UNIVERSITY OF CAPE COAST

MICROBIOLOGICAL QUALITY OF FAST FOODS IN THE CAPE COAST MUNICIPALITY IN THE CENTRAL REGION OF GHANA

BY

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MARCH 2008

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature: .... Date: 30th January, 2009

Supervisors' Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

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ABSTRACT

The microbiological quality of fast foods, some vegetables, water and vegetable milling machines in Cape Coast Municipality of the Central Region of Ghana was studied between July 2005 and April 2006 using survey and laboratory studies. Temperature, pH and moisture content, which affect microbial load of dishes, were also assessed. Twenty-four and 21 fast food sites were used for survey and laboratory studies respectively. Dishes examined were jollof, plain and fried rice and chicken, spring rolls, coleslaw and pepper sauce. The vendors consisted of 50% males and 50% females, mainly between the ages of 15 and 30 years (79.2%) and acquired their training mostly through apprenticeship.

The temperature range of fried rice at start of selling (37.2-79.4°C) was significantly ($P<0.05$) different from that at the end (22.5-62.8°C). The least percentage moisture content range for test food at start was 49.3-66.5% and end 49.1-67.4%, and highest at start was 69.9-89.2% and end 72.9-89.9%. The least and highest pH range for the test foods at start and end were 4.0-5.7 and 4.0-6.8 respectively. The least and highest microbial load for test foods at start and end were 0.0-27.8 and 16.8-578.9 $\times 10^5$ cfu/g respectively. Microbial load of coleslaw was significantly ($P<0.05$) higher than those of fried rice, chicken, and pepper sauce. The least fungal microbial load range of test foods was 0.0-17 $\times 10^3$ cfu/g and the highest was 8-115$\times 10^3$ cfu/g. Yeast was the predominant fungal isolate. Poor sanitation significantly ($P<0.05$) encouraged high microbial load (163$\times 10^5$ cfu/g) of the fast food. Washing of fresh cabbage in 0.004M salt solution reduced the microbial load from 153 $\times 10^5$ cfu/g of water-treated to 31$\times 10^5$ cfu/g of salt-treated cabbage. *Salmonella, Shigella* spp., *Aspergillus* and *Penicillium* spp. were isolated from coleslaw, tomatoes and vegetable milling machines indicating faecal pollution or unhygienic handling. Most of the test foods had high microbial load, well above the world Health Organisation recommendation. These findings indicate that consumers of these foods are at high risk of falling sick.

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DEDICATION

To Mrs. Miriam G. Baiden, my mother

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CHAPTER ONE

INTRODUCTION AND LITERATURE REVIEW

Fast foods are reasonably priced and readily available food, which is prepared quickly, and are an alternative to home cooking (FAO, 1990; Arambulo *et al.*, 1995; Taylor *et al.*, 2000). Fast foods are also known as ready-to-eat food and this can also be defined as any food, including beverages, handled, processed, mixed, cooked, or otherwise prepared into a form in which it is normally consumed without further processing. The term "street foods" or fast food describes a wide range of ready-to-eat foods and beverages sold and sometimes prepared in public places, notably streets. Like fast foods, the final preparation of street foods occurs when the customer orders the meal that can be consumed where it is purchased or taken away. Street foods and fast foods are low in cost compared with restaurant meals and offer an attractive alternative to home-cooked food (Muinde and Kuria, 2005). In spite of these similarities, street food and fast food enterprises differ in variety, environment, marketing techniques and ownership.

Street foods often reflect traditional local cultures and exist in an endless variety. Vendors' stalls are usually located outdoors or under a roof that is easily accessible from the street. They have low-cost seating facilities that are sometimes rudimentary. Their marketing success depends exclusively on location and word-of-mouth promotion. Street food businesses are usually owned and operated by individuals or families but benefits from their trade extend throughout the local economy. For instance, vendors buy their fresh ingredients locally, thus linking their enterprises directly with small-scale farms and market gardens. By contrast, fast food outlets specialize in fewer foods that are usually prepared by frying. Hamburgers, chicken, chips and pizza often predominate (Mensah *et al*., 2002).

The common food items served in Ghana are spring rolls, hamburgers, pizzas, fried rice and chicken, yam balls, fried plantain and beans, beverages and pastries. The food is prepared on a large scale for public consumption and may be susceptible to contamination from the environment and handlers (Osei-Kofi, 2002). More people than ever before are buying ready–to–eat food, fast food, eating out in cafés and restaurants. The change in life style has given people new choices in the food they eat, but it has also created new problems.

Fast food business is expanding in many developing countries today. Its expansion is linked to urbanization and the need of urban populations for both employment and food. Fast food vendors are normally found along the streets of many urban towns, but adequate attention has not been paid to the potential dangers of street and fast foods consumption (Drapper, 1996). Other studies done in Africa on street food, show how their tremendous unlimited and unregulated growth has placed severe strain on city resources, such as water sewage systems and interference with the city plans through congestion and littering and adversely affecting daily life (Canet and N'diaye, 1996). Studies carried out in Kenya revealed that street food vendors are often unlicensed, untrained in food hygiene and sanitation, and work under crude unsanitary conditions (FAO, 1997).

According to FAO (1999) report, by 2020, the developing world's urban populations will double, reaching 3.4 billion. This increase in the urban population poses great challenges to food systems and how they are managed. Rapid urbanization has led urban services to be stretched beyond their limits, resulting in inadequate supplies of potable water, sewage disposal and other necessary services. Increasing wealth, an urban lifestyle and sometimes lack of facilities mean that people eat much of their food away from home.

A feature of the urbanization process has been the development of informal food supply systems. Resource-poor groups have developed livelihood strategies with limited capital assets to meet opportunities in urban areas. This is typified by the increase in ready-to-eat food prepared and sold by street food vendors. However, while street food vending can be an effective way of providing low cost nutrition to urban populations, it can also pose risks to health, in particular for the young, the elderly and those with HIV/AIDS (Buzby and Roberts, 1997).

In Ghana as well as in most African countries fast foods and street foods, tend to have an enormous impact on the urban food supply, economically, socially and nutritionally. Women normally operate street food businesses, but nowadays, young men also operate fast foods business. About 60 per cent of the workers living in Accra alone and other urban centers of the country depend on the foods sold on the streets for breakfast, lunch and supper on daily basis (WHO, 2003). Most of our students in the second cycle and tertiary institutions rely mostly on these fast food vendors for their meals.

With the globalization of the world's food supply, food contamination knows no borders. Due to innovations in transportation and refrigeration, food is mass produced and rapidly moved across countries and between continents. While consumers benefit from having access to fresh affordable food from all parts of the world, the risks are growing. Food contamination that originates in one area is distributed widely and can cause illness in large numbers of people in distant places. Globalization of the world's food supply had also increased the risks of contamination (WHO, 2002; Safety Food International (SFI), 2004).

Studies in developing countries have shown that up to 20-25% of household food expenditure is incurred outside the home, and some segment of the population depends entirely on street foods. This has been one of the consequences of rapid urbanization, with millions of people having no access to a kitchen or other cooking facilities. There are millions of single workers without families and a largely floating population who move in and out of the city for work, and there are people who largely depend upon street foods for their daily sustenance (Tinker, 1987; Muinde and Kuria, 2005).

Street food micro-industries are vital for the economic planning and development of many towns. In the Indonesian city of Bogor, annual sales of street foods amount to US$67 million (SFI, 2004). In Cotonou in the Republic of Benin, in the early 1990's it was estimated that the yearly turn over of the street food trade was about US$ 20 million. A mini-census and a survey by the National Resources Institute of 334 street vendors in Accra, Ghana, indicated that the street food sector employs over 60,000 people and has an estimated annual turnover of over US$100 million and also in Malaysia the annual street food sales is about $2.2 billion (United Nations Centre for Human Settlement (UNCHS), 2002).

Bacteria are the main cause of food-borne illness or food poisoning and food spoilage. They thrive where there is food, moisture and suitable temperature, as in the nose, throat, skin, bowel and lower urinary tract of humans and animals. They are unicellular prokaryotic organisms usually having a definite outer envelope or capsule for protection. They multiply rapidly by dividing into two, can be motile and form chains or masses of cells. Bacterial endo spores can resist damage by heat, by cold and by chemicals such as disinfectants. An endospore can survive in dust, on vegetation and in soil for weeks, months or even years until conditions become favourable (Beuchart, 1996; Synder, 1997). They, however, support life through their numerous activities, such as, decomposition of organic matter and humus formation, nutrient re-cycling in soil and aquatic bodies, nitrogen fixation and enrichment of soil, and commercial application as in fermentation of food and diary products and production of antibiotics and vaccines.

Yeasts are eukaryotic unicellular fungal organisms much larger than bacterial cells and can be found in the soil, on plants, skin and body of humans. They multiply mainly by budding. Some can cause diseases and skin infections in humans. Some yeasts spoil food, but beneficial uses are in the making of fermentation products such as beer, wine and bread (Wardlaw and Kessel, 2002).

Moulds are filamentous and branch to form mycelial mats which are familiar sights on foods such as jam, cheese and bread. They produce clusters of dry spores, which are blown by the wind. Many moulds spoil food and can cause disease in plants and humans, but beneficial uses are, for example, in soil formation, nutrient re-cycling in soil and aquatic bodies in the ripening of cheeses and production of antibiotics (Atlas, 1995).

Mycotoxins are substances produced by moulds that contaminate various agricultural commodities either before harvest or under post-harvest conditions. They have been implicated in foodborne diseases outbreak worldwide. Mycotoxins are another group of highly toxic or carcinogenic chemical contaminants of biological origin produced by certain species of fungi. Five important mycotoxins are aflatoxins, ochratoxins, fumonisins, zearalenone, and trichothecenes. Crops such as peanuts, corn, pistachio, walnuts, and rice are susceptible to mycotoxin contamination (Barret, 2000; Etzel, 2002). Aflatoxins are among the most studied mycotoxins, and the relationship between aflatoxin ingestion and primary liver cancer is well established (Berry, 1988). The most well-known mycotoxin, the potent human hepatocarcinogen aflatoxin, is produced by *Aspergillus flavus* and *A. parasiticus* (Palmgren and Hayes, 1987).

Certain environmental conditions favour the growth and multiplication of microorganisms and these are availability of nutrients, suitable temperature, pH, moisture and oxygen. Each microorganism has an optimum temperature where it grows most rapidly and a maximum and minimum temperature at which it will grow. Outside this range it will grow very slowly, or not at all. Bacteria that grow best at low temperatures (< 20 °C) are called psychrophiles, those that reproduce fastest at moderate temperatures (20 °C – 40 °C) are called mesophiles. An example of mesophile is *Escherichia coli*. Bacteria whose growth is fastest at temperatures above 40 °C are called thermophiles and an example of such bacteria is *Bacillus stearothermophilus* which grow at relatively high temperatures between 55° and 70 °C. Microorganisms can grow and multiply only within a certain pH range. Most bacteria grow well over a pH range of 6 – 9. Fungi generally exhibit a wider pH range, growing within a range of pH 5 – 9. Most bacteria are considered neutrophiles because they thrive well under neutral pH conditions. Acidophiles are bacteria restricted to growth at low pH. *Thiobacillus* species are examples of acidophiles that grow at pH 2. Yeasts and moulds are most capable of growth at low pH. Alkalophiles are bacteria that thrive in environment with high sodium concentrations such as some salt lakes with pH range of 9 – 11.

Without water, dehydration occurs and the life and growth processes of microorganisms slow down and may stop. Bacteria grow well when the relative humidity and water activity (A_w) is high.

Obligate aerobic organisms use oxygen obtained from their environment to produce energy for life and growth. Facultative anaerobic organisms can produce energy in the presence or absence of oxygen. An example of facultative anaerobe is *Escherichia coli*. Obligate anaerobes are bacteria that grow only in the absence of air and carry out fermentative metabolism (Atlas, 1995).

Food borne and water borne diseases are regarded as intoxications or infections. Intoxications are diseases in which bacterial toxins or poisons in food and water are ingested. Examples are botulisms, staphylococcal food poisoning, and clostridial food poisoning. An infection refers to diseases where live bacteria in food and water are ingested and subsequently grow in the body. These infections include typhoid fever, salmonellosis, shigellosis, cholera, diarrhoeas, and several other bacterial diseases (El-sherbeny *et al.*, 1985; Campbell *et al.*, 1998). Food may also be contaminated by food employees via exposure to raw animal products during processing (Coates *et al.*, 1987;

Paulson, 1994). According to a study by Scott and Bloomfield (1990), if surfaces are contaminated with low numbers, about 120 cells per cm^2 of organisms such as *E. coli*, *Salmonella*, and *Staphylococcus aureus*, contact with fingers can transfer organisms in sufficient numbers to pose a potential infection hazard.

Botulism is a very dangerous food borne intoxication. It is caused by *Clostridium botulinum*. *C. botulinum* is a Gram-positive anaerobic bacillus that forms endospores. As the endospores enter anaerobic environment such as sealed cans, and jars, they develop into bacillus that produce exotoxins. A pint of pure exotoxin is believed to be sufficient enough to eliminate the entire population of the world. However, the organism will not grow in the presence of oxygen or nitrate salts and it does not produce the toxin at a pH below 4.7. Symptoms of botulism are blurred vision, slurred speech, and difficulty in swallowing and chewing and labored breathing. Botulism is usually related with cold food. In 1997, 58 people became ill after eating home-canned peppers at a restaurant. Also in 1982, canned salmon was believed to have caused an outbreak of botulism. Some foods linked to botulism include mushrooms, olives, salami, and sausage. *C. botulinum*'s toxins are destroyed at a temperature of 90°C (Arnon, 1979; Burros, 1982).

Staphylococcal food poisoning ranks as the second most reported of all types of food borne diseases. *Staphylococcus aureus*, a gram-positive coccal bacterium is responsible for this food poisoning. *S. aureus* is a common inhabitant of the human body, being found on skin and in the nose and is considered part of natural flora of the human body. It releases enterotoxins into the intestine of victims and the victims experience abdominal cramps, nausea, vomiting and diarrhoea. The toxins induce release of water. The incubation period for staphylococcal food poisoning is brief, one to six hours. The possible contamination factors are moisture content, how acidity and improper heating. The staphylococcal enterotoxin is among the most heat-resistant of all enterotoxins. The organism grows over a broad temperature range of 8^{0} to $45^{o}C$. Since refrigerator temperatures are set at about $5^{o}C$, refrigeration is not absolutely a safeguard (Alcamo, 1991).

Clostridial food poisoning is also another common food poisoning disease. The causative organism is *Clostridium perfringens.* It is also Gram-positive, anaerobic endospore former and usually contaminates protein-rich foods such as meat poultry and beans. It usually lives in the environment, especially in the soil, intestines of farm animals and humans, and sewage. *C. perfringens* contamination occurs via the faecal-oral route during slaughtering and food preparation. Their endospores are able to survive the cooking process and develop into vegetative cells between the temperature range 21^{o} and $49^{o}C$. *C. perferinges* organisms are found in cooked beef, turkey, gravy, dressing, stews, and casseroles. The incubation period for *C. perfringens* is between eight and twenty hours (Shandra *et al.*, 1983; Wardlaw and Kessel, 2002).

Typhoid fever is caused by *Salmonella typhi*, a gram-negative rod. It is resistant to most environmental conditions outside the body. This factor enhances its ability to remain alive for long period of time in water, sewage and certain foods. *S. typhi* is acid-resistant, and with the buffering effect of food and beverages, it generally survives passages through the stomach. *S. typhi* causes diseases in only man and it is transmitted by flies, food, fingers, faeces and fomites (Rodrigues-leiva, 1979). Most outbreaks of *Salmonella* infection can be traced to improper food handling. Picnics pose a special challenge, because food is frequently held for hours at a dangerously high temperature between 40°C and 60°C. According to the Center for Disease Control (CDC), in 1987 there were 400,000 reported cases of typhoid fever in United State of America and 600 deaths per year (Daniels, 1998; Wardlaw and Kessel, 2002; Tansel *et al.*, 2003).

Shigella bacilli are small Gram-negative rods found mainly in humans and other primates. The various species that cause shigellosis are *Shigella sonnei*, *Shigella dysenteriae*, *Shigella flexneri*, and *Shigella Boydii*. *S. sonnei* is the most common agent and can be found in contaminated water, vegetables, shellfish and diary products. CDC estimates that more than 400,000 cases occur every year in the United States of America. The infection is transmitted by the faecal-oral route, primarily by way of the hands, as well as via food and water (Blaser, 1983; Wardlaw and Kessel, 2002).

Cholera is caused by a gram-negative rod, comma shaped *Vibrio cholerae*. The bacilli enter the intestinal tract through contaminated drinking water or food. Large epidemics are often related to faecal contamination of water supplies or street vended foods. Vegetables from fields fertilised by faeces are a possible source. *V. cholerae* is extremely susceptible to stomach acid. However, if sufficient numbers are ingested, enough will remain to colonize the intestine. This will lead to loss of fluid from the body. The disease is estimated to cause between four and five million deaths throughout the world annually. The Daily Graphic edition of 19th April 2006 reported 256 cholera cases at the Kole-Bu Teaching Hospital within a month.

Bacillus cereus causes a toxin-mediated food poisoning. *B. cereus* is an aerobic and facultatively anaerobic, endospore-forming, gram-positive bacillus. A preformed heat-stable toxin causes the emetic syndrome. The diarrhea syndrome is caused by in vivo production of heat-labile enterotoxins. *B. cereus* is found in about 25% food products sampled, including cream, pudding, meat, spices, dry potatoes, dry milk, spaghetti sauces and rice. Contamination of the food product generally occurs prior to cooking. Vegetative forms can grow and produce enterotoxins over a wide range of temperatures from 25° to 42°C. Endospores can survive extreme temperatures, and when allowed to cool relatively slowly, they will germinate and multiply (Wardlaw and Kessel, 2002). If cooked rice is subsequently held at room temperature, vegetative forms multiply, and heat-stable toxin is produced that can survive brief heating, such as stir-frying (Little *et al.*, 2001a).

Eating food containing preformed toxin, most commonly fried rice, may cause the emetic, short incubation syndrome. Endospores originally present in raw rice survive and at ambient temperature, the endospores germinate in the cooked rice, and there is rapid growth of vegetative bacteria. Levels of *B. cereus* in foods incriminated in the emetic form of food poisoning have ranged from 1,000 to 50 billion colony-forming units (cfu)/gram; high numbers are also present in faecal samples from affected persons. Eating food contaminated with *B. cereus* endospores, which produce toxin in the gastrointestinal tract is more commonly caused by contaminated meat or vegetables and results in the longer incubation period syndrome (Atlas, 1995).

Escherichia coli is a normal inhabitant of the human and animal gut and is the most studied bacterium on the planet. It is a gram negative, motile, plump, non-spore-forming rod. The numbers 0157 and H7 refer, respectively, to the antigenic characteristics of number, 0157, and a flagella protein, H7. This bacterium enters its victims via the faecal-oral route and produces and infection in the victim's intestine. 0157:H7 contains a plasmid that carries the gene for a virulent toxin. Once the infection is established, the toxin is released, causing hemmorrhagic colitis and hemolytic uremic syndrome (Buchana and Doyle, 1997). The bacteria reside in food and water that is contaminated with faecal material, usually from cattle, although other sources may exist, including humans.

Advances in agronomic, processing, preservation, packaging, shipping, and marketing technologies on a global scale have enabled the fresh fruit and vegetable industry to supply consumers with a wide range of high-quality produce year round. Some of the same technologies and practices have also introduced an increased risk for human illness associated with pathogenic bacteria, mycotoxigenic moulds, viruses, and parasites. The use of manure rather than chemical fertilizer, as well as the use of untreated sewage or irrigation water containing pathogens, viruses, or parasites, undoubtedly contributes to this increased risk. Changes in the produce industry, social demographics, food consumption patterns, and awareness of fresh fruits and vegetables as potential vehicles of infection may also be contributing to an increase in documented produce-associated outbreaks of human illness (Hedberg *et al.,* 1994). Endospores of *Clostridium* species, including *C. botulinum* and *C. perfringens,* as well as endospores of enterotoxigenic *Bacillus cereus*, are commonly found in soil, so their occasional presence on fruits and vegetables is not unexpected. Numbers of clostridial endospores on some types of vegetables appear to increase during the summer (Ercolani, 1997).

The presence of other pathogenic bacteria, viruses, and parasites in soil is likely as a result of large application of faeces or untreated sewage, either by chance or design. Whatever the case, soil on the surface of fruits and vegetables may harbour pathogenic microorganisms that remain viable through subsequent handling to the point of consumption unless effective sanitizing procedures are administered and the use of sewage as a fertilizer could contaminate vegetation destined for human consumption (MacGowan *et al.*, 1994).

Irrigation and surface run-off waters can be sources of pathogenic microorganisms that contaminate fruits and vegetables in the field. Irrigation water containing raw sewage or improperly treated effluents from sewage treatment plants may contain hepatitis A, Norwalk viruses, or enteroviruses, poliomyelitis, echoviruses, and Coxsackie viruses and rotaviruses are known to retain viability on the surface of vegetables held at 4°C for up to 30 days (Badaway *et al.*, 1985).

Fresh fruits and vegetables can be contaminated if they are washed or irrigated with water that is contaminated with animal manure or human sewage. Some vegetable sellers normally wash large quantities of vegetables and fruits in dirty water in which they had earlier washed other vegetables and fruits. In this case the vegetables and fruits cannot escape the contamination by microorganisms. The quality of the water used for washing and chilling the produce after it is harvested is critical in food safety (Buzby and Roberts, 1997).

According to a report by the Centers for Disease Control and Prevention (CDC), hands may be the most important means by which enteric viruses are transmitted (LeBaron *et al.*, 1990). Food workers may transmit pathogens to food from a contaminated surface, from another food, or from hands contaminated with organisms from their gastrointestinal tract (Anyanwu and Jukes, 1990). Guzewich (1995) and Bean *et al.* (1996) reported that between 1988 and 1992 there were 1435 outbreaks of food borne diseases in the United State of America and the practices responsible were improper holding temperatures of foods, poor personal hygiene of food workers and inadequate refrigeration in 59, 36 and 20% of outbreaks, respectively. Studies in the USA in 1995, have estimated that the annual cost of the 3.3–12 million cases of food borne illness caused by seven pathogens was US $6.5–35 billion. The medical costs and the value of the lives lost during just five food borne outbreaks in England and Wales in 1996 were estimated at UK£ 300–700 million. The cost of the estimated 11,500 daily cases of food poisoning in Australia was calculated at AU$ 2.6 billion annually (Her Majesty Stationery Office, 1990; Public Health Laboratory Service, 2002; Roberts *et al.*, 2003).

Food borne diseases have a significant impact not only on health but also on development. Moreover, globalization of the food trade and development of international food standards have raised awareness of the interaction between food safety and export potential for developing countries. Food safety is the accessing of the wholesomeness of food to ensure that there are no harmful substances, be it physical objects, chemical substances and living microorganisms, present in the food that may cause injury or sickness to the consumers (Abdussalam and Kaferstein, 1993; Food and Agriculture Organisation (FAO) / World Health Organisation (WHO), 2002). The FAO/WHO, (2002) explained that food safety refers to those hazards, whether chronic or acute, that makes food injurious to the health of the consumer. Schlundt *et al.* (2003) observed that food safety programmes are increasely focussing on a farm-to-table approach to reducing food borne hazards. This involves consideration of every step in the chain, from raw material to consumption, without forgetting surveillance and monitoring by the health sector of cases of food diseases.

The safety of food from farm to table has always been a major concern for the WHO. In its quest for the provision of safe food for consumers it collaborated with some food safety agencies and came out with a programme named Hazard Analysis of Critical Control Points (HACCP). HACCP is a management system in which food safety is addressed through the analysis and control of biological, chemical, and physical hazards from raw material production, procurement and handling, to manufacturing, distribution and consumption of the finished product. For successful implementation of a HACCP plan, management must be strongly committed to the HACCP concept. A firm commitment to HACCP by top management provides company employees with a sense of the importance of producing safe food (FAO, 1990).

HACCP is designed for use in all segments of the food industry from growing, harvesting, processing, manufacturing, distributing, and merchandising to preparing food for consumption. Food safety systems based on the HACCP principles have been successfully applied in food processing plants, retail food stores, and food service operations. The success of a HACCP system depends on educating and training management and employees in the importance of their role in producing safe foods. This should also include information on the control of foodborne hazards related to all stages of the food chain. Effective training is an important prerequisite to successful implementation of a HACCP plan. There are seven principles of HACCP, which have been universally accepted by government agencies, trade associations and the food industry around the world. These are (i) Performing a Hazard Analysis, (ii) Deciding on the Critical Control Points (CCPs), (iii) Determining the Critical Limits, (iv) Establishing Procedures to Monitor CCPs, Establishing Corrective Actions, Establishing Verification Procedures and (v) Establishing a Record Keeping System.

The role of WHO in food safety is to reduce the burden of food borne illness by advising and assisting member states to reduce unacceptable levels of chemicals or microorganisms in food (WHO, 1983).

The 1948 WHO Constitution includes the following specific charges relating to food safety:

- assist governments in strengthening health services relating to food safety,
- promote improved nutrition, sanitation and other aspects of environmental hygiene,
- develop international standards for food,
- assist in developing informed public opinion among all peoples on matters of food safety.

In WHO (2003) report, the WHO Executive Board endorsed the Strategy in January 2002. The Strategy includes the following approaches:

- strengthening surveillance systems of food borne diseases;
- improving risk assessments;

- developing methods for assessing the safety of the products of new technologies;
- enhancing the scientific and public health role of WHO in Codex;
- enhancing risk communication and advocacy;
- improving international and national cooperation;
- strengthening capacity building in developing countries.

The WHO, based on the recommendation of Codex Alimentarius Commission formulates regional food safety strategies on the basis of the WHO global food safety strategy and of specific regional needs such as technical support, educational tools and training.

In Ghana, during the rescent past months, there had been an upsurge in reported cases of cholera, a disease attributed to unsanitary conditions in an environment. For instance the Shama Ahanta East Metropolis had recorded 32 cases of cholera with two deaths since February 2, 2006 (Daily Graphic, 26th April, 2006). Statistics from the Tema Municipal Health Directorate (TMHD) has indicated that in 2004, the Municipality recorded 5,415 and 938 cases of diarrhoea and typhoid fevers, respectively (Daily Graphic, July 18, 2005). According to some doctors at the University of Cape Coast and Central Regional hospitals, each time there was 'food fair' organized by the various halls on campus, reported cases of food poisoning increase. Furthermore, the fact that Cape Coast is a great historic city and the destination of many tourists, foreign and local, make studies on the need to determine the microbiological quality in relation safety of fast foods that are patronized by both Ghanaians and foreigners and to ensure that they meet the Ghana Food and Drugs Board (GFDB) regulations very important.

