UNIVERSITY OF CAPE COAST

MICROBIAL AND NUTRITIONAL EVALUATION OF FOOD PACKAGED IN BANANA (*Musa sapientum*) AND PLANTAIN (*Musa paradisiaca*) LEAVES

ESTHER LOMO-MENSAH

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BY

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

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DECLARATION

Candidate's Declaration

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

Candidate's Signature: .... Date: ....

Name: Esther Lomo-Mensah

Supervisors' Declaration

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

Supervisor's Signature: ………….................................... Date: ....

Name: Dr. (Mrs) Augusta Adjei Frimpong

ABSTRACT

The availability of varied packaging materials for global food services has accounted for ready-to-eat foods in wrappings of plant leaves, of which the Ghanaian food industry is not an exception. This study evaluated the microbial and nutritive status of food packaged in both *Musa sapientum* and *Musa paradisiaca* in the Sekondi-Takoradi metropolis. Standard methods were used in conducting the experiments. Qualitative data and quantitative data obtained were analyzed and the results were expressed in frequencies, percentages, means and graphs. The study revealed that majority of the food service operators who packaged food in *M. sapientum* and *M. parasidiaca* leaves where mainly food vendors who engaged in kenkey selling. Consumer preferences were geared towards presumed health and safetiness, medicinal properties and availability. In this study, the proximate analysis showed that *M. sapientum* and *M. parasidiaca* leaves add important nutrients to the wrapped food compared to food wrapped in Cellophane. The study also revealed appreciably high contents of phosphorus, potassium, and β-Carotene in oblongo, which had been wrapped in *M. sapientum* and *M. parasidiaca* fresh leaves, while copper and zinc were noticeable in the oblongo wrapped in dry leaves. At the same time, traceable amounts of bacteria count, coliforms, yeast, and mold and antioxidants were identified on both fresh and dry leaves collected across the three locations. Alternatively, there were no detectable traces of microbes on the Cellophane and the oblongo packaged in leaves under hygienic conditions. It is recommended that consumers and food service operators who patronize *M. sapientum* and *M. sparadisiaca* leaves, but to ensure high food hygiene to control and/ or avoid bacterial contamination and infection.

KEYWORDS

Antioxidant

Cellophane

Consumer

Microbial

Musa paradisiaca

Musa sapientum

Oblongo

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Finally, my appreciation to all and sundry for their contribution in diverse ways. God bless you all.

DEDICATION

To my children Elizabeth, Lawrence, Ogerh, Korli, Tetegah and Mawujigua

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CHAPTER ONE

INTRODUCTION

Background to the Study

Food is usually explained as any substance that contains vital nutrients: protein, carbohydrate, mineral elements and vitamins, which are required to support the basic metabolism of the human body. Acceptably, after the ice age experience, humans wanted to create some feeling of security by controlling the kind of plants and animals to consume or use as food (Helen & James, 2003). This continually led to ways of improving upon the way in which food could be obtained (Gordon, 2010). The vigorous development of food and food substances led to several ways of packaging food: Styrofoam, plastics, cans, polythene, Cellophane and plant leaves (Abraha & Desta, 2012).

The aforementioned materials for serving or packaging food by food service operators, whether at home, workplaces, restaurants, and hotels, are not without importance (Kora, 2019). Food packaging is meant to preserve, prolong the lifespan, conserve nutrients, and make food presentable for consumption (Abraha & Desta, 2012). Without packaging, food processing could become compromised with various contaminants in the environment either by humans, physical, chemical, or biological objects (Ningwei & Mahat, 2009; Rather et al., 2017; Thompson & Darwish, 2019). Notwithstanding, the life span of food is attributed to the innovative ways of packaging food, because they to tend support safety and quality properties for consumers' convenience (Bach, Dauchy, Chagnon & Etienne (2012) Many techniques used in packaging foods vary according to the geographical location, tradition, and level of industrialization, which includes economic status, desired effect of the manufacturer, and the preference of the end-user (Singh, Dar, & Sharma, 2012).

Although food packaging is an integral component of the food industry that supports the storage of meals in a hygienic manner, it could also cause concern for food safety (Chisenga, Tolesa & Workneh., 2020) This is because certain packaging materials like plastic, polythene, Cellophane, Styrofoam, and plant leaves release toxins when they are heated and eventually cause health hazards to consumers (Opara, 2013). Materials irradiated often transfer unsafe non-food substances into the food (Gordon, 2010). In the view of Mark and John (2003), a variety of substances such as dyes for printing colourful labels and glues and adhesives for keeping packaging closed, could be a source of worry to consumer’s health

In Ghana, just as in other countries, fast food industries are established to meet the dietary needs of the populace in the geographical parts of the country. According to oral history, leaves for food packaging are very ancient, although their basis is difficult to ascertain. Leaves have physical characteristics of a large surface area that make them suitable for packaging large volumes of food (Dosumu & Akinnuoye, 2014). However, the various types of plant leaves differ based on the location of the food preparation and availability of the various leaves: *Musa sapentium* and *Musa paradisiaca* leaves (Onzo, Azokpota, Akissoe, & Agbani, 2013)

Statement of the Problem

The use of leaves as food packaging materials is no longer constricted to local populace residents in remote areas. The trend has gained widespread acceptance in Ghana's towns and cities and in some parts of the world

(Schiffman, Castle, Jeronimo, Rodriguez & Wacholder, 2007). Among the different types of useable leaves are the *Musa paradisiaca and Musa sapientum* which could be identified as sustainable materials because of the low cost and availability for food packaging (Jeenusha & Amritkumar, 2020; Mohapatra, Mishra, & Sutar, 2010). However, it is argued that very little has been done on the microbial and nutritional impact of food packaging with leaves, and for that matter, *Musa sapentium* and *Musa paradisiaca* leaves (De Lucca, Cleveland, & Wedge, 2005). With this lapse continuing, the autgus emphasize the need to assess the leaves in order to highlight any potential hazard or otherwise. Currently, foods packaged in papers, metals and plastic materials have been identified with large numbers of chemicals either added intentionally or unintentionally that often leach into food and affect the quality of food consumed

Personal observation at foodservice outlet also found lots of unwanted materials on some of these leaves, often cleaned with a rag-like napkin by fastfood sellers. The consistent use of these leaves as packaging materials, especially within the indigenous fast food and food processing industries, calls for a study into the safety and values of such leaves. This study therefore seeks to investigate evaluating the microbial effects and nutritional value of *Musa sapientum* and *Musa paradisiaca* leaves to authenticate their use as packaging material for consumers.

Purpose of the Study

The purpose of this study was to evaluate the demand, perception and preference of food packaged in *Musa sapientum* and *Musa paradisiaca* leaves and assess the microbial and nutritive value of such packaged foods by foodservice operators in Sekondi-Takoradi metropolis.

The specific objectives for the study were to;

i. Identify the types of food service operators currently using *Musa paradisiaca* and *Musa sapientium* leaves for packaging food for consumers.

ii. Assess consumer's preference for the use of *Musa sapientium* and *Musa paradsiaca* leaves as packaging materials in Sekondi-Takoradi Metropolis.

iii. Assess the nutritional value of food packaged in *Musa sapientum* and *Musa paradisiaca* leaves in comparison with Cellophane.

iv. Assess microbial effects and antioxidant of food packaged in *Musa sapientium* and *Musa paradisiaca* leaves.

Research Questions

In order to address the problem at hand, these research questions were formulated to guide the study:

i. Which range(s) of foodservice operators are currently engaged in the use of *Musa sapentum* and *Musa paradisiaca* as packaging materials for serving their foods?

ii. What are the perception and preferences for the use of *Musa sapientium* and *Musa paradsiaca* leaves as packaging materials for consumers of the Sekondi-Takoradi metropolis?

iii. Which food nutrients are contained in foods packaged in *Musa sapientum* and *Musa paradisiaca leaves* and Cellophane?

iv. What are the microbial effects and antioxidants of food packaged in *Musa paradisiaca* and *Musa sapientum* leaves?

Hypothesis

Ho: There are no significant differences between nutrient contents (protein, carbohydrate, fibre, iron and B-carotene in the food packaged in *Musa paradisiaca, Musa sapientum* leaves and Cellophane.

H_1: There are significant differences in nutrient contents (protein, carbohydrate, fibre, phosphorus, iron and B-carotene) between food packaged with *Musa sapientum, Musa paradisiaca* leaves and food packaged in Cellophane.

Ho: There are significant differences in the level of microbial activity and antioxidant of food packaged with *Musa sapientuma, Musa paradisiaca* leaf, and food packaging without the leaves.

H_1: There are no significant differences in the level of microbial activity from food packaged with *Musa sapientum, Musa paradisiaca* leaves and of food packaged without the leaves.

The purpose of the research hypothesis was to explore any significant differences; in the nutrient contents (protein, carbohydrate, fibre, phosphorus iron and B-carotene) between food packaged with *Musa sapientum, Musa paradisiaca* leaves and food packaged in Cellophane (plastics). More so, to investigate whether there were significant differences in the level of microbial activity and antioxidant of food packaged with *Musa sapientum,*

Musa paradisiaca leaves and that of food packaged without the leaves at a Significance difference of ($P < 0.05$) by comparing the variances of each test group at a Significance difference of ($P < 0.05$) for two-tailed analysis.

Significance of the Study

This study provides information beneficial to the indigenous foodservice operators (including the hospitality industry, local food providers and restaurants) on the use of *Musa sapientum* and *Musa paradiscca* leaves as packaging materials for their products. The study will enable consumers to make an informed decision or choices regarding materials for packaging food. It will also support consumers' choice in the selection of packaging materials that are used for food. The findings would also support the existing literature on consumer perception and preference of food packages and as well as the nutritional value of these packages. Other researchers would use the findings as premises for further studies. Additionally, this study's results will be useful for national and international stakeholders who formulate policies, particularly on food packaging materials for the foodservice industry.

Delimitation

Although there are many commercial industries in Ghana, this study looked at few indigenous foodservice operators and consumers in the Western region of Ghana. The study was also restricted to the residents in Sekondi - Takoradi metropolis.

Limitation

The main limitation of the study was that data were collected only from three major markets in the Sekondi Takoradi Metropolis which may not give a true total reflection on preference and perception of leaves usage in the entire Western Region.

Organization of the Study

This study is organized into five chapters. Chapter one introduces the study that comprised background to the study, the significance of the study statement of the problem, the purpose of the study, research question, delimitation and organization of the study.

Chapter two reviewed relevant literature on concepts bordering on the demographical *Musa paradisiaca* and *Musa sapientum* leaves and variety of *Musa paradisiaca* and *Musa sapientum* leaves. Empirical review on the perception, preference and nutritional component of *Musa paradisiaca* and *Musa sapientum* leaves as well as their microbial and antioxidant activity were also reported. Theoritical reviews on consumer choice and preference were also analysed.

Chapter Three deals with the research methods comprised of research design, the population, sample and sampling procedures, data collection instruments, data collection procedures and data processing and analyses.

Chapter four highlights the results and discussions. The first part addressed the demographic information of respondents. The second part presented the results and discussions according to the research objectives of the study.

Chapter five provides the summary, conclusion and recommendations.

CHAPTER TWO

LITERATURE REVIEW

Overview

This chapter reviewed the related literature to the study and considered the conceptual review of the geographical location *of Musa sapientum* and *Musa paradisiaca.* The chapter also looked at various *Musa paradisiaca* and *Musa sapientum* and identified challenges in use by both operators and consumers. Additionally, an empirical review of the nutritional components and microbial activity of *Musa sapientum and Musa paradisiaca* leaves, their uses and nutritional benefits, microbial effects of some food packaging materials, as well as the demand and challenges for the use of *Musa sapientium* and *Musa paradsiaca* leaves as a packaging material for consumers were undertaken. The chapter included the types of foodservice operators currently using *Musa paradisiaca* and *Musa sapientum* leaves for packaging food for consumers.

Conceptual Review

Musa sapientum and *Musa paradisiaca* leaves (dried and fresh) are used by most traditional areas in southern Ghana as packaging materials for food (Mensah, Adei. Adei & Ashei, 2012). According to the authors, this is important because both dried and fresh leaves are found in the different demographical locations in the country with myriad varieties. In using these types of leaves, it is noteworthy that while some foods are packaged raw before applying heat, other foods are packaged instantly after heat for consumers.

It is, however, acknowledged that chemicals such as non-particles from packaging and other food contact materials and, for that matter, fresh and dry leaves of *Musa paradisiaca* and *sapientum*, can migrate into food and subsequently find their way to the stomach of a consumer (Castle, 2007). While the fresh and dry leaves of *Musa paradisiaca* and *sapientum* can migrate some non-particles into food when it is wrapped or packaged in, it could be said that such particles are in the form of nutrients like phytochemicals, antioxidants, including microbial substances (Imam & Akter, 2011).

Leafy packaged foods absorb macronutrients such as protein and carbohydrates in addition to micronutrients like vitamins and minerals (Otitoju, Ene-Obong & Otitoju, 2014). There are possibilities that microbial organisms such as E. *coli*, yeast and mould, and any form of phytochemical or antioxidant (Rashama, Ijoma & Matambo, 2021) from both dry and fresh leaves are absorbed. These possible absorptions could affect consumers' preferences and perception in selecting food packaging materials like leaves.

Concept of geographical Location of *M. paradisiaca* and *M. sapientum*

According to Jyothirmayi and Rao (2015), *Musa sapientum* (Genus Musa) cultivars were grown for a long time. Today the fourth most significant food produced in the world for human consumption is a plant genus of Musa (Bartoshuk & Klee, 2013). In Africa, Ghana ranks second to Cameroon as the largest *Musa paradisiaca* and *Musa sapientum* (Darfour & Rosentrater, 2016). The Musa species are grown almost everywhere in the country and have various functions, ranging from the edible *Musa sapientum* and *Musa* *paradisiaca* of the tropics to cold-hardy fibre and ornamental plants (Aurore, Parfait & Fahrasmane, 2009). The plants have been a staple of the human diet over generations (Bartoshuk & Klee, 2013).). Currently, Musa species have gained ground because of their versatility and ease of cultivation. This may be because *Musa sapientum* and *paradisiaca* are ideally cultivated in full sun (Singh, Dar& Sharma, 2012).

Conceptual Framework

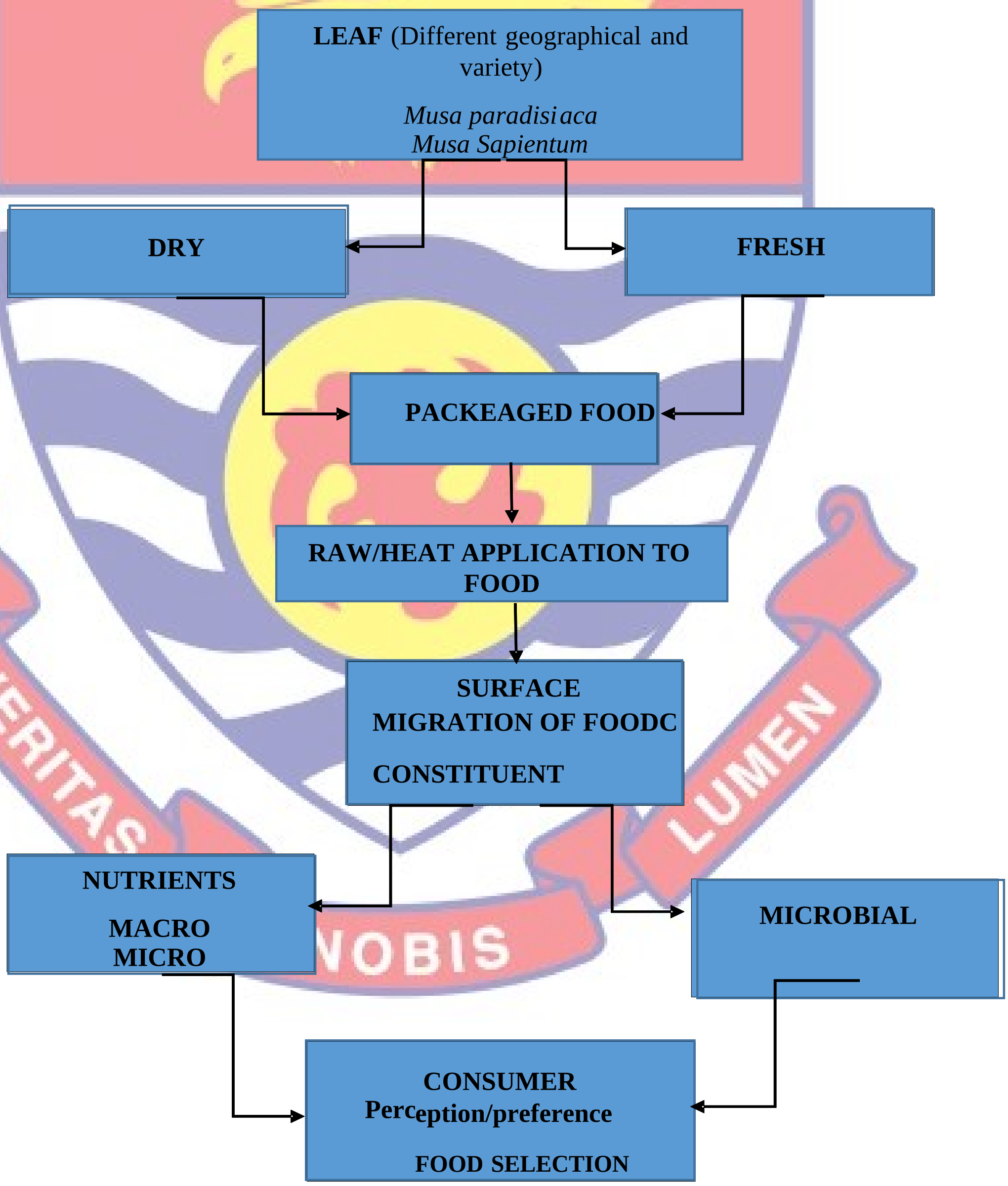


Figure 1 : Diagrammatic Presentation of the Conceptual Framework

Source: Author's construct

Variety of *Musa paradisiaca* and *Musa sapientum*

Almost all modern cultivated varieties of edible *Musa sapientum* and *paradisiaca* are hybrids and polyploidy of two wild, seeded *Musa acuminata* and Musa *balbisiana*. Cultivated *Musa sapientum* is almost seedless (parthenocarpic) and therefore is cloned (FAO, 2011). They are classified according to a genome-based system introduced by Caballero (2012), indicating the degree of genetic inheritance from the two wild parents and the number of chromosomes. Cultivars derived from *Musa acuminata* are more likely to be used as dessert *Musa sapientum* (eaten without cooking), while those derived from *Musa balbisiana* and hybrids are usually plantains or cooking Musa *paradisiaca* (FAO, 2011).

Nutritive value of *Musa paradisiaca* and *Musa sapientum* Leaves

Mostly, packaging materials of which some are metals, plastics and leaves, have their nutritional impact on any food they are used to wrap (Huhalov, 2004). Food packaging has become the vital section of every finished product in that it makes the products complete and attractive (Marsh & Bugusu, 2007). It has been noted that plants are known to produce secondary metabolites which can be found in leaves that prevent soma microbial attack. (Zailani & Ahmed, 2008). Besides bacterial properties that can destroy some microorganisms are also found in the leaves of *Musa sapientum* (Kumar, Bhowmik, Duraivel, Umadevi, 2012). *Musa sapientum* and *Musa Paradisiaca* leaves have special flavour, just cooked food are placed on them. This shows that the leaves introduced a distinct flavour into the food, giving the food a better taste. (Marriott & Palmer, 1980). Food served on a plate can also be contaminated by chemicals from traces of soap use for cleaning it However, *Musa sapientum* and Musa *Paradisiaca* leaves need only to be rinsed with a little water, without the use of soap and this makes food packaged in them free from chemicals (Padam, Tin, Chye & Abdullah, 2014; Kora, 2019).

Nutritional Component of *Musa Paradisiaca* and *Musa Sapientum*

Adepoju, Sunday & Folaranmi(2012) conducted a study in Nigeria, University of Ibadan on nutrient composition and contribution of plantain (*Musa Paradisiaca*). The result showed that *Musa paradisiaca* products contains some macro nutrients (protein and carbohydrates) and micro nutrients (phosphorus, iron, zinc, calcium and magnesium) while some nutrients also tend to denature as you roast, fry or boil before eating. Also, low sodium content makes it suitable for the hypertensive, and the low carbohydrate content coupled with relatively high energy makes it suitable for consumption by people with diabetes. However, the researchers failed to elaborate on the nutrient composition of the leaves (that may migrate to the food when in use as packaging material), which is necessary in that it forms part of the plant and its wide use is gaining acceptability in various countries.

