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BAHIR DAR UNIVERSITY
BAHIR DAR INSTITUTE OF TECHNOLOGY
SCHOOL OF RESEARCH AND POST GRADUATE
STUDIES
FACULTY OF CHEMICAL AND FOOD ENGINEERING

ASSESSMENT ON STATUS OF FOOD SAFETY PARAMETERS FOR
STREET FOOD VENDORS IN BAHIR DAR CITY

BY:
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Bahir Dar, Ethiopia
September 7, 2017

ASSESSMENT ON STATUS OF FOOD SAFETY PARAMETERS FOR STREET
FOOD VENDORS IN BAHIR DAR CITY

BY:

Nurhussen Osman

A thesis submitted to the school of Research and Graduate Studies of Bahir
Institute of Technology, BDU in partial fulfillment of the requirements for the
of
Master of Science in Food Technology, the Faculty of Chemical and Food Engineerir

Advisor Name Demewez Moges (Asst. Professor)

Co-Advisor Dr. Takele Ayanaw (Asst. Professor)

Bahir Dar, Ethiopia

September 7, 2017

DECLARATION

I, the undersigned, declare that the thesis comprises my own work. In compliance with internationally accepted practices, I have acknowledged and refereed all materials used in this work. I understand that ~~adherence~~ adherence to the principles of academic honesty and integrity, misrepresentation/ fabrication of any idea/data/fact/source will constitute sufficient ground for disciplinary action by the University and can also evoke penal action from the sources which ~~have~~ been properly cited or acknowledged.

Name of the student _____ Signature _____

Date of submission: _____

Place: Bahir Dar

This thesis has been submitted for examination with my approval as a university advisor.

Advisor Name: _____

Advisor's Signature: _____

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Bahir Dar University
Bahir Dar Institute of Technology-
School of Research and Graduate Studies
Faculty of Chemical and Food Engineering
THESIS APPROVAL SHEET

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The following graduate faculty members certify that this student has successfully presented the necessary written final thesis and presentation for partial fulfillment of the thesis requirements for the Degree of Master of Science in Food Technology

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DEDICATION

I dedicate this thesis to Allah my Creator and my master, my strong pillar, my source of inspiration, wisdom, knowledge and understanding, my great teacher and messenger, Mohammed (May Allah bless and grant him), who taught me the purpose of life, my great parents, who never stop giving of themselves in countless ways, my dearest brother, who leads me through the valley of darkness with light of hope and support, my friends who encourage and support me and the people in my life who touch my heart, thank you. My love for you all can never be quantified. Let Allah be with you.

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ABSTRACT

The street food is prepared on the streets and ready, or prepared at home and consumed on streets without further preparation. Street foods have a lot of socio economic benefits including provision of variety of low cost, convenient and often nutritious food, provision of employment and income, especially for women. The objective of this study was to find out current information on the status of food safety parameters, which are knowledge, attitude, practice, and microbiological quality of different street foods in Bahir Dar City. This study was conducted using descriptive cross-sectional study using quantitative method of data collection. A total 160 food vendors (32 Vendors from each food item widely sold in the street namely: fried fish, Sambussa, potato chips, Ambasha and Bonbolino) operating in the major streets and open air market were selected. An informed consent was obtained from the willingness of food vendors to participate in the study and KAP data was collected through face-to-face interviewing of street food vendors using structured questionnaire. It contained several questions. From a total of 160 street food vendors participated in the study the majority (93.8%) were women.

The proportion of vendors with average food safety knowledge levels was only 8.1% as they obtained scores between 60 and 80. The majority of the street food vendors (91.9%) had an insufficient food safety knowledge level as they obtained scores less than 59.9. Moreover, none of the vendors had good food safety knowledge. The mean food safety attitude score of the street food vendors was (56 ± 14) . Microbial quality data analysis part shows that the Standard plate count varied from 2.25×10^5 cfu/g - 3.8×10^5 cfu/g. The Maximum value was enumerated in Fried fish while the minimum value was in Bonbolino. Based on the observation and finding this study confirmed that street foods sold in Bahir Dar city have a safety problem and street food vendors is lack of adequate information regarding food safety principles. Therefore Bahir Dar city administrator should facilitate the access to food safety training, health education to the vendors on personal hygiene, food safety and finally on the proper disposal of wastes.

Keywords: Street foods, attitude, knowledge, practice, vendors, microbial quality

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LIST OF ABBREVIATIONS

BiT	Bahir Dar Institute of Technology
SOP	standard operating procedures
GHP	good hygienic practice
WHO	World Health Organizations
KAP	Knowledge, Attitudes and Practices
FAO	Food and Agricultural Organization
Cfu	colony forming unit
g	gram
MA	MacConkey Agar
MSA	Mannitol Salt Agar
FBDs	Pathogens can cause food poisoning and food diseases
SPSS	Statistical Package for Social Science

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1. INTRODUCTION

1.1. Background

The street food is prepared on the streets and ready, or prepared at home and consumed on the streets without further preparation. Street vended foods not only appreciated for their unique flavors, convenience and the role which they play in the cultural and social heritage of societies, but also become important and essential for maintaining nutritional status of populations (FAO, 2013). The street food industry plays an important role in cities and towns of many developing countries both economical and in meeting food demands of city dwellers. It also contributes substantially to household food spending and provides an income to many formal households.

Street food market has become an important component of food distribution system in many cities in both developing and industrialized countries. In developing countries a large proportion of ready-to-eat food is sold on the streets. Most of these products are ready-to-serve or ready to eat foods sometimes under poor cooking and trading conditions which can lead to poor nutritive value and low hygienic quality (WHO, 2007).

Microbial contamination of ready-to-eat foods sold by street vendors has become a major health problem. They are frequently associated with diarrhea and other food borne diseases due to their improper handling and serving practices (WHO, 2007). Street food vendors are very often poor, uneducated and show little concern towards the safe handling of foods (Lues et al, 2006).

Street food vendors are mostly untrained of good hygiene practices (GHP) and they are possible sources of contamination which can causes of food borne diseases. Microbial contamination of street vended foods could occur due to different possible reasons such as: poor personal hygiene of food handlers, storing food in cheap utensils, holding food

at a temperature that would permit bacterial growth, utilization of water of questionable hygienic quality, using packing materials that was not of good quality, vending site that had no facilities for waste disposal and utilization of unclean utensils (Mensah et al, 2002: Tambekar et al, 2008).

Consumers who depend on such food are more interested in its convenience and usually pay little attention to its safety, quality, and hygiene (Muleta & Ashenafi, 2000: Muinde & Kuria, 2005). A general lack of factual knowledge about the epidemiological significance of many street vended foods, poor knowledge of street vendors in basic food safety measures and inadequate public awareness of hazards posed by certain foods has severely hampered the deployment of a precise scientific approach to this very serious problem and the conditions of street food preparation and vending raise many concerns for consumer's health (Rane, 2011: WHO, 2002).

In the past few years, street foods are flourishing in major towns of Ethiopia including Bahir Dar. There are many people who get involved in the preparation and sale of street foods. It becomes common practice to observe them around School, Bus stations and other places where several people are found. Previous studies in Bahir Dar, Gondar, Addis Ababa and Jimma towns reported food safety concerns related to street foods in Ethiopia, almost all categories of people are consuming street foods; while some are protected from using these foods for fear of contamination (Ashenafi, 1995).

1.2 Statement of the Problem

It is an undisputable fact that every food can cause illness if it is contaminated with harmful microorganisms. By their nature, street food contamination is inevitable, yet millions of people depend on this source of nutrition. Up to 40% of urban consumers in developing countries depend on street food for the daily diet to meet their nutritional requirements. Thus, street food though cheap and convenient may be a vehicle for food-borne diseases and food poisoning if it is not handled properly. Food safety is a key public health concern, because a large number of people take their meals outside the home and are exposed to food borne illnesses.

In Bahir Dar city labour workers, and other low income community use food vended through the streets due its low price and availability. However, specifically in Bahir Dar the quality of these foods and their safety for human health is not well known. Even though limited information is available on Sambussa and fried fish samples on microbial load and safety, no further study has been conducted microbial safety related to all categories of street foods including Ambasha, Bonbolino and Chips , and aspects of food safety knowledge and practices of street food vendors. Therefore, this study is initiated with the purpose of assessing the food safety parameters, such as knowledge, attitude, and practices as well as the microbial characteristics and safety of major street vended foods in Bahir Dar city

1.3. Objectives

1.3.1. Main objectives

The objectives of this study were to assess the status of food safety knowledge, attitude and practice (KAP) of street food vendors, as well as to assess the safety of different street foods in Bahir Dar City.

1.3.2. Specific objective of the study

1. To assess the sociodemographic characteristics of the street food vendors
2. To assess the food safety knowledge, attitude and practice of street food vendors
3. To determine the microbiological safety of major street foods sold by street food vendors.