This research work seeks to examine, isolate, and identify pathogens, which may be present in the fast foods as well as identify the source of contamination and make appropriate recommendations to improve on the safety of fast foods in Cape Coast and Ghana as a whole. In the Central Region of Ghana, diarrhoea and typhoid fever, which are also, diseases attributed to unhygienic environment form 6.8% of deaths at the hospitals and diarrhoea disease cases increased from 4.67% in 1995 to 5.35% in 2000 (Ghana Health Service, 2004). The proliferation of fast food joints on the streets and the resultant increases in the reported cases of food borne diseases by the Cape Coast District Community Health Center (CCDCHC) (2004) makes studies into the microbiological safety of the fast foods in the Cape Coast Municipality in the Central Region of Ghana imperative. The main objectives of this study therefore were to

- collect biodata on fast food vendors and observe sanitation and safe food practices at the vending sites;
- determine the microbial load of the test food;
- isolate and identify food borne microorganisms present in the test food;
- determine the relationship between sanitation of selling premises and microbial load of test food;
- to establish the possible source of microbial contamination.

The results of this study will lead to appropriate recommendations which will make fast foods and for that matter street food safe.

CHAPTER TWO

MATERIALS AND GENERAL METHODS

Study area

Cape Coast

Cape Coast is the capital city of the Central Region in the southern part of the republic of Ghana. The town is famous for its castles, the centre for slave transport during the slave trade era, serving as a very important monument for tourism. It is also known for being the citadel of education, having many secondary schools, teacher-training colleges, nurses training colleges and a university. Cape Coast city plays host to a lot of visitors who have come in as tourists and also to pursue academic excellence. In the year 2000, Cape Coast municipality had a population of 118,106 comprising of 57,365 males and 60,741 females (Ghana Statistical Services, 2002). The economic activities engaged in by the people of Cape Coast, a city located on the Gulf coast is fishing, farming, trading in goods and services. The town also has good transport and communication facilities. The selling and buying of cooked food on the streets of Cape Coast is a common phenomenon and characteristic of any growing town such as Cape Coast.

Sampling sites

Cape Coast municipality was chosen for this study because Cape Coast is a point of great tourist attraction and learning, and must provide food for these groups of people. Seven areas in Cape Coast municipality, which have increasing numbers of fast food joints were surveyed, the operators interviewed and their food samples collected for analysis. These areas were University of Cape Coast, Kingsway, Kotokuraba, Abura, Tantri, Adisadel and Cape Coast Polytechnic.

University of Cape Coast

The University of Cape Coast is an institution of higher learning and as a matter of fact services offered there, are supposed to be of high standard. One of such services is the sale of food. The food vendors in this community serve lecturers, students, workers, and other inhabitants. Most of the fast food joints on campus do not have satisfactory hygienic condition. The fast food operators mostly prepare and serve their food in the open. In the open air the dusty nature of the environment is a source of worry, since it can be a source of contamination. Flying objects easily fall on food to contaminate them. Waste water is thrown just some few meters away from the spot of selling. This practice always creates an enabling environment for rapid breeding of flies, carriers of infectious bacteria. At the north campus of the university, there has been an attempt by the university authorities to create a market area in an enclosed area, but this has rather worsened sanitation in the area, as the new market is too small. The market has no standpipe, lacks urinals and toilet facilities, and a well-structured drainage system. The waste water has created pools of stinking stagnant water breeding mosquitoes and other opportunistic microorganisms that may contaminate food being sold at the market. Very close to the market are rubbish containers which over flow with accompanying stench. These inappropriate hygienic conditions pose serious health hazards to both traders and their customers.

Kingsway

This area is part of the central business area of Cape Coast. Food is usually sold on tables with raised nets. This is an attempt to prevent flies from getting to the food, but this has not proved to be very effective. The surfaces of the tables are generally not clean. In this area most of the food vendors are generally clean. Most of the gutters are not covered and usually choked with garbage including human liquid waste. Flies can be observed settling on the spoons and ladles as well as tongs that are used in serving. The food vendors do not properly wash the vegetables before using them.

Adisadel

Adisadel fast food joints served secondary school students, and mostly mechanics of refrigerators, televisions and vehicles. Sanitation is generally not good. Most of the food sold is not properly covered, while a few of the food vendors have well netted kiosks to prevent flies from settling on the food.

Tantri

The sanitation conditions at the selling joints in this area are poor. Most of the fast food joints operators sell the food on tables which is exposed to flies, while a few food sellers keep their food in netted kiosks. Most of the drainages are commonly choked with filth creating a potential breeding site for contaminants.

Kotokuraba

This is the central business area of Cape Coast. The sanitation at this site is very poor. The market area and the surrounding streets are characterized by heaps of gabbage, decomposing rubbish and drainage system perpertually filled with standing stinking waste water. Most of the foods sold in this area are exposed to flies, posing a health hazard to the consumers. Due to the brisk business in this area, the food vendors serve people from all walks of life such as travellers, workers, students, children, and traders. The vendors do not either care much about hygiene or are ignorant of food hygiene practices.

Cape Coast Polytechnic

The area serves mainly the polytechnic students and inhabitants of the area. Sanitation is generally poor. The food standing on dirty tables is either uncovered or covered with dirty insect-proof nets.

Abura

This is the second largest business area in Cape Coast with a large market. The general sanitation in the area is very poor. Most of the operators have their kiosks situated close to open gutters gutters choked with filth. The stench coming from the gutters makes it very difficult for consumers who are health conscious to patronize the food. Because of the market, filth generation is a very common phenomenon. Some of the fast food vendors do not bother about the health risk posed to them by the unhygienic conditions under which they work. Contrary to this general trend of bad hygiene practice, some operators are somewhat conscious of safe food practice.

Sanitation of vending sites

Sanitation at vending sites was described as excellent, very good, good, poor or very poor. These gradations were coded according to the cleanliness of the vending sites. A vending site was described as very good when there was no filth present, and a vending site was described as very poor when there was too much filth present.

Food samples

Samples of the following foods were obtained from University of Cape Coast, Kingsway, Kotokuraba, Abura, Tantri, Adisadel and Cape Coast Polytechnic.

- Fried rice: a mixture of boiled rice and vegetables fried.
- Coleslaw: a mixture of sliced cabbage, carrot, onion, and lettuce.
- Uncooked frozen chicken.
- Fried spiced chicken.
- Fried pepper sauce: blended onion, ginger, pepper, tomatoes, fish and shrimps fried in oil.
- Meat pie: folded pastry filled with meat, fish or vegetables and baked.
- Spring rolls: rolled pastry filled with meat or fish and vegetables and deep fried in oil.
- Sachet water: popularly called 'pure water'. (Filtered or sterillised water in sealed polythene bags.)
- Pipe-borne water.
- Dug-well water.
- Fresh cabbage.

Other test item is washings of the milling machine for grinding pepper, tomatoes, onions, etc.

General methods

Method of collection of food samples

The food samples were collected from randomly selected fast food vendors from the sampling sites in Cape Coast municipality. The Cape Coast municipality was stratified (zoned) into University of Cape Coast, Kingsway, Kotokuraba, Abura, Tantri, Adisadel and Cape Coast Polytechnic.

The various fast food vending sites that were randomly selected were 'Adom', 'Akwaaba', 'California', 'Check Check', 'Chicago', 'D'taste catering', 'Finger licking', 'Friends', 'God's Grace' 'God's love', 'Good shepherd', 'Helenus', 'Idaric', 'Majestic', 'Nyame adom', 'Obaapa fausty', 'Silver Bird corner', 'Singapore', 'Texas', 'Unity' and 'Yanky's'. The food was bought as any other customer would have done, put in an ice chest to maintain the food temperature, which was determined with a thermometer, and the food later analyzed. Food samples were collected from the fast food vendors at the start of their selling and at a period towards the end of the selling. An average of three fast food vending sites was sampled per stratified area. For each particular vending site, food samples were collected on four different occasions. Most of the fast food vendors had the fried rice in a thermos ice-chest container, while the fried chicken was in a container covered with an insect-proof net.

Fried rice and chicken

Fried rice was served into a polystyrene box, with the fried chicken placed on the rice, covered and placed in the ice-chest.

Pepper Sauce

The pepper sauce was put in a sterile 'container' and also placed in the ice-chest.

Coleslaw

The coleslaw is a mixture of chopped cabbage, lettuce, onions, carrots and cucumber. These were also put in a sterile container, placed in the ice-chest and brought to the laboratory for analysis.

Whole Cabbage and Tomatoes

Three heads of cabbage and fruits of tomato were randomly obtained from the Kotokuraba and Abura markets for analysis. The analysis was done for the cabbages and tomatoes on five different occasions.

Pastry

Meat pie and spring rolls were also randomly sampled on five different occasions from the study area and on each occasion they were placed in sterilized transparent polythene bags, and brought to the laboratory for analysis.

Water

Various kinds of water samples such as 100 ml each of pipe borne water and dug well water, sachet water which was approximately 500 ml each of the brand names, delta spring, mobile and sun, were all collected into sterilized containers and brought to the laboratory for analysis. The samples were collected on five different occasions.

Method of collection of washings of milling machine

A total of four milling machines were also randomly sampled within the study areas. Two hundred millitres of sterile distilled water were poured into the milling machine and collected through the nozzle of the milling machine after the machine had been switched on. A total of 80 ml was collected into a well labelled sterile container which was then placed in a sterilized thermos ice chest and transported to the laboratory for analysis. Collection was done on five different occasions.

Methods of sterilization

All glassware, spatulae, crucibles, forceps, knives, were first washed with liquid soap, rinsed in several changes of clean tap water, drained and allowed to dry. The Petri dishes and pipettes were put into canisters and sterilized at a temperature of 160 °C in SIBATA THERMOTEC SPF-450 oven for six hours before use. Spatulas, crucibles, forceps and knives were first wrapped in grease-proof paper and sterilized in an oven at 160 °C for 6 hours

The inoculating room was sterilized by spraying heavily with methylated spirit and allowed to stand for one hour before use. The top of the work bench was mopped with cotton wool soaked in 4 % dettol solution before and after use.

Media

Sabouraud Agar: Maltose, 40 g; Peptone, 10 g; Agar 15 g;

Distilled water, 1 litre

The maltose, peptone and agar powder were put in a 1-litre Erlenmeyer flask, one litre distilled water added and the mixture dissolved in a water bath. The pH of the mixture was adjusted to 5.8 using the buffer hydrochloric acid solution. The mixture was thoroughly mixed and 150 ml poured into each of six 250 ml Erlenmeyer flasks and stoppered with a non-absorbent cotton wool. The media were then autoclaved at 121 °C for 15 minutes.

MacConkey Agar medium

MacConkey Agar powder (PLASMATEC), 40 g; distilled water, 1litre.

The MacConkey agar was put in a 1litre Erlenmeyer flask and one litre distilled water added. The pH of the mixture was adjusted to 7.0 using the buffer sodium hydroxide solution. The mixture was then dissolved by heating in a water bath. One hundred and fifty mililitres of the well-dissolved mixture was poured into each of six 250 ml Erlenmeyer flasks and stoppered with a non-absorbent cotton wool and then autoclaved at 121 °C for 15 minutes.

Plate Count Agar medium

Plate Count Agar powder (ozoid), 22.5 g; Distilled water, 1 litre.

The plate count agar was dissolved in one litre distilled water. The pH of the mixture was adjusted to 7.0 using the buffer sodium hydroxide solution. The mixture was thoroughly mixed and heated in a water bath to dissolve. One hundred and fifty mililitres of the medium was poured into each of six 250 ml-Erlenmeyer flasks and stoppered with a non-absorbent cotton wool. The medium was sterilized at 121 °C for 15 minutes in the autoclave.

Salmonella Shigella (S.S.) agar medium

S.S. agar (PLASMATEC), 60 g; distilled water, 1 litre.

The weighed S.S. agar was put in one litre distilled water and soaked for 10 minutes. The mixture was swirled to mix and heated to boiling and used immediately without further sterilization.

One per cent Peptone Water (Oxoid)

Peptone, 10 g; Sodium Chloride, 5 g; Distilled water, 1 litre.

The peptone and sodium chloride were put in a one litre Erlenmeyer flask. One litre of distilled water was added to dissolve the mixture. The pH was adjusted to 7.2. Eighteen millilitres of the peptone water were poured into each of 80 test tubes and stoppered with a non-absorbent cotton wool. The peptone water was then sterilized at a temperature of 121 °C for 15 minutes in the autoclave, allowed to cool and used for preparation of serial dilutions of the test food samples.

Inocula

Preparation of serial dilutions of the test food samples

Two grammes of food sample were taken and put in a test tube containing 18 ml of sterile 1 % peptone water and shaken vigorously for 15 minutes using a mechanic shaker. Ten-fold serial dilutions were subsequently prepared to obtain 1:100000 dilution and used as the inoculum. The procedure was used for fried rice, fried chicken, coleslaw, pepper sauce and cabbage.

Surface microflora of tomato fruits

Forty grammes of whole tomato fruits were put in a sterile polythene bag containing 200 ml of sterile distilled water. This was well shaken to allow any microorganisms on the fruits to dislodge into the solution. Two mililitres of the suspension were pipetted into a test tube containing 18 ml of sterile 1 % peptone water and 10-fold serial dilutions prepared.

Microflora of milling machine

Two millilitres of of sterile distilled water was poured into a milling machine which had been switch on and the fluid that came out was collected. Two mililitres of the suspension was used to prepare 10-fold serial dilutions using 1 % sterile peptone water as the diluents. The procedure was repeated in the morning just before the start of work and at the close of work in the evening.

Polystyrene boxes

Polystyrene boxes were collected from stores at Kingsway, Kotokuraba and Abura. Each was put in a sterile polythene bag and 100 ml of sterile distilled water poured onto it. This was then shaken to allow microorganisms that may be present to dislodge into the sterile distilled water.

Determination of microbial population and identification of microorganisms

Plating

A 1 ml blow-out pipette was used to transfer 1 ml aliquot suspension from the 1:100000 dilution of a test food sample into each of replicate Petri dishes (9cm diameter). An amount of approximately 10 ml of the appropriate molten medium cooled to 40°C was then poured intoeach of the Petri dishes and swirled in both clock-wise and anti-clockwise directions to uniformly distribute the inoculum in the agar medium before it solidified. The MacConkey and S.S. agar media were for isolation and differentiation of colonies of enterobacteria, plate count agar for total viable bacteria count and Sabouraud agar medium for the isolation of fungi. For each of the sample, there were three replicate dishes. One millilitre of 1:1000 dilution of food samples were plated for isolation of fungi. In the case of the polystyrene boxes and milling machine, 1 ml aliquots of each washing were plated. Also 1 ml aliquots of sachet water, pipe-borne and dug well water were plated directly (Harrigan and McCance, 1973).

Incubation and enumeration

The Sabouraud agar Petri dishes for isolation of fungi were incubated at 25 °C for four to seven days while the inoculated MacConkey, S.S. and plate count agar Petri plates were incubated at 41 ± 2 °C and 38 ± 1 °C for 48 hours and 24 hours, respectively, in the GALLENKAMP PLUS II incubator. The colony forming units (CFUs) in each replicate Petri plates were counted using the colony counting machine and the mean determined. Colonies of *Escherichia coli* were identified as pink colonies on the MacConkey medium, *Salmonella* colonies were also identified as pink colonies with black centers, while *Shigella* was identified as transparent colonies and transluscent with rough edges on the S.S. agar medium (HPA, 2003).

$$\text{Mean Cfu} = \frac{\text{Total number of colony forming units (cfu) on replicates plates}}{\text{number of replicates}}$$

Gram staining

The differential staining obtained with the Gram stain occurs because Gram-positive and Gram-negative bacteria differ significantly in their cell envelope composition. The cell envelope of both gram-positive and gram-negative bacteria contains a cell wall known as murein layer. It is the murein that causes the differencial staining seen with Gram stain. The gram-positive bacteria have a thick cell wall that retains the crystal violet, while the gram-negative bacteria have a very thin cell wall that does not retain the crystal violet-iodine (Murray *et al*., 2003; Forbes *et al*., 2002).

An inoculating loop was used to pick a small sample from the bacterial colonies growing on the culture medium and stirred in a drop of water on a glass slide to make a smear. The smear was air-dried and then heat-fixed by passing the slide held horizontal with the smear-side facing upwards three times over a low flame. The heat-fixed material was then flooded with crystal violet and allowed to remain for 30 seconds, after which it was rinsed with water. The slides were flooded with iodine and allowed to stand for 60 seconds, after which the iodine was rinsed off with water. The cells were decolorized with alcoholacetone (50-50) and then rinsed with water. The counter stain, safranin, was next applied to the cells and allowed to remain for 60 seconds, after which it was rinsed with water. The prepared slides were air dried and examined under the oil immersion of the microscope with a magnification of x100 and photographed.

Identification of cultures

The microorganisms that had grown on the media were identified using manuals such as 'Illustrated Genera of Imperfect Fungi (Barnett, 1969); Microbiological Applications: Laboratory Manual in General Micrbiology (Benson, 1998); and Laboratory Methods in Microbiology (Harrigan and McCance, 1973) and with the help of the selective differential media (for enterobacteria).

Determination of moisture content

The moisture content of each test food sample was determined by weighing fresh weights of 20 g of rice, 10 g of chicken, and 5 g of coleslaw and 2 g of pepper sauce and dried in the THERMOTEC SPF-450 oven at 80 °C for 48 hours, after which the final weights were determined.

$$\%\text{ Moisture content} = \frac{\text{Wt of fresh food sample - Wt of dried food sample}}{\text{Wt of fresh food sample}} \times 100$$

Statistical analysis

Descriptive statistics from SPSS 13.0 software was used to analyse the social responses from the questionnaire, while the significant difference between the various means of colony counts from the various sampling sites was calculated using the ANOVA from MINITAB 15.0 software.

Experimental precautions

- Different food samples were collected into separate sterile containers.
- Tests on food sample collected were carried out on the same day.
- Glassware were thoroughly washed with liquid soap, rinsed in several changes of clean tap water and dried before sterilization.
- Inoculation was done under aseptic conditions.
- The various media were cooled to 40 °C before pouring into Petri dishes.
- Old cultures in Petri dishes were immersed over-night in 4 % dettol solution autoclaved at 121 °C for 15 minutes before being discarded.
- Gloves were worn during washing of Petri dishes and inoculations to prevent infections.
- All dilutions were thoroughly mixed before aliquot samples were taken.

CHAPTER THREE

RESULTS

Survey of fast food vendors and vending sites

The results of analysis of responses obtained from the fast food vendors from the administered questionnaires are presented in Table 1 to 16.

A total of 21 vending sites were encountered distributed among the seven areas of the municipality that were covered in the survey between the period July, 2005 to April, 2006 as shown in Table 1.

Table 1: Name and location of fast food vending sites

Location	Name of fast food enterprise
University of Cape Coast	Helenus
	Chicago
	Singapore
Kingsway	Unity
	Texas
	Yanky's
Kotokuraba	Adom
	Good Shepherd
	Check Check

Table 1 cont'd.

Location	Name of fast food enterprise
Abura	Obaapa Fausty
	D'taste Catering Services
	Finger Licking
Cape Coast Polytechnic	Nyame Adom
	California
	Friends
Adisadel	Silver Bird Corner
	Idaric
	God's love
Tantri	Akwaaba
	Majestic
	God's Grace

Types of dishes

The types of dishes sold are presented in Table 2. There was very little variation in the kinds of dishes that were served at the 21 vending sites. Twenty-one out of the twenty-four vending sites surveyed initially had food available when food samples were collected for the laboratory studies but the vendors responded to the questionnaire (Appendix). Out of these 21 fast food enterprises encountered, nine (42.6%) of them sold jollof rice with fried chicken, green vegetables and pepper sauce. Only one (4.8%) of the fast food enterprises sold plain rice with fried chicken, green vegetables and pepper sauce (shito). Eleven

(52.4%) of them sold fried rice with fried chicken, green vegetables and pepper sauce.


x 4/9

Plate 1: A meal of fried rice and fried chicken in a polystyrene box

Table 2: Types of dishes encountered at the fast food vending sites

Location	Collection Times	
	Morning	Evening
Helenus	Fried rice/Fried chicken	Fried rice/Fried chicken
	Green vegetables/Pepper sauce	Green vegetables/Pepper sauce
Chicago	Jollof rice/Fried chicken	Jollof rice/Fried chicken
	Green vegetables/Pepper sauce	Green vegetables/Pepper sauce
Singapore	Jollof rice/Fried chicken	Jollof rice/Fried chicken
	Green vegetables/Pepper sauce	Green vegetables/Pepper sauce
Unity	Jollof rice/Fried chicken	Jollof rice/Fried chicken
	Green vegetables/Pepper sauce	Green vegetables/Pepper sauce
Texas	Fried rice/Fried chicken	Fried rice/Fried chicken
	Green vegetables/Pepper sauce	Green vegetables/Pepper sauce

Table 2 cont'd

Location	Collection Times	
	Morning	Evening
Yanky's	Fried rice/Fried chicken Green vegetables/Pepper sauce	Fried rice/Fried chicken Green vegetables/Pepper sauce
Adom	Jollof rice/Fried chicken Green vegetables/Pepper sauce	Jollof rice/Fried chicken Green vegetables/Pepper sauce
Good Shepherd	Fried rice/Fried chicken Green vegetables/Pepper sauce	Fried rice/Fried chicken Green vegetables/Pepper sauce
Check Check	Fried rice/Fried chicken Green vegetables/Pepper sauce	Fried rice/Fried chicken Green vegetables/Pepper sauce
Finger Licking	Fried rice/Fried chicken Green vegetables/Pepper sauce	Fried rice/Fried chicken Green vegetables/Pepper sauce
Obaapa Fausty	Jollof rice/Fried chicken Green vegetables/Pepper sauce	Jollof rice/Fried chicken Green vegetables/Pepper sauce
D'taste Catering	Fried rice/Fried chicken Green vegetables/Pepper sauce	Fried rice/Fried chicken Green vegetables/Pepper sauce
Friends	Jollof rice/Fried chicken Green vegetables/Pepper sauce	Jollof rice/Fried chicken Green vegetables/Pepper sauce
Nyame Adom	Fried rice/Fried chicken Green vegetables/Pepper sauce	Fried rice/Fried chicken Green vegetables/Pepper sauce
California	Jollof rice/Fried chicken Green vegetables/Pepper sauce	Jollof rice/Fried chicken Green vegetables/Pepper sauce
Silver Bird Corner	Fried rice/Fried chicken Green vegetables/Pepper sauce	Fried rice/Fried chicken Green vegetables/Pepper sauce

Table 2 cont'd

Location	Collection Times	
	Morning	Evening
Idaric	Plain rice/Fried chicken	Plain rice/Fried chicken
	Green vegetables/Pepper sauce	Green vegetables/Pepper sauce
God's Love	Jollof rice/Fried chicken	Jollof rice/Fried chicken
	Green vegetables/Pepper sauce	Green vegetables/Pepper sauce
Akwaaba	Fried rice/Fried chicken	Fried rice/Fried chicken
	Green vegetables/Pepper sauce	Green vegetables/Pepper sauce
Majestic	Fried rice/Fried chicken	Fried rice/Fried chicken
	Green vegetables/Pepper sauce	Green vegetables/Pepper sauce
God's Grace	Jollof rice/Fried chicken	Jollof rice/Fried chicken
	Green vegetables/Pepper sauce	Green vegetables/Pepper sauce

The number, gender and age of the fast food vendors

From the survey of fast food vending sites, 24 food vendors were encountered. Half of them (50%) were females and the other half, (50%) were males (Table 3). Nineteen (79.2%) out of the 24 fast food vendors were between the ages of 15-30 years and the remaining five (20.8%) were between the ages of 31-45 years. Nine out of the 12 female fast food vendors (37.5%) were between the ages of 15-30 years and three (12.5%) were between 30-45 years. Ten (41.7%) out of the 12 males were between 15-30 years and two (8.3%) were between the 31-45 years (Table 3).

Educational status and place of training of fast food vendors

Examination of the responses from the questionnaire revealed that two (8.3%) of the fast food vendors encountered had tertiary (polytechnic) education. Four (16.7%) had post-secondary, nine (37.5%) had completed secondary school. Only one person (4.2%) of the 24 fast food vendors did not have any formal education (Table 4).

Three (12.5%) out of the 24 fast food vendors had their training in food preparation at senior secondary school (SSS). Seven (29.2%) had their training at a vocational institution. Ten (41.7%) had their training through apprenticeship. Only one (4.2%) of the 24 fast food vendors had training in food preparation at the tertiary institution (polytechnic). Three (12.5%) had no training in food preparation (Table 5).

Table 3: Gender and age distribution of fast food vendors

Age	Female		Male		Total	
	Number	% Freq.	Number	% Freq.	Number	% Freq.
15 – 30	9	37.5	10	41.7	19	79.2
31 – 45	3	12.5	2	8.3	5	20.8
Total	12	50.0	12	50.0	24	100.0

Table 4: Formal educational status of fast food vendors

Educational Level	Number	% Frequency
None	1	4.2
Basic	8	33.3
Secondary	9	37.5
Postsecondary	4	16.7
Tertiary	2	8.3
Total	24	100.0

Table 5: Place of training in food preparation of fast food vendors

Training	Number	% Frequency
Senior Secondary School (SSS)	3	12.5
Vocational	7	29.2
Apprentice	10	41.7
None	3	12.5
Tertiary	1	4.2
Total	24	100.0

Nature of fast food vending facilities

Table 6 showed 13 of the 24 fast food vendors surveyed (54.2%) sold their food on tables under an umbrella. Eight representing 33.3% of the sample size sold their food in a netted kiosk. Three (12.5%) sold their food in an enclosed structure.

Source of raw materials

Twenty-three of the fast food vendors (95.8%) purchased their raw materials for the preparation of the food from the market. Only one, representing 4.2%, bought the raw materials from the farm gate (Table 7).

Method of washing vegetables

The methods of washing of vegetables by the food vendors interviewed were the use of water and salt solution. Twenty-two (91.7%) of the fast food vendors claimed to wash their vegetables with salt solution and two (8.3%) washed their vegetables with only water (Table 8). The washing and rinsing in several changes of water and salt solutions was not a common practice with the food vendors.

Treatment of left over food

During the survey thirteen out of the twenty-four fast food vendors (54.2%) said they gave left over food freely to friends and neighbours. One (4.2%) said they reheated it the following day and sold again to the consuming public. Ten (41.7%) of the fast food vendors refrigerated the left over food and reheated it again before selling to the public (Table 9).

Table 6: Nature of fast food vending facilities

Selling site	Number	% Frequency
Under an umbrella	13	54.2
Netted Kiosk	8	33.3
Enclosed structure	3	12.5
Total	24	100.0

Table 7: Source of raw materials

Source	Number	% Frequency
Market	23	95.8
Farm gate	1	4.2
Total	24	100.0

Table 8: Materials used for washing vegetables by fast food vendors

Material	Number	% Frequency
Water	2	8.3
Salt solution	22	91.7
Total	24	100.0

Table 9: Treatment of left over food by fast food vendors

Treatment	Number	% Frequency
Given to people freely	13	54.2
Reheated	1	4.2
Refrigerated	10	41.7
Total	24	100.0

x 1/25

Plate 2: A neatly enclosed fast food vending site

x 1/25

Plate 3: A fast food vending site near a gutter with filth

Licensing and medical examination regularity

The study showed that 22 of the vendors surveyed, representing 91.7%, were licensed by the Cape Coast municipal authority and two, representing 8.3% were not licensed (Table 10).

Three out of the total fast food vendors surveyed representing 12.5% had medical examination once every six months. Eighteen of the fast food vendors representing 75% had medical examination once a year. One person representing 4.2% had medical examination once in five years. Two fast food vendors representing 8.3% had never been examined medically (Table 11).