Uses of *Musa paradisiaca* and *Musa sapientum* Leaves

The leaves of *Musa sapientum* and *Musa sapientum* are largely used in most tropical regions for serving by foodservice operators Imam & Akter, 2011; Padam et tal., (2014). The leaves are also used as food wrappers to hold and protect food during the application of dry and moist heat to the food. Additionally, while *Musa sapientum* and *Musa sapientum* leaves are used for beautification, the extract is used to cure dryness and dandruff (Kole, Jadhav, Thakurdesa Nagappa, 2005; Maregesi, Kagashe & Felix, 2014). Again, *Musa* *sapientum* leaves are used to cure wounds and skin irritation. Livestock such as goats, sheep, cows, chickens, and rabbits enjoy the leaves as food, especially the leaves of young plants (Cooper, 2012). The leaves of both *Musa sapientum* and *Musa paradisiaca* cure sore throat, which happens to be a symptom of many respiratory-related illnesses that are mainly caused by a virus (Jena, Sumalde, Behura, Hossain, & Narciso, 2012). They are used for beverages, medicines, flavourings as well as for ceremonial and religious celebrations (Gordon, 2010). In India, Sampath, Debjit, Duraivel, and Umadevi (2012) conducted a study on traditional and medicinal uses of Musa *sapientum*.

The study revealed that *Musa sapientum* is one of the oldest plants. All the parts of the *Musa sapientum* plant had medicinal value especially the leaves for treating diabetes, ulcer dysentery and diarrhoea (Belhaj & Zidane, 2021). Fresh *Musa sapientum* leaves boost wound healing and the dried ones are identified as a rich source of allantois and polyphenol; both substances have been found helpful in reducing intestinal bleeding (Ross, 2007). It also helps manage body weight in that when the leave is steamed and drunk, it removes body cellulite. *Musa sapientum* and *Musa sapientum* leaves also contain good nutrition and act as natural medicine (Kumar, Bhowmik, Duraivel & Umadevi, 2012). Livestock or pets at home fed with fresh *Musa sapientum* leaves provide many nutritional benefits (Huque & Sarker, 2014).

Food packaging

There are huge loses of resources from productive activities as a result of poor handling, distribution, storage, and purchase consumption behaviors (Esguerra, Rolle & Rahman, 2018). However, these losses can be reduced by using appropriate packaging (Kramer, Wunderlich & Muranyi, 2018). According to literature, the packaging of food is an essential part for future development when blended with technologies and processes (Olsmats & Wallteg, 2009). Across the globe food packaging industry should contribute to addressing food losses and ensuring options for food safety and enhancing global food trade (Shiferaw, Prasanna, Hellin & Bänziger, 2011). Emerging views currently indicate that more and better packaging are being introduced to support and /or help address challenges of food losses (Halloran, Clement, Kornum, Bucatariu & Magid, 2014; Vanderroost, Ragaert, Devlieghere & De Meulenaer, 2014). Therefore, it is argued that increases in the understanding of both production and marketing functions of packaging coupled with a better appreciation of the economics could promote its use (Johnson, 2002). Advances in packaging, however, will lead to improved food quality and safety, they will also address an equally important concern in developing countries: livelihood enhancement of small producers through enhanced market access and integration into sustainable value chains (Shahbaz, Akram, Ahn, & Kwon, 2016).

Relevance of food packaging

Different authors have classified the various functions of packaging. Selke (1994) reported the packaging functions in three basic groups: as a protection for the product from its surroundings during transportation; as a means of communication-which describes the nutritional information on the package with its specifications from the manufacturer, including the storage and disposal of the package (Dobson & Yadav, 2012). Additionally, it plays the role of convenience for consumers and distributors in handling that and facilitates the use of a product (Rundh, 2009). Alternatively, other authors argue that the aforementioned basic functions are limited because Robertson, Paine, Sonnewald and Jepson (2000) identified other ognes, such as containment (Yam, 2005). Again, the increasing use of technology has made packaging more important and efficient storage (Beitzen-Heineke, Balta-Ozkan, & Reefke, 2017).

Furthermore, the attention of consumers is capture by the use of packaging and, at the same time, influences consumers' perception in assessing products (Sullivan & Kim, 2018). Thus, packaging is an essential medium for reducing chemicals preservatives used in food. Food packaging ensures food protection against harmful chemicals, particles, bacteria, pests (Ahmed, Sameen, Lu, Li, Dai, Qin & Liu, 2020) and for easy movement. Food is protected in the package for various reasons like vibration, shock, compression, temperature (Marsh & Bugusu, 2007). Another basic function of food Packaging is to prevent oxygen, dust, water from coming into contact with the food, retain moisture, conserve nutrient maintains the freshness, healthiness and prolong the shelf life of the food (Youssef & El-Sayed, 2018)

Proper food packaging with proper information plays a vital role in encouraging potential consumers to buy the product (Aurore, Parfait & Fahrasmane, 2009; Idumah, Zurina, Ogbu, Ndem & Igba, 2019) and reduce the security risks of shipment (Idumah, et al., 2019). With appropriate packaging, there is reduced chances of the food packages being destroyed or contaminated (Rout & Behera, 2021). Food packages have some basic characteristics that make it more convenient to open, use, re-closing handling and sale.

Leaves use in packaging food in Ghana

The word "packaging" to the indigenous Ghanaian is a foreign word reaching Ghana through western influence or formal education (Evans, 2009). Differently put, Ghanaian local dialects or languages do not have an appropriate word for packaging. According to oral presentations, packaging to the Ghanaian has been an integral part of Ghanaians local food preparations and processes. Broad Leaves from high trees were used for packaging food in the primary stages of life. Some of these leaves are used today to package ready-to-eat foods. Dried leaves of *Sterculia tragacanta* for packaging dokono pa, dried sheaths of Zea mays for Ga kenkey and nkyekyara , dried leaves of *Marantochloa cuspidate* for packaging osino kenkey, fresh leaves of Thespesia populnea for packaging aboloo. *Thespesia populnea* for kaafa, fresh and dried leaves of *Musa paradisiaca* and *Musa sapientum* for nsiho, estwe, aboloo, sugar kenkey (Eyland, Breton, Sardos, Kallow, Panis, Swennen & Carpentier, 2021) apiti, aboloo etc. The most common packaging material in Ghana includes corn husk, *Musa paradisiaca* and *Musa sapientum* leaves (Mensah, Adei, & Adeihie 2012).

Corn Sheath

These are some corn husk characteristics; light green in colour, which turns whitish-yellow when dried (Bernhardt, Ponce, Basanta, Stortz, & Rojas, 2019). The author proposes that although the husk tapers towards a pointed edge at the top, it broadens at the bottom and slightly curves towards the broad edge. Again, the husk has lines running through it from the pointed edge to the broad edge and is in a slight relief that gives a pattern for the corn sheath. The husk is flexible, does not tear easily, very pliable when soaked in water for some time, with the part closer to the fruit very soft than the outer husks. Although the dried corn husk absorbs water easily, it has poor tensile strength and breaks easily (Bernhardt, Ponce, Basanta, Stortz, & Rojas, 2019)

Musa paradisiaca and Musa sapientum leaves

These are some of the characteristics of *Musa paradisiaca and Musa sapientum* leaves: Green in colour but turns brown when dried). The authors go on to state that the leaves of *Musa paradisiaca and Musa sapientum* have a broader surface which becomes slightly crisp when dried. They continue that their various shades of brown on the surface of the leaves, which have poor tensile strength and tears easily vertically. Furthermore, according to the authors, the dried leaves become flexible and pliable when wet. Again, the fibre of the dried leaves has many pores, which makes it absorbs water at a faster rate, although a single dried leaf cannot be used alone unless combined with at least 4 or 5 leaves to wrap kenkey.

Plastic Containers and Polythene Bags for Packaging

Plastic bags and polythene have served the commonest material for packaging food by the food service operators. Across nationwide there are varieties of plastics and polythene (Abraha & Desta, 2012). In the process of manufacturing plastics, many chemicals in the form of additives (e.g. plasticizers) are added to plastics at the time. However, these additives are noted to interact with food making its consumption (Ningwei & Mahat, 2009; Mark, & John, 2003).

It is clear that Bisphenol, which synthetic chemical compound in production plastics is capable of interfering with the action of estrogen in humans (Hamilton, Hewitt, Arao, & Korach, 2017). Even though manufacturers are now producing BPA free plastics (Hamilton et al., 2017) it not still not safe because they may contain some bisphenol chemicals. Moreover, monomers use in the production of plastics has been linked to cancer even though the actual amount of consumption or exposure have not known. The ingesting of food in these packaging materials exposes consumers to these harmful chemicals (Sangster, 2010). Therefore, the only safe way to avoid that is to discourage the use of plastics in packaging food and encourage use of leaves that may be more beneficial to humans. Plastics and polythene also serve as a pedigree for microorganisms which could lead of the spreads of infectious diseases. Packaging food in these plastics or polythene bags are therefore susceptible to carcinogenic agents and cross-contamination by microorganisms (Abraha & Desta, 2012). In view of these, there is the need to reconsider leaves as a packaging material that may add an active and intelligent ingredient to food.

Other Packaging Materials

The purpose for using metals in packaging foods is to be able to preserve and protect the content and resist any form of chemical reactions (Ebner, Morgan, & Manuel, 2021), but mechanical damage to cans, such as denting, result in the cracking of the internal lacquer (González-Velázquez, 2018) is harmful for human consumption. Nonetheless, packaged in these materials provides poor protection against insects and environmental factors (Bolaji, 2010). Foods package in a basket and jute bags are susceptible to pathogenic microorganisms because they are difficult to sanitize; hence crosscontamination is highly possible (Zhao, Ndayambaje, Liu & Xia, 2020) than leaves.

Effects of Some Packaging Materials in Food

It been noted that some non-particles can migrate from packaged material to food for consumers' consumption and this can cause an adverse effect to the consumer (Castle, 2007). The implication here is to find possible means of monitoring this migration to ensure the safety of food. This is because the severity of the danger of the leaching chemicals from packaging material to food largely depends on their quantity and characteristics (Maria & Timothy, 2010).

There has been significant improvement in food packaging materials by providing safe, wholesome and nutritious foods. However, migration of chemical or substances are inevitable is some pacakaging materials especially when applied to heat. These migrations could be undesirable or hazardous to consumers' health. Therefore, there is the need to use packaging with an active and intelligent component, which may leach beneficial substances into the food (Castle, 2007), which are beneficial to human consumption.

A small quantity of chemicals is released when thermostat, thermosetting plastics metals, glass and papers are used in food packaging before and after cooking. The leaching of chemicals from packaging materials into the food may be due to varied factors which includes; the type of the packaging material, the type of the food, temperature of contact and mobility of the chemicals in the packaging (Castle, 2007).

Theoretical Review

Willingness to Pay Willingness to Pay Measurements

Revealed and stated preference method are the common types of preferences. The presumption of revealed is based utility maximizing behavior and deduce infer how individuals make choices in analyzing a task. Natural and designed experiments are some of the choices made by individuals in terms of the use of revealed preference in studies. Answers to questions and surveys are usually used to obtained information from individuals in collection of data a non-market product. It had been argued that stated preference methods may not be accurate in relation to the real-world circumstances and be biased due to assumptive nature. Revealed preferences are usually considered due to availability of data and given the reflection of an individual's actual preferences. However, a researcher as not get access to data due its unavailability. In terms of less difficulty in assessments of particular research question and cost effectiveness the may preferred stated preference.

Discrete Choice Experiments

A discrete choice experiment approach was used to analyze consumer preferences and perceptions for packaging material. A variety of studies have used the choice experiment methodology to better understand individual preferences for products and product attributes. The choice experiment technique enables researchers to easily compare consumer preference for intangible attributes, such as product health, safeties and medicinal properties that are not revealed in markets (Mangham et al., 2009). Researchers can determine which characteristics have the greatest impact on consumer utility and derived product demand after carefully selecting which attributes are expected to influence consumers' choices and carefully designing the options and levels of choice decisions. Choice experiments are rooted in Lancastrian consumer theory (Lancaster, 1966) and random utility theory (Manski & Lerman, 1977; Hanemann & Kanninen, 1999). The Lancastrian approach to consumer theory holds that utility is derived from the properties of goods rather than from the goods themselves. Models based on random utility theory then assume that consumers strive to enhance their expected utility. There are several methods for recording for and modeling preference heterogeneity in the discrete choice literature. Evaluation of random parameter models is a common method for assessing preference heterogeneity. As is customary, we assume that indirect utility is linear, with each individual's indirect utility function. Furthermore, because the researcher has insufficient information, the individual's utility is regarded as a random variable. (Manski, & Lerman, 1977).

Foodservice Operators who use Leaves for Packaging Food for Consumers

The eating habit of people all over the world has gone through some rapid changes. Men and women working outside the home and school children have caused changes in the eating habits of Ghanaians (Yiran, Ablo and Asem, 2020). Parents are often employed outside the home and children attend schools far away. Consequently, fewer people, especially in the urban areas, are eating full home-cooked meals; much food is purchased from food service operators. As a result, the fast-food industry is gaining ground worldwide, in Africa food vendors, are found mostly along the streets of urban and rural communities, at schools, hospitals, and working places (D’Amour, Pandey, Reba. Creutzry and Seto 2020). To improve upon the food service operators' sanitation practices, numerous attempts have been made (Reddy, Recart, Cadman, 2020). Guidelines for packaging food by food service operators have been provided by the national and international code of practice.

However, in Ghana, most packaging food regulations are rarely observed if even the code of practice exists (Arnold & Loconto, 2021). In packaging some dishes, they are packaged hot just after is prepared or packaged cold before applying heat (Dzikunoo et al., 2020). In preparing dishes such as oblongo and fante kenkey, the dish is packaged in *Musa Sapietum* or *Musa Paradisiaca* leaves before heat is applied.

In addition, waakye sellers formally use *Musa Sapientum* leaves in the packaging of their rice but not recently. It can be inferred that aside fante kenkey, the indigenous meals that were formally sold in leaves have gone into extinction in Ghana but different countries are using it.

Perception of Leaves as Packaging Material

Challagulla, Vijayakumar, Sri Rohita, Elsa, Bharathi Sankar, Narasinga Rao, and Karthik (2020) researched on "Consumer Preferences" and "Demand for Packaging Material and Recyclability in Michigan State University". Even though Plastics were used for this study, consumers hailed the use of leaves as a packaging material because their perception was that it decomposes on its own when disposed of after usage; however, plastics must be recycled, which may or may not be easily executed because of the cost. Carbonaro, Bradstreet, Barrett, MacLean, Jesse, Johnson, and Griffiths (2016) also researched on Consumers' perceptions regarding sustainable packaging at Wageningen University. Plastic was seen as a less sustainable material than the other packaging materials. Hence, consumers' perception of the use of leaves is positive and on the increase because of the numerous benefits and advantages. Most consumers have a negative perception of the use of plastics to packaging food because of its harmful consequences. A positive perception regarding the use of leaves as food packaging material is on the increase, however, it has become very hard to come across such foods. As food is sold in leaves, the idea of selling food has gone extinct with the remnant food samples missing in the system.

Mensah etal (2012), in the article "Perceptions of the use of indigenous leaves as packaging materials in the ready-to-eat corn meals," provides deeper insight into the use of indigenous leaves used as packaging material. Perceptions of consumers and producers about indigenous leaves such as dried plantain leaves (*Musa paradisiaca* and dried corn husk Zea mays) were examined. The major reason relating to the perpetual usage of leaves as a packaging material given by producers was medicinal, which is, the infusion of valuable phytonutrients into the meal, and this, in turn, provides a unique aroma and taste for the meal - 61%. Other reasons include biodegradability - 14%, availability 4% at relative low cost - 4%. This subjective evidence of the leaves being medicinal was factually demonstrated medicinal because of the infusion of valuable phytonutrients into meals and the unique aroma and taste for the meal. Other reasons included biodegradability (14%), availability (4%) at a relative low cost (4%).

Preference of Leaves as Packaging Material

This subjective evidence of the leaves being medicinal was factually demonstrated as Mensah etal (2012) added the leaves of *Musa paradisiaca* comprise a broad class of polyphenolic phytochemicals release chemo preventive anticancer properties in humans. Another concern raised in their research was that consumers (69%) via experience accurately deduced that fante kenkey has a shelf life of 6-10 days while a greater number (81%)

indicated that the shelf life of Ga Kenkey was 2-5 days. This perception is highly attributed to the fact that dried *Musa paradisiaca* leaves of fante kenkey help maintain the moisture content of the meal, preventing spoilage of food and longer shelf life of fante kenkey**.** The value of Ga kenkey was attributed to the physical separation between adjacent *Zea mays* sheaths wrapping. This literature did not indicate whether the consumers are aware of nutrients and phytochemicals in the leaves can migrate in food when used as a packaging material, which can affect consumer perception and preference toward food.

Moreover, many people now prefer biodegradable materials for food packaging than plastics (Barnes, Chan-Halbrendt, Zhang, & Abejon, 2011). *Musa paradisiaca and Musa Sapientum* leaves are 100% biodegradable. The demand for *Musa Sapientum* and *Musa Paradisiaca* leaves for packaging food have increased due to these reasons. They are cheap because the leaves are very common (Jeenusha & Amritkumar, 2020; Mohapatra, Mishra, & Sutar, 2010) especially, in tropical areas. The cultivation of the *Musa paradisiaca and Musa Sapientum* they cost-effective. The leaves are as large in the surface area hence can be used to serve vessels (Dosumu & Akinnuoye, 2014). They are clean due to the slick nature of the leaves. They are easy to clean off which other leaves do not have such qualities. The leaves are attractive in that they have bright color and can retain the color, which makes them fresh all the time. They are naturally do not need additional treatments to remain fresh-looking or water-resistant. Consequently, they are perfect for those who are interested in natural foods. However, the challenges for the use of these leaves for packaging are yet to be discovered.

Microbial effect of Packaging

Food in *Musa Sapientum* and *Musa Paradisiaca* leaves Nathalia, Sebastián, Javier, Andrés, and Carolina (2017), research by packaging lulo in *Musa sapientum* leaves at a varied storage temperature. The study was based on a central composite rotational experimental design (CCRD) with two independent factors (or variables): temperature (between 7 and 20°C) and a number of impacts suffered (NI) (between 5 and 25). The study revealed that packaging besides protecting the fruit, also reduces the amount of oxygen available for the lulo, and this consequently brings in the delay to manifest the characteristic yellow-orange hue of a mature lulo. The outcome, therefore, suggests that packaging food (lulo) with *Musa Sapientum* leaves has a positive impact on the food; however, the study considered only used fruit to the neglect of other foods, which could possibly highlight certain important characteristics that could affect the information to both producers and consumers on what food to serve and eat in *Musa Sapientum* leaves.

Zakariah, Malaka, Laga and Ako (2019) also conducted research in Indonesia concerning the effect of *Musa sapientum* and plastic material packaging on microbial contamination of dangke fresh white cheese. The explorative descriptive was the methodology used to analyze the microbial contamination of dangke. Conclusion on this research was that, dangke packaged by material *Musa Sapientum* leaf potentially reduced the microbial contamination than plastic material on the dangke product. This study unveiled how best *Musa sapientum* leaves can protect food as compared to plastics in relation to food packaging. It therefore suggests that packaging some food in *Musa sapientum* leaves gives a positive effect as it reduces the level of contamination.

Antibacterial properties of *Musa sapientum* and *Musa paradisiaca*

Packaged foods sometimes grow fungi, changes taste, and changes colour due to the various reaction of the packaged materials on the food Yancheva, Stoyanova, Velcheva, & Georgieva, (2016). Egbuonu, Ogele, and Amaraihu, (2016) conducted a study on antibacterial properties of *Musa Paradisiaca* leaves. The conclusion from the study was *Musa paradisiaca* leaves exhibited antibacterial properties. The ethanol extracts of *Musa paradisiaca* showed a broad spectrum of antibacterial activity on the tested microorganisms with high inhibitory potency against

Escherichia coli. The extract of *Musa Paradisiaca* leaves showed good antimicrobial activity and whether these antibacterial that can migrate in the food when packaged in with *Musa sapietum* and *Musa paradisiaca* are yet to be discovered.

Antioxidant and phytochemical

Antioxidance are radical scavengers which protect the human body against free radicals that may cause pathogenical conditions such as anemia, inflammation aging process and others. It can also reduce inflammation and uneasiness during fever and boost the immune system. Phytochemicals on the other hand are biologically, active, natural occurring chemical compound found in plant, which provide health benefit for human's further than those attribute to macro and micro nutrient (Naeem, Maimoona. Jabeen, Khan and Igbal 2020). They protect plants from diseases damage and contribute to the plant colour, aroma, and flavor (Do, Yang, Lopez, Mason, Margolin &

Dunton, 2020). It has been clearly established that the roles in the protection of human health, when their dietary intake is significant (Liu, Wang, Wu, Ding, Yao, Zhang, & Chen, 2020). Dietary phytochemical are found in fruits, legumes, vegetable, seeds nuts fungi herbs spices and garlic (Mathai 2000) of which garlic, grapes, tomatoes are of common source.

However, phytochemical accumulate in different part of plant, root, stem, fruits, leaves (Costa, Zia, Davin & Lewis, 1999) of which Musa *sapientum* and *Musa paradisiaca* leaves may not be exception. These phyto constituent works hand in hand with fibres and nutrients to fight against diseases. Basically, phytochemicals are divided into primary and secondary constituents; according to the way they function in plant metabolism. Common sugars, amino acid, and chlorophyll form the primary group while alkaloids, terpenoid, steroids and flavonoids etc. forms and secondary group (Thilagavathi, Arvindganth, Vidhya & Dhivya, 2015).