2. LITERATURE REVIEW

2.1. Overview of street foods

Street foods are described as ready to eat foods and beverages prepared and sold by vendors or hawkers especially in streets and other similar public places (FAO, 1990). Street foods contribute significantly to the diets of many people in the developing world (FAO, 1989). In addition to offering business opportunities for local entrepreneurs, the sale of street foods can make a sizeable contribution to the economies of developing countries. Moreover, street foods play an important role in developing societies as they support the livelihoods of millions of the urban poor. Traditional and indigenous exotic street foods have emerged as a new form of tourism in developing countries.

Due to socioeconomic changes in many countries, the street food sector has experienced phenomenal growth in the past few decades. Urbanization and population growth are expected to continue and street foods, which are largely but not exclusively an urban phenomenon, was expanded accordingly (Atkinson, 1992). Street food trade has emerged as an economic activity and a source of income for the poor in many developing countries. Street foods are also considered essential for maintaining the nutritional status of the population (Maxwell, 2000). In a longitudinal study conducted in Africa specifically in Ghana, street foods accounted for 27% of food expenses and provided 134-417 kcal per day per person. Street food vending assures food security for low income urban populations and provides a livelihood for a large number of workers who would otherwise be unable to establish a business. The benefits of this trade extend throughout the local economy as vendors buy their ingredients locally (Winarno & Allain, 1991). Various projects have shown that street food trade generates a large

volume of business, involving large amounts of money and provides a competitive source of employment and income to millions of people. The FAO estimates that there are approximately 100,000 vendors in Malaysia whose collective total annual sales amount to over \$2 billion (FAO, 1995). In a survey conducted in Accra, Ghana, the street food sector is shown to employ over 6000 people with an estimated turnover of US\$ 100 million.

Street foods are defined by the Food and Agricultural Organization (FAO) as ready-to-eat foods and beverages prepared and sold by vendors and hawkers in streets and other similar public places (FAO, 1997). The central characteristic of street foods in this definition is their retail location, namely, that they are sold on the street and it is this that categorizes them as part of the informal sector.

To differentiate street food vendors from formal sector food establishments, such as restaurants are analyzed (Tinker, 1987). Adds a further qualification that street foods are sold on the street from "pushcarts or baskets or balance poles, or from stalls or shops having fewer than four permanent walls" (Tinker, 1987). Thus those who manufacture and/or sell street foods are micro-entrepreneurs forming part of the so-called informal sector. In light of this, the informal sector is not enumerated by official collecting agencies, and thus official statistics on the street food trade are virtually nonexistent (Tinker, 1987). Street foods are a heterogeneous food category, encompassing meals, drinks, and snacks. They are mass consumer foods that are prepared without further processing or cooking. Street foods show variation in terms of ingredients, methods of processing, and consumption (Ekanem, 1998). Street food trade usually involves both retail and production activities, although the sale of street foods is the most visible part of the trade. Most street foods have a process to some extent, much of which may have occurred unseen off-street. Because of this, the trade is seen as part of the whole food system, rather than just as a service activity.

2.2. Safety of Street Foods

In 1993, the WHO through its six regional offices undertook a survey of its member states to assess the current safety situation of street food and the result shows that

street foods are found to be one of the most common risks associated with the increase in outbreaks of foodborne diseases in developing countries in recent years (WHO, 1996).

There are several documented cases of food poisoning outbreaks associated to street foods. Street foods are responsible for 691 food poisoning outbreaks and 49 deaths from 1983 to 1992 in Shangdong province. In 1988, 14 deaths are reported in Malaysia because of foodborne diseases related to street foods the same year 300 people become ill in Hong Kong after consumption of street vended foods (Bapat, 1992). In 1981 a cholera epidemic in Pune, India is linked to consumption of street vended juice. An outbreak of cholera in Singapore in 1987 is attributed to the consumption of street foods (Javed et al, 2016).

The main health hazard associated with street foods is microbial contamination, although pesticide residues, transmission of parasites, the use of unpermitted chemical additives, environmental contamination and limited access to safe water have also been identified as possible hazards (Abdussalam & Kaferstein, 1993). The potential for the contamination of street foods with pathogenic microorganisms has been well documented and several disease outbreaks have been traced to consumption of contaminated street foods (Arambulo et al, 1994). The risk of microbial contamination is dependent on the type of street food and how the food is prepared. Food risk is influenced by food type, pH, and method of preparation, water availability, handling, exposure temperature, and holding time (Mathee et al, 1996). In general, cereal and bakery products with low moisture content, products that have been adequately sugared, salted, or acidulated, and some fermented products are less likely to support bacterial growth as opposed to dairy, egg, and meat products. A food that is cooked immediately prior to consumption is safer than those which have been cooked and stored at ambient temperature. Other factors implicated in causing microbial contamination include poor food preparation and handling practices, inadequate storage facilities, the personal hygiene of vendors, and a lack of adequate sanitation and refuse disposal facilities (Arambulo et al, 1994). In most countries, in a study that investigated the microbial quality of street foods, *Shigella*, *Escherichia coli*, and *Salmonella* are the pathogens isolated from some food samples (Muleta & Ashenafi, 2001). In Ethiopia, a similar

study isolated *Bacillus* spp., staphylococci and micrococci as the dominant groups in some foods (Martins & Anelich 2000).

Much of the work done in South Africa has focused on the microbiological quality of street foods as health risk is related to the potential of food to support microbiological growth or the microbiological contamination (Mosupye & von Holy 1999), conducted a formative assessment on 200 street food vendors and 800 consumers in greater Johannesburg investigating the socioeconomic background of vendors and their customers, as well as vendors' facilities and aspects relating to the quality and safety including microbiological testing, of foods. The author found that street vendors do observe good hygienic practices in preparing, cooking and handling foods, even though they are not aware of the reasons for doing so (Mosupye & von Holy, 1999). Additionally, food is not kept overnight (a potential opportunity for contamination) due to the lack of refrigeration facilities. In 1997, Mosupye and von Holy compares the microbiological quality and safety of street foods involving 51 ready to eat street food samples taken in Johannesburg to those sampled and tested in other countries. The authors concluded that the bacterial counts in Johannesburg are lower than that of other countries.

The health risk from street foods may be no greater than that posed by foods or dishes from other sources such as in restaurants (Asambulo et al, 1994). Two studies conducted in India found that the microbial quality of street foods is equivalent to, if not better, than that of foods bought from hotels and restaurants (Bhat 1992). In South Africa, a comparative study found no significant difference between 116 formal and informal food vendors regarding microbiological food quality. With regard to potential risks, formal vendors had more vending experience, used some processed food preparation and had better hygiene practices. However, whilst food from the informal vendors is hot, food from formal food vendors tended to be cool and 73% stored leftovers for sale the next day, both of which are potential risks for microbiological contamination (Mathee et al, 1996).

2.3. Food safety Knowledge, Attitudes and Practices (KAP)

According to (Rane, 2011) the poor knowledge and improper food handling of street vendors in basic food safety measures and poor knowledge and practices among consumers on the potential hazards associated with certain foods could explain the health and safety issues that street foods may pose.

Knowledge, attitude and practice of the street food vendors towards food safety have a crucial impact on food safety. In addition to this is the fact that street food vendors are often unlicensed, untrained in food hygiene and sanitation and work under crude unsanitary conditions (Bas, 2004). According to the WHO, street food vendors in most developing countries should be educated as they are currently not sufficiently organized and responsive to undertake the responsibility of their own trade (WHO, 1996). Food vendors should be adequately educated on the role of food in disease transmission as well as on rules of personal hygiene and approved practices in handling street food. According to the WHO, education of food handlers and consumers is considered as an effective strategy for reducing foodborne illness and economic losses associated with foodborne diseases (WHO, 1996).

A study to assess knowledge, attitudes, and behavior concerning food borne diseases and food safety issues amongst formal food handlers conducted in Italy found that the majority of food handlers who had attended a training course had knowledge and a positive attitude toward food borne diseases control and preventive measures (Kasrua, 2002). The positive attitude is not supported when asked about reported behaviors and when observed during food preparation for practice of hygienic practices. This is on the basis that only 21% used gloves when touching raw, unwrapped food. Predictors of the use of gloves are educational level and attending training courses. The authors suggested that emphasis should continue on improving knowledge and control of food borne diseases amongst food handlers (Kasrua, 2002).

In Malawi, a study on the KAP on food hygiene of caregivers also showed a poor relation between knowledge, behavioral and sanitary practices, as swabs from caregivers' hands and food tested positive for coliforms and E Coli (Mukhola, 1998).

