UNIVERSITY OF CAPE COAST

MICROBIOLOGICAL AND CHEMICAL CONTAMINANTS IN COMMERCIAL "MASHED KENKEY": A CASE OF NEW JUABEN MUNICIPALITY

DORCAS ANFOBEA AGYARKO

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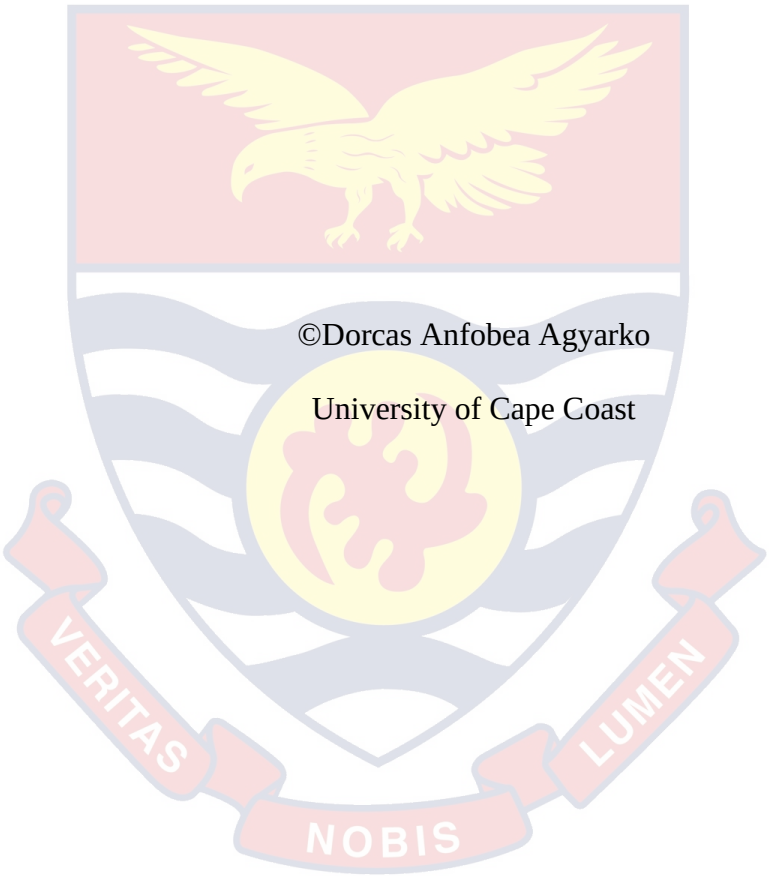

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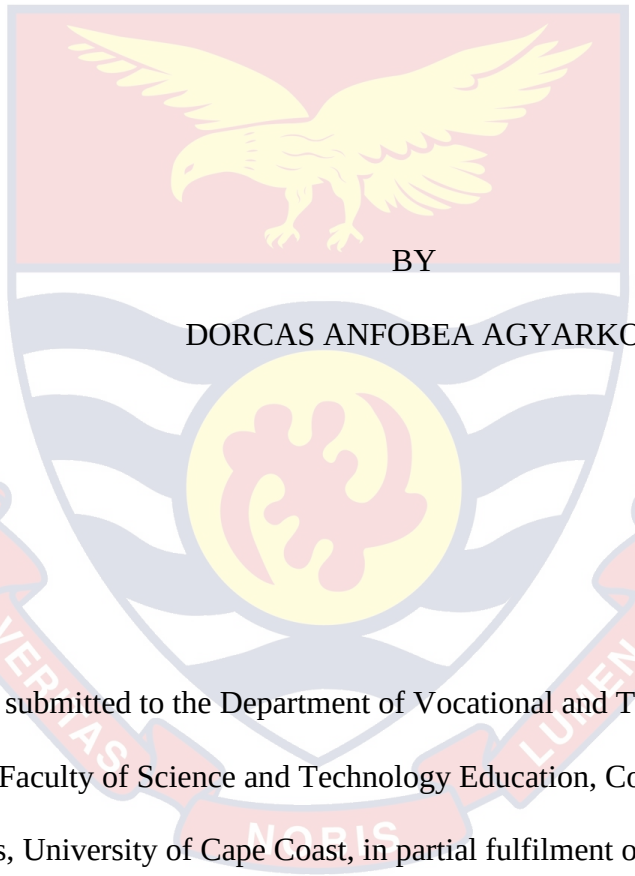

BY

DORCAS ANFOBEA AGYARKO

Thesis submitted to the Department of Vocational and Technical Education of the Faculty of Science and Technology Education, College of Education Studies, University of Cape Coast, in partial fulfilment of the requirements for the award of Master of Philosophy degree in Home Economics Education

SEPTEMBER 2021

DECLARATION

Candidate's Declaration

I hereby declare that this dissertation is the result of my own original research and that no part of it has been presented for any Degree in Education in this University or elsewhere.

Candidate's Signature……. Date……

Name: DORCAS ANFOBEA AGYARKO

Supervisor's Declaration

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

Supervisor's Signature……. Date……

Name: PROF. MRS. SARAH DARKWA

ABSTRACT

The study explored the microbiological and chemical contaminants in "mashed kenkey" from selected milling plants in the New Juaben Municipality in the Eastern Region of Ghana. The descriptive survey design was used for the first phase to obtain baseline data on the incidence of chemical and microbiological contaminants in the "mashed kenkey". Ten milling plant operators and 5 "mashed kenkey" vendors were purposively sampled for the study. Millers hygienic practices were obtained through observation using a checklist. The second phase of the study employed experimental research design to enumerate and identify microbes of interest. Swabs taken from unmilled, milled and mashed kenkey were analysed at the laboratory as well as water used in mashing the kenkey. Most of the millers used grinding plates that were 2-3months old. Millers were observed using their bare hands in handling the kenkey. Also, the population of aerobic mesophylls found in the packed "mashed kenkey" ranged from 10^5 – 10^6 cfu/g. There was a statistically significant difference in the microbial contaminants found in "mashed kenkey" collected from the milling plants. The microbial levels increased from the beginning of the process through to the packaging with the final packaging having the highest. From the findings it can be concluded that the aerobic mesophylls were found in the "mashed kenkey" but at levels that may not necessarily cause harm to consumers. Faecal and other common contaminants were within acceptable levels thus could explain why the risk of the final product affecting the health of consumers is minimal. The study recommended that "mashed kenkey" millers and vendors must adopt safe and hygienic practices in "mashed kenkey" production for consumers to prevent contamination.

KEYWORDS

HACCP

Kenkey

Mashed kenkey

Milling plant

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DEDICATION

To my Husband, Mr. Thomas Akrofi, my children, parents, sisters and Mr. James Kofi Tetteh.

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LIST OF ACRONYMS

ATSDR: Agency for Toxic Substances and Disease Registry

CSIR : Council for Scientific and Industrial Research

EFSA : European Food Safety Agency

FAO: Food and Agriculture Organization

FRI : Food Research Institute

HACCP: Hazard Analysis Critical Control Point

WRI: Water Research Institute

NMKL: Nordic Committee on Food Analysis

CHAPTER ONE

INTRODUCTION

Background to the Study

The risk of food becoming contaminated by microorganisms, chemicals, or both are high, especially during food production. In such cases, it is the food producers in the process of the acquisition of natural products often compromise quality to make significant profits. With an increased number of Ghanaian women having to work for long hours to cater for the family, most cannot cook at home. This has contributed to increased street foods' patronage, especially "mashed kenkey." Mashed Fanti or Ga kenkey has always been popular in most homes and individual institutions like the boarding senior high schools in the country. Fanti and Ga kenkey are prepared from fermented maize dough and are usually mashed, milk and sugar are added and chilled. This mashed product is popularly called "mashed-ke," and people of all ages in Ghana enjoy it. Some drink it alone or with bread, pies, doughnuts, or any wheat flour products. Some people also add roasted groundnuts to it.

In the past, "mashed- kenkey" was often prepared by individuals for their own consumption. Only a few people made it in large quantities, bottled it, and sold or retailed it. However, in recent times, "mashed- kenkey" is being prepared on a large scale in different parts of the country. Due to this, most producers have started to use the corn mill to mash the kenkey rather than using the hands or blender to mash the kenkey as it was formerly done. Using the milling plant to mill the kenkey, producers believe that the "mashed kenkey" becomes smoother, more appealing to consumers, and better enjoyed. Most consumers prefer Fanti "mashed kenkey" to Ga kenkey because the Ga kenkey

is often salty. Most "mashed-kenkey" producers purchase the kenkey, in large quantities, and store them for processing or producing of mashed kenkey. These are usually stored under poor conditions such that they tend to be mouldy before being used in the production of mashed kenkey.

From earlier study, milling plants have been found to have their associated issues, such as introducing metal pieces into the food being milled or microbial contamination (Hinson & Darkwa, 2016). These milling plants are often not well cleaned, especially after milling different foods from different sources so that issues related to one milling process are not carried on to the other. The sugar used in sweetening the "mashed kenkey" also has a high risk of yeast contamination, the water used for milling the "kenkey and the mixing of the blended kenkey and other ingredients into "mashed -kenkey" is a probable source of contamination. The operators of these mills often do not have any food safety knowledge and tips to ensure that they do not use their bare hands and dirty sticks to handle and process kenkey into "mashed -kenkey."

The World Health Organization (2000) emphasized the importance of some chemicals found in food items. However, they also indicated that high levels of chemicals might negatively impact human health. It has also been noted that consumption of high levels of several metals is toxic to humans (Horváth, 2011). In 2016, Hinson and Darkwa reported that the presence of other possible contaminants identified in milling plants include soap and detergents which the operators at the milling plants use to clean the mills, as well as low-quality oils employed to lubricate the parts of the milling plants to prevent friction and to enhance milling. This implies that the adoption of preventative measures during the production of "mashed-kenkey" could reduce

such contamination. Along with the primary carbohydrate source, protein and iron, maize may contain toxins when not properly dried and stored contaminated with aflatoxins. (Ugland & Veggeland, 2006).

Several bodies have come up with different definitions for contaminants which include the Codex Alimentarius Commission (CODEX) and the European Food Safety Agency (EFSA). The heart of these meanings is any substance that is not deliberately adjoined to food but appears in the food due to the production, preparation, storage, treatment, processing, packing, packaging, transporting manufacture or handling of food as such or due to environmental pollution (Millstone & Van Zwanenberg, 2002). Food biological and chemical pollution is a field of concern that involves a wide range of products, such as pesticides, predominantly veterinary drug deposits and agrochemicals, environmental toxins, such as heavy metals, persistent organic pollutants and contaminants processed as a result of prepation, manufacturing or packaging (Cooper , Rushton & Grimes, 2014). As the popular statement "All things are toxic, and everything is poisonous; only the prescription makes it not poisonous," meaning every everything taken in excess is poisonous. Therefore, all food products are in danger of pollution from numerous resources, and "mashed kenkey" is no exception. Low-grade lubricants used in greasing milling plants often leak into the kenkey during milling increasing the risk of contamination. Aflatoxins and *fumonisin* B_1, hepatotoxic and cancer-causing metabolites produced by *Aspergillus flavus* and *Fusarium moniliforme*, could be found in kenkey prepared from mouldy maize. This further compound the issue of contamination in food, food safety and health of consumers. People from all walks of life in Ghana patronize "mashed kenkey" and even require it

as healthy convenience food. In this respect, this research seeks to identify the microbiological and chemical contaminants present in commercial mashed kenkey.

Statement of the Problem

Several people of varying ages and different walks of life in Ghana are buying and consuming "mashed kenkey." The safe food handling processes associated with the production of "mashed kenkey" on a large scale is often compromised and serves as a health threat to those who consume it. All factors which contribute the microbiological and chemical safety of mashed kenkey such as the poor storage conditions that the kenkey is exposed to before being milled at production, the hygiene of the mills, the food safety practices of the mill operators, and the conditions under which the final product that is the kept before selling to the final consumer are all to be identified and assessed so that measures can be implemented to safeguard safety of "mashed kenkey" consumed by the majority of Ghanaians.

Various studies have been carried out on kenkey production in Ghana; researchers ascribe numerous benefits to results obtained and ways to improve upon them. However, there is little work done on microbiological and chemical contaminants in commercial "mashed kenkey" in the New Juaben Municipality and most parts of Ghana. Therefore, this study assessed the microbiological and chemical contaminants in "mashed kenkey" from selected milling plants in the New Juaben Municipality in the Eastern Region of Ghana.

Purpose of the Study

The main aim of this study was to assess probable microbiological and chemical contaminants in "mashed kenkey" from selected milling plants in the New Juaben Municipality in the Eastern Region of Ghana.

Objectives of the Study

The study sought to:

1. ascertain the hygienic practices involved in the production of "mashed kenkey"
2. determine the probable microbiological contaminants in "mashed kenkey"
3. identify the chemical contaminants in "mashed kenkey."
4. determine other possible contaminants in the "mashed kenkey"

Research Question

This research question guided the study:

1. What are the possible contaminants in the "mashed kenkey" produced?

Research Hypotheses

1. There are no differences in the hygienic practices in "mashed kenkey" milling plants in the New Juaben Municipality.

   Alternate hypothesis

There are differences in the hygienic practices in "mashed kenkey" milling plants in the New Juaben Municipality.

2. There is no statistically significant difference in the microbiological contaminants in "mashed kenkey" produced in different milling plants in the New Juaben Municipality.

Alternate Hypothesis

There is a statistically significant difference in the microbiological contaminants in "mashed kenkey" produced in different milling plants in the New Juaben Municipality

3. There is no statistically significant difference in the chemical contaminants in "mashed kenkey" produced in different milling plants in the New Juaben Municipality.

Alternate Hypothesis

There is a statistically significant difference in the chemical contaminants in "mashed kenkey" produced in different milling plants in the New Juaben Municipality.

Significance of the Study

It is expected that the findings of this study will go a long way to improve the handling processes in the production of "mashed kenkey" to obtain safe and healthy "mashed kenkey" for consumers. The HACCP intervention programme that was developed, could be introduced for use in other "mashed kenkey" commercial production venues. The HACCP intervention could also be extended to other similar convenience foods that are commonly found in the streets, so developing a successful intervention for safe production is a plus to Ghana's street foods' safety.

Delimitations of the Study

There are many plants for milling food in Ghana, but the researcher decided to select the milling plants in Koforidua. There are also many milling machines for processing foods, but the researcher focused on milling plants used in milling kenkey into mashed kenkey. There are so many ways food can be

contaminated, but for this study, the researcher decided to investigate the microbiological and chemical contaminants in making commercial "mashed kenkey" from milling plants. The microbiological contaminants that the study looked at were yeast and moulds, Total coliform counts, *E.coli, Staphylococus aureus*, *Salmonella* and *Clostridium perfringes*. The chemical contaminants looked at in the study were mycotoxins (aflatoxins), toxic elements and compounds (heavy metals) and lubricating grease.

Limitations of the Study

The researcher would have wished all the kenkeys brought to the milling plant before milling were not peeled but some of them were peeled before they were brought to the milling centres and this might introduce contamination before milling, consequently it might affect the results.

The unwillingness of some millers to take part in the study posed a major problem. This affected the number of milling plants that participated in the study.

The outbreak of COVID-19 caused a delay in collection of data, the lockdown in Accra also delayed the work since the analysis was carried out at the CSIR -WRI and FRI in Accra. After the lockdown ,the researcher was not allowed into the laboratory and most of the workers worked from home.

Organisation of the Study

The study is structured into five chapters. The first chapter introduces the background to the study, statement of the problem, purpose of the study, research hypothesis, significance of the study, delimitation, limitation, definition of terms, and the study's organization.

The second chapter reviews literature related to theoretical and conceptual issues of the study. It is based on food and its safety for human consumption, toxic elements, food contamination, HACCP in "mashed kenkey", food regulation, and laws. The third chapter presents the methods used in conducting the research and covers the research design, study area, population, sampling procedure, data collection instrument, data collection procedures, data processing, and analysis. Cphapter four presents and discusses the results obtained from data collected, including analytical techniques employed and the evaluation of the findings Chapter five is a summary of the study results, which incorporates the conclusion of the study, recommendations and suggestions in some areas for further research.

Definition of Terms

Contaminant: It is any biological, physical, radiological, or chemical substance that becomes harmful for living organisms (including humans) when introduced into air, water or food that may compromise its safety.

Contamination the act of introducing something in food, which is not supposed to be there, thereby making food unsafe for human consumption.

Critical Control Point: It is a point in a stage or method in the food process where control is to be applied to avoid or eradicate a food safety hazard or minimize it to a suitable level.

Kenkey: It is a popular staple food in Ghana which consists of fermented and cooked maize dough wrapped in leaves.

Mashed kenkey: It is a famous gluten-free smoothie or milk shake made with fermented corn dumpling known as kenkey in Ghana.

Ga Kenkey: corn dough which is fermented for at least two days and cooked with salt while wrapped in corn husk.

Fanti Kenkey: corn dough fermented for at least three days and boiled for a more extended period wrapped in banana or plantain leaves without salt.

Food hygiene: It is the state and technique essential to guarantee food safety from production to consumption.

Food handler: A person who operates in a food firm and handles food or surfaces that are likely to be in touch with food.

Food safety: It is a scientific field explaining the preparation, handling, and storage of food to avert foodborne diseases.

HACCP: Hazard Analysis and Critical Control Points is an organised defensive technique for food safety from physical, chemical, biological, hazards, and more recently radioactive food production hazards.

Hazard: It is any physical, chemical, or biological condition or agent or food that can cause harmful health consequences for consumers.

HPLC- High Performance Liquid Chromatography

Microbes: They are microorganisms, most microorganisms do not cause disease. Microbes which caused diseases are called pathogens or commonly germs.

Toxins: They are poisonous substances produced by bacteria, animals, or plants and may trigger an allergic reaction.

CHAPTER TWO

LITERATURE REVIEW

This section discusses similar significant studies carried out by others. Related relevant literature was reviewed on food safety, quality and contamination, the concept of HACCP and the prevention or control of food contamination. It looks at HACCP at the various stages of "mashed kenkey" production, food laws, and country regulations.

Theoretical framework

This study is rooted in Crosby Quality Theory. The theory is enshrined in four absolute quality management. The first absolute is the definition of quality is conformance to requirements. The second absolute is system of absolute in prevention. The third absolute is performance standard is zero defect. The final absolute is the measurement of quality is the price of non-conformant. This theory was formulated in the year 1979. He was a quality consultant and was well versed in the philosophy in quality management: zero defect and quality management.

His quality management emphasized on doing it right the first time with 100% acceptable output. In relation to Crosby quality management theory, the process involved in the mashed kenkey production in terms of receiving the kenkey, sorting, peeling of the kenkey, milling of the kenkey and packaging of the mashed kenkey should conform to specification. The process involved in the production of mashed kenkey must prevent the intrusion of microbial and chemical contaminants thereby achieving 100% quality of the product that is the mashed kenkey produce for consumption. It is achieved by subjectinget the process of mashed kenkey to Hazard Analysis and Critical Control Point

(HACCP principle). According to Crosby (1979), doing the thing right at first time ensures economic performance by reducing cost of mitigation through rework or legal confrontation as in the case of food poisoning. This could lead to consumers having health issues and in extreme cases can lead to death which can have negative financial implication on the food handlers. The cost of quality is the expense on non-conformance. Financial implication as a result of non-conformance to specification can be prevented if the process involved in mashed kenkey is done right at first time .The ability to control microbial and chemical contaminants from entering the mashed kenkey at the various stages of production could help eliminate the contaminants load from the mashed kenkey produced. The effective control is the ability to identify possible sources of contamination. According to Crosby (1979), quality management theory, there is fiduciary relationship between producers and consumers in that case food handlers have to protect consumers by serving them with quality.

Food is one of the psychological needs of humans, but food can also be a source of death and many illnesses because food gets contaminated through its preparation and preservation. Food can get contaminated through biological, chemical, and physical contaminants. The basic facts of diet and health are to look good, feel good, live long by obtaining the right quantity of food from the right source at the right value, and consume at the right time and the right quantity. Food plays a vital role in the world economy; mostly, human resource need is partly obtained from foods. Ensuring food safety enhances people's well-being, and it is a fundamental right of humans. Safe food contributes to fitness and output and offers an efficient unit for improvement and deficiency mitigation, World Health Organisation (WHO) food safety programme, 2002.

Government establishments regulate organizations and private individuals must adapt acceptable operational practices . Ghana's government has established the Ghana Standards Authority to oversee food safety in Ghana. They have standards for all consumables. The acceptable standard for some foods set by Ghana Standards Authority is measured in cfu/gram. The recommended standards for some cereal foods are as follows: the microbiological limit for test of yeast and moulds in cereals and pulses (dried grains of maize, sorghum, millet, cowpea etc) is 1×10^3 is the minimum standard and the maximum standard is 1×10^4. Businesses observe a structured government regulation that promotes social, environmental, and economic activities into their functions to legitimize their operations (Zhu & Sarkis, 2007).

Definition of food

According to Tull (1996), food is defined as anything solid or liquid substance which, when taken into the body, delivers the essential ingredients to enable us to grow, replace malfunctioning tissues and injured parts, and function usually. As mankind grow and develop, some cells wither and wear out. These cells must be replaced to ensure that the body grows and functions normally. According to Nartey (2019), food promotes growth, provides heat and energy, and regulates and maintains body processes. Food is anything liquid or solid that, once eaten, helps the body grow, protect the body against diseases, control body processes, and give energy. This shows food is indispensable in the physical development in human growth. The above definitions by previous authors indicate that food is intended to promote good health, growth and prolong life. Food exists in two forms that is liquid and solid. Liquid foods

include beverages, soup, milk and mashed kenkeys while the solid foods are "banku", "ampesi", bread, kenkey and beans. Food is not merely meant to fill the stomach; it contains chemical substances which the body uses to function properly and stay healthy. It also supports drugs administered to patients to work effectively, the efficacy and potency of a drug depends on food to help the body makes use of the drug. Therefore, doctors' advice patients to eat before and after taking their medications.

Food is obtained from two primary sources: plants and animals. Food obtained from the plants source includes corn, plantain, yam, rice, tomatoes, cassava and so forth. Moreover, the animal sources include meat, poultry, cheese, milk, and egg. Food can also be grouped under perishable and non-perishable. Foods considered as perishable are those that begin to spoil immediately they are produced examples are meat, milk, fish, tomatoes while non -perishable foods are foods that keep a bit longer before beginning to spoil; examples are sugar, "gari", dried cereals and grains.

All foods have specific characteristics. These characteristics are used to judge food in terms of appearance and palatability. They include taste, colour, flavour, texture and consistency. Events such as birthday celebrations, weddings, funeral rites, etc. are occasions that allow us to learn about the dishes of other cultures.

Food Contamination

Not all foods that appear normal are fit for human consumption. Food contamination is when physical, biological, and chemical hazards are found in foods that are not supposed to be the in the food (Brown & Grunberg, 1996). When food is contaminated, it affects consumers' health and well-being, and

this contamination occurs during production, processing, packaging, handling, and storage (Beck, 2000). Every year many people go to an early grave and others hospitalized because of diet related diseases in the form of diabetes, stroke, cancers, kidney failure, obesity, airborne diseases and other cardiovascular diseases. Food is a leading risk factor of death and disability in the worldwide.

Physical Contaminants

These are foreign bodies that find their way into food from the environment, thus any extraneous substance that enters food such as hair, plant, plastics/ metals that can occur as contaminants in food. They occur unknowingly and these happens when health and safety measures are not adhered to. Sometimes the foreign object is a natural component of the food (eg. a fruit stalk), google search accessed date 12/11/2019.

Biological contaminants

These are harmful microorganisms found in food and water, they are not seen physically with our naked eyes, and there are good microorganisms that are important to food such as yeast in bread production, beverages, and fruits. Bacteria (lactic acid) in yoghurt preparation, cheese, meats among others and some are harmful and dangerous, and these are bacteria (spore forming and non-spore forming), viruses, and Parasitic protozoa and worms. When such harmful microorganisms enter our bodies, food poisoning occurs, resulting from eating contaminated foods. Food poisoning signs include diarrhoea, stomach pains, muscle weakness, fever, and death in extreme cases. (Alli, 2004).

Filth and Foreign Matter

Objectionable substances in foods from foreign substances that makes food more Belligerent and unessential consist of (for example, cigarette butts, metal, sand, stones, wood, stones, and glass), undesirable portions of the raw plant material (such as stem, pieces of shell in canned oysters, cigarette butts pits in pitted olives), and filth (called insect, decomposition rodent parts, excreta. mould, and rot).