Among the phenolic the largest group of naturally occurring phenolic compounds which occur as glycosides is flavonoid (Ijaiya, Arzika, & Abdulkadir, 2014). Flavonoids are a good source of antioxidants that protect the human body against diseases such as heart diseases and certain types of cancer. Their polyphenolic nature act as free radicals such as superoxide and hydroxyl radicals (Dewick, 2001). Bisht, Pavan and Sheetal (2016) researched into a phytochemical analysis of leaf extract of medicinal fruit plants in India. The study concludes that fruit leaves are potential source for bioactive metabolites and may be used in the pharmaceutical industry.

Literature Gap

The reviewed studies have contributed to literature on this immerging area of study. In addition, these studies emphasized on the various health benefits derived from the consumption of *Musa sapientum*. However, the various reviewed work overlooked the effects of *Musa sapientum* and *Musa Paradisiaca* leaves used as food packages on food quality. This literature failed to talk about the specific nutrients, microbial and antioxidant properties that can migrate in food when use in packaging which may affect the consumer's perception and preference in terms of using *Musa Sapientum* and *Musa Paradisiaca* leaves as food packaging material. The above recommendations in the reviewed works are in line with the purpose of this study and could serve as guidelines to achieve the aim of this study.

This study envisages that substituting leaves as packaging materials for food prepared in Ghana could go a long way to support both food service operators and consumers to enhance participation in foodservice operations in the country. The study embarked on a primary data collection exercise in line with its methodology outlined in this viewpoint.

CHAPTER THREE

RESEARCH METHODS

This chapter explains the methods and materials employed in carrying out the research to develop validated findings. It deals with the research design, target population, sample and sampling procedure, research instruments, and method of data analysis.

Research Design

A descriptive survey was chosen to assess the types of foodservice operators who packaged food in *Musa sapientum* and *Musa paradisiaca* leaves and the perception and preference of food packaged in *Musa sapentium* and *Musa paradisiaca* leaves to consumers. With this design, the researcher analyzed the sample from a subjective point without interfering with the studied phenomenon**.**

Also, an experimental research design was employed to carry out laboratory work on nutritional, antioxidant and microbial analysis of steamed plantain pudding (oblongo) made from the different variations using dry and fresh leaves of *M. sapientum* fresh dry leaves *Musa paradisiaca* and the steamed pudding packaged in the Cellophane. According to Amedehe (2002), this experimental research design allows the researcher to manipulate at least one independent variable while controls other sets of variables and observes what will happen to the subjects of an experiment.

Study Area

Sekondi-Takoradi is the most popular metropolitan area in the Western region. It is situated in South-Eastern. The Metropolis is bordered by the Shama District (east), Ahanta West District (west), Wassa East District (north) and to the South. Atlantic is located at the Southern part of the Metropolis and at the ern part is which covers a land size of 191.7 km2. The Metropolis is of a varied landscape; the coastline has capes and bays and the central portion of the Metropolis is undulating with ridges and hills.

According to the 2010 population and housing census (PHC, 2010), the population of Sekondi-Takoradi Metropolis is 559,548 representing 23. 5% of the region's total population. 48.9 % is made up of males and the rest are females (Gyedu, Nakua, Otupiri, Mock, Donkor, & Ebel, 2015). There are 3 paramount areas namely Sekondi, Essikadu-Kojokrom and Takoradi which major markets are located. The 75 % makes up the employed population and they are mainly engaged in fishing, forestry and agricultural whereas 8 % are into sales and service. 5 % are engaged as professionals, technicians and managers.

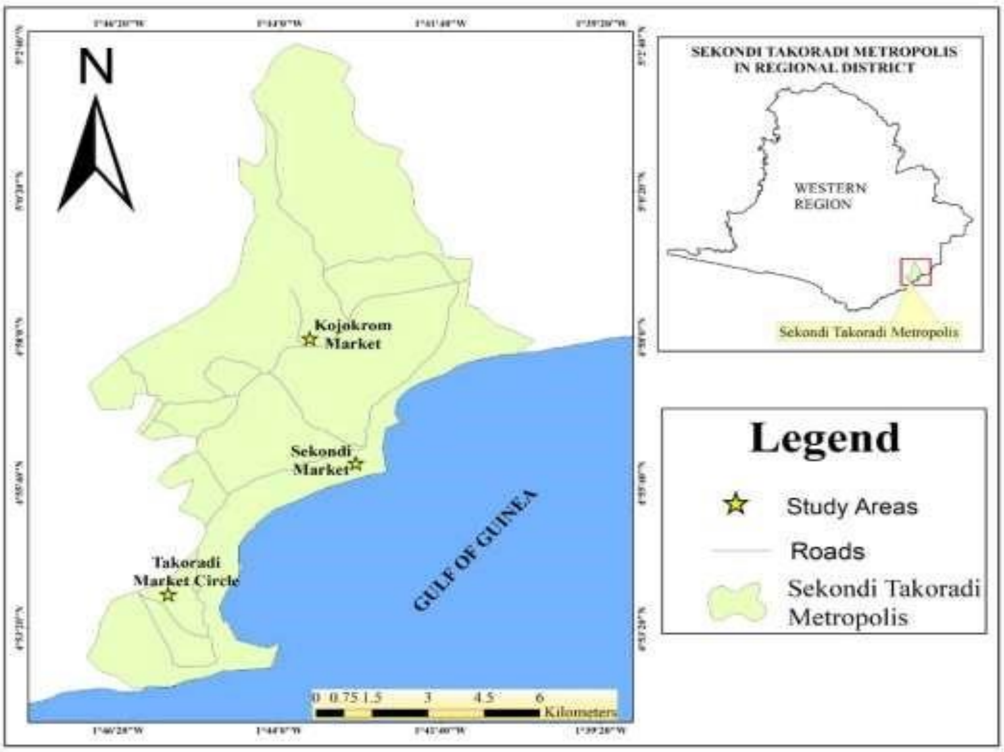


Figure 2: Geographic diagram of study area (Sekondi-Takoradi Metropolis)

Population

The study population was comprised of all foodservice operators and consumers in three major markets: Sekondi Market, Takoradi Market Circle and Kojokrom Market in the Sekondi–Takoradi Metropolis. They involved different kinds of food service operators and consumers with varied status in the Metropolis. An estimated 5183 food service operators in the Sekondi-Takoradi Metropolis (2150) food venders in Takoradi, (1,002) food vendors in Sekondi and 2031 food vendors in (Essikado-Ketan).

Pre-testing

The need for appropriate instrumentation and adequate knowledge about the target population for the study promoted a comprehensive pre-testing conducted (Rademakers, Waverijn, Rijken, Osborne & Heijmans. 2020). The questionnaire was pretested to ascertain the feasibility in line with consumers' and food service operators' expectations, responses, outcomes, and understanding levels. Consumers and food operators from the nearby minimarket at Ketan in Takoradi metropolis were used from 8th December to14th December 2020 to pre-test the instruments. The sample size for the pre-testing was 20, comprising 15 consumers and five food operators. The consumers and food service operators were used because the researcher considered them as having similar characteristics with consumers and food service operators in Sekondi Takoradi metropolis. The present result was incorporated in revising the questionnaires in line with consumers and food service operators.

Sampling Procedures

According to Torrado, Carreras, Raventos, Macpherson, & Pascual (2020) a sample is a group chosen from a population to yield information about the whole population. Data accessed at the Environmental Health Department of the Secondi-Takoradi Metropolis (2020), revealed the number of food service operators as; 2150 - Takoradi, 1,002 - Sekondi and 2031 - Essikado-Ketan. Based on the estimated 5183 food service operators population, a sample of hundred (100) were selected to represent the study population. The sample for this study was selected from the population, using an adopted sample calculator suggested by (Thiry & Laursen, 2011).

The respondents were selected through a proportional stratified sampling technique from their respective markets in the Sekondi Takoradi Metropolis, as highlighted in Table 1.

Table 1: Sample distribution of the study

Market	Population	Proportion (%)	Sample
Takoradi Market Circle	2150	41.5	42
Takoradi Sekondi Market	1002	19.3	19
Kojokrom Market	2031	39.2	39
Total	5183	100	100

$$n = \frac{N}{1 + N\,(e)2}$$

$$n = \frac{5183}{1+5183(0.10)2} = 100$$

Where:

n= sample size

N = Population size e= error of margin

This technique was used in this research to statistically measure subsets on individuals selected from the population to approximate a response from the entire group. The stratified sampling ensured a fair representation since their respective food vendors represented each stratum (market).

On the other hand, with the Okain (2020) formula, 246 consumers were selected because there were over 10,000 potential consumers in the district at the various market centres. Convenient sampling was also employed to allow 246 consumers based on their acceptability and availability for this study (Seeger, 2020), which allowed a group of people to be chosen.

Data Collection Instrument

Questionnaires was used for data collection for this study. This was because it is known to be appropriate to give adequate time for respondents to give thoughtful answers for the survey work as used by Ranjan, (2021). Additionally, Breit, Brunner & Preckel (2020). Kothari (2004) argues on using large samples as a means of enhancing the reliability and dependent rate of results. Moreover, the use of questionnaires provides a relatively cheap, quick and efficient way of obtaining large amounts of information from a large sample of people. Again, it is an effective means of measuring the behaviour, attitudes, preferences, opinions, and intentions of respondents (ElHaffar, Durif, & Dubé, 2020).

Ethical Consideration

The study was approved by the University of Cape Coast, Institutional Review Board (UCC-IRB/CES/2020/62). All respondents were provided with written informed consent before entering the study. The researcher assisted participants who could not communicate in a written form, to answer the questions. It is noteworthy that items demanding personal identity of respondents such as names and contacts were not included and they were not coerced to be part of the study. Anonymity and confidentiality of the respondents were highly paramount in the instrument to protect the respondents.

Recruitment of Field Assistants

Five trained research assistants who were colleague teachers from the Home Economics department at the Ahantaman Girls' Senior High School were used to collect data. Before administering the questionnaires, the assistants were trained to understand the questionnaire, focusing on the purpose of the study. They were allowed to administer the questionnaires among themselves to test their understanding of the questions. They were then sent out to do a pilot study and, after that assisted in administering and collecting of the questionnaire.

Data Collection Procedure

In the data collection process, the respondents were given explanation the aim of the study prior to administering the questionnaires (Alam, 2020). The respondents were given up to 15 minutes to complete the questionnaires. The researcher and the assistants made themselves available to answer questions posed by respondents. An extra five minutes were given to respondents who could not complete the questionnaires within the stipulated time. Respondents were informed that they should not write their names on the questionnaires. All COVID 19 protocols were observed during data collection.

Laboratory Analysis

Nutrient Concentration Determination

The experiment was conducted at the School of Agriculture Research at the Technology Village, University of Cape Coast between December 2020 and January, 2021.

Material Preparation

Fresh and dry leaves of *Musa paradisiaca* (variety *'Apem'*) and *Musa sapientum* (variety *'Kwadu Obolo'*) leaves were bought from Kojokrom market in Sekondi Takoradi municipality in the Western region. The *Musa paradisiaca* and *Musa sapientum* leaves were authenticated at the Department of Crop Science Laboratory, University of Cape Coast. The Cellophane, the riped *Musa paradisiaca* and the *Musa paradisiaca* flour were all obtained from the Sekondi market in the Western Region. The chemicals for microbial, antioxidant, and food analysis were obtained from the chemistry laboratory at the University of Cape Coast (UCC). The equipment and machines for the experimentation were available at the chemistry laboratory and the food laboratory at the Vocational and Technical Education (VOTEC) department-UCC.

Preparation of oblongo for nutritional analysis

The researcher prepared the oblongo at the Vocational and Technical Education Foods lab in the Univerisity of Cape Coast. Four (4) riped *Musa paradisiaca* weighing 400g were washed and peeled. The bulk of *Musa paradisiaca* was pounded in a palm fruit mortar with a pestle to obtain puree as describe in Adi, Oduro, Tortoe, Kwofie &Simpson (2018). The mixture was mixed with 100g of plantain flour for firmness, 20ml of palm oil to improve colour and seasoned with ginger and garlic for flavour. The mixture was divided into five (5) equal portions to make 5 samples. Each portion was packaged in dried leaf of *Musa sapientum,* fresh leaves of *Musa sapientum,* dried leaf of *Musa paradisiaca,* fresh leaf of *Musa paradisiaca* that were thoroughly washed with distilled water to clean all the dirt and a cellophane. The food were steamed separately for 15 minutes each. Below are the samples of oblongo:

Figure 3: Oblongo packaged in fresh leaves of Musa sapientum (OPSFL) - Sample 1

Figure 4: Oblongo packaged in dried leaves of Musa sapientum (OPSDL)- Sample 2

Figure 5: Oblongo packaged in fresh leaves of Musa paradisiaca (OPPDL)-Sample 3

Figure 6: Oblongo packaged in dried leaves of Musa paradisiaca (OPPDL)-Sample 4

Figure 7: Oblongo packaged in Cellophane ((OPC)-Sample 5) – Sample 5

The samples packaged in the Cellophane were used as the control. The five prepared food samples were stored in a vacuum food flask and transported to the Chemistry laboratory at the University of Cape Coast, where the approximate and mineral concentration was determined.

Proximate Composition

Food samples were assessed and composition of the good were determined. Ash, moisture, fat, crude fibre, crude protein and crude carbohydrate were the measured parameters express in percentages.

Moisture content Determination (AOAC, 2005)

Porcelain crucibles were washed and dried. The weight of the empty crucible was determined. The clean oven dried crucibles were filled with fresh sample of about 10-12g. A thermostat-controlled oven at a temperature of 105°c was used to dried the samples in the crucible for two days (Jain, Yadav, Bisht, Kodavaty, & Yatirajula, 2021). Samples in the crucible were evenly distributed at the bottom of the oven. Samples were reweighed after it was removed and cooled in a desiccator. Each sample was triplicated. The moisture content was then calculated and expressed as percentage of water loss by the sample.

$$\% \text{ Moisture} = \frac{\text{Weight of Moisture (WM)}}{\textit{Weight} \text{ of sample (WS)}}$$

WM =WS – (DC – EC)

Where:

WS = Weight of sample

DC = Weight of dried sample crucible

EC = Weight of empty crucible

Ash Determination

Application of heat in a furnace was used to further dried samples at 550°c for two days. All the carbons in the sample were burnt away due to the persistent heating. The ash left in the dish was weighed after it was removed, cooled in a desiccator.

The ash content was then calculated as a percentage of the original sample.

(Ajayi, 2020)

$$\% \text{ Ash} = \frac{\text{Weight of Ash} \times 100}{\text{Weight of Sample}}$$

WA = WAC – WEC

Where:

WA = Weight of Ash

WAC = Weight of Ash and Crucible

WEC = Weight of Empty Crucible

Oil/ Fat Determination

About 10- 12g of the milled samples were weighed into a 50 ×10mm soxhlet extraction thimble. It was then transferred to a 50ml capacity soxhlet extractor. A clean dry 250ml round bottom flask was weighed. About 150ml Petroleum spirit was added and connected to the soxhlet extractor. The extraction was done for 6 hours using a heating mantle as a heating source. After 6 hours, the flask was removed and placed in an oven at 60oC for 2 hours. The flask and its content were removed and cooled to room temperature and kept in a desiccator which was weighed (Razack, Suresh, Sriram Ramakrishnan, Sadanandham, Veerasamy & Sahadevan, 2020). The weight of the flask and content was determined and differences the weight was recorded as crude fat from which the percentage fat/oil was calculated as followed.

Calculation

$$\text{Crude Fat (\%)} = \frac{W\ (g) \times 100}{\text{Sample (g)}},$$

Where: W is Weight of Oil

Carbohydrate Determination

Reagent

*1: **Glucose Solution***

250g D-glucose was dissolved in water and diluted to 1liter and used as the stock solution. A range of the working standard was from 0-0.20mg glucose which was diluted to a volume. It was determined from stock solution pipetted into 50ml flasks. 2ml of each standard gives the range.

*2: **Anthrone Reagent***

An addition of 760ml conc H_2SO_4 to 330ml water was kept cool while stirring in a boiling flask with care. Magnetic stirrer was used to dissolved 1g anthrone, 1g of thiourea when added to the mixture. It was conveyed to a dark bottle for 2 hours at a storage point of + 1˚C before its use.

Procedure Extraction

30ml distilled water was added to 50mg of the milled sample in a 50ml conical flask. Mixture was allowed to simmer gently on a hot plate for 2 hours with a bubble placed on the neck of the conical flask. Systematically it was topped up to 30ml and allowed to cool slightly. No.44 Whatman paper was used to filtered into a 50ml volumetric flask and diluted to volume when cool. The same steps were used in preparation of a blank (Mikheev, Pirogova, Usoltseva, Uzhel, Bolotnik, Kareev& Proskurnin, 2021).

Colour Development

Two milliliters (2ml) of each standard were pipette into a set of boiling tubes, and 2ml of the extract and water blank was pipetted into a boiling tube. Standards and samples were treated the same way.10ml of anthrone solution was added rapidly to mix and the tubes were immersed in running tap water or ice bath. The tubes were placed in a beaker of boiling water in a dark fume cupboard and boil for 10minutes.

The tubes were then placed in the dark in cold water and allowed to cool. Water was used as reference to determine the optical density with a red filter (Lee, Rizzo, Surman & Zenobi-Wong, 2020). A calibration graph was prepared from the standards and used to obtain mg glucose in the sample aliquot. The blank determination was treated same way and subtraction done where necessary.

$$\text{Soluble carbohydrates (\%)} = \frac{\text{C (mg)} \times \text{extract volume (ml)}}{10 \times \text{aliquot (ml)} \times \text{sample wt (g)}}$$

Where C = carbohydrate concentration from the calibration graph

Protein Determination

Protein present in food was calculated from nitrogen concentration of the food. The kjeldahl was used in the determination of protein. The method was divided into three steps: digestion, neutralization or distillation and titration.

Digestion

About 0.2g of the sample was weighed into a 100 ml numbered Kjeldahl flask. Follow this 4.4ml of the digestion mixture (mixture of Hydrogen per oxide, Selenium, powder of lithium and Sulpheric acid) was added and the samples digested for two hours at 360oC. A blank was prepared. (Digestion of the digestion mixture without sample) were carried out in the same way Valenti, PortoSelvaggi & Pecorino, (2020). The mixtures were then transferred into 50ml volumetric flasks which was diluted make up to the volume.

Distillation

A steam distillation apparatus was set up. The steam was then pass through the digest for about twenty (20) minutes. 5 milliliters of boric acid indicator solution were poured into a 100 ml conical flask placed under the condenser of the distillation apparatus with the tip of the condenser condenser completely immersed in the boric acid solution. Trap funnel was then used to transfer an aliquot of the sample digest was transferred to the reaction chamber. After which 10ml of alkali mixture was added immediately and about 50ml of the distillate was collected.

Titration

The distillate was titrated with 0.1N HCl solution until the mid-end point (from green to the initial wine red). Digestion blanks were treated the same way and subtracted from the sample titre value (Okon, 2020). The titre values obtained were used to calculate the nitrogen and hence the protein content. The conversion factor used was 6.25.

%Total Nitrogen (%N) =

$$\frac{(\text{Sample titre value} - \text{Blank titre value}) \text{ X } 0.1 \text{ x} 0.01401 \text{ x } 100}{\textit{sample weight X } 10}$$

% Protein = %N x 6.25

Crude Fibre Determination

Procedure

About 1g of sample was weighed and placed in a boiling flask. 100ml of the 1.25% sulphuric acid solution was added and boiled for 30mins. After the boiling, filtration was done in a numbered sintered glass crucible. The residue was transferred back into the boiling flask and 100ml of the 1.25% NaoH solution was added and boiled for 30mins. Filtration continued after the boiling and the residue washed with boiling water and methanol. The crucible was dried in an oven at 105 degrees overnight and weighed (Chinenye, Chidiebere, & Nnenna , 2020). . The crucible was placed in a furnace at 500 degrees for about 4 hours. The crucible was slowly cooled to room temp in a desiccator and weighed.

Calculation

$$\% \text{ Crude fibre} = \frac{\text{weight loss thro ashing}}{\text{Sample weight}} \times 100$$

AOAC (2005)

Preparation of Sample Solution for the Determination of N, K, Na, Ca, Mg, P, Zn, Cu & Fe

Acid oxidation process was used for the destruction of the organic matter before a complete experimental analysis was carried out.

Sulphuric Acid-Hydrogen Peroxide Digestion

The digestion mixture comprised of 350mL of hydrogen peroxide, 0.42g of selenium powder, 14g Lithium Sulphate and 420mL sulphuric acid. As outlined in Stewarte et al (1974), the digestion procedure states that between 0.1000g to 0.2000g of the oven-dried ground sample was weighed into a 100mL Kjeldahl flask and 4.4mL of the mixed digestion reagent was added and the samples digested at 360°C for two hours. Blank digestions were carried out in the same way. After the digestion, the digests were transferred quantitatively into 100mL volumetric flasks and made up to volume.

Colorimetric Determination of Phosphorus using the Ascorbic Acid Method

Colour forming reagent and P standard solutions was pepared as a pre requisit.The reagent's color forming was made up of A and B. Reagent A was made up of 12g ammonium molybdate in 20ml distilled water 0.2908g of potassium antimony tartarate in 100mL distilled water and 1L of 2.5M H_2SO_4. The three solutions were mixed together in a 2L volumetric flask and made up to volume with distilled water.