Furthermore in a study conducted in Mauritius on 50 street food vendors, it is reported that despite the efforts of Health Inspectors in promoting the risks of poor hygiene practices, and an awareness of hygienic conditions, the majority are not putting their knowledge into practice as they perceived their products to be of low risk (Sukratty et al, 2004). The authors attributed this to lack of knowledge and recommended a need to strengthen the educational programme. In assessing the factors influencing the safety and quality of street food in a rural area in Limpopo examined the knowledge, attitude and perceptions in both street food vendors and consumers. Her findings indicated that the majority of street food vendors and consumers had little information regarding the proper preparation and storage of food as well as environmental conditions that may be detrimental to health. Furthermore 64.4% of consumers thought that street food is sold under unacceptable conditions and these needed improvement (Sukratty et al, 2004).

According to (WHO, 1996) food handlers play an important role in ensuring food safety throughout the food production chain. In particular, food vendors who have poor handling practices or disregard hygienic practices may increase the risk of pathogens coming into contact with foods. These pathogens in some cases can survive and multiply to numbers sufficient to cause illness in consumers. Several studies conducted to assess the quality of street foods in several countries have indicated that street foods are positive vectors of foodborne illnesses (Harakeh et al, 2005). This is mainly explained by the poor practices on hygienic measures associated with the production and vending of street foods. As an example most of the vendors arrange both raw and cooked food items together, a consequence of which is an increased risk of cross contamination. In addition, the hands are the most important vector for the transfer of organisms from faces, nose, skin or other parts of body to food (WHO, 1996). Moreover, food handlers can contaminate food either passively or actively. The biological hazards may be introduced from a sick handler, from organisms on the food handler's skin or faces, from their respiratory tract or by cross contamination after handling raw materials (WHO, 1996).

Physical hazards may be introduced by food handlers wearing jewelry, bandages or by careless food handling practices (WHO, 1996). Furthermore, street food vendors have frequently been considered to use improper food preparation and selling practices

(Harakeh et al, 2005) In particular, previous studies in some developing countries have highlighted the lack of clean (potable) water at vending sites resulting in hand washing often being done in buckets of water (without soap); waste water and garbage are discarded in the streets, which provides food for insects and rodents; food material is usually not effectively protected from dust and flies which may harbour harmful pathogens; and safe food storage is difficult to maintain (Ekanem, 1998). In lower middle income countries including Vietnam, preparing and processing street foods is often done by traditional methods using kitchen utensils which are produced by handmade bamboo or wood without any quality control. Instead, vendors should be motivated by government to replace the traditional utensils by modern plastic or stainless steel utensils.

Many studies have reported that schooled street vendors with higher education levels had a positive impact on food hygiene practices. On the other hand, vendors with a high income may be less attentive to their hygiene practices in that the greater earnings, the more time they tend to spend on their sales and customers. Therefore, education and training of street food vendors can contribute to a marked improvement of their food handling practices, which may be the most effective way to reduce the incidence of food-borne diseases by contaminated street vended foods (Guisen et al, 2010). Some studies have revealed that although vendor training in good practices in food hygiene by local authorities was widespread, most vendors do not translate acquired basic hygiene knowledge into safe food practices (FAO, 2013). This lack of translation of acquired knowledge has been explained the fact that there are usually large numbers of small street food units which need to be attended to by the local authorities, the low educational level of the majority of street food vendors and their generally poor knowledge of good practices in food hygiene; and the crude conditions under which the vendors often operate. In some cases, street vendors may completely ignore basic food hygiene practices but consumers probably do not pay much attention to demand safe food (Edema & Omemu, 2004). In addition, as one of the major factors contributing to unhygienic practices among street food vendors is the absence of sanitary amenities at vending sites. Therefore, it is urgently required to redesign and organize street food stalls

following sanitary guidelines combined with vendor training and consumer sensitization programs so that a sufficient provision of food safety and nutritional quality of street foods can be ensured (WHO, 1996). Therefore, the street food sector deserves official attention from local authorities in developing countries regarding to planning, investments, regulations and education. Furthermore, local governments need to provide support for street vendors with regards to adequate infrastructure in terms of well designed vending structures, water supply, toilet facilities and waste disposal facilities. It is emphasized that the availability of safe and clean water plays as a crucial and vital contribution to reduce foodborne disease associated with consumption of street vended foods, whilst education plays as a potential strategy to improve the safety of street vended foods. In conclusion, food safety training to the street vendors and consumers as well as develop food safety strategies, procedures and guidelines should be given by local governments in collaboration with academia to minimize the problems associated with street vended food contaminations in urban poor recently.

Studies on street foods have highlighted a number of food safety problems and issues. Most of people involved in the preparation and vending of street foods have low levels of education and little or no knowledge of good hygienic practice and preparation of food and delivery to the consumers (WHO, 1996; FAO, 2000).

The study conducted in Bahir Dar (Angaw, Kibret & Abera, 2015) showed that, street food vendors practiced minimal hygienic and sanitary practices. Based on their observation, about 75% of the vendors interviewed prepared their foods in unhygienic conditions, 70% of the vendors did not use aprons, 42.5% had long nails and 77.5% had not covered their hair. According to (Angaw, Kibret and Abera, 2015), majority of the fried fish samples had shown an increase in unacceptability limit of AMES and S. aureus (36.67%- 76.67% and 35% 65%), that of Sambusa samples were within unsatisfactory limit ranges (70% to 75% respectively). Other studies which were conducted in Gondar revealed that 64.3% of the food samples were contaminated with one or more bacteria. The isolates were S. aureus accounts 29 (53.7%) and E. coli 25 (46.3%) and the level of aerobic mesophilic counts ranged from 1.10×10^5 to 6.1×10^6 CFU/g. so study indicates that the probability of street foods contamination was high in Gondar town.

Similar study conducted in north Gonder showed two bacterial species, Staphylococcus aureus and Escherichia coli were mainly isolated. S. aureus was isolated from all 32 samples while E.coli was isolated from 28 and total Staphylococcal count ranged from 1.3×10^3 CFU/g to 1.3×10^5 CFU/g.

Generally Justification of the study showed that Food borne diseases represent a major concern in the above mentioned places and Bahir Dar is no exception. Although Very little is known about street food consumption in the city. There were no specific studies that have been performed in Bahir Dar especially in Ambasha, Bonbolino and Chips. As a result the microbial quality of majority street vended foods in Bahir Dar is still unknown and until now no study has been done to evaluate their safety. So this study is crucial to gain more information on the attitudes, knowledge, practices and microbial safety of the food handlers in Ethiopia, various street foods have been reported to carry aerobic mesophilic bacteria, total coliforms, Staphylococcus aureus (Mogessie, 1995). Even if several literatures clearly states the situations and challenges prevail in Ethiopia, where food safety issues are not well understood and have received little attention. In addition there is limited information on the microbial load and safety of street foods in Bahir Dar.

3. MATERIALS AND METHODS

3.1. Study Design and Period

A cross-sectional method of study was conducted in Bahir Dar city which is located in west Gojame zone, in Amhara National Regional State from March 14, 2016 to June 12, 2017 G.C.

3.2 Study Areas

This study was conducted in Bahir Dar city which is located in west Gojame zone, in Amhara National Region State, in northern west part of Ethiopia, at a distance of 565 km from Addis Ababa. It has a population of 221,991 (CSA, 2007) people with a land area of 28 km². Popularly vended street foods in Bahir Dar include local snacks like Sambussa, Ambasha, fish, Bonbolino, potato chips and others many.

Figure 1: Bahir Dar city Map

3.3. Source and Study population

3.3.1. Source population

All street vended foods and vendors that are found in Bahir Dar city was considered as the source population

3.3.2. Study population

Selected street vended foods and vendors in Bahir Dar city is considered as the study population. The person in charge of the vending points (referred to as the vendor) was the main subjects of study

3.4. Study Design

The study is conducted using a descriptive cross-sectional quantitative method data collection. A descriptive study design uses quantitative method to describe the knowledge, attitudes and practices of street food vendors was used. Besides, this study is also conducted microbiological laboratories to assess indicator and pathogenic microorganisms in selected food items.

3.5. Inclusion and exclusion

3.5.1. Inclusion criteria

A street food vendor who is working in Bahir Dar city and willing to give informed consent were included in the study.

3.5.2. Exclusion criteria

Street food vendors who are working in Bahir Dar city and not willing to give informed consent are excluding from the study.

3.6. Sampling and Sample size determination

The target study sample for this study was determined following the appropriate sampling strategy for a cross-sectional study that is enough to be able to draw valid conclusions and adequate reflection of the study population.

Among 174 street food vendors identified during the preliminary assessment, a total of 160 food vendors only for the selected food items (32 Vendors from each food item widely sold in the street namely: fried fish, Sambussa, potato chips, Ambasha and Bonbolino) operating in the major streets and open air market were selected using simple random methods.