Knowledge of food hygiene by fast food vendors

Twenty-one out of the 24 fast food vendors encountered in the survey had knowledge in food hygiene and practiced some sort of personal hygiene (Table 12).

Table 10: Licensing of fast food vendors

Status	Number	% Frequency
Not licensed	2	8.3
Licensed	22	91.7
Total	24	100.0

Table 11: Frequency of medical examination of fast food vendors

Frequecy	Number	% Frequency
Once in six months	3	12.5
Once a year	18	75.0
Once in five years	1	4.2
None	2	8.3
Total	24	100.0

Table 12: Knowledge of food hygiene by fast food vendors

Knowledge of food hygiene	Number	% Frequency
No	3	12.5
Yes	21	87.5
Total	24	100.0

Temperature of food samples at sampling dates

The mean recorded temperature values of the fried rice food samples at each sampling time and date are presented in Table 13. The mean temperature varied slightly from one sampling time and date to the other for all the vending sites. Generally, the mean temperature of food samples collected towards the end of selling period, after about 8 hours of selling, was much lower as compared to that of food samples collected at the start of selling. For example, at Helenus fast food vending site on 28 / 07 / 2005, the mean temperature for food samples collected at the start of selling and towards the end of selling were 48.5° and 34.2 °C, respectively. On 09 / 03 / 2006, a mean temperature of 50.8 °C was recorded at the time the food had just been brought to be sold. After about 8 hours of selling, the mean temperature had dropped to 34.1 °C. This was the trend that was observed on the other sampling dates as well as the other fast food vending sites. But, Finger licking had much higher mean temperatures on the various dates of sampling both at the time of start of selling and towards the ending of selling, 78.7, 77.9, 79.4 and 78.1 °C, and 60.9, 61.4, 62.8 and 61.9 °C respectively than the other vending sites.

Table 13: Temperature (°C) of fried rice food sample at start (S) and end (E) of selling

Date of sampling	Fast food vending site	Temperature (°C)	
		S	E
28/07/2005	Helenus	48.5	34.2
24/10/2005		46.2	35.1
05/01/2006		49.4	36.9
09/03/2006		50.8	34.1
02/08/2005	Chicago	57.4	27.6
27/10/2005		58.5	29.5
09/01/2006		60.2	28.7
11/03/2006		56.7	30.2
08/08/2005	Singapore	49.6	32.4
31/10/2005		50.9	31.5
12/01/2006		51.8	30.9
14/03/2006		52.3	33.4
12/08/2005	Unity	56.2	38.6
03/11/2005		57.6	39.4
16/01/2006		59.2	40.6
16/03/2006		58.5	41.9
16/08/2005	Texas	58.3	29.6
07/11/2005		59.6	30.6
20/01/2006		57.4	32.4
18/03/2006		58.9	29.1

Table 13 cont'd

Date of sampling	Fast food vending site	Temperature (^oC)	
		S	E
20/08/2005	Yanky's	52.9	29.1
10/11/2005		51.8	30.5
24/01/2006		53.6	33.1
21/03/2006		55.1	32.5
24/08/2005	Adom	39.7	22.8
14/11/2005		41.4	23.4
23/01/2006		38.9	24.5
24/03/2006		42.7	22.5
30/08/2005	Good Shepherd	44.4	24.1
17/11/2005		45.6	24.8
26/01/2006		46.5	25.6
27/03/2006		45.2	26.1
03/09/2005	Check Check	48.7	28.7
21/11/2005		49.3	29.4
30/01/2006		50.2	30.6
30/03/2006		49.5	31.2
12/09/2005	Obaapa Fausty	65.8	39.8
28/11/2005		66.3	40.6
06/02/2006		64.9	41.8
03/04/2006		67.2	42.7

Table 13 cont'd

Date of sampling	Fast food vending site	Temperature (°C)	
		S	E
16/09/2005	D'taste catering	63.6	40.5
02/12/2005		62.8	39.7
09/02/2006		64.6	41.6
06/04/2006		67.1	42.8
06/09/2005	Finger licking	78.7	60.9
24/11/2005		77.9	61.4
02/02/2006		79.4	62.8
01/04/2006		78.1	61.9
26/09/2005	Nyame Adom	49.5	28.3
08/12/2005		50.8	29.7
14/02/2006		51.6	30.3
11/04/2006		49.9	29.5
30/09/2005	California	37.2	25.7
12/12/2005		38.4	26.8
17/02/2006		39.4	27.1
13/04/2006		37.8	24.8
20/09/2005	Friend's	58.4	36.3
05/12/2005		59.8	35.9
11/02/2006		57.3	37.2
08/04/2006		60.3	38.1

Table 13 cont'd

Date of sampling	Fast food vending site	Temperature (°C)	
		S	E
03/10/2005	Silver Biro Corner	63.6	43.8
15/12/2005		62.7	44.8
20/02/2006		64.5	45.1
15/04/2006		65.1	44.3
07/10/2005	Idaric	69.3	47.5
19/12/2005		70.2	48.2
23/02/2006		71.5	49.5
17/04/2006		69.8	46.8
11/10/2005	God's love	53.9	36.9
22/12/2005		54.7	35.4
25/02/2006		55.4	36.8
19/04/2006		55.9	37.1
14/10/2005	Akwaaba	62.8	37.4
27/12/2005		61.4	38.6
28/02/2006		64.3	39.4
22/04/2006		67.4	38.1
18/10/2005	Majestic	57.1	33.1
30/12/2005		56.8	34.5
03/03/2006		62.8	35.7
24/04/2006		61.5	33.9

Table 13 cont'd

Date of sampling	Fast food vending site	Temperature (°C)	
		S	E
21/10/2005	God's Grace	57.8	35.7
02/01/2006		56.9	36.3
06/03/2006		62.3	34.9
27/04/2006		61.9	37.9

Percentage moisture content of dishes collected from vending sites

The mean recorded percentage moisture values of the food samples at each sampling time and date are presented in Table 14. On the whole most of the dishes had quite high percentage moisture content. There was not much difference between the percentage moisture content values of dishes at vending sites, sampling dates and collection times. 'Helenus' for example, showed 68.0 % and 69.0 %; 67.9 % and 68.5 %; 70.1 % and 67.4 % for fried rice at the collection times respectively on 28 / 07 / 2005 and 09 / 03 / 2006. Among the dishes, pepper sauce was observed to have the highest percentage moisture content at all the vending sites. For example, at 'God's Love' vending site the percentage moisture at the start of selling and towards the end of selling, that is approximately 8 hours of selling were 81.6 % and 78.9 % respectively on 11 / 10 / 05. The next highest percentage moisture was fried rice 72.5 %, followed by the coleslaw which was 68.5 %, fried chicken had the least percentage moisture of 54.7 %. The other sampling dates 22 / 12 / 2005 and 19 / 04 / 2006 had 86.4 % and 83.1 %; and 85.3 % and 79.8 % respectively for the pepper sauce. The above trend was observed for most of the sampling times and vending sites, though at certain times the values fluctuated as can be seen at 'Idaric' on 17 / 04 / 2006 and at 'Majestic' on 24 / 04 / 2006.

Table 14: Mean percentage moisture content of dishes collected from vending sites at start (S) and end (E) of selling

Date of Sampling	Fast food vending sites	Mean moisture content (%) of indicated dishes							
		Fried rice		Fried chicken		Coleslaw		Pepper sauce	
		S	E	S	E	S	E	S	E
28/07/05	Helenus	68.0	69.0	57.3	55.9	61.4	63.4	72.0	77.1
24/10/05		67.9	68.5	49.3	57.8	59.1	61.5	75.1	79.8
05/01/06		65.8	70.9	55.8	61.2	62.0	58.8	78.4	75.8
09/03/06		70.1	67.4	58.6	49.1	58.4	60.7	70.9	78.1
02/08/05	Chicago	68.3	70.7	57.2	53.2	62.2	65.0	75.3	80.7
27/10/05		67.5	71.5	59.7	54.8	64.3	66.4	77.3	74.9
09/01/06		69.8	72.6	56.4	55.4	62.3	63.8	80.1	82.5
11/03/06		67.5	69.7	58.9	50.9	61.0	67.1	76.4	81.3
08/08/05	Singapore	72.4	72.2	56.6	51.8	63.4	61.5	73.5	81.8
31/10/05		74.6	71.4	56.7	53.4	66.3	58.7	75.4	77.6
12/01/06		71.3	69.4	61.8	61.6	59.2	63.8	71.6	82.6
14/04/06		73.8	70.6	55.1	57.2	64.7	62.9	69.9	78.3
12/08/05	Unity	66.3	71.6	58.0	51.7	61.4	63.0	74.6	79.5
03/11/05		67.8	73.5	59.1	53.7	63.5	61.8	73.5	76.8
16/01/06		69.8	69.5	62.7	52.1	58.8	59.4	70.3	80.9
16/03/06		70.3	74.3	63.8	54.8	65.5	65.7	75.8	79.3

Table 14 cont'd

Date of Sampling	Fast food vending sites	Mean moisture content (%) of indicated dishes							
		Fried rice		Fried chicken		Coleslaw		Pepper sauce	
		S	E	S	E	S	E	S	E
16/08/05	Texas	67.4	70.3	56.4	58.1	60.7	64.7	74.1	80.5
07/11/05		68.4	71.5	55.3	59.3	58.6	65.7	78.3	76.3
20/01/06		65.3	68.2	56.7	61.8	62.7	70.5	83.1	83.7
18/03/06		70.6	76.1	60.3	62.3	63.2	73.1	76.2	83.4
20/08/05	Yanky's	73.0	71.1	55.7	56.3	65.7	73.2	75.3	77.8
10/11/05		72.1	69.4	56.3	57.8	66.3	74.5	76.3	81.3
24/01/06		74.5	73.5	54.5	54.3	70.1	72.6	73.8	77.8
21/03/06		73.2	72.6	61.4	62.5	68.5	71.6	79.9	80.5
24/08/05	Adom	69.0	72.9	58.9	58.5	58.1	65.2	75.0	80.7
14/11/05		70.2	73.5	59.6	57.3	59.6	64.7	80.1	79.6
23/01/06		68.4	69.4	63.5	64.3	60.5	68.2	84.1	82.5
24/03/06		73.5	68.9	61.8	62.3	63.4	66.5	78.4	78.3
30/08/05	Good Shepherd	73.2	68.4	54.9	53.9	64.5	61.7	77.6	79.3
17/11/05		71.5	69.5	55.6	58.9	60.4	62.1	76.8	80.7
26/01/06		69.5	67.3	58.8	54.5	68.2	61.9	78.3	79.9
27/04/08		78.2	70.5	53.7	51.7	65.1	59.8	79.3	82.1
03/09/05	Check Check	68.7	71.5	55.7	58.4	70.2	70.9	76.2	80.9
21/11/05		67.7	68.9	53.1	53.4	70.3	65.7	75.8	79.9
30/01/06		69.8	70.8	56.4	56.2	74.1	72.4	80.7	84.5
30/03/06		65.3	73.5	55.1	57.1	68.4	73.8	77.6	87.6

Table 14 cont'd

Date of Sampling	Fast food vending sites	Mean moisture content (%) of indicated dishes							
		Fried rice		Fried chicken		Coleslaw		Pepper sauce	
		S	E	S	E	S	E	S	E
12/09/05	Obaapa	66.7	71.0	62.9	50.5	64.2	70.2	76.3	87.2
28/11/05	Fausty	65.4	75.2	62.8	51.6	63.8	67.3	79.2	84.6
06/02/06		63.0	69.4	58.7	56.3	67.8	73.5	83.2	81.9
03/04/06		62.7	73.1	63.7	57.8	61.3	72.8	78.6	79.8
16/09/05	D'taste	67.8	71.1	57.2	61.0	68.0	63.7	82.2	84.0
02/12/05	Catering	68.7	72.6	56.2	62.3	67.3	65.1	77.5	79.2
09/02/06		65.8	75.1	63.8	64.3	65.9	61.8	82.6	85.1
06/04/06		70.9	68.4	52.8	59.3	70.2	59.9	80.4	78.6
06/09/05	Finger	70.7	70.5	64.1	62.2	69.9	63.6	86.6	82.3
24/11/05	Licking	68.2	75.2	63.5	61.3	71.5	62.3	77.1	80.3
02/02/06		71.0	67.8	65.0	64.3	68.3	65.9	76.9	79.5
01/40/06		72.3	69.3	61.2	58.9	72.4	60.2	79.0	81.4
26/09/05	Nyame	70.5	66.3	57.8	61.7	67.3	70.6	81.3	75.7
08/12/05	Adom	69.8	65.6	58.3	59.3	66.7	68.5	78.9	74.9
14/02/06		68.5	64.0	56.3	63.1	67.8	73.8	83.1	83.7
11/04/06		70.0	67.5	57.0	58.7	69.5	74.6	79.1	80.1

Table 14 cont'd

Date of Sampling	Fast food vending sites	Mean moisture content (%) of indicated dishes							
		Fried rice		Fried chicken		Coleslaw		Pepper sauce	
		S	E	S	E	S	E	S	E
30/09/05	California	69.2	70.7	59.9	65.0	66.2	66.1	79.7	87.2
12/12/05		67.2	68.7	58.6	64.8	65.3	65.9	80.2	78.6
17/02/06		71.8	72.8	57.9	67.3	67.4	67.2	83.4	79.8
13/04/06		74.6	71.6	62.8	63.8	63.0	68.1	78.6	83.1
20/09/05	Friends	69.5	71.4	66.5	58.6	63.7	68.8	81.9	78.1
05/12/05		68.3	70.8	65.3	57.8	62.7	62.4	78.5	77.5
11/02/06		73.5	69.0	58.7	58.2	61.8	61.9	76.1	82.5
08/04/06		69.4	72.8	63.9	59.4	64.8	65.4	70.9	83.7
03/10/05	Silver Bird Corner	73.2	71.3	62.8	60.4	61.9	63.6	86.9	81.0
15/12/05		73.5	68.2	60.5	57.3	60.4	62.8	80.8	76.8
20/02/06		70.2	73.2	63.7	63.8	62.4	61.5	79.7	82.4
15/04/06		69.8	71.9	59.7	64.5	63.8	65.7	78.7	83.7
07/10/05	Idaric	69.4	67.5	55.9	57.7	62.3	64.2	89.2	89.0
19/12/05		68.7	68.4	54.5	53.4	61.5	60.2	75.8	79.1
23/02/06		67.5	695.0	56.3	55.4	65.8	61.7	80.7	72.9
17/04/06		71.6	70.3	53.9	52.7	57.3	59.2	78.1	79.8
11/10/05	God's Love	72.5	69.8	59.2	54.7	68.4	63.9	81.6	78.9
22/12/05		69.4	65.3	57.1	56.4	66.1	65.2	86.4	83.1
25/02/06		68.7	70.2	55.3	57.8	68.7	69.7	79.9	84.7
19/04/06		73.5	64.5	56.8	60.7	67.8	61.8	85.3	79.8

Table 14 cont'd

Date of Sampling	Fast food vending sites	Mean moisture content (%) of indicated dishes							
		Fried rice		Fried chicken		Coleslaw		Pepper sauce	
		S	E	S	E	S	E	S	E
14/10/05	Akwaaba	72.9	67.3	60.4	62.3	65.6	59.0	86.0	82.4
27/12/05		71.5	63.5	59.3	63.9	64.8	57.6	83.6	81.3
28/02/06		69.7	64.7	62.7	61.7	67.3	64.7	79.4	77.8
22/04/06		73.4	68.5	61.4	59.3	66.0	63.0	80.6	85.6
18/10/05	Majestic	67.2	69.6	66.8	56.5	67.7	70.3	80.6	85.6
30/12/05		68.9	68.4	54.9	55.8	65.4	71.9	86.1	83.4
03/03/06		75.3	67.9	58.4	55.4	66.9	72.4	79.5	79.4
24/04/06		62.6	72.5	57.3	53.4	68.1	69.4	77.8	81.2
21/10/05	God's Grace	72.7	63.0	62.4	57.7	62.9	64.9	89.5	89.9
02/01/05		71.6	72.6	58.7	58.2	64.8	65.1	78.6	77.6
06/03/06		67.8	61.3	65.3	56.1	57.3	63.4	83.7	86.4
27/04/06		75.3	60.5	67.5	58.4	65.8	69.7	81.0	80.9

pH Values of food samples

The mean pH values of the indicated dishes are presented in Table 15. The pH values recorded for fried rice, fried chicken, coleslaw and pepper sauce did not differ much. Among the vending sites the values did not differ much. 'Chicago' for instance had pH 4.5 and 5.1 at start of selling and towards the end of selling, respectively for fried rice on 02 / 08 / 05. The pH values for most of the indicated dishes were slightly acidic.

Table 15: Mean pH values of food samples at start (S) and end (E) of selling

Date of Sampling	Fast food vending sites	Mean pH value of indicated dishes							
		Fried rice		Fried chicken		Coleslaw		Pepper sauce	
		S	E	S	E	S	E	S	E
28/07/05	Helenus	4.4	5.2	5.8	5.6	4.6	5.8	4.1	4.0
24/10/05		4.8	4.8	5.1	5.5	4.9	4.9	4.5	5.5
05/01/06		4.3	4.6	4.9	4.7	5.0	5.4	4.1	4.3
09/03/06		5.7	5.1	5.3	4.1	5.3	5.1	4.2	0.6
02/08/05	Chicago	4.5	5.1	5.3	4.8	4.6	5.1	4.3	4.1
27/10/05		5.8	5.3	5.4	5.2	4.0	5.3	4.1	4.1
09/01/06		4.6	6.0	4.8	5.7	6.5	5.7	4.1	4.8
11/03/06		4.7	5.8	6.2	5.6	6.8	5.4	4.3	5.0
08/08/05	Singapore	4.0	5.4	6.7	5.3	4.8	5.3	4.0	4.0
31/10/05		4.8	4.8	5.8	5.4	4.3	4.8	4.9	4.5
12/01/06		4.4	4.7	5.4	4.8	5.4	4.6	5.2	5.2
14/04/06		4.8	5.3	4.6	4.5	5.6	4.7	4.0	4.0
12/08/05	Unity	4.9	4.6	6.5	5.3	5.7	4.0	4.1	4.1
03/11/05		5.3	5.7	6.0	6.3	5.1	6.1	4.1	4.2
16/01/06		5.7	4.8	5.8	5.7	4.9	5.4	4.3	4.1
16/03/06		4.9	6.2	4.7	4.6	4.4	5.5	4.9	4.8
16/08/05	Texas	5.3	5.8	6.2	4.3	4.6	5.2	5.1	4.9
07/11/05		4.3	5.2	6.1	4.5	4.5	4.9	4.6	4.5
20/01/06		5.3	5.3	5.6	4.6	4.6	5.1	4.3	4.8
18/03/06		5.6	4.9	4.8	4.6	5.6	4.9	4.8	5.1

Table 15 cont'd

Date of Sampling	Fast food vending sites	Mean pH value of indicated dishes							
		Fried rice		Fried chicken		Coleslaw		Pepper sauce	
		S	E	S	E	S	E	S	E
20/08/05	Yanky's	4.9	4.6	4.2	5.6	5.6	4.7	5.4	5.0
10/11/05		4.8	4.8	4.9	5.2	5.6	5.2	6.0	5.5
24/01/06		5.6	4.6	5.6	5.1	5.2	4.8	5.2	4.9
21/03/06		5.3	5.1	5.0	4.9	5.6	5.1	4.6	4.7
24/08/05	Adom	5.7	5.3	4.9	5.3	5.8	5.0	4.7	5.1
14/11/05		4.6	4.2	5.3	5.2	5.3	4.9	4.6	4.9
23/01/06		4.8	4.1	4.2	4.4	5.7	5.6	5.3	5.7
24/03/06		4.2	5.6	6.2	5.9	4.5	4.9	5.1	5.9
30/08/05	Good Shepherd	5.3	4.8	5.4	5.6	4.8	5.0	4.1	4.6
17/11/05		6.0	5.8	4.8	4.6	4.2	4.8	4.0	4.8
26/01/06		6.2	5.1	4.6	4.4	4.4	5.1	4.0	5.8
27/04/08		5.4	4.3	4.8	4.9	5.7	4.9	4.1	5.2
03/09/05	Check Check	5.3	4.8	5.6	4.8	5.3	4.9	4.1	5.2
21/11/05		4.9	4.3	5.2	5.6	4.5	5.2	4.3	4.9
30/01/06		4.6	5.7	5.4	5.7	5.4	5.1	4.0	5.4
30/03/06		4.2	5.5	4.9	5.8	4.6	4.9	4.1	4.9
12/09/05	Obaapa Fausty	4.9	4.6	4.0	4.8	5.7	4.9	5.1	4.0
28/11/05		5.3	5.3	5.0	5.3	5.0	5.2	5.3	4.6
06/02/06		4.6	5.2	5.3	4.6	4.3	4.7	4.6	4.8
03/04/06		5.3	5.3	4.6	5.2	6.3	5.3	4.8	4.3

Table 15 cont'd

Date of Sampling	Fast food vending sites	Mean pH value of indicated dishes							
		Fried rice		Fried chicken		Coleslaw		Pepper sauce	
		S	E	S	E	S	E	S	E
16/09/05	D'taste	4.2	4.6	5.8	4.6	5.9	4.8	4.7	4.1
02/12/05	Catering	4.5	4.3	5.7	5.6	5.7	4.3	4.5	4.1
09/02/06	Services	5.3	4.8	5.6	5.4	4.6	4.7	5.1	4.1
06/04/06		4.4	4.9	5.9	4.6	4.5	5.3	4.6	4.8
06/09/05	Finger	6.3	5.9	4.8	5.4	4.8	5.3	4.4	5.0
24/11/05	Licking	5.5	5.3	4.6	5.3	4.6	5.2	4.3	4.0
02/02/06		4.6	4.8	4.3	4.9	4.3	4.6	5.0	4.1
01/04/06		4.3	5.3	4.8	5.6	4.5	4.8	4.6	4.1
26/09/05	Nyame	5.0	5.7	4.8	5.3	4.8	4.6	5.3	4.1
08/12/05	Adom	4.9	4.3	4.6	4.7	5.7	5.2	4.9	4.6
14/02/06		5.3	5.6	5.3	5.2	6.0	5.1	4.8	4.1
11/04/06		4.3	4.8	4.1	4.5	4.3	4.9	47.0	4.9
30/09/05	California	5.1	5.7	4.9	5.1	5.8	4.6	4.5	4.1
12/12/05		4.6	5.3	4.6	4.9	5.3	5.1	4.4	4.0
17/02/06		4.3	4.8	4.3	5.2	4.8	4.9	4.3	4.3
13/04/06		4.9	4.6	4.5	4.6	5.2	5.3	4.5	4.0
20/09/05	Friends	4.6	5.8	4.6	4.3	4.3	4.8	5.1	4.9
05/12/05		4.8	4.5	5.8	5.9	5.3	4.9	4.6	4.5
11/02/06		5.2	5.8	4.3	4.6	5.2	5.4	4.7	4.0
08/04/06		4.7	4.8	4.6	4.7	4.2	5.1	4.6	4.8

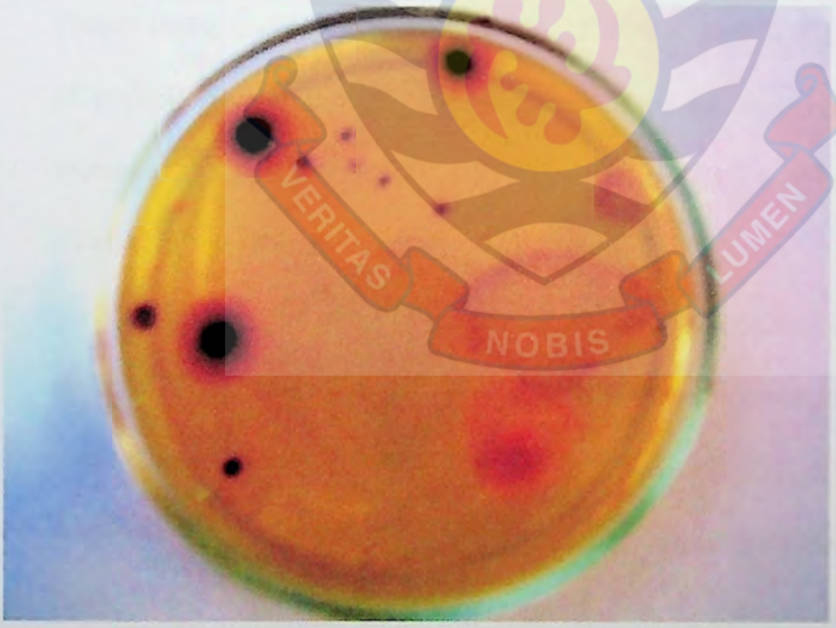
Date of Sampling	Fast food vending sites	Mean pH value of indicated dishes							
		Fried rice		Fried chicken		Coleslaw		Pepper sauce	
		S	E	S	E	S	E	S	E
03/10/05	Silver Bird	5.0	4.8	4.2	4.5	4.9	4.8	4.8	4.6
15/12/05	Corner	5.3	5.1	5.3	4.7	4.6	4.6	4.0	4.1
20/02/06		6.0	5.5	5.7	4.3	4.5	5.3	4.0	4.1
15/04/06		4.8	5.3	4.9	5.3	4.7	5.7	4.8	4.1
07/10/05	Idaric	4.6	5.6	5.3	4.6	5.3	4.6	4.1	4.6
19/12/05		5.1	4.8	5.6	5.1	5.7	4.3	4.1	4.0
23/02/06		4.3	4.7	4.8	4.9	4.2	4.8	4.8	4.3
17/04/06		4.6	5.3	5.7	4.8	5.1	5.8	4.1	4.0
11/10/05	God's	4.8	5.9	4.4	5.3	4.9	4.7	4.8	4.3
22/12/05	Love	5.2	4.8	5.2	5.8	5.3	5.7	4.6	4.6
25/02/06		4.9	5.4	4.9	5.2	5.0	5.5	4.0	4.7
19/04/06		4.6	4.9	5.4	4.9	6.1	4.9	4.1	4.0
14/10/05	Akwaaba	4.8	5.0	5.3	4.6	5.9	5.2	4.9	4.0
27/12/05		4.9	5.5	4.6	5.3	6.3	5.6	4.4	4.6
28/02/06		5.2	5.6	4.7	5.7	5.2	5.7	4.0	4.4
22/04/06		4.6	4.5	4.3	4.4	4.9	4.6	4.3	4.0
18/10/05	Majestic	4.5	5.4	5.1	5.5	5.2	5.5	4.0	4.0
30/12/05		4.5	5.3	5.2	5.4	5.3	5.6	4.9	5.4
03/03/06		5.5	4.9	4.4	4.8	4.6	5.8	5.5	4.9
24/04/06		4.9	4.8	5.7	5.1	4.8	4.6	5.6	4.8

Table 15 cont'd

	Fast food	Mean pH value of indicated dishes							
Date of	vending	Fried rice		Fried chicken		Coleslaw		Pepper sauce	
Sampling	sites	S	E	S	E	S	E	S	E
21/10/05	God's	5.6	5.1	5.5	4.9	5.3	5.1	5.3	4.1
02/01/05	Grace	5.8	5.3	4.9	4.3	4.7	5.9	4.8	4.6
06/03/06		4.6	4.8	5.6	4.6	4.8	5.1	4.9	4.5
27/04/06		5.7	5.6	5.1	4.5	4.8	4.6	4.7	4.9

Microbial load of dishes

Tables 16a to 36c show the general trends in the total bacteria, total coliform bacteria, and *Salmonella* and *Shigella* counts from the fast foods of the different vending sites.



x 7/9

Plate 4: *Salmonella* (pink with black center) and *Shigella* (pink) colonies on SS agar

Total bacteria count

The total viable bacteria count was very low at the time of start of selling (S) as compared with time at end of selling (E). Helenus fast food vending site on 28/07/05 had 20.8 x 10^5 cfu/g and 57.4 x 10^5 cfu/g for fried rice at the start and end of selling, respectively. Also on 24/10/05 the total bacteria for fried rice at start and end of selling was 5.6 x 10^5 and 57.1 x 10^5 cfu/g, respectively. On all the four sampling dates no total bacteria were encountered in fried chicken at both collection times, coleslaw had the highest total bacteria count on all four sampling dates. The total bacteria count was much higher at the time towards end of selling than at the time of start of selling. At the time of start of selling on 28/07/05, 24/10/05, 05/01/06 and 09/03/06, the total bacteria count were 297.5 x 10^5, 285.5 x 10^5, 216.4 x 10^5 and 205.2 x 10^5 cfu/g respectively, for coleslaw. Towards end of selling, total bacteria counts were 442.5 x 10^5, 445.5 x 10^5, 450.5 x 10^5 and 262.3 x 10^5 cfu/g, respectively. Pepper sauce had 12.5x10^5, 38.0 x 10^5, 24.2 x 10^5 and 33.4 x 10^5 cfu/g in order of collection dates at the start of selling. Towards the end of selling it had increased to 44.4 x 10^5, 92.3 x 10^5, 46.0 x 10^5 and 85.7 x 10^5 cfu/g, respectively on all sampling dates (Table 16a).