Types of food poisoning

1. **Microbial poisoning or toxins of the microbes**: This is microbial infection or toxins from the microbes
2. **Chemical poisoning:**
    - **Metal poisoning:** This could occur as a result of storing acidic foods such as fruit juices in containers coated with cadminna, zinc or lead or in poor quality cooking utensils.
    - **Pesticide poisoning:** This could occur because of consuming vegetables or fruits not washed properly after being sprayed with high dose of pesticides. It could happen also from pesticides used improperly at home.
    - Poisoning by chemical toxins and industrial detergents used in washing production hires. This could happen due to improper usage be it in high doses or nor washing well after use, leading to the materials ending up in foods.
    - Poisoning from food additives used for flavour or colour or as preservative meant enhancing the taste, smell, and durability. If used in the appropriate quality, they do not pose health risks; but they

could cause poisoning when they are used more than the appropriate quality.

- Poisoning by cleaning or sterilization agents, stored improperly besides food or because of their residues remaining in cooking utensils due to insufficient washing.

Food micro-organisms

Staphylococcus aureus

Staphylococcus spp is a whole organism that poisons foods. When viewed under a microscope, the roundly shaped bacterium appears in grape-like clusters. When expected to progress over more than a few periods in food, such as cream filling or chicken pot pie, it produces a heat-stable toxin. No change in colour, odour, texture, or flavour may be caused by bacterial growth, but the contaminant might be released into the food (Reynolds *et al.*, 2003). *Staphylococcus* toxin, as it is heat stable, is not distinctly distressed by using heating. When the food is heated before one eats, even though the heat kills the bacterial cells, the food's poison will lead to disease. People and domestic animals are significant sources of *staphylococcus* toxicity. It is typically discovered in most people on the skin and through the nose. In scratches, boils, cuts, blemishes on the skin, *staphylococcus* bacteria can be found. During food preparation, these organisms (bacteria) enter the food from sores and cuts on workers' hands. At body temperature (98^{o}F), the organism grows best, but it can grow over the much more complete range of 50^{o}F to 115^{o}F. Foods with a pH more than 4.5 are preferred, so they are rarely seen in acidic foods like pickles, tomatoes, and citrus juices (Reynolds *et al.*, 2003).

Symptoms of *Staphylococcus* food poisoning

Symptoms of *staphylococcus* pollutant occur too quickly, between four to six hours after food consumption, characterised by abdominal cramps, nausea, vomiting, headache, diarrhoea, and a common feeling of washing out. A lot of patients may fall off from *staphylococcus* food contaminated and never report it or do not know they have it.

Prevention

The greatest way of avoiding *staphylococcus* food poisoning is to keep food properly and minimize the temperature under 40^{o}F within four hours of distributing. For *staphylococcus* to develop and emit contaminants, it should have enough time. Roughly two to four hours are required, based on the conditions, at an appropriate heating rate for toxins creation. Thus, it is important to heat or cool food via the 40^{o}F to 140^{o}F risk region as quickly as possible.

Secondly, keeping sores or wounds closed and preventing body contact with food that are cooked prevents infection by *staphylococcus* species. Worker's hands are the primary means of contamination. Good laundry conducts and good personal hygiene are crucial for avoiding contamination (Reynolds *et al.*, 2003).

Clostridium botulinium

Botulism is another form of actual food poisoning. Organism of this sort has gained much attention and is right, because in 60 percent of cases, it is not just causing disease, it is lethal. It is present in soil, water, sewage, and human and animal intestines. In the presence of oxygen, this organism does not expand and it is thus termed to as an anaerobe, *Clostridium botulinium* is an organism

which is rod-shaped in nature, forms spores , develop heat resistant and can destroy its epithelial cells by heating, but to kill them, the spores need 240^{o}F at pressure canning or sea level. These spores behave similarly to seeds. They would not germinate whether they are put in a dry position or under unfavourable conditions. They can tolerate dry conditions for long periods and can withstand hot water for many periods. Each of these spores is inserted in a food that will germinate and expand at the proper temperature, humidity, low acid levels, and lack of oxygen. Cells of bacteria are formed once. They will therefore maturate and have the potential to create toxins.

As a result of this, the only harmless technique for canning low acid foods is pressure canning (Reynolds *et al.*, 2003). The introductory note to the development of *Clostridium botulinum* and its contaminant production is pH of the canned food. At first meat and meat carry this microorganism, but fruits will not permit its growth since they are acidic in nature (pH of 4.6 or below). Meat and most vegetables are not acidic and will help its development. This microscopic organism does not essentially produce an adverse effect so in the food in development process. For instance, there will be no puffiness, off-odour or off- colour even though the contaminant will be available.

For contaminants to grow, the temperature for caning must be insufficient to inhibit the activities of the spores present. At least seven toxins are known to be produced by this organism. The most normally associated with human sickness are types A, B and E. The best temperature at which toxins are produced is within 85^{o}F and 95^{o}F but be produced from 38^{o}F to 118^{o}F (Reynolds *et al.*, 2003).

Symptoms of *Botulism*

In some circumstances, mortality is the eventual consequence of an epidemic of dizziness, tiredness, headache, botulism, acute indigestion, vomiting, nausea, diarrhoea may be clinical signs. In the final stages, throat compression and muscle paralysis come, accompanied by loss of life due to unconsciousness except an anti-contaminant is immediately given out.

Prevention

In the United States, around ten to twenty incidents of botulism happen annually. Home-canned foods that are adequately treated are the primary cause of the issue. A required temperature should always be used when home canning food, about three occurrences of botulism from commercially canned foods have happened since 1925, leading to in four deaths. In 1941 we have one person died of botulism, two in 1963, and we have on record that one person died in 1971. This was outstanding record for the commercial canning firm when one considers that each year, more than 17 million cans of foods are traded (Reynolds *et al.*, 2003).

Food infection microorganisms

Salmonella

There are over 1200 species of *Salmonella spp*. They are all extremely harmful to individuals. *Salmonella spp* lives in humans and animals' digestive tracts and is continuously transferred from human to animal, from animal to human, and from human to human in a non-stop sequence. The leading cause of salmonella toxins in our food supplies is from the mammalian intestines. Salmonella is also borne by vermin, such as rats, cockroaches, and flies. The ingestion of infected foods, like milk, cheese beef, eggs, fish, desserts, candies,

and pastries has resulted in *Salmonellosis* spp (Reynolds *et al.*, 2003). Sandwiches, mayonnaise, tacos, yoghurt, smoked fish, and crab are also associated with *Salmonella* spp. (Eschbach, 1994). When we ingest foods containing the bacteria, salmonellosis is induced. It is an illness from food. In the small intestines, these species begin to expand and reproduce. Sickness is the consequence, so eight to twenty-four hours after we consume the infected food.

Fraser *et al*., 2010, argue that people vary in their tolerance to *salmonella* infections, but morbidity in an outbreak is usually high. *Salmonellosis* is well known among all food-related diseases. About twenty thousand instances are informed annually to the Centre for Disease Control (CDC). It is potentially just a tiny out of a hundred annual occurrences (Reynolds *et al.*, 2003). Several occurrences result from cross-contamination from uncooked to cooked food and by infected food lingering too long in the temperature hazard zone.

Symptoms of *Salmonellosis*

The sudden start of diarrhoea, stomach pain, nausea, fever, prostration, vomiting, and chills are well thought-out by salmonellosis. Symptoms range from mild to extreme severity. Except for babies or older adults who may dehydrate rapidly, the symptoms rarely cause death.

Prevention

Salmonellosis can, without much of a stretch, be forestalled. Heating kills this creature. Sickness frequently happens because of the tainting of food after the cooking. *Salmonella* can simply be monitored by acceptable hygienic activities to stop cross-contamination. On cutting boards or instruments used to prepare raw goods, cooked food must never be processed. The first line of

defence against this organism is the immediate refrigeration of cooked food or leftovers. Often keep food in a container that will not permit food produce to be quickly cooled using shallow pans with a depth of no over three inches. Using industrial heating elements to freeze the product food beneath the fast-growing temperature hazard zone (40^0F) if large amounts have to be chilled (Reynolds *et al.*,, 2003).

Clostridium Perfringes

Clostridium perfringes are anaerobic, rod-shaped, gram-positive bacteria. During cooking, the vegetative cells of *Clostridium perfringes* dies, yet they structure spores ready to endure the harmful conditions. The spores can grow into nonsexual cells that can duplicate to many. Once the profoundly debased food is ingested, even though the cells cannot fill in the gut, the structure spores, and as the cells break to deliver the spore, much poison is delivered into the gut. (Czeczulin *et al.*, 1993).

Because most occurrences are aligned with bulk eating activities such as at feasts, *Clostridium perfringes* food intoxication has often been labelled as a food firm dilemma. Each year, many food intoxication occurrences from *Clostridium perfringes* happens, in fast food joints, institutions and home kitchens, particularly individuals providing meat stews, broths or gravy (Reynolds *et al.*, 2003). This species also have strict growth requirements; therefore, it is commonly linked with protein dishes. This bacterium is somehow different from other bacteria that poison food since it generates toxins and brings about food disease by expanding and developing toxins after consumption in the intestinal tract. *Clostridium perfringe*s can maturate over a broad temperatures range at low temperatures but expand bit by bit. The

temperature range of *Clostridium perfringes* is minimum 10°C, maximum 54°C and optimum 43°C (Li & McClane, 2006). These spores can develop and nurture greatest at temperatures within 100°F and 117°F, unlike most other food poisoning bacteria. Regrettably, in food provision stations, such as oven style warmers and steam tables, this is a temperature range commonly seen in hot food keeping areas (Reynolds *et al.,* 2003). There is an ideal heat shock of about 75°C that will cause any spores' vegetative growth in the diet. Slow repetition and cooling rate provide conditions for propagating spores and nay living vegetative cells (710°C to < 54°C) that allow large numbers to multiply, mainly because competitive flora would have just been destroyed (McClane &Rood, 2002).

The critical reasons for *Clostridium perfringes* with food provision or bulk feeding are such that it includes an air-free environment, high temperature, storage time and a stringent provision of nutrients. Usually, these situations result when sauces, soups, meat stews and gravies are stored wrongly. Typically, the food is prepared in a broad, shallow vessel. After frying, one believes (wrongly) there are no microorganism and that the vessel is put in the refrigerator. Reheating is complicated because of the volume of the tanks, and the bacteria will not be destroyed. Many individuals are generally disturbed while food is consumed (Zottola & Busta, 1971).

Symptoms

These food contamination indications are moderately gentle as a rule and might be known as a "belly infection". If the situation occurs at a huge social event, for example, a dinner or church work, it is generally announced and recorded manifestations of illness including stomach pains, occasional

nausea, diarrhoea, and even sometimes vomiting or fever. The side effects normally seem 40 to 22 hours in the wake of ingestion and may continue for one up to five days period.

Prevention

Numerous nourishments, for example, poultry and meat, may convey the living being, yet the simple presence of *Clostridium perfringes* in food is not sufficient to cause sickness. Many developing cells are required. The counteraction of this current life form's development is best refined by adhering to the standard food administration rehearses or quickly chilling arranged nourishments in shallow holders and keeping cold food and hot food hot. It is additionally fundamental to lessen defilement by continuing working regions spotless and sterile (Reynolds *et al.*, 2003).

Vibrio parahaemolyticus

Vibrio parahaemolyticus is a specific organism in food contamination that is not common to some persons, but it is a critical topic. This organism is often linked with mollusc and other fishes from contaminated marine water. *Vibrio parahaemolyticus* is a comma-shaped organism that grows at a lower temperature, 50^{o}F, and higher temperatures. It is halophilic and is well suited to develop in saltwater (Reynolds *et al.*, 2003).

Symptoms

A high dose is needed to cause illness with symptoms such as nausea, vomiting and abdominal cramps,

Prevention

The critical prevention of this foodborne disease stems from the prohibition of fishing in polluted waters. However, keeping shellfish

refrigerated to avoid growth is the best guarantee for a foodservice operation to escape Vibrio food poisoning. Always make sure to cook the shellfish thoroughly, commercial food vendors should acquire from decent and approved sources.

Yersinia Entrocolitica

Food becoming contaminated with *Yersinia enterocolitica* have raised much safety concerns.The *Yersinia* bacteria is a rod-shaped organism causing food infection in humans. The organism is an anaerobe, around 66^{o}F to 82^{o}F, the organism grows best. Pasteurization only lowers the growth rate. For *Yersinia*, a growth temperature of 24°F needed. Fruits andvegetables, meat, milk, , eggs, fish, poultry, tofu and certain acidic foods like mayonnaise are good habitats for the bacteria to grow. In acidic foods, a pH less than 4.0 will generally limit growth. Heat and chemical sanitizers will destroy the organism (Brackett, 1986).

Symptoms

Yersiniosis is the name of the contamination brought about by *Yersinia enterocolitica*. The symptoms of Yersiniosis are severe stomach pains, fever, and gastroenteritis, which can happen 24 to 36 hours after eating the food and can keep going for one to two days. *Yersiniosis* can be mistaken for a ruptured appendix and has brought about pointless appendectomies (Brackett, 1986).

Prevention

The primary means to avoid a foodborne disease are proper cooking of food, the avoidance of cross-contamination, decent cleanliness and sanitation, and personal hygiene. Proper pH regulation is essential for acidic foods.

Listeria Monocytogenes

Listeria monocytogenes is bacteria that causes food infection and has gain public awareness as a safety problem in food products. *Listeria* is a small, non-spore-forming rod (Adams, 1987). *Listeria monocytogenes* is a pathogenic Gram-positive food born bacteria that cause *listeriosis* (Lety *et al.,* 2006). The general growth conditions for the growth of the bacteria include oxygen, temperature ranging from 37^{o}F to 104^{o}F, and a pH range of(5.6 to 9.8). Since *Listeria* can grow at refrigerated temperature, withstand milk acid. Conditions that can survive heat treatment is up to 170^{o}F and cause foodborne illness. This bacterium is a significant health concern in the food system. Lety *et al.* (2006) indicated that a temperature as low as 0^{o}C allows its multiplication in refrigerated foods because this organism can grow in such temperature. At a refrigeration temperature of 4^{o}C, the amount of ferric iron can affect its growth. This bacteria was discovered in California as an infections agent in a foodborne illness outbreak involving 86 individuals. In the epidemic, the fatality rate was over 30%. The main source of contamination was Mexican cheese. Listeria monocytogenes in food is a health threat to the feeding public. Actual or alleged contamination of food products with Listeria monocytogenes has also contributed to the closure or discontinuation of companies' producing this lucrative food products (Reynolds *et al.*, 2003).

Food is a primary means of transmission of illness to humans. (Reynolds *et al.,* 2003). Plants to humans, animals to humans, air to humans, and humans to humans are other potential ways. Ramaswamy *et al.*, (2007), stated that there are many possibilities for Listeria contamination during food processing since Listeria is ubiquitous in the environment. It can grow in soil, birds, insects, waste, vegetation, and domestic and wild animals.The main route

of infection with Listeria is the ingestion of contaminated foods, mostly ready to eat foods that have not been properly refrigerated and raw food. Listeriosis is the disease caused by *Listeria monocytogenes.*

Symptoms

Listeria monocytogenes infection in an average healthy person may be asymptomatic, or flu-like characteristics of the disease. In sensitive persons, however, advanced states can occur. People with special cases such as Pregnant mothers, newborns, older people, cancer patients, patients with AIDS, people with rheumatoid arthritis, diabetes, alcoholics, and people undergoing steroids, chemotherapy or renal dialysis are vulnerable. Listerosis can lead to stillbirth or miscarriage of the foetus in pregnant mothers. Meningitis and septicemia can affect immune-depressed individuals (Reynolds *et al.,* 2003).

Prevention

Llisteria can grow and multiply in refrigerated storage . Neither refrigeration nor freezing will destroy the organism. The organism is generally destroyed by heat treatment, 170^{o}F for 15 seconds , Proper personal hygiene, good sanitation, proper cooking and preventing cross contamination of raw and cooked food are the best control measure known to date (Adams, 1987).

Campylobacter

The rod-shaped, motile, non-spore-forming bacilli of *Campylobacter jejuni,* and *Campylobacter coli* are thought to be the causative agent of health enteric disease than Salmonella or shigella (Reynolds *et al.,* 2003). Types of *Campylobacter* are organisms that trigger *Campylobacteriosis,* a gastrointestinal disease with similar characteristics like appendicitis. Several *Campylobacteriosis* cases are not fatal.This infection has also been linked with

Guillain-Barre Syndrome, leading to gradual muscle weakness. *Campylobacter* species are common in many animals and their intestines. *Campylobacter species* are Gram-positive and belongs to the family of *campylobacteraceae*. The genus *Campylobacter* is made up of 17 species and 6 subspecies (Nachamkin, 2007; Silva *et al.,* 2011). *Campylobacter jejuni* and *Campylobacter*-related human illness are the two bacteria most often involved in human illnesses, with *Campylobacter coli* attributing to 18.6 percent of human illness. The human foodborne disease has also been associated with *Campylobacter fetus* (Gurtler *et al* ,2005). Some factors influence either the growth or survival of *Campylobacter* species. Ecological factors like oxygen, temperature and water makes the organism more vulnurable , and have limited capacity to withstand environmental stress. *Campylobacter* species thrives in the 30^{o}C – 45^{o}C temperature range. In about 6 hours, at 32^{o}C, *Campylobacter jejuni* can double its number (Forsythe, 2000). At temperatures below 30^{o}C, *Campylobacter* species do not multiply. Hence, the number of *Campylobacter* species would not increase in foods kept at room temperature (20^{o}C – 25^{o}C) (Park, 2002). Under moist conditions at the temperature as low as 4^{o}C the organism can survive. Although the organism is unable to grow below 30^{o}C (Hazeleger *et al.*, 1988; Park, 2002). Survival of the organism in food is also extended at refrigeration temperatures as compared to room temperature, with viable cells being found after seven months of storage at 4^{o}C (Lazaro et al., 1999) .A study of *campylobacter* species that investigated its survival at freezing temperatures (-22^{o}C) on contaminated chicken and minced meat, (Sampers *et al.*, 2010) found that numbers decreased by around the first 24 hours 1log10. No further substantial reduction is possible by extended freezing, with

the species of *campylobacter* were found after 84 days in enrichment samples. Though species of *Campylobacter* live well at cold temperatures, they are heat sensitive and are readily inactivated by pasteurization or domestic cooking procedure. Heating at 55ºC-60ºC readily kills campylobacter species for many minutes (ICMSF,1996). *Campylobacter* species are very susceptible to moisture loss and do not thrive on dry surfaces (Fernandez *et al.*, 1985).

Campylobacter Jejuni grows rapidly in a sodium chloride concentration of 0.5% , or the presence of 2% or higher concentrations of sodium chloride (Wallace, 2003) *Campylobacter* have varying degrees of oxygen tolerance (3-5%) between species (Forsythe, 2000). Most *campylobacter* strains do not grow in the presence of air, other than a few strains that may grow under slightly oxygen-rich conditions. Optimal growth occurs at 5% oxygen and 2-10% carbon dioxide (Park, 2002). *Campylobacter Jejuni* can acclimate to high-impact conditions because of the capacity to create a biofilm. The degree of biofilm arrangement is higher in motiles, lashed strain than in non-whipped, non-motile strain. This capacity upgrades the endurance and transmission in the food handling climate, for example, poultry preparing (Reuter *et al.,* 2010). Several studies have shown that *Campylobacter Jejuni* is sensitive to acidic foods. (Levin *et al.*, 2007). These organisms have four main virulence factors : motility,adherence, ,invasion, and toxin production. The exact nature of how these organisms adhere to and invade the intestinal epithelial cells is not fully understood (Levin *et al.*, 2007). It is thought that the combination of its spiral shape and flagella leads to rapid motility that enables the organisms to penetrate through the intestinal lining, unlike conventional bacteria (Levin *et al.*, 2007) . *Campylobacter* species are transmitted to humans, primarily through the

ingestion of contaminated food or water or through direct contact with infected animals. They are often found in the gut or domestic and wild animals such as cattle, sheep, chickens, dogs, wild birds, and rodents .(Ellis-Iversen *et al.*, 2012). Before being moved to the final consumers , Campylobacter species found on raw meats may have infected the kitchen workers' hands (Coats *et al.*, 1987). Outer packaging material for raw meat (raw chicken, game-fowl, lamb and beef) has been described as a cross-contamination route for Campylobacter species in retail and consumer premises (Burgess *et a*l., 2009). In all Australian states and territories except New South Wales, Campylobacter infection is notifiable. In 2012, with a prevalence of 102.3 cases per 100,000 population, Campylobacter was Australia's most frequently recorded foodborne infection (15, 664 cases). It decreased by 112.8 cases per 100,000 populations (ranging from 107.4-119.9 cases per 100,000 populations per year) from the mean of the previous five years (NNDSS, 2013).

In 2010, a Campylobacter infection rate of 13.6 cases per 100,000 population was reported by the Food Net surveillance (representing 15 % of the population). This was equivalent to the 13.0 cases per 100,000 population average for 2009 (CDC, 2011). In 2011, the number of cases of Campylobacteriosis in the European Union (EU) was 50.3 per 100,000 people. There was an improvement in the number of cases from 2010 to 2.2 percent (EFSA, 2013). It is understood that the incidence of infection with *Campylobacter* is associated with seasonal changes in many countries. In Australia, infection with *Campylobacter* is most predominant during spring (Unicomb *et al.*, 2009). In Germany, a central summer peak of *Campylobacter* jejuni and a prime of winter, campylobacter coli have been noticed (Gurtler *et*

al., 2005). *Campylobacter jejuni* is the most widely identified foodborne disease-related agents in developing nations, including New Zealand, the United Kingdom (U.K.), and the United States (Mead *et al.*, 1999, Park, 2002). Foods linked with outbreaks of *Campylobacter spp* include animals foods and products (IFT, 2004).

Symptoms

Diarrhoea (sometimes bloody), stomach pain, fever, muscle pain, headache, and nausea are signs of campylobacteriosis. Before the onset of the disease, the incubation period is usually 2-5 days, with the infection generally persisting 2-10 days. The disease's distinctive characteristic is the severity of abdominal pain, which could become chronic and sufficiently extreme to mimic acute appendicitis (FDA, 2012). As a consequence of *campylobacter Jejuni* infection few individuals develop accompanied condition such s reactive arthritis or Guillan-Barre syndrome, in which a harmful immune response of the body attacks part of the peripheral nervous system resulting to symptoms of muscle weakness or paralysis (Havelaar *et al.*, 2012).

Food Allergens

An irregular reaction to food caused by the body's immune system is food allergy, one type of adverse reaction to food in which the body develops a particular antibody called Immunoglobin E (IgE) occurs in many forms of immune responses to food. The binding of IgE to particular molecules found in food activates the immune response. The reaction may be mild or associated with a severe and life-threatening reaction, called anaphylaxis, in extreme cases. A food reaction is often not an allergy, but another form of reaction called aversion to food. As many as 220 to 520 million people worldwide could be

affected by food allergies, with most of these sufferers being children (Wood, 2003). Upwards of 12 million Americans are believed to have been diagnosed with food allergies. Around 25% of the United States population are perceived to have allergic reaction to food. The skin, gastrointestinal tract, and the respiratory or cardiovascular system can be affected by a food allergy. Allergens can be many kinds of foods, but some foods are far more likely to cause an allergic reaction than others. In 90% of allergies, a mere eight (8) foods are responsible. These involve milk from cows, chickens, peanuts, fish, shellfish (crabs, shrimps, and lobsters), nuts, wheat, and soy. Food allergies does differ by culture and population. Recent survey by Imamura suggested that of 1,383 Japanese patients from 878 families, allergies were found in milk, eggs, wheat, peanuts, and soybeans, followed by sesame and buckwheat were the most common allergens perculiar to the United States.

Classification of food allergens

Food-allergic event is a general term describing any unusual clinical response associated with food intake and in addition it is also defined by the pathophysiological mechanism of food intolerance or food allergy. Food intolerance refers to an unfavourable physiological response to food. It may not be reproducible and often dose-dependent because of the food's inherent properties (that is, a toxic contaminant, an active pharmacological component), or the host's behaviourist is, metabolic disorders idiosyncratic responses, psychological disorders).There is the perception that food intolerance represents many of the negative effects of food (Taylor *et al.*, 1992). An irregular immunologic reaction to a food that occurs in a susceptible host refers to food

allergy. Every time food is consumed, these reactions are reproducible and often do not depend on the dosage.