The total sample size of the items determine by the formula of an online software epitools.ausvet.com.au. Where; N=the desired sample size for target population > 10,000, Z = normal standard deviation corresponding to 95% confidence interval, that is 1.96, P = Proportion of the population estimated to have desired characteristics, $d=$ degrees of accuracy desired (0.05). Even though, this study employed a p value of 20% as used in a similar study in Ethiopia (Muleta & Ashenafi, 2000) The samples sizes were calculated as follows. The population under study was <10,000 and hence an online Cochran 2000 formula was further employed to calculate the actual sample size, since a preliminary survey done in areas revealed that the population of interest was a total of 384.16. Generally, an online software epitools.ausvet.com.au was used with a desired precision of 0.025, and 95% confidence interval.

$$n = (Z^2 * P (1 - P)) / e^2$$

Where:

Z = value from standard normal distribution corresponding to desired confidence level (Z=1.96 for 95% CI)

P is expected true proportion

E is desired precision (half desired CI width). For small populations n can be adjusted so that $n_{adj} = (N * n) / (N + n)$.

$$n_{f} = n / (1 + n/N)$$

Where N= population size

n= Sample size if N is infinite (N > 10,000)

n_{f} = Sample size if N is finite (N < 10,000)

$$= 245.86 / (1 + 245.86 / 384.16)$$

$$= 157$$

3.7. Data collection

3.7.1. KAP Data Collection

The questionnaire that was used in this study was adopted from Angelillo, et al. (2001), Bolton et al. (2008) and Ansari et al. (2010). The same questionnaire was also used in a previous study made in the municipal schools of Camacari, Bahia in the northeast of Brazil (Soares et al., 2012) and that of observation checklist was used to assess the food safety practices of street food vendors. The checklist was a combination of different checklists used in previous studies (Chukuezi, 2010; Dirks, 2010; Muinde and Kuria, 2005). The questionnaire was prepared in English and then translated to Amharic which is the local language of the study participants. An informed consent was obtained for the willingness of food vendors to participate in the study. KAP data was collected through face-to-face interviewing of street food vendors using structured questionnaire contained several questions including: socioeconomic and demographic characteristics of the respondents, Food safety, health and personal hygiene KAP of vendors. A 3-point scale (correct, wrong and do not know) was used to assess the food safety knowledge and attitude of street food vendors. Observations using checklist were used to collect data on facilities & observed food safety practices of street food vendors related to food hygiene and safety. Some critical elements to food safety and hygiene were listed on the observation checklist as part of the questionnaire. A 2-point scale (Yes or No) was used to assess the practice of the vendor towards food safety of street food vendors. Finally the KAP data was ranked into three categories namely poor, average and good by Bloom's formula as explained below.

The overall KAPs of the study participants were assessed using the sum score of each outcome based on Bloom's cut point. Having a score above the cut point was equated with having high levels of knowledge, positive attitude and good practice as follows: Knowledge grading using 18 questions, A correct answer will give 1 score and 0 score for wrong answer. The scores vary from 180 points and will classify into 3 levels as follows: Bloom's cut off point, 60%.

Scores Descriptions 1418 (80-100%) High levels, 813 (60-80%) Moderate levels, 7 (Less than 59%) was considered as low levels. Attitude was graded using 12 questions, Individuals who will respond to 12 statements are a Likert's scale which include both positive and negative. The rating scale will be measured as follows: 1 correct, 2 wrong and 3 do not know.

The scores will be classified into 3 levels Positive attitude scores (80%), Neutral attitude scores (60-80%) and Negative attitude scores (Less than 59%)

3.7.2. Microbiological Data Collection

To assess microbiological quality of the street foods samples were randomly collected and analyzed in the Microbiology laboratory of Bahir Dar Institute of technology according to the food and agricultural organizations (FAO, 1997) and food and drug administration's FDA's Bacteriological Analytical Manual (BAM, 1998). The standard microbiological methods suggested technique by FDA was employed in order to enumerate, isolate and identify different bacterial species. Since this method (BAM, 1998), manual is a practical handbook for the analysis of foods for microbiological indicator of quality and contamination. Its ultimate aim is to assure that a microbiological laboratory produces reliable high quality analytical results using analytical methodology which has been shown to be accurate, reproducible and effective operation of microbiological laboratories.

Sample Collection and Transportation

Food sample collection and transportation was carried out according to the following standard procedures (Mackie and Mac Cartney, 1989). A study sample (Street vended foods) was purchased from the study places and study participants as displayed for sell for consumers. The food items (32 samples from the five selected foods namely: Sambusa, Ambasha, fish, Bonbolino and potato chips) were collected one by one in a clean, dry, sterile aluminum foil using sterile hand forceps and a single forceps was used for each sample. The samples was wrapped tightly one by one to avoid contact with one another so that to prevent any external contaminations then each sample was labeled with information written over sticky plaster.

The information includes the type of the food, the name of the sampling place, date and time of the sampling and identification number. Care was taken to avoid the label damage during transporting the sample. The labeled samples were then stored in sterile ice boxes at 1-4°C and transported by Bajaj within 4 hrs for the laboratory processing in a condition microbiologically unchanged from that existing at the time of sampling (Mackie and Mac Cartney, 1989). Upon arrival to the laboratory the samples were dispatched and analyzed immediately to determine the bacterial profile of the street foods following aseptic sampling techniques and analysis procedures.

Microbiological Enumeration, Isolation and Identification Procedure

Upon reaching the laboratory, the purchased ready-to-eat street vended food was aseptically collected using sterile forceps. A weighed sample of food (10g) by digital Balance (Balance, Heraeus) from each sample was homogenized in a measured volume of diluents (90 mL) buffered peptone water to give a 1:10 homogenate. A 1:10 sample suspension was prepared by mixing one part of sample with nine parts of diluents and then sample suspension was prepared in a peristaltic homogenizer (Stomacher 400, UK). Then, the serial dilution was made up to 10^{-5} using test tubes. After mixing each tube, 0.1 ml suspension was transferred and spread on to a sterile plate count agar (PCA) in duplicate for total Aerobic plate count and to MacConkey agar (MAC) for *E. coli*, Mannitol salt agar (MSA) for *S. aureus* and PDA for yeast and molds (Hanashiro et al, 2005). All media for culture and bacterial count was prepared according to the manufacturer's instruction as follows for each parameter:

Total plate count: Total plate count was determined according to Food and Agriculture Organization of the United Nations (FAO, 1997). The process is 10gm of each food type was added in to 225ml of different flasks containing each sterile 0.1% (w/v) peptone water and shaken for 2 minute using shaker (STUART, UK) in stomacher bag, to prepare initial (10^1) homogenate dilution. Further dilution was made through transfer of 1ml of the 10^1 food homogenate in to test tube containing 9ml of sterilized 0.1 % (w/v) peptone water to prepare dilution up to 10^{-5} . One ml of the last three dilutions (10^3 , 10^4 , & 10^5) was dispensed on to sterilized Petri plate in duplicate.

20 ml of sterile molten plate count agar that was tempered to 49°C was added to each Petri plate and mixing was taken place using pour plate technique. The plates were then incubated at 37°C for 48 h. Then colonies were counted using colony counter SC6 (ENGLAND) device that allows viewing of individual colonies. For solid products the counted plate colony counts were reported as CFU/g for liquid products as CFU/ml. The method used was:

$$X = (A \cdot V) / I$$

Where X = Colony Forming Units (CFU) per g or ml of products,

A = Numbers of colonies,

V = Reciprocal of dilution factor and

I = Inoculum volume (ml)

Colonies beyond 300 per plate was considered as too many to count and colonies less than 30 per plate was considered as too few to count.

Coliform count Total Coliform count was determined according to FDA's Bacteriological Analytical Manual (BAM, 1998). The process is 10gm of each food type was added in to 225ml of different flasks containing each sterile 0.1% peptone water shaken for 23 minute using shaker (STUART, UK) in a stomacher bag, to prepare initial 10⁻¹ food homogenate. Further serial dilution (10⁻², 10⁻⁴, and 10⁻⁵) was prepared as above, then 1ml from each dilution was added into duplicate Petri dishes containing 20 ml of the VRBA tempered to 48°C. then it was incubated 35 for 24hrs. After presumptive test for total coliforms was carried, 5 presumptive colonies were selected and inoculated each colony into a tube of BGLB Broth containing an inverted Durham fermentation tube. BGLB tubes were Incubated at 37 for 24- 48 hours and examined for gas production. The numbers of tubes which show gas formation from each dilution were recorded and finally coliforms were calculated.

Detection of Escherichia coli Suspected colonies of the fecal coliform were confirmed in E.C Broth at 44°C for 24 hours with the production of gas, after which one loop of the positive tube were transferred into Tryptone water and incubated at 44°C for 48 hours 3 drops of Kovacs reagent was added to the test culture and observed for any reaction.