This was the trend in almost all of fast food vending sites except a few such as Finger licking at Abura which had no total bacteria count in pepper sauce, fried chicken and for almost all of the collection times of fried rice except the collection time toward the end of selling on 06/09/05. Coleslaw from Finger licking had the total bacteria count on both collection times, 9.0 x 10^5, 13.1 x 10^5, 14.2 x 10^5 and 10.2 x 10^5 cfu/g at start of selling and 18.8 x 10^5, 21.0

x 10^5, 16.8 x 10^5, and 23.0 x 10^5 cfu/g at the end of selling in chronological order (Table 27a).

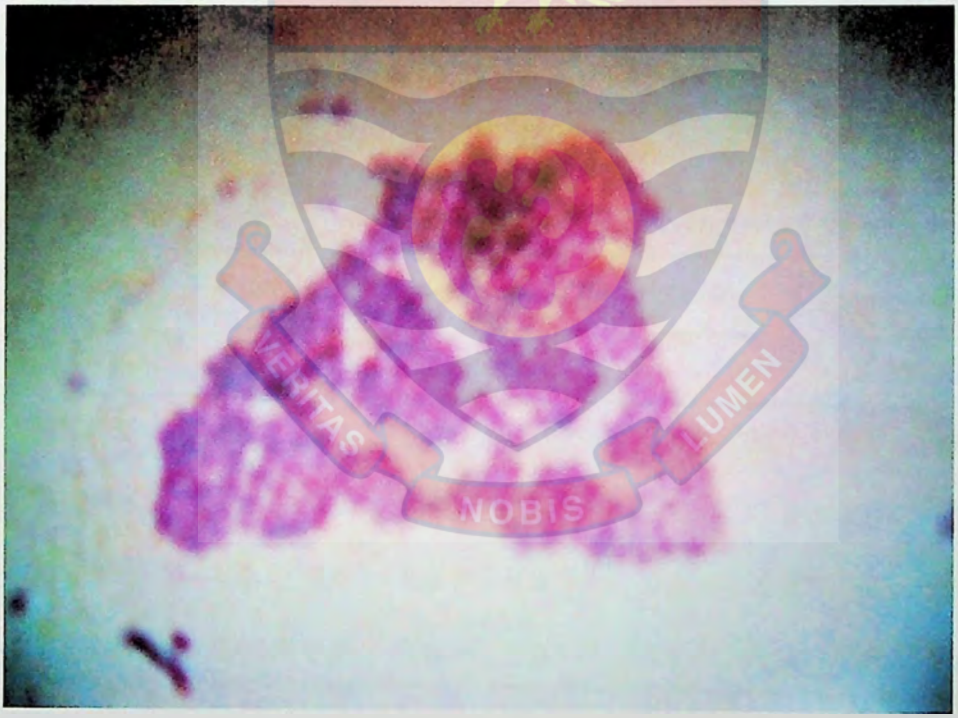
x 1

Plate 5: Total bacterial colonies on plate count agar

Coliform

Coliform bacteria isolated from the test food samples at the various fast food vending sites are recorded and presented in Tables 16b, 17b, 18b, 19b, 20b, 21b, 22b, 23b, 24b, 25b, 26b, 27b, 28b, 29b, 30b, 31b, 32b, 33b, 34b, 35b and 36b. At Helenus, coliform bacteria were not recorded in fried rice, fried chicken and pepper sauce at any of the collection times for the four sampling dates (Table 16b). However, some coliforms were encountered in coleslaw. At the start of selling the mean number of coliforms encountered was 135 x 10^5, 28.8 x 10^5, and 34.5 x 10^5cfu/g on 28/07/05, 24/10/05 and 09/03/06, respectively. For collections done towards the end of selling the mean numbers of coliforms were 200.7 x 10^5, 57.6 x 10^5 and 64.6 x 10^5 cfu/g, respectively on the various collection dates respectively (Table 16b).

This trend of observations was also recorded for all the other fast food vending sites. However, Finger licking recorded very low coliforms, coleslaw from Finger licking had 2.4 x 10^5, 4.7 x 10^5 and 6.8 x 10^5 cfu/g (Table 27b). Helenus fast food did not record any *Salmonella* colonies in almost all the samples taken for analysis except for the sample take towards the end of selling for coleslaw which was 2.3 x 10^5cfu/g on 09/03/06. On the same sample collected on 09/03/06, 1.8 x 10^5 cfu/g was recorded for *Shigella* (Table 16c). Chicago, Texas, Finger licking, did not record any *Salmonella* nor *Shigella* in food samples collected from them (Tables, 17c, 20c, 27c). Friends fast food vending site had *Salmonella*, but not *Shigella* (Table 30c).



x700

Plate 6: Stained *Staphylococcus* sp. isolated from test food samples

Table 16a: Total bacteria isolated from food samples on four sampling dates from Helenus fast food vending site at UCC at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
	S	E	S	E	S	E	S	E
28/07/05	20.8	57.4	0.0	0.0	297.5	442.2	12.5	44.4
24/10/05	5.6	57.1	0.0	0.0	285.6	445.5	38.0	92.3
05/01/06	39.8	63.9	0.0	0.0	216.4	450.5	24.2	46.0
09/03/06	24.2	45.2	0.0	0.0	205.2	462.3	33.4	85.7

Table 16b: Coliform bacteria isolated from food samples on four sampling dates from Helenus fast food vending site at UCC at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
	S	E	S	E	S	E	S	E
28/07/05	0.0	0.0	0.0	0.0	135.0	200.7	0.0	0.0
24/10/05	0.0	0.0	0.0	0.0	28.8	57.6	0.0	0.0
05/01/06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/03/06	0.0	0.0	0.0	0.0	34.5	64.6	0.0	0.0

Table 16c: *Salmonella* and *Shigella* isolated from food samples on two sampling dates from Helenus fast food vending site at UCC at start (S) and end (E) of selling

Sampling Date	Organism	Mean number of colony forming units (cfu/g x 10^5) fried rice S	fried rice E	fried chicken S	fried chicken E	coleslaw S	coleslaw E	Pepper sauce S	Pepper sauce E
05/01/06	*Salmonella*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/03/06		0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0
05/01/06	*Shigella*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/03/06		0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0

Table 17a: Total bacteria isolated from food samples on four sampling dates from Chicago fast food vending site at UCC at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units (cfu/g x 10^5) fried rice S	fried rice E	fried chicken S	fried chicken E	coleslaw S	coleslaw E	Pepper sauce S	Pepper sauce E
02/08/05	9.6	58.1	0.0	0.0	175.3	259.9	19.4	94.8
27/10/05	8.4	38.6	0.0	0.0	160.7	252.2	22.7	70.6
09/01/06	23.6	70.5	0.0	0.0	239.3	279.6	51.6	104.8
11/03/06	16.3	45.4	0.0	0.0	145.9	207.1	35.3	112.5

Table 17b: Coliform bacteria isolated from food samples on four sampling dates from Chicago fast food vending site at UCC at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
	S	E	S	E	S	E	S	E
02/08/05	0.0	0.0	0.0	0.0	28.0	43.5	0.0	0.0
27/10/05	0.0	0.0	0.0	0.0	12.1	26.0	0.0	0.0
09/01/06	0.0	0.0	0.0	0.0	14.5	39.8	0.0	0.0
11/03/06	0.0	0.0	0.0	0.0	19.3	31.9	0.0	0.0

Table 17c: *Salmonella* and *Shigella* isolated from food samples on two sampling dates from Chicago fast food vending site at UCC at start (S) and end (E) of selling

Sampling Date	Organism	Mean number of colony forming units (cfu/g x 10^5)							
		fried rice		fried chicken		coleslaw		Pepper sauce	
		S	E	S	E	S	E	S	E
09/01/06	*Salmonella*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11/03/06		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/01/06	*Shigella*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11/03/06		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 18a: Total bacteria isolated from food samples on two sampling dates from Singapore fast food vending site at UCC at start (S) and end (E) of selling

Sampling	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
Date	S	E	S	E	S	E	S	E
08/08/05	15.4	34.2	0.0	0.0	144.1	231.5	0.0	9.8
31/10/05	33.2	62.3	0.0	0.0	121.1	239.9	6.5	39.6
12/01/06	44.2	101.1	0.0	0.0	112.4	206.8	12.2	22.6
14/03/06	26.6	92.4	0.0	0.0	108.2	251.2	0.0	19.2

Table 18b: Coliform bacteria isolated from food samples on four sampling dates from Singapore fast food vending site at UCC at start (S) and end (E) of selling

Sampling	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
Date	S	E	S	E	S	E	S	E
08/08/05	0.0	0.0	0.0	0.0	35.3	43.6	0.0	0.0
31/10/05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12/01/06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14/03/06	0.0	0.0	0.0	0.0	22.5	32.6	0.0	0.0

Table 18c: *Salmonella* and *Shigella* isolated from food samples on two sampling dates from Singapore fast food vending site at UCC at start (S) and end (E) of selling

Sampling Date	Organism	Mean number of colony forming units (cfu/g x 10^5)							
		fried rice		fried chicken		coleslaw		Pepper sauce	
		S	E	S	E	S	E	S	E
12/01/06	*Salmonella*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14/03/06		0.0	0.0	0.0	0.0	2.4	3.0	0.0	0.0
12/01/06	*Shigella*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14/03/06		0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0

Table 19a: Total bacteria isolated from food samples on four sampling dates from Unity fast food vending site at Kingsway at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
	S	E	S	E	S	E	S	E
12/08/05	5.8	23.2	2.4	8.0	83.2	187.2	11.0	103.0
03/11/05	0.0	39.9	0.0	0.0	161.8	218.2	0.0	0.0
16/01/06	0.0	0.0	0.0	0.0	59.2	104.5	0.0	0.0
16/03/06	15.9	69.1	0.0	0.0	139.0	221.7	0.0	0.0

Table 19b: Coliform bacteria isolated from food samples on four sampling dates from Unity fast food vending site at Kingsway at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
	S	E	S	E	S	E	S	E
12/08/05	0.0	0.0	0.0	0.0	9.2	18.5	0.0	0.0
03/11/05	0.0	0.0	0.0	0.0	14.7	32.1	0.0	0.0
16/01/06	0.0	0.0	0.0	0.0	2.0	15.9	0.0	0.0
16/03/06	0.0	0.0	0.0	0.0	9.5	25.9	0.0	0.0

Table 19c: *Salmonella* and *Shigella* isolated from food samples on two sampling dates from Unity fast food vending site at Kingsway at start (S) and end (E) of selling

Sampling Date	Organism	Mean number of colony forming units (cfu/g x 10^5)							
		fried rice		fried chicken		coleslaw		Pepper sauce	
		S	E	S	E	S	E	S	E
16/01/06	*Salmonella*	0.0	0.0	0.0	0.0	0.0	9.1	0.0	0.0
16/03/06		0.0	0.0	0.0	0.0	2.6	6.1	0.0	0.0
16/01/06	*Shigella*	0.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0
16/03/06		0.0	0.0	0.0	0.0	1.6	3.3	0.0	0.0

Table 20a: Total bacteria isolated from food samples on four sampling dates from Texas fast food vending site at Kingsway a start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units ($cfu/g \times 10^5$)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
	S	E	S	E	S	E	S	E
16/08/05	2.5	15.9	0.0	0.0	44.8	107.1	7.8	91.7
07/11/05	38.5	93.4	27.4	43.7	114.8	350.0	20.9	115.8
20/01/06	26.4	81.2	0.0	18.3	92.9	192.9	75.0	71.7
18/03/06	20.1	82.4	0.0	27.8	39.1	85.6	14.0	63.4

Table 20b: Coliform bacteria isolated from food samples on four sampling date from Texas fast food vending site at Kingsway at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units ($cfu/g \times 10^5$)							
	fried rice		fried chicken		coleslaw		Pepper auce	
	S	E	S	E	S	E	S	E
16/08/05	0.0	0.0	0.0	0.0	10.0	35.7	0.0	0.0
07/11/05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20/01/06	0.0	0.0	0.0	0.0	4.8	15.2	0.0	0.0
18/03/06	0.0	0.0	0.0	0.0	7.0	16.8	0.0	0.0

Table 20c: *Salmonella* and *Shigella* isolated from food samples on two sampling dates from Texas fast food vending site at Kingsway at start (S) and end (E) of selling

Sampling		Mean number of colony forming units (cfu/g x 10^5)							
		fried rice		fried chicken		coleslaw		Pepper sauce	
Date	Organism	S	E	S	E	S	E	S	E
20/01/06	*Salmonella*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18/03/06		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20/01/06	*Shigella*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18/03/06		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 21a: Total bacteria isolated from food samples on four sampling dates from Yanky's fast food vending site at Kingsway at start (S) and end (E) of selling

Sampling	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
Date	S	E	S	E	S	E	S	E
20/08/05	39.7	130.5	18.4	44.2	114.0	340.2	66.7	224.2
10/11/05	7.3	63.9	0.0	29.3	72.0	148.5	31.4	102.0
24/01/06	26.0	97.6	0.0	41.6	182.4	244.2	41.9	130.2
21/03/06	7.6	100.7	0.0	18.4	154.7	333.3	4.7	33.9

Table 21b: Coliform bacteria isolated from food samples on four sampling dates from Yanky's fast food vending site at Kingsway at start (S) and end (E) of selling

	Mean number of colony forming units (cfu/g x 10^5)							
Sampling	fried rice		fried chicken		coleslaw		Pepper sauce	
Date	S	E	S	E	S	E	S	E
20/08/05	0.0	0.0	0.0	0.0	26.3	73.8	0.0	0.0
10/11/05	0.0	0.0	0.0	0.0	9.4	17.5	0.0	0.0
24/01/06	0.0	0.0	0.0	0.0	3.1	9.2	0.0	0.0
21/03/06	0.0	0.0	0.0	0.0	0.0	10.9	0.0	0.0

Table 21c: *Salmonella* and *Shigella* isolated from food samples on two sampling dates from Yanky's fast food vending site at Kingsway at start (S) and end (E) of selling

		Mean number of colony forming units (cfu/g x 10^5)							
Sampling		fried rice		fried chicken		coleslaw		Pepper sauce	
Date	Organism	S	E	S	E	S	E	S	E
24/01/06	*Salmonella*	0.0	0.0	0.0	0.0	2.2	3.8	0.0	0.0
21/03/06		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24/01/06	*Shigella*	0.0	0.0	0.0	0.0	1.8	2.6	0.0	0.0
21/03/06		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 22a: Total bacteria isolated from food samples on four sampling date from Adom fast food vending site at Kotokuraba at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
	S	E	S	E	S	E	S	E
24/08/05	155.4	350.8	23.8	32.6	247.6	556.8	0.0	0.0
14/11/05	155.1	334.9	26.4	37.2	226.2	578.9	0.0	0.0
23/01/06	203.2	348.6	27.8	50.4	234.2	331.5	5.0	27.6
24/03/06	194.7	305.6	4.3	29.7	203.5	516.3	0.0	24.6

Table 22b: Coliform bacteria isolated from food samples on four sampling dates from Adom fast food vending site at Kotokuraba at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
	S	E	S	E	S	E	S	E
24/08/05	0.0	0.0	0.0	0.0	4.8	31.4	0.0	0.0
14/11/05	1.0	1.6	0.0	0.0	2.4	30.7	0.0	0.0
23/01/06	0.0	0.0	0.0	0.0	2.6	8.4	0.0	0.0
24/03/06	10.2	46.4	0.0	0.0	8.7	42.7	0.0	0.0

Table 22c: *Salmonella* and *Shigella* isolated from food samples on two sampling dates from Adom fast food vending site at Kotokuraba at start (S)and end (E) of selling

		Mean number of colony forming units (cfu/g x 10^5)							
Sampling		fried rice		fried chicken		coleslaw		Pepper sauce	
Date	Organism	S	E	S	E	S	E	S	E
23/01/06	*Salmonella*	0.0	0.0	0.0	0.0	1.8	2.4	0.0	0.0
24/03/06		0.0	0.0	0.0	0.0	4.3	8.5	0.0	0.0
23/01/06	*Shigella*	0.0	0.0	0.0	0.0	1.2	2.1	0.0	0.0
24/03/06		0.0	0.0	0.0	0.0	2.5	3.6	0.0	0.0

Table 23a: Total bacteria isolated from food samples on four sampling dates from Good shepherd fast food vending site at Kotokuraba at start (S) and end (E) of selling

	Mean number of colony forming units (cfu/g x 103)							
Sampling	fried rice		fried chicken		coleslaw		Pepper sauce	
Date	S	E	S	E	S	E	S	E
30/08/05	21.8	125.6	0.0	0.0	241.7	334.4	0.0	0.0
17/11/05	78.6	117.7	0.0	33.6	188.8	277.6	14.0	66.0
26/01/06	84.1	152.6	0.0	0.0	130.3	300.0	12.2	66.7
27/03/06	39.3	95.6	15.2	40.9	189.1	350.8	6.5	20.4

Table 23b: Coliform bacteria isolated from food samples on four sampling dates from Good Shepherd fast food vending site at Kotokuraba at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
	S	E	S	E	S	E	S	E
30/08/05	0.0	12.3	0.0	0.0	13.2	18.0	0.0	0.0
17/11/05	0.0	0.0	0.0	0.0	23.8	51.0	0.0	0.0
26/01/06	11.5	57.2	0.0	0.0	23.7	107.7	0.0	0.0
27/03/06	0.0	0.0	0.0	0.0	7.5	33.3	0.0	0.0

Table 23c: *Salmonella* and *Shigella* isolated from food samples on two sampling dates from Good Shepherd fast food vending site at Kotokuraba at start (S) and end (E) of selling

Sampling Date	Organism	Mean number of colony forming units (cfu/g x 10^5)							
		fried rice		fried chicken		coleslaw		Pepper sauce	
		S	E	S	E	S	E	S	E
26/01/06	*Salmonella*	0.0	0.0	0.0	0.0	11.8	30.8	0.0	0.0
27/03/06		0.0	0.0	0.0	0.0	4.6	9.4	0.0	0.0
26/01/06	*Shigella*	0.0	0.0	0.0	0.0	5.8	16.9	0.0	0.0
27/03/06		0.0	0.0	0.0	0.0	2.1	4.9	0.0	0.0

Table 24a: Total bacteria isolated from food samples on four sampling dates from Check Check fast food vending site at Kotokuraba at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
	S	E	S	E	S	E	S	E
03/09/05	42.6	73.6	0.0	0.0	120.5	277.3	15.6	103.7
21/11/05	37.1	72.7	0.0	0.0	111.5	162.3	23.5	62.3
30/01/06	26.0	48.4	4.6	16.3	158.0	240.5	9.8	45.1
30/03/06	33.0	52.5	2.2	18.0	256.1	349.3	45.7	113.1

Table 24b: Coliform bacteria isolated from food samples on four sampling dates from Check Check fast food vending site at Kotokuraba at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
	S	E	S	E	S	E	S	E
03/09/05	0.0	10.5	0.0	0.0	35.4	39.4	0.0	0.0
21/11/05	0.0	0.0	0.0	0.0	29.5	39.0	0.0	0.0
30/01/06	9.4	35.6	0.0	0.0	8.4	97.7	0.0	0.0
30/03/06	0.0	0.0	0.0	0.0	77.7	167.8	0.0	0.0

Table 24c: *Salmonella* and *Shigella* isolated from food samples on two sampling dates from Check Check fast food vending site at Kotokuraba at start (S) and end (E) of selling

Sampling Date	Organism	Mean number of colony forming units (cfu/g x 10^5) fried rice S	fried rice E	fried chicken S	fried chicken E	coleslaw S	coleslaw E	Pepper sauce S	Pepper sauce E
30/01/06	*Salmonella*	0.0	20.7	0.0	0.0	0.0	35.1	0.0	0.0
30/03/06		0.0	0.0	0.0	0.0	34.0	65.1	0.0	0.0
30/01/06	*Shigella*	0.0	0.0	0.0	0.0	0.0	22.5	0.0	0.0
30/03/06		0.0	0.0	0.0	0.0	29.1	51.4	0.0	0.0

Table 25a: Total bacteria isolated from food samples on four sampling dates from Obaapa Fuasty fast food vending site at Abura at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units (cfu/g x 10^5) fried rice S	fried rice E	fried chicken S	fried chicken E	coleslaw S	coleslaw E	Pepper sauce S	Pepper sauce E
12/09/05	3.0	61.5	0.0	0.0	27.8	91.2	0.0	0.0
28/11/05	5.8	35.5	2.9	6.0	48.4	138.3	0.0	5.3
06/02/06	0.0	13.6	0.0	0.0	38.1	62.4	0.0	0.0
03/04/06	6.0	36.0	12.4	38.8	93.9	151.9	7.6	52.4

Table 25b: Coliform bacteria isolated from food samples on four sampling dates from Obaapa Fausty fast food vending site at Abura at start (S) and end (E) of selling

	Mean number of colony forming units (cfu/g x 10^5)							
Sampling	fried rice		fried chicken		coleslaw		Pepper sauce	
Date	S	E	S	E	S	E	S	E
12/09/05	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0
28/11/05	0.0	0.0	0.0	0.0	0.0	13.1	0.0	0.0
06/02/06	0.0	0.0	0.0	0.0	2.9	4.8	0.0	0.0
03/04/06	0.0	0.0	0.0	0.0	15.4	46.6	0.0	0.0

Table 25c: *Salmonella* and *Shigella* isolated from food samples on two sampling dates from Obaapa Fausty fast food vending site at Abura at start (S) and end (E) of selling

		Mean number of colony forming units (cfu/g x 10^5)							
Sampling		fried rice		fried chicken		coleslaw		Pepper sauce	
Date	Organism	S	E	S	E	S	E	S	E
06/02/06	*Salmonella*	0.0	0.0	0.0	0.0	1.6	2.8	0.0	0.0
03/04/06		0.0	0.0	0.0	0.0	6.3	14.7	0.0	0.0
06/02/06	*Shigella*	0.0	0.0	0.0	0.0	1.2	1.9	0.0	0.0
03/04/06		0.0	0.0	0.0	0.0	3.7	8.6	0.0	0.0

Table 26a: Total bacteria isolated from food samples on four sampling dates from D'taste fast food vending site at Abura at start (S) and end (E) of selling

Sampling	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
Date	S	E	S	E	S	E	S	E
16/09/05	15.6	42.6	4.2	16.3	69.1	119.0	0.0	0.0
02/12/05	0.0	33.1	0.0	25.4	46.3	115.9	4.8	35.0
09/02/06	3.4	20.9	0.0	0.0	24.6	56.7	0.0	0.0
06/04/06	8.3	41.2	0.0	0.0	53.9	108.7	9.5	47.1

Table 26b: Coliform bacteria isolated from food samples on four sampling dates from D'taste fast food vending site at Abura at start (S) and end (E) of selling

Sampling	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
Date	S	E	S	E	S	E	S	E
16/09/05	0.0	0.0	0.0	0.0	10.6	47.9	0.0	0.0
02/12/05	0.0	0.0	0.0	0.0	18.7	33.3	0.0	0.0
09/02/06	0.0	5.5	0.0	0.0	2.6	6.9	0.0	0.0
06/04/06	3.4	11.7	0.0	0.0	21.2	37.6	0.0	0.0

Table 26c: *Salmonella* and *Shigella* isolated from food samples on two sampling dates from D'taste fast food vending site at Abura at start (S) and end (E) of selling

		Mean number of colony forming units (cfu/g x 10^5)							
Sampling		fried rice		fried chicken		coleslaw		Pepper sauce	
Date	Organism	M	E	M	E	M	E	M	E
09/02/06	*Salmonella*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
06/04/06		0.0	0.0	0.0	0.0	0.0	9.3	0.0	0.0
09/02/06	*Shigella*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
06/04/06		0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0

Table 27a: Total bacteria isolated from food samples on four sampling dates from Finger Licking fast food vending site at Abura at start (S) and end (E) of selling

	Mean number of colony forming units (cfu/g x 10^5)							
Sampling	fried rice		fried chicken		coleslaw		Pepper sauce	
Date	S	E	S	E	S	E	S	E
06/09/05	0.0	6.5	0.0	0.0	9.0	18.8	0.0	0.0
24/11/05	0.0	0.0	0.0	0.0	13.1	21.0	0.0	0.0
02/02/06	0.0	0.0	0.0	0.0	14.2	16.8	0.0	0.0
01/04/06	0.0	0.0	0.0	0.0	10.2	23.0	0.0	0.0

Table 27b: Coliform bacteria isolated from food samples on four sampling dates from Finger Licking fast food vending site at Abura at start (S) and end (E) of selling

Sampling	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		pepper sauce	
Date	S	E	S	E	S	E	S	E
06/09/05	0.0	0.0	0.0	0.0	0.0	6.8	0.0	0.0
24/11/05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
02/02/06	0.0	0.0	0.0	0.0	2.4	4.7	0.0	0.0
01/04/06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 27c: *Salmonella* and *Shigella* isolated from food samples on two sampling dates from Finger Licking fast food vending site at Abura at start (S) and end (E) of selling