Food allergies can also be categorized as a) IgE-mediated, which are mediated by antibodies belonging to Immunoglobulin E (IgE) and are the best-described food allergy symptoms, based on the immunological mechanism involved; b) cell-mediated when a food allergy is caused by the cell portion of the immune system and often involves the gastrointestinal tract; mixed IgE-mediated

Epidemiology

"In recent decades, several studies have shown that while 40 percent-60 percent of parents assume that signs and symptoms shown by their children are linked to food intake, only four percent-8 percent of children have symptoms reproduced by oral food challenges. Food allergy incidence is highest in infants and toddlers (6-8 percent) and decreases marginally with age, affecting almost 4 percent of adults. Food allergy is the leading cause of anaphylaxis treated in hospital emergency units in Western Europe and the United States.

Due to the severity of atopic dermatitis, young people with mild to extreme atopic dermatitis have a high rate of IgE-mediated food allergy, estimated at 10-30 percent. In over 90 percent of children with eosinophilic esophagitis, food allergies tend to play a role. Cow milk, eggs, peanuts, tree nuts, soy, wheat, fish, and shellfish are the most popular food allergens in the paediatric population, while peanuts, tree nuts, fish, and shellfish predominate in adults in the United States (US). The frequency of sensitization to particular food allergens varies depending on the population studied age and features. The reasons for the increased prevalence of food allergies are unclear, although the

brief period over which the rise occurred implies that environmental factors are more likely to be critical than genetic factors as part of the hygiene theory. Additional factors are likely to play an essential role in food preparation methods, increased antacids, and sensitivity to food allergens containing medicinal creams. It was postulated that the introduction of food later in the infant diet would play a role in increased food allergies (Taylor *et al.*,1992).

Toxic elements and Compounds (Heavy Metals)

In the air we breathe, the liquid we drink, the food individuals consume, the objects people touch, and the items they use, people are exposed to various potentially harmful agents. Chemicals have been an essential component of human life, sustaining and evolving operations, preventing and managing many diseases, and increasing agriculture efficiency. Despite their benefits, chemicals can have adverse effects on human health and environmental integrity, primarily when contamination is caused. (WHO, 2000). Majority of the chemical elements belong to metals. Metals are significant environmental pollutants because of prolonged use and immense amounts produced. Metals can be classified into light, and heavy, those with a density over 5glcm^3 were regarded as heavy metals, but this categorization has been superseded by other aspects, including toxicity and confusion (Duffus, 2002). Oregon Health Authority (OHA, 2011) cites that heavy metals apply to metals with similar chemical properties some of these include copper, zinc, iron and lead. These play a lot of roles in the body for example arsenic chemicals in food, water and wood products as well as mercury can be built up in fish we eat and high levels of the metals can cause health problems.

Zinc

Zinc is essential in human diet and its deficiency is bad on the human's health. The effects of lack of zinc are neurosensory changes, oligospermia, retarded growth, delayed wound healing, immune disorder and dermatitis. Taking too much of zinc into the body through food, water or any dietary supplement can affects one's health, too much of zinc can cause anaemia, decrease levels of high-density lipoprotein (HDL) cholesterol in human, high levels of zinc prevent copper absorption (Institute of Medicine, 2011).

Lead

Lead is a soft silvery grey metal melting at 327.5^{0}C. It is high resistant to corrosion but is soluble in nitric and sulphuric acids. Lead also forms salt with organic acids such as lactic and acetic and stable organic compounds such as tetraethyl lead and tetramethyl lead (Horváth, 2011). Lead is used in cells, cables petrol (gasoline additives). It can be used to solder water distribution pipes and seam can and close packaging etc. The level of exposure to lead depends upon many lifestyle factors including foodstuff consumed, use of lead solder. Levels of lead in water etc.

Iron

It is an essential element in humans, it can react with water, air, and dilute acids. This contributes to water contamination because iron present in solution are more mobile (Lenntech, 2011), iron can be found in shallow wells. Too much of iron has a negative effect in the body.When three milligrams per litre (mg/L) or more of iron is found in drinking water, it will exhibit rust colour, an odour and leave residue on clothes and food; however this concentration is

not harmful to health. If people ingest too much iron, it is stored in the pancreas, liver, spleen and heart.

Lubricant Additives

Lubricant additives are the essential elements in modern lubricants to enhance the specific performance.Lubricant base oils, either mineral base or synthetic base, may not have all of the required properties to maintain their functions under various conditions. A variety of additives have been used as performance enhancers for lubricants since the 1920s. The concentration of additives in lubricant ranges from one thousand to three hundred thousand ppm depending on the applications (Pirro & Daschner, 2001). Most additives are chemical compounds, the possible chemical reactions between additives may create adverse effects to lubricant performance (LePera, 2000). Lubricant manufacturers need to use additives in formulating lubricants to achieve optimal performance properly. The following are the typical additives used today for enhancing lubricant performance."

Trace Metals (Including Organo-Metallics)

According to Sequeira, 1994, water process of crude oil emulsions, trace metals and organo-metalics typically present in crude oils are either inorganic water-soluble salts, such as sodium, potassium, magnesium, and calcium chlorides and sulphates or oil-soluble compounds, such as vanadium, copper and iron.

Used Lubricants

Several studies have reported that lubricants based on petroleum are slow to degrade, harmful to the natural world, and highly toxic to human health, fauna, and flora. Studying the possible impacts on human health, livestock,

plants, and the ecosystem of used petroleum-based lubricants is vital in increasing public awareness of the proper handling of used lubricants to avoid the release of used lubricants into the environment. This section presents the analysis of the general composition of most used lubricants, the evaluation of the biodegrability and toxicity of used lubricants, and the assessment of relative risk of used lubricants to human health and ecosystems.

As the scarcity of petroleum is becoming a global issue today, across human history, the regeneration of used petroleum-based goods is gradually becoming more important than ever. Most notably, lubricants have been used to protect the atmosphere and to conserve energy and natural resources.

Composition of Used Lubricants

The composition of used lubricants obtained from engines and machinery varies greatly from location to location. In addition to hydrocarbon compounds (C4 to C50) extracted from base oils and unburned fuels, the lubricants used often contain different additives from the original formulation, as alluded to in the preceding sections, and different quantities of pollutants, such as metal particles, soot gel networks, soot aggregates, dirt, organic compounds (e.g., benzene, toluene, xylene, PAHs) and heavy metals (e.g., cadmium, chromium).

I. Characterizing used lubricants is difficult because the composition of used lubricants varies widely only with type and age of vehicles and equipment, the service life for lubricants, collection locations, and operational parameters.

II. It is challenging to characterize used lubricants because lubricants' composition varies widely with vehicles or machines' type and age,

lubricants' service life, the collecting places, and operating conditions. Impurities found in used lubricants may significantly affect lubricant functions and reduce the performance of engines or machines. The common impurities found in used lubricants are enumerated as follows:

- ✓ Coal dust particles that are generated by frequent fuel combustion.
- ✓ Enormous sediment totals irreversibly changed from residue particles.
- ✓ large soot gel networks resulting from the interaction between dispersants in lubricant and soot aggregates.
- ✓ PAHs are generated from the incombustible low-molecular-weight of aromatic hydrocarbon compounds.
- ✓ trace metals from the source of lubricant base oils, crude oils.
- ✓ metallic fragments from wear and tear of moving parts in engines or machines.
- ✓ oxidized metals from the corroded metal fragments in used lubricant.
- ✓ sand and dirt from collection places and during transit between collecting places; and
- ✓ water and moisture introduced into used lubricant by blow-by vapors in the air, the leakage of the cooling system of vehicles, and the combustion of fuels.

Table 1: ***Chemical Requirements (Ghana/International Standards)***

Chemical parameter	**Ghana**	**International standard**	**Method**
Aflatoxins	15µg/kg	15-20µg	ISO 16050:2003
Organophosphorus	0.005mg/kg	0.05mg/kg	MRM by GC-PFPD and GC-ECD GSA-SM-T03
Organochlorides	0.010mg/kg	0.05mg/kg	MRM by GC-PFPD and GC-ECD GSA-SM-T03
Synthetic pyrethoids	0.010mg/kg	0.05mg/kg	MRM by GC-PFPD and GC-ECD GSA-SM-T03
Iron	0.2mg/kg	0.2mg/kg	AAS
Zinc	0.03-1mg/kg	0.03-1mg/kg	AAS
Lead	0.05mg/kg	0.05mg/kg	AAS
Grease		0.05mg/kg	HPLC-GC-FID

Source: GSA (2009)

It is expected that the food we consume is wholesome and nutritious, and non-toxic in the short and long term (Birch, 1979). During food processing, food is protected from light, moisture, heat, chemicals, and physical damage

along the food production chain. Therefore, it is essential to protect food from contamination and poisoning either by micro-organisms or chemical contaminants.

A significant cause of foodborne illness remains chemical hazards. Harmful substances such as pesticides, machine oils, cleaners and cleaning solutions, sanitizers, dissolved metals, and excessive quantities of food additives are chemical hazards. Natural toxicants such as mycotoxins, marine toxins, environmental contaminants, mercury and lead, and natural substances in plants may also be included. In the food chain, food additives, micronutrients, pesticides, and veterinary drugs are intentionally used; however, assurance that all such uses are safe must first be obtained (WHO, 2000). Pesticides are used extensively to protect crops, livestock, and other animals from insects, pests and diseases. For thousands of years, people have been using pesticides to combat different kinds of pests, such as mosquitoes, weeds, bacteria, rodents and other biological species. The use of pesticides has significantly helped to increase and boost the production of food worldwide. It allows farmers to raise income by avoiding crop losses due to insect attacks and weeds' infestation. Despite their merits, pesticides are harmful chemicals that can lead to adverse effects on the environment, non-target species, animals, and humans if managed and misused. A focus should be on planning, processing, and producing foods that uphold adequate hygiene standards in the processing environment. They are the route through which food can become contaminated (Ijabadeniyi & Omoya 2006). Chemicals can get into food from tools and equipment, lubricants, food additives, and pesticides (Mensah *et al.*, 2002). It implies that contamination can occur in milling plant since the equipment itself is its route. During the

milling of ‘mashed kenkey’ metals like iron, zinc, aluminium, cadmium and so on may leach into it as a result wear and tear of the grinding plates due to friction.

The high concentration of these metals in human body is undoubtedly injurious to mankind. Also, the application of lubricants and cleaning sanitizing agents can also get into the milled kenkey causing contamination during processing. For example, petroleum-based lubricants such as grease, diesel or engine oil get into the “mashed kenkey” either by direct contact from the milling plants' lubricated parts, leakage, or accidental pour during processing. This mixes with food and affects its quality by making it appear dark. This is since when grease oxidizes it usually darkens causing a build-up of acidic oxidation of products. According to Hughes *et al.* (2001) the effect of oxidation is more harmful in grease. It gives off-flavour even when the “mashed kenkey” is produced and makes it difficult to eat it. Foods containing such chemicals are potential health hazards.

A certain mycotoxin can enter the milling plants during milling, this is due to the fact during the milling processes mycotoxins are distributed when disease or damaged grains are milled to make corn dough and further used to make the kenkey which is further milled to produced mashed kenkey with mycotoxin such as aflatoxin. Aflatoxins are known as teratogenic, mutagenic, carcinogenic agents, immuo-suppressants and potent inhibitors of protein synthesis. Farag (2008) continues that the primary target of aflatoxin is the hepatic system. Aflatoxins induced liver cancer and bile duct proliferation.

“Mashed kenkey” has become one of the favourite foods made from corn, “mashed kenkey” is liked by most averaged Ghanaian which is usually

taken in the afternoons, most people enjoy it because it has been refrigerated and since Ghana is found in the tropics, the temperature is usually hot and the "mashed kenkey" cools the heart when taken. People like it so much that almost every home, people prepare it domestically. Nevertheless, because of its high demand for the market, people have taken its production as a full-time business. As a result of this, it has become a commercial commodity. The handling and processing of this delicacy are carelessly done, getting contaminated biologically, chemically, and physically. People tend to enjoy the sweet and the cooling effect of "mashed kenkey" and sometimes forget to pay attention to its health hazards that are associated with it.

The health risks resulting from the handling and processing of the "mashed kenkey" are what the investigator aims to bring to the fore, so the emphasis is on acquiring the kenkey. The milling of the kenkey, the water used to mill the kenkey, and the mashed kenkey's bottling. The study adopted the Hazard Analysis Critical Control Point (HACCP) system. The HACCP is a management system that addresses food safety by analysing and controlling biological, chemical, and physical hazards from raw material production, procurement, and handling to manufacturing, distribution, and consumption of the finished product.

The HACCP is a plan or process that seeks to identify and control the process of food manufacturing, and it is keen on the safety of the product. It aims at the producers to manage and maintain a cost-effective food safety operation. HACCP emanated from the need to supply safe food for human-crewed space flights by the National Aeronautics and Space Administration (NASA) in 1959, which collaborated with Pillsbury COMPANY IN 1.

According to Van der Meulen & Van der Velde (2004). HACCP is keen on identifying that manufacturers are responsible for identifying the crucial aspects of producing safe foods. It makes food producers improve efficiency by controlling all the necessary things to ensure consumers' safety food. The food industry must identify potential food hazards and take the necessary actions to remove food hazards until it reaches consumers. As the HACCP is used in all stages of food production until it reaches the final consumer, Codex Alimentarius (2003, 2009b) has formulated seven basic safety approaches which food handlers and food businesses are put in place and go by it to maintain permanent procedures, and these are as follow:"

1**. Conduct a Hazard Analysis**: this seeks to find the hazard(s) and identify various ways to control the hazards; one should determine the primary potential food safety risk at each stage of the preparation process. The hazards can be biological, e.g., microbes, or chemical or physical.

2. Identification of Critical Control Point (CCP): The main aim of this phase is to decide where in the production process the selected high-risk hazard(s) must be monitored. A Critical Control Point (CCP) is a step (that is, a point, a process, or a stage in the food production system) at which control may be applied and where control is necessary, whether biological, chemical or physical, to avoid or remove a food safety hazard or reduce it to an appropriate level. For each phase in the workplace, essential control points are unique as they start from the raw state of the food through processing, where control can be applied to the food production chain process and be applied to anything that will make the food unsafe. (Lunning & Marcelis 2011).

3. **Establishment of critical limits**: Critical limits is the minimum and maximum value to which a physical, biological, and chemical hazard must be controlled at a critical point to eliminate to the acceptable levels. To control the hazard(s) at a critical control point, the essential thing one must have is standards and tolerance (limits) against which the actual and process condition can be compared with. Tolerance is the permissible variation in the dimension. Tolerance are necessary because it is not possible to produce food, all of which comply precisely with.

4**. Establishment of a monitoring system:** monitoring a CCP relative to its critical limits. It is necessary to assess whether the CCP is under control and provides written documentation for verification purposes (Lunning & Marcelis 2011). To track the parameter values, you must create a process. Monitoring activities are necessary to ensure that the process is under control at each process step,

5. **Establishment of a corrective action plan**. There are actions to be taken when monitoring reveals a deviation from an established critical limit. If monitoring data reveal that a product or parameters deviate from critical limits, corrective action must be taken. Corrective actions must ensure that the CCP will be brought under control again.

6**. Establishment of verification procedure:** validation is obtaining evidence that the HACCP plan elements are significant but considered part of the 6th principle. Validation activities involve checking in advance that effectively designed control measures Codex Alimentarius (2003). Verification procedures must ensure that the HACCP plan is adequate. Verification procedures may

include reviews of HACCP plans, CCP records critical limits, and microbial sampling and analysis.

7. **Establish record-keeping and documentation;** documentation and record-keeping are essential for an effective Food Safety Management System, and they support typical assurance activities like verification. Documentation aims to store knowledge and information, whereas recordkeeping aims to collect data, procedures, manuals (work instruction), flow charts, research reports, complaints, statistical analysis, and specific information and knowledge documentation sources. Record-keeping procedures regulation requires that all plans maintain a particular document, including analysis and HAACP plan, records, documentation, and monitoring of critical control points, critical limits, verification activities, and handling of processing deviations. In summary, the HACCP principles aim at ensuring total quality management (prevention of food hazard(s).

"Mashed kenkey" Production

"Kenkey, a sour , stiff dumpling made from fermented maize meal is one of Ghana's most common street foods. Kenkey is manufactured by steeping for two days of whole or dehulled maize grain in water. With a water absorption of 55%, the maize steeped are milled and kneaded into a dough. For approximately 2-4 days, the dough can ferment spontaneously.In Aflata, part of the sour dough is then cooked and this is mixed with the remaining uncooked dough to get a distinctive sticky texture.The blend is moulded and leaf- wrapped into balls and cooked in kenkey for hours (Halm *et al.*, 2004). There are several kenkey types, but two main types of kenkey, both produced from whole grains of corn, Ga and Fanti kenkey, are known.

Fanti kenkey is fermented for three days, and Ga kenkey is fermented for a minimum of two days. Ga kenkey has salt, whereas Fanti kenkey has no salt. While Fanti kenkey is wrapped in maize husk and cooked in it, Fanti kenkey is cooked in plantain or banana leaves for a more extended period (Halm *et al.,* 2004). Kenkey is eaten as a main dish with fried or grilled fish and vegetable sauce. Kenkey can also be taken as a chilled drink,' mashed kenkey'. "Mashed kenkey" is usually produced by splitting Ga or Fante kenkey into smaller pieces and mill it into a mash in an open market service mill. The kenkey is broken into pieces mashed small with water and poured into a milling plant with small grinding plates with ridge, and it comes out into a bucket. The content is milled several times to the desired smoothness of the vendor. A beverage is formed by mashing and blending the kenkey with water, sugar, and sometimes milk . Some producers mashed the pieces with roasted or groundnut paste; the beverage is either packed in a low-density polythene bag in screw-capped bottles and packed in an ice chest containing crushed ice and sold as mashed kenkey. Despite the very low pH of the cereal beverage, about 3.7, its safety is a concern due to some poor production and hygiene observed during this semi-commercial operations. The production area, utensils, and milling machines are often not adequately cleaned. Most of the producers do not adhere to essential element of acceptable hygienic practices. This work was done to access the safety of “mashed kenkey” sold in the municipality regarding the microbiological, heavy metals and aflatoxin contamination in order for preventive measure that will be used to train mashed-kenkey vendors and milling operators.”

Production of "mashed kenkey "the HAACP way

In mashed kenkey production, the raw materials used in preparing are Fanti kenkey, water, milk, sugar and sometimes groundnut are mixed with the mashed kenkey. First, the HACCP plan the diagram below shows the stages involved in preparing commercial "mashed kenkey" (flow chart). There is also the determination at each level where potential hazards are more likely to occur and control them (Atter *et.al.,* 2015).

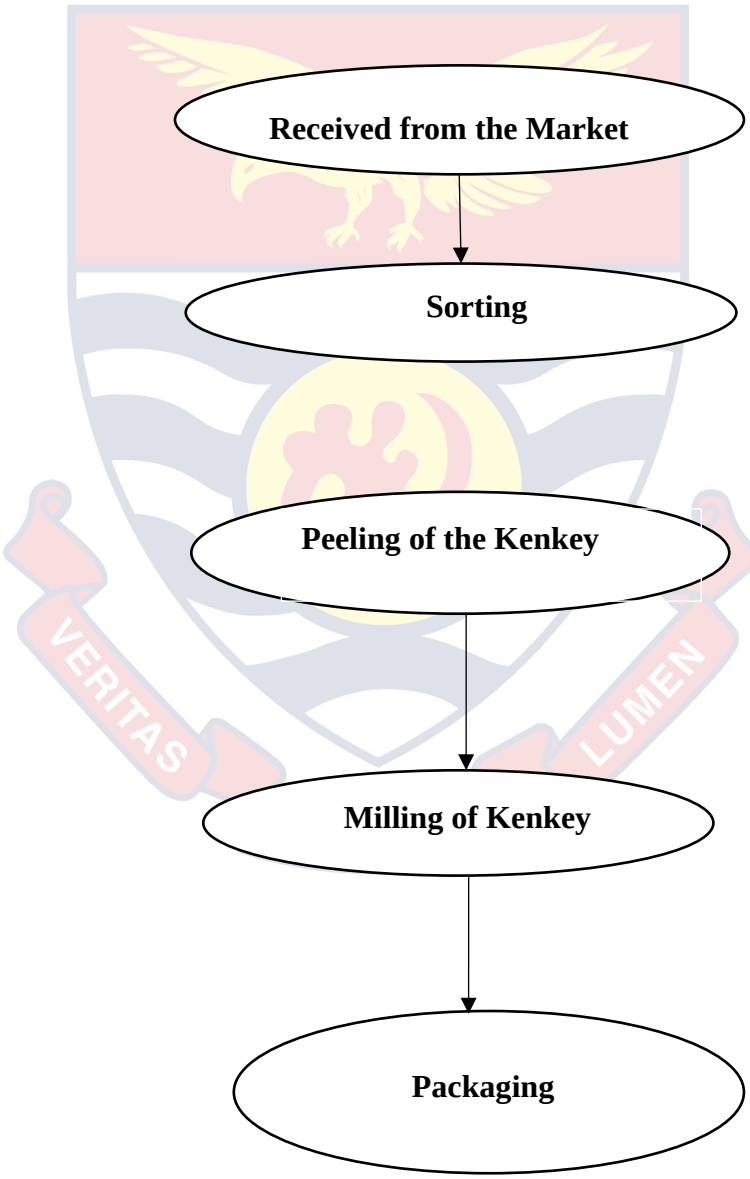


Figure 1: Flow Chart for the preparation of Mashed Kenkey

Source: Atter. *et al.,* 2015

Receiving: Receiving is the first stage in the preparation of mashed kenkey. The safety of produced kenkey from the market directly affects its safety. The receiving stage is a critical control point for mashed kenkey. the presence of foreign body and contamination occur during distribution and marketing. Effects to control or eliminate them later in the process is time and energy consuming and may be impossible too. When challenges occur at the CCP, such as receiving, immediate action is necessary. This means rejecting or discarding food that do not meet the HACCP limits.

Sorting of Mashed kenkey

This is a CCP because physical hazard such as rapid fungal (mould) growth, the presence of foreign body and contamination occurs and must be controlled. This is performed to isolate the contaminated ones from the uncontaminated ones.

Peeling of the Kenkey

This is also a CCP because chemical, physical and biological hazard can occur and must be controlled when peeling and washing. Set limit to control household pests and flies. The limit set at this stage is also to remove damaged grains (spoilt), foreign matter, insects as well as dust. Use clean trays when peeling of the kenkey and hands must be washed before doing such activity. Use clean water to wash the ingredient (Kenkey). This process also involves the breaking of kenkey into pieces for processing. Wear disposable gloves in the process of peeling of the kenkey

Milling of the Kenkey

This is also a CCP because chemical, physical and biological hazard can occur and must be controlled when milling the ingredient. There should be a

thorough inspection of grinding plates for rusting before milling. Moreover, millers need to clean and wash the milling machine thoroughly with warm water to prevent uninviting particles into the kenkey. Millers must put of gloves before milling the kenkey.

Packaging

This involves bottling of the ingredients. Bottles must be sterilized before the filling of the ingredient because chemical, physical and biological hazard can occur and must be controlled. This is a crucial stage in iced kenkey production.