Reagent B was prepared by dissolving 1.56g of ascorbic acid to every 200mL of reagent A. Additionally, a stock solution of 100μgP/mL solution was prepared from which 5μgP/mL solution a set of working standards of P with concentrations 0, 0.1, 0.2, 0.4, 0.6, 0.8 and 1.0μgP/mL in 25mL volumetric flasks. 2mL aliquot of the digested samples were pipetted into 25mL volumetric flasks. 2mL aliquot of the blank digest was pipetted into each working standard to give the samples and the standards the same background solution. Ten milliliters (10ml) of distilled water was added to the standards and the samples after which 4 mL of reagent B was added and their volumes made up to 25mL with distilled water and mixed thoroughly. The flasks were allowed to stand for 15minutes for colour development. Which after the absorbances of the standards and samples were determined using a

Calculation

If C = μgP/mL obtained from the graph, then μgP/g (sample) = $\frac{\text{C x Dilution Factor}}{\text{weight of sample}}$

(Ng, & Hahn, 1985)

Determination of Potassium and Sodium

A flame photometer (Tejavathi, Sujatha, & Karigar, 2020) was used to determine the presence of potassium and Sodium in the digest srample. Working standards solutions of: 0, 2,4,6,8 and 10 μg/mL were prepared to determine both K and Na. Recorded the various emissions when each of the operational standards and the sample solutions, were aspirated into the phlame photometer. A with the use of concentrations and emmissions of the working standard a calibration curve was plotted. Their emmission were determined from the concentration of the solution that were derived from the standard curve. using the

Calculation

$$\mu gK/g = \frac{\text{C x solution volume}}{\text{Sample weight}}$$

(Stewart, & Lee,1974)

Determination of Calcium and Magnesium by EDTA Titration

Calcium and magnesium were determined with ethylene diaminetetra-acetic acid (EDTA) by chelation of cation. Calcium and magnesium were determined together. The difference was found in assessment of calcium alone and magnesium.

10mL of an aliquote sample solution was placed into a 250mL conical flask to assessed the presence of calcium and magnesium together. 15mL of buffer solution was used to dilute 150mL with distilled water. 1 mL each of potassium cyhydroxylamineanide, hydrochloride, potassium ferro-cyanide and triethanolamine (TEA). The was tiittrated against 0.05M after five drops of ferrichrome Black T (EBT) were added.

10mL of the sample was pipetted into a 250conical flask in the determination of calcium. The solution was diluted with distilled water to 150mL. The solution was then titratec with 0.005M EDTA after five drops of calcium indicator was added to 1mL each of potassium cyanide, hydroxyl-amine-hydrochloride potassium ferrocyanide.

ulations

$$\% \text{ Ca} = \frac{0.005 \times 40.08 \times T}{\text{Sample wt}}$$

$$\% \text{ Mg} = \frac{0.005 \times 24.31 \times T}{\text{Sample wt}}$$

Where T = titre value

Barrows & Simpson, (1962).

Determination of Iron, Copper and Zinc using atomic Absorption

Spectrophotometer

The presence of Iron, Copper and Zinc were assessed when the standard solutions were aspirated into the atomic absorption spectrophotometer (AAS). The aspirited sttandard were prepared from solutions of 1, 2 and 5 μg/mL.The respective calibration curves were plotted on the AAS. As the sample solutions were aspirated, their respective concentrations were provided.

Calculations

$$\text{Fe } (\mu g/g) = \frac{\text{C x solution volume}}{\text{Sample weight}}$$

$$\text{Cu } (\mu g/g) = \frac{\text{C x solution volume}}{\text{Sample weight}} \; /g) \quad = \frac{\text{C x solution volume}}{\text{Sample weight}}$$

Antunes, et al., (2017)

Procedure for ß-Carotene Determination

About (0.1 to 0.3g) of the dried and milled sample. was weighed in a glass beaker and hydrate for 10 minutes with still water (1:5; sample: water). The hydrated sample was placed in a mortar containing a small amount of Hyflosupercel, add 30ml of cold acetone and mix with the help of pestle and filter with suction through a sintered glass funnel, receiving the extract in a protected suction flask. After which mortar, pestle and residue with a small amount of acetone were washed. The extraction was repeated 3 to 4 times until the residue was devoid of colour.

20ml of Petroleum ether was put in a separatory funnel and small portion of the acetone extract was added after which distilled water was added slowly, letting it flow along the walls of the funnel. This petitioned the solution to petroleum ether. Formation of an emulsion was avoided by not allowing it to shake. Two phases were allowed to separate and the lower aqueous-acetone phase discarded. Another portion of the acetone extract was added and repeated until all of the extract was transferred to petroleum ether, then washed 4 to 5 times with water to remove residual acetone were removed. Petroleum ether phase was poured in a 25ml volumetric flask passed through a glass funnel containing an anhydrous sodium Sulfate. The Spectrophotometric analysis of total carotenoid was determined by reading the carotenoid ethereal extract at 450nm and calculated the total carotenoid concentration used the coefficient of absorption for ßcarotene (2592).

Total carotenoid determination

The carotenoid ethereal extract a 450 nm was read and calculated the total the total carotenoid content Meregalli, Puton, Camera, Amaral, Zeni, Cansia & Backes, (2020), with the following formula:

$$X\ (\mu g) = \frac{AxY(ml)x10^6}{A_{1cm}^{1\%} \times 100}$$

$$X\ (9\ \frac{\mu g}{g}) = \frac{X(\mu g)}{weight\ of\ sample\ (g)}$$

Where;

X - weight Concentration carotenoid

Y - volume of solution gives an absorbance (A) at 450 nm $A_{1cm}^{1\%}$ was the absorption coefficient of ß-carotene in petroleum ether

Statistical Analysis

Each determination of proximate and all mineral analyses were carried out and the figures averaged. Data was analysed using One-way Analysis of Variance in GenStat Discovery and Microsoft Excel was used to plot the graph.

The significant difference was determined at ($P < 0.05$)

Microbial analysis

Sample preparation for microbial analysis

The oblongo was prepared by Esther Lomo-Mensah (researcher) a Mphil student of the University of Cape Coast at the VOTEC foods laboratory in UCC. Four (4) ripe plantains (*Musa paradisiaca)* weighing 400g were washed and peeled. The plantain was pounded in a palm fruit mortar with a pestle to obtain puree (Adi, Oduro, Tortoe, Kwofie &Simpson, (2018). The mixture was mixed with 100g of plantain flour for firmness. The mixture was divided into five (5) equal portions. Each portion of the food samples was packaged in a prewashed and disinfected with 70% alcohol base sanitizer of dried and fresh leaves of *Musa sapientusm* and *Musa paradisiaca*, purchased from the three major markets (Kojokrom, Sekondi and Takoradi) in Sekondi Takoradi metropolis and the cellophane. Immediately after preparation of steamed oblongo, they were stored for four days in an open cupboard at room temperature. The microbial load was determined as follows:

1. Untreated dried and fresh leaves of *Musa sapientum* and *Musa paradisiaca* from the three major markets.

   i. Fresh leaf *Musa sapientum* (SFL)
   ii. Dry leaf of *Musa sapientum* (SDL)
   iii. Fresh leaf of *Musa paradisiaca* (PFL)
   iv. Dry leaf of *Musa paradisiaca* (PDL)

2. The four (4) steamed oblongo packaged in dry and fresh leaves of *Musa sapientum* and *Musa paradisiaca*

   i. Oblongo steamed in fresh leaf *Musa sapientum (*OPSFL-P)
   ii. Oblongo steamed in dry leaf of *Musa sapientum* (OPSDL-P)
   iii. Oblongo steamed in fresh leaf of *Musa paradisiaca* (OPPFL-P)
   iv. Oblongo steamed in dry leaf of *Musa paradisiaca* (OPPDL-P)

3. The stock from the steamed oblongo of the dry and fresh leaves of *Musa sapientum* and *Musa paradisiaca*

   i. stock of steam oblongo in fresh leaf *Musa sapientum*(OPSFL-S)
   ii. Stock of steamed oblongo in dry leaf of *Musa sapientum* (OPSDL-S)
   iii. Stock of steamed oblongo packaged in a fresh leaf of *Musa paradisiaca* (OPPFL-S)

iv. Stock of steamed oblongo packaged in dry leaf of *Musa paradisiaca* (OPPDL-S)

4. The steamed oblongo wrapped in cellophane (OPC-P)

5. The stock from the steamed oblongo wrapped in cellophane (OPC-P).

6. Cellophane only

The oblongo wrapped in the cellophane, stock from the steamed oblongo in cellophane and the cellophane only were used as the control. In all SIxteen (16) samples labeled differently were analysed for microbial assessment. The microbial analysis was carried out in triplicates for three (3) consecutive weeks to ascertain the reliability and validity of the outcome.

Determination of Microbial load

Aerobic Plate Count, Total Coliforms, Yeast and Molds were determined using the Standard plate count method (Chouhan, 2015). By ISO standards (ISO-4833-2, 2013) {E}), the samples was analyzed for Aerobic Plate Count, Total coliforms, and *E. coli*, Culture media consisting of Plate Count agar (Oxoid, Hampshire, England), Peptone Water (Oxoid) and Eosin Methylene Blue agar (Oxoid), and Potato Dextrose agar (Oxoid) was prepared according to the manufacturer’s instructions.

Using Peptone Water (Oxoid) as recovery diluent, 180ml of the peptone water was prepared in triplicate and sterilized using autoclaving along with all prepared media and petri dishes at a temperature of 121°C, the pressure of 15psi for 15 minutes Yeast and Molds all in colony-forming units (CFU) per ml using the pour plate method.

The sample was adequately homogenized. 20mls of the test sample was weighed aseptically into Peptone water (recovery diluent) and incubated in a water bath at 37°C for 30minutes. The test sample was serially diluted to 10^{-3} in a sterile peptone water.

Triplicate dilutions of 0.1 ml and 1 ml of 10^{-2} dilution of the sample was plated on plate count agar and incubated at 37°C for 48 hours. All colonies will be counted and an average of duplicate samples was recorded as aerobic plate counts (CFU/ml) for the sample.

Likewise, Triplicate dilutions of 0.1 ml and 1 ml of 10^{-1} each sample was plated on Eosin Methylene Blue agar. Each of the duplicate dilutions was incubated at 37°C for 48 hours to observe Total Coliform counts (CFU/ml) for the sample.

Triplicate dilutions of 0.1 ml and 1 ml of 10^{-1} each sample was plated on Mannitol Salt agar. Each of the duplicate dilutions will be incubated at 37°C for 48 hours to observe *staphylococci* counts (CFU/ml) for the sample.

For Yeast and Molds, triplicate dilutions of 0.1 ml and 1 ml of 10^{-1} each sample was plated on Potato Dextrose agar supplemented with ampicillin. Each triplicate dilutions were incubated at room temperature for 7 days to observe for yeast and mold counts (CFU/ml) for the sample.

For *Escherichia coli* presumptive test, isolated colonies of about 2-3mm diameter exhibiting a greenish metallic sheen by reflected light and dark purple centers were identified as possible colonies of *Escherichia coli* (Oxoid.com, 2011)

Isolated colonies were inoculated into Oxoid SIM (Sulfite Indole Motility) medium stabbing the needle approximately two-thirds of the way into the deep. It was incubated at 37°C for 24 hours or until growth is evident. To test for indole presence, five drops of Kovác's reagent were added to the top of the deep. A positive indole test was indicated by forming red color in the reagent layer on top of the agar deep within seconds of adding the reagent (Jones, 2020)

Determination of antioxidant

Preparation of extract for phytochemical screening

The fresh plant samples (*Musa sapientum* and *Musa paradisiaca* fresh and dry leaves) were collected and washed under the running tap water to remove dust particles. The leaves were air-dried under laboratory condition at room temperature for 15days. The dried leaves samples were ground well into a fine powder with the help of mixer grinder. A 10g of air dry plant was soaked into 50ml organic solvents, separately for 24hours in ana orbital shaker at normal temperature. The extract was filtered through the Whitman No. 1 filter paper and lowered to dry using rotary evaporator. The condensed extracts were stored airtight container at 40˚C till further investigation.

Phytochemical screening

The experiment was conducted at the Biomedical and Forensic Science Laboratory, University of Cape_Coast, between January and March 2021

Chemical/ Reagents

Fehling solution A and B, gelatin, $FeCl_3$, $AlCl_3$, Wagner solution, Dregendor and glacial acetic acid and conc. H_2SO_4

Test for Tannins and Polyphenols

To 2ml of each extract, five drops of 10% gelatin solution were added. The appearance of Buff precipitation indicates the presence of tannins. To 2ml of each extract, five drops of $FeCl_3$ solution the appearance of Bluishgreen coloration of indicating the Presence of tennis Polyphenols

Test for Steroids and Triterpenes

In Salkowski's test, deep brown coloration in the chloroform layer showed the presence steroids or triterpenes. Again, 2ml of extract is added to equal volumes of glacial acetic acid and conc. H_2SO_4, brown to deep ring formation diffused to the entire solution, indicating Steroids and Triterpenes' presence.

Test for Glycosides

2 ml of Fehling solution A and B were added to 5ml extracts in a test tube and heated on steam bath for 20mins. A brick red precipitate was observed indicating the presence of reducing sugars.

Screening for Saponins

5ml portion of the test sample was placed in a boiling tube and agitated gently and shaken vigorously in the palms, after which it was observed for the formation of foam which took considerable time to break, indicating the presence of Saponins

Test for Alkaloids

3 drops of Wagner's solutions were added to 2ml of each extract. The appearance of reddish brown precipitate formation indicates alkaloid present 3 drops of Dragendorff's solution were added to 2ml of each extract. The

appearance of Yellowish/Orange precipitate confirms the presence of Alkaloids.

Screening for Flavonoids

5 drops of 10% $AlCl_3$ solution were added to 2ml of each extract, the formation of yellowish coloration indicates flavonoid.

Data Processing and Analysis

After the data was collected, sorting, editing, coding and analysis were carried out. The sorting was done to group the questionnaires. Editing was also done to validate uncompleted questionnaires (Rousta, Zisen, & Hellwig, 2020). Coding was then done to assign numbers to questionnaires to enhance further analysis. The Statistical tool used for the analysis was Statistical Package Service Statistic (SPSS). According to Zakaria et. al., (2019), the analysis tackled descriptive statistics (frequency tables and percentages). Quantitative data obtained from microbial and nutritive was subjected to one-way Analysis of Variance (ANOVA) in GenStat Discovery version 12.0. A one-way ANOVA (analysis of variance) compares the means of two or more groups for one dependent variable as observed in this study.

CHAPTER FOUR

RESULTS AND DISCUSSION

Overview

This chapter puts forward the pictorial and tabulated presentation of results along with their interpretations. The study was to evaluate the perception, preference and demand of food packaged in *Musa sapientum* and *Musa paradisiaca* leaves and assess the microbial and nutritive value of food packaged in these leaves as compared to food packaged cellophane for consumers by foodservice operators in Sekondi- Takoradi metropolis.

Demographic Characteristics

This section presents the background information of the respondents. These include both foodservice operators and consumers. It focused on sex, age, educational level and well as occupational status. Data were gathered on these variables and the results are presented in Table 1.

Gender

Females (79, 48.9%) dominated foodservice operators while males were few (14, 15.1%). Similarly, females (120, 52.2%) were a little higher than males in the situation of consumers.

Age

Food service operators found within the ages of 41-50 were 45 (48.4%), followed by 24 respondents found within 21-30 years. With the consumers, more than one-third were found within the ages of 31-40 years, followed by 31 respondents found with 41-50 years. Thus, most of both respondents were found below 50 years. Women of all ages play important roles in food service provision as demonstrated by the observation that most food service operators were women

Educational status

Regarding educational status, a larger proportion of the foodservice operators have had no form of formal education (34, 36.6%), while a small proportion has either have basic education (32, 34.4%) or secondary education (27, 29%). Most of the consumers encountered were highly educated except for some few (22.6%) of the respondents who have had no form of formal education. Since food packaged in leaves is traditional, little or no formal education is required for engagement in dual production and selling activities (Mensah et al., 2012). This justifies the larger proportion of the food service operator not having formal education.

Occupation

On occupation, most of the food service operators were food vendors (47, 50.5%), restaurant operators (33, 35.5%), food hawkers (9, 9.7%) and chop bar operators (4, 4.3%). On the other hand, more consumers were students, followed by traders, public servants, teachers, and artisans such as drivers, welders, and carpenters. However, only a few of the consumers were midwives and police personnel.

Table 2: Descriptive statistics on demographic characteristics of the respondents variable

	Food vendor	Consumer
Sex		
Male	14(15.1%)	110(47.8%)
Female	79(84.9%)	120(52.2%)
Total	93(100%)	230 (100%)
Age		
10-20	2(2.2%)	29(12.6%)
21 – 30	24(25.8%)	52(22.6%)
31 – 40	0	98(42.6%)
41 – 50	45(48.4%)	31 (13.5%)
50+	22(23.7%)	20 (8.7%)
Total	93(100%)	230 (1005)
Education		
No formal education	34(36.6%)	52(22.6%)
Basic Education/MSLC	32(34.4%)	89(38.7%)
WASSCE/SSCE/O LEVEL	27(29%)	45(19.6%)
Training College	0(0%)	12(5.2%)
Undergraduate degree/Masters	0	32(13.9%)
Total	93(100%)	230(100%)
		-
Occupation	47(50.5%)	
Food vendor		
Restaurant operator	33(35.5%)	-
Food hawker	9(9.7%)	-
Chop bar operator	4(4.3%)	-
Hotel service operator	0(0)	-
Total	93(100%)	-
Public servant	-	34(14.8%)
Teacher	-	30(13%)
Student	-	57(24.8%)
Trader	-	56(24.3%)
Driver	-	24(10.4%)
Store keeper	-	5(2.2%)
Welder	-	8(3.5%)
Police	-	4(1.7%)
Midwifery	-	4(1.7%)
Carpenter	-	8(3.5%)
Total	-	230(100%)

Respondents (Food services operators)

In total 93 food service operators were encountered. Half of the foodservice operators were operating as food vendors (50.5%), followed by

21.5% who were hawkers, 14% operated chop bars, restaurants (9, 9.7%) and hotels (4, 4.3%). These food joints are places where local foods are sold to consumers.

Table 3: Food service operators and their joints

Joint	Frequency	Percent (%)
Chop bar	13	14.0
Hawkers	20	21.5
Hotel	4	4.3
Food vendor	47	50.5
Restaurant	9	9.7
Total	93	100

Source: Survey (2021)

Table 4 shows that fante kenkey sellers were 41, followed by Nsiho, Aboloo, and Etew. A greater proportion of the food service operators sold more of kenkey and Nsiho. These foods are normally wrapped with leaves. Similarly, (Mensah et al., 2012), identified eleven different foods that were packaged with *M. sapientum* and *M. paradisiaca* leaves in the selected market in the Kumasi metropolitan area. This food includes Fante Kenkey (Dokon Pa), fomfom, aboloo fomfom, nsiho, estew and aboloo

Table 4: Type of food sold by food service operators

Food	Frequency	Percent
Fante Kenkey	41	44.1
Aboloo	8	8.6
Etew	9	9.7
Nsiho	24	25.8
Apiti	5	5.4
Fomfom	6	6.5
Total	93	100

Source: Survey (2021)

Moreover, all the food service operators preferred the use of banana or plantain leaves in packaging food items such as Fante kenkey, Fomfom and Nsiho, Apiti, and Etew. Respondent we further asked about their preference to the form of leaves. It shows that a little beyond half (51.6%) of the respondents used fresh leaves in packaging food items, followed by 20.5% respondents who package food items with dry leaves. Nevertheless, 28% respondents used any of them (either fresh or dry leaves) in packaging food items

Table 5: Form of leaves to use for packaging of food

Form	Frequency	Percent
Fresh leaf	48	51.6
Dry leaf	19	20.5
Either fresh or dry	26	28
Total	93	100

Source: Survey (2021)

More than half of the food service operators identified leaves as a packaging material due to their availability (56, 60.2%), followed by their long shelf life (23, 24.7%) and no apparent concerns (9, 9.7%). Only a few (5, 5.4%) used leaves as a packaging material due to their hygienic nature (Table 6).

Table 6: Reasons why leaves are best packaging material by foodservice operators

Reason	Frequency	Percent
Availability	56	60.2
Long shelf life	23	24.7
No apparent concerns	9	9.7
Hygienic/medicinal	5	5.4
Total	93	100

Source: Survey (2021)

Figure 8 shows that 88 (95%) of the foodservice operators were aware that packaging materials could migrate some particles into the food, while few (5, 5%) were unaware.