Sampling		Mean number of colony forming units (cfu/g x 10^5)							
		fried rice		fried chicken		coleslaw		Pepper sauce	
Date	Organism	S	E	S	E	S	E	S	E
02/02/06	*Salmonella*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
01/04/06		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
02/02/06	*Shigella*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
01/04/06		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 28a: Total bacteria isolated from food samples on four sampling dates from Nyame Adom fast food vending site at C-Poly at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
	S	E	S	E	S	E	S	E
26/09/05	46.3	75.2	0.0	0.0	211.3	521.9	0.0	55.2
08/12/05	58.6	107.5	0.0	0.0	145.4	241.4	13.9	80.1
14/02/06	52.7	93.2	47.7	95.7	74.4	121.4	80.5	104.8
11/04/06	44.9	103.5	5.2	29.1	132.7	161.8	0.0	0.0

Table 28b: Coliform bacteria isolated from food samples on four sampling dates from Nyame Adom fast food vending site at C-Poly at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
	S	E	S	E	S	E	S	E
26/09/05	0.0	0.0	0.0	0.0	2.6	5.8	0.0	0.0
08/12/05	0.0	0.0	0.0	0.0	0.0	13.1	0.0	0.0
14/02/06	0.0	0.0	0.0	0.0	2.9	4.8	0.0	0.0
11/04/06	0.0	0.0	0.0	0.0	15.4	46.6	0.0	0.0

Table 28c: *Salmonella* and *Shigella* isolated from food samples on two sampling dates from Nyame Adom fast food vending site at C-Poly at start (S) and end (E) of selling

Sampling Date	Organism	Mean number of colony forming units (cfu/g x 10^5) fried rice S	fried rice E	fried chicken S	fried chicken E	coleslaw S	coleslaw E	Pepper sauce S	Pepper sauce E
14/02/06	*Salmonella*	0.0	0.0	0.0	0.0	1.7	2.3	0.0	0.0
11/04/06		0.0	0.0	0.0	0.0	5.3	8.3	0.0	0.0
14/02/06	*Shigella*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11/04/06		0.0	0.0	0.0	0.0	3.3	4.7	0.0	0.0

Table 29a: Total bacteria isolated from food samples on four sampling dates from California fast food vending site at C-Poly at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units (cfu/g x 10^5) fried rice S	fried rice E	fried chicken S	fried chicken E	coleslaw S	coleslaw E	Pepper sauce S	Pepper sauce E
30/09/05	51.7	84.4	0.0	0.0	74.5	143.7	0.0	0.0
12/12/05	34.4	67.9	0.0	0.0	22.4	48.7	12.5	42.6
17/02/06	40.2	71.4	2.6	13.2	47.3	97.2	0.0	0.0
13/04/06	30.6	52.9	0.0	0.0	66.3	131.7	13.6	82.1

Table 29b: Coliform bacteria isolated from food samples on four sampling dates from California fast food vending site at C-Poly at start (S) and end (E) of selling

Sampling	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
Date	S	E	S	E	S	E	S	E
30/09/05	0.0	0.0	0.0	0.0	10.6	47.9	0.0	0.0
12/12/05	0.0	0.0	0.0	0.0	18.7	33.3	0.0	0.0
17/02/06	0.0	5.5	0.0	0.0	2.6	6.9	0.0	0.0
13/04/06	3.4	11.7	0.0	0.0	21.2	37.6	0.0	0.0

Table 29c: *Salmonella* and *Shigella* isolated from food samples on two sampling dates from California fast food vending site at C-Poly at start (S) and end (E) of selling

Sampling		Mean number of colony forming units (cfu/g x 10^5)							
		fried rice		fried chicken		coleslaw		Pepper sauce	
Date	Organism	S	E	S	E	S	E	S	E
17/02/06	*Salmonella*	0.0	0.0	0.0	0.0	1.9	3.9	0.0	0.0
13/04/06		0.0	0.0	0.0	0.0	5.3	10.8	0.0	0.0
17/02/06	*Shigella*	0.0	0.0	0.0	0.0	1.3	2.3	0.0	0.0
13/04/06		0.0	0.0	0.0	0.0	3.0	6.1	0.0	0.0

Table 30a: Total bacteria isolated from food samples on four sampling dates from Friends fast food vending site at C-Poly at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
	S	E	S	E	S	E	S	E
20/09/05	6.5	32.9	0.0	0.0	42.2	164.1	0.0	0.0
05/12/05	0.0	24.9	0.0	0.0	65.0	163.8	0.0	53.1
11/02/06	28.1	42.7	0.0	19.8	115.7	260.5	0.0	40.9
08/04/06	16.2	45.0	0.0	21.7	89.5	305.9	0.0	30.7

Table 30b: Coliform bacteria isolated from food samples on four sampling dates from Friends fast food vending site at C-Poly at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
	S	E	S	E	S	E	S	E
20/09/05	0.0	12.9	0.0	0.0	18.1	26.3	0.0	0.0
05/12/05	0.0	0.0	0.0	0.0	18.4	55.2	0.0	0.0
11/02/06	5.9	13.2	0.0	0.0	47.2	67.3	0.0	0.0
08/04/06	0.0	0.0	0.0	0.0	7.7	28.1	0.0	0.0

Table 30c: *Salmonella* and *Shigella* isolated from food samples on two sampling dates from Friends fast food vending site at C-Poly at start (S) and end (E) f selling

Sampling Date	Organism	Mean number of colony forming units (cfu/g x 10^5) fried rice M	fried rice E	fried chicken M	fried chicken E	coleslaw M	coleslaw E	Pepper sauce M	Pepper sauce E
11/02/06	*Salmonella*	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0
08/04/06		0.0	0.0	0.0	0.0	0.0	3.5	0.0	0.0
11/02/06	*Shigella*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/04/06		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 31a: Total bacteria isolated from food samples on four sampling dates from Silver Bird Corner fast food vending site at Adisadel at start (S) and end (E) of selling.

Sampling Date	Mean number of colony forming units (cfu/g x 10^5) fried rice S	fried rice E	fried chicken S	fried chicken E	coleslaw S	coleslaw E	Pepper sauce S	Pepper sauce E
03/10/05	11.5	41.6	0.0	11.2	163.5	296.6	17.8	173.7
15/12/05	7.7	47.3	19.8	59.2	194.8	424.3	0.0	97.7
20/02/06	0.0	24.4	0.0	27.8	153.0	215.0	61.5	138.4
15/04/06	14.1	32.4	24.5	65.5	180.9	200.4	6.1	196.4

Table 31b: Coliform bacteria isolated from food samples on four sampling dates from Silver Bird Corner fast food vending site at Adisadel at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
	S	E	S	E	S	E	S	E
03/10/05	4.7	11.3	0.0	0.0	14.6	45.4	0.0	0.0
15/12/05	0.0	0.0	0.0	0.0	9.9	81.2	0.0	0.0
20/02/06	0.0	0.0	0.0	0.0	27.0	27.6	0.0	0.0
15/04/06	2.1	13.6	0.0	0.0	31.9	43.4	0.0	0.0

Table 31c: *Salmonella* and *Shigella* isolated from food samples on two sampling dates from Silver Bird Corner fast food vending site at Adisadel at start (S) and end (E) of selling

Sampling Date	Organism	Mean number of colony forming units (cfu/g x 10^5)							
		fried rice		fried chicken		coleslaw		Pepper sauce	
		S	E	S	E	S	E	S	E
20/02/06	*Salmonella*	0.0	0.0	0.0	0.0	9.6	16.4	0.0	0.0
15/04/06		0.0	0.0	0.0	0.0	8.0	14.5	0.0	0.0
20/02/06	*Shigella*	0.0	0.0	0.0	0.0	5.0	11.4	0.0	0.0
15/04/06		0.0	0.0	0.0	0.0	4.6	8.7	0.0	0.0

Table 32a: Total bacteria isolated from food samples on four sampling dates from Idaric fast food vending site at Adisadel at start (S) and end (E) of selling

Sampling	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
Date	S	E	S	E	S	E	S	E
07/10/05	16.4	39.6	17.5	64.9	148.4	180.5	38.1	115.2
19/12/05	12.6	28.2	0.0	0.0	120.9	225.4	0.0	37.1
23/02/06	0.0	21.7	4.2	17.3	65.5	84.1	13.7	40.4
17/04/06	19.5	39.6	0.0	19.2	112.2	199.1	0.0	52.0

Table 32b: Coliform bacteria isolated from food samples on four sampling date from Idaric fast food vending site at Adisadel at start (S) and end (E) of selling

Sampling	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
Date	S	E	S	E	S	E	S	E
07/10/05	0.0	0.0	0.0	0.0	19.0	27.2	0.0	0.0
19/12/05	0.0	3.4	0.0	0.0	7.0	14.5	0.0	0.0
23/02/06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17/04/06	0.0	0.0	0.0	0.0	16.3	29.8	0.0	0.0

Table 32c: *Salmonella* and *Shigella* isolated from food samples on two sampling dates from Idaric fast food vending site at Adisadel at start (S) and end (E) of selling

Sampling Date	Organism	Mean number of colony forming units (cfu/g x 10^5)							
		fried rice		fried chicken		coleslaw		Pepper sauce	
		S	E	S	E	S	E	S	E
23/02/06	*Salmonella*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17/04/06		0.0	0.0	0.0	0.0	4.8	14.9	0.0	0.0
23/02/06	*Shigella*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17/04/06		0.0	0.0	0.0	0.0	2.2	10.1	0.0	0.0

Table 33a: Total bacteria isolated from food samples on four sampling dates from God's Love fast food vending site at Adisadel at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
	S	E	S	E	S	E	S	E
11/10/05	17.0	47.9	0.0	6.8	96.4	172.9	4.5	100.0
22/12/05	14.8	57.4	2.0	20.2	197.8	241.9	0.0	40.0
25/02/06	0.0	24.8	6.5	34.6	32.4	89.1	15.5	66.7
19/04/06	10.8	35.0	0.0	0.0	45.4	99.2	25.1	73.8

Table 33b: Coliform bacteria isolated from food samples onfour sampling dates from God's Love fast food vending site at Adisadel at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
	S	E	S	E	S	E	S	E
11/10/05	0.0	0.0	0.0	0.0	19.8	46.5	0.0	0.0
22/12/05	0.0	0.0	0.0	0.0	28.5	37.7	0.0	0.0
25/02/06	0.0	2.2	0.0	0.0	19.4	29.3	0.0	0.0
19/04/06	0.0	0.0	0.0	0.0	18.1	26.9	0.0	0.0

Table 33c: *Salmonella* and *Shigella* isolated from food samples on two sampling dates from God's Love fast food vending site at Adisadel at start (S) and end (E) of selling

Sampling Date	Organism	Mean number of colony forming units (cfu/g x 10^5)							
		fried rice		fried chicken		coleslaw		Pepper sauce	
		S	E	S	E	S	E	S	E
25/02/06	*Salmonella*	0.0	0.0	0.0	0.0	2.6	7.9	0.0	0.0
19/04/06		0.0	0.0	0.0	0.0	5.3	16.2	0.0	0.0
25/02/06	*Shigella*	0.0	0.0	0.0	0.0	1.5	4.2	0.0	0.0
19/04/06		0.0	0.0	0.0	0.0	3.7	8.8	0.0	0.0

Table 34a: Total bacteria isolated from food samples on four sampling dates from Akwaaba fast food vending site at Tantri at start (S) and end (E) of selling

Sampling	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
Date	S	E	S	E	S	E	S	E
14/10/05	40.4	77.3	0.0	42.4	68.6	89.4	0.0	15.9
27/12/05	0.0	37.6	14.5	47.8	148.9	188.6	10.3	35.6
28/02/06	6.8	51.1	10.2	28.9	45.6	187.1	0.0	83.9
22/04/06	0.0	27.4	0.0	61.0	120.5	286.5	18.2	108.6

Table 34b: Coliform bacteria isolated from food samples on four sampling dates from Akwaaba fast food vending site at Tantri at start (S) and end (E) of selling

Sampling	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
Date	S	E	S	E	S	E	S	E
14/10/05	0.0	0.0	0.0	0.0	28.0	57.5	0.0	0.0
27/12/05	0.0	0.0	0.0	4.3	31.6	80.3	0.0	0.0
28/02/06	0.0	8.1	0.0	0.0	21.4	86.1	0.0	0.0
22/04/06	0.0	0.0	0.0	0.0	5.1	48.3	0.0	0.0

Table 34c: *Salmonella* and *Shigella* isolated from food samples on two sampling dates from Akwaaba fast food vending site at Tantri at start (S) and end (E) of selling

Sampling Date	Organism	Mean number of colony forming units (cfu/g x 10^5)							
		fried rice		fried chicken		coleslaw		Pepper sauce	
		S	E	S	E	S	E	S	E
28/02/06	*Salmonella*	0.0	0.0	0.0	0.0	13.4	32.7	0.0	0.0
22/04/06		0.0	0.0	0.0	0.0	2.7	8.3	0.0	0.0
28/02/06	*Shigella*	0.0	0.0	0.0	0.0	8.0	26.7	0.0	0.0
22/04/06		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 35a: Total bacteria isolated from food samples on two sampling dates from Majestic fast food vending site at Tantri at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
	S	E	S	E	S	E	S	E
18/10/05	0.0	90.5	0.0	23.0	94.8	177.3	0.0	66.8
30/12/05	12.8	66.7	0.0	0.0	183.0	340.4	17.0	125.9
03/03/06	0.0	63.3	30.9	44.3	90.4	232.0	0.0	62.4
24/04/06	35.6	93.7	15.1	36.9	165.2	255.9	3.4	97.1

Table 35b: Coliform bacteria isolated from food samples on four sampling dates from Majestic fast food vending site at Tantri at start (S) and end (E) of selling

Sampling	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
Date	S	E	S	E	S	E	S	E
18/10/05	0.0	0.0	0.0	0.0	10.2	33.4	0.0	0.0
30/12/05	0.0	0.0	0.0	0.0	53.2	99.3	0.0	0.0
03/03/06	0.0	18.1	0.0	1.9	32.1	68.0	0.0	0.0
24/04/06	0.0	0.0	0.0	2.6	80.7	109.1	0.0	0.0

Table 35c: *Salmonella* and *Shigella* isolated from food samples on two sampling dates from Majestic fast food vending site at Tantri at start (S) and end (E) of selling

Sampling		Mean number of colony forming units (cfu/g x 10^5)							
		fried rice		fried chicken		coleslaw		Pepper sauce	
Date	Organism	S	E	S	E	S	E	S	E
03/03/06	*Salmonella*	0.0	0.0	0.0	0.0	11.7	38.0	0.0	0.0
24/04/06		0.0	0.0	0.0	0.0	0.0	30.1	0.0	0.0
03/03/06	*Shigella*	0.0	0.0	0.0	0.0	6.2	16.0	0.0	0.0
24/04/06		0.0	0.0	0.0	0.0	0.0	23.9	0.0	0.0

Table 36a: Total bacteria isolated from food samples on four sampling dates from God's Grace fast food vending site at Tantri at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
	S	E	S	E	S	E	S	E
21/10/05	7.4	38.2	0.0	0.0	203.3	257.1	0.0	20.0
02/01/06	0.0	23.3	2.9	8.9	105.7	172.1	0.0	21.3
06/03/06	0.0	36.8	0.0	6.5	92.0	128.5	6.3	78.6
27/04/06	7.9	55.1	0.0	4.7	113.2	168.3	58.7	104.2

Table 36b: Coliform bacteria isolated from food samples on four sampling dates from God's Grace fast food vending site at Tantri at start (S) and end (E) of selling

Sampling Date	Mean number of colony forming units (cfu/g x 10^5)							
	fried rice		fried chicken		coleslaw		Pepper sauce	
	S	E	S	E	S	E	S	E
21/10/05	0.0	0.0	0.0	0.0	35.7	50.0	0.0	0.0
02/01/06	0.0	5.5	0.0	0.0	25.8	90.9	0.0	0.0
06/03/06	0.0	2.5	0.0	0.0	23.0	50.8	0.0	0.0
27/04/06	0.0	0.0	0.0	0.0	36.4	58.8	0.0	0.0

Table 36c: *Salmonella* and *Shigella* isolated from food samples on two sampling dates from God's Grace fast food vending site at Tantri at start (S) and end (E) of selling

		Mean number of colony forming units (cfu/g x 10^5)							
Sampling		fried rice		fried chicken		coleslaw		Pepper sauce	
Date	Organism	S	E	S	E	S	E	S	E
06/03/06	*Salmonella*	0.0	0.0	0.0	0.0	0.0	12.0	0.0	0.0
27/04/06		0.0	0.0	0.0	0.0	7.8	8.0	0.0	0.0
06/03/06	*Shigella*	0.0	0.0	0.0	0.0	0.0	13.8	0.0	0.0
27/04/06		0.0	0.0	0.0	0.0	0.0	4.1	0.0	0.0

Mean temperature and microbial load of fried rice at vending sites

Fried rice obtained from Finger Licking had no microbial load at a mean temperature value of 78.5 °C at start (S) and 0.5 x 10^5 cfu/g at 61.8 °C at end (E) of selling period respectively (Fig. 1). However, at Adom, the microbial load recorded at 40 °C at start (S) and at 23.3 °C at end (E) of selling period were 54.8 x 10^5 cfu/g and 91.0 x 10^5 cfu/g of fried rice respectively (Fig. 1).

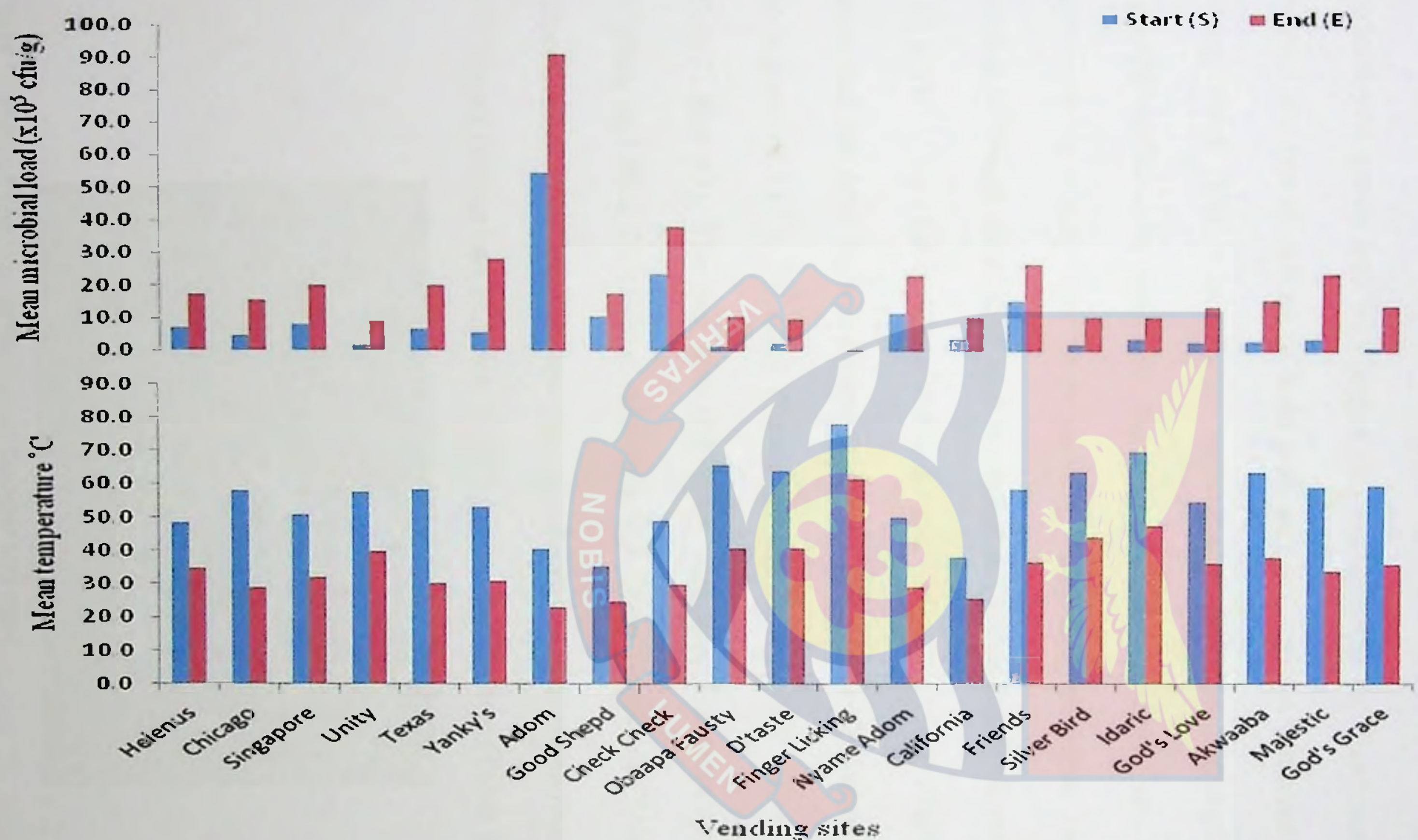


Fig. 1: Mean temperature and microbial load of fried rice at start (S) and end (E) of selling period for each of the 21 vending sites

Fungal population

A list of fungi isolated from the four dish samples, fried rice, fried chicken, coleslaw and pepper sauce obtained from all the vending sites on the sampling dates are presented in Tables 37 - 57. Few fungal species were isolated from the dish samples. These were *Aspergillus candidus*, *Aspergillus flavus*, *Aspergillus niger*, *Aspergillus ochraceus*, *Cladosporium herbarum*, *Fusarium* sp., *Penicillium* sp. and *Rhizopus* sp. Generally, yeast constituted the predominant group and was higher in population in the food samples obtained towards the end of selling of food than in food samples obtained at the start of selling food. The other fungi encountered such as *Aspergillus candidus*, *Aspergillus flavus*, *Aspergillus niger*, *Aspergillus ochraceus* and *Cladosporium herbarum* were very low in population. Generally, coleslaw had the highest number of fungal population as it is evident at Friends fast food vending site with 133 x 10^3 cfu/g (Table 51). California had 135 x 10^3 cfu/g (Table 50). Pepper sauce had the next highest fungal species population with Nyame Adom having the highest of 115 x 10^3 cfu/g (Table 49) and followed by Adom with 97 x 10^3 cfu/g (Table 43). The rice also had quite high fungal population, that is, 76 x 10^3cfu/g and 80 x 10^3cfu/g at Akwaaba and Good Shepherd (Tables 55 and 44, respectively). Fried chicken had very low fungal species population (Tables 37 to 57). Finger licking had very low fungal species population (Table 48).

x 2

Plate 7: Fungal species growing on Sabouraud agar

Table 37: Fungal species isolated from food samples obtained from Helenus fast food vending site at UCC at start (S) and end (E) of selling

Sampling		Mean number of colony forming units (cfu/g x 10^3)							
		fried rice		fried chicken		coleslaw		pepper sauce	
Date	Species	S	E	S	E	S	E	S	E
28/07/05	*Rhizopus* sp.	0	2	0	0	0	0	0	0
	Yeasts	0	0	0	0	0	12	0	0
24/10/05	*A. flavus*	0	0	0	0	1	3	0	0
	A. niger	0	0	0	0	0	2	0	0
	Fusarium sp.	0	0	0	0	2	2	0	0
	Penicillium sp.	2	6	0	0	0	0	0	0
	Rhizopus sp.	0	2	0	0	0	0	0	6
	Yeasts	0	29	0	0	25	32	0	37
05/01/06	*Fusarium* sp.	0	2	0	0	0	0	0	0
	Penicillium sp.	0	0	0	0	0	2	0	0
	Rhizopus sp.	0	3	0	0	0	0	0	1
	Yeasts	0	0	0	0	0	0	0	8
09/03/06	*A. niger*	0	0	0	0	0	3	0	0
	Fusarium sp.	0	2	0	0	0	0	0	0
	Penicillium sp.	0	0	0	0	0	0	1	3
	Yeasts	0	16	0	0	0	7	0	11
Total		2	62	0	0	28	63	1	66

Table 38: Fungal species isolated from food samples obtained from Chicago fast food vending site at UCC at start (S) and end (E) of selling

Sampling		Mean number of colony forming units (cfu/g x 10³)							
		fried rice		fried chicken		coleslaw		pepper sauce	
Date	Species	S	E	S	E	S	E	S	E
12/08/05	*A. niger*	0	0	0	0	1	2	0	0
	Penicillium sp.	0	0	2	3	0	0	0	0
	Rhizopus sp.	0	4	0	0	0	0	2	2
	Yeasts	0	9	0	0	0	0	0	0
03/11/05	*A.niger*	0	0	0	0	1	2	0	0
	Penicillium sp.	0	0	0	0	0	0	1	4
	Rhizopus sp.	0	2	0	0	0	0	0	0
	Yeasts	0	12	0	0	0	0	0	8
16/01/06	*Rhizopus* sp.	0	3	0	0	0	0	0	5
	Yeasts	0	14	0	0	8	17	0	9
16/03/06	*Penicillium* sp.	0	0	0	0	0	0	3	7
	Yeast	0	15	0	0	0	19	4	18
Total		0	59	2	3	10	40	10	53

Table 39: Fungal species isolated from food samples obtained from Singapore fast food vending site at UCC at start (S) and end (E) of selling

Sampling Date	Species	Mean number of colony forming units (cfu/g x 10^3)							
		fried rice		fried chicken		coleslaw		pepper sauce	
		S	E	S	E	S	E	S	E
08/08/05	*A. flavus*	0	0	0	0	1	1	0	0
	A. niger	0	0	0	0	0	2	0	0
	Fusarium sp.	0	1	0	0	0	0	0	3
	Penicillium sp.	0	2	0	0	0	0	0	2
	Rhizopus sp.	0	3	0	0	0	0	0	0
	Yeasts	0	22	0	0	0	0	9	28
31/10/05	*Penicillium* sp.	0	0	0	0	0	0	1	5
	Rhizopus sp.	0	1	0	0	0	0	2	2
	Yeasts	0	4	0	0	14	31	0	0
12/01/06	*Rhizopus* sp.	0	2	0	0	0	0	0	0
	Yeasts	0	0	0	0	0	0	0	4
14/03/06	*A. flavus*	0	0	0	0	0	1	0	0
	A. niger	0	0	0	0	0	1	0	0
	Penicillium sp.	0	0	0	0	0	0	2	4
	Rhizopus sp.	0	3	0	0	0	0	0	2
	Yeasts	0	11	0	0	0	0	0	10
Total		0	49	0	0	15	36	14	60

Table 40: Fungal species isolated from food samples obtained from Unity fast food vending site at Kingsway at start (S) and end (E) of selling

Sampling		Mean number of colony forming units (cfu/g x 10³)							
		fried rice		fried chicken		coleslaw		pepper sauce	
Date	Species	S	E	S	E	S	E	S	E
12/08/05	*Fusarium* sp.	0	0	0	0	0	2	3	0
	Penicillium sp.	2	6	0	0	1	4	0	2
	Yeasts	0	14	0	0	0	9	2	7
03/11/05	*Fusarium* sp.	0	2	0	0	0	0	0	0
	Penicillium sp.	0	0	0	0	0	0	2	5
16/01/06	*A. niger*	0	0	0	0	0	0	2	5
	Fusarium sp.	0	0	0	0	1	3	0	0
	Penicillium sp.	3	4	0	0	0	0	0	0
	Rhizopus sp.	1	1	0	0	0	0	0	0
	Yeasts	0	0	0	0	0	0	11	24
16/03/06	*A. niger*	0	0	0	0	2	5	0	0
	Fusarium sp.	1	5	0	0	0	0	0	2
	Penicillium sp.	0	0	0	0	0	0	1	0
	Rhizopus sp.	3	4	0	0	0	0	0	1
Total		10	36	0	0	4	23	21	46