Table 2: ***HACCP Plan to produce "mashed kenkey"***

Critical control point	Hazard identified	Control measures	Critical limits	Monitoring procedure	Corrective Action
Maize used to make Fante kenkey	Chemical: aflatoxins	Use Aflatoxins free maize for kenkey preparation	Maximum limits of 15µg/kg of aflatoxins for maize	Physical inspection of maize grains	Reject maize and change supplier
Fante Kenkey	Chemical: aflatoxins	Use freshly prepare kenkey	Maximum limits of 15µg/kg of aflatoxins for maize	Physical inspection of moldy kenkey	Reject kenkey and change supplier
Breaking of kenkey into pieces	Microbiological contamination with pathogens	Wear disposable gloves	Coliforms and *E. coli*, Total Plate Counts$<10^3$ CFU/ml	Rapid testing e.g. ATP Meter/Strip	Pasteurize meal after milling
Milling	Microbiological: Contamination with pathogens from milling machine.	Wash and rinse milling machine with warm water (60°C) before use	Coliforms and *E. coli*=0, Total Plate Count$<10^3$CFU/ml	Rapid testing. ATP Meter/String	Reject
	Physical: Pieces of metal from grinding teeth	Use stainless steel machine. Avoid handling of product with bare hands	No visible traces of any metal pieces in the milled meal	Inspection of grinding plates for rust before milling	Reject

Table 2 (Continued)

Packaging	Contamination with pathogens	Bagging: Pasteurize the Constituted mashed-kenkey before packaging aseptically in sterile polythene pouches or Bottling: before filling with Constitute ice-kenkey. Then pasteurize the bottled mashed-kenkey	Coliforms and *E. coli*=0, Total Plate Count< 10^2 CFU/ml	Monitor temperature time during pasteurization. Rapid testing eg ATP Meter/Strip	Pasteurize product again if bottled

Source: Atter. *et.al.*, 2015

Food Laws and Regulations in Ghana

Food is an undeniable and inextricable foundation of livelihood; its wholesomeness is essential to maintain its nutritive value. The sayings that 'a country is healthy as its citizens' and that health is wealth; thus, safe food is of interest to both government and its citizenry. It is because of this that, in Part 6,7,8 of the Public Health Act, ACT851(2012), the legislating parliament of Ghana established an inalienable constitutional basis of the Food and Drugs Authority of Ghana to guarantee, among several other things, compliance with accredited and enacted safety and quality assurance standards that promote the overall health of the nation's people. The legal requirements for food safety and quality have been established many governments to protect consumers and ensure that foods are fit for human consumptions. The Provisional National Defence Council Proclamation (3035) of the Food and Drugs Law 1992 was formulated. The law forbids the sale of unwholesome, poisonous, and adulterated foods. It also looks at the food being sold under poor sanitary conditions, which will make the food to be contaminated easily. Food safety in Ghana is controlled through licensing and regular inspection (Ntiforo, 2001). Food vendors are always inspected and required to renew their licenses every year, and if one defaults, the person is likely to be punished. He further stated that law enforcement was proper due to the unskilled and unqualified staff, and some were inadequately equipped to do their work. The continuous implementation of the food laws requires qualified professional and efficient food inspection since they directly contact the producers and handlers. It is essential to reinforce and educate the food industry on the approach to reduce foodborne disease.

CHAPTER THREE

RESEARCH METHODS

"This section covers the procedure that was used in the study. It comprises the research design, population, sample and sampling , data collection instruments and the data collection procedure. The study was conducted in two phases. Phase one (1) assessed the millers' maintenance and hygienic practices at the milling plants. Based on the assessment results, four milling plants (two each found to observe best and poor maintenance and hygienic practices) were selected, and samples of water were used to mix the milled "kenkey". Un-milled and milled "kenkey" were taken for phase two. The second phase involved evaluating biological and chemical contaminants found in the samples selected at phase one."

Research Design

"Two designs were used in this study. The descriptive survey design was used for phase one to obtain baseline data on the incidence of chemical and microbiological contaminants in the mashed kenkey millers' practices. According to Quartey and Awoyemi (2002), the descriptive survey design is a type of design that can be described as gathering data to answer research questions or test hypotheses, which relates to a phenomenon's prevailing status. This design was deemed appropriate for the first phase of the study as the researcher sought to evaluate the maintenance and hygienic practices of millers at selected milling plants and report the conditions as they exist. The second phase of the study employed experimental research design. The experimental design was used to establish whether there were microbiological and chemical contaminants in the "mashed kenkey" from the selected milling plants.

According to Childress *et al.* (1991), experimental research is manipulating variables to cause change or otherwise on the independent variable. This design was deemed appropriate for the second phase as the researcher took samples for laboratory analysis."

Study Area

The study was conducted in the New Juaben Municipality (North and South) in the Eastern Region of Ghana. The New Juaben South Municipality is one of the 260 Municipal Assemblies in Ghana and it is one of the 33 (thirty-three) Municipalities and Districts in Eastern Region. It was established in 1988 by the Legislation Instrument (LI) 1426. The Municipality lies between longitudes103°West and 30° East, latitudes 60° South and 70° North with Koforidua as its capital while the New Juaben North Municipal Assembly is one of the Municipalities curved out of the New Juaben Municipal Assembly as one of the 38 newly created, and upgraded districts Assemblies on March 15, 2018. It was created by Legislation Instrument (LI) 2303, the New Juaben North Municipal Assembly, with its capital as Effiduase. The experimental analysis was carried out at the Microbiology and Chemistry laboratories of the Food Research Institute and Water Research Institute of the Council for Scientific and Industrial Research, (CSIR).

Population

The population refers to all individuals of interest to the researcher. Breakwell *et a.*, (2006) explain the population as a set of individuals (objects, events, subjects) with shared noticeable features for which a researcher is concerned. The conditions for the addition of a unit in a survey was dependent on characteristics of respondents who were suitable for the participation in the

survey. Due to this reason, the target population for the study was ten (10) "mashed kenkey" milling plant operators and five (5) "mashed kenkey" vendors within the New Juaben South Municipality.

Sample and Sampling procedure

Breakwell *et a*l. (2006) underscore that the population is often extremely large or infinite, thus making it impossible or too costly to study. According to Breakwell *et al.* (2006), in addition to cost savings it is usually appropriate to make more detailed observations of each sampled element.

Two (2) milling plants in the Municipality were used; thus, purposive sampling was used for the first phase of the study. The milling plant one has the model number Honday Gx 200, 6.5 Hp and milling plant two has model number Honday Gx 160, 5.5Hp. The researcher observed their maintenance and hygienic practices at the milling centres for two weeks.

Data collection Instruments

"The instruments for data collection for phase one of the study included the observation check list. The observation checklist has been attached at Appendix A. The observation used was a passive one in which the researcher (observer) was being just a strict recorder of data (Amedahe & Asamoah-Gyimah, 2002). Refer to observation guide in Appendix A). This enabled the researcher to collect data at different times. It also allowed the researcher to get the desired results as what was observed and recorded were the actual occurrences. An unstructured interview was also conducted to gather data for the study (see Appendix B). An interview is a form of questioning characterized by the fact that it employs verbal interrogation as its main data collection method (Amedahe & Asamoah-Gyimah, 2002). An interview also signifies direct

attempt by the researcher to get dependable and effective measures of characteristics, behaviours, attitudes and so on in the form of verbal answers from one or more respondents. For phase two, which involved laboratory analysis, employed the Atomic Absorption Spectrophotometer, Microbial count enumeration, and microbes identification. Samples of water, unmilled kenkey, milled kenkey and final processed milled kenkey gathered from the milling plants were packaged in a sealed container and put in a cold chamber. They were then sent to the laboratory for analysis."

Data Collection Procedure

"The self-developed interview guide was used to collect data on the milling plant operators' maintenance and hygienic practices. An observation was done with the aid of an observation checklist to collect data at the milling plant. The millers and the vendors who volunteered to take part in the study were guaranteed anonymity and confidentiality. Two weeks was use to observe the millers' activities and the vendors at the milling centre. "Samples of water, un-milled, milled kenkey and the final product were collected from selected milling plants at regular intervals in triplicate at different intervals to ensure validity and reliability of the test results. The samples taken were packaged in airtight containers, labelled, frozen, and carried in ice chest containers to the CSIR, Water Research Institute and Food Research Institute in Accra, for microbiological and chemical analysis.

The statistical analytical method used was sample size determination. HPLC analysis for aflatoxins, Microbial analysis, The pH in the "mashed kenkey" and Atomic Absorption Spectrophotometry. The samples were labelled milling plant one and milling plant two. Thus, water for milling, unmilled

kenkey, milled kenkey, and final product from milling plant one and water for milling, unmilled kenkey, milled kenkey and final product from milling plant two. The unmilled kenkey served as the control group for the experiment.

The parameters tested for in the Microbiological laboratory at the Food Research Institute were aerobic mesophiles, coliform counts, *E.coli*, yeast and moulds, *Clostridium perfringes* ,*Salmonella typhi*, *Staphylococcus aureus* in the unmilled, milled and final bottled kenkey. At the Chemistry laboratory of the Food Research Institute, HPLC aflatoxin analyses was done on the three products from the two milling plants.

At the Water Research Institute, full physio-chemical constituents of the water and metals such as Lead, Copper and Zinc were the parameters analysed at the Chemistry laboratory and at the Biological laboratory, the parameters tested for were Total Coliform, Faecal Coliforms and E.coli were tested from the water used in milling the 'kenkey'.

Atomic Absorption Spectrophotometry (AAS) Method of Water Analysis

"The flame method was used to analyse metals in the water samples. Samples were put in cleaned translucent bottles. Some amount of nitric acid was added to the samples to break down the electron bonds thereby making the samples free to be analysed. Concentration standards of 0.5ml, 1.0ml and 2.0ml; were prepared to run alongside the samples.

A computer monitor related to the Atomic Absorption Spectrophotometer (AAS) and the AAS was placed on. Hollow cathode lamps D2 have been chosen and put in their respective places. A calibration was performed using the display, and the wavelengths for lead, iron, and zinc were chosen. The samples of water were then submitted to the AAS and aspirated into

the blaze. The flame glowed as the sample was aspirated, showing the concentration of each metal. Thus, the flame intensity was an indicator of the concentration of metal in the sample. The absorbance was indicated on the monitor as the sample was aspirated and it was registered. A blank (that is a standard) sample was also analysed. In measuring the number of metals in the samples, a calibration graph was drawn to get the absorbance.

Determination of pH

The pH meter was calibrated using standard buffers, and 10 grams of the sample was combined with 10ml of distilled water, and the pH was measured using a pH meter (Radiometer PHM 92, Bagsvaerd, Denmark)

Mycotoxin Analysis

ISO 160 Method of Determing Aflatoxin

The quantitative analysis for aflatoxins, according to Stroka & Anklam (1991), the extraction technique was used for the ascertaining of aflatoxin. A test portion of (50g) was extracted with 200 ml methanol/ water solvent solution containing 5g of sodium chloride, the sample was extracted and filtered and with phosphate-buffered saline to a specified solvent concentration, and applied to the immunoaffinity column (R-Biopharm Rhone Ltd. Easi-Extract Aflatoxin) containing antibodies specified solvent aflatoxins B_1 ,B_2 ,G_1, G_2. Aflatoxins were eluted from the immunoaffinity with neat ethanol.

A reverse-phase high-performance liquid chromatography was used to enumerate Aflatoxins with post-column derivatization involving bromination. With pyrimidinum hydrobromide perbromide, accompanied by fluorescence detection, post-column derivatization was achieved. Waters Associated (Milford, MA, USA) was the instrument system used for the HPLC study and

included the Waters 1525 Binary HPLC pump, Waters 2707 Autosampler, Waters Model 1500 Column Heater, Waters2475 Multi λ Fluorescence Detector and Breeze 2 software.

The separation of aflatoxins was carried out on a Spherisorb S5 ODS-1 column of dimensions 25×4.6mm packed with 5µm particles (Phase separations Inc., Norwalk, USA) MAINTAINED AT 35^0C. The HPLC mobile phase flow rate was1.0 ml/min and post-column bromine derivation of Aflatoxin B_1 and G_1 was achieved by PBPB dissolved in 500 ml of distilled water pumped at a flow rate of 0.5 ml/ min using Eldex precision metering pump(Eldex Laboratories Inc., San Carlos, USA). The excitation and emission wavelengths used were 360 nm and 440, respectively. The aflatoxins were identified by their retention times, and peak areas were used to determine their concentrations in the samples by reference to standard curves gotten by chromatographing pure aflatoxin standard (obtained from R-Biopharm) solutions under same conditions.

Microbiological analysis of the kenkey

For both samples, 10 g is homogenized in a stomacher (Lab Blender, Model 4001, Seward Medical, London, England) for 30 seconds at an average velocity in 90 ml sterile diluent (0.1 percent peptone, 0.8 percent NaCl, pH 7.2). From suitable ten-fold dilutions.

Aerobic mesophiles were counted by pour plate on Plate Count Agar (Oxoid CM365; Oxoid Ltd., Basingstoke, Hampshire, UK), incubated at 30^0C for 72 hours according to NMKL No. 86 (2006).

"Total coliforms and *E. coli* were enumerated by pour plate on Trypton Soy Agar (Oxoid CM439), pH 7.3 overlaid with Violet Red Bile Agar (Oxoid

CM807), pH 7.4 and incubated at 37 ^{0}C with incubator model number NE8-_240S for 24 hours for total coliforms and at 44 ^{O}C for 24 h for *E. coli*. Colonies suspected to be coliforms were confirmed on Brilliant Green Bile Broth (Oxoid CM31), pH 7.4, incubated at 37^{0} C for 24 h according to NMKL No. 44 (2004) and *E. coli* on EC Broth (Oxoid CM753), pH 6.9, followed by Trypton Water (Oxoid CM97), pH 7.5, all incubated at 44 ^{0}C for 24 h according to NMKL. No. 125 (2005)."

Staphylococus aureus was determined by spread plate on Baird Parker Agar (BP, CM 275 Oxoid Ltd, Hampshire, England) with Egg Yolk Tellurite Emulsion (SR54) added and Blood Agar Base (BAB, CM 55 Oxoid Ltd, Hampshire, England). Both media were incubated at 37 ^{0}C for 48 h. S. aureus counts were verified by biochemical tests with respect to NMKL Method No. 66 (2009).

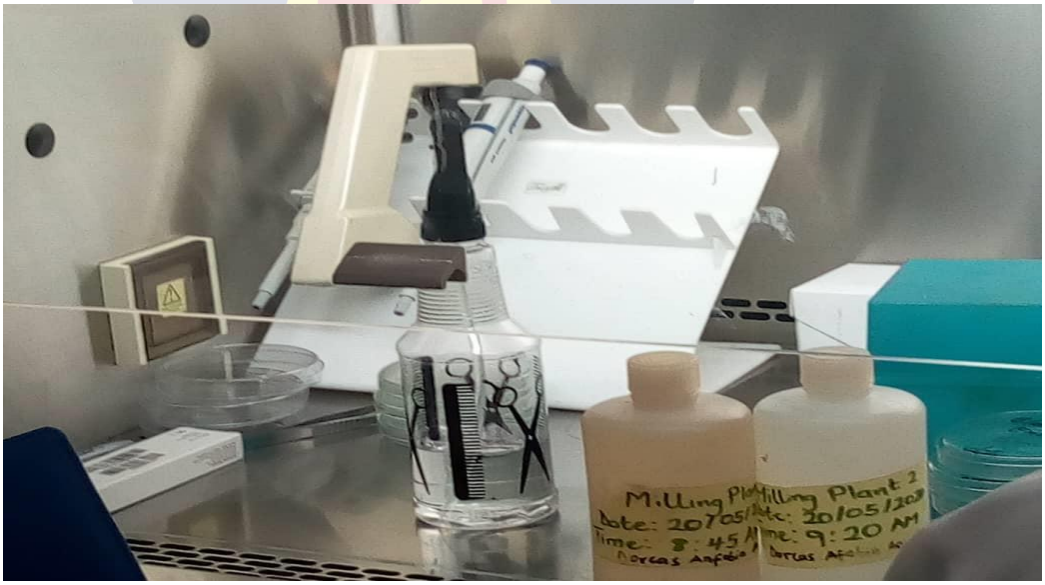


Figure 2: Samples to be tested

Source: Agyarko, 2020

Clostridium perfringens were enumerated by pour plate on *perfringens* Agar Base (PAB, CM 267 Oxoid Ltd, Hampshire, England) with Egg Yolk

Emulsion(SR 056) and *perfringens* supplement(SR009E) added and incubated anaerobic at 37^0C for 20 h. in accordance with ISO 7937,2004(E).

Yeast were counted by spread plate on Dichloran-Rose Bengal Chloramphenicol Agar (Oxoid CM0827), pH 5.6, holding Chloramphenicol supplement to inhibit the growth of the bacteria and incubated at 25 ^{0}C for 48e120 h with respect to ISO 21527-1:2008.

Moulds were identified by morphological characteristics,

Isolates were inoculated at three points on DRBC and Czapek Yeast Extract Agar (CYA); incubated at 25 ^{0}C incubator (I_{16}) for 7 days. Morphological examination was carried out by staining and wetting a piece of moulds on a microscope slide with lactophenol (Merck), squashing the fruit bodies and teasing mycelium to determine the general form of growth. To advance the indifference and specificity of scheduled culture approach for identifying moulds in the species level, some differential media including (10.0 ml of czapek concentration, 1g of K2HPO4, 5g of powder yeast extract, 30g of sucrose, 15g of Agar and 1L of DW) were used. The colony diameter was measured after 5 days and colony characteristics were observed. Morphological features of *Penicillium commune*, *Aspergillus niger*, and *Fusarium verticillioides* cultures were observed. The primary and notable macroscopic features in species detection were the colony diameter and color (conidia and reverse). Riddle's classic slide culture method (Riddle, 1950)was used for the isolates' microscopic research. Microscopic characteristics for the detection were conidia width, conidia length, conidia ornamentation, conidia shape, stipe ornamentation, stipe width, stipe length, branching pattern and phialide shape.

Detection of aerobic plate.

One millilitre of each dilution was poured into a sterile Petri dish and about 15 ml of molten plate count agar (PCA) was added. The inoculum was evenly spread by gently shaking and left to solidify for 10-15 minutes. Then the plates were incubated at 30°C for 72 hours. Colonies on selected plates were counted using a colony counter (18).

Detection of *Staphylococus spp*

One millilitre of each dilution was pipetted into a Petri dish that contains Baird-parker agar plates. The inoculum was spread evenly by shaking and incubating in incubators 24 and 48 hours at 37^0C ± 1.0°C. Typical colonies of *Staphylococus spp* (black or grey, shining and convex), diameter 1.0-1.5 mm after 24 hours incubation and 1.5- 2.5 mm after 48 hours incubation and with each colony surrounded by a clear zone were isolated and tested for coagulase positive as a confirmatory test and finally recorded

Detection of total coliform in "mashed kenkey"

Total coliform was detected by transferring 1.0 ml of sample from each dilution into sterile Petri dish and 15 ml of molten and cooled Violet Red Bile agar were added. The inoculum was evenly mixed by shaking and left to solidify and incubated the plates at 37°C for 24 ± 2 hours. The red colonies were counted and then confirmed by transferring the selected five colonies to BGB Broth by their gas production.

Detection of total coliforms in the water used for milling and mashing the kenkey using membrane filtration

" This technique explains filter procedure for detecting and enumeration of total coliform in water. This method applies to drinking water, other domestic

water supplies, freshwater, saline water, and wastewater. Coliforms are commonly found in the faeces of humans and other warm-blooded animals. The existence of coliforms in water indicates faecal pollution and the likely existence of enteric pathogens. The Membrane Filtration method directly counts bacteria in water-based on colonies' development on the membrane filter's surface. A water sample is filtered via the membrane, which retains bacteria. The membrane containing the bacterial cells is placed on a selective medium mEndo agar) and incubated for 24h at 37°C. The media has bile salts to block growth of aerobic spore forming bacteria. During fermentation of lactose, the aldehyde produced reacts with bile salts. Colonies appear as dark red with a characteristic metal sheen. The Membrane Filtration technique offers a direct count of bacteria in water depending on colonies' development on the membrane filter's surface. Water samples having suspended, or colloidal particulate matter can clog the membrane filter, avert filtration, or spread bacterial colonies, which could restrict identifying colonies on target.

Colony counts per filter should be between 20 to 80 CFU. Colony counts greater than 200CFU may give erroneous statistical data due to overcrowding. This problem is minimized by appropriate dilution of the water sample. Analyse other waters (waste and surface water) by filtering three (3) different volumes (undiluted or diluted), based on anticipated bacterial density.

When below 10ml of sample (diluted or undiluted) is filtered, add about 10ml sterile distilled water to the funnel before filtration. The increase in water volume is to aid in uniform dispersion of the bacterial suspension over the entire effective filtering surface."

Enumeration of Faecal Coliform by Membrane Filtration

Scope and field of application

This technique explains a membrane filter procedure for the detection and enumeration of faecal coliform in water. faecal coliforms are usually seen in the faeces of humans and other warm-blooded animals. The presence of faecal coliform in water indicates faecal pollution and the likely occurrence of enteric pathogens.

Principle

The Membrane Filtration technique offers a direct count of bacteria in water depending on colonies' development on the membrane filter's surface. A water sample is filtered via the membrane, which holds bacteria. The membrane containing the bacterial cells is positioned on a selective medium MFC agar) and incubated for 24h at 37°C. The media contains bile salts and rosalic acid to prevent growth of aerobic, spore-forming bacteria. During fermentation of latose, the acid produced reacts with aniline blue and the colonies appear as blue.

Interferences

Water samples containing colloidal or suspended particulate matter can clog the membrane filter, prevent filtration, or spread bacterial colonies, which could interfere with identifying target colonies.

Colony counts per filter should be between 20 to 80 CFU. Colony counts greater than 200CFU may give erroneous statistical data due to overcrowding. This problem is minimized by appropriate dilution of the water sample. Analyse other water (waste and surface water) by filtering three different volumes (diluted or undiluted), depending on expected bacterial density.

NB: when less than 10ml of sample (diluted or undiluted) is to be filtered, add approximately 10ml sterile distilled water to the funnel before filtration. The increase in water volume is to aid in uniform dispersion of the bacterial suspension over the entire effective filtering surface.

Enumeration of *E.coli* and total Coliforms by Membrane Filtration, Scope and field of application

This method describes a membrane filter procedure for detecting and enumeration of both total coliform and *E.coli* in water samples.

The membrane filtration method applies to drinking water, other domestic water supplies, fresh water, saline water and wastewater.

Total coliforms include species that may inhabit warm-blooded animals' intestines or occur naturally in soil, vegetation, and water. They are usually found in faecal polluted water and are often associated with disease outbreaks. Although they are not usually pathogenic themselves, their presence in drinking water indicates the possible presence of pathogens. *E. coli*, one coliform group species, is always found in faeces and is, a more direct indicator of faecal contamination and the possible presence of enteric pathogens. Besides, some strains of *E.coli* are pathogenic.

Principle

"The Membrane Filtration method directly counts bacteria in water-based on colonies' development on the membrane filter's surface. A water sample is filtered through the membrane, which retains bacteria. The membrane containing the bacterial cells is placed on a selective medium (Hicome coliform agar (FLUKA 81938)) and incubated for 18-24h at 37±2 °C.

Hicome coliform agar (FLUKA 81938) contains two chromogenic substrates as Salmon-Gal and, X-glucuronide. The enzyme β-D- galactosidase produced by coliforms cleaves Salmon-Gal, resulting in the salmon to red coloration of coliform colonies. The enzyme β-D-glucoronidase produced by *E.coli*, cleaves X-glucuronide. *E .coli* forms dark blue to violet coloured colonies due to cleavage of both Salmon-Gal and, X-glucuronide. The addition of tryptophan improves the indole reaction, thereby increasing detection reliability in combination with the two chromogens. oxidase enzyme and produce rose pink colour."