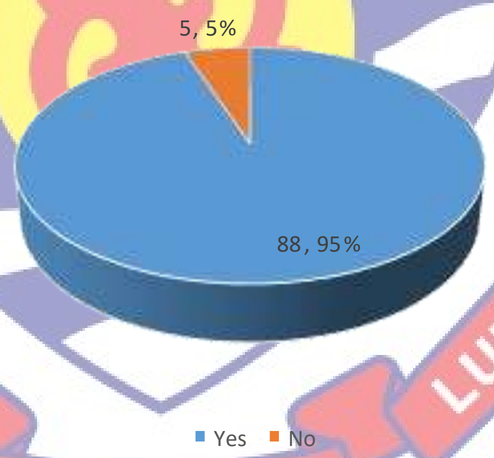
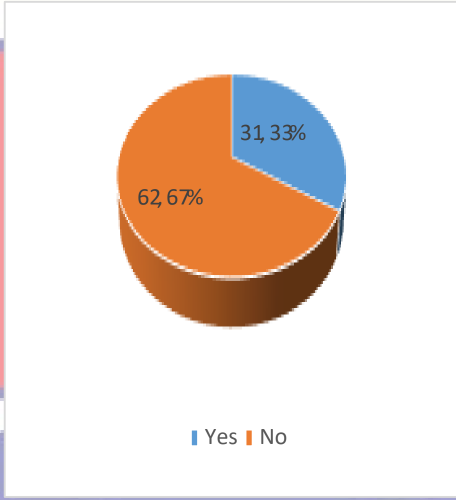


Figure 8: Migrate some particles into the food

Source: Survey (2021)

62 (67%) of the foodservice operators were aware of some nutritional benefits of using M. *paradisiaca* leaves to wrap food while 31(33%) were

unaware. However, 26 (28%) of the foodservice operators were aware of some nutritional benefits of using banana leaves to wrap food, while 67(72%) were unaware. This implies that most of the respondents were not aware while a small proportion of the respondents have an idea about such benefits.



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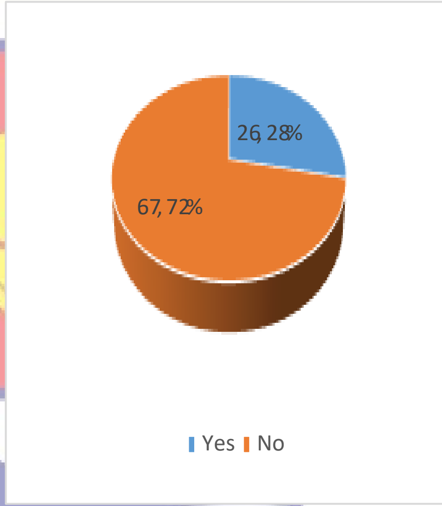

B

Figure 9: Awareness of nutritional benefits of food wrapped in Musa parasidiaca (A) and Musa sapientum (B)

Source: Survey (2021)

Among the various challenges of packaging and selling leaf-packaged food, a higher number of foodservice operators 39 (41.9%) identified difficulties in wrapping food with leaves as the major challenge. This was followed by 15 (16.1%) respondents who claimed a shortage of leaves in the locality serves as a challenge to the foodservice operators, while 12 (12.9) respondents said leaf-packaged foods could not be exported for higher income. However, few respondents 9 (9.7%) identified either wrapping foods in leaves is time-consuming, foods wrapped in leaves can easily pour out, or leaf-wrapped foods look unattractive sometimes as a challenge (Table 7).

Table 7: Challenges faced by foodservice operators in packaging and selling of leaf-packaged food

Challenge	Frequency	Percent
Shortage of leaves in the locality	15	16.1
Difficulty in wrapping	32	34.4
leaf-packaged foods cannot be exported	12	12.9
leaf-wrapped foods look unattractive sometimes	9	9.7
wrapping foods in leaves is time-consuming	9	9.7
foods wrapped in leaves can easily pour out	9	9.7
Superstitional believes	7	7.5
Total	93	100

Source: Survey (2021)

Consumer Preferences

The survey reported that 90 (39.1%) out of 230 consumers mostly purchase food from food vendors followed by 77(33.5%), 38 (16.5) and 12 (5.2%) respondents who buy food from hawker, restaurants, chop bars and a few eat from hotels.

Table 8: Food service operators patronize by the consumers

Food joint	Frequency	Percent
Restaurant	38	16.5
Hotel	12	5.2
Food vendor	90	39.1
Chop bar	77	33.5
Total	230	100

Source: Survey (2021)

Preference to leaves by consumers as packaging material for their food was very prodigious, thus 130 (56.5%) (Table 10). Preference to Polythene/plastic, cellophane disposable bowls or plastics, and politeness' followed among 42(18.3%) 26 (11.3%) 16 (7%) and 16 (7%) consumers respectively.

Table 9: Consumers' preference of package material

Material	Frequency	Percent
Polyethene	42	18.3
Paper	16	7
Cellophane	26	11.3
Leaves	130	56.5
Disposable bowls or plastics	16	7
Total	230	100

Source: Survey (2021)

Moreover, the paramount reason why consumers preferred leaves over other packaging material was because of its Safe and healthiness (52.6%), followed by it presumed medicinal properties 20, availability (18.3%), cost (3.9%), portability 3.5%, and presumed antioxidant properties (1.7%) (Table 10).

Table 10: Reasons why consumers perceive leaves as best packaging material

Perception	Frequency	Percent
Cheap	9	3.9
Availability	42	18.3
Safe and healthy	121	52.6
Medicinal properties	46	20
Has antioxidant properties	4	1.7
portable	8	3.5
Total	230	100

Source: Survey (2021)

146 (63%) of the respondents accepted that they would prefer the use of leaves in packaging food, especially when it comes to fast food, while 37 % did not accept (Figure 10).

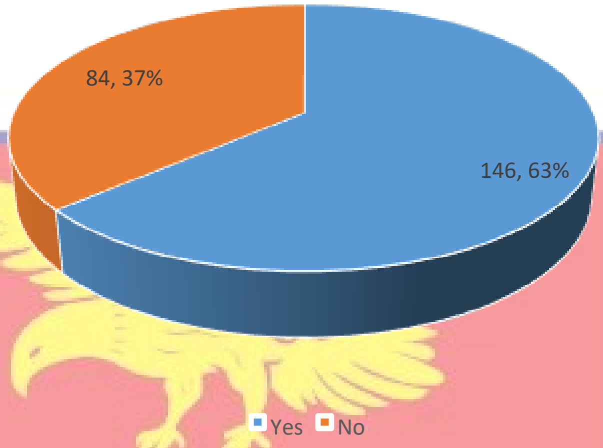

Figure 10: Consumers preference regarding fast food packaging

Source: Survey (2021)

Almost all the respondents (98%) testified that they have purchased food packaged in a leaf before while few (4, 2%) have not. Thus, the majority of the consumers have bought food packaged in a leaf before.

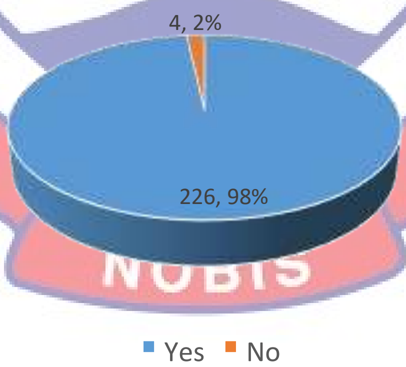

Figure 11: Consumers purchase of food packaged leaves

Source: Survey (2021)

With respect to the frequency at which consumer purchase food packaged in *Musa sapientum* and *Musa parasidiaca* leaves, 137 (60%) of the respondents normally purchase food packaged in *M. parasidiaca* leaves. Whereas 62 (27%) of the respondents normally purchase food packaged in *M.*

sapientum leaves (Figure 12)

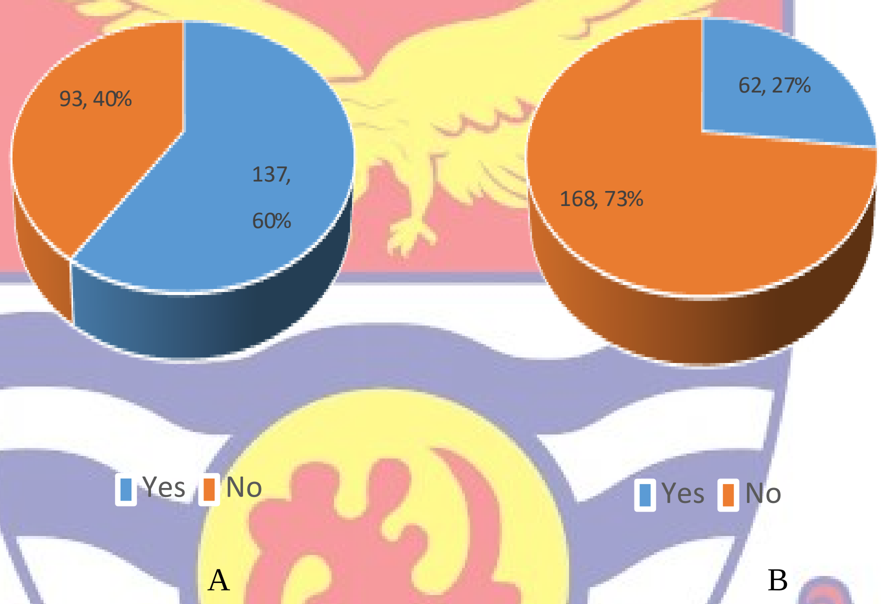

Figure 12: Frequency of consumer's purchase of food packaged in M.parasidiaca and M. sapientum leaves. Source: Survey (2021)

More than half of the consumers (53.9%) purchase Fante kenkey followed by Apiti (20.4%), Aboloo (14.3%), Waakye (7.8%) and Fomfom (3.5%) in dry *M. sapientum* and *M. parasidiaca* leaves (Table 12). Whilst 34.3% of consumers purchase Fante kenkey, followed by Apiti (24.3%), Aboloo (15.7%), Momooi (19.6%) and fomfom (1.7%) in fresh leaves of *M. sapientum* and *M. parasidiaca*.

Table 11: Kind of dish consumers used to purchase in dry or fresh leaf of *M. sapientum* and *M. parasidiaca.*

Kind of dish	Dry leaves		Fresh leaves	
	Frequency	Percent	Frequency	Percent
Fante kenkey	124	53.9	79	34.3
Apiti	47	20.4	56	24.3
Momooi	-	-	45	19.6
Waakye	18	7.8	10	4.3
Aboloo	33	14.3	36	15.7
Fomfom	8	3.5	4	1.7
Total	230	100	230	100

Source: Survey (2021)

Table 12 shows that majority of the respondents agreed that *M. sapientum* and *M. parasidiaca*. leaves are the cheapest packaging material in terms of cost (89.1%), have health benefits (76.5%), leaves are the safest packaging material (82.6%) while only a few respondents agreed that plastic is less expensive and more hygienic than food in leaves. However, most (66.5%) of the respondents agreed that packaging food in leaves was more difficult than in plastics.

Table 12: Consumers perception on the benefits of using leaves for food packaging

Perception	Mean	Std Dev
Leaves are the safest packaging material?	4.01	1.15
Food wrapped in leaves has a pleasant flavour.	4.11	1.04
Banana/ plantain leaves are the cheapest packaging material in terms of cost.	4.26	0.82
Banana/ plantain leaves are the cheapest packaging material in terms of availability.	3.74	1.39
Banana/Plantain leaves enhance food nutrients.	3.88	1.28
Food packaged in plastics is convenient than food packaged in leaves.	3.45	1.21
Banana/plantain leaves have health benefits.	4.12	0.86
Food in plastics is less expensive than food in leaves.	1.90	1.05
Food in plastics is more hygienic than food in leaves.	2.13	1.19
Packaging food in leaves is difficult than in plastics	3.45	1.44

Source: Survey (2021)

The consumers' awareness was examined on whether they were aware or not that some particles can be migrated into the food commodity due to the packaging materials and the result is presented in Figure 8. It shows that the majority (84%) of the consumers were aware that it could migrate some particles into the food commodity, while only a few (37, 16%) were not aware. In addition, respondents who were aware further confirmed that dirt, followed by microbes (58%), nutrients (44%), and colour (14%) and few (5%) mentioned chemical constituents of plastics.

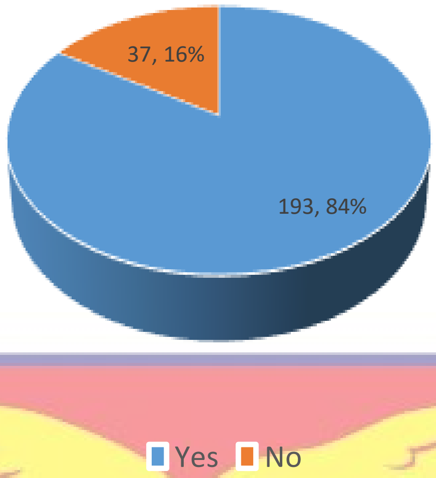

Figure 13: Awareness that packaging materials can migrate some particles into the food commodity

Source: Survey (2021)

Figure 9 shows that 97 (42%) of the consumers were aware that some nutritional benefits of using plantain leaves in packaging food while 133 (58%) of the consumers do not. However, among the few consumers who were aware of the benefits, (55) of them identified minerals, protein (17) and vitamin (25) as the main benefits.

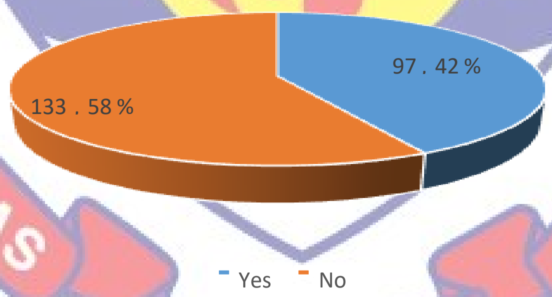

Figure 14: Awareness of nutritional benefits of using plantain leaves for packaging.

Source: Survey (2021)

The consumers were examined whether they were aware that *Musa paradisiaca* and *Musa sapientum* may contain an antioxidant and the result is presented in Figure 16. It depicts that most (60%) of consumers were not aware, while 40 % of the consumers were aware.

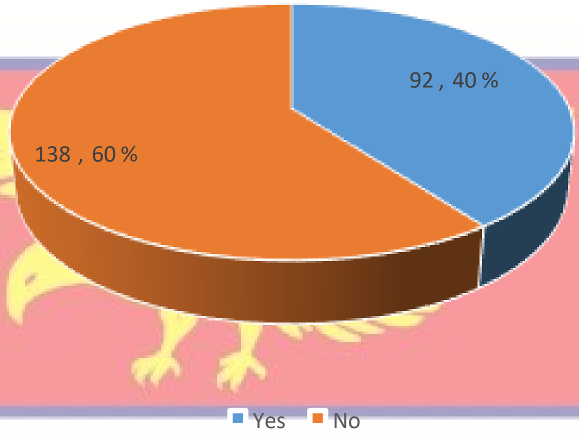

Figure 15: Awareness of consumers on antioxidant content in banana leaf

Source: Survey (2021)

The consumers were examined whether they were aware that plantain leaves might contain an antioxidant and the result is presented in Figure 16. It depicts that majority (90%) of the consumers were not aware of that while only 10 % of the consumers were aware. Also, respondents explained that due to the antioxidant content in the plantain leaves, they prevent cancer and fight bacterial activities.

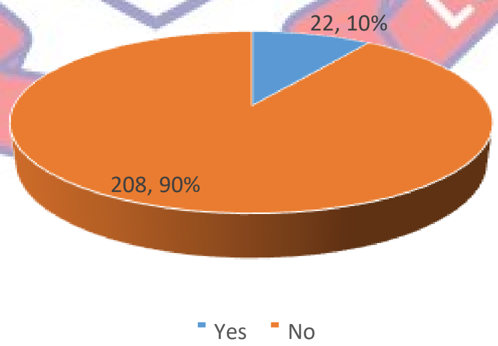

Figure 16: Awareness of consumers on antioxidant content in plantain leaf

Source: Survey (2021)

Respondents were asked whether they would prefer the use of food packaged with banana leaves that have important components that may be good to their health over plastic food packing and the result is presented in figure 17. It shows that most consumers would prefer the use of banana leaves for food packaging compared to plastics.

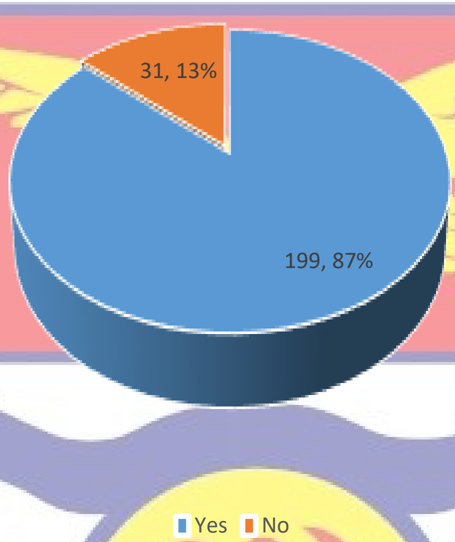

Figure 17: Consumers' preference on for banana leaves over plastics for food packaging

Proximate Analysis

Proximal Content

The proximate composition; protein, fibre, fat, moisture, and carbohydrate were assessed, the result exhibited that all the parameters of the proximate composition were significantly different ($p < 0.05$) among each other. The moisture content level recorded in this study ranged from an average of (42.6 – 44.6%) in Oblongo packaged in *Musa Sapientum* and *Musa paradisiaca* fresh and dry leaves and from an average of (44.9%) in oblongo packaged in Cellophane which was the highest. It was noticed that dry matter in the food packaged in cellophane had the highest (55.09) than that of oblong packaged in *Musa paradisiaca Musa paradisiaca* leaves.

It was also observed that food packaged in cellophane was recorded the lowest ash (1.2%) and food packaged in dry and fresh of *Musa paradisiaca Musa paradisiaca* dry leaves ranges (1.1 – 1.5%). The highest ash was in the dried *Musa Sapientum* (1.5%). This may indicate there may be higher trace of mineral element in food packaged in fresh and dried leaves *Musa Sapientum* and *Musa paradisiaca.*

The protein content recorded for this study ranged from an average of (4.5 - 4.9%) in oblongo wrapped in fresh and dry leaves of *Musa Sapientum* and *Musa paradisiaca.* food packged in Cellophane, an average of (4.3%) which was the lowest. The highest level of protein was showed in food in dry leaves of *Musa sapientum*. Slightly rich amount of protein. From the analysis it was realized that the fat content was (7.0 – 7.5%) in *Musa sapientum* fresh and dry leaves and *Musa paradisiaca* fresh and dry leaves reduce, while (7.8%) the highest fat content was observed in food packged in Cellophane.

The analysis showed that fiber content was (3.2%) in Oblongo wrapped in cellophane was the lowest while (3.4 – 3.7%) was recorded in *Musa sapientum* dry leaves, in *Musa paradisiaca* dry leaves. *Musa sapientum* dry leaves showed the highest, this made the fresh leaf of both *Musa sapientum* and *Musa paradisiaca* a good fibre.

In the analysis the total carbohydrate content ranged from an average of (82.4%) in oblongo wrapped in cellophane tape (OWCellophane), an average of (83,4 – 83.8%) in *Musa sapientum* dry and fresh and *Musa sapientum* fresh and leaves repectively.

Table 13: Nutritional status of Oblongo wrapped in Cellophane and fresh and dry leaves of Musa sapientum and Musa paradisiaca

Sample (oblongo packaged)	%DM	%Moisture	%Ash	%Protein	%Oil	% Fibre	%CHO
Cellophane	44.9^{a}	55.09^{c}	1.2^{b}	4.3^{c}	7.8^{a}	3.4^{bc}	83.4^{b}
Musa sapientum dry leaves	44.6^{a}	55.39^{c}	1.5^{a}	4.5^{bc}	7.5^{b}	3.7^{a}	82.7^{c}
Musa paradisiaca dry leaves	44.36^{ab}	55.64^{bc}	1.1^{b}	4.6^{b}	7.0^{d}	3.5^{ab}	83.8^{a}
Musa sapientum fresh leaves	43.4^{bc}	56.62^{ab}	1.0^{b}	4.9^{a}	7.3^{c}	3.2^{c}	83.6^{ab}
Musa paradisiaca fresh leaves	42.6^{c}	57.39^{a}	1.1^{b}	4.8^{ab}	7.0^{d}	3.3^{c}	83.8^{a}
Grand Mean	43.97	56.03	1.18	4.62	7.32	3.42	83.46
P-value	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
CV%	0.8	0.7	6.1	2.4	0.7	2.7	0.1

Note: Means followed by the same letter in each column are not significantly different (P = 0.05) as indicated by Tukey's method. Df-3; confidence level- 95%;

Micronutrient Composition

The comparative mineral content of Oblongo wrapped in cellophane, *Musa sapientum*, and *Musa paradisiaca* dry and fresh leaves, respectively, are present in table 15. Phosphorus (P) content was highest in the dry leaves of *Musa sapientum* (2675 - 2731.7 ug/g) and *Musa paradisiaca* (2731.90 ug/g), respectively. Similarly, the dry and fresh leaves of food packaged in *Musa sapientum* and *Musa paradisiaca* showed the ranges of (6142.9 – 7882.) potassium (K) content, respectively, with the lowest observed in Oblongo wrapped in cellophane (5274.6). Sodium (Na) content was highest in Oblongo wrapped in cellophane (255 ug/g) and dry *Musa sapientum* leaves (240.9 251.8) while the iron (Fe) was observed to be relatively high in Oblongo wrapped in cellophane (916.7) respectively. Copper (Cu) content was also observed to be high in the Oblongo wrapped in cellophane (167 ug/g) than food packaged in dry leaves of *Musa sapientum* and *Musa paradisiaca* ((85.925 - 111.05).