Table 41: Fungal species isolated from food samples obtained from Texas fast food vending site at Kingsway at start (S) and end (E) of selling

Sampling		Mean number of colony forming units (cfu/g x 10^3)							
		fried rice		fried chicken		coleslaw		pepper sauce	
Date	Species	S	E	S	E	S	E	S	E
16/08/05	*A. niger*	0	0	0	0	2	5	0	0
	Fusarium sp.	0	0	0	0	1	3	1	4
	Penicillium sp.	1	3	0	0	0	0	0	0
	Rhizopus sp.	1	5	0	0	0	0	0	0
07/11/05	*Fusarium* sp.	2	5	0	0	0	0	0	0
	Penicillium sp.	0	0	0	0	4	8	1	4
	Yeasts	0	0	0	0	6	17	12	29
20/01/06	*A. flavus*	0	0	0	0	2	6	0	0
	A. niger	0	0	0	0	1	5	0	0
	Penicillium sp.	0	0	0	0	0	0	1	4
	Yeasts	0	13	0	0	0	0	16	25
18/03/06	*A.niger*	0	0	0	0	1	4	0	0
	Fusarium sp.	3	5	0	0	0	0	0	0
	Rhizopus sp.	2	7	0	0	0	0	2	6
	Yeasts	0	0	0	0	0	0	9	21
Total		9	38	0	0	17	48	42	93

Table 42: Fungal species isolated from food samples obtained from Yanky's fast food vending site at Kingsway at start (S) and end (E) of selling

Sampling Date	Species	Mean number of colony forming units (cfu/g x 10^3) fried rice S	fried rice E	fried chicken S	fried chicken E	coleslaw S	coleslaw E	pepper sauce S	pepper sauce E
20/08/05	*Penicillium* sp.	1	3	0	0	0	0	1	3
	Rhizopus sp.	2	3	0	0	0	0	0	0
10/11/05	*A. niger*	0	0	0	0	1	4	0	0
	Fusarium sp.	0	0	0	0	1	7	0	0
	Penicillium sp.	0	5	0	0	0	0	0	0
	Rhizopus sp.	0	0	0	0	0	0	0	1
	Yeasts	0	0	0	0	0	0	7	19
24/01/06	*A. flavus*	0	0	0	0	1	3	0	0
	A. niger	0	0	0	0	1	5	0	0
	Fusarium sp.	0	0	0	0	0	0	2	5
	Rhizopus sp.	1	6	0	0	0	0	1	4
	Yeasts	0	18	0	0	0	0	13	32
21/03/06	*A. flavus*	0	0	0	0	0	1	0	0
	A. niger	0	0	0	0	1	1	0	0
	Fusarium sp.	2	5	0	0	0	0	0	3
	Penicillium sp.	0	0	0	0	0	0	2	6
	Yeasts	11	28	0	0	22	29	0	17
Total		17	68	0	0	27	50	26	90

Table 43: Fungal species isolated from food samples obtained from Adom fast food vending site at Kotokuraba at start (s) and end (E) of selling

Sampling		Mean number of colony forming units (cfu/g x 10^3)							
		fried rice		fried chicken		coleslaw		pepper sauce	
Date	Species	S	E	S	E	S	E	S	E
24/08/05	*A. niger*	0	0	0	0	1	3	0	0
	Fusarium sp.	0	0	0	0	2	4	0	0
	Penicillium sp.	1	4	0	0	0	0	0	0
	Yeasts	0	8	0	0	24	32	0	18
14/11/05	*Fusarium* sp.	0	3	0	0	0	0	0	2
	Penicillium sp.	0	0	0	0	0	0	1	5
	Rhizopus sp.	0	0	0	0	0	0	0	4
	Yeasts	0	14	0	8	0	0	0	0
24/08/05	*C. herbarum*	0	0	0	0	0	2	0	0
	Fusarium sp.	0	0	0	0	4	6	0	0
	Penicillium sp.	0	1	0	0	0	0	0	0
	Rhizopus sp.	0	3	0	0	0	0	0	0
	Yeasts	0	17	0	0	18	31	0	34
24/03/06	*A. flavus*	0	0	0	0	0	1	0	0
	A. niger	0	0	0	0	2	3	0	0
	Fusarium sp.	0	1	0	0	0	0	0	2
	Rhizopus sp.	0	0	0	0	0	0	0	3
	Yeasts	0	0	0	0	14	16	0	26
Total		1	51	0	8	65	98	1	94

Table 44: Fungal species isolated from food samples obtained from Good Shepherd fast food vending site at Kotokuraba at start (S) and end (E) of selling

Sampling		Mean number of colony forming units (cfu/g x 10^3)							
		fried rice		fried chicken		coleslaw		pepper sauce	
Date	Species	S	E	S	E	S	E	S	E
30/08/05	*A. niger*	0	0	0	0	2	3	0	0
	Penicillium sp.	1	4	0	0	0	0	0	0
	Rhizopus sp.	0	0	0	0	0	0	3	5
	Yeasts	0	23	0	2	15	29	0	22
17/11/05	*A. niger*	0	0	0	0	0	3	0	0
	Fusarium sp.	0	2	0	0	0	0	0	0
	Rhizopus sp.	1	2	0	0	0	0	0	0
	Yeasts	0	0	0	0	9	28	0	4
26/01/06	*A. flavus*	0	0	0	0	4	5	0	0
	Fusarium sp.	1	3	0	0	0	0	0	0
	Penicillium sp.	0	3	0	0	0	0	0	0
	Rhizopus sp.	0	0	0	0	0	0	0	6
	Yeasts	0	27	0	0	15	26	0	0
27/03/06	*A. niger*	0	0	0	0	0	3	0	0
	Fusarium sp.	0	0	0	0	2	6	0	0
	Penicillium sp.	0	0	0	0	0	0	0	2
	Rhizopus sp.	0	0	0	0	0	0	0	3
	Yeasts	0	16	0	5	0	11	0	0
Total		3	80	0	7	47	114	3	42

Table 45: Fungal species isolated from food samples obtained from Check Check fast food vending site at Kotokuraba at start (S) and end (E) of selling

Sampling Date	Species	Mean number of colony forming units (cfu/g x 10^3) fried rice S	fried rice E	fried chicken S	fried chicken E	coleslaw S	coleslaw E	pepper sauce S	pepper sauce E
03/09/05	*A. niger*	0	0	0	0	0	2	0	0
	Penicillium sp.	3	5	0	0	0	0	0	0
	Rhizopus sp.	0	0	0	0	0	0	1	1
	Yeasts	0	28	0	0	9	18	0	33
21/11/05	*A. flavus*	0	0	0	0	0	1	0	0
	A. niger	0	0	0	0	0	2	0	0
	Fusarium sp.	0	0	0	0	2	4	0	0
	Penicillium sp.	0	0	0	0	0	0	3	8
	Rhizopus sp.	0	3	0	0	0	0	2	4
	Yeasts	0	0	0	0	11	21	0	0
30/01/06	*A. niger*	0	0	0	0	1	1	0	0
	Penicillium sp.	0	0	0	0	0	0	1	3
	Rhizopus sp.	1	3	0	0	0	0	0	4
	Yeasts	0	9	0	0	15	31	0	36
30/03/06	*Penicillium* sp.	0	0	0	0	0	0	3	3
	Rhizopus sp.	0	0	0	0	0	0	0	0
	Yeasts	0	8	0	0	22	31	0	0
Total		4	56	0	0	60	111	10	92

Table 46: Fungal species isolated from food samples obtained from Obaapa Fausty fast food vending site at Abura at start (S) and end (E) of selling

Sampling Date	Species	Mean number of colony forming units (cfu/g x 10^3)							
		fried rice		fried chicken		coleslaw		pepper sauce	
		S	E	S	E	S	E	S	E
12/09/05	*A. flavus*	0	0	0	0	0	1	0	0
	A. niger	0	0	0	0	3	6	0	0
	Penicillium sp.	0	0	0	0	2	6	0	4
	Rhizopus sp.	0	4	0	0	0	0	0	7
	Yeasts	0	16	0	0	11	25	8	15
28/11/05	*A. candidus*	0	0	0	0	1	1	0	0
	Rhizopus sp.	1	2	0	0	0	0	0	0
	Yeasts	0	0	0	10	8	12	0	31
06/02/06	*A. niger*	0	0	0	0	0	3	0	0
	Penicillium sp.	5	8	0	0	0	5	0	0
	Yeasts	0	23	0	0	19	27	0	17
03/04/06	*A. niger*	0	0	0	0	3	3	0	0
	C. herbarum	0	0	0	0	1	2	0	0
	Fusarium sp.	0	0	0	0	4	5	0	0
	Penicillium sp.	4	4	0	0	0	0	0	2
	Rhizopus sp.	3	3	0	0	0	0	6	7
	Yeasts	0	35	0	0	8	29	0	0
Total		13	95	0	10	60	125	14	83

Table 47: Fungal species isolated from food samples obtained from D'taste fast food vending site at Abura at start (S) and end (E) of selling

Sampling Date	Species	fried rice S	fried rice E	fried chicken S	fried chicken E	coleslaw S	coleslaw E	pepper sauce S	pepper sauce E
		Mean number of colony forming units (cfu/g x 10^3)							
16/09/05	*A. niger*	0	0	0	0	0	4	0	0
	Penicillium sp.	0	0	0	0	0	0	0	4
	Rhizopus sp.	0	0	0	0	0	2	0	0
02/12/05	*Fuasrium* sp.	0	0	0	0	1	1	0	0
	Yeasts	0	0	0	0	18	31	0	14
09/02/06	*A. niger*	0	0	0	0	3	3	0	0
	C. herbarum	0	0	0	0	0	1	0	0
	Penicillium sp.	0	0	0	0	2	5	0	0
	Rhizopus sp.	0	0	0	0	0	0	0	6
	Yeasts	0	0	0	9	12	29	0	26
06/04/06	*A. flavus*	0	0	0	0	1	4	0	0
	A. niger	0	0	0	0	2	2	0	0
	C. herbarum	0	0	0	0	0	1	0	0
	Fuasrium sp.	0	0	0	0	5	7	0	0
	Penicillium sp.	3	8	0	0	0	0	0	0
	Rhizopus sp.	0	4	0	0	0	0	2	6
	Yeasts	0	0	8	12	5	28	9	36
Total		3	12	8	21	49	118	11	92

Table 48: Fungal species isolated from food samples obtained from Finger licking fast food vending site at Abura at start (S) and end (E) of selling

Sampling Date	Species	Mean number of colony forming units (cfu/g x 10^3)							
		fried rice		fried chicken		coleslaw		pepper sauce	
		S	E	S	E	S	E	S	E
06/09/05	*Fusarium* sp.	0	0	0	0	0	2	0	0
	Rhizopus sp.	0	2	0	0	0	0	0	1
24/11/05	*Fusarium* sp.	0	0	0	0	0	1	0	0
	Rhizopus sp.	0	1	0	0	0	0	0	0
	Yeasts	0	0	0	0	0	0	0	3
01/04/06	*Penicillium* sp.	0	1	0	0	0	0	0	0
	Yeasts	0	0	0	0	0	0	0	4
Total		0	4	0	0	0	3	0	8

Table 49: Fungal species isolated from food samples obtained from Nyame Adom fast food vending site at C-Poly at start (S) and end (E) of selling

Sampling Date	Species	Mean number of colony forming units (cfu/g x 10^3) fried rice S	fried rice E	fried chicken S	fried chicken E	coleslaw S	coleslaw E	pepper sauce S	pepper sauce E
26/09/05	*A. niger*	0	0	0	0	1	2	0	0
	Penicillium sp.	0	1	0	0	0	0	0	0
	Rhizopus sp.	0	0	0	0	0	0	0	5
	Yeasts	0	29	0	0	11	17	0	19
08/12/05	*A. flavus*	0	0	0	0	1	1	0	0
	A. niger	0	0	0	0	0	3	0	0
	Penicillium sp.	2	3	0	0	0	0	0	0
	Rhizopus sp.	1	1	0	0	0	0	0	0
	Yeasts	0	0	0	0	0	0	0	19
14/02/06	*A. niger*	0	0	0	0	2	2	0	0
	Rhizopus sp.	0	0	0	0	0	0	0	4
	Yeasts	0	9	0	0	0	0	0	21
01/04/06	*A. niger*	0	0	0	0	1	2	0	0
	Fusarium sp.	0	0	0	0	2	3	0	4
	Penicillium sp.	0	2	0	0	0	4	0	0
	Rhizopus sp.	0	5	0	0	0	0	0	5
	Yeasts	0	15	0	0	0	27	0	38
Total		3	65	0	0	18	61	0	115

Table 50: Fungal species isolated from food samples obtained from California fast food vending site at C-Poly at start (S) and end (E) of selling

Sampling Date	Species	Mean number of colony forming units (cfu/g x 10^3)							
		fried rice		fried chicken		coleslaw		pepper sauce	
		S	E	S	E	S	E	S	E
30/09/05	*A. flavus*	0	0	0	0	1	1	0	0
	Penicillium sp.	2	2	0	0	0	0	0	3
	Rhizopus sp.	1	2	0	0	0	2	0	0
	Yeasts	0	0	0	0	0	22	0	18
12/12/05	*A. flavus*	0	0	0	0	0	2	0	0
	A. niger	0	0	0	0	0	2	0	0
	Penicillium sp.	0	3	0	0	0	0	0	0
	Yeasts	0	0	0	0	28	37	0	0
17/02/06	*A. candidus*	0	0	0	0	0	1	0	0
	A. flavus	0	0	0	0	0	1	0	0
	A. niger	0	0	0	0	2	3	0	0
	Fusarium sp.	0	0	0	0	3	5	0	0
	Rhizopus sp.	0	3	0	0	0	0	3	6
	Yeasts	0	11	0	0	13	24	0	30
13/04/06	*A. niger*	0	0	0	0	0	2	0	0
	Penicillium sp.	0	0	0	0	0	0	0	1
	Rhizopus sp.	1	2	0	0	0	0	0	4
	Yeasts	0	9	0	0	19	23	0	0
Total		4	32	0	0	66	125	3	62

Table 51: Fungal species isolated from food samples obtained from Friends fast food vending site at C-Poly at start (S) and end (E) of selling

Sampling Date	Species	Mean number of colony forming units (cfu/g x 10^3) fried rice S	fried rice E	fried chicken S	fried chicken E	coleslaw S	coleslaw E	pepper sauce S	pepper sauce E
20/09/05	*A. niger*	0	0	0	0	2	2	0	0
	A. ochraceus	0	0	0	0	1	1	0	0
	Fusarium sp.	0	0	0	0	0	1	0	0
	Yeasts	0	0	0	0	18	26	29	38
05/12/05	*A. flavus*	0	0	0	0	2	3	0	0
	Fusarium sp.	0	0	0	0	4	5	0	0
	Penicillium sp.	0	4	0	0	0	0	0	4
	Rhizopus sp.	0	3	0	0	0	0	0	2
	Yeasts	0	31	0	0	22	38	0	0
11/02/06	*Rhizopus* sp.	0	2	0	0	0	0	0	0
	Yeasts	0	0	0	0	0	0	0	8
08/04/06	*A. flavus*	0	0	0	0	1	4	0	0
	A. ochraceus	0	0	0	0	0	1	0	0
	C. herbarum	0	0	0	0	0	1	0	0
	Penicillium sp.	0	6	0	0	0	0	0	0
	Rhizopus sp.	2	3	0	0	0	0	0	0
	Yeasts	0	8	0	0	14	39	0	0
Total		2	57	0	0	64	121	29	52

Table 52: Fungal species isolated from food samples obtained from Silver Bird Corner fast food vending site at Adisadel at start (S) and end (E) of selling

Sampling Date	Species	Mean number of colony forming units (cfu/g x 10³) fried rice S	fried rice E	fried chicken S	fried chicken E	coleslaw S	coleslaw E	pepper sauce S	pepper sauce E
03/10/05	*A. niger*	0	0	0	0	3	4	0	0
	Fusarium sp.	0	0	0	0	3	3	2	4
	Penicillium sp.	3	5	0	0	0	0	0	6
	Rhizopus sp.	1	3	0	0	0	0	3	5
	Yeasts	0	17	0	0	19	28	0	35
15/12/05	*A. niger*	0	0	0	0	2	3	0	0
	A. ochraceus	0	0	0	0	3	3	0	0
	Rhizopus sp.	0	3	0	0	0	0	0	0
	Yeasts	9	19	0	0	21	27	0	0
20/02/06	*A. niger*	0	0	0	0	0	3	0	0
	C. herbarum	0	0	0	0	2	2	0	0
	Penicillium sp.	0	0	0	0	0	0	0	7
15/04/06	*A. flavus*	0	0	0	0	0	4	0	0
	A. niger	0	0	0	0	0	3	0	0
	Fusarium sp.	0	0	0	0	3	3	0	0
	Penicillium sp.	0	0	0	0	0	0	2	4
	Rhizopus sp.	4	6	0	0	0	0	0	5
	Yeasts	0	0	0	0	25	39	11	29
Total		17	53	0	0	81	122	18	95

Table 53: Fungal species isolated from food samples obtained from Idaric fast food vending site at Adisadel at start (S) and end (E) of selling

Sampling Date	Species	fried rice S	fried rice E	fried chicken S	fried chicken E	coleslaw S	coleslaw E	pepper sauce S	pepper sauce E
		Mean number of colony forming units (cfu/g x 10^3)							
07/10/05	*Penicillium* sp.	0	0	0	0	0	0	0	8
	Yeasts	0	0	7	9	0	0	0	0
19/12/05	*A. niger*	0	0	0	0	1	2	0	0
	C. herbarum	0	0	0	0	0	1	0	0
	Fusarium sp.	0	0	0	0	0	2	0	0
	Penicillium sp.	0	4	0	0	0	0	0	8
	Rhizopus sp.	3	5	0	0	0	0	0	0
	Yeasts	0	0	0	0	18	31	0	0
23/02/06	*Penicillium* sp.	0	0	0	0	0	0	0	4
17/04/06	*A. niger*	0	0	0	0	0	3	0	0
	C. herbarum	0	0	0	0	1	1	0	0
	Fusarium sp.	0	0	0	0	2	8	0	0
	Penicillium sp.	0	5	0	0	0	0	0	6
	Rhizopus sp.	3	3	0	0	0	0	0	2
	Yeasts	0	0	0	0	13	15	0	0
Total		6	17	7	9	35	63	0	28

Table 54: Fungal species isolated from food samples obtained from God's Love fast food vending site at Adisadel at start (S) and end (E) of selling

Sampling Date	Species	Mean number of colony forming units (cfu/g x 10³)							
		fried rice		fried chicken		coleslaw		pepper sauce	
		S	E	S	E	S	E	S	E
11/10/05	*A. flavus*	0	0	0	0	0	1	0	0
	A. niger	0	0	0	0	0	3	0	0
	Fusarium sp.	0	0	0	0	0	7	0	0
	Penicillium sp.	2	6	0	0	0	2	0	9
	Yeasts	0	27	0	0	23	28	0	33
22/12/05	*A. flavus*	0	0	0	0	0	4	0	0
	Penicillium sp.	0	0	0	0	0	0	0	3
25/02/06	*A. flavus*	0	0	0	0	1	3	0	0
	A. niger	0	0	0	0	1	2	0	0
	Fusarium sp.	0	0	0	0	0	6	0	0
	Rhizopus sp.	0	4	0	1	0	0	0	0
	Yeasts	0	0	0	0	0	0	10	18
19/04/06	*A. niger*	0	0	0	0	0	1	0	0
	A. ochraceus	0	0	0	0	0	3	0	0
	C. herbarum	0	0	0	0	0	2	0	0
	Penicillium sp.	0	0	0	0	2	8	0	6
	Rhizopus sp.	0	3	0	0	0	3	2	2
	Yeasts	0	8	0	0	0	0	0	0
Total		2	48	0	1	27	73	12	71

Table 55: Fungal species isolated from food samples obtained from Akwaaba fast food vending site at Tantri at start (S) and end (E) of selling

Sampling Date	Species	Mean number of colony forming units (cfu/g x 10³) fried rice S	fried rice E	fried chicken S	fried chicken E	coleslaw S	coleslaw E	pepper sauce S	pepper sauce E
14/10/05	*A. niger*	0	0	0	0	1	1	0	0
	Fusarium sp.	0	0	0	0	0	5	0	0
	Penicillium sp.	0	0	0	0	0	0	2	8
	Rhizopus sp.	0	0	0	0	0	0	0	4
	Yeasts	0	18	0	0	13	17	0	27
27/12/05	*A. niger*	0	0	0	0	0	4	0	0
	A. ochraceus	0	0	0	0	1	2	0	0
	Fusarium sp.	0	0	0	0	1	2	0	0
	Penicillium sp.	0	8	0	0	0	0	0	9
	Rhizopus sp.	2	3	0	0	0	0	0	0
	Yeasts	0	0	0	0	19	26	0	0
28/02/06	Yeasts	0	0	0	0	0	0	0	7
22/04/06	*A. flavus*	0	0	0	0	2	2	0	0
	A. niger	0	0	0	0	3	4	0	0
	C. herbarum	0	0	0	1	0	2	0	0
	Penicillium sp.	0	6	0	0	0	0	0	6
	Rhizopus sp.	0	3	0	0	0	0	0	2
	Yeasts	15	38	0	0	18	23	0	0
Total		17	76	0	1	60	86	2	63

Table 56: Fungal species isolated from food samples obtained from Majestic fast food vending site at Tantri at start (S) and end (E) of selling

Sampling Date	Species	fried rice S	fried rice E	fried chicken S	fried chicken E	coleslaw S	coleslaw E	pepper sauce S	pepper sauce E
		Mean number of colony forming units (cfu/g x 10^3)							
18/10/05	*Penicillium* sp.	0	3	0	0	0	0	0	0
	Rhizopus sp.	0	0	0	0	0	0	0	2
30/12/05	*A. flavus*	0	4	0	0	0	0	0	0
	A. niger	0	0	0	0	4	5	0	0
	A. ochraceus	0	0	0	0	0	3	0	0
	C. herbarum	0	0	0	0	1	0	0	0
	Fusarium sp.	0	0	0	0	5	6	0	0
	Rhizopus sp.	1	3	0	0	0	0	0	3
	Yeasts	0	0	0	0	21	29	0	0
3/3/2006	*C. herbarum*	0	0	1	1	0	0	0	0
	Penicillium sp.	0	0	0	0	0	0	3	6
	Rhizopus sp.	0	0	0	0	0	0	0	7
24/04/06	*A. niger*	0	0	0	0	1	2	0	0
	A. ochraceus	0	0	0	0	0	1	0	0
	Fusarium sp.	0	0	0	0	3	4	0	0
	Penicillium sp.	0	0	0	0	0	0	0	9
	Rhizopus sp.	0	5	0	0	0	0	0	2
	Yeasts	12	28	0	0	0	0	0	0
Total		13	43	1	1	35	50	3	29

Table 57: Fungal species isolated from food samples obtained from God's Grace fast food vending site at Tantri at start (S) and end (E) of selling

Sampling Date	Species	Mean number of colony forming units (cfu/g x 10^3) fried rice S	fried rice E	fried chicken S	fried chicken E	coleslaw S	coleslaw E	pepper sauce S	pepper sauce E
21/10/05	*A. flavus*	0	2	0	0	0	2	0	0
	A. niger	0	0	0	0	2	3	0	0
	C. herbarum	0	0	0	0	0	2	0	0
	Fusarium sp.	0	0	0	0	1	1	0	0
	Penicillium sp.	0	0	0	0	0	0	4	4
	Yeasts	0	26	0	0	0	0	0	31
02/01/06	*Penicillium* sp.	0	0	0	0	6	11	0	0
03/03/06	*A. flavus*	0	0	0	0	2	3	0	0
	A. ochraceus	0	0	0	0	3	5	0	0
	C. herbarum	0	0	1	1	0	0	0	0
	Fusarium sp.	0	0	0	0	0	1	0	0
	Rhizopus sp.	0	3	0	0	0	0	0	2
	Yeasts	6	19	0	0	0	0	0	0
27/04/06	*Rhizopus* sp.	0	0	0	0	0	0	2	3
Total		6	50	1	1	14	28	6	40

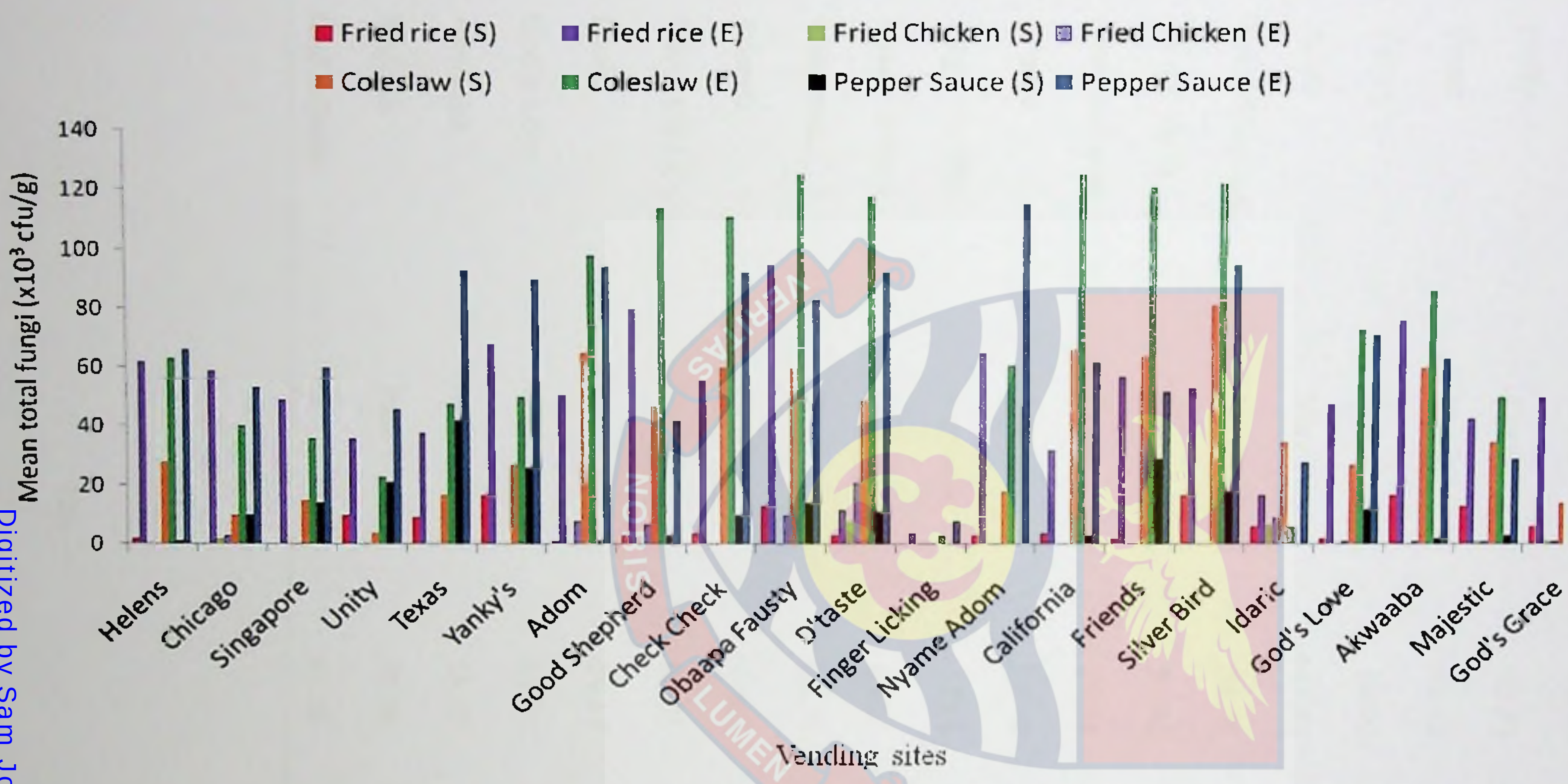


Fig. 2: Mean total fungi isolated from food samples at vending sites

Table 58: Sanitation and microbial load of fast food vending sites

Vending site	Sanitation grade	Mean microbial load (cfu/g x 10^5)
Helenus	Poor	129.68
Chicago	Good	78.19
Singapore	Good	77.33
Unity	Good	45.41
Texas	Good	61.41
Yanky's	Poor	89.05
Adom	Very Poor	163.52
Good Shepherd	Poor	96.98
Check check	Poor	81.92
Obaapa Fausty	Good	29.34
D'taste	Good	28.17
Finger licking	Very Good	4.14
Nyame Adom	Poor	84.51
California	Good	38.50
Friends	Good	49.04
Silver Bird Corner	Poor	90.85
Idaric	Good	54.17
God's Love	Good	65.27
Akwaaba	Good	58.22
Majestic	Poor	75.76
God's Grace	Good	61.28

Sanitation and microbial load of fast food vending sites

The mean microbial load of the vending sites in relation to the sanitation at the sites showed Figer Licking with very good sanitation had microbial load of 4.14 x 10^5 cfu/g and Adom with poor sanitation had 163.52 x 10^5 cfu/g (Table 58).