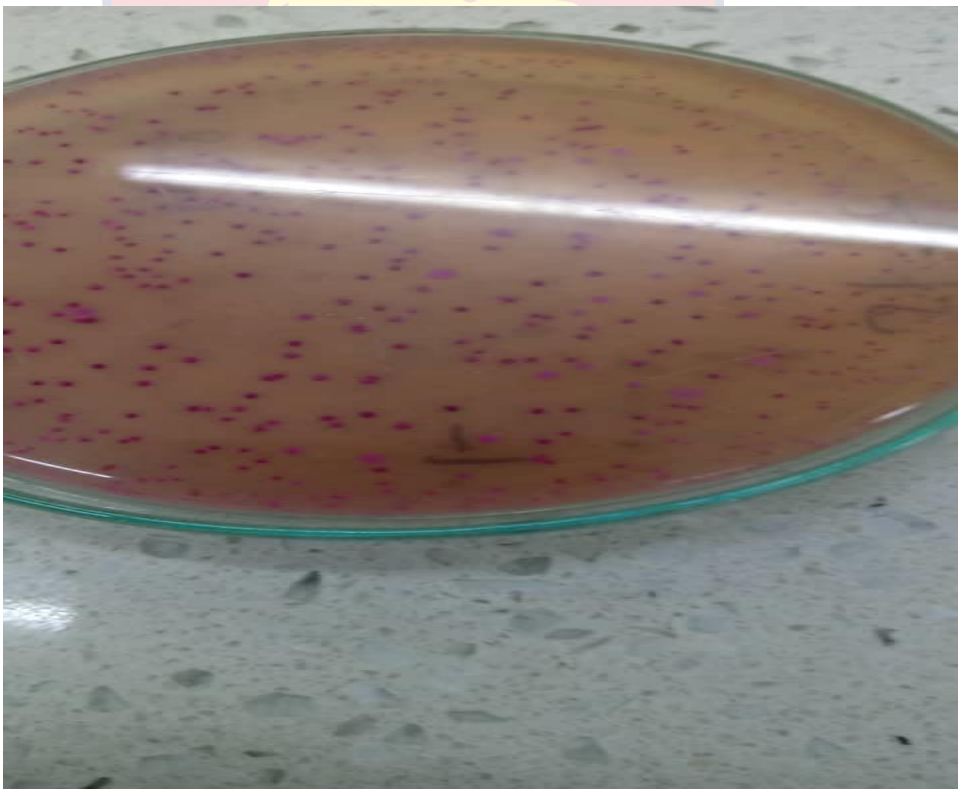


Figure 3: Enumeration of total Coliforms

Source: Agyarko, 2020

Interferences

"Water samples holding suspended or colloidal particulate matter can prevent filtration, spread bacterial colonies, or even clog the membrane filter, which could inhibit the identifying colonies on target.

Colony counts per filter should be between 20 to 80 CFU. Colony counts greater than 200CFU may give erroneous statistical data due to overcrowding. This problem is minimized by appropriate dilution of the water sample. Analyse other waters (waste and surface water) by filtering three different volumes (undiluted or diluted), depending on anticipated bacterial density.

NB: When less than 10ml of sample (diluted or undiluted) is to be filtered, approximately 10ml sterile distilled water should be added to the funnel before filtration. The increase in volume of water is to aid in homogeneous distribution of the bacterial suspension over the entire operative filtering surface.

Figure 4: Enumeration of samples

Source: Agyarko, 2020

Data Processing Analysis

Data collected was presented in a tabular form and analysed using simple percentages. The first category of tables were present data collected by the researcher with the observation checklist. A comparison was made between data from the samples of kenkey, milled kenkey and mashed kenkey collected from milling plant one and milling plant two. It also include the presentation of data collected with unstructured interview with the "mashed kenkey" vendors. Field data was used to determine whether differences exist in the microbiological and chemical contaminants in "mashed kenkey" sampled from the selected milling plants of unmilled kenkey, milled kenkey, final product of the commercial "mashed kenkey" and the water used for milling the mashed the kenkey.

In summary, two designs were used in this study. The descriptive survey design was used for phase one to obtain baseline data on the incidence of chemical and microbiological contaminants in the millers' practices.

The second phase of the study employed experimental research design. Experimental design was used to establish whether there were biological and chemical contaminants in the "mashed kenkey" from the selected milling plants. The millers were apprehensive that the swap was taken, and the pictures would be used against them as evidence of processing contaminated kenkey for "mashed kenkey" vendors, so they were unwilling to cooperate with the researcher. However, they were assured of confidentiality and anonymity to allay their fears. A lot of visits were made to the milling centre to establish a good interpersonal relationship with the millers and the vendors.

The “mashed kenkey” vendors were not willing to allow the researcher to pick their food as samples because of superstitious belief that the researcher will use it against them to reduce their business fortune and to destroy their mark and also the analysis will reveal the contamination in their products, and which will in the long run affect their market. Frequent power shortages also affected the collection of the samples. The outbreak of COVID19 also delayed the work since there was a lockdown in Accra where the analysis will be done. After the lockdown they didn’t the researcher into their laboratory to work because of the fear of a visitor infesting them with the disease. Most of the workers for fear of contracting COVID 19 were working from home so they were not physically present at their workplaces this affected the way samples were taken, received, processed, and analysed. This has considerably affected the biological and chemical analysis of the samples. This has unduly delayed the work. However, these have in no way affected the results of the study.

Ethical Considerations

Ethical authorisation was obtained from the Institutional Review Board (IRB) of University of Cape Coast. Letters of introduction were attained from the Vocational and Technical Education (VOTEC) Department to the various institutions where data were collected. The ethical clearance ID (UCCIRB/CES/2020/57) was given by the IRB to be used to collect data.

The milling plant operators and “mashed kenkey” vendors who participated in the research were guaranteed of confidentiality and anonymity for all interviews. Participants’ responses were kept private and unspecified. Interviewees were given the chance to withdraw whenever they wanted to.

Data Management from the study

Data obtained from the respondents were protected at the researcher's apartment locked in a drawer. The data were coded without participants' names. After the data was coded, the researcher uploaded the pictures taken and the coded responses to the researcher's email and drop box account encrypted with a password created for the purpose of the study. The analysis continued immediately after the data collection. The data analysed were protected on the researcher's laptop with a password until the results were released to the lecturer for possible additions and/or subtractions. A soft copy was also uploaded to the email, drop box account, and the researcher's external drive for backup purposes. All information pictures of study were finally destroyed or deleted from the email and drop box account and the memory card formatted after final thesis was submitted.

Procedure for data analysis

Simple percentages were used to analyse the data collected from the "mashed kenkey" vendors at the milling plant operators on the hygienic practices of the milling operators and mashed kenkey vendors. The data from the laboratory test analysis on microbiological and chemical analysis of the mashed kenkey were analysed using standard deviation and mean.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

The previous chapter highlighted the research methods for data collection and data analysis. In the present chapter, the analysed data from the field are presented as results and are discussed according to the study's objectives. The chapter is in two parts. The first section presents the demographic characteristics of the respondents. It looks at the gender, the educational level, and the marital status. The second section highlights on the main results from the study data. Frequencies and percentages are used in the presentation of the results. All aspects of the data were analysed following the objectives of the study. The analysis is presented below.

Demographic Characteristics of the Respondents (Millers)

This portion of the analysis tackled the background information of the respondents. It consists of the gender, educational levels, and marital status of the respondents. The results of the findings are presented in Table 3.

Table 3: ***Demographic Characteristics of the respondents***

SN	VARIABLE		Freq. (%)
1	Gender	Male	7(70.00)
		Female	3(30.00)
2	Level of Education	Non-formal education	1(10.00)
		Basic/Middle school	3(30.00)
		Secondary/Technical/Vocational school	6(60.00)
3	Marital Status	Single (Never married)	1(10.00)
		Married	8(10.00)
		Widowed	
		Separated	1(10.00)

Source: Agyarko, 2020.

Out of the 10 millers who were interviewed, 7(70%) were males while the female were 3(30%). Corn mill operators are mostly men because of the tedious nature of the work. 6(60%) of the millers had secondary education, Also, 3(30%) only had their primary education whiles 1(10%) had no formal education. With respect to marital status of the millers, 8(80%) were married, 1(10%) separated, and 1(10%) single. The majority of the interviewee the researcher sampled were the married people.

Gender of "mashed kenkey" Vendors

The researcher interviewed five (5) mashed kenkey vendors. Out of the five interviewed four (4) of them were females and one (1) was a male. This shows that majority of the mashed kenkey vendors were females and this represent 80% and only one male representing 20%. The results shows that females dominated males in terms of mashed kenkey production

Level of education of "mashed kenkey" Vendors

The level of education of the "mashed kenkey" vendors shows that majority of the "mashed kenkey" vendors which is three (3) representing 60% have had non-formal education and two (2) of the vendors representing 20% basic school education The rest of the vendors have secondary education.

Main Findings from the study

What hygienic practices are involved in handling "mashed kenkey" production?

The study's objective seeks to find out the hygienic practices involved in the handling of masked kenkey. The response of the participants is presented accordingly per the objectives of the study. Frequencies and percentages were used for the analysis of the result. The results are presented in table 4 below.

Table 4: ***Lubrication and Processing of Milling Machines***

S/N	Statements	P (%)
1	**Number of Years in using the milling machine**	
	0-3	2(20.00)
	4 – 6	1(10.00)
	7 – 10	4(40.00)
	10 years and above	3(30.00)
2	**How old is your grinding Plate (months)**	
	0 – 1	3(30.00)
	2 – 3	5(50.00)
	4 – 5	2(20.00)
3	**Number of times in changing the grinding Plate**	
	Daily	1(10.00)
	Weekly	3(30.00)
	Fortnightly	4(40.00)
	Monthly	2(20.00)
4	**Do you sharpen your grinding Plate?**	
	Yes	9(90.00)
	No	1(10.00)
5	**If yes, how often do you sharpen it?**	
	Daily	1(10.00)
	Weekly	2(20.00)
	Fortnightly	5(50.00)
	Monthly	2(20.00)
6	**Treatment given to your grinding Plate after sharpening**	
	Wash with water	4(40.00)
	Wash with water, sponge and soap	2(20.00)
	Clean with napkin	4(40.00)
	No washing at all	
7	**Do you lubricate the milling machine?**	
	Yes	10(10.00)
	No	

Table 4 (continued)

8	**If yes, which parts of the milling machine do you lubricate?**	
	The funnel	1(10.00)
	The bushings / bearings	1(10.00)
	The tip of the shaft, bushings / bearings and steer pot	2(20.00)
	The bushings / bearing, key, steer pot, tip of the shaft/cone	6(60.00)
9	**The type of lubricant usually used for lubricating the milling machine?**	
	Grease and engine oil	7(70.00)
	Palm kernel oil and grease	1(10.00)
	Palm oil and grease	
	Vegetable cooking oil and sheabutter	2(20.00)
10	**How often do you lubricate the milling machine?**	
	Daily	2(20.00)
	Weekly	2(20.00)
	Fortnightly	3(30.00)
	Monthly	3(30.00)
11	**When do you usually apply the lubricant?**	
	Before milling and any time the lubricant dries up	4(40.00)
	Before milling and whenever the cover is opened	5(50.00)
	Throughout the milling process	
	After milling	1(10.00)
12	**Material used in applying lubricants to the milling machine**	
	Brush	3(30.00)
	Bare hand	5(50.00)
	Duster	2(20.00)
	Paper	
13	**Do you clean your hands after lubricating the milling machine?**	
	Yes	8(80.00)
	No	2(20.00)
14	**If yes, what do you use in cleaning your hands?**	
	Napkin	3(30.00)
	Garment	1(10.00)

Table 4 (continued)

	Paper	
	Water	6(60.00)
15	**If you use napkin in cleaning your hands, how often is it washed?**	
	Daily	2(20.00)
	Weekly	6(60.00)
	Dispose it	1(10.00)
	Fortnightly	1(10.00)
16	**Do you clean the milling machine after use?**	
	Yes	8(70.00)
	No	2(30.00)
17	**If yes, how many times do you clean the milling machine?**	
	Daily	8(80.00)
	Weekly	
	Fortnightly	2(20.00)
	Monthly	
18	**Which cleaning agent(s) do you use in cleaning the milling machine?**	
	Broom	10(100.00)
	Sponge, soap and water	
	Steel wool and water	
19	**If is operated manually which petroleum product does your "mashed kenkey" milling machine use in its operation?**	
	Petrol	2(20.00)
	Diesel	6(60.00)
	Engine oil	2(20.00)
20	**Do you clean your hands after filling the engine of the "mashed kenkey" milling machine?**	
	Yes	7(70.00)

Table 4 (continued)		
	No	3(30.00)
21	**Do you use any soap or detergent in washing the "mashed kenkey" milling machine?**	
	Yes	3(30.00)
	No	7(70.00)
22	**Do you rinse the "mashed kenkey" milling machine after washing it with detergent?**	
	Yes	7(70.00)
	No	3(30.00)
23	**During the processing of "mashed kenkey" does lubricant sometimes gets into contact with the mashed kenkey?**	
	Yes	6(60.00)
	No	4(40.00)
24	**If yes, how does the lubricant gets into the mashed kenkey?**	
	As a result of leakage from the milling plant and direct contact of the product with some lubricated parts	6(60.00)
	Accidently pour into the product	1(10.00)
	Direct contact of the product with some parts that are lubricated and leakage from some part of the milling plant and as a result of accident lubricant pour into the product	3(30.00)
25	**If lubricant mixes with "mashed kenkey" during milling do your customers complain?**	
	Yes	8(80.00)
	No	2(20.00)
26	**If they complain what action do you take to ensure their satisfaction**	
	Plead with them	8(80.00)
	Compensate them	2(20.00)
	Advise them to dispose of the affected part	

Source: Agyarko, (2020).

Table 4 shows that 40% of the participants interviewed on the practices such as lubrication on the milling plant had been operating milling plants for a period of 7-10 years. This group was the largest. Also, 50% of the remaining participants had been operating the milling plants for more than 10 or more years. Two thirds of the remaining participants had been operating for 4-6 years and the last one third for 3 or less years.

In response to whether the participants used old grinding plates in their operations or not, it was found out that 50% percent of the participants used grinding plates which were 2-3 months old, followed by 30% who used old plates which were less than one month and subsequently 20% of the remaining participants used 4-5 months old grinding plates. With references to these figures, one can say that, majority of the millers used grinding plates which were 2-3 months old.

A study by Abrefah *et al.* (2011) , reported that poor quality and old grinding plates wear easily due to friction , leading to leaching of metals in "mashed kenkey" .Relating this to the current study one may suggest that using the grinding plates for 2 to 3 months increased the risk of metal pieces been introduced into the "mashed kenkey". With reference to the frequency at which grinding plates were changed, less than half of the millers (40%) reported that they did that every two (2) weeks. This was followed by (30%) of the millers who performed this exercise weekly and finally (20%) also changed the grinding plates monthly. Surprisingly just about (10%) of the millers did so daily. From these findings one can conclude that the millers do not often change the grinding plates as often as expected of them. This practice may maximize the risk of chemical contaminants being introduced into the "mashed kenkey".

It was interesting to find that all the participants or millers sharpen their grinding plates at all times.

About 50% of them sharpened the plates fortnightly, other (20%) sharpened their grinding plates every week and another (20%) did so every month. Barely 10% of the remaining millers sharpened the grinding plates daily. The results show that the millers hardly sharpened their grinding plates. Sharpening and washing these grinding plates frequently would remove leftover mashed kenkey on the blades but in the case where this is not done, there is increased risk of introducing chemical contaminants during the "mashed kenkey" production process. The grinding plates may harbour stale "mashed kenkey" coupled with exposure to air and moisture may cause rust in the mill which could further mix up with the "mashed kenkey" and pose a health risk.

Millers often washed the grinding plates washed the grinding plates with water after sharpening. Less than half (40%) of the participants used soap during washing of the grinding plates. Fortunately, just about 20% of the millers were found to clean the grinding plates with napkin and water. All the millers lubricated the milling plants especially the bushing /bearing, key, steer pot tip of the shaft / cone as reported by (60%) of the millers.

The common type of lubricants used for lubricating the milling plants were grease, oil and engine oil. As many as (70%) of the millers were keen on greasing the parts mentioned. The use of grease and engine oil which are petroleum products could also introduce chemical contaminants into "mashed kenkey" when it comes directly in contact with the "mashed kenkey" during operation of the plants.

The periods of lubricating the milling plants ranged from 2 weeks to a month respectively, as indicated in table 2. Thirty percent of the millers lubricated their milling plants every 2 weeks and monthly, about 50% of the participants applied the lubricants before mulling and whenever the cover was opened.

Fifty percent of the millers used their bare hands in applying grease or oils to the plants. This could introduce chemical contaminants into the "mashed kenkey" because they often use the same hands to push the corn from the funnel of the plant to the grinding plate where it is milled. Again, they use the same hands to check if the texture of the "mashed kenkey" is good.

Table 4 show that all "the mashed kenkey" millers used brooms in cleaning the inside the bucket of the milling machine, resulting in the probable introduction of chemical contaminants into the "mashed kenkey". This is because the use of brooms may not necessarily remove dirt from the milling plants efficiently. The use of any soap or detergent in washing the milling plant, was very minimal among the millers. Most millers were found not to be using detergent or soap as reported earlier.

Knowledge of Food Hygiene

This aspect required "mashed kenkey" millers to express their understanding and knowledge about food hygiene. The responses of the participants were recorded for quality purposes. The results are presented using the frequency distribution table, specifically percentages. The results are shown in Table 5 below.

Table 5: ***Knowledge on food hygiene***

S/N	Statements	No of Yes (%)	No of No (%)
1	Do you have any knowledge on food hygiene	8(80.00)	2(20.00)
2	**If "Yes", how was the knowledge acquired?**		
	By special training	2(20.00)	0(0.00)
	From association	6(60.00)	0(0.00)
	In school	1(10.00)	0(0.00)
	From parents	1(10.00)	0(0.00)
3	**Have you had any medical check-up**	8(80.00)	2(20.00)
4	**If yes, after the first medical examination how frequent have you been having the examination**		
	Once a year	2(20.00)	0(0.00)
5	Once in two years	6(60.00)	0(0.00)
	Once in five years	2(20.00)	0(0.00)
	Occasionally	0(0.00)	0(0.00)
6	**Have you been licensed**?	9(90.00)	1(10.00)
	If yes, who gave you the license		
	City council	1(10.00)	0(0.00)
	Municipal assembly	8(80.00)	0(0.00)
	Association	1(10.00)	0(0.00)
7	**Do the Environmental Protection Agency / Food and Drug Authority supervise your activities?**	4(40.00)	6(60.00)

Source: Agyarko, (2020).

Findings presented in Table 5 shows that eight (8) millers representing 80% had knowledge about food hygiene. Then also five (5) of the millers representing 60% have (60%) had their knowledge from the mashed kenkey vendors association. The table also shows that eight (8) millers, representing 80% did not have regular medical check ups. The study revealed that 6 millers

representing (60%) had their medical check-up once in five years. Within 5 years, any of the millers could have some communicable ailments that they could transmit to others through the "mashed kenkey". The study revealed that nine (9) of the millers representing (90%) indicated they have licenses issued by the municipal assembly for operation

Membership in Association

Membership of the millers were ascertained and presented as frequencies and percentages. The results are as shown in table 6.

Table 6: ***Membership of Association of "Mashed kenkey" millers***

	Statement	**Yes (%)**	**N0 (%)**
1	Do you have any "mashed kenkey" millers association in your community?	8(80.00)	2(20.00)
2	If yes, are you a member of the "mashed kenkey" millers association?	7(70.00)	3(30.00)
	What are the aims of the association		
3	To make more profit in your business	5(0.00)	0(0.00)
	Together take loans	2(20.00)	0(0.00)
	Learn rules governing the trade	1(10.00)	0(0.00)

Source: Agyarko, (2020).

Table 6 shows the membership of association of the milling operators. The Results identified "mashed kenkey" operators Association in the study. Majority of the milling operators (80.00%) responded "Yes" to the existence of an association. Majority of the millers 70% joined the association with the view of making profit from their business.

Preparation of mashed kenkey

This section highlights the preparation of "mashed kenkey" by vendors. The results were presented using frequencies and percentages as shown in Table 7 below.

Table 7: ***Preparation of mashed kenkey***

	STATEMENT	Yes (%)	No (%)
1	Do you buy the kenkey?	3(60.00)	(40.00)
2	If no, do you prepare the kenkey yourself?	2(40.00)	3(60.00)
3	**What material is usually used to wrap / package kenkey?**		
I.	Polythene	3(60.00)	0(0.00)
	Leaves	2(40.00)	0(0.00)
4	Do you think it is good to eat kenkey that has been wrapped with polythene?	3(60.00)	2(40.00)

Source: Agyarko, (2020).

Table 7 shows that majority 3(60.00%) of the "mashed kenkey" vendors buy already prepared kenkey from the market and did not prepare the kenkey themselves. This is an indication that most of the "mashed kenkey" vendors utilized the already produced kenkey from the market. On the materials usually used in wrapping or packaging the kenkey, it was revealed that polythene and leaves were the most preferable materials for the packaging of the kenkey as presented 3(60.00%) of the vendors.

Knowledge on Food- borne Illness.

This section deals with the knowledge of vendors on food-borne illnesses. Findings from the study are presented using percentages and frequencies.

Table 8: Knowledge on Food- borne Illness.

	Statements	Yes (%)	No (%)
1	Do you wash the kenkey before or after peeling?	5(100.00)	0(0.00)
2	Do you ensure that the machine is washed before you mill the kenkey?	3(60.00)	2(40.00)
3	Do you accept and use the "mashed kenkey" when oil from the machine leaks into the kenkey?	4(80.00)	1(20.00)
4	Do you have any knowledge on food- borne illness?	5(100.0)	0(0.00)
5	**If yes, where did you acquire the knowledge**?		
I.	School	1(20.00)	0(0.00)
II.	Association	3(60.00)	0(0.00)
III.	From parents	1(20.00)	0(0.00)
6	**What do you think brings about food-borne illness?**		
	I. By eating contaminated food	3(60.00)	0(0.00)
	II. By eating cold food	1(20.00)	0(0.00)
	III. By eating leftover food	1(20.00)	0(0.00)

Source: Agyarko, (2020).

Results from Table 8 show that the entire "mashed kenkey" vendors washed the kenkey after unwrapping before milling. This exercise is a good practice which if continued could reduce food contamination. But as to whether they wash the kenkey very well with clean water could also have a negative effect on the food borne illness. The study revealed that 3 out of the 5 kenkey vendors saw to it that the machine was washed before the milling of the kenkey. On the other hand, the researcher discovered that all the 5 vendors had some knowledge on food contamination and poisoning. On the issue of food vendors adding "mashed kenkey" when oil from the machine leaked into the kenkey, all evidence points out clearly that 4 out of the 5 vendors w accepted the "mashed kenkey" mixed with oil without throwing it out.

Regarding where the vendors had their knowledge about food poisoning, the researcher found that, 3 out of the 5 vendors had their knowledge on food illness from the association they joined. This shows that vendors have some knowledge about food illnesses but because of the monetary benefits in the production of the "mashed kenkey", they ignore the risk factors associated with the intake of contaminated food, which thus makes the produced "mashed kenkey" unwholesome. On the effect of food illness, some of the vendors mentioned common ones such as stomach cramps, nausea, diarrhoea and sometimes vomiting.

Knowledge on Food Hygiene

This section highlights the vendors' understanding on food hygiene. The results are presented in Table 9 below.

Table 9: ***Knowledge on Food Hygiene***

	Statement	Yes (%)	No (%)
1	Do you have knowledge on food hygiene?	5(100.0)	0(0.00)
2	**Where did you acquire the knowledge?**		
	I. School	3(60.00)	0(0.00)
	II. Association	1(20.00)	0(0.00)
	III. From parents	1(20.00)	0(0.00)
3	Do you have knowledge on wholesome foods?	5(100.0)	0(0.00)
4	**Where did you acquire the knowledge?**		
	In school	3(60.00)	0(0.00)
	From association	1(20.00)	0(0.00)
	From parents	1(20.00)	0(0.00)

Source: Agyarko, (2020).

The results in Table 9 show that all the kenkey vendors know about food hygiene. This knowledge they seemed to have acquired through school as reported by 3 out of 5. It was also revealed that the vendors had knowledge on wholesome foods and such knowledge was acquired from school. Their level of knowledge on food could significantly influence preventing food-borne illness, as evidenced from Table 9.

Things that can be done to improve upon the quality of "mashed kenkey".

On the issue of what should be done to improve the quality of "mashed kenkey", various suggestions were made by the vendors. Some suggestions made were that all foods, should be cleaned, sanitary bins and equipment well cleaned with water and soap. Others were also of the view that vendors needed to throw away milled kenkeys that has changed colour in the milling plant rather than adding such "mashed kenkey" because of the money they could make out of it.

Research question one

What are the other possible contaminants in the "mashed kenkey" produced?

The study's objective sought to find out the other possible contaminants in the "mashed kenkey". The responses of the participants are presented accordingly to the objectives of the study. Laboratory results were also presented. The results are presented in table 10.