Similarly, zinc (Zn) content was highest in Oblongo wrapped in cellophane (167.50 ug/g) and dry leaves of *Musa sapientum* (108.28 - 4.72 ug/g) respectively. Magnesium (Mg) content was generally low, with the highest levels in fresh leaves of *Musa sapientum* and *Musa paradisiaca*, respectively, with a similar average of (0.15 ± 0.002%). β-Carotene was noticeably high and was the highest in fresh leaves of *Musa sapientum* (80.50 ug/g) and *Musa paradisiaca* (75.61 ± 0.41 ug/g), respectively.

Generally, mineral content for phosphorus, potassium and β-Carotene were appreciably high in oblongo wrapped in *Musa sapientum* and *Musa paradisiaca* (fresh leaves). At the same time, iron, copper and zinc were noticeable in the oblongo wrapped in dry leaves of *Musa sapientum* and *Musa paradisiaca* respectively. This mineral content variation might be owing to their different growing environmental conditions and genetic variations.

Microbial Analysis

The total bacteria count of samples across the three locations ranged from 1.2×10^3 to 1.5×10^4. However, there was no detectable trace of bacteria colony in OPSFL-P, OPSDL-P, OPSFL-S, OPSDL-S, OPPFL-P, OPPDL-P, OPPFL-S, OPPDL-S, and Control (OPC-P, OPCS, and Cellophane only) across the three locations. Bacterial colonies were observed on *Musa Paradisiaca* dry leaves only, *Musa Paradisiaca* fresh leaves only, *Musa sapientum* fresh leaves only, and *Musa sapientum* dry leaves, respectively. The highest bacterial count (1.5×10^4 cfu/g) was observed in *Musa Paradisiaca* dry leaves in Sekondi. The lowest bacterial count (0.2×10^3 cfu/g) was observed in *Musa sapientum* dry leaves only from Kojokrom (Table 17)

Table 14: Micronutrient composition of Oblongo wrapped in Cellophane, Musa sapientum and Musa paradisiaca fresh and dry leaves

ample (oblongo packaged)	P ug/g	Kug/g	Na ug/g	Fe ug/g	Cu ug/g	Z ug/g	%Ca	%Mg	β-Carotene ug/g
Cellofane (Control)	2708.07	5274.6[d]	255	916.7[a]	167.5	76.5[c]	1.2[ab]	0.15[a]	70.20[d]
Musa sapientum dry leaves	2731.9	7882.44[a]	243.2	792.2[b]	85.925	85.1[b]	1.3[a]	0.15[a]	75.61[b]
Musa paradisiaca dry leaves	2675	6142.9[c]	240.9	615.9[d]	91.808	107.0[a]	1.1[b]	0.13[b]	74.31[c]
Musa sapientum fresh leaves	2726.52	7366.18[b]	246.5	804.4[b]	97.995	58.5[d]	1.2[ab]	0.15[a]	80.50[a]
Musa paradisiaca fresh leaves	2708.42	6250.5[c]	251.8	724.4[c]	111.05	108.3[a]	1.1[b]	0.13[b]	74.24[c]
Grand Mean	2709.98	6583.32	247.48	770.72	110.85	87.08	1.18	0.14	74.97
P-value	<0.733	<0.05	0.059	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
CV%	2.0	1.7	2.3	1.5	2.6	3.2	4.2	2.3	0.6

Note: Means followed by the same letter in each column are not significantly different (P = 0.05) as indicated by Tukey's method. Df-3; confidence level- 95%;

Table 15: Esherichia coli content, Aerobic plate count and Coliform count of oblong wrapped with cellophane, fresh and dry leaves of plantain and Musa sapientum at three locations, respectively.

Sample	Aerobic plate count (log cfu/g)			Coliforms Count (log cfu/g)			*E. Coli* (log cfu/g)		
	Kojokrom	*Sekondi*	*Takoradi*	Kojokrom	Sekondi	Takoradi	Kojokrom	Sekondi	Takoradi
OPSFL-P	ND	ND	ND	ND	ND	ND	ND	ND	419.35
OPSDL-P	ND	ND	ND	ND	ND	ND	ND	ND	ND
OPSFL-S	ND	ND	ND	ND	ND	ND	ND	ND	ND
OPSDL-S	ND	ND	ND	ND	ND	ND	ND	ND	ND
OPPFL-P	ND	ND	ND	ND	ND	ND	ND	ND	ND
OPPDL-P	ND	ND	ND	ND	ND	ND	ND	ND	ND
OPPFL-F	ND	ND	ND	ND	ND	ND	ND	ND	ND
OPPDL-F	ND	ND	ND	ND	ND	ND	ND	ND	2
PDL ONLY	1.2 X 10^3	1.5 X 10^4	2.0 X 10^3	ND	0.5 X10^3	2.0 X 10^2	ND	ND	ND
PFL ONLY	1.4 X 10^4	1.2 X 10^4	0.5 X 10^3	ND	0.6 X10^3	0.3 X 10^2	ND	ND	ND
SFL ONY	1.4 X10^4	1.4 X 10^4	1.8 X 10^3	ND	1.0 X10^3	0.2 X10^2	ND	ND	ND
SDL ONLY	0.2 X10^3	1.4 X 10^4	0.1 X 10^3	ND	0.4 X10^3	0.1 X10^2	ND	ND	ND
OPC-P	ND	ND	ND	ND	ND	ND	ND	ND	ND
OPCS	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cellophane only	ND	ND	ND	ND	ND	ND	ND	ND	ND

***Note**: ND- Not detected*
***OPSFL-P**-Oblongo wrapped in Musa sapientum fresh leaves (Product);*
***OPSD**; **L-P**- Oblongo wrapped in Musa sapientum dry leaves (Product);*
***OPSFL-S**= Oblongo wrapped in Musa sapientum fresh leaves (Stock);*
***OPSDL-S**= Oblongo wrapped in Musa sapientum dry leaves (Stock);*
***OPPFL-F**= Oblongo wrapped in Musa Paradisiaca fresh leaves (Product*
***OPPFL-S**- Oblongo wrapped in Musa Paradisiaca fresh leaves (Stock);*
***OPPDL-S**- Oblongo wrapped in Musa Paradisiaca dry leaves (Stock);*
***PDL ONLY** - Musa Paradisiaca dry leaves only;*
***PFL ONLY**- Musa Paradisiaca fresh leaves only;*
***SFL ONLY** -Musa sapientum Fresh leaves only;*
***SDL ONLY** –Musa sapientum Dry leaves only*
***OPC-F**- Oblongo wrapped in cellophane–Product; **OPCS**- Oblongo wrapped in cellophane*
***OPPDL-F** – Oblongo wrapped in Musa Paradisiaca rapped in dry leaves (Product);*

In general, there was no significant difference (P>0.05) among the samples. The total coliform count of samples across the three locations ranged from 0.1 X10^2 to 0.6 X10^3cfu/g The presence of microbes could be an indicator of the hygiene of leaves used for food packaging (Freeman, 2007). However, there was no detectable trace of bacteria colony in OWBFL-P, OWBDL-P, OWBFL-S, OWBDL-S, OWPFL-P, OWPDL-P, OWPFL-S, OWPDL-S, and Control (OWC-P, OWCS, and Cellophane only) across the three locations.

Bacterial colonies were observed on *Musa Paradisiaca* dry leaves only, *Musa Paradisiaca* fresh leaves only, *Musa sapientum* fresh leaves only, and *Musa sapientum* dry leaves, respectively. The highest bacterial count (1.5 X 10^4 cfu/g) was observed in *Musa Paradisiaca* dry leaves in Sekondi. The lowest bacterial count (0.2 X 10^3 cfu/g) was observed in *Musa sapientum* dry leaves only from Kojokrom. This bacterial count observed could be due to the unhygienic practices of the various food sellers in Sekondi and Takoradi, respectively (Table 15).

The *Escherichia coli* count on all samples across the three locations is present in table 5. A very low *Escherichia coli* count was observed on samples across the three locations, respectively. The highest *Escherichia coli* count of 419.35 was observed on Oblongo wrapped in *Musa sapientum* fresh leaves (Product) sampled from Takoradi. This could be due to the percentage moisture content in the fresh leaves resulting in a suitable medium for the growth of *E. coli*. Also, a count of two *E. coli* was found on Oblongo wrapped in *Musa Paradisiaca* fresh leaves (Stock) which was sampled from Takoradi.

The controls had no *E. coli* count. The presence of *E. coli* could be due to the contaminant from the environment (Table 16).

People are more convinced that the quality of their health is associated with the food they consume. The yeast and mold count of the samples across the three locations are present in table 16. The yeast count ranged from 0.7 to 333 across the three locations. The highest count was obtained on *Musa Paradisiaca* fresh leaves only across the three locations, respectively. A significant count was obtained on the raw fresh and dry leaves only but not on the food wrapped in leaves. Controls had no Yeast and mold detection. The yeast count observed could due to the relatively high percentage moisture content, which was approximately 50%.

Table 16: Yeast and Mold of Oblongo wrapped with cellophane, fresh and dry leaves of Musa Paradisiaca and Musa sapientum banana at three locations.

Sample	Yeast and Mold(log cfu/g)		
	Kojokrom	Sekondi	Takoradi
OPSFL-P	20.7	11.7	52.0
OPSDL-P	37.0	6.7	26.7
OPSFL-S	19.3	ND	0.7
OPSDL-S	ND	ND	2.3
OPPFL-P	ND	4.0	13.7
OPPDL-P	7.00	3.0	12.0
OPPFL-F	ND	ND	ND
OPPDL-F	ND	ND	ND
PDL ONLY	167.7	133.3	321.0
PFL ONLY	266.0	139.3	333.0
SFL ONY	107.0	135.3	283.3
SDL ONLY	126.0	70.7	160.0
OPC-P	ND	ND	ND
OPCS	ND	ND	ND
Cellophane only	ND	ND	ND

Note: ND- Not detected

OPSFL-P = Oblongo wrapped in Musa sapientum banana fresh leaves

(Product);
OPSDL-P- Oblongo wrapped in Musa sapientum dry leaves (Product);
OPSFL-S= Oblongo wrapped in Musa sapientum fresh leaves (Stock);
OPSDL-S= Oblongo wrapped in Musa sapientum dry leaves (Stock);
OPPFL-F= Oblongo wrapped in Musa Paradisiaca fresh leaves (Product);
OPPDL-F = Oblongo wrapped in Musa Paradisiaca dry leaves (Product);
OPPFL-S=Oblongo wrapped in Musa Paradisiaca fresh leaves (Stock);
OPPDL-S= Oblongo wrapped in Musa Paradisiaca dry leaves (Stock);
PDL ONLY= Musa Paradisiaca dry leaves only;
PFL ONLY = Musa Paradisiaca fresh leaves only;
SFL ONLY = Musa sapientum Fresh leaves only;
SDL ONLY = Musa sapientum Dry leaves only
OPC-F= Oblongo wrapped in cellophane–Product;
OPCS= Oblongo wrapped in cellophane

Phytochemical constituents of aqueous extract of *Musa sapientum* and *Musa Paradisiaca*

The table 19 showed the presence of somephytochemical constituents from the aqueos extract of fresh and dried leaves of *Musa sapientum* and *Musa Paradisiaca*. There was the presence of tannis and polyphenol, Steroids and triterpenes and saponin, alkaloid, flavonoid and glycosides.

Table 17: Phytochemicals (Antioxidants) composition of aqueous extract of *Musa sapientum* and *Musa paradisiaca* leaves

	Occurrence			
Phytochemical	SFL	SDL	PDL	PFL
Tannins and Polyphenols	+	+	+	+
Steroids and Triterpenes	+	+	+	+
Glycosides	+	+	+	+
Saponins	+	+	+	+
Alkaloids	+	+	+	+
Flavonoids	+	+	+	+

Source: Survey (2021)

Discussion

People who played vital roles in producing, selling, and consuming leaves packaged in *M. sapientum* and *M. parasidiaca* as shown by current study were women of all ages. Most of the foodservice operators who often use these leaves were women. Unlike consumption, production requires some form of onthe job training and experience. Using leaves to package food is an ancient method and the involvement of the old aged (Table 1) this possibly explains why the foodservice operators/producers and consumers were mostly 41 years and above. Since formal education is not the prerequisite for engagement in the production and selling of the leaves-packaging industry, hence most of the food service operators who used leaves for packaging had little or no formal education. Food service operators or vendors who uses leaves engaged members of their immediate or extended family and others to asssist in the small scale production of the packaging (Macusi, Morales, Macusi, Pancho, & Digal, 2022) While some producers sell directly to consumers, others utilize the services of family members (Farrell, 2022).

Most of the food service operators who employ *M. sapientum* and *M. parasidiaca* leaves were food vendors (50.5%) who mostly sold kenkey. Among all packaging material in Ghana one of the most fundamental and economical calories for most Ghanaians is food packaged in leaves (Mensah et al., 2012) In this study, food service operators chose leaves as packaging material was predominated by its availability and longer shelf life. Whereas, consumers preference was geared because of its presumed medicinal properties as well as its availability and cost. *Musa paradisiaca* and *Musa sapientum* are grown in more than 120 countries in back yard or mixed cropping system (Ubi & Brisibe, 2021). This suggest that *Musa paradisiaca* leaves is very common and readily available in Ghana. Again, it is observed that consumers as well as food service operators had an informed or presumed perception on some available nutrition in leaves. Actually, leaves help maintain the moisture content, preventing recontamination and consequent degradation or spoilage of the food once cooked, as demonstrated by the relatively high moisture content and longer shelf life of Fante Kenkey (Mensah et al., 2012). About 88.5% of the food service operator and 84 % of consumers perceived the migration of some particles into wrapped food. Mensal et al., (2012) as well (Idumah, Hassan, & Ihuoma, 2019) reported that it is likely that leaves may contain some active and intelligent material in the of form phytoconstituent and antimicrobials that prevent microbial growth processes flavour and colour of food.

However, food services operator had challenges with leaves as compared with other packaging materials. Most of the respondents complained the difficulty in wrapping and the unattractiveness of the packaged foods. About 72.6 % of the consumers in this study buy food from food vendors who sell Kenkey, Nsiho, Oblongo, and Fomfom. Most consumers preferred food wrapped with plantain leaves to those wrapped with banana leaves with no apparent reason.

Food packaged in green leaves was one of the best dishes the aged preferred to be served (Oniang'o, Mutuku, & Malaba, 2003). Even though leaves are not used often in serving or packaging foods these days, consumer's preference for leaves was surprising (Table 4). About 56.5% of consumers in this study preferred leaves to other packaging materials. Consumer perceived that *M. sapientum* and *M. parasidiaca* leaves are the cheapest (Jeenusha & Amritkumar, 2020; Mohapatra, Mishra, & Sutar, 2010) packaging materials in terms of cost and are safe as compared to other packaging materials such as plastics.

Leaves as packaging materials provide additional function, such as convenience in its ready to eat attributes and less time used in peeling off. Hence less time is spent in its use as a consumer. Perhaps its convenience is exhibited by its patronage as Ga or Fante Kenkey per year either away from home or in a home setting. Notwithstanding the unattractiveness of leave packages consumers show, there is still high consumer tolerability and great requests. In fact, food packaged with *M. sapientum* and *M. parasidiaca* have lasted and thrived in contemporary times, especially in Ghana. Even though food is packaged to attract the attention of consumers the only difference between competitive brands is in the complexity of the packaging Ahiable, (2020). In fact, food packaged with *M. sapientum* and *M. parasidiaca* has constantly withstand consumer respectability without the advantages of eye-catching graphics. However, a new trend has emerged nowadays where few producers wrap the food in polyethylene bags before packing with leaves. Moreover, only a few (4, 1.7%) respondents buy them often among those who normally buy it. Moreover, most (61) of the respondents liked fresh leaf of banana used for packaging food as compared to dry leaf or both. Therefore, it can be said that only a few respondents purchased food packaged in dry banana leaves but not often. Also, respondents explained that due to an antioxidant content in the banana leaves, it might repair dead cells, while others posited that it might contain some antioxidant that fights against disease-causing bacteria naturally.

Furthermore, most of the respondents believed banana leaves were medicinal and attractive, while few identified it as poorly finished or unhygienic.

The proximate composition of food packagaed in *Musa sapientum* and *Musa paradisiaca* leaves is essential in assessing the quality of the food which is normally the aim for establishing nutritional value and overall acceptance of food by consumers (Novianti & Yuniasti, 2018; Villacís-Chiriboga, Elst, Van Camp, Vera, & Ruales, 2020). Every food contains two major components, moisture and dry matter. While water is very important, the nutrients (energy, protein, minerals, and vitamins) are also found in the dry matter portion. The dry matter is vital in terms of prolonged of the shelf life of food, quality and resistance to deterioration (Turner, Luo & Buchanan, 2020). The percentage dry matter was higher in oblongo packaged in *M. paradisiaca* fresh leaves (57.39%), followed by oblongo packaged *M. sapientum* fresh leaves, Musa *paradisiaca* dry leaves, *Musa sapientum* dry leaves and cellophane. These differences may be as a result of the porosity nature of leaves. This result was contrary to report by Karigidi, Akintimehin, Fayemiro, Balogun and Adetuyi (2022), who assessed *Sorghum bicolor* leaf sheath and recorded a percentage dry matter of 93.22% and 93.46%. The dry observed suggests that food may not be easily susceptible to microbial attack which could lead to food spoilage.

There was significant difference ($P < 0.05$) among the food package with the *M. sapientum* and *M. paradisiaca* fresh and dry leaves in terms of their moisture content level. The study recorded an average 43.97% of moisture content, ranging from 44.9% - 42.6%. Oblongo packaged in Cellophane recoreded the highest. The differences may be as a result of the porosity nature of leaves (Michael, Iwarhue & Bamidele, 2018), whereas the compact nature of the cellophane may had caused the retention of moisture in the food.

After complete oxidation of an organic matter in food the inorganic residue that remain is the ash (Sinay & Harijati, 2021). Ash represents the total amount mineral elements in food. From this study oblongo packaged in cellophane was recorded as the lowest of (1.2%) and food packaged in dry and fresh of *Musa paradisiaca Musa paradisiaca* dry leaves ranges (1.1 – 1.5%). The highest ash was found in oblongo in the dry *Musa Sapientum leaves* (1.5%). This may indicate there may be a higher trace of mineral element in food packaged in fresh and dried leaves *Musa Sapientum* and *Musa paradisiaca.*

Protein are large molecules consisting of amino acid which regulate the body cells, tissue and organs. The protein content recorded for this study significantly (P< 0.05) ranged from an average of (4.5 - 4.9%) in oblongo wrapped in fresh and dried leaves of *Musa Sapientum* and *Musa paradisiaca*. Oblongo packaged in Cellophane, recorded the lowest (4.3%). The highest level of protein was showed in food in dry leaves of *Musa sapientum*. The slight enrichment of oblongo with protein may have result from the migration of proteins from leaves to the food.

Fat is vital for body processes such as digestion, transport conversion and energy extraction, it in the absorption of fat-soluble vitamins and antioxidants like beta carotene and lycopene. However, too much consumption of fat can lead to health-related issues such as obesity and cardiovascular diseases. From the study it was realized that the fat content was significantly (P< 0.05) higher oblongo packaged in cellophane (7.8%). This may be as a result of the compact nature of the cellophane which caused the retention of fats in the food.

Fibre is the amount of the non-digestible cellulose constituent in food that cannot be completely broken down by human digestive enzymes. The analysis showed significant difference in fibre among the food packaged leaves and cellophane. The dietary fiber content was ranged from 3.2% – 3.7% with a mean of 3.4%. *M. sapientum* dry leaves showed the highest, 3.7 %. This made the dry leaf of both *M. sapientum* and *M. paradisiaca* a good fibre rich diet that can aid digestion and prevent constipation.

The bulk of the Ghanaian dish contain carbohydrate and is needed in the diet to supply the body with heat and energy. In this study, there was significantly (P<0.05) higher carbohydrate content among oblongo packaged with the different forms of leaves. The total carbohydrate content of oblongo in the various packages ranged (82.7 – 83.8%). Processing has been reported to improve carbohydrate availability in a more digestible form, suggesting the cause of the higher percentage observed. The proximate analysis results show a variation of concentration of biochemical and supplementary substances, and this finding is similar to that of El Abbadi, (2021).