Microbial counts of Meat pie, spring rolls and water

The highest mean bacterial load for meat pie was 5 x 10^2 cfu/g and this was recorded on 30/07/05. Spring rolls had a mean bacteria load of 1 x 10^2 cfu/g which was recorded on 18/08/05. Coliform bacteria were not isolated in either meat pie or spring rolls (Table 59).

Well-water had the highest mean bacterial load of 17 cfu/ml. This was followed by pipe borne water with 10 cfu/ml (Table 60). Coliform bacteria were isolated from some sachet water bags, but a higher number was isolated from well water (Table 60).

Table 59: Total and coliform bacteria isolated in meat pie and spring rolls

	Mean number of colony forming units (cfu/g x10^2)			
	Total bacteria		Coliform bacteria	
Sampling Date	Meat Pie	Spring roll	Meat Pie	Spring roll
30/07/05	5	0	0	0
18/08/05	2	1	0	0
16/11/05	4	0	0	0
25/01/06	0	1	0	0
16/02/06	3	0	0	0

Table 60: Total and coliform bacteria isolated from water on five sampling occasions

	Mean number of colony forming units (cfu/ml)									
	Total bacteria					Coliform bacteria				
Water Samples	1	2	3	4	5	1	2	3	4	5
Mobile Sachet Water	0	3	0	0	0	0	1	0	0	0
Delta Sachet Water	0	0	0	0	0	0	0	0	0	0
Standard Sachet Water	0	0	0	0	0	0	0	0	0	0
Anet sachet water	0	0	2	0	1	0	0	0	0	1
Sobac 69	4	0	0	0	0	1	0	0	0	0
Pipe borne Water	10	0	5	4	8	2	0	1	0	3
Well water	12	16	11	13	17	4	5	2	0	1

Bacterial counts on cabbage and tomatoes at Kotokuraba and Abura markets

A high total bacterial load of 262 x 10^5 cfu/g was recorded on the outer leaves of cabbage bought from the Kotokuraba market on 23/09/05 and tomatoes also had high bacterial load of 279 x 10^5 cfu/g on 04/01/06. No total bacteria as well as coliform bacteria were isolated from the inner leaves of cabbage (Table 61a). Coliforms isolated on the outer leaves of cabbage and on tomatoes were *Salmonella* sp. and *Shigella* sp. (Table 61b). Fungal species of *Aspergillus niger*, *Aspergillus flavus*, *Cladosporium herbarum*, *Fusarium* sp. and *Penicillium* sp. were isolated from the outer leaves of cabbage only (Table 61c). *A. flavus* and *Penicillium* sp. had the highest fungal population of 9 x 10^3 cfu/g on cabbage, while *A. niger* had the highest fungal population of 14 x 10^3

cfu/g on tomatoes (Table 61c). The cabbages and tomatoes bought from Abura market had a mean total bacteria load of 267 x 10^5 cfu/g and 282 x 10^5 cfu/g respectively (Table 62a). Coliforms were not isolated from the middle and inner leaves of the cabbages bought from the Abura market (Table 62a). *Salmonella* sp. and *Shigella* sp. were isolated from the outer leaves of cabbage (Table 62b). *A. niger*, *A. flavus*, *A. ochreasus*, *Fusarium* sp., *Penicillium* sp. were some of the fungal species isolated from cabbages bought from the Abura market. *A. niger* had the highest fungal population of 14 x 10^3 cfu/g on cabbage while *A. flavus* had the highest fungal population of 17 x 10^3 cfu/g on tomatoes bought from the Abura market (Table 62c).

Table 61a: Total and coliform bacteria isolated from cabbage and tomato at Kotokuraba market

Sampling	Bacterial	Mean number of colony forming units (cfu/g x10^5)			
		Cabbage			
Date	count	Outer leaf	Middle leaf	Inner leaf	Tomato
22/08/05	Total	254	0	0	268
23/09/05		262	1	0	271
04/01/06		242	2	0	279
29/03/06		258	0	0	263
22/08/05	Coliform	84	0	0	108
23/09/05		92	0	0	91
04/01/06		73	0	0	79
29/03/06		98	0	0	89

Table 61b: *Salmonella* and *Shigella* isolated from parts of cabbage and tomato at Kotokuraba market

Sampling		Mean number of colony forming units (cfu/g x 10^5)			
		Cabbage			
Date	Organism	Outer leaf	Middle leaf	Inner leaf	Tomato
04/01/06	*Salmonella*	41	0	0	49
29/03/06		34	0	0	51
04/01/06	*Shigella*	19	0	0	33
29/03/06		31	0	0	29

Table 61c: Fungal species isolated from parts of cabbage and tomato at Kotokuraba market

	Mean number of colony forming units (cfu/g x 10^3)			
	Cabbage			
Species	outer leaf	middle leaf	inner leaf	Tomato
Aspergillus niger	8	0	0	14
Aspergillus flavus	9	0	0	11
Cladosporium herbarum	8	0	0	9
Fusarium sp.	7	0	0	12
Penicillium sp.	9	0	0	12

Table 62a: Total and coliform bacteria isolated from cabbage and tomato at Abura market

Sampling Date	Bacterial count	Mean number of colony forming units (cfu/g x10^5)			
		Cabbage			
		Outer leaf	Middle leaf	Inner leaf	Tomato
13/10/05	Total	267	0	0	274
25/11/05		234	2	0	256
10/02/06		256	2	0	282
05/04/06		249	1	0	267
13/10/05	Coliform	86	0	0	104
25/11/05		79	0	0	96
10/02/06		68	0	0	82
05/04/06		81	0	0	87

Table 62b: *Salmonella* and *Shigella* isolated from parts of cabbage and tomato at Abura market

Sampling Date	Organism	Mean number of colony forming units (cfu/g x 10^5)			
		Cabbage			
		Outer leaf	Middle leaf	Inner leaf	Tomato
10/02/06	*Salmonella*	37	0	0	52
05/04/06		29	0	0	47
10/02/06	*Shigella*	24	0	0	35
05/04/06		28	0	0	31

Table 62c: Fungal species isolated from parts of cabbage and tomato at Abura market

	Mean number of colony forming units (cfu/g x 10^3)			
	Cabbage			
Species	outer leaf	middle leaf	inner leaf	Tomato
Aspergillus niger	14	0	0	16
Aspergillus flavus	13	0	0	17
Aspergillus ochraceus	5	0	0	0
Fusarium sp.	11	0	0	14
Penicillium sp.	9	0	0	11

Treatment of cabbage and tomatoes with water and 0.004M salt solution

When cabbage and tomatoes were washed with only water the highest total bacterial load was 153 x 10^5 and 158 x 10^5 cfu/g, respectively, recorded on 22/08/05 and 29/03/06 from the Kotokuraba market. When treated with salt solution the total bacterial load reduced to 27 x 10^5 cfu/g for cabbage and 23 x 10^5 cfu/g for tomatoes (Table 63). Coliform bacteria were not isolated from the middle and inner leaves of cabbage from Kotokuraba and Abura markets after treatment with both water and salt solution (Tables 63 and 64).

Table 63: Total and coliform bacteria isolated from parts of cabbage and tomato from Kotokuraba market after treatment with water and 0.004 M salt solution

		Mean number of colony forming units (cfu/g x10^5)							
		Cabbage							
Sampling	Bcaterial	Outer leaf		Middle leaf		Inner leaf		Tomato	
Date	count	Water	Salt	Water	Salt	Water	Salt	Water	Salt
22/08/05	Total	153	27	0	0	0	0	156	25
23/09/05		146	31	0	0	0	0	148	21
04/01/06		136	28	0	0	0	0	142	18
29/03/06		149	24	0	0	0	0	158	23
22/08/05	Coliform	61	11	0	0	0	0	47	19
23/09/05		56	13	0	0	0	0	56	14
04/01/06		51	10	0	0	0	0	52	10
29/03/06		42	9	0	0	0	0	49	12

Table 64: Total and coliform bacteria isolated from parts of cabbage and tomato from Abura market after treatment with water and 0.004 M salt solution

		Mean number of colony forming units (cfu/g x10^5)							
		Cabbage							
Sampling	Bcateria	Outer leaf		Middle leaf		Inner leaf		Tomato	
Date	count	Water	Salt	Water	Salt	Water	Salt	Water	Salt
13/10/05	Total	139	21	0	0	0	0	147	18
25/11/05		151	19	0	0	0	0	131	23
10/02/06		163	22	0	0	0	0	133	16
05/04/06		142	17	0	0	0	0	149	19
13/10/05	Coliform	55	7	0	0	0	0	43	9
25/11/05		63	11	0	0	0	0	48	11
10/02/06		58	15	0	0	0	0	56	8
05/04/06		49	9	0	0	0	0	39	5

Bacterial count in milling machine and polystyrene box

Table 65a shows mean total bacterial load in the milling machine before the start of the days' work was high, the highest being 239 x 10^5 cfu/ml recorded on 02/02/06 at Abura as compared to total bacteria load in samples taken during the day. Some coliforms isolated from the milling machine were *Salmonella* sp. and *Shigella* sp. (Table 65b). The highest mean total bacteria isolated from the polystyrene boxes were 9 x 10^5 cfu/ml on 31/03/06 (Table 65a). *Salmonella* sp. and *Shigella* sp. were not isolated from the polystyrene boxes (Table 65b).

x 1/25

Plate 8: A milling machine for grinding pepper, onions and tomatoes

Table 65a: Total and coliform bacteria from milling machines at four locations and polystyrene boxes

		Mean number of colony forming units (cfu/ml x 10^5)								
		Milling machine								P'sty
Sampling	Bacterial	K'way		K'ba		Abura		Tantri		Box
Date	count	M	A	M	A	M	A	M	A	A
25/11/05	Total	215	103	229	123	226	116	229	119	4
16/12/05		196	113	203	108	218	131	210	124	0
31/01/06		224	106	198	116	207	123	203	118	6
02/02/06		206	132	231	109	239	119	209	121	1
31/03/06		193	119	211	113	212	101	216	121	9
25/11/05	Coliform	63	19	58	18	71	16	57	16	1
16/12/05		57	22	65	25	53	19	62	17	0
31/01/06		71	28	47	15	49	21	52	20	2
02/02/06		69	17	59	24	51	26	48	16	0
31/03/06		55	21	61	14	59	18	68	28	0

M – Morning; A – Afternoon; P'sty – Polystyrene Box; K'way- Kingsway; K'ba- Kotokuraba

Table 65b: *Salmonella* and *Shigella* isolated from milling machines and polystyrene boxes on two sampling dates

Sampling Date	Organism	Mean number of colony forming units (cfu/ml x 10^5)								
		Milling machines at								P'sty
		K'way		K'ba		Abura		Tantri		Box
		M	A	M	A	M	A	M	A	A
02/02/06	*Salmonella*	18	10	14	9	17	8	13	5	0
31/03/06		16	7	19	6	13	4	15	6	0
02/02/06	*Shigella*	8	3	10	5	11	4	14	6	0
31/03/06		9	3	7	0	8	1	7	0	0

M – Morning; A – Afternoon; P'sty – Polystyrene Box; K'way- Kingsway; K'ba- Kotokuraba

Bacterial load of uncooked frozen chicken

The highest frozen chicken contaminated with bacteria was recorded at the Abura market with a mean total bacterial load of 21 x 10^2 cfu/g on 25/02/06 (Table 66). Trinity Enterprise showed no bacterial load on three sampling dates and the highest being 2 x 10^2 cfu/g recorded on 25/01/06 (Table 66). Coliform bacteria were not isolated from any of the frozen chicken (Table 66).

Table 66: Total and coliform bacteria isolated from uncooked frozen chicken from three sources

Sampling Date	Mean number of colony forming units (cfu/g x 10^2)					
	Total bacteria			Coliform bacteria		
	Trinity Ent.	Kotokuraba Market	Abura Market	Trinity Ent.	Kotokuraba Market	Abura Market
25/01/06	2	12	16	0	0	0
28/01/06	0	18	13	0	0	0
04/02/06	0	10	19	0	0	0
13/02/06	1	8	15	0	0	0
25/02/06	0	17	21	0	0	0

CHAPTER FOUR

DISCUSSION, CONCLUSIONS, RECOMMENDATIONS AND SUMMARY

Discussion

The fast food business has become a thriving enterprise, which has brought employment to many especially the youth (Table 3). In the survey fast food vendors were located at densely populated areas of the study area, as these are the areas where they can make good sales. These areas were University of Cape Coast campus, Kotokuraba and Cape Coast Polytechnic campus (Table 1). At the university campus, due to the busy schedules of the students and lecturers especially during the revision and examination weeks, they found it very difficult and time wasting to cook their own food and so resort to the buying of food from food vendors such as the fast food vendors. In most cases the fast food vendors had some assistants who may not necessarily be involved in the processing and preparation of the food, but helped in transporting and arranging of equipment and washing of bowls where necessary at the vending sites. On the average a fast food vendor in Cape Coast earns about one hundred and sixty Ghana cedis (GH¢160) a day making an annual income of GH¢49,600. When the youth are encouraged to go into such bussiness ventures as fast food vending with the necessary requiste skills and knowledge, it will generate lucrative employment for them and their families. The studies showed that 79.2% of the total number of fast food vendors surveyed was between the ages of 15-30 years (Table 3), an indication that the youth were highly involved in this trade and this will prevent the youth from idling and engaging in social vices to the detriment of the society.

In the study, male and females were all equally involved in the fast food trade. This implied that males are now interested in the selling of food, an occupation which used to be the preserve of women. Most of the fast food vendors had attained secondary education, and thus should be able to benefit from workshops and seminars to train them in food safety techniques. The low number of tertiary graduates in the fast food business may be due to the notion that the business of cooking and selling to the general public is a preserve of those who are not so much inclined to higher academic ambitions (Table 4). The involvement of tertiary graduates in the food industry will however, improve the quality of service delivery and also ensure good food safety practices. Apprenticeship was the most popular method of training by which vendors acquired their skill since it was cheap. They learn the dynamics of the trade while offering a helping hand to the proprietor. Mostly the apprentices learn only the skills in cooking and serving food and may not pay much attention to good hygiene and safety of the food to the consuming public. FAO (1997) recommends that food handlers should have the necessary knowledge and skills to enable them handle food hygienically and also systems should be put in place to ensure that food handlers remain aware of all procedures necessary to maintain the safety and suitability of food.

Most of the ingredients for the food preparation were bought from the market, while few were bought from the farm gate. Fresh food stuffs bought from the markets were washed with water only or with salt solution to free it from all microorganisms. One negative practice of the fast food vendors is that even though water for the washing of the vegetables got dirty they hardly changed the water and this rather contaminated the subsequent vegetables to be washed. The use of unchanged water for washing plates also increased the risk of high bacteria contamination in food (Ansari *et al.*, 1988) and this was observed with some of the fast food vendors who did not change the water used for the washing of plates and other utensils frequently, but rather kept washing more plates and utensils in the already dirty water resulting in the contamination of these items.

From the studies conducted, only three sampling sites, Chicago (Table 17c), Texas (Table 20c) and Finger Licking (Table 27c), out of 21 had no *Salmonellae* and *Shigellae* organisms. This can be attributed to the fact that most of the fast food vendors did not have good cleaning detergents at their premises, improper use of detergents, unhygienic handling of food and its accompanying equipment, and generally poor sanitation at the vending sites. Larson (1985) observed that the use of soap to wash utensils and cookery reduced bacterial load. Gram-negative bacilli such as *Salmonella typhi* are fairly susceptible to soap from unsaturated fatty acids. Most of the microorganisms die after coming into contact with soap, but their susceptibilities vary.

Sanitation was a major factor in microbial levels or contamination of food (Table 58). Fast food vending sites with very poor sanitation had high microbial loads with a mean of 163 x 10^5 cfu/g (Table 58). When equipment used in food preparation gets contaminated through bad sanitation or unhygienic practices, they also contaminate the food. Human beings are the commonest contamination sources of food (Marriot, 1985). Most of the fast food vendors did not wear aprons and caps or any protective clothing creating a conducive atmosphere for the cross contamination from the hair and clothes to the food. The vendors used tongs, forks and spoons in serving the food to the public, a practice which is contained in the revised guidelines for the design of control measures for street-vended foods in Africa (FAO, 1990). The use of these equipment helps to minimise contamination of food by the bare human hands. Though these equipment are of great benefit care must be taken to prevent their contamination by the environment. Another source of microbial contamination is the dual usage of the hand for the purpose of serving food and also handling money (FAO, 1997). The handling of money contaminated with all sort of microorganisms as result of exchanges between people such as mechanics, construction workers, children, food sellers, sanitary workers, drivers, makes it imperative for food sellers not to use the same hands to collect money and serve food to the public. Food must always be covered and protected from contamination from flies and dust (FAO, 1990; Kinton and Ceserani, 1992; FAO, 1995), also adequate drainage and waste disposal systems and facilities should be provided at the street food industry and designed properly so that the risk of contamination of food and potable water may be minimized. At the Science market which has no good drainage facilities, free flow of waste water was impeded and flooding the market anytime it rained leaving a foul stench at the market.

Leftover foods were given to people freely, because some of the vendors did not have good refrigerators which could store their food at a temperature of 4 °C or below. At 4 °C most microorganisms in the vegetative state may die or growth may be suppressed. Two (8.3%) of the fast food vendors had not received any medical examination, a violation of the rules outlined by the Food and Drug Board for people who intend to cook and sell food to the general public. However, 75% of the vendors had medical examination once a year. Fast food vendors who are not medically fit may be carriers of cholera, typhoid and other communicable food borne diseases and may transmit the diseases to other people through the food they sell. The municipal authority license food vendors based on the results from a thorough medical examination done by a qualified medical doctor. This is done to check or eliminate people who are carriers of food borne diseases from cooking and selling to the public. FAO (1990) recommends that every vendor/helper of food should undergo a basic training in food hygiene before being licensed. Though 87.5% of the fast food vendors were aware of food hygiene (Table 12) some of them were not practicing good hygiene nor having regular medical examination (Table 11) because they did not place much importance on it, and claim it is time consuming and expensive.

Generally at high holding temperatures the bacterial load was very low and at low holding temperatures the microbial load was high in fried rice. This was the observed trend in all 21 vending sites. Figure 1 shows the high and low temperatures at start (S), 78.5°C, 40°C and end (E), 61.8°C, 23.3°C with their corresponding mean microbial load of 0.0, 54.8 and 0.5, 91 x 10^5 cfu/g for Finger Licking and Adom respectively. The high holding temperatures creates unfavourable conditions for the rapid growth of microbial contaminants especially those in the vegetative form and as a result reducing the microbial load. The high microbial load of 91 x10^5 cfu/g recorded at 23.3°C below the incubating temperature of 38.0°C is as a result of the microorganism's ability to survive the incubating temperature. The bacteria load of 163 x 10^5 cfu/g of Adom and the high microbial load of the other vending sites (Table 58), where unsatisfactory according to the WHO/HPA (2000) acceptable standard of 10^5 cfu/g. The good effect of high temperature on food is seen evidently in the low bacteria levels in fried chicken which is usually fried in boiling oil (Tables 16a-36c). The most reliable method of killing bacteria in food is by cooking at a temperature well above 82 °C (Wardlaw and Kessel, 2002). Food, which is not be eaten immediately, have to be kept at a holding temperature of 65 °C. Foods are to be refrigerated at a temperature of 4 °C or below, since bacteria multiply rapidly within the temperature range of 5° to 60 °C. Microorganisms multiply if food is stored within this range. Dangerous microorganisms are widely found in soil, water, animals and humans. These microorganisms are carried on the hands, wiping cloths and utensils, especially cutting boards and the slightest contact can transfer them to food and cause food borne diseases. By holding at temperatures below 5 °C or above 60 °C the growth of microorganisms is slowed down or stopped. This is evident in the frozen chicken that was sampled from some cold stores and the markets (Table 66). The frozen chicken had very low bacteria load because they were stored at freezing point below 3 °C. Almost all the fast food vending sites recorded low bacteria load on fried chicken. The process of preparation might be a contributing factor. Fried chicken is prepared by frying the pieces of chicken parts in hot vegetable oil at a temperature microorganisms cannot survive. Pepper sauce also had quite low bacterial load which can also be attributed to its mode of preparation that is frying ground pepper, onion and dried fish in a boiling oil to form a sauce. The difference in temperature of fried rice at the various vending sites at start and towards end of selling was highly significant ($p<0.05$). The high bacteria load in the fried rice after several hours of selling as compared to those at the start of the selling could be attributed to the unhygienic way of handling equipment for serving food such as the laddle and tongs being exposed to open air. The preparation of fried rice involves the mixing of chopped vegetables such as onions, carrots, cabbages with already boiled rice. The mixture is then fried in little oil with a soy sauce. Some of the fast food vendors who prepare the food used their bare hands to mix the food whiles frying the rice and vegetables under low heat, and this practice is a sure way of cross contamination from the hands to the food. Most of the fast food vendors scoop their food into an ice-chest which are not of high hygienic standards and carried to their vending sites, making it another possible way of contamination. Some vendors were observed not to be washing their hands before serving. The washing of hands removes dirt and other microorganisms, which can contaminate food and other equipment, which is directly or indirectly involved in the serving of food. Enteropathogen can survive on the hands for three hours or longer and it is for this reason that hands must be washed with warm soapy water and thoroughly rinsed with clean water before handling food. Restainno and Wind (1990) observed that *Escherichia coli* was detected in hand washing of high-income and low-income mothers in India at levels of $7.0 \pm 4.2 \log_{10}$ cfu/ml and $9.0 \pm 5.7g \log_{10}$ cfu/ml respectively indicating that the hand is a major source of contamination and an easy tool for transmitting contaminants such as microoganisms. Another bad practice observed were some vendors leaving the laddle on the fried rice. The part of the laddle held by the hand would be naturally contaminated and consequently contaminate the rice.

Fried rice had been a leading source of *Bacillus cereus* emetic-type food poisoning in the United States. *B. cereus* is frequently present in uncooked rice, and heat-resistant endospores may survive cooking. If cooked rice is subsequently held at room temperature at about 25 °C, vegetative forms multiply, and heat-stable toxin is produced that can survive brief heating, such as stir frying (Center for Disease Control and Prevention (CDC), 2003). CDC (2003) had reported Chicken fried rice prepared at a local restaurant was the only food significantly associated with illness; illness occurred in 14 out of 48 persons who ate chicken fried rice, compared with none out of 16 who did not. The contamination of cooked food by microbes could be due to the handling process such as dishing out the food, food not being covered to prevent flies and dust from contaminating it. *Salmonella typhimurium* and *Shigella* can multiply in the gut of the housefly and can be voided for weeks or longer period (Little *et al.*, 2001b). Food exposed to flies, therefore, will readily be contaminated with a diversity of harmful microorganisms.

Bacteria in diarrhoeal stools of infected persons can be passed from one person to another if hygiene or hand washing habits are inadequate. It is for this reason that food vendors who suffer from a food borne disease or have not been medically examined to declare them medically fit must be prevented from preparing and selling food to the public. The mean number of coliforms isolated from the various fast food vendors, the food types such as fried rice, fried chicken, coleslaw and pepper sauce, as well as the time of sampling collection, statistically showed a highly significantly difference among them ($p<0.05$). This implied that the mean number of coliforms isolated from each fast food vending site was significantly different from each other. The mean number of coliforms also isolated from fried rice, fried chicken, coleslaw and pepper sauce was highly significantly different from each other with coleslaw having the highest mean number of coliforms. The mean number of coliforms isolated at the start and towards end of selling was also significantly different from each other. The mean number of coliforms isolated from food type dishes in relation to each of the 21 vending site was also highly significant. The same can be said of the various types of food dishes in relation with the vending sites. The relative mean number of coliforms isolated from the food types was almost the same among all the 21 fast food vending sites sampled. That is, the difference between their means were not significant ($p>0.05$). The mean number of *Salmonella* sp. and *Shigella* sp. isolated from the four dish types, fried rice, fried chicken, coleslaw and pepper sauce was highly significantly different from each other and also in relation to all 21 vending sites, as well as the time of sample collection ($p<0.05$). The presence of feacal bacteria such as *Salmonella* sp. in the food dishes made them unwholesome for consumption.

The pH of the food samples ranged between 4 and 7 (Table 15), a conducive range of pH for the rapid growth of most microorganisms especially bacteria since the minimum pH required for most microorganisms to grow is 4.5 (Varma, 2003). The pepper sauce had a higher percentage moisture content (Table 14) than any of the food samples because of the mode of preparation, which involved frying dried milled pepper in a lot of cooking oil to form sauce. The presence of bacteria in rice could also be attributed to the reasonably high percentage moisture content, a contributing factor to rapid growth of microorganisms, as microorganisms require adequate moisture for good growth.

Spring rolls had very low bacterial contamination, a mean of 0.400 x 10^5 cfu/g which was within the acceptable range of WHO/HPA (2000) due to the mode of preparation and serving. The spring rolls are usually served hot after deep-frying at high temperature in hot oil. At this temperature most of the bacteria are killed. Meat pie is also a pastry made from meat and vegetables stuffed in flour dough and baked in an oven at very high temperature. Meat pie had more bacterial load (mean = 2.800 cfu/g) than spring roll probably due to the fact that most meat pies are served at ambient temperatures that can be comparable to that of the human body temperature 37 °C, an optimum temperature that favours the rapid multiplication of bacteria. The contamination of meat pie can be attributed to the exposure to the open air and handling. The difference in bacterial contamination of spring rolls and meat pie was significant ($p<0.05$).

