid Soap
    d. Detergent
7. Hand drying
    a. Paper towel
    b. Towel
    c. Do not dry
8. Changing of attire
    a. Every day
    b. Every 2 days
    c. Every 3/4 days
    d. Weekly

Polar Question for vendors:

1. Usage of plastic wraps, foils and covers when storage
2. Work under bad health conditions
3. Cleanliness of utensils
4. Waste disposal
5. Seperation of cooked foods and raw foods
6. Storing cooked products before selling
7. Prevention of smokers in the workplace
8. Work under environmental condition
9. Adequate lighting in the food preparation area
10. Suitable water storage container
11. Pre-prepared or ready-to-eat foods are handled with pertinent utensils, without manual contact
12. Appropriate uniform of Vendors.
13. Protection covering completely the hair
14. Short/clean nails
15. Hands free of sores
16. Smoking while working with food
17. Coughing over food
18. Handling food and money withoutwashing hands in between

Questionnaire for consumer:

1. Do you think street food is important to choose healthy food?
    A. I don't know
    B. No
    C. Yes
2. How do you rate the facilities of street food?
    A. Outstanding
    B. Good
    C. Satisfactory
    D. Inadequate
3. How do you rate the facilities in the healthy water?
    A. Outstanding
    B. Good
    C. Satisfactory
    D. Inadequate
4. How much money do you receive per dry to spend on street food?
    A. 50 tk
    B. 100 tk
    C. 100 tk more
5. Do you consume Street food?
    A. Yes
    B. No
6. Is income influencing the chosen street food?
    A. Strongly agree
    B. Agree
    C. Neutral
    D. Disagree
    E. Strongly disagree
7. Which one is your favorite street food place?
    A. GEC
    B. Kotowali
    C. New market
    D. Pahartoli
    E. Tiger pass
    F. Station road
    G. Gpo
    H. Chokbazar
    I. Bahaddarhat

8. How often do you eat street food?
    A. Everyday
    B. Once a week
    C. Once a month
9. What time of day do you eat street food?
    A. Before 10 AM
    B. Between 10-12 AM
    C. Between 1-2 PM
    D. Between 4-5 PM

10. Why they like street foods?
    A. Cheap
    B. Tasty
    C. Easily accessible
    D. Fast consumption
    E. Varity
    F. Satisfies Hunger
    G. Food Preparation can be seen
    H. More satisfying

11. Why do you eat street food?

Features	Strongly Agree	Agree	Disagree	Strongly disagree	Comments
QuicklyCook					
Inexpensive					
I like theTaste					
I like the environment					

Brief Biography

Srijan Das is a candidate for the degree of "MS in Biochemistry" under the Department of Physiology, Biochemistry and Pharmacology, Faculty of Veterinary Medicine, Chattogram Veterinary and Animal Sciences University (CVASU). He passed the Secondary School Certificate Examination in 2010 from Kanungopara Dr. B. B. High School, Chattogram and then Higher Secondary Certificate Examination in 2012 from Hazera-Taju Degree College, Chattogram. He obtained his B.Sc. (Hon's) in Food Science and Technology degree from the Faculty of Food Science and Technology of Chattogram Veterinary and Animal Sciences University, Chattogram, Bangladesh. He has great interest in molecular and clinical Biochemistry.