Table 10b: ***Aflatoxins Sample 1 Per Laboratory Results of Milling machine 1***

Sample	**Aflatoxins (µg/kg)**				**Total aflatoxins (µg/kg)**
	B1	B2	G1	G2	
kenkey	3.10 µg/kg	Not detected	1.38 µg/kg	Not detected	4.48 µg/kg
Milled kenkey	1.40 µg/kg	Not detected	Not detected	Not detected	1.40 µg/kg
Mashed product	Not detected	Not detected	Not detected	Not detected	None detected

Table 10b: ***Aflatoxins sample 1 per laboratory results of milling machine 2***

Sample	Aflatoxins (µg/kg)				Total aflatoxins (µg/kg)
	B1	B2	G1	G2	
kenkey	Not detected	Not detected	Not detected	Not detected	Not detected
Milled kenkey	not detected	Not detected	Not detected	Not detected	Not detected
Mashed kenkey	Not detected	Not detected	Not detected	Not detected	None detected

Source: Agyarko, (2020).

In carrying out a laboratory test to find out whether there was aflatoxins in “mashed kenkey”, an initial sample of kenkey, milled kenkey and mashed kenkey were taken from milling plant one and milling plant two. The results from the laboratory test are presented above. Table (10) shows that aflatoxins contaminations of mashed kenkey was followed during the production of mashed kenkey. In the first production which sample one from milling plant one, the total aflatoxins content of the kenkey before milling was 4.48 µg/kg made up of aflatoxin B1, 3.10 µg/kg and aflatoxin G1, 1.38 µg/kg . Aflatoxins B2 and G2 were not detected in the kenkey samples. The total aflatoxins content of the kenkey after milling the kenkey was 1.40 µg/kg and was made up entirely of aflatoxins B1 thus aflatoxins B2, G1 and G2 were not detected in the milled kenkey. The final mashed kenkey which was produced did not contain any aflatoxins , that is neither aflatoxin B1, B2,G1 and G2 was detected in the mashed kenkey .This was likely to be due to the addition of water to the milled kenkey during mashing which resulted in the dilution of the aflatoxins content to a level which was not detected by the HPLC analysis. Detection of aflatoxins in mashed kenkey production at milling plant one was done in two other occasions.

However in aflatoxins sample one from milling machine two (2) it is shown from the table that aflatoxins B1, B2, G1 and G2 were not detected in the kenkey, milled kenkey and mashed produced from the milling plant using HPLC analysis.

Table 11a: ***Aflatoxins Sample 2 Per Laboratory Results of Milling machine 1***

SAMPLE	**AFLATOXINS (µg/kg)**				**TOTAL AFLATOXINS (µg/kg)**
	B1	B2	G1	G2	
Kenkey	2.10 µg/kg	Not detected	1.28 µg/kg	Not detected	3.38 µg/kg
Milled kenkey milling	1.38 µg/kg	Not detected	Not detected	Not detected	1.38µg/kg
Mashed product	Not detected	Not detected	Not detected	Not detected	None detected

Table 11b: ***Aflatoxins Sample 2 Per Laboratory Results of Milling machine 2***

SAMPLE	AFLATOXINS (µg/kg)				TOTAL AFLATOXINS (µg/kg)
	B1	B2	G1	G2	
Kenkey	1.72 µg/kg	Not detected	1.28 µg/kg	Not detected	3.0 µg/kg
Milled kenkey	1.25µg/kg	Not detected	Not detected	Not detected	1.25 µg/kg
Mashed kenkey	Not detected	Not detected	Not detected	Not detected	None detected

Source: Agyarko, (2020).

Table (11) shows that aflatoxins contaminations of mashed kenkey was followed during the production of mashed kenkey. In the second production which is sample two from milling plant one, the total aflatoxins content of the kenkey before milling was 3.38 µg/kg made up of aflatoxin B1, 2.10 µg/kg and aflatoxin G1, 1.28 µg/kg. Aflatoxins B2 and G2 were not detected in the kenkey samples. The total aflatoxins content of the kenkey after milling the kenkey was 1.38µg/kg and was made up entirely of aflatoxins B1 thus aflatoxins B2, G1 and G2 were not detected in the milled kenkey. The final mashed kenkey which was produced did not contain any aflatoxins , that is neither aflatoxin B1, B2,G1 and G2 was detected in the mashed kenkey .This was likely to be due to the addition of water to the milled kenkey during mashing which resulted in the dilution of the aflatoxins content to a level which was not detected by the HPLC analysis.

However in aflatoxins sample two from milling machine two (2) it is shown from the table , the total aflatoxins before milling the kenkey was 3.0 µg/kg made up of aflatoxin B1, 1.72µg/kg and aflatoxin G1, 1.28 µg/kg . Aflatoxins B2 and G2 were not detected in the kenkey samples. The total aflatoxins content of the kenkey after milling the kenkey was 1.25µg/kg and was made up entirely of aflatoxins B1 thus aflatoxins B2, G1 and G2 were not detected in the milled kenkey. The final mashed kenkey which was produced did not contain any aflatoxins , that is neither aflatoxin B1, B2,G1 and G2 was detected in the mashed kenkey .This was likely to be due to the addition of water to the milled kenkey during mashing which resulted in the dilution of the aflatoxins content to a level which was not detected by the HPLC analysis.

Table 12a: ***Aflatoxins Sample 3 Per Laboratory Results of Milling machine 1***

SAMPLE	**AFLATOXINS (µg/kg)**				**TOTAL AFLATOXINS (µg/kg)**
	B1	B2	G1	G2	
Kenkey	3.10 µg/kg	Not detected	1.38 µg/kg	Not detected	4.48 µg/kg
Milled kenkey	1.40 µg/kg	Not detected	Not detected	Not detected	1.40µg/kg
Mashed product	Not detected	Not detected	Not detected	Not detected	None detected

Table 12b: ***Aflatoxins Sample 3 Per Laboratory Results of Milling machine 2***

SAMPLE	AFLATOXINS (µg/kg)				TOTAL AFLATOXINS (µg/kg)
	B1	B2	G1	G2	
Kenkey	3.0 Mg/kg	Not detected	1.36 Mg/kg	Not detected	4.36 µg/kg
Milled kenkey	1.5µg/kg	Not detected	Not detected	Not detected	1.5 µg/kg
Mashed kenkey	Not detected	Not detected	Not detected	Not detected	None detected

Source: Agyarko, (2020).

Table (12) shows that aflatoxins contaminations of mashed kenkey was followed during the production of mashed kenkey. In the third production which is sample three from milling plant one, the total aflatoxins content of the kenkey before milling was 4.48 µg/kg made up of aflatoxin B1, 3.10 µg/kg and

aflatoxins G1, 1.38 µg/kg. Aflatoxins B2 and G2 were not detected in the kenkey samples. The total aflatoxins content of the kenkey after milling the kenkey was 1.40 µg/kg and was made up entirely of aflatoxins B1 thus aflatoxins B2, G1 and G2 were not detected in the milled kenkey. The final mashed kenkey which was produced did not contain any aflatoxins, that is neither aflatoxin B1, B2,G1 and G2 was detected in the mashed kenkey . This was likely to be due to the addition of water to the milled kenkey during mashing which resulted in the dilution of the aflatoxins content to a level which was not detected by the HPLC analysis.

However in aflatoxins sample 3 from milling machine (2). It is shown from the table , the total aflatoxins before milling the kenkey was 4.36 µg/kg made up of aflatoxin B1,3.0µg/kg and aflatoxin G1, 1.36 µg/kg . Aflatoxins B2 and G2 were not detected in the kenkey samples. The total aflatoxins content of the kenkey after milling the kenkey was 1.5µg/kg and was made up entirely of aflatoxins B1 thus aflatoxins B2, G1 and G2 were not detected in the milled kenkey. The final mashed kenkey which was produced did not contain any aflatoxins , that is neither aflatoxin B1, B2,G1 and G2 was detected in the mashed kenkey .This was likely to be due to the addition of water to the milled kenkey during mashing which resulted in the dilution of the aflatoxins content to a level which was not detected by the HPLC analysis.

Microbiological Water Analysis Report

Water samples for milling kenkey during mashed kenkey production were obtained from two (2) milling plants on three (3) separate occasions and analysed for total coliforms, faecal coliforms, E.*coli* and total heterotrophic bacteria. The results are presented on Table 13 and 14.

Table 13: ***Microbiological Quality of Water used in Mashed Kenkey Production***

Microbiological Quality	Mean	Std. Dev.	Std. Error
Total Coliform (TC) (cfu/100ml)	10.00	6.26	2.56
Faecal Coliform (FC) (cfu/100ml)	25.67	36.47	14.89
E`. coli (cfu/100ml)	26.50	36.07	14.72
Total Heterotrophic Bacteria (cfu/1ml)	9.50	3.89	1.59

Source: Agyarko, (2020).

Table 13 shows the analytical report (analysis one) of a sample of milling plant water. The total coliform method (APHA 9222A), Faecal Coliform method (APHA 9222D), *E Coli* Method (APHA 9260F), and the Heterotrophic Bacteria method (APHA 9215B) were adopted and used to obtain the microorganic components present in the milling plant one water. The result indicated a mean score (M = 10.0; SD = 6.26; SE = 2.56) of Total Coliform from the two milling plants

For Faecal Coliform, a mean score of 25.67 with a standard deviation of 36.47 was recorded in the two milling plants water. With regards to *E-coli* (cfu/1ml), the mean score was 26.50(SD = 36.07; SE = 14.72) in the two milling plants water and with total Heterotrophic Bacteria (cfu/1ml), the mean score was 9.50(SD = 3.90; SE = 1.59) in the milling plants water. The results indicate that differences exist in the Total Coliform (TC), Faecal Coliform (FC), *E coli* and the Heterotrophic Bacteria method for the milling plants water.

Table 14: ***The pH of Mashed Kenkey***

Sample 1 plant 1	**pH1**	**pH2**	**pH3**	**Average pH**
Kenkey	3.67	3.69	3.68	3.68
Milled Kenkey	3.47	3.57	3.59	3.54
Mashed Kenkey	3.71	3.69	3.75	3.72
Sample 1 plant 2	**pH1**	**pH2**	**pH3**	**Average pH**
Kenkey	3.76	3.75	3.72	3.76
Milled Kenkey	3.82	3.84	3.82	3.83
Mashed Kenkey	3.94	3.98	3.94	3.95
Sample 3	**pH1**	**pH2**	**pH3**	**Average pH**
Kenkey	3.73	3.75	3.76	3.75
Milled Kenkey	3.84	3.84	3.86	3.85
Mashed Kenkey	3.92	3.93	3.92	3.92

Agyarko (2020).

Table 14 shows the pH of "mashed kenkey" from the various samples taken. The mean pH of all the kenkey samples that were analysed ranges from 3.68-3.76. For the milled kenkey the mean pH of the samples were between 3.54-3.85 pH. The pH of the mashed kenkey ranged from3.72-3.95. The low pH values of kenkey and "mashed kenkey" sampled are in agreement with the low pH values of 3.6 to 3.9, for kenkey reported several authors including as Halm *et. al*., (1996). The low pH of kenkey is a very important factor which contributes to the safet consumption of kenkey and it is as a result of the lactic fermentation which occurs during the steeping of maize grains and dough fermentation in kenkey production.

Table 15: ***Microbial Population in Cfu/G at Various Stages of "mashedkenkey" Production***

Aerobic Mesophylls (PCA)	**Sample 1 P1**	**Sample 1 P2**	**Sample 2 P1**	**Sample 2 p1**	**Sample 3 P1**	**Sample 3 P2**
Kenkey	2.5*10^5	2.3*10^4	3.5*10^5	6.5*10^4	4.5*10^5	3.3*10^4
Milled Kenkey	4.3*10^5	5.7*10^4	4.8*10^5	6.8*10^4	5.4*10^5	6.7*10^4
Mashed kenkey	7.7*10^6	6.7*10^5	8.0*10^6	7.2*10^5	9.2*10^6	7.7*10^4
COLIFORM						
Kenkey	ND	ND	ND	ND	ND	ND
Milled Kenkey	ND	ND	ND	ND	ND	ND
Mashed kenkey	7.7*10^6	6.7*10^5	4.2*10^1	1.5*10^1	2.5*10^1	3.5*10^1
E COLI						
Kenkey	ND	ND	ND	ND	ND	ND
Milled Kenkey	ND	ND	ND	ND	ND	ND
Mashed kenkey	ND	ND	1.2*10^1	3.5*10^1	1.5*10^2	4.1*10^1
CLOSTRIDIUM PERFRINGES						
Kenkey	ND	ND	ND	ND	ND	ND
Milled Kenkey	ND	ND	ND	ND	ND	ND

Table 15 (continued)

Mashed kenkey	ND	ND	ND	ND	ND	ND
SALMONELLA TYPHIMURIUM						
Kenkey	ND	ND	ND	ND	ND	ND
Milled Kenkey	ND	ND	ND	ND	ND	ND
Mashed kenkey	ND	ND	ND	ND	ND	ND
STAPHYLOCOCUS AUREUS						
Kenkey	ND	ND	ND	ND	ND	ND
Milled Kenkey	ND	ND	ND	ND	ND	ND
Mashed kenkey	ND	ND	ND	ND	$2.1*10^1$	$3.4*10^1$
YEAST AND MOULDS						
Kenkey	$2.9*10^3$	$2.7*10^3$	$1.6*10^4$	$1.1*10^3$	$2.6*10^4$	$2.1*10^3$
Milled Kenkey	$1.8*10^4$	$1.5*10^4$	$4.6*10^4$	$5.6*10^3$	$3.6*10^4$	$5.8*10^4$
Mashed kenkey	$2.8*10^5$	$1.7*10^5$	$5.4*10^4$	$5.8*10^3$	$6.4*10^4$	$6.8*10^4$

Agyarko (2020).

Table 15 shows the Microbial Population at the various stages in the production of “mashed kenkey”. The results shows that the population of aerobic mesophylls in the final bottled mashed kenkey ranged from 10^5-

10^6Cfu/g. This was the highest level of aerobic mesophylls found during the production of mashed kenkey. This was because no preceding treatment were applied during the processing, which could have reduce the microbial load. A percentage of microbes found in the packaged kenkey could have been due to contamination from the hands of the producers' during unwrapping of the balls of kenkey and breaking into pieces and also during milling.

The results also shows that *Clostridium perfringens* and *Salmonella typhimurium,* were not found in any of the 6 samples kenkey pieces, 6 samples of milled kenkey and 6 samples packaged mashed kenkey analysed. With regards to Coliforms, this was found in all 6 samples of the packaged mashed kenkey analysed but not in the samples of kenkey pieces and milled kenkey. Similarly

E.coli was found in out of the 6 samples of packaged mashed kenkey but not in the kenkey pieces nor milled kenkey samples. With *Staphylococus aureus,* theses were only found in 2 of the 6 samples of package mashed kenkey sample. Yeast and moulds were isolated in all the 6 samples of kenkey pieces, 6 samples of milled kenkey and 6 samples of packaged mashed kenkey. These results could be attributed to the low pH of kenkey which gives it antimicrobial activity. The low pH is due to the to the production of lactic acid bacteria during the steeping of dough fermentation in kenkey production. Regarding the yeast which were found in all samples, this could be attributed to synergetic effect between lactic acid bacteria and yeast. In lactic acid fermentation of most Ghanaian foods, concurrent increases in lactic acid bacteria and yeast have been reported. Yeast and moulds presence, the study revealed that yeasts and moulds were present at each production stages of mashed kenkey. Compared to aerobic

mesophylls at the various stages of “mashed kenkey” production, the results may be inferred from a statistically significant difference among various “mashed kenkey” produced.

There is a statistically significant difference in the microbiological contaminants found in “mashed kenkey” produced in different milling plants in the New Juaben Municipality. The comparison of the aerobic mesophylls results at the various stages of “mashed kenkey” production which yielded different outputs. For instance, the number of aerobic mesophylls were only found in the packaged kenkey produce.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this study was to assess the potential microbiological and chemical contaminants in "mashed kenkey" from selected milling plants in the New Juaben Municipality in the Eastern Region of Ghana. The summary, conclusions, and recommendations of the study are presented in this chapter. Suggestions for further studies have also been presented.

Summary

Milling plants are suspected to be contaminated with deplorable chemical contaminants, probable microbiological and chemical contaminants in "mashed kenkey" from selected milling plants in the New Juaben Municipality in the Eastern Region of Ghana was determined using the HACCP principles. These principles were used to analyse the possible microbiological and chemical contaminants as hazards and identified whether statistically significant differences existed in the milling plant's biological and chemical contaminants. The study specifically examined the practices that were likely to introduce microbiological and chemical contaminants into "mashed kenkey" production, stages where contamination was likely to occur, the extent to which microbiological and chemical qualities of "mashed kenkey" samples met acceptable Ghana/International Standards, identified differences in the microbial and chemical load of mashed kenkey samples from between selected milling plants, "mashed kenkey" consumers views concerning chemical contamination and instituted measures that helped mitigate to microbiological and chemical contamination of "mashed kenkey."

The study adopted the descriptive and experimental design. An interview schedule and a guided observation were used as part of the research instruments for the study. The respondents of the study comprised 10 “mashed kenkey” millers and 5 “mashed kenkey” vendors. The samples collected comprised water samples for milling the kenkey, unmilled kenkey, milled kenkey, and final processed milled kenkey from different milling plants at different times of the milling process. All the samples collected at every sampling period were analysed for laboratory analysis.

Conclusions

From the findings it can be concluded that the aerobic mesophylls were found in the “mashed kenkey” but at levels that may not necessarily cause harm to consumers. The water analysis showed that the level of faecal and other common contaminants were within acceptable levels thus could explain why the risk of the final product affecting the health of consumers is minimal.

Regarding the lubrication and processing of milling machines, 50% of the millers used grinding plates that were 2-3months old which easily break into pieces due to friction and get mixed up with the “mashed kenkey”. It was also found that parts of the milling plants millers lubricated were mostly bushings/bearing, key, steer pot, and tip.

Milling operators hardly sharpened their grinding plates thus introduce chemical contaminants into the “mashed kenkey” during production since the grinding plates harbour stale kenkey, which when exposed to air and moisture lead to rust formation.

The study revealed that the respondents were knowledgeable in food hygiene, and in food borne illnesses and gained their knowledge from the

various Associations they belong to. During the preparation of the "mashed kenkey," it was found that most of the "mashed kenkey" vendors utilize the already produced "kenkey" from the market. The profits the mashed kenkey vendors would like to make, made them overlook the safety measures that will ensure wholesome products for consumption.

The study found that the even though there aflatoxins detected in kenkey samples from milling machines there were they were minimal and not injurious to human consumption even the final product(mashed kenkey) did not have any trace of aflatoxins .This is probably because the water used to mashed the kenkey has diluted the traces of aflatoxins detected in the kenkey to the level HPLC analysis couldn't detect it.. The low pH standards for the "mashed kenkey" sampled were uniform with the low pH values of 3.6 to 3.9 found in the "mashed kenkey" were consistent with documented other similar products. High populations of aerobic mesophylls were found in the already packaged kenkey ranging from 105-106Cfu/g.

Recommendations

The following recommendations for policy and practice were made based on the findings from the study.

1. "Mashed kenkey" millers must recognize and minimize the risk of chemical contaminants entering the mashed kenkey production process in order to reduce the load of chemical contaminants that render "mashed kenkey" unhygienic.
2. Millers should strictly observe personal, food, and environmental hygiene practices. Personal hygiene includes having regular baths,

frequent changing clothing before milling, and frequent washing hands after lubricating the milling plants, and visiting the toilets.

3. "Mashed kenkey" millers must observe the mandatory health review and medical examination yearly, which are requirements instituted by the Ministry of Health.
4. Food hygiene should include using hot water, detergent, abrasives, and sponge to clean the milling plants instead of a broom, not putting hands in "mashed kenkey," not talking directly onto "mashed kenkey" during milling, using soap and water to wash hands before milling "mashed kenkey," washing milling plant after usage, washing grinding plates after sharpening, regularly changing the grinding plate, using quality grinding plates, rejecting mouldy kenkey, repairing plant leakages, avoid using locally made grinding plates and using edible lubricants instead of petroleum-based lubricants.

Mashed kenkey" vendors

1. "Mashed kenkey" vendors must comply with the mandatory annual medical examination established by the Ministry of Health.
2. Food hygiene must include sorting and washing the kenkey thoroughly, mashing in transparent and stainless steel vessels, using clean water and avoid putting dirty hands in "mashed kenkey", covering "kenkey" during and when sending it to the milling site, not talking directly onto "mashed kenkey" during milling, using soap and water to wash hands before mixing "mashed kenkey", avoid using rusted container for storage of "mashed kenkey", keeping "mashed kenkey" away from chemicals.

Manufacturers of milling plants

1. "Mashed kenkey" milling plants manufacturers should avoid using inferior metals in making milling plants.
2. "Mashed kenkey" milling plants manufacturers should use stainless steel in making grinding plates as this does not quickly wear out.
3. These manufacturers must produce products that meet standard specifications.

Ghana Standards Authority

1. The Ghana Standards Authority must implement current legislation and acceptable restrictions to ensure that the producers of milling plants comply and act accordingly. Those who violate the law should be prosecuted, and premises shut down to instill discipline and standard operating procedures.
2. This body must guarantee that cornflour, kenkey, and other milled foodstuffs produce items that match the required standard.

Areas For Further Study

1. Any interested researcher may replicate this research in any region or district where there is scarcity of water to see if it will have any effect on the mashed kenkey.
2. Interested researchers may also research into contamination in the production of porridge 'kooko', ' brukina', 'sobolo', gari, ground nut paste, 'fura' , pepper and tomatoes.

REFERENCES

Abrefah, R. G., Mensimah, E., Sogbadji, R. B. M. & Opata, N. S. (2011). *The effects of milling of corn flour using.* Instrumental neutron activation analysis*:* A case study of three selected corn millers with Accra Metropolis Ghana Energy Commission, National Research Institute, Legon – Accra, Ghana.

Adams, C. E. (1987). *Listeria-The organism and the disease.* US Department of Agriculture, Extension Service.

Alli, F. (2004). *Food quality assurance: Principles and practices.* New York: CRC Press LLC.

Amedahe, F. K., & Asamoah Gyimah, E. (2002). *Introduction to education research.* Cape Coast: Centre for Continuing Education of the University of Cape Coast.

ATSDR, U. (2002). *Toxicological Profile for Di (2-ethylhexyl) phthalate (DEHP).*

Atter, A., Ofori, H., Anyebuno, G. A., Amoo-Gyasi, M., & Amoa-Awuah, W. K. (2015). *Safety of a street vended traditional maize beverage, ice-kenkey, Food Control*, *55*, 200-205.

Beck, B. (2000). Neuropeptides and obesity. *Nutrition*, *16*(10), 916-923.

Birch, L. L., (1979). Preschool children's food preferences and consumption patterns. *Journal of Nutrition Education*, *11*(4), 189-192.

Brackett, R. E. (1986). Growth and survival of Yersinia enterocolitica at acidic pH. *International Journal of Food Microbiology*, *3*(5), 243-251.

Breakwell, G. M., & Hammond, S. F-S., & Smith, J. A. (Eds.) (2006). *Research methods in psychology.* London: Sage.

Brown, K. J., & Grunberg, N. E. (1996). Effects of environmental conditions on food consumption in female and male rats. *Physiology & Behavior*, *60*(1), 293-297.

Burgess, C. M., Smid, E. J., & van Sinderen, D. (2009). Bacterial vitamin B2, B11 and B12 overproduction: an overview. *International Journal of Food Microbiology*, *133*(1-2), 1-7.

CDC (2011) Vital signs:Incidence and trends of infection with pathogens transmitted commonly through food-Foodborne Diseases Active Surveillance Network,10 U.S. sites, 19996-2010. *Morbidity and Mortality Weekly Report*, *60*(22), 747-755.

Childress, J. J., Fiala-Medioni, A., Fisher, C. R., & Page, H. M. (1991). Experimental evidence for filter-feeding by the hydrothermal vent mussel, Bathymodiolus thermophilus. *Deep Sea Research Part A. Oceanographic Research Papers*, *38*(12), 1455-1461.

Coats, D., Hutchinson D. N., & Bolton F.J. (1987) Survival of thermophilic Campylobacter on fingertips and their elimination by washing and disinfection. *Epidememiology and infection*, *99*, 265-274.

Codex, A. (2003). Recommended international code of practice general principles of food hygiene. *CAC/RCP*, *1*, e1969.

Codex Alimentarius Commission (2003b). Good hygienic practices according to the codex. *General Principles of Food Hygiene CAC/RCP 1-1969, Rev.*, 4-2003.

Codex, A. (2009). Maximum levels for lead. *CODEX STAN 230-2001, Rev.* 1-200.