Formation of red colour indicated a positive reaction, thereby confirms the presence of *Escherichia coli* and recorded those organisms producing red ring as indole positive. Presence of a red ring on the surface of the tube with gas production denoted presence of indole hence confirming the presence of *E. coli*.

Staphylococcus aureus was determined according to the standard of FDA's Bacteriological Analytical Manual (BAM, 1998). *S. aureus* were isolated from 10gm homogenized samples in 225ml of 0.1% sterile peptone water. Further dilutions of 10^2 , 10^3 and 10^4 were made as mentioned above from the food homogenate. One ml of each 10^2 , 10^3 and 10^4 serial dilution were dispensed on to sterilized Petri plate in duplicate. Sterile molten Manitol salt agar which is tempered to 48 °C was poured to each Petri plate and spread evenly over the surface. The plates were then incubated at 37°C for 48 h. Yellow to orange colonies surrounded by yellow zone due to Manitol fermentation were counted using colony counter (BIO-RAD) and recorded as colony forming unit per gram (cfu/g) of the food items. Five of these yellow color colonies were purified and transferred to nutrient agar (MERCK) slant for further biochemical tests. All biochemical tests were performed after gram staining.

Yeasts and moulds counts From the serial dilutions, 0.1 ml aliquot was spread on presolidified surfaces of Potato Dextrose Agar (Oxoid) and incubated at 25°C for 5-7 days (Spencer et al., 2007). Smooth (hairy) colonies without extension at periphery were counted as yeasts whereas hairy colonies with extension at periphery were counted as moulds. In addition test parameters on common foodborne pathogens including *Salmonella*, *Shigella* and *Listeria monocytogenes* which have been frequently associated with street foods were considered to perform however, it was not possible to conduct more tests due to lack of selective media and specific biochemical test reagents in the laboratory.

3.8. Data Analysis

The data entry was done immediately after completion of data collection. The collected data was checked, verified and then entered into SPSS (Statistical Package for Social

Science), version 20.0 for analysis and then percentage, frequency, mean and range of results were displayed using descriptive statistics.

3.9. Ethical Considerations

Approval of this study was obtained from the program of food technology in the faculty of chemical and food engineering, Bahir Dar institute of technology.

Individual consent was obtained from the study participants before the questionnaires were administered, and before food samples were collected. The attached consent form was read in the local language for the vendors and a copy of it was given to them upon request. Selected vendors for study were informed on the general purpose, possible risks, and benefits of the study in Amharic language. Participation in the study was voluntary. To ensure confidentiality, participants' data was linked to code numbers and registered. A participant was told that they have the right not to answer any of the questions, terminate the interview, and also the right not to give a food sample if they are not comfortable.

4. RESULTS AND DISCUSSIONS

4.1. Food safety knowledge and attitude results

The demographic characteristics of the 160 street food vendors who participated in this study are shown in Table 1. The majority of the street food vendors who participated in the study was women 93.8% (n=150/160). The same findings have been observed in other studies conducted in Gondar (Derbew, Sahle & Endris, 2016), Keja (Muinde & Kuria, 2005) and Nigeria (Chukuezi, 2010). This shows that as street foods are occupied by females. The educational background of the street food vendors in Bahir Dar is somewhat similar to those described for street food vendors in Nigeria (Chukuezi, 2010).

Based on education, 6.9% (n=11/160) vendors had no proper education or they are illiterates while majority of them 80% (n=128/160) had a primary education. And only 11.9% (n=19/160) of the vendors obtained secondary school certificate, only 1.3% of the participants obtain college or university certificate. The low education levels could with poor hygiene practices during handling and storage of foods which can intern increase the risk of street food contamination in Adama (Misrak & Sintayehu, 2016). All 160 of the street food vendors do not have any food safety training. Other findings have shown that even lower levels of trained street food vendors including those in (Chukuezi, 2010).

Table 1: sociodemographic characteristics of street food vendors in Bahir Dar city

Characteristics	number	Percent (%)
Sex		
male	10	6.3%
female	150	93.8%
age		
15-25	17	10.6%
26-35	95	59.4%
36-45	42	26.3%
46-55	6	3.8%
Education		
Illiterate	11	6.9%
Primary Education	128	80.0%
high school Education	19	11.9%
University	2	1.3%
Training		
Yes	0	0
no	160	100%

The individual results of the assessment to determine the food safety knowledge of the street food vendors is presented in Table 2. Results show that the majority of the street food vendors do not know that hepatitis A (93.8%, (150/160), Salmonella 77.5% (124/160) and S. aureus 98.1% (157/160) are food borne pathogens. In similar the study conducted in Brazil (Soares et al, 2012), street food vendors were unable to identify these foodborne pathogens

Nevertheless, nearly the majority of the vendors (69.4%, (111/160) know that bloody diarrhea can be transferred through food. Somewhat higher percentage of the vendors 66.3% (106/160) says that AIDS can be transmitted by food. 88.8% (142/160) of the vendors also understand as they should leave from work when infectious diseases of the

skin are happen and 11.3% (18/160) of the vendors recognized that microbes could be found in the skin, nose and mouth of healthy handlers.

In the same way 32.5% (52/160) of the vendors do not know that abortion could be induced by foodborne diseases. Furthermore some of the street food vendors are aware of the importance of washing hands 71.3% (114/160), proper cleaning 45.6% (73/160) and the use of gloves 65% (104/160) in the prevention of foodborne diseases.

Table 2: Assessment of the food safety knowledge of street food vendors

Questions	Number of respondents (%)		
	Correct	Wrong	Do not Know
abortion in pregnant women can be induced by foodborne disease	77(48)	319(9.4)	52(32.5)
Bloody diarrhea can be transmitted by food	111(69)	12(7.5)	37(23.1)
During infectious disease of the skin, it is necessary to take leave from work.	142(88.8)	14(8.8)	4(2.5)
Eating and drinking in the work place increase the risk of food contamination	70(43.8)	76(47.5)	14(8.8)
Hepatitis A virus is a foodborne pathogens	8(5.0)	2(1.3)	150(94)
Microbes are in the skin, nose and mouth of healthy handler	18(11.3)	60(37.5)	82(51.3)
Salmonella is among the foodborne pathogens	8(5.0)	28(17.5)	124(78)
Staphylococcus is among the foodborne pathogen	2(1.3)	1(.6)	157(98)
Typhoid fever can be transmitted by food	52(32.5)	55(34.4)	53(33.1)
Using gloves while handling food reduces the risk of food contamination	104(65)	32(20.0)	24(15.0)
Washing hands before work reduces the risk of food contamination	114(71)	24(15.0)	22(13.8)

Children, healthy adults, pregnant women and older individuals are at equal risk for food poisoning	91(56.9)	27(16.9)	42(26.3)
Food prepared in advance reduces the risk of food contamination	111(69)	25(15.6)	24(15.0)
Proper cleaning and sanitization of utensils increase the risk of food contamination	38(23.8)	73(45.6)	49(30.6)
Reheating cooked foods can contribute to food contamination	91(56.9)	43(26.9)	26(16.3)
washing utensils with detergent leaves them free of contamination	45(28.1)	97(60.6)	18(11.3)

The Overall food safety knowledge level of street food vendors in Bahir Dar City are shown in Table 3. It is noticeable that the mean knowledge score of the Vendors was (95% (CI= 44±9.9), which shows that the participated vendors in the city had poor (unsatisfactory) food safety knowledge level as they obtained scores less than 60. However, it can be seen that (8.1%) of the street food vendors had a moderate food safety knowledge levels as they obtained scores between 60 and 80.

In addition, the range of scores varied considerably between 17 and 72 when compared to previous studies in Malaysia (Rosnani et al, 2014). The vendors in Bahir Dar had much lower food safety knowledge levels. However, the study conducted in Vietnam shown that mean food safety knowledge score of 60, which were higher than that of Bahir Dar.

Table 3: Average Level food safety knowledge of street food vendors

Levels of knowledge	Ranges	
	Number	Percent
High level of knowledge	0	0
Moderate level of knowledge	13	8.1
low level of knowledge	147	91.9
Total	160	100.0

The results of the survey on the food safety attitudes of the street food vendors in Bahir Dar city are shown in table 4. The mean food safety attitude score (56 ± 14) of the vendors were found in average ranges since it had score of 70. This indicates that the food vendors have average food safety attitudes or an adequate understanding of food safety.

Even a medium proportion of the vendors (31.3%) had neutral food safety attitude as it had a scores >60 (= at least an adequate understanding of food), whilst (63.8%) had poor food safety attitudes or a poor understanding of food safety (scores <60) and only 5% had a good attitude towards food safety (scores >80).