Aerobic plate count (APC) shows the microbial level of a product and is valuable in evaluating food quality (Maturin & Peeler, 2001). Large values of APC maybe an indication of poor sanitation or processing. Statistically, there were no significant differences (p >110.05) among the samples regarding their Aerobic plate count. The total bacteria count of samples across the three locations ranged from 1.2x10^3 to 1.5 X 10^4 (Table). However, there was no detectable trace of bacteria colony in OWBFL-P, OWBDL-P, OWBFL-S, OWBDL-S, OWPFL-P, OWPDL-P, OWPFL-S, OWPDL-S and Control (OWC-P, OWCS, and Cellophane only) across the three locations. This could be attributed to the heat applied to the food as well as the treatment or processing of leaves prior to cooking. Bacteria colony count on plantain dry and fresh leaves (PDL and PFL) and *Musa sapientum* fresh and dry leaves (BFL and BDL) before it was used in wrapping Oblongo detectable trace of bacteria across the three locations. The highest bacteria count was found Sekondi. PDL recorded the highest count (1.5x10^4) followed by BFL (1.4 x10^4). Lowest bacteria count was found in BDL across the three locations. *Micrococcus*, *Pseudomonas*, *Alcaligenes* and *Bacillus* sp. were reported to be among thebacterial species on the surface of plants. (Pereira, 2018). A study showed that, organisms isolated from the leaves of *Musa sapientum*, were *Salmonella spp*, *Citrobacter spp and Staphylococcus spp* (Christiana, Ikechukwu, Christian, Forstinus, & Victo, 2016).

Total coliform (TC) count is regarded as a hygiene indicator, particularly to test whether there are foecal contaminations. However, in view of Naikwade, Gaurav, Sharayu, & Kailas, (2014) their presence does not indicate the presence of pathogenic microorganisms. In this study, coliforms were not detected in all leave packaged products and stock but recorded on leave prior to packaging. Yet, there were no significant differences among the samples in terms of their total coliform count. However, PDL, PFL and SFL recorded coliform count ranging from 0.1 X10^{2} ^{to} 0.6 X10^3cfu/g in only two study area-Sekondi and Takoradi. These results is contrary to those of many investigations where 68% of the analyzed samples had more than 4.0 log cfu/g, with most samples having counts of 6.0–7.9 log cfu/g (Seo & Lim, 2022). Moreover, sanitary conditions at the production and post-production levels, could also have contributed to the differences.

The observed mean of yeast and mold was higher than that of aerobic plate count (Table 4 and 5). This conformed to Ju, Chen, Xie, Yu, Guo, Cheng and Yao (2019) who showed that the level of bacterial isolated in vegetables was lower in leaves and moulds. The present study showed that yeast and mold count ranges from to 3.0 to 333 cfu/g. In contrast with study carried out by Daranas, Roselló, Cabrefiga, Donati, Francés, Badosa, and Bonaterra (2019) there was a significant drop in yeast and mold count of untreated PDL and SFL to a product of OPSDL and OPSFL. This may be due to the processing before being used for packaging foods. This is similar to Ortiz-Solà, Abadias, Colàs-Medà, Anguera, & Viñas (2021) who obtained similar results on the minimally processed vegetable.

However, there are possible health problems associated with the presence of mould found in vegetables, as some mould may produce mycotoxins or induce allergies (Varner, 2021). All the extracts were positive of phenolic compound. It shows that the high content of phenolic of fresh and dry leaves of *Musa sapientum* and leaves of *Musa paradisiaca*. In addition, it gives a clear indication that these compounds in the leaves contribute to the antioxidant activity, which similar to garlic acids and can be a natural source of radicals scavenger activity potential for preventing life threatening diseases of the consumer. Indeed, Phytochemicals are known to exhibit numerous plant and different biochemical actions in animal species when ingested (Naz, Roberts, Bano, Nosheen, Yasmin, Hassan & Anwar, 2020). The presence of saponin tested in the aqueous extract of fresh and dried leaves of *M. sapientum* and *M. Paradisiaca* in this study is in contrast with Abidin (2021) where saponin is absent in *Musa pardisiaca* leaf. These differences may be due to the different location of the plant. Saponin precipitates proteins, lower cholesterol, exhibits anti-diebetic and anticarcinogen properties (Kifle& Belayneh 2020). Saponin are also glycosides and triterpenes and steroid which have hypotensive and cardiac depressant properties (Alamgir, 2018; Pranati, Krishna, Ranjan, Sweta, Chandi, & Lata, 2018). Polyphenol, tannis were also present. These compounds such as caffeic acid and gallic acid are very important plant constituents (Sheth, Elm, Molyneaux, Hinson, Beslow, Sze & Kimberly, 2016), equivalent to antioxidants.

Although alkaloids were present in this study, it showed otherwise in the work of (Salawu, 2021). The differences in result may be due to difference in environmental condition in Ghana and in Nigeria. Acidri, et al., (2020) stated that the most valuable of all the phytochemicals, they have analgic system, antiplasmasmodiiac and bacteria effect (Gitsels, Sanders, & Vanrompay, 2019; Uzuazokaro, Okwesili & Chioma, 2018). In addition, triterpens which have anti- microbial or antiseptic properties were present. This makes the fresh and dried leaves of *Musa sapientum* and *Musa Paradisiaca* safe for packaging.

Flavonoids are which act as antioxidants and gives protection against cardiovascular disease, certain forms of cancer and age-related degeneration of cell components was also found in the extract of the fresh and dry leaf *Musa* *sapentum* and *Musa Paradisiaca.* Their polyphenolic nature enables them to scavenge injurious free radicals such as super oxide and hydroxyl radicals (Płonka, Górny, Kokoszka, & Barchanska, 2020).

The research hypothesis was explored thoroughly and there were significant differences; in the nutrient contents (protein, carbohydrate, fibre, phosphorus iron and B-carotene) between food packaged with *Musa sapientum, Musa paradisiaca* leaves and food packaged in Cellophane (plastics). More so, there were significant differences in the level of microbial activity and antioxidant of food packaged with *Musa sapientum,*

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Overview

This chapter summarizes the data collected during the study with relevant findings. It also, presents the conclusions reached on the main issues raise further outlines the recommendations based on the findings.

The study generally made an in-depth evaluation on perception and preference of food wrapped in fresh and dry leaves of *Musa Sapientum* and *Musa paradisiaca* for consumers, as well as an assessment on the nutritional and microbial effects of food wrapped in fresh and dry of Musa *Sapientum* and *Musa paradisiaca*

Summary

The study investigated the consumer's perception, preference and demand for food packaged in *Musa sapientum* and *Musa paradisiaca* leave in three major markets in the Sekondi-Takoradi metropolis and assessed the microbial and nutritive value of food packaged in these leaves. A descriptive survey was conducted to assess the preference, perception and demand of food vendors who packaged food in *M.sapientum* and *M. paradisiaca* leaves as well as consumers. A proportional stratified sampling technique was used to select 100 food vendors and convenient sampling to select 246 consumers in the three major markets in the Sekondi-Takoradi Metropolis. Five-trained research assistance was employed in the collection of data. Data were analyzed using descriptive statistics in SPSS. Quantitative data obtained from microbial and nutritive was subjected to one-way Analysis of Variance (ANOVA) in GenStat Discovery version 12.0. The results of this work were to determine specific nutrients and the safetiness of food packaged in *Musa sapientum* and *Musa paradisiaca* leaves to enable consumers and food vendors to make an informed decision in terms of material for food packaging.

Key Findings

The study revealed that majority of the food service operators who packaged food in *M. sapientum* and *M. parasidiaca* leaves where mainly food vendors who engaged in kenkey selling.

Consumer preferences were geared towards presumed health and safetiness, medicinal properties and availability of the leaves

The study revealed that there was significant amount of mascronutrient such protein, carbohydrate and fibre present in food packaged in *Musa sapientum* and *Musa paradisiaca* leaves.

The study also revealed appreciably high contents of phosphorus, potassium, iron and β-Carotene in oblongo, which had been wrapped in *M. sapientum* and *M. parasidiaca* fresh leaves, while copper and zinc were noticeable in the oblongo wrapped in dry leaves.

At the same time, traceable amounts of bacteria count, coliforms, yeast, and mold and antioxidants were identified on both fresh and dry leaves collected across the three locations. Alternatively, there were no detectable traces of microbes on the Cellophane and the oblongo packaged in leaves under hygenic conditions.

Conclusions

The study evaluated the perception, preference, and demand of food packaged in *Musa sapientum* and *Musa paradisiaca* leaves and assessed its microbial and nutritive value. In view of that, four main objectives were investigated. Identify the types of foodservice operators currently using *Musa paradisiaca* and *Musa sapientium* leaves for packaging food for consumers. The study revealed. 72.6 % of the consumers responded that they mainly buy food from food vendors with Kenkey, Nsiho, Oblongo, and Fomfom packaged in *Musa sapientum* and *Musa parasidiaca* leaves.

Evaluate consumer's Perception and Preference for the use of Musa *sapientium* and *Musa paradisiaca* leaves.

This study showed the foodservice operator's choice to choose *Musa sapientum* and *Musa paradisiaca* leaves as packaging material was based on their availability and longer shelf life. On the other hand, consumers preference was based on the presumed medicinal properties of the leaves as well as their availability and cost. Again, it was observed that both consumers and foodservice operators had an informed or presumed perception of some available nutrition in leaves. About 95% of the foodservice operators and 84 % of consumers perceived the migration of some particles in nutrients into wrapped food. However, few of the respondents (9.2%) complained about the difficulty in wrapping and unwrapping and the packaged foods' unattractiveness. Consumer 89.1% agreed that *M. sapientum* and *M. parasidiaca* leaves are the cheapest packaging materials in terms of cost and are safe compared to other packaging materials such as plastics. Despite consumers' responses for leaves as unattractive as a packaging material, their acceptability and demand for using leaves were high**.** They agreed that food packaged with *M. sapientum* and *M. parasidiaca* has continuously sustained consumer needs.

The proximate composition of food packaged in *Musa sapientum* and *Musa paradisiaca* leaves; protein, fibre, fat, moisture, and carbohydrate were assed, the result exhibited that all the parameters of the proximate composition were significantly different (p < 0. 05) among each other. Due to sufficient amount of calorie and protein, Protein Energy Malnutrition (PEM) could be reduced if food packaged in *Musa sapientum* and *Musa paradisiaca* leaves are consumed.

Generally, the study also revealed that mineral content for phosphorus, potassium, iron and β-Carotene, were appreciably high in oblongo wrapped in *Musa sapientum* and *Musa paradisiaca* fresh leaves. At the same time, copper and zinc were noticeable in the oblongo wrapped in *Musa sapientum* and *Musa paradisiaca* dry leaves, respectively. The values of the mineral content showed significant differences ($p < 0.05$) among the products. Calcium is the most abundant among the micronutrient. The presence of calcium as a mineral content which are essential for strong and healthy bones which can help prevent bone related diseases (oesteomalacia and osteoporosis) in adult and children when food packaged in leaves of *Musa sapientum* and *Musa paradisiaca* leaves are consumed.

Assess microbial effects and antioxidants of food packaged in *Musa sapientium and Musa paradisiaca* leaves

The total bacteria count of samples across the three locations ranged from 1.2 x 10^3 to 1.5 x 10^4cfu/g. However, there was no detectable trace of bacteria colony in OPSFL-P, OPSDL-P, OPSFL-S, OPSDL-S, OPPFL-P, OPPDL-P, OPPFL-S, OPPDL-S, and Control (OPC-P, OPCS, and Cellophane) across the three locations. Bacterial colonies were observed only on *Musa paradisiaca* dry leaves, fresh leaves, *Musa sapientium* fresh leaves, and *Musa sapientium* dry leaves, respectively. The highest bacterial count (1.5 x 10^4 cfu/g) was observed on *Musa paradisiaca* dry leaves purchased in Sekondi. The lowest bacterial count (0.2 x 10^3 cfu/g) was observed on *Musa sapientium* dry leaves only bought from Kojokrom. The highest bacterial count (1.5 x 10^4 cfu/g) was observed on *Musa paradisiaca* dry leaves bought from Sekondi. The lowest bacterial count (0.2 x 10^3 cfu/g) was observed on *Musa sapientium* dry leaves only from Kojokrom. This bacterial count could be attributed to the observed unhygienic practices of the various food sellers in Sekondi and Takoradi. All the extracts were also signs of phenolic compound similar to an antioxidant in garlic. The presence of the antioxidant extract of *Musa sapientum* and of *Musa paradisiaca* leaves indicate these compounds can be regarded as a promising plant species for a natural source of radical's scavenger activity potential for preventing life-threatening diseases as well as a good source for material for food packaging

In conclusion, food packaged with *Musa sapientum* and *Musa paradisiaca leaves* contains some active and intelligent ingredients in the form of nutrients and antioxidants. However, high-quality control or hygiene needs to be observed to avoid bacterial infection.

Recommendations

1. This study calls for strong nutrition education for foodservice operators on the use of both fresh and dry leaves of *Musa sapientum* and *Musa paradisiaca* for packaging food.

2. Foodservice operators should be encouraged to wash the leaves with clean water and pay particular attention to the parts of the leaves that could harbor any type of microorganism before using them.
3. All foods wrapped in these leaves should be consumed as soon as possible, when hot, to reduce microorganisms' multiplication.
4. Foodservice operators must implement high level of aseptic techniques when packaging food with fresh and dry of *Musa sapientum* and *Musa paradisiaca* leaves.

Suggestion for Further studies

1. Another experiment should be conducted to ascertain the toxicity of food that has been packaged with fresh and dry leaves of *Musa sapientum* and *Musa paradisiaca.*
2. A study on finding the specific microorganisms on leaves of *Musa sapientum* and *Musa paradisiaca* can leach into food.

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APPENDICES

APPENDIX A- PHYTOCHEMICAL ANALYSIS

Table A: Total Phenolic Content (Ascorbic acid equivalent)/mgL^{-1}

Sample ID	*Musa sapientum* extract	*Musa paradisiaca extract*
Dry Leaves		
	35.01869159	146.3271028
	35.20560748	148.1028037
	35.48598131	146.7009346
Fresh Leaves		
	19.13084112	64.64485981
	20.1588785	65.39252336
	19.78504673	65.6728972

Table B: Total Antioxidant Capacity (Gallic acid equivalent)/mgL^{-1}

Sample ID	*Musa sapientum* extract	*Musa paradisiaca extract*
Dry Leaves		
	33.752212	150.0354
	34.19469	151.71681
	34.637168	151.45133
Fresh Leaves		
	70.389381	88.672566
	71.185841	86.017699
	72.867257	86.902655

GenStat Release 12.1 (PC/Windows Vista) 23 January 2021 12:22:55
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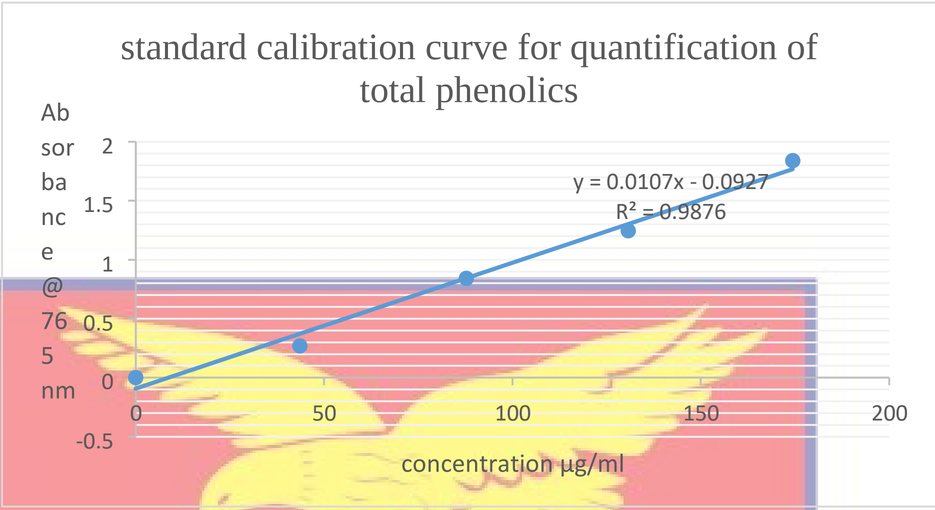

Figure 18: Quantification of the total Phenolic Content (Ascorbic acid equivalent)/ugml-11

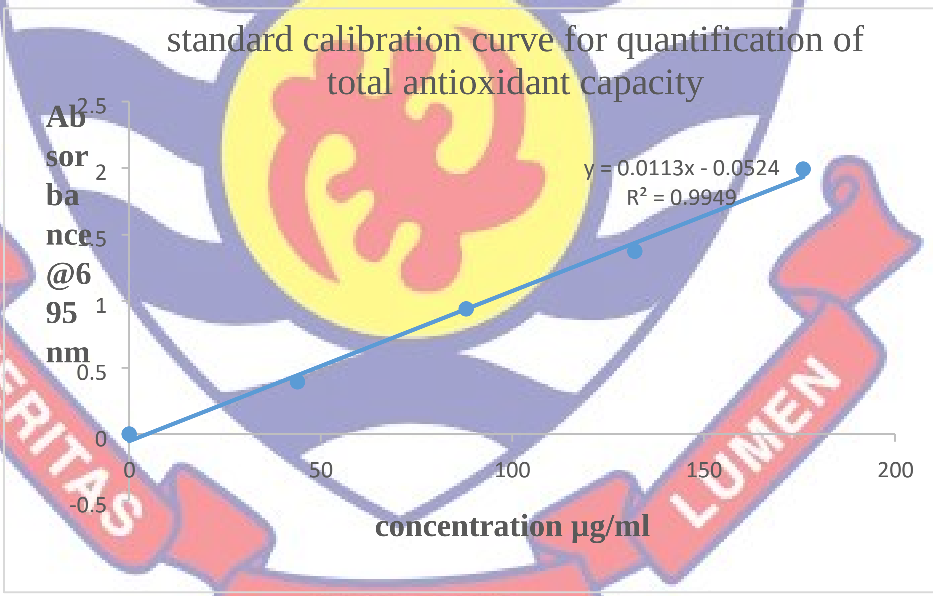

Figure 19: Quantification of the total Antioxidant Capacity (Gallic acid equivalent)/ugml

APPENDIX B- MICROBIAL ANALYSIS

GenStat Twelfth Edition

GenStat Procedure Library Release PL20.1

```
%CD 'C:/Users/asiam/OneDrive/Documents'
"Data taken from unsaved spreadsheet: New Data;1"
DELETE [REDEFINE=yes] _stitle_: TEXT _stitle_
READ [PRINT=*; SETNVALUES=yes] _stitle_
PRINT [IPRINT=*] _stitle_; JUST=left
 Data imported from Clipboard
 on: 23-Jan-2021 12:28:49

DELETE [REDEFINE=yes]
Sample,SAMPLE_LOC,AV_APC,AV_CC,AV_ECOLI,AV_Y_M
UNITS [NVALUES=*]
FACTOR [MODIFY=yes; NVALUES=45; LEVELS=15;
LABELS=!t('BDL ONLY','BFL ONY',\
'Cellophane only','OWBDL-F','OWBDL-S','OWBFL-F','OWBFL-
S','OWC-F','OWCS',\
'OWPDL-F','OWPDL-S','OWPFL-F','OWPFL-S','PDL ONLY','PFL
ONLY')\
; REFERENCE=1] Sample
READ Sample; FREPRESENTATION=ordinal
```

Identifier	Values	Missing	Levels
Sample	45	0	15

```
17      FACTOR [MODIFY=yes; NVALUES=45; LEVELS=3;
LABELS=!t('Kojokrom','Sekondi',\
18      'Takoradi'); REFERENCE=1] SAMPLE_LOC
19      READ SAMPLE_LOC; FREPRESENTATION=ordinal
```

Identifier	Values	Missing	Levels
SAMPLE_LOC	45	0	3

```
22      VARIATE [NVALUES=45] AV_APC
23      READ AV_APC
```

Identifier	Minimum	Mean	Maximum	Values	Missing
AV_APC	0.0000	1742	15706	45	0

Skew

```
27      VARIATE [NVALUES=45] AV_CC
28      READ AV_CC
```

Identifier Minimum Values Missing

Mean Maximum

AV_CC 0.0000 56.80 1072 45

0 Skew

32 VARIATE

[NVALUES=45] AV_ECOLI

33 READ

AV_ECOLI

Identifier Minimum Values Missing

Mean Maximum

AV_ECOLI 45

0.0000 899.3 7930

0 Skew

37 VARIATE [NVALUES=45]

AV_Y_M

38 READ AV_Y_M

Identifier Minimum

Mean Maximum Values

Missing

AV_Y_M 0.0000 54.65 333.0 45

0 Skew

44

45 %PostMessage 1129; 0; 83065112 "Sheet Update Completed"

46 "Two-way ANOVA (no Blocking)."

47 BLOCK "No Blocking"

48 TREATMENTS Sample*SAMPLE_LOC

49 COVARIATE "No Covariate"

50 ANOVA [PRINT=aovtable,information,means,%cv; CONTRASTS=7; PCONTRASTS=7; FPROB=yes;\

51 PSE=diff] AV_APC

Analysis of variance

Variate: AV_APC

Source of variation d.f. v.r. F pr.

Sample 14

558399224.

39885659.

SAMPLE_LOC 2

52099868.

26049934.

Sample.SAMPLE_LOC 28

302777837.

10813494.