Cooper, M. W. D., Rushton, M. J. D., & Grimes, R. W. (2014). A many-body potential approach to modelling the thermomechanical properties of actinide oxides. *Journal of Physics: Condensed Matter*, *26*(10), 105401.

Crosby, P. B. (1979). *Quality is free: The art of making quality certain*. McGraw-Hill. New York, NY, USA. 270 pp.

Czeczulin, J. R., Hanna, P. C., & McClanr, B. A. (1993). Cloning, nucleotide sequencing and expression of the *Clostridium perfringes* enterotoxin gene in *Escherichia coli*. *Infection and Immunity*, *61*, 3429-3439.

Duffus, J. H. (2002). Heavy metal–a meaningless term. *Pure Appl Chem*, *74*, 793-807.

EFSA, A. N. S. (2013). Panel (EFSA Panel on Food Additives and Nutrient Sources added to Food). Scientific Opinion on the re-evaluation of aspartame (E 951) as a food additive. *EFSA Journal*, *11*(12), 3496.

Ellis-Iversen, J., Ridley, A., Morris, V., Sowa, A., Harris, J., Atterbury, R., & Allen, V. (2012). Persistent environmental reservoirs on farms as risk factors for Campylobacter in commercial poultry. *Epidemiology & Infection*, *140*(5), 916-924.

Eschbach, J. W. (1994). Erythropoietin: The promise and the facts. *Kidney International Supplement*, *44*, S70.

FDA (2012). Guidance for industry: Drug interaction studies—study design, data analysis, implications for dosing, and labeling recommendations. *Food and Drug Administration*, 1-75.

Fernandez, L. A., Twickler, J., & Mead, A. (1985). Neovascularization produced by angiotensin II. *The Journal of laboratory and clinical medicine*, *105*(2), A2.

Farag, M. D. H. (2008). *Aflatoxins: Awareness and control. National Research and Scientific affairs*. Center for Radiation and Research and Technology, Cairo-Egypt.

Fraser, R. W., Williams, N. T., Powell, L. F., & Cook, A. J. C. (2010). Reducing Campylobacter and salmonella infection: two studies of the economic cost and attitude to adoption of on-farm biosecurity measures. *Zoonoses and Public Health*, *57*(7-8), e109-e115.

Forsythe, S.T. (2000) The Microbiology of Safe Food.Blackwell Science, Oxford.

Ghana Standards Authority (2009). *Quality requirement for food*. Accra; Ghana: GSA.

Gurtler, J. B., Kornacki, J. L., & Beuchat, L. R. (2005). Enterobacter sakazakii: A coliform of increased concern to infant health. *International Journal of Food Microbiology*, *104*(1), 1-34.

Halm, M., Amoa-Awua, W. K., & Jakobsen, M. (2004). Kenkey: An African fermented maize product. In *Handbook of food and beverage fermentation technology* (pp. 799-816). Marcel Dekker.

Havelaar, A. H., Haagsma, J. A., Mangen, M. J. J., Kemmeren, J. M., Verhoef, L. P., Vijgen, S. M., ... & van Pelt, W. (2012). Disease burden of foodborne pathogens in the Netherlands, 2009. *International Journal of Food Microbiology*, *156*(3), 231-238.

Hazeleger, W. C., Helmerhorst, T. H., Vlegels, P. P., & Wouters, J. M. (1988). Phage resistance of Streptococcus cremoris due to low adsorption efficiency. *Netherlands Milk and Dairy Journal*, *42*(2), 195-206.

Hinson, M., & Darkwa, S. (2016). Assessment of chemical contaminants in corn dough from selected corn wet milling plants in Mankessim. *Asian Journal of Agriculture and Rural Development, 6*(6), 106-118.

Horváth, E. (2011). *Neurotoxicity of a modelled complex environmental heavy metal exposure in rats.* (Doctoral dissertation, szte).

Hughes, K. J., Turányi, T., Clague, A. R., & Pilling, M. J. (2001). Development and testing of a comprehensive chemical mechanism for the oxidation of methane. *International Journal of Chemical Kinetics, 33*(9), 513-538.

ICMSF (1996) *Campylobacter*. Ch4. In *Microorganisms in food 5: Microbiological specifications of food pathogens*. Blackie Academic and Professional, London, p.45-65.

IFT (2004) Bacteria associated with foodborne diseases. *Food Technology Magazine, 58*(7), 20-21.

Ijabadeniyi, A., & Omoya, F. O. (2006). *Safety of small-scale food fermentations in developing countries.* Department of Microbiology, Federal University of Technology. Akure, Nigeria.

Institute of Medicine (2011). *Dietary reference intakes of vitamin A, vitamin K, arsenic, boron, silicon, vanadium and zinc*. National Academy Press, Washing, DC.

Lazaro, B., Carcano, J., Audicana, A, Perales, I., & Fernandez-Astorga, A. (1999). Viability and DNA maintenance in non culturable spiral *Campylobacter Jejuni* cells after long -term exposure low temperature. *Applied and Environmental Microbiology, 65*(10), 4677-4681

Lenntech, B. V. (2011). Water treatment solutions. *Delft, The Netherlands*.

LePera, M. (2000). Low-Sulfur and Diesel Fuel Lubricity--The Continuing Saga. *Published in Defense Energy Support Center's Fuel, Line Magazine*, *4*, 18-19.

Lety, M. A., Frehel, C., Raynaud, C., Dupuis, M., & Charbit, A. (2006). Exploring the role of the CTL epitope region of listeriolysin O in the pathogenesis of Listeria monocytogenes. *Microbiology*, *152*(5), 1287-1296.

Levin, R., Lang, K. W., Murphy, G. B., & Dibble, J. W. (2007). *U.S. Patent No. 7, 252, 850*. Washington, DC: U.S. Patent and Trademark Office.

Li, J., & McClane, B. A. (2006). Further comparison of temperature effects on growth and survival of Clostridium perfringens type A isolates carrying a chromosomal or plasmid-borne enterotoxin gene. *Applied and Environmental Microbiology*, *72*(7), 4561-4568.

Lunning, P. A., & Marcelis, W. J. (2011). *Food quality management technological and management principles and practices*. Wageningen Academic Publishers, The Netherlands.

McClane, B. A., & Rood, J. I. (2002). Clostridium Perfringens: Enterotoxaxaemic Disease. In M. Sussman (Ed.), *Molecular medical microbiology* (pp. 1117 – 1139). Academic Press.

Mead, P. S., Slutsker, L., Dietz, V., McCaig, L. F., Bresee, J. S., Shapiro, C., ... & Tauxe, R. V. (1999). Food-related illness and death in the United States. *Emerging infectious diseases*, *5*(5), 607.

Mensah, P., Yeboah-Manu, D., Owusu-Darko, K., & Ablordey, A. (2002). Street foods in Accra, Ghana: How safe are they?. *Bulletin of the World Health Organization*, *80*, 546-554.

Millstone, E., & Van Zwanenberg, P. (2002). The evolution of food safety policy–making institutions in the UK, EU and codex alimentarius. *Social Policy & Administration*, *36*(6), 593-609.

Nachamkin, I. (2007). Campylobacter jejuni. In *Food Microbiology: Fundamentals and Frontiers*, Third Edition (pp. 237-248). American Society of Microbiology.

Nartey, B. A. (2019). *A Study of Short-Lived Climate Pollutants Associated with Solid Waste Management Activities in Accra.* (Doctoral dissertation, University of Ghana).

NNDSS, A. R. W. G. (2013). Australia's notifiable disease status, 2011: Annual report of the National Notifiable Diseases Surveillance System. *Communicable Diseases Intelligence Quarterly Report*, *37*(4), E313.

Ntiforo, A. (2001). *Street food situation in Ghana.* Accra: Institute of Statistical, Social and Economic Research.

Oregon Health Authority (2011). *Heavy metals and your health: Frequently asked questions about testing, treatment and prevention*. Oregon Public Health Division. Oregon, Portland.

Park, H., Hung, Y. C., & Brackett, R. E. (2002). Antimicrobial effect of electrolyzed water for inactivating Campylobacter jejuni during poultry washing. *International journal of food microbiology*, *72*(1-2), 77-83.

Park, S. F. (2002). The physiology of Campylobacter species and its relevance to their role as foodborne pathogens. *International Journal of Food Microbiology*, *74*(3), 177-188.

Pirro, D. M., & Daschner, E. (2001). *Lubrication fundamentals*. Washington, DC: CRC Press.

Quartey, S. M., & Awoyemi, M. O. (2002). *Research methodology in education.* Ghana: K "N: AB Ltd.

Ramaswamy, V., Cresence, V. M., Rejitha, J. S., Lekshmi, M. U., Dharsana, K. S., Prasad, S. P., & Vijila, H. M. (2007). Listeria-review of epidemiology and pathogenesis. *Journal of Microbiology Immunology and Infection*, *40*(1), 4.

Reuter, K. E., Randell, H., Wills, A. R., & Sewall, B. J. (2016). The consumption of wild meat in Madagascar: drivers, popularity and food security. *Environmental Conservation*, *43*(3), 273.

Reynolds, K. A., Watt, P. M., Boone, S. A., & Gerba, C. P. (2003). Occurrence of bacteria and biochemical markers on public surfaces. *International Journal of Environmental Health Research*, *15*(3), 225-234.

Reynolds, E., Schuler, G. T., Hurst, W., & Tybor, P. T. (2003). *Preventing food poisoning and food infection.* Retrieved from http://www.ces.uga.edu/pubcd/b901-w.html.

Riddle, W.K. (1950). Permanent stained mycological preparation ontained by slide. *Mycologia*, *42*, 265-70

Sampers, I., Habib, I., De Zutter, L., Dumoulin A, Uyttendae, M., (2010) Survival of *Campylobacter spp* in poultry meat preparations subjected to freezing, refrigeration, minor salt concentration, and heat treatment. *International Journal of Food Microbiology*, *137*, 147-153

Sequeira, A. (1994). *Lubricant base oil and wax processing*. CRC press.

Silva, R. A., Montes, R. H., Richter, E. M., & Munoz, R. A. (2011). Rapid and selective determination of hydrogen peroxide residues in milk by batch injection analysis with amperometric detection. *Food Chemistry, 133*(1), 200-204.

Stroka, J., & Anklam, E. (1991). Quantitative analysis for aflatoxins. *JAOAC, 74*, 81-4.

Taylor, S. L., Nordlee, J. A., & Bush, R. K. (1992). *Food allergies.* New York: Sage.

Tull, A. (1996). *Food and nutrition* (3rd ed.). New York: Oxford University Press.

Ugland, T., & Veggeland, F. (2006). Experiments in food safety policy integration in the European Union. *JCMS: Journal of Common Market Studies*, *44*(3), 607-624.

Ugland, T., & Veggeland, F. (2006). The European Commission and the integration of food safety policies across levels. In *Multilevel Union Administration* (pp. 143-0162). Palgrave Macmillan, London.

Unicomb, L. E., Fullerton, K. E., Kirk, M. D., & Stafford, R. J. (2009). Outbreaks of campylobacteriosis in Australia, 2001 to 2006. *Foodborne Pathogens and Disease*, *6*(10), 1241-1250.

Van der Meulen, B., & Van der Velde, M. (2004). *Food safety law in the EU*. Amsteveen: Weningen Academic Publishers.

Wallace, R. B. (2003). Campylobacter: Ch10. In A. D. Hocking, (Ed), *Foodborne microorganisms of public health significance*. (6th ed). Australia Institute of Food Science and Technology (NSW Branch), Sydney, p.311-331.

Wood, R. A. (2003). The natural history of food allergy. *Pediatrics*, *111*(Supplement 3), 1631-1637.

World Health Organization. (1999). *The world health report: 1999: Making a difference*. World Health Organization.

World Health Organization. (2000). *The world health report 2000: Health systems: Improving performance*. World Health Organization.

World Health Organization. (2002). *The world health report 2002: Reducing risks, promoting healthy life*. World Health Organization.

Zhu, Q., & Sarkis, J. (2007). The moderating effects of institutional pressures on emergent green supply chain practices and performance. *International journal of production research*, *45*(18-19), 4333-4355.

Zottola, E. A., & Busta, F. F. (1971). Microbiological Quality of Further-Processed Turkey Products. *Journal of Food Science*, *36*(7), 1001-1004.

APPENDICES

APPENDIX A

TOOLS FOR DATA COLLECTION

OBSERVATION CHECK LIST

The researcher designed this observation check list to collect information from the millers at the milling plants in the New Juaben municipality where the samples for the laboratory analysis were collected. The researcher observed the millers' hygienic practices at the milling plant before and after milling the kenkey.

OBSERVATION CHECKLIST FORM FOR THE MILLERS

Milling Plant: Date of Observation: Duration of the Observation: Frequency of the Observation:

The researcher checks YES if the behaviour is available and NO if the behaviour is not available.

S/N	BEHAVIOUR OBSERVED	YES	NO
1	Is the environment of the milling plant neat?		
2	Is the milling plant itself kept neat?		
3	Does the operator wash inside the milling plant before milling the kenkey?		
4	Does the operator wash inside the milling plant after every milling?		
5	Is the water use to mill the kenkey clean?		
6	Is the container used to keep the water clean and covered?		
7	Are there traces of oil on objects in the milling center?		
8	Is the operator neatly dressed?		
9	Does the milling plant operator have a covered dustbin?		
10	Is the machine leaking with grease?		

OBSERVATION CHECKLIST FOR VENDORS

Milling Plant: Date of Observation: Duration of the Observation: Frequency of the Observation:

The researcher checks YES if the behaviour is available and NO if the behaviour is not available

S/N	BEHAVIOUR OBSERVED	YES	NO
1	Do the vendors wash their hands before milling the kenkey?		
2	Do the vendors wash the kenkey before milling?		
3	Do the vendors see to it that the milling plant is washed before they mill the kenkey?		
4	Do the vendors bring their water for milling or they used the water at the milling plant?		
5	Do the vendors wash the bucket at the milling used for collecting their milled kenkey?		
6	Has the kenkey they milled grown moulds?		
7	Is the unhusked kenkey covered properly before milling?		
8	If some of the oil leached into the kenkey do the vendors accept the milled kenkey with the mixed oil?		
9	Do the vendors do the mixing of the other ingredients at the milling plant?		
10	Do the vendors do the packaging at the milling plant?		

UNSTRUCTURED INTERVIEW GUIDE FOR THE MILLERS

The researcher designed this interview guide to collect information about the practices of the millers at the milling plants in the New Juaben Municipality where the samples for the laboratory analysis are collected.

SECTION A

Demographic Characteristics

1. Gender
   a. Male [ ]
   b. Female [ ]
2. What is your highest level of education?
   a. Non formal education [ ]
   b. Basic / Middle school [ ]
   c. Secondary / Technical /Vocational school [ ]
   d. Any other (specify)

   ……..

   ……
3. Indicate your marital status
   a. Single (Never married) [ ]
   b. Married [ ]
   c. Widow [ ]
   d. Separated [ ]

SECTION B

Lubrication and Processing

4. How long have you used the milling plant?
   a. 0 – 3 years [ ]
   b. 4 – 6 years [ ]
   c. 7 – 10 years [ ]
   d. 10 years and above [ ]
5. How old is your grinding plate old or new?
   a. 0 – 1 month
   b. 2 – 3 months
   c. 4 – 5 months
   d. 5 months and above
6. How often do you change the grinding plate?
   a. Daily [ ]
   b. Weekly [ ]
   c. Fortnightly [ ]
   d. Monthly [ ]
7. Do you sharpen your grinding plate?
   a. Yes [ ]
   b. No [ ]
8. If yes, how often do you sharpen it?
   a. Daily [ ]
   b. Weekly [ ]
   c. Fortnightly [ ]
   d. Monthly [ ]

e. Any other (specify)……..……

……

9. What treatment do you give to your grinding plate after sharpening?

a. Wash with water [ ]

b. Wash with water, sponge and soap [ ]

c. Clean with napkin [ ]

d. No washing at all [ ]

a. Do you lubricate the milling plant?

a. Yes [ ]

b. No [ ]

10. If yes, which parts of the milling plant do you lubricate?

a. The funnel [ ]

b. The bushings / bearings [ ]

c. The tip of the shaft, bushings / bearings and steer pot [ ]

d. The bushings / bearing, key, steer pot, tip of the shaft/cone [ ]

11. Which type of lubricant do you usually use for lubricating the milling plants?

a. Grease and engine oil [ ]

b. Palm kernel oil and grease [ ]

c. Palm oil and grease [ ]

d. Vegetable cooking oil and sheabutter [ ]

e. Any other (specify)

……..……..

……

12. How often do you lubricate the milling plant?

    a. Daily [ ]

    b. Weekly [ ]

    c. Fortnightly [ ]

    d. Monthly [ ]

    e. Any other (specify) ……..……

    ……

13. When do you usually apply the lubricant?

    a. Before milling and any time the lubricant dries up [ ]

    b. Before milling and whenever the cover is opened [ ]

    c. Throughout the milling process [ ]

    d. After milling [ ]

    e. Any other (specify)……

    ……

14. Which material do you use in applying lubricants to the milling plant?

    a. Brush [ ]

    b. Bare hand [ ]

    c. Duster [ ]

    d. Paper[ ]

15. Do you clean your hands after lubricating the milling plant?

    a. Yes [ ]

    b. No [ ]

16. If yes, what do you use in cleaning your hands?

    a. Napkin [ ]

    b. Garment [ ]

    c. Paper [ ]

    d. Water [ ]

17. If you use napkin in cleaning your hands, how often is it laundered?

    a. Daily [ ]

    b. Weekly [ ]

    c. Dispose it [ ]

    d. Fortnightly [ ]

18. Do you clean the milling plant after use?

    a. Yes [ ] b. No [ ]

19. If yes, how many times do you clean the milling plant?

    a. Daily[ ]

    b. Weekly [

    c. Fortnightly [ ]

    d. Monthly [ ]

20. Which cleaning agent(s) do you use in cleaning the milling plant?

    a. Broom [ ]

    b. Sponge, soap and water [ ]

    c. Steel wool and water [ ]

    d. Any other (specify)

21. If is operated manually which petroleum product does your mashed kenkey wet milling plant use in its operation?
    a. Petrol [ ]
    b. Diesel [ ]
    c. Engine oil [ ]
    d. Any other (specify)……
    ……
22. Do you clean your hands after filling the engine of the mashed kenkey wet milling plant?
    a. Yes [ ]
    b. No [ ]
23. Do you use any soap or detergent in washing the mashed kenkey wet milling plant?
    a. Yes [ ]
    b. No [ ]
24. If yes, indicate the type of detergent……..……
    ……
25. Do you rinse the mashed kenkey wet milling plant after washing it with detergent?
    a. Yes [ ]
    b. No [ ]

26. During the processing of mashed kenkey does lubricant sometimes gets into contact with the mashed kenkey?
    a. Yes [ ]
    b. No [ ]
27. If yes, how does the lubricant gets into the mashed kenkey?
    a. As a result of leakage from the milling plant and direct contact of the product with some lubricated parts [ ]
    b. Accidently pour into the product [ ]
    c. Direct contact of the product with some parts that are lubricated and leakage from some part of the milling plant and as a result of accident lubricant pour into the product [ ]
    d. Any other (specify)……
    ……
28. If lubricant mixes with mashed kenkey during milling do your customers complain?
    a. Yes [ ]
    b. No [ ]
29. If they complain what action do you take to ensure their satisfaction?
    a. Plead with them [ ]
    b. Compensate them [ ]
    c. Advise them to dispose of the affected part [ ]
    d. Any other (specify)……

SECTION C

Knowledge of Food Hygiene

30. Do you have any knowledge on food hygiene?

    a. Yes [ ]

    b. No [ ]

31. If "Yes", how was the knowledge acquired?

    a. By special training [ ]

    b. From association [ ]

    c. In school [[

    d. From parents [ ]

    e. Any other (specify)……

    ……

32. Have you had any medical checkup?

    a. Yes [ ]

    b. No [ ]

33. If yes, after the first medical examination how frequent have you been having the examination?

    a. Once a year [ ]

    b. Once in two years [ ]

    c. Once in five years [ ]

    d. Occasionally [ ]

    e. Any other (specify)……

34. Have you been licensed?

    a. Yes [ ]

    b. No [ ]

35. If yes, who gave you the license

    a. City council [ ]

    b. Municipal assembly [ ]

    c. Association [ ]

    d. Any other (specify)……

36. Do the Environmental Protection Agency / Food and Drug Authority supervise your activities?

    a. Yes [ ] b. No [ ]

SECTION D

Membership in Association

37. Do you have any mashed kenkey millers association in your community?

    a. Yes [ ]

    b. No [ ]

38. If yes, are you a member of the mashed kenkey millers association?

    a. Yes [ ]

    b. No [ ]

39. What are the aims of the association

    a. To make more profit in your business [ ]

    b. Together take loans [ ]

    c. Learn rules governing the trade [ ]

    d. Any other (specify)……..……

    ……

40. In your opinion what are the some of the things that have to be done to improve mashed kenkey milling.

……

……

……

APPENDIX B

INTERVIEW SCHEDULE FOR MASHED KENKEY VENDORS

SECTION A

Demographic Characteristics

1. Gender
   a. Male [ ]
   b. Female [ ]
2. What is your age? …….....
3. What is your highest level of education?
   a. No formal education [ ]
   b. Basic / Middle school [ ]
   c. Secondary / Technical /Vocational school [ ]
   d. Any other (specify)……..…
      ……
4. Indicate your marital status
   a. Single (Never married) [ ]
   b. Married [ ]
   c. Widow [ ]
   d. Separated [ ]

SECTION B

Preparation of mashed kenkey

5. Do you buy the kenkey?

   a. Yes [ ]

   b. No [ ]

6. If no, do you prepare the kenkey yourself?

   a. Yes [ ]

   b. No [ ]

7. What material is usually used to wrap / package kenkey?

   a. Polythene and leaves [ ]

   b. Leaves [ ]

   c. Polythene [ ]

   d. Any other (specify)……

   ……

8. Do you think it is good to eat kenkey that have been wrapped with polythene?

   a. Yes [ ] b. No [ ]

9. If no what are your reasons?

   .....

   .....……

   ……

   ……..