Table 4: Average food safety attitudes level of street Food Vendors

Levels of attitude	Ranges	
	Number	Percent
positive attitude	8	5.0
Neutral attitude	50	31.3
Negative attitude	102	63.8
Total	160	100.0

The mean food safety attitude scores of the vendors surveyed in this study was slightly higher than that of those surveyed in Malaysia (mean score = 18.5), Turkey (mean score = 44.2) (Rosnani et al, 2014), however, it was lower than that reported in Haiti (mean score = 73). Some studies have reported that trained handlers have a higher food safety attitude compared to untrained food handlers (McIntyre, 2013) so training has a great impact on attitude of the vendors.

Tables 5 shows that Majority of the street food vendors (47.55% (76/160)) was able to identify wearing masks as an important practice to reduce the risk of food contamination.

The bottom most percentage of wrong answers (16.9%) was observed for the question concerning Raw and cooked foods should be stored separately to reduce the risk of food contamination.

In contrast with the findings of other studies conducted in Ghana (Donkor et al, 2009) and South Africa (Liu, Zhang & Zhang, 2014), a high percentage of the street food vendors (60.6%) who participated in this study was aware of the importance of Wearing gloves is an important practice to reduce the risk of food contamination in order to prevent foodborne diseases. 16.9% of the vendors did not separate raw, partial and cooked food products whilst only 53.1% kept previously cooked foods in refrigerators for vending in the following days.

Table 5: Food safety attitudes of street food vendors

Questions	Number of respondents (%)		
	Correct	Wrong	Do not Know
Proper hand hygiene can prevent foodborne disease	81(50.6)	46 (29)	33(20.6)
Raw and cooked foods should be stored separately to reduce the risk of food contamination.	113(69)	27(16.9)	20(12.5)
It is necessary to check the temperature of refrigerators, freezers periodically to reduce the risk of food contamination	85(70.6)	43(26.9)	32(20)
The health status of workers should be evaluated before employment	79(49.4)	46(28.8)	35(21.9)
The best way to thaw a chicken is in a bowl of cold water	100(63)	49(30.6)	11(6.9)
Wearing gloves is an important practice to reduce the risk of food contamination	97(60.9)	41(25.6)	22(13.8)
Wearing caps is an important practice to reduce the risk of food contamination	91(56.9)	48(30.0)	21(13.1)
Dish towels can be a source of food contamination	94(58.8)	46(28.8)	20(12.4)

Knives and cutting boards should be properly sanitized to prevent cross contamination	81(50.6)	40(25.0)	39(24.4)
Food handlers who have abrasions or cuts on their hands should not touch foods without gloves	78(48.8)	40(25.0)	42(26.3)
Well-cooked foods are free of contamination	93(58.1)	61(38.1)	6(3.8)

As indicated in Table 6 only 2.5% (4/160) street food vendors were clean and proper uniform wearing including shoes. Similar observations were reported by Muinde & Kuria, 2005) and (Muleta & Ashenafi, 2001), in studies conducted on street foods in Nairobi (Kenya) and Addis Ababa, respectively. Lack of proper wearing may give a chance for different types of pathogens to introduce to the prepared foods, leading to transfer of pathogens from human body and environment into foods (Rane, 2011).

Regarding the hygienic condition surrounding the street food vendors 101 (63.1%) of the street food vendors have not garbage containers and kept covered. Similarly, studies performed in Kenya (FAO, 2010) and Mauritius (AF, 2010), reported that 93% and 78% of the vendors did not have garbage containers and kept covered respectively hence they dispose their garbage just near the street (Subratty et al, 2004), but, according to the FAO, the place of food preparation should be kept clean at all times and should be far from any source of contamination such as rubbish and (FAO, 1995). As a result, this dirty environment attracted flies, which are not only an indication of poor hygiene and sanitary conditions, but also vectors of fecal pathogens. A proper garbage collection and disposal facility was also found to be lacking in a study performed in Nairobi, Kenya (Muinde & Kuria, 2005). In order to decrease the risk of contamination of prepared food and potable water, sufficient drainage and waste disposal facilities should be installed properly in the street food vendors (FAO/WHO, 1999).

In this study more than half 71.9% (115/160) of the vendors did not wash their hands before handling, preparing & serving foods and the vendor was observed to predominately have poor levels of personal hygiene. Although (WHO, 1999),

recommend food should be preferably handled with clean tongs, forks, spoons or disposable gloves. 81.9% (131/160) of the vendors handled Food without suitable utensils, such as single use gloves or tongs and 99.4% (159/160) did not apply any Procedures in place to prevent cross contamination. Only 24.4% (39/160) of the observed vendors make Food equipment utensils, and food contact surfaces are properly washed, rinsed, and sanitized before every use. These findings were in agreement with those of studies performed in India (Rane, 2011), Uganda (Muyanja, 2011), Kenya (Muinde & Kuria, 2005) and Addis Ababa (Muleta & Ashenafi, 2000). Lack of proper hand washing during food preparation, serving and handling may contribute to the occurrence of food borne pathogens. According to the FAO, the hands are a crucial factor in the contamination and spreading of fecal transmitted bacteria; therefore, this risk greatly enhances when food is handled with bare hands (FAO, 1999). According to the FAO's guidelines for handling street foods in Africa, clean tongs, forks, spoons or disposable gloves should be used regularly when handling serving or selling food (FAO/WHO, 1999).

Almost all of the vendors 97.5% (156/160) did not cover their hair and in comparison to these results (Chukuezi, 2010) reported better food safety practices in Nigeria as 52% of the food handlers in that study did not cover their hair while 19% wore uncovered jewelry while serving food so favorability for contamination of street foods due to improper hygiene in Bahir Dar is high.

A large proportion 64.4% (103/160) of the vendors observed did not to cover their utensils. Utensils in which the food is displayed for sale must be kept clean, covered and protected as they easily become contaminated (FAO, 1995) and others like (Arambulo et al, 1994) also recommended that foodstuffs of all kinds should be kept covered to prevent contamination from dust and flies. It can be generalized that street foods that are sold in Bahir dar city are under unsafe conditions as it consisting of the dirty open air environments in which the foods compounded by poor food handling practices and often inadequate storage conditions. The condition of the food environment plus the poor food safety KAP makes street foods a public health concern.

Table 6: Facilities and observed food safety practices of street food vendors in Bahir dar city

Observation check list items	Observations %	
	Correct	Wrong
Personal Hygiene		
Vendors wear clean and proper uniform including shoes	3(1.9)	157(98.1)
Effective hair restraints are properly worn.	97(60.6)	63(39.4)
Fingernails are short, unpolished, and clean (no artificial nails).	97(60.6)	63(39.4)
Jewelry is limited to a plain ring, such as wedding band	75(46.9)	85(53.1)
Hands are washed properly, frequently, and at appropriate times.	45(28.1)	115(71.9)
Eating, drinking, and chewing gum are allowed only in designated areas	56(35.0)	104(65.0)
Vendors use disposable tissues when coughing or sneezing and then immediately wash hands.	67(41.9)	93(58.1)
Vendors appear in good health.	108(67.5)	52(32.5)
All food stored or prepared in facility is from approved sources.	19(11.9)	141(88.1)
Food equipment utensils and food contact surfaces are properly Washed, rinsed, and sanitized before every use	39(24.4)	121(75.6)
Food is tasted using the proper procedure.	3(1.9)	157(98.1)
Procedures are in place to prevent cross contamination	1(.6)	159(99.4)
Food is handled with suitable utensils, such as single gloves or tongs	29(18.1)	131(81.9)
Storage		

Clean reusable towels are used only sanitizing equipment and surfaces and not for drying hands, utensils or floor	0	160(100.0)
All food and paper supplies are stored at least 6 inches above the floor.	24(15.0)	136(85.0)
The FIFO (First In, First Out) method of inventory management is used	86(53.8)	74(46.3)
Food is protected from contamination.	52(32.5)	108(67.5)
All food surfaces are clean.	41(25.6)	119(74.4)
Food is stored in food grade container.	49(30.6)	111(69.4)
Cleaning and Sanitizing		
Water is clean and free of grease and food particles.	143(89.4)	17(10.6)
Water temperatures are correct for washing and rinsing	1(.6)	159(99.4)
If heat sanitizing, the utensils are allowed to remain immersed in 171 °F water for 30 seconds	0	160(100.0)
If using a chemical sanitizer, it is mixed correctly and a sanitizer strip is used to test chemical concentration.	2(1.3)	158(98.8)
Small ware and utensils are allowed to air dry.	28(17.5)	132(82.5)
Wiping cloths are stored in sanitizing solution while in use.	1(.6)	159(99.4)
Utensils and Equipment		
All small equipment and utensils, including cutting boards and knives, are cleaned, sanitized, and allowed to air dry before use.	79(49.4)	81(50.6)
Work surfaces are cleaned and sanitized before use.	71(44.4)	89(55.6)

Drawers and racks are cleaned and sanitized before use		
Clean utensils are handled in a manner to prevent contamination of areas that will be in direct contact with food or a person's mouth.	57(35.6)	103(64.4)
Garbage storage and Disposals		

Garbage containers are clean and kept covered.	59(36.9)	101(63.1)
Garbage containers are emptied as necessary, but at least daily.	72(45.0)	88(55.0)
Boxes and containers are removed from site.	65(40.6)	95(59.4)

4.2. Microbial Quality

Table 7 Summarizes the Isolated bacterial species and their Mean bacterial count from the studied street foods in Bahir Dar City.