Total 44 913:

Tables of means

Variate: AV_APC

Grand mean 1741.80

Sample BDL ONLY BFL ONY Cellophane

only OWBDL-F

269.78 10417.89 0.00 0.00

Sample OWBDL-S OWBFL-F OWBFL-S OWC-F

0.00 0.00 0.00 0.00

Sample OWCS OWPDL-F OWPDL-S

OWPFL-F

0.00 0.00 0.00 0.00

Sample OWPFL-S PDL ONLY PFL ONLY

0.00 6332.33 9107.00

SAMPLE_LOC Kojokrom Takoradi

Sekondi 2040.42 2884.69

300.29

Sample _LOC Kojokrom Sekondi Takoradi

BDL ONLY 223.00 447.00 139.33

BFL ONY 14903.33 14506.67 1843.67

Cellophane only 0.00 0.00 0.00

OWBDL-F 0.00 0.00 0.00

OWBDL-S 0.00 0.00 0.00

OWBFL-F 0.00 0.00 0.00

OWBFL-S	0.00	0.00	0.00
OWC-F	0.00	0.00	0.00
OWCS	0.00	0.00	0.00
OWPDL-F	0.00	0.00	0.00
OWPDL-S	0.00	0.00	0.00
OWPFL-F	0.00	0.00	0.00
OWPFL-S	0.00	0.00	0.00
PDL ONLY	1270.00	15706.33	2020.67
PFL ONLY	14210.00	12610.33	500.67

Standard errors of differences of means

Table	Sample	SAMPLE_LOC	Sample SAMPLE_LOC	
rep.	3	15	1	d.f. *
s.e.d.	*	*	*	

Stratum standard errors and coefficients of variation

Variate: AV_APC

d.f.	s.e.	cv%
0	*	*

52 "Two-way ANOVA (no Blocking)."

53 BLOCK "No Blocking"

54 TREATMENTS Sample+SAMPLE_LOC

55 COVARIATE "No Covariate"

56 ANOVA

[PRINT=aovtable,information,means,%cv; CONTRASTS=7;

PCONTRASTS=7; FPROB=yes;\

57 PSE=diff] AV_APC

Analysis of variance

Variate: AV_APC

Source of variation	d.f.		v.r.	F pr.
Sample	14	5	3.69	0.002
SAMPLE_LOC	2	5	2.41	0.108
Residual	28	3		
Total				

Message: the following units have large residuals.

units 9	8231.	s.e.	2594.
units 40	-7165.	s.e.	2594.
units 41	-7133.	s.e.	2594.

Tables of means

Variate: AV_APC

Grand mean 1742.

Analysis of variance

Variate: AV_CC

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Sample	14	506718.	36194.	1.10	0.402
SAMPLE_LOC	2	205746.	102873.	3.11	0.060
Residual	28	925219.	33044.		
Total	44	1637683.			

Analysis of variance

Variate: AV_ECOLI

Source of variation	d.f.		v.r.	F pr.
Sample	14	147	3.77	0.001
SAMPLE_LOC		7088461.	2.54	0.097
Residual		2790901.		

Total

Message: the following units

have large residuals.

units 9	4086.	s.e.	1318.
units 40	-3652.	s.e.	1318.
units 41	-3718.	s.e.	1318.

Stratum standard errors and coefficients of variation

Variate: AV_ECOLI

d.f.	s.e.	cv%
28	1670.6	185.8

70 "Two-way ANOVA (no Blocking)."

71 BLOCK "No Blocking"

72 TREATMENTS Sample+SAMPLE_LOC

73 COVARIATE "No Covariate"

74 ANOVA [PRINT=aovtable,information,means,%cv; CONTRASTS=7; PCONTRASTS=7; FPROB=yes;\

75 PSE=diff] AV_Y_M

Analysis of variance

Variate: AV_Y_M

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Sample	14	315199.	22514.	13.64	<.001
SAMPLE_LOC	2	16842.	8421.	5.10	0.013
Residual	28	46230.	1651.		
Total	44	378270.			

SAMPLE_LOC	Kojokrom	Sekondi	Takoradi
	50.0	33.6	80.3

Standard errors of differences of means

Table	Sample	SAMPLE_LOC
rep.	3	15
d.f.	28	28
s.e.d.	33.18	14.84

Stratum standard errors and coefficients of variation

Variate: AV_Y_M

d.f.	s.e.	cv%
28	40.63	74.3

APPENDIX C- PROXIMATE ANALYSIS PROXIMATE ANALYSIS AND RESULT

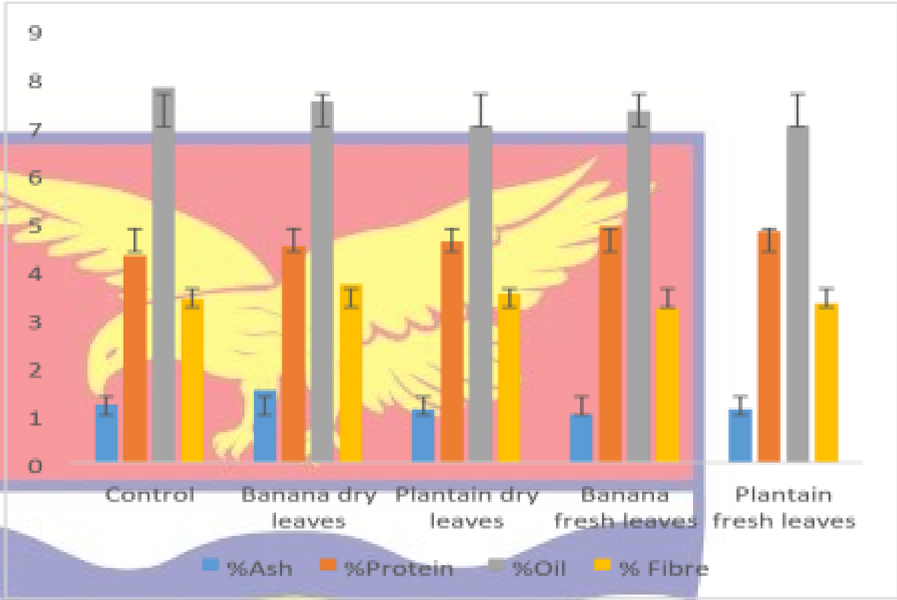

Figure 20: Lab result of percentage Ash, percentage protein, percentage oil and percentage fiber of control, Banana (*Musa parasidisiaca*) and Plantain (*Musa sapientum*) fresh and dry leave, respectively

Source: Lab Work, 2021

Table A : Nutritional status of Oblongo wrapped in Cellophane, Banana and Plantain fresh and dry leaves

Sample	%DM	%Moisture	%Ash	%Protein	%Oil	% Fiber	%CHO
OW-Cellophane	44.91 ± 0.12	55.09 ± 0.12	1.17 ± 0.09	4.27 ± 0.11	7.77 ± 0.09	3.35 ± 0.08	83.43 ± 0.04
Banana dry leaves	42.61 ± 0.44	57.39 ± 0.44	1.08 ± 0.05	4.77 ± 0.04	7.05 ± 0.04	3.27 ± 0.04	83.83 ± 0.06
Plantain dry leaves	44.36 ± 0.38	55.64 ± 0.38	1.08 ± 0.06	4.58 ± 0.03	7.02 ± 0.02	3.56 ± 0.10	83.76 ± 0.08
Banana fresh leaves	43.38 ± 0.47	56.62 ± 0.47	1.03 ± 0.05	4.89 ± 0.20	7.27 ± 0.05	3.21 ± 0.78	83.59 ± 0.18
Plantain fresh leaves	44.60 ± 0.30	55.39 ± 0.30	1.54 ± 0.09	4.53 ± 0.06	7.50 ± 0.03	3.77 ± 0.14	82.67 ± 0.10

Table : Mineral status of Oblongo wrapped in Cellophane, Banana and Plantain fresh and dry leaves

Sample	P ug/g	K ug/g	Na ug/g	Fe ug/g	Cu ug/g	Zn ug/g	%Ca	%Mg	β-Carotene ug/g
Control	2708.07 ± 25.68	5274.6 ± 43.28	255 ± 4.71	916.7 ± 12.81	167.5 ± 3.70	167.50 ± 0.93	1.21 ± 0.03	0.15 ± 002	70.20 ± 0.20
BDL	2708.42 ± 88.51	6250.53 ± 189.64	251.85 ± 9.28	724.39 ± 19.39	111.05 ± 4.46	108.28 ± 4.72	1.09 ± 0.05	0.13 ± 0.003	74.24 ± 0.57
PDL	2675.00 ± 73.48	6142.90 ± 99.96	240.94 ± 5.20	615.93 ± 6.40[d]	91.81 ± 1.98	85.14 ± 2.35	1.12 ± 0.06	0.13 ± 0.002	74.31 ± 0.31
BFL	2726.52 ± 19.16	7366.18 ± 53.45	246.47 ± 2.94	804.37 ± 9.34	98.00 ± 1.17	58.54 ± 2.91	1.20 ± 0.05	0.15 ± 0.004	80.50 ± 0.55
PFL	2731.90 ± 21.10	7882.44 ± 120.96	243.17 ± 3.76	792.18 ± 2.23	85.92 ± 1.57	76.54 ± 1.18	1.26 ± 0.05	0.15 ± 0.002	75.61 ± 0.41

APPENDIX D- QUESTIONAIRES

UNIVERSITY OF CAPE COAST, GHANA

QUESTIONNAIRE FOR FOOD SERVICE OPERATORS (FOOD VENDORS)

The Researcher (graduate student) from the above named university is undertaking a research project on Microbial and Nutritional Evaluation of Food Packaged in *Musa sapientum* and *Musa paradisiaca* (banana and plantain leaves). The purpose of this study is to collect information on the perception, challenge and demand for the use of *Musa sapientium* and *Musa paradsiaca* leaves as a packaging material for consumers of Sekondi-Takoradi Metropolis.Your views are very much important to the study. Every information you provide would remain highly confidential. Thanks for accepting to participate in the study.

SOCIO-DEMOGRAPHIC CHARACTERISTICS

Occupation	Tick (√)	Gender	Tick (√)	Location	Educational Qualification	Tick (√)
Food vendor		Male			No Educational Qualification	
Restaurant operator		Female			Basic Education Cert / Middle School Leaving Cert	
Food hawker					WASSCE/SSCE/O/A Level	
					Training college	
Other, please indicate …………………………… ………………….					Undergraduate Degree Master's Degree	
					Other, please indicate ……………………………………	

Age:

1. 10-20
2. 21-30
3. 31-40
4. 41-50
5. 51+

FOOD SERVICE OPERATOR (FOOD VENDOR)
6. **From which of the following food joint do you operate?** ○ **Restaurant** ○ **Hotel** ○ **food vendor** ○ **chop bar** ○ **Other, please indicate ……………………………………**

7. What type of food do you sell

○ Yes

○ No

8. What do you use to packaged food for consumers?

○ Polythene ( )

○ paper ( )

○ cellophane ( )

○ leaves ( )

○ others ( )

9. Reasons for your choice in question (6)…………………………………………………………

○ Cheap ( )

○ Availability ( )

○ Safe and Healthy ( )

○ Consumer preference ( )

- Others (specify) …………………………………………..

10. Among these packaging materials do you agree that the use of leaves can be the safest and cheapest packaging material?

- Yes ( )
- No ( )

- Have you ever use plantain leaves to package food before?

a. Yes () b. No ( )

- Have you ever use banana leaves to package food before?

a. Yes ( ) b. No ( )

- How often does you use it?
- Always ( )
- Most often ( )
- Sometimes ( )
- Rarely ( )
- Never ( )
- Why your choice in '9'?

……………………………………………………………………………

- Are you aware of any nutritional benefit of food wrapped or packaged in plantain / banana leaves? a. Yes ( ) b. No ( )

- If yes state some of the benefits

……………………………………………………

○ In terms of food packaging do you prefer the use of plastic over the use of leaves?

○ Yes ( )

○ No ( )

○ Are you aware banana and plantain leaves may contain an antioxidant?

○ Yes ( )

○ No ( )

○ If yes please explain

………………………………………………………………………………………

……………………………………………………………………………………

○ When you get the opportunity to be well informed on all the benefits of plantain /banana leaves will you recommend it for other food service operators (food vendors).

28. Yes ( )

29. No ( )

CONSUMER PERCEPTION

On a scale of Strongly Disagree to Strongly Agree, please indicate your level of agreement with the following statements:

S/N	BENEFITS / PROSPECT	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
16.	Leaves are the safest packaging material?					
17.	Food wrapped in leaves have pleasant smell.					
18.	Banana/ plantain leaves are the cheapest packaging material in terms of cost.					
19.	Banana/ plantain leaves are the cheapest packaging material in terms of availability.					
20.	Banana/Plantain leaves enhance food nutrient.					
21	Food packaged in plastics are convenient than food packaged in leaves.					
22.	Leaves are important contribution to diet.					
23.	Food in plastics are less expensive than food in leaves.					
24.	Food in plastics are more hygienic than food in leaves.					
25.	Packaging food in leaves are difficult than in plastics					

26. Are you aware packaged materials can migrate some particles into the food source?

- ○ Yes
- ○ No

27. What particles do you know can be migrated into the food source?

- ○ Dirt
- ○ Microbial
- ○ Colour
- ○ Water
- ○ Nutrients
- ○ Others…………………………

1. Are you aware of any nutritional benefit of food wrapped or packaged in plantain leaves? a. Yes ( ) b. No ( )
2. If yes state some of the benefits

Protein

Carbohydrate

Vitamin

Minerals

Others…………………

3. Are you aware of any nutritional benefit of food wrapped or packaged in banana leaves?
4. What challenge do you face in packaging and selling leaf packaged foods?……………………………………………………..……

5. Do you have any questions/ comments/ suggestions?

……………………………………………………………………………………

……………………………………………………………………

Thank you.

END OF QUESTIONS THANK YOU

UNIVERSITY OF CAPE COAST, GHANA

QUESTIONNAIRE FOR CONSUMERS

The Researcher Esther Lomo-Mensah from the above named university is undertaking a research project on Microbial and Nutritional Evaluation of Food Packaged in *Musa sapientum* and *Musa paradisiaca* (banana and plantain leaves). The purpose of this study is to collect information on the perception, challenge and demand for the use of *Musa sapientium* and *Musa paradsiaca* leaves as a packaging material for consumers of Sekondi-Takoradi Metropolis.Your views are very much important to the study. Every information you provide would remain highly confidential. Thanks for accepting to participate in the study.

SOCIO-DEMOGRAPHIC CHARACTERISTICS

Occupation	Tick (√)		Gender	Tick (√)		Location		Educational Qualification	Tick (√)
Food vendor			Male					No Educational Qualification	
Restaurant operator			Female					Basic Education Cert / Middle School Leaving Cert	
Teacher								WASSCE/SSCE/O/A Level	
Student								Training college	
Trader									
Other, please indicate ……………… ……………… ……………….								Undergraduate Degree Master’s Degree	
								Other, please indicate …………………………………	

Age:

6. 10-20
7. 21-30

8.	31-40
9.	41-50
10.	51+
	CONSUMER PREFERENCE
○	From which of the following food service operators do you purchase food?
○	Restaurant
○	Hotel
○	Food vendor
○	Chop bar
○	Other, please indicate ……………………………………

- Which of the following food do you often buy?
- Abodoo ( )
- Fante Kenkey ( )
- Ofam
- waakye
- Others (specify) ……………………………….
- What do you prefer the food vendor use to package food?
- Polythene/Plastic ( )
- paper ( )
- cellophane ( )
- leaves ( )
- Others (specify)………………………………………………………………………
- Reasons for your choice in question (2)..
- Cheap ( )
- Availability ( )
- Safe and Healthy ( )
- Medicinal ( )
- Has antioxidant ( )
- Others (specify) ……………………………………………..
- In terms of fast food packaging do you prefer the use of leaves?
- Yes ( )
- No ( )

- If yes in which form?
- Fresh leaf ( )
- Dry leaf ( )
- Any ( )
- Why do you think leaves is the best packaging material?
- Hygienic ( )
- Attractive ( )
- Long shelf life ( )
- No Apparent concerns ( )
- None of the above
- Others (specify) …………………………………………..
- Why do you think leaves is not the best packaging material?
- Unhygienic ( )
- Unattractive ( )
- Short shelf life ( )
- Harden easily ( )
- No Apparent concerns ( )
- Others (specify)……………………………………………………….
- Have you ever purchased food packaged in leaves before?
- Yes ( )
- No ( )
- Which leaf/ leaves was it packaged in?
- Plantain fresh leaf ( )

- Banana leaf ( )
- Waakye leaf ( )
- Others (specify)………………………….
- Do you normally purchased food packaged in plantain leaves before?
- Yes ( )
- No ( )
- If Yes, how often? ……………………………………………………………………..
- Always ( )
- Often (
- Rarely
- Sometimes
- Never
- Do you normally purchased food packaged in banana leaves before?
- Yes ( )
- No ( )
- If Yes, how often? ……………………………………………………………………..
- Always ( )
- Often
- Rarely
- Sometimes
- Never
- In which form is plantain/banana leaf often used for food packaging.
- Fresh leaf

- Dry leaf
- Both
- Which food do you normally purchased in dry leaf of plantain/banana
- Apiti
- Aboloo
- Kenkey
- Moimoi
- Other (specify)……………………….
- Which kind of dish do purchased in a fresh leaf of plantain/banana
- Fante kenkey
- Apiti
- Moimoi
- Tubani
- Other (specify)

CONSUMER PERCEPTION

On a scale of Strongly Disagree to Strongly Agree, please indicate your level of agreement with the following statements:

S/N	BENEFITS / PROSPECTS	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	Leaves are the safe packaging material?					
2.	Food in leaves has pleasant smell.					
3.	Banana/ plantain leaves a the cheapest packagi material in terms of cost.					
4.	Banana/ plantain leaves a the cheapest packagi material in terms availability.					
5.	Banana/Plantain leav enhance food nutrient					
6.	Food packaged in plasti are convenient than fo packaged in leaves					
7.	Banana/plantain leav have some health benefits					

8.	Food in plastics is le expensive than food leaves.					
9.	Food in plastics are mc hygienic than food leaves.					
10.	Your family prefer food plastics over food leaves?					

11. Are you aware that packaged materials can migrate some particles into the food source?

- Yes
- No

1. In your opinion, which particles do you know can be migrated into the food?

- Dirt
- Microbial
- Colour
- Water
- Nutrients
- Others……………………………

2. Are you aware of any nutritional benefit of food wrapped or packaged in plantain leaves? a. Yes ( ) b. No ( )

3. If yes state some of the benefits

12. Protein
13. Carbohydrate
14. Vitamin
15. Minerals
16. Others…………………

4. Are you aware of any nutritional benefits of food wrapped or packaged in banana leaves?

- Yes ( ) b. No ( )

5. If yes state some of the benefits

Protein

Carbohydrate

Vitamin

Minerals

Others…………………

6. Are you aware banana leaves may contain an antioxidant?

- Yes ( )
- No ( )

7. If yes please explain

…………………………………………………………………………………………

8. Are your plantain leaves may contain an antioxidant?

- Yes ( )
- No ( )

9. If yes please explain ……………………………………………………………………

……………………………………………………………………………

10. What is your impression of buying food packaged in banana leaves?

a. Attractive

b. Unattractive

c. Expensive

d. Poorly finished

e. Unhygienic

f. Medicinal

g. Others (Specify) ………………………………………………………

11. If offered, would you prefer the use of food packaged with banana leaves that have an active and intelligent component that may be good for your health, overuse of plastic food packing?

- Yes ( )
- No ( )

12. Do you have any questions/ comments/ suggestions?

……………………………………………………………………………………………

……………………………………………………………………………………………

Thank you.

END OF QUESTIONS THANK YOU

APPENDIX E- INTRODUCTORY LETTER

UNIVERSITY OF CAPE COAST

INSTITUTIONAL REVIEW BOARD SECRETARIAT

TEL: 0558093143 / 0508878309
E-MAIL: irb@ucc.edu.gh
OUR REF: UCC/IRB/A/2016/846
YOUR REF:
OMB NO: 0990-0279
IORG #: IORG0009096

27TH NOVEMBER, 2020

Ms. Esther Lomo-Mensah
Department of Vocational and Technical Education
University of Cape Coast

Dear Ms Lomo-Mensah,

ETHICAL CLEARANCE – ID (UCCIRB/CES/2020/62)

The University of Cape Coast Institutional Review Board (UCCIRB) has granted **Provisional Approval** for the implementation of your research titled **Microbial and Nutritional Evaluation of Food Packaged in Musa Sapientum and Musa Paradisiaca (Banana and Plantain Leaves).** This approval is valid from 27TH November, 2020 to 26th November, 2021. You may apply for a renewal subject to submission of all the required documents that will be prescribed by the UCCIRB.

Please note that any modification to the project must be submitted to the UCCIRB for review and approval before its implementation. You are required to submit periodic review of the protocol to the Board and a final full review to the UCCIRB on completion of the research. The UCCIRB may observe or cause to be observed procedures and records of the research during and after implementation.

You are also required to report all serious adverse events related to this study to the UCCIRB within seven days verbally and fourteen days in writing.

Always quote the protocol identification number in all future correspondence with us in relation to this protocol.

Yours faithfully,

Samuel Asiedu Owusu, PhD
UCCIRB Administrator

ADMINISTRATOR
INSTITUTIONAL REVIEW BOARD
UNIVERSITY OF CAPE COAST

APPENDIX F- DATA ON FOOD SERVICE OPERATORS/ FOOD HANDLERS

REPUBLIC OF GHANA
OUR REF