SECTION C

Knowledge on Food- borne Illness

10 Do you wash the kenkey before milling?

a. Yes

b. No

11. Do you ensure that the machine is washed before you mill the kenkey?

a . Yes

b .No

12. Do you accept and use the mashed kenkey when oil from the machine leaked into the kenkey?

a Yes

b.. No

13. Do you have any knowledge on food- borne illness?

a. Yes [ ]

b. No [ ]

14. If yes, where did you acquire the knowledge?

a. School [ ]

b. Association [ ]

c. From parents [ ]

d. Any other (specify)……..……

……

……

15. What do you think brings about food- borne illness?

a. By eating contaminated food [ ]

b. By eating cold food [ ]

c. By eating leftover food [ ]

d. Any other (specify)……

……

16. Indicate the effects of food-borne illness……

……

17. How can you prevent food-borne illness?

……

……

……

SECTION D

Knowledge on Food Hygiene

18. Do you have knowledge on food hygiene?

a. Yes [ ]

b. No [ ]

19. Where did you acquire the knowledge?

a. School [ ]

b. Association [ ]

c. From parents [ ]

d. Any other

(specify)……

……

20. Do you have knowledge on wholesome foods?

a. Yes [ ]

b. No [ ]

21. Where did you acquire the knowledge?

    a. In school [ ]

    b. From association [ ]

    c. From parents [ ]

    d. Any other (specify)……..……

    ……

22. What do you think will happen to you when eat unwholesome food?

    ……

    ……

    ……

23. Suggest some of the things that can be done in order to improve upon the quality of mashed kenkey

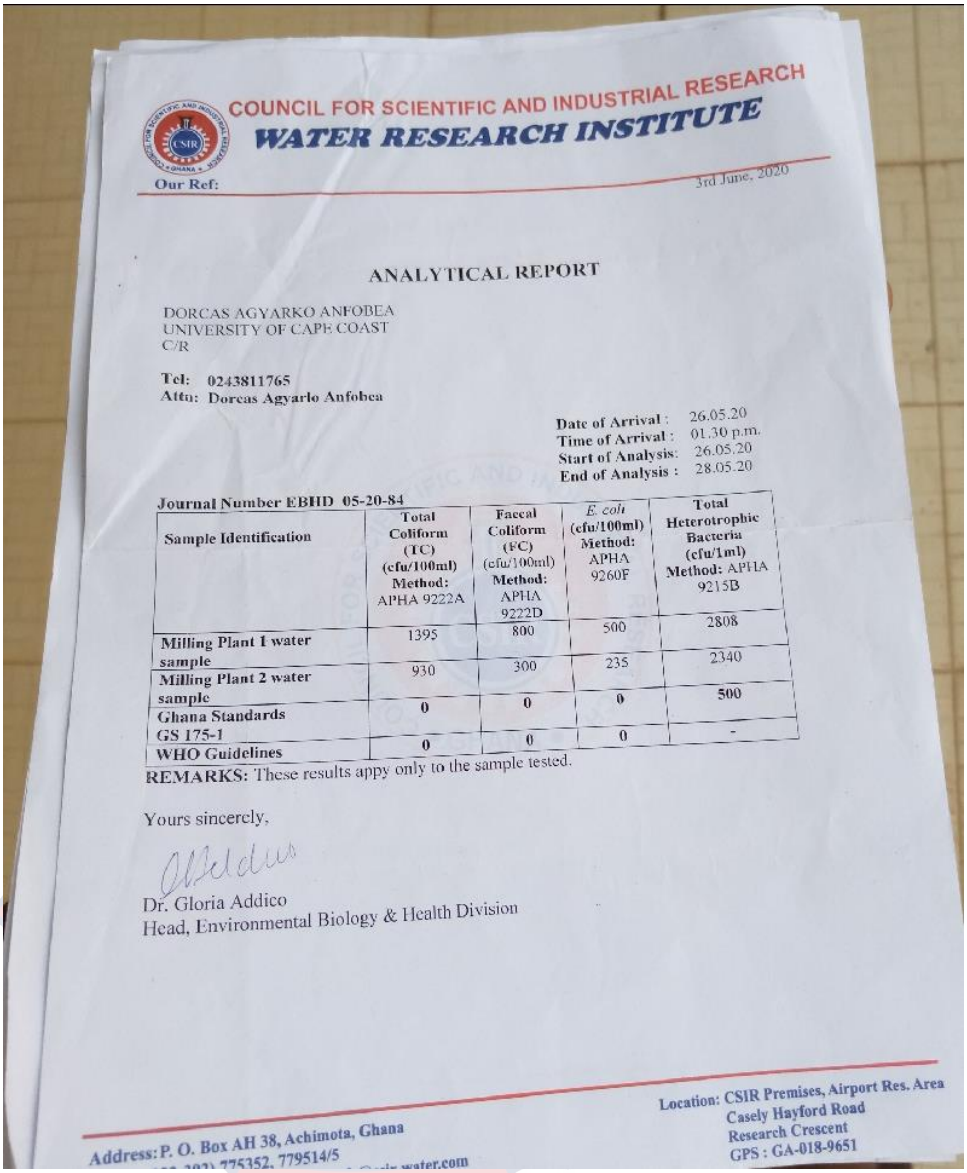
    preparation……..…

    ……

    ……..

APPENDIX C

LABORATORY RESULTS



COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH
WATER RESEARCH INSTITUTE

Our Ref: 3rd June, 2020

ANALYTICAL REPORT

DORCAS AGYARKO ANFOBEA
UNIVERSITY OF CAPE COAST
C/R

Tel: 0243811765
Attn: Dorcas Agyarko Anfobea

Date of Arrival : 26.05.20
Time of Arrival : 01.30 p.m.
Start of Analysis: 26.05.20
End of Analysis : 28.05.20

Journal Number EBHD 05-20-84

Sample Identification	Total Coliform (TC) (cfu/100ml) Method: APHA 9222A	Faecal Coliform (FC) (cfu/100ml) Method: APHA 9222D	*E. coli* (cfu/100ml) Method: APHA 9260F	Total Heterotrophic Bacteria (cfu/1ml) Method: APHA 9215B
Milling Plant 1 water sample	1395	800	500	2808
Milling Plant 2 water sample	930	300	235	2340
Ghana Standards GS 175-1	0	0	0	500
WHO Guidelines	0	0	0	-

REMARKS: These results appy only to the sample tested.

Yours sincerely,

Dr. Gloria Addico
Head, Environmental Biology & Health Division

Address: P. O. Box AH 38, Achimota, Ghana
Location: CSIR Premises, Airport Res. Area
Casely Hayford Road
Research Crescent
GPS : GA-018-9651

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH
WATER RESEARCH INSTITUTE

Our Ref:

22nd June, 2020

ANALYTICAL REPORT

DORCAS AGYARKO ANFOBEA
UNIVERSITY OF CAPE COAST
C/R

Tel: 0243811765
Attn: Dorcas Agyarlo Anfobea

Date of Arrival : 16.06.20
Time of Arrival : 01.30 p.m.
Start of Analysis: 16.06.20
End of Analysis : 18.06.20

Journal Number EBHD 06-20-51

Sample Identification	Total Coliform (TC) (cfu/100ml) Method: APHA 9222A	Faecal Coliform (FC) (cfu/100ml) Method: APHA 9222D	*E. coli* (cfu/100ml) Method: APHA 9260F	Total Heterotrophic Bacteria (cfu/1ml) Method: APHA 9215B
Milling Plant 1 water sample	18600	0	0	3276
Milling Plant 2 water sample	4000	1800	3100	2808
Ghana Standards GS 175-1	**0**	**0**	**0**	**500**
WHO Guidelines	**0**	**0**	**0**	-

REMARKS: These results appy only to the sample tested.

Yours sincerely,

for

Dr. Gloria Addico
Head, Environmental Biology & Health Division

Address: P. O. Box AH 38, Achimota, Ghana
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COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH
WATER RESEARCH INSTITUTE

Our Ref:

3rd June, 2020

ANALYTICAL REPORT

DORCAS AGYARKO ANFOBEA
UNIVERSITY OF CAPE COAST
C/R

Tel: 0243811765
Attn: Dorcas Agyarlo Anfobea

Date of Arrival : 26.05.20
Time of Arrival : 01.30 p.m.
Start of Analysis: 26.05.20
End of Analysis : 28.05.20

Journal Number EBHD 05-20-84

Sample Identification	Total Coliform (TC) (cfu/100ml) Method: APHA 9222A	Faecal Coliform (FC) (cfu/100ml) Method: APHA 9222D	*E. coli* (cfu/100ml) Method: APHA 9260F	Total Heterotrophic Bacteria (cfu/1ml) Method: APHA 9215B
Milling Plant 1 water sample	1395	800	500	2808
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WHO Guidelines	0	0	0	-

REMARKS: These results appy only to the sample tested.

Yours sincerely,

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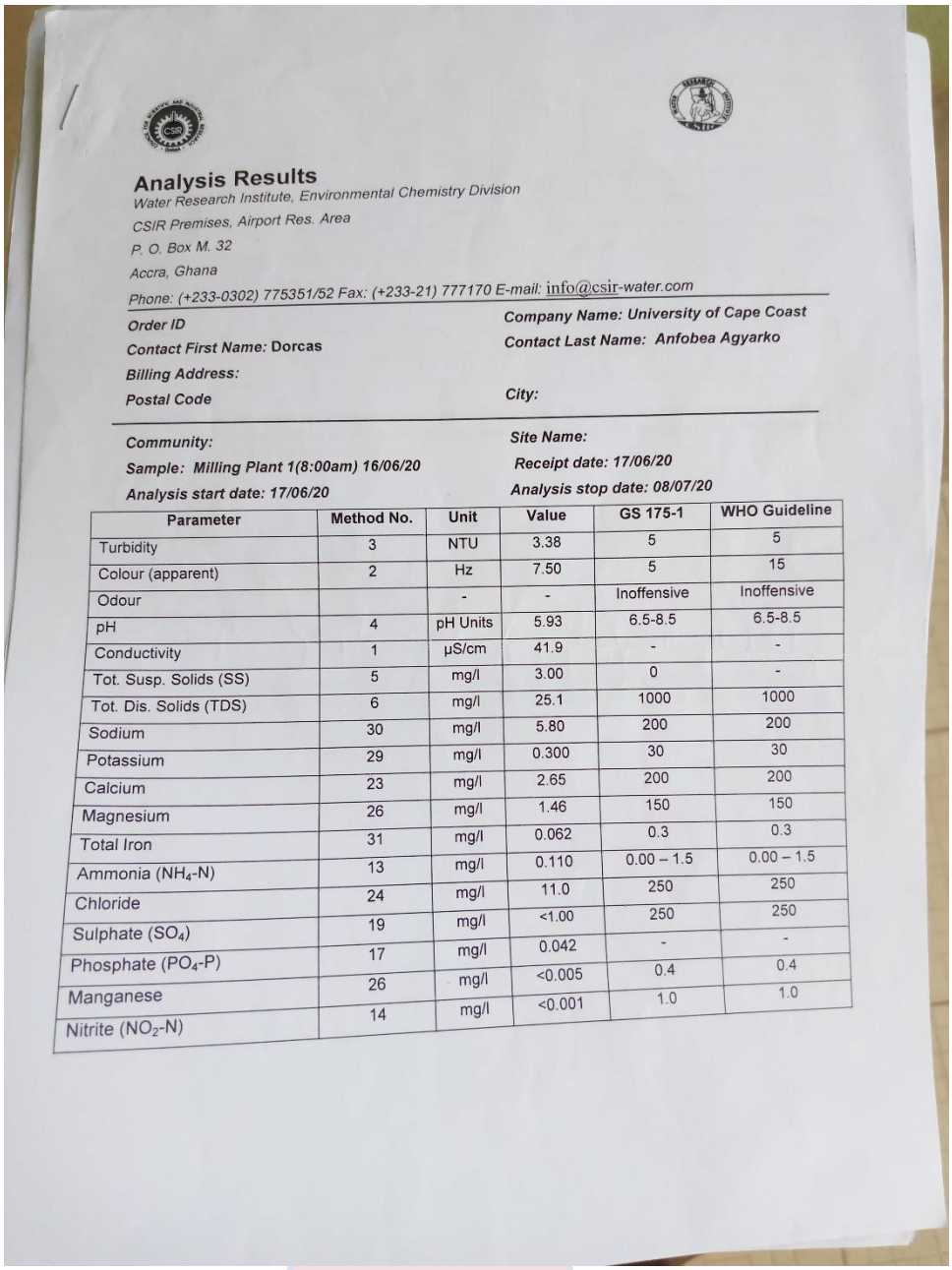


Analysis Results

Water Research Institute, Environmental Chemistry Division
CSIR Premises, Airport Res. Area
P. O. Box M. 32
Accra, Ghana
Phone: (+233-0302) 775351/52 Fax: (+233-21) 777170 E-mail: info@csir-water.com

Order ID
Company Name: University of Cape Coast
Contact First Name: Dorcas
Contact Last Name: Anfobea Agyarko
Billing Address:
Postal Code
City:

Community:
Site Name:
Sample: Milling Plant 1(8:00am) 16/06/20
Receipt date: 17/06/20
Analysis start date: 17/06/20
Analysis stop date: 08/07/20

Parameter	Method No.	Unit	Value	GS 175-1	WHO Guideline
Turbidity	3	NTU	3.38	5	5
Colour (apparent)	2	Hz	7.50	5	15
Odour		-	-	Inoffensive	Inoffensive
pH	4	pH Units	5.93	6.5-8.5	6.5-8.5
Conductivity	1	µS/cm	41.9	-	-
Tot. Susp. Solids (SS)	5	mg/l	3.00	0	-
Tot. Dis. Solids (TDS)	6	mg/l	25.1	1000	1000
Sodium	30	mg/l	5.80	200	200
Potassium	29	mg/l	0.300	30	30
Calcium	23	mg/l	2.65	200	200
Magnesium	26	mg/l	1.46	150	150
Total Iron	31	mg/l	0.062	0.3	0.3
Ammonia (NH_4-N)	13	mg/l	0.110	0.00 – 1.5	0.00 – 1.5
Chloride	24	mg/l	11.0	250	250
Sulphate (SO_4)	19	mg/l	<1.00	250	250
Phosphate (PO_4-P)	17	mg/l	0.042	-	-
Manganese	26	mg/l	<0.005	0.4	0.4
Nitrite (NO_2-N)	14	mg/l	<0.001	1.0	1.0

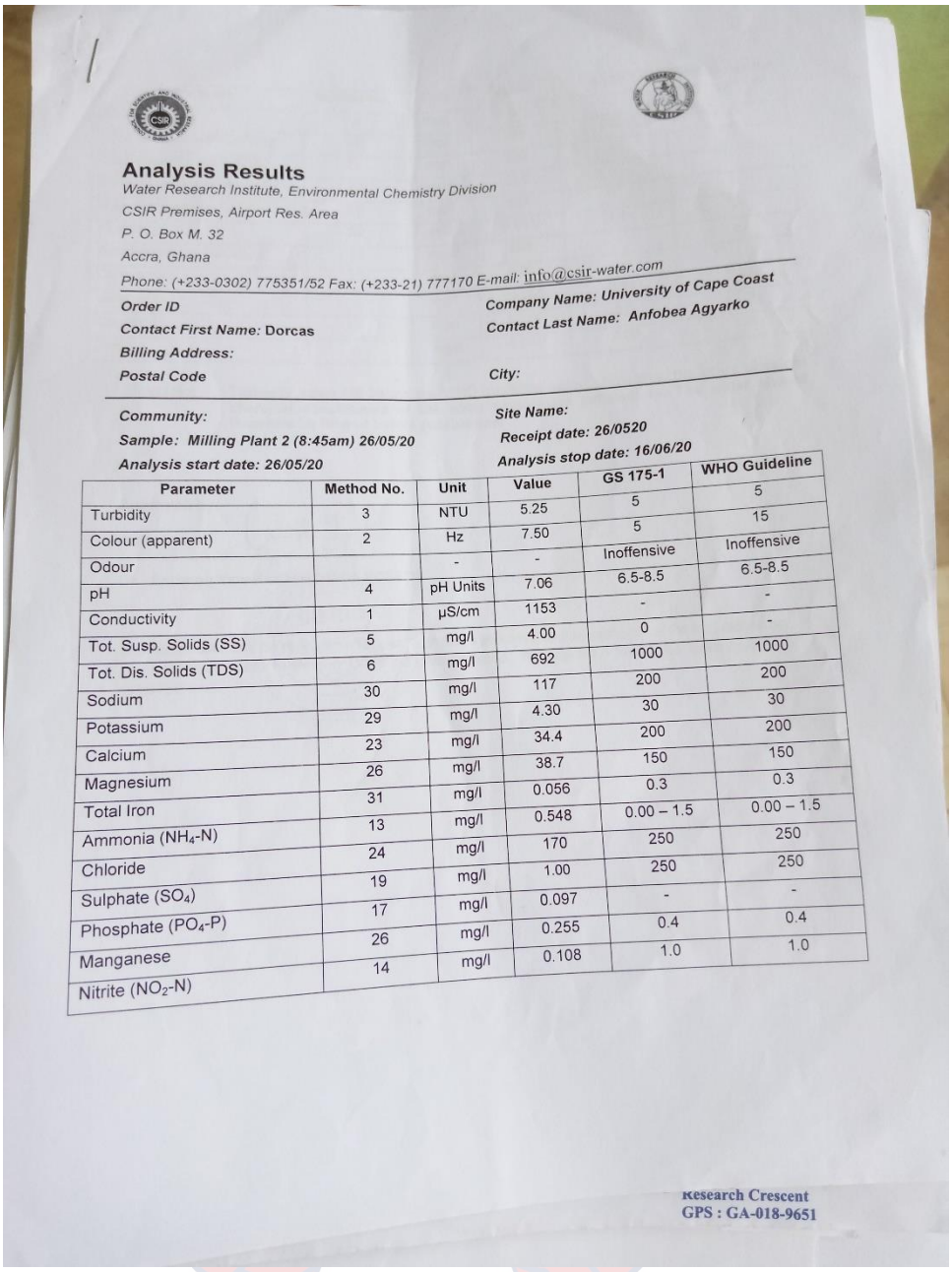
Parameter	Method No.	Unit	Value	GS 175-1	WHO Guideline
Nitrate (NO_3-N)	15	mg/l	1.44	10	10
Total Hardness (as $CaCO_3$)	25	mg/l	12.6	500	500
Total Alkalinity (as $CaCO_3$)	22	mg/l	10.0	-	-
Calcium Hardness (as $CaCO_3$)	23	mg/l	6.61	-	-
Mag. Hardness as $CaCO_3$)	26	mg/l	5.99	-	-
Fluoride	20	mg/l	<0.005	1.5	1.5
Bicarbonate (as $CaCO_3$)	22	mg/l	12.2	-	-
Carbonate	22	mg/l	0.00	-	-
Lead	-	mg/l	<0.005	0.01	0.01
Copper	-	mg/l	<0.010	2.0	2.0
Zinc	-	mg/l	0.064	2.00	2.00

Remarks **pH value fell below the WHO guideline value. However, the other physico-chemical constituents of the water sample are satisfactory. The water should therefore be limed before potable use.**

Approved by:

Dr. Anthony Yaw Karikari (Head, ECSED)

The report shall not be reproduced in part or in full, without the written approval of the test laboratory. The analytical results relate only to the samples analysed. The bracket (<) indicates value below detection limit.



Analysis Results

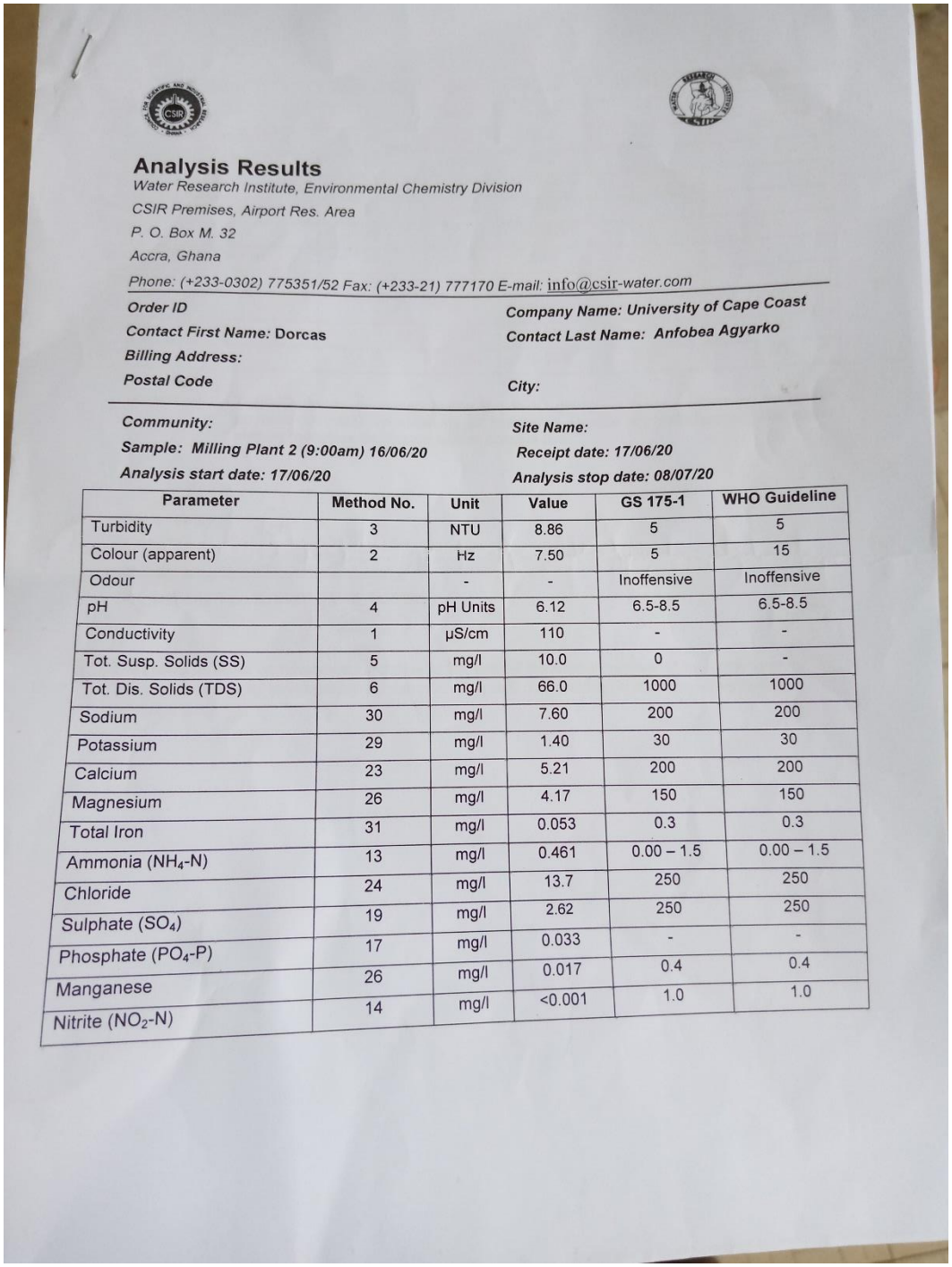
Water Research Institute, Environmental Chemistry Division
CSIR Premises, Airport Res. Area
P. O. Box M. 32
Accra, Ghana
Phone: (+233-0302) 775351/52 Fax: (+233-21) 777170 E-mail: info@csir-water.com

Order ID
Company Name: University of Cape Coast
Contact First Name: Dorcas
Contact Last Name: Anfobea Agyarko
Billing Address:
Postal Code
City:

Community:
Site Name:
Sample: Milling Plant 2 (8:45am) 26/05/20
Receipt date: 26/0520
Analysis start date: 26/05/20
Analysis stop date: 16/06/20

Parameter	Method No.	Unit	Value	GS 175-1	WHO Guideline
Turbidity	3	NTU	5.25	5	5
Colour (apparent)	2	Hz	7.50	5	15
Odour		-	-	Inoffensive	Inoffensive
pH	4	pH Units	7.06	6.5-8.5	6.5-8.5
Conductivity	1	µS/cm	1153	-	-
Tot. Susp. Solids (SS)	5	mg/l	4.00	0	-
Tot. Dis. Solids (TDS)	6	mg/l	692	1000	1000
Sodium	30	mg/l	117	200	200
Potassium	29	mg/l	4.30	30	30
Calcium	23	mg/l	34.4	200	200
Magnesium	26	mg/l	38.7	150	150
Total Iron	31	mg/l	0.056	0.3	0.3
Ammonia (NH_4-N)	13	mg/l	0.548	0.00 – 1.5	0.00 – 1.5
Chloride	24	mg/l	170	250	250
Sulphate (SO_4)	19	mg/l	1.00	250	250
Phosphate (PO_4-P)	17	mg/l	0.097	-	-
Manganese	26	mg/l	0.255	0.4	0.4
Nitrite (NO_2-N)	14	mg/l	0.108	1.0	1.0

Research Crescent
GPS : GA-018-9651



Analysis Results

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Order ID ***Company Name: University of Cape Coast***
Contact First Name: Dorcas ***Contact Last Name: Anfobea Agyarko***
Billing Address:
Postal Code ***City:***

Community: ***Site Name:***
Sample: Milling Plant 2 (9:00am) 16/06/20 ***Receipt date: 17/06/20***
Analysis start date: 17/06/20 ***Analysis stop date: 08/07/20***

Parameter	Method No.	Unit	Value	GS 175-1	WHO Guideline
Turbidity	3	NTU	8.86	5	5
Colour (apparent)	2	Hz	7.50	5	15
Odour		-	-	Inoffensive	Inoffensive
pH	4	pH Units	6.12	6.5-8.5	6.5-8.5
Conductivity	1	µS/cm	110	-	-
Tot. Susp. Solids (SS)	5	mg/l	10.0	0	-
Tot. Dis. Solids (TDS)	6	mg/l	66.0	1000	1000
Sodium	30	mg/l	7.60	200	200
Potassium	29	mg/l	1.40	30	30
Calcium	23	mg/l	5.21	200	200
Magnesium	26	mg/l	4.17	150	150
Total Iron	31	mg/l	0.053	0.3	0.3
Ammonia (NH_4-N)	13	mg/l	0.461	0.00 – 1.5	0.00 – 1.5
Chloride	24	mg/l	13.7	250	250
Sulphate (SO_4)	19	mg/l	2.62	250	250
Phosphate (PO_4-P)	17	mg/l	0.033	-	-
Manganese	26	mg/l	0.017	0.4	0.4
Nitrite (NO_2-N)	14	mg/l	<0.001	1.0	1.0