Fast food vending sites that had bad sanitation were observed to have high bacterial load in their food samples. These bad sanitation practices such as the unavailability of special containers for the collection and proper disposal of refuse at the vending site, and the drainages that are choked with filth provide an enabling environment and breeding grounds for flies which are carriers of microorganisms that cause diseases such as cholera, typhoid fever, diarrhoea and food poisoning.

Coleslaw had high bacterial load averagely of 450.5 x 10^5 cfu/g compared with fried rice (57 x 10^5 cfu/g), fried chicken (18 x 10^5 cfu/g) and pepper sauce (38 x 10^5 cfu/g). The high bacterial contamination is attributed to the improper handling process. The high level of contamination in vegetables was expected. In Ghana all sorts of water are used for watering vegetables, especially those grown in the cities along streets and open gutters. *Shigella flexneri* and *E. coli* have been isolated from lettuce in Accra (Kotoku, 1978). Lettuce and tomatoes were contaminated with faecal bacteria, *Salmonella* and *Shigella*. Animal waste e.g. chicken droppings were used as manure for these vegetables (Mensah *et al*., 2001). Tables 16a-37a showed the increased in microbial load of coleslaw stored at ambient temperature for several hours during the period of selling, because microorganisms especially bacteria multiply rapidly at ambient temperature. The high bacterial load, averagely 252.75 x 10^5 cfu/g during holding temperatures of selling are unsatisfactory according to the WHO/HPA (2000).

Observations made at the fast food vending sites showed that most of the fast food vendors do not properly wash these vegetables. They chopped the vegetables on dirty chopping board, which were not washed. The disregard for simple hygienic practice can be responsible for the high bacterial load in coleslaw. Coleslaw is served at room temperature about 25 °C, very optimum temperature for the rapid multiplication of bacteria. The bacterial load in the coleslaw served several hours after preparation was highly significant ($p<0.05$). The coleslaw was kept and served cold a condition which favours prolific bacterial growth.

Microorganisms form part of the epiphytic flora of vegetables and are usually present at the time of consumption. Majority of the bacteria found on the surface of vegetables are usually Gram-negative and belong to the Pseudomonas group or to the Enterobacteriaceae (Lund, 1992). Cabbages and tomatoes sampled from the Kotokuraba and Abura markets had very high microbial load on the outer leaves and that there was no significant difference among the samples collected from either market ($p>0.05$). The inner leaves of cabbages were without any bacterial contamination (Table 62). The microbial contamination of vegetables reflects the environment through which the product had passed. *Salmonella* survival was greatest in soil amended with poultry compost and least in soil containing alkaline-pH-stabilized dairy cattle manure compost. Survival profiles of *Salmonella* on vegetables and soil samples contaminated by irrigation water were similar to those observed when contamination occurred through compost. Hence, both contaminated manure compost and irrigation water can play an important role in contaminating soil and root vegetables with *Salmonella* for several months (Insam *et al.*, 1996). Microbiological analyses have shown that vegetables routinely contain high levels of microorganisms including coliforms and faecal coliform (National Advisory Committee on Microbiological Criteria for Foods, 1999; Taormina *et al.*, 1999). The handling process of cutting, slicing, and shredding removes or damage the protective surface of the vegetables making it possible for the spread of pathogens from contaminated parts to uncontaminated parts. The cutters and slicers used by the fast food vendors are potential source of contamination as they are not properly cleaned before and after use. Garg *et al.*, (1990) and Kaneko *et al.* (1999) reported the increase in microbial numbers in vegetables that had been subjected to various cutters and slicers. The widespread use of human and animal feacal waste in agricultural practice contributes to presence of enteric pathogens such as *Salmonella* sp., *Shigella* sp., enterovirulent *E. coli*, *Campylobacter sp.*, *Clostridium botulinum*, *Clostridium perfringens*, and some *Bacillus* sp. and *Staphylococcus aureus*

(Husu, 1990; Van Renterghem *et al.*, 1991; Strauch, 1991) which contaminate agricultural produce and cause outbreaks of illness following consumption.

The washing of vegetables is intended to remove adhering soil or any other dirt. In the study, vegetables washed with 0.004M salt solutions had the bacterial load significantly reduced as compared to the vegetables that were washed with only water ($p<0.05$). The difference between the microbial load of the outer, middle and inner leaves of cabbage after treatment with the salt solution was highly significant ($p<0.05$) as the microorganisms were only isolated from the outer leaves of cabbage. Most of the vegetables such as cabbage, lettuce, carrots, onions etc are grown and irrigated with untreated sewage water and dirty water from the gutters. These two sources of water for irrigation are rich pool of reservoir for pathogen bacteria such as *Vibrio cholera*, *Salmonella* sp., *Shigella* sp. and many other coliform bacteria. Soaking and rinsing lettuce and broccoli either in water, lemon juice, vinegar or vegetable solution reduced *Listeria innocua* within the range 1.41 to 1.88 log CFU/g, and in apples and tomatoes within 2.00 to 2.89 log units. The vegetable wash solution significantly reduced ($P < 0.05$) bacterial population on tomatoes by 2.89 log units (Barmore, 1995). Treatment of produce with chlorinated water reduces populations of pathogenic and other microorganisms on fresh produce but cannot eliminate them. There was no significant difference between the bacterial load of vegetables and tomatoes from both Abura and Kotokuraba markets ($p>0.05$), since they all have basically the same environmental conditions such as poor storage facilities and very poor sanitation at the markets. It has been well established that bacteria, viruses, protozoans, nematodes, and fungi capable of causing diseases can be found in foods contaminated with sewage water (Murell, 1995). One of the general methods used to clean vegetables is tap water rinse, but was realized that tap water was not effective in removing faecal coliforms (Strauch, 1991). Generally, the consumption of raw vegetables that have not been properly cleaned implies a health hazard, because they are a reservoir for bacteria capable of producing infections in susceptible patients in hospitals (Beuchat, 1996). Varma (2003) observed the bacteriological contamination of crops by use of raw waste water in irrigation increases the gastrointestinal diseases which are at present one of the most significant causes of death, mainly in children. Therefore for more satisfactory results, waste water should be treated to remove harmful substances and microorganisms before it is used for irrigation. The documented presence of *Salmonella, Shigella sonnei*, and *Listeria monocytogenes* (Hedberg *et al.*, 1991; Wong *et al.*, 2004) on salad vegetables, coupled with the inefficiency of washing and sanitizing procedures administered for the purpose of removing microflora (Adams *et al.*, 1989), indicates the need for increased attention to microbiological safety implications associated with their consumption. Gram-positive *Staphylococcus* typically forms grape-like clusters (Plate 5) when viewed under microscope and their presence still after washing the vegetables with saline water attests to the fact that most strains of *Staphyloccocus* can grow in the presence of 15% NaCl (Atlas, 1995). Species of *Staphylococcus* commonly occur on skin surfaces, and an example is *Staphylococcus aureus*, a potential human pathogen, infecting wounds and causing food poisoning. In the survey some food vendors were observed to be using their bare hands in stirring and mixing the vegetables. This can explain the presences of *Staphylococcus* in some of the test food samples.

When bacteria grow on foods they can cause spoilage and the sensory properties of the food can become such that it is no longer acceptable to the consumer. Unfortunately detectable changes in the food quality are not always noticed before the infective dose is reached or a toxin is produced. This factor is particularly true with the growth of moulds When the moulds are growing they may not cause the putrefactive breakdown of the food and it may still be consumed with or without the mould being removed. In fact, in some cases growth of the mould is encouraged as part of the fermentation process. Since 1959, when the death of a large flock of turkeys in the UK was associated with a toxin that had been produced in the feed by moulds there has been considerable interest in the toxigenic activity of mould metabolites (Garret, 1995). The toxin, which killed the turkeys, was aflatoxin. Aflatoxins are now known to be produced by *Aspergillus flavus* and *Aspergillus parasiticus* both of which are common in the tropics and sub-tropics. It has been established that moulds produce a large number of toxic substances. Studies have demonstrated that mycotoxins can be acutely toxic but that they can also have chronic activity (Atlas, 1995). The mycotoxins have been shown to cause serious problems in countries such as Africa, where the staple diet contains large quantities of mouldy grain and products from such cereals. Mycotoxins are thermostable indicating that the best method to reduce the risks from mycotoxins is to prevent moulds growing in the food and many studies have identified conditions appropriate for food storage which either retards the growth of the mould or which prevents toxin formation. However, aflatoxins are not only a problem due to poor storage, but can be produced in the growing crop. Many countries have responded to the problem of mycotoxins by setting tolerance levels for aflatoxins in foods, and strains used in food fermentations are checked for their ability to produce toxins (Mossel *et al.*, 1995). The fungal species that were isolated in this study were *Aspergillus flavus*, *Aspergillus niger*, *Aspergillus ochraceus*, *Cladosporium herbarum*, *Fusarium* sp., *Rhizopus* sp., and *Penicillium* sp. The growth of these fungal species was enhanced by the high moisture content of the various test food samples, 70% for rice, 80% for pepper sauce, and 67% for the vegetables. Remarkably, fried chicken because of its preparations does not encourage fungal growth resulting in very low microbial growth on them. Moulds cannot grow in rice grains with a 14% or less moisture content. *Penicillium* and *Aspergillus* grow well in even small amount of moisture, and this explains why there was high fungal growth in the vegetables and pepper sauce which had high moisture content.

Mycotoxins, such as aflatoxin and ochratoxin A, are found at measurable levels in many staple foods; the health implications of long-term exposure of such toxins are poorly understood. In one Bulgarian study, ochratoxin produced by *A. ochraceus* contamination of food and the presence of ochratoxin in human serum were more common in families with endemic Balkan nephropathy and urinary tract tumors than in unaffected families (Castegnaro *et al.*, 1987). In developed countries, sufficient amounts of food combined with regulations that monitor aflatoxin levels in these foods protect human populations from significant aflatoxin ingestion. However, in countries where populations are facing starvation or where regulations are either not enforced or nonexistent, routine ingestion of aflatoxin produced by *Aspergillus flavus* may occur (Cotty *et al.*, 1994). People who have enough to eat normally avoid foods that are heavily contaminated by moulds, so it is believed that dietary exposure to acute levels of mycotoxins is rare in developed countries. Nevertheless, many mycotoxins survive processing into flours and meals. When mould-damaged materials are processed into foods and feeds, they may not be detectable without special assay equipment. It is important to have policies in place that ensure that such "hidden" mycotoxins do not pose a significant hazard to human health.

The milling machine had very high significant levels of bacterial load before the start of the days' activity as compared to the samples taken at noon ($p<0.05$). There was no significant difference among the microbial load of the milling machines sampled ($p>0.05$) and those in respect of the location of the milling machine, the microbial loads were virtually the same ($p>0.05$). The high levels of bacterial contamination in the milling machine in the early morning had resulted from the improper cleaning of the machine after the previous day's work, allowing for multiplication of bacteria. The low level of bacterial load at noon might due to the self-cleaning action of the milling process.

Most of the vending sites did not have standpipe and so stored water in small gallons. This practice did not provide them with enough water for preparing the food and washing of utensils and plates and other preparations resulting in hygiene being compromised which is in agreement with a similar research done in Accra on safety of street food, which found out that standing pipe was not available at the vending sites (Mensah *et al.*, 2002) and a study done in Kenya (Muinde and Kuria, 2005). Latham (1997) assert to the fact that safe and adequate water is an essential component for good personal hygiene. This requires that fast food vendors should have sufficient potable water for drinking, preparation of all kinds of foods and sufficient running water for all washing operations. Three brands of sachet water that were sampled had 1 cfu/ml coliform bacteria on one of the five samples in each case (Table 60) indicating the presence of pollution. This can be traced to the handling process where most of the people who bag this sachet water do not keep any good personal hygiene. Some also do not change their filters after the specified period of usage. Some coliforms were also isolated in tap water and well water. This implies that tap and well water used in the preparation of food by fast food vendors must be thoroughly boiled in order to kill all microorganisms that may be present in the food. In Cape Coast, due to the seasonal shortage of water most fast food vendors resort to the well water for cooking. This well water may be a source of contaminating microorganisms such as pathogenic protozoa, bacteria and viruses. The occurrence of *Listeria monocytogenes*, *Salmonella* sp. and some viruses had been reported in some water sources such as streams and dug wells etc (Wong *et al.*, 2004; Nguyen-the and Carlin, 1994).

Most of the fast food vendors did not follow any of the recommended HACCP programme by the United Nations agency on food safety leading to the neglect of safety precautions to prevent foodborne disease outbreak. The attainment of secondary education by most of the fast food vendors makes it very easy for their training in the HACCP programme, since the success of a HACCP programme is dependent upon both facilities and people. The facilities and equipment are designed to facilitate safe food preparation and handling practices of the fast food vendors. Based on the HACCP programme guidelines the critical control points identified in this study were the source of purchase of food stuffs, handling process during processing and sale of food, sanitation at vending sites, and lack of indepth knowledge of food hygiene.

The health authorities, Food and Drug Board, Municipal Authority and District Assemblies must ensure that fast food vendors operate under strict hygienic conditions and that those in breach of the laid down guidelines must be closed down.

Conclusion

The results of the research showed that some of the fast food were contaminated with *Salmonella* and *Shigella* spp., an indication of pollution and, therefore, not fit for human consumption. Vegetables used in preparing coleslaw were heavily contaminated and this resulted in the high microbial loads of coleslaw. The handling practices and poor sanitation encouraged high microbial load of the fast food dish. Possible sources of contamination were raw food materials, environment, food handling practices and vendors. On the whole the fast foods studied were not safe.

Recommendations

1. Since most of the fast food vendors had attained secondary level of education, workshops should be organized for them on regular basis to increase their knowledge in food hygiene and safety.
2. The fast food vendors as well as the assistants who wash bowls must undergo mandatory medical examinations every six months.
3. Food must always be kept in netted closed kiosks or buildings.
4. Cabbages, onions, carrots and cucumber, bought from the markets should be washed in several changes of salt water and clean water before use.

5. Dug-well water used for cooking must be boiled before use.
6. High-risk foods should be kept at temperatures that inhibit the growth of bacteria. Food should be kept below 4°C in a refrigerated unit or above 70°C in a suitable warming unit.
7. Vegetable milling machine cleaned thoroughly at start and end of the day's work.
8. The Municipal Authority should make funds available to fast food operators to enable them acquire modern facilities that will keep the food warm through out the selling period.

SUMMARY

1. The microbiological quality of fast foods in the Cape Coast Municipality of the Central Region of Ghana was studied using a survey and laboratory studies (determining the microbial load and identifying the microbes isolated from each dish).
2. Twenty-four fast food vending sites were encountered at the beginning of the study. Three then folded up in the course of the study.
3. The fast food vending sites were Helenus, Chicago, Singapore at the University of Cape Coast; Unity, Texas, Yanky's at Kingsway; Adom, Good Shepherd, Check Check at Kotokuraba; Obaapa Fausty, D'taste, Finger licking at Abura; Nyame Adom, California, Friends at Cape Coast Polytechnic; Silver Bird Corner, Idaric, God's Love at Adisadel; and Akwaaba, Majestic, God's Grace at Tantri.
4. The types of dishes served were fried, jollof, and plain rice, chicken, coleslaw and pepper sauce. All the vending sites served the same type of dishes.
5. Twelve (50%) of the vending sites were operated by females while the other 12 (50%) sites by males.
6. Majority of the vendors were in their youth. Nine (37.5%) of the female and ten (41.7%) of the male vendors were between the age of 15 and 30 years and only three (12.5%) of the females and two (8.3%) of the males were between the ages of 31 to 45 years.
7. Majority of the vendors acquired their training through apprenticeship (41.7%) followed by training in a vocational institution (29.9%) and the

rest either from a senior secondary school (12.5%), tertiary institution (4.2%) or had no training (12.5%).

8. The fast food vendors sold their wares either on tables under an umbrella, in a kiosk or in building.
9. The vendors obtained their raw food items either from the market (95.8%) or from the farm gate (4.2%) and washed in salt solution (91.7%) or in water (8.3%).
10. Left-over cooked food was either given out for free (54.2%), refrigerated (41.7%) or reheated for sale (4.2%) the next day.
11. Most of the fast food vendors were licensed (91.7%) and 8.3% not licensed. Of the licensed 75% of them had medical examination once a year, 12.5%, once in six months, 4.2% had theirs once in five years and 8.3% never had any medical examination.
12. Majority of the vendors (87.5%) had knowledge of food hygiene and (12.5%) of them had no knowledge of food hygiene.
13. The temperature of fried rice differed with time of sample collection and also among the vending sites. The temperature at the start of selling ranged from 38.9 °C to 79.4 °C; and towards the end of selling was from 22.5 °C to 62 °C.
14. The percentage moisture content and pH of the dishes varied among the various dishes, vending sites and the time of sample collection. Pepper sauce had the highest moisture content (69.9% - 89.5%), and (74.9% - 89.9%) respectively at start and end of selling period. This was followed by fried rice (62.6% - 74.6%) and (60.5% - 76.1%); then coleslaw (57.3% - 74.1%) and (57.6% - 74.5%). Fried chicken had the

least (49.3% - 67.5%) and (49.1% - 67.3%) respectively at the start and end of the selling period. The pH range for all the dishes were fried rice (4.2 – 6.0) and (3.9 – 6.0); fried chicken (4.2 – 6.7) and (4.3 – 6.3); coleslaw (4.2 – 6.8) and (4.3 - 5.9); and shito (3.2 – 6.0) and (3.1 – 5.9) respectively at the start and end of selling period for each of the dishes.

15. The total bacteria count varied from dish to dish, the vending sites and time of sample collection. Coleslaw had the highest total bacteria count ranging from 9.0 to 216.4 x 10^5 cfu/g and 18.8 x 10^5 cfu/g to 450.5 x 105 cfu/g at the start and end of selling period respectively. Fried chicken had the least total bacteria count or in some cases they were totally absent. When present the population range from 2.4 x 10^5 cfu/g to 27.8 x 10^5 cfu/g; and 8.0 x 10^5 cfu/g to 50.4 x 10^5 cfu/g at the start and end of selling period respectively.

16. Coliforms isolated from coleslaw ranged from 2.4 x 10^5 cfu/g to 161.8 x 10^5 cfu/g and 26 x 10^5 cfu/g to 221.7 x 10^5 cfu/g at the start and end of selling period respectively. The fried chicken and pepper sauce were usually free from coliforms.

17. The Faecal coliforms, *Salmonella* and *Shigella sp* were isolated mostly from coleslaw; their population ranged between 2.4 x 10^5 cfu/g to 34 x 10^5 and 1.8 x 10^5 cfu/g to 65.1 x 10^5 cfu/g at start and end of selling period respectively. The presence of these faecal pollutants indicate faecal pollution of the dishes especially coleslaw.

18. The total fungal count isolated from the dishes varied between vending sites, the dishes and the time of sample collection. The fungal count was highest for coleslaw, 28 x 10^3 cfu/g to 71 x 10^3 cfu/g and 3.0 x 10^3 to

135 x 10^3 cfu/g at start and end of selling period respectively. This was followed by pepper sauce, 2 x 10^3 cfu/g to 26 x 10^3 cfu/g and 29 x 10^3 cfu/g to 115 x 10^3 cfu/g at start and towards end of selling respectively. Fried chicken had the least fungal count, as low as 1 x 10^3 cfu/g and in most instances they were absent. Yeast was the predominantly fungus isolated.

19. Vending sites that had poor sanitation had a high mean microbial count of 163 x 10^5 cfu/g whiles vending sites with very good sanitation had mean microbial load of 4.14 x 10^5 cfu/g.

20. The total bacteria count in meat pie ranged from 2 x 10^2 cfu/g to 5 x 10^2 cfu/g and spring rolls had 1 x 10^2 cfu/g, but coliforms were absent.

21. Well water had total bacteria count of 11 cfu/ ml to 17 cfu/ ml. pipe borne water had 1 cfu/ ml to 4 cfu/ ml. Population of coliforms isolated ranged from 1 to 4 cfu/ ml for well water; 1 to 3 cfu/ ml for pipe borne and sachet water.

22. Outer leaves of cabbage had total bacteria count of 242 x 10^5 cfu/g to 262 x 10^5 cfu/g, while middle cabbage leaves had 2 x 10^5 cfu/g and the inner leaves had no bacteria. Coliform bacteria were not isolated from both middle and inner leaves, but coliform population of 73 x 10^5 cfu/g to 98 x 10^5 cfu/g was isolated from the outer leaves. The total bacteria count on tomatoes ranged from 263 x 10^5 cfu/g to 270 x 10^5 cfu/g and for coliforms the count ranged from 79 x 10^5 cfu/g to 108 x 10^5 cfu/g.

23. Outer leaves of cabbage had 41 x 10^5 cfu/g of *Salmonella* and 31 x 10^5 cfu/g *Shigella* colonies. Tomatoes had 51 x 10^5 cfu/g for *Salmonella* and 33 x 10^5 cfu/g for *Shigella*.

24. *Aspergillus flavus* and *Penicillium* sp. were the dominant fungi isolated from the outer leaves of cabbage with a population of 9×10^3 cfu/g and *Fusarium* sp. the least in population (7×10^3 cfu/g). Tomatoes had *Aspergillus niger* being the dominant fungus (14×10^3 cfu/g) and *Cladosporium herbarum* was the least (9×10^3 cfu/g).

25. Total bacteria count after washing cabbage leaves with water was 153×10^5 cfu/g and when washed in salt solution it was 31×10^5 cfu/g. Tomatoes had 158×10^5 cfu/g and 25×10^5 cfu/g after washing in water only and salt solution respectively. Cabbage leaves had coliforms of 61×10^5 cfu/g and 13×10^5 cfu/g after washing in water and salt solution respectively. Tomatoes had 56×10^5 cfu/g and 19×10^5 cfu/g after washing in water and salt solution respectively.

26. Total bacteria count in vegetable milling machine sampled from Cape Coast ranged from 193×10^5 cfu/g to 239×10^5 cfu/g before start of business in the morning and 102×10^5 cfu/g to 132×10^5 cfu/g at noon. The coliform count was 47×10^5 cfu/g to 71×10^5 cfu/g and 14×10^5 cfu/g to 28×10^5 cfu/g in the morning and at noon. Polystyrene boxes used for packaging of meals had total bacteria of 9 cfu/ml, but no coliforms were isolated.

27. Total bacteria count of frozen chicken was 1×10^2 cfu/g to 21×10^2 cfu/g. However, no coliforms were isolated.

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APPENDIX

UNIVERSITY OF CAPE COAST

DEPARTMENT OF MOLECULAR BIOLOGY AND BIOTECHNOLOGY

INTERVIEW SCHEDULE FOR VENDORS

ALL INFORMATION PROVIDED ON THIS PAPER SHALL BE TREATED AS CONFIDENTIAL.

CODE [ ]

1. Gender: Male [ ] Female[ ]
2. Age: 15-30yrs [ ] 31-45yrs [ ] 46-60yrs [ ]
3. Nationality: Ghanaian [ ] Non-Ghanaian [ ]
4. Educational Background: None [ ] Basic [ ] Secondary[ ]
   Post-secondary [ ] Tertiary [ ]
5. Any formal training in catering? Yes [ ] No [ ]
6. Where was the training done?
   SSS [ ] Vocational school [ ] Apprenticeship [ ]
   Any other (specify)…………………………………………………………
7. Location of selling site:………………………………………………………
8. For how long have you been in this food business?…………………………
9. What item(s) is/are sold by you?………………………………
10. Do you sell your food under an umbrella [ ], in a netted kiosk [ ]
    Enclosed building [ ] any other (specify)………………………
11. What time of the day do you sell?
    Only in the mornings [ ]only in the afternoons [ ]only evening [ ]
    Morning to afternoon [ ] afternoon to evening [ ]whole day [ ]
12. Where do you obtain the raw materials / ingredients?
    Market [ ] tenders [ ] shop or store [ ] farm gate [ ]
13. How do you wash your vegetables? With
    Only water [ ] Salty water [ ] Vinegar [ ] vinegar & salt[ ] Potassium permanganate solution [ ]
14. What is the source of the water you use for cooking and other operations?
    Bore-hole [ ]Pipe borne [ ] Well-water [ ] Water tanker [ ]

15. Where do you prepare the food?

At home [ ] at vending point [ ] taken from mass producer [ ]

16. How do you dish out food: With tongs [ ] Ladle [ ] Ladle & tongs[ ]

Bare hands [ ] Bare hands and ladle [ ]

17. Which type of container is food served in?

In plastic/enamel/glass plates, bowls [ ] in leaves [ ]

In polythene [ ] polystyrene box [ ]

18. If you serve in plates, etc. how are they washed?

In cold water with detergent and sponge [ ]

In warm water with detergent and sponge [ ]

Dish waster [ ] Any other (specify)....................................

19. Do you serve the food items hot/warm/cold?..............................

20. What is the source of drinking water for your clientele?....................

21. Who are your clientele? Workers [ ] School children [ ]

travelers [ ] market women [ ] any other (specify)..................

22. Do you have separate towels or napkin for staff and clientele?

Yes [ ] No [ ]

23. If no to item 22, explain..

24. How often is it washed with detergent?..................................

25. How do you grind your tomatoes, pepper, etc?.............................

26. Means by which food is conveyed to vending point:

Taxi [ ] "Trotro" [ ]Push truck [ ] Private car [ ]On head [ ]

27. If you have food left over after sales how is it handled?

Given out to people freely [ ] reheated and used the following day [ ]

Kept in the refrigerator (12°C) or freezers (4°C) and used later [ ]

Wrapped or kept in a closed container and sold the following day [ ]

28. Do you have any knowledge on food hygiene?

Yes [ ] No [ ]

29. How was it acquired? By special training [ ] In school [ ]

at association meetings [ ] Intuitively [ ] during apprenticeship [ ]

30. Have you been licensed? Yes [ ] No [ ]

31. Who gave you the license (If Yes in item 30)

District/Municipal/Metropolitan Assembly, any other (specify)...........

32. Do you belong to any association? Yes [ ] No [ ]

33. Have you had any medical examination? Yes [ ] No [ ]

34. If yes in item 33, after the first medical examination how frequent have you been having the examination?Once every six months [ ]

Once a year [ ] Once in two years [ ]Once in five years [ ]

35. Do you have repeat test after sickness? Yes [ ] No [ ]

36. Do you handle food when even you are sick? Yes [ ] No [ ]

37. What type of food-borne sicknesses do you often suffer from:............

38. How many times do you wash your hands during selling?

Once [ ] Twice [ ] Trice [ ] Very often [ ]

39. What problems do you face in your business?.............................

40. How much do you earn at the end of selling in a day? ....

CODE

Sanitation at selling site.

Excellent [ ] Very good [ ] Good [ ] Poor [ ] Very poor [ ]

Clean clothes.

Excellent [ ] Very good [ ]Good [ ] Poor [ ] Very poor [ ]

Fingernails cutYes [ ] No [ ]

Hair covered Yes [ ] No [ ]

Appearance of water for washing plates.

Excellent [ ] Very good [ ]Good [ ] Poor [ ] Very poor [ ]

Food exposed to flies. Yes [ ] No [ ]