Table 7: Mean bacterial count of different street vended food items in Bahir Dar city (n=32)

Type of food	Mean bacterial count (CFU/g)			
	MTPC	MTCC	MSC	yeast & molds
Fried fish	3.8X10 ⁵	4.5X10 ⁵	3.7X10 ⁵	8.4X10 ²
Ambasha	3.6X10 ⁵	2.9X10 ⁴	2.3X10 ⁴	1.8X10 ³
Sambussa	2.35X10 ⁵	1.8 X10 ⁴	2.4X10 ⁴	No growth
Bonbolino	2.25X10 ⁵	2.9X10 ⁴	5.0X10 ³	1.7X10 ²
Chips	3.6 X 10 ⁵	3.2X 10 ⁴	2.23X10 ⁵	No growth

Foot note:

MTPC = mean total plate count

MSC = Mean Staphylococcal Count

MTCC= Mean total coliform count

Standards: Simple comparison using international standards was done according to the public health laboratory service guidelines for the microbiological quality of ready to eat foods (PHLS, 2000; NSW, 2012).

Total plate count: Good $<10^4$; Acceptable $<10^5$; Unsatisfactory $>10^5$

Total Coliform: Good $<10^3$; Acceptable $<10^4$; Unsatisfactory $>10^4$

S. aureus: Good $<10^2$; Acceptable $<10^3$; Unsatisfactory $>10^4$

The study showed that total plate count varied from 2.25×10^5 cfu/g - 3.8×10^5 cfu/g indicating that microbial load is above the limit. The Maximum count was found in Fried fish while the minimum value was accounted to Bonbollon. Similar studies conducted in north Gonder (Muhammad, 2016) showed that total plate count 2.1×10^5 cfu/g - 3.9×10^6 cfu/g which were above the limit or unsatisfactory. The aerobic plate count (APC) also referred to as the total viable count or the standard plate count performed indicated poor microbial quality and shelf life of these street food samples. In Addis Ababa and fried fish were highly contaminated with bacteria. This may be due to the method of handling, preparation and lack of proper cooking time. Because total plate count (when it is compared with the standard TPC = 5×10^5 which is above the limit) were unsatisfactory and as it is indicator for spoilage microorganisms. When it is compared to other researches, the total count was higher than the studies carried out on street food in Gondar and Addis Ababa (Derbew, Sahle & Endris, 2018; Muleta & Ashenafi, 2000) and other studies overseas like in Nigeria (Akusu et al, 2016).

The mean total Coliform count value ranges from 1.8×10^4 to 4.5×10^5 , the maximum value was in fried fish and the least encountered was in Samosas. These results again showed high Coliform load which is above the acceptable limit given by the guidelines for the microbiological quality of ready to eat foods (PHLS, 2000; NSW, 2012). These results were in contrary with the findings of Masan et al, (2017) reported $0.28 - 3.99 \times 10^3$ cfu/g for total Coliform in street foods conducted in Bangladesh.

High level of total Coliform implies that the street vended foods were linked to contamination resulted from inappropriate processing, incomplete heating, use of dirt

water during preparation and washing or secondary contamination via contact with contaminated equipments such as chopping boards, knives, and serving wares.

The total *Staphylococcus* count varied from 5.0×10^3 cfu/g to 3.7×10^5 cfu/g, the minimum and maximum value of count was encountered in Bonbolino and fried fish respectively. The maximum value which happened in fried fish was above the limits and the minimum value which was in Bonbolino was in acceptable limit according to the guidelines for the microbiological quality of ready to eat food (PHLS, 2000; NSW, 2012). In contrary the study conducted in Gonder town (Derbew, Sahle, & Endris, 2013) showed that 0.9 to 2.3×10^3 cfu/g which is unacceptable limit. This implies that the street foods is bare handled excessively during preparation, storage and stored openly in the air for long period of time after its preparation. Yeast & molds in these study varied from 1.7×10^2 cfu/g - 8.4×10^2 cfu/g. The Maximum value was enumerated in Fried fish while the minimum value was gotten in Bonbolino and no growth was happen in Sambussa and chips. .

4.2.1. Prevalence of isolates from street foods

Food samples were categorized into 3 depending on the number of colony forming units. Based on these 3 categories and the results obtained in this study, Sambussa samples, 17(53.13) were unsatisfactory (APC 10^5), and also interms of MSC the majority 23(71.84) of its proportion being unsatisfactory since *S. aureus* is $> 10^4$. In agreement with this study, Similar results was seen in a study conducted in jijjiga city ((Firew et al., 2014)) showed that 69.0 % of *S. aureus*. On the other hand for total coliform (62.5%) of the samples are in good and acceptable range according to the standard (PHLS, 2000; NSW, 2012). Studies conducted in Bahir dar relatively agrees on total plate count and *aureus* limits, which were majority of the Sambusa samples, were within unsatisfactory limit ranges 70% and 75% respectively (Angaw, Kibret & Abera, 2015)

Table 8: Number and percentage of good, acceptable and Unacceptable levels in Sambussa samples

Microbial parameters	Ranges		
	No (%) of good Samples	No (%) of Acceptable sample:	No (%) of Unacceptable samples
TPC	6(18.75)	9(28.12)	17(53.13)
MSC	8(25)	1(3.12)	23(71.84)
MTCC	18(56.25)	2(6.25)	12(37.5)

As shown in table 9 the conformity taste for Ambasha shows that, TPC and MSC 18(56.25) & 22(68.75) respectively are found in unsatisfactory ranges. On the other hand there were not Ambasha samples that found within good and acceptable limits for coliforms according to the standard (PHLS, 2000: NSW, 2012).

The results therefore indicate that the majority of the street foods sampled were prepared and sold under unhygienic conditions. This confirms in part the conclusions from the food handling practices study which showed that foods handled improperly under a high contamination levels.

Table 9: Number and percentage of good, acceptable and Unacceptable levels in Ambasha samples

Microbial parameters	Ranges		
	No (%) of good Samples	No (%) of Acceptable samples:	No (%) of Unacceptable samples
TPC	13(40.62)	1(3)	18(56.25)
MSC	7(21.87)	3(9.34)	22(68.75)
MTCC	11(34.4)	-	21(65.6)

From the following table, fried fish samples nearly half of the samples 15(46.88), 18(56.25) & 17(53.13) were unsatisfactory respectively for TPC, MSC and MTCC. However, fried fish samples 2(6.25%) & 5(15.63%) for TPC and MTCC respectively are in acceptable range according to the standard (PHLS, 2000: NSW, 2012).

Table10: Number and percentage of good, acceptable and unacceptable levels in fried fish samples

Microbial parameters	Ranges		
	No (%) of good Samples	No (%) of Acceptable samples	No (%) of Unacceptable samples
TPC	4(12.5)	13(40.63)	15(46.88)
MSC	12(37.7)	2(6.25)	18(56.25)
MTCC	10(31.25)	5(15.63)	17(53.13)

From the table11 shows that, TPS, MSC and MTCC majority of the Bonbolino sample were within unsatisfactory limit ranges of 47%, 56% and 53% respectively according to the standard (PHLS, 2000: NSW, 2012).

Table11: Number and percentage of good, acceptable and Unacceptable levels in Bonbolino samples

Microbial parameters	Ranges		
	No (%) of good Samples	No (%) of Acceptable sample	No (%) of Unacceptable samples
TPC	10(31.25)	5(15.63)	17(53.13)
MSC	8(25)	3(9.34)	21(65.63)
MTCC	12(37.5)	2(6.25)	18(56.25)

As shown in table12 the majority of the samples 59.4% & 62.5% respectively for MTCC and MSC are in unsatisfactory state range according to the standard (PHLS, 2000: NSW, 2012) and there are eleven too count too many samples.

Table 12 Number and percentage of good, acceptable and Unacceptable levels in chips samples

Microbial parameters	Ranges		
	No (%) of good Samples	No (%) of Acceptable sample:	No (%) of Unacceptable samples
TPC	6(18.75)	1(3.13)	14(43.75)
MSC	9(28.13)	3(9.34)	20(62.5)
MTCC	12(37.5)	1(3.1)	9(59.4)

* = 11 TPC samples were too many to count in chips samples

As shown in table 13 Escherichia coli have been used as indicators of possible post processing contamination and the presence of E. coli in street foods almost always indicates as there was a recent fecal contamination.

Escherichia coli were identified in majority street food samples. This indicates that Escherichia coli are the most predominant bacteria in selected food items. The hands of the food handlers are the most important vehicle for transfer of organisms from feces, nose and skin to the food. As a result the food, food related materials, skin, clothes, displaying sites and other materials which are related with poor hygiene condition can be contaminated. Besides, some of the foods are held in the pans in which they are cooked, until sold or reheated, which results in longer holding time, hence creating favorable conditions for the growth of food borne pathogens. The predominance of the E-coli in street food was also supported with other studies in Bangladesh, India and Ethiopia (Tabashsum et al, 2013; Sharma & Mazumdar, 2014 & Derbew, Sahle, & Endris, 2013).

Table 13 Prevalence of E-coli isolates from the five street food items

Types of food	Number	Bacteriological results
		E. coli
Fried fish	32	23(71.8%)
Ambasha	32	21(65.6%)
Sambussa	32	15(46.86%)
Bonbolino	32	18(56.3%)
Chips	32	16(50%)
Over all	160	93(58.75%)

The above table (tables) is clearly revealed that, the street foods in Bahir Dar city were contaminated with different pathogenic bacteria. The existence of these bacteria in foods facilitates favorable conditions for potential health problems in the end users. Escherichia coli were detected in 58.75%) of the food samples in agreement with these studies 46.3% prevalence of E. coli was conducted in Gonder, Ethiopia (Derbew, Sahle, & Endris, 2013) This detection rate was relatively in agreement with the previous studies carried out in Amravati city, which have reported finding E. coli in 41% of all food samples (Tambeker De et al., 2011). The presence of E. coli in our study might attribute to the heat processing failure or post processing contamination, faecal contamination, poor hygienic practice of food handlers, especially if they fail to wear protective clothing such as aprons and the head gears or handling money and food with an open palm (AR, 1992). In contrary the study conducted in Zimbabwe where all the egg roll samples (20/20; 100%) were contaminated with E. coli. As I have seen in the study on both of survey assessment and microbial analysis part, poor personal hygiene, improper handling and storage practice of foods and poor knowledge of food vendors towards food borne disease were the major causes of contamination of the food items.

The pathogen load may be diverse from place to place due to many reasons which includes environmental condition which is promising for bacterial proliferation &

predominantly issue of hygienic measurements to avoid post contamination of food starting from the beginning of preparation of food till delivery of the consumers

In addition to these some parts of the foods may be left over in the materials in which they are prepared, until sold or reheated, which results in longer holding time, hereafter generating advantageous conditions for the growth of food borne pathogens (Agge & Bendeck et al, 2013). Contaminated foods are the indirect sources by which the bacteria are spread. It is therefore bacteria are introduced into the food by food handlers, contaminated foods and indirectly by the using apparatus (Guisaiga, G. M., 2012). Thus it is very necessary for the street food vendors to keep their personal hygiene specifically their hands clean to avoid contamination. As a consequence a result showed that the street food was highly contaminated because of poor personal hygiene and food handling practices. The finding is in agreement with the previous study in North Gondar, Gondar Town majority of vendors (56.25%) responded that they had no habit of washing their cloth for food preparation regularly and wear the same clothing for long time without washing and almost all the places (91%) were not quiet clean and (Deabew, Sahle & Endris, 2013)

The occurrence of this organism in street vended food is proven with many other previous studies (Angaw, Kibret & Abera, 2015) (Mekonnen et al 2001). According to WHO food handling personnel play an important role in ensuring food safety throughout the chain of food production, processing, storage and preparation. Miss-handling and disregarding of hygienic measures on the part of food vendors may enable pathogens to get access to food and in some cases to survive and multiply in sufficient numbers to cause illness to the consumers (Solomon, 2007).

Generally, the present study results shows that the five types assessed street-vended food items in Bahir dar city was contaminated with pathogenic bacteria. The occurrence of these pathogenic bacteria in foods could lead to potential health problems for consumers. Lack of food safety training, Poor personal hygiene, improper handling and poor storage practice of foods and poor knowledge of food vendors towards food borne diseases were the main factors to contamination

5. LIMITATION OF THE STUDY

During carrying out this study, there were some limitations that we have faced, some of those were:

- Small size of study sample was included in the study due to the bulky laboratory processes & resources.
- Due to lack of some reagents, selective media and specific biochemical test reagents in the laboratory some vital tests were remain; therefore limited and common laboratory tests were carried out in this study and I have suggest this for the next researchers.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusion

The results showed that most of street vendors had primary educational level and did not have any formal or informal food safety training which may have contributed to safe practice of street foods. In addition, this study identified although the majority of vendors exhibited low food safety knowledge and attitude, only few of them had a score higher than 60% which means food safety knowledge and attitude still need to be addressed in the city. The conditions in which street vendors operated in Bahir Dar city are precarious with no access to garbage removals, washing hands and good serving facilities and an effort should be made to improve their conditions.

Most of the street food vendors did not have any awareness of Hepatitis A, Salmonella spp. and Staphylococcus spp. as they are pathogen reservoirs of foodborne diseases. More of the street food vendors are unaware of the importance of reheating food to against foodborne diseases. The conditions in which street food vendors operate in Bahir dar city are mostly unacceptable from a food safety point of view and an effort should be made to improve their conditions by development of appropriate infrastructure i.e. good personal hygiene, good preparation areas, trainings, potable water, toilets, waste disposal facilities and others many. The majority of the vendors did not have any food safety training and the street food vendors had a poor understanding of food safety which was reflected in their unhygienic practices during the preparation and vending of the foods.

The study finding indicated although foodborne pathogens were confirmed in a street food sample, the high bacteria count observed in the samples correlate to the low hygienic conditions in which the food is prepared. These isolated microorganism included Escherichia coli (58.75%), and Staphylococcus aureus (65.1%). Any intervention should therefore target organizing periodic training on food safety, food preparation, means of contaminating food, strictly regulating and monitoring activities of

food vendors and organizing routine screening of food vendors on some selected medical conditions.

In conclusion, this study has revealed that the selected food items that are sold at the city of Bahir dar do not meet required quality and safety. Therefore access to food safety training and health education to the vendor on personal hygiene, food safety and proper disposal of waste would improve food quality thereby reducing food borne incidences is crucial.

6.2. Recommendation

Based on this finding the present study recommends the following:

- Ø Further analytical studies to identify the associated significant risk factors of poor knowledge and poor practices for the street food safety in the locality.
- Ø It is also important to consider more microbiological safety common pathogens which can occur in ready to eat foods should be analyzed in order to entirely evaluate the risk of food borne pathogenic bacteria caused by street food consumption, i.e. Salmonella, Campylobacter, Clostridium perfringens which are not analyzed in this study due to lack of reagents and medias.
- Ø Furthermore, local governments need to provide support for street vendors with regards to adequate infrastructure in terms of well designed vending structures, water supply, toilet facilities and waste disposal facilities.

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Annex

Annex I: - Questionnaire and Consent Form

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1. ‘- 4•j 5 •H•s Tele, +251(0)913931849Email: nura232@gmail.com
2. đ ÈÝ 5 í Tele, +251(0)910009728, EmailDemewez2007@yahoo.com

Annex II a è - > E C í E

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Annex II A a è ¥ - 5 Î ` + Ê “ Ê ” s • í 5

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Annex II B: - ¥ - 5 î e Ý uÈE ð Î u C í ¥ É @ u í 5

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5	e ` Ø ` u f s e u " # u è e e - u í (+			
6	è È M = s (è ` ù = \$ e È õ ` = s • É			
7	ð B Ø « (u c - t , ð ` \$ • > 0 É í « u í »			
8	3 " " e E õ ` = s l } « " • ñ • E			
9	¥ 5 s J @ " 5 e E õ ` = s l } « " • ñ • E			
10	ë • u p 5 (f p ð È í sí N í õ ` e p M è }			
11	f } • ` • • « ` u U • u @ è e e - u í @ • 3			
12	" e Y u ` J u ¥ • s e è e e - u í @ • 3			
13	è ð õ 5 = s ` e p M í }			
14	è e (Y } • d \$ • > E # v } • ð - Y ¥ " v } ¥ " Û É • v } ¥ © ë C			
15	e • ` Ø " E • õ Ø u è e e - u í @ • 3			
16	e Y u è @ c x l • O C l } c = ó u è e e - u í (+			
17	è ` 0 • e • ¥ • ð " F e è e e - u ë # í }			
18	e Y u è @ c x l • O C l } ` • = = ó u è e e - u í @ • 3 È í ë K			

Annex II C: - è ¥ - 5 Î • Ê • = “ p “ p ÷ E =

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Annex II D: - _ ó“ í è @ - a f } • è 0 (p u ” s ¥ “ e • ` • = “ ë ë Ý ã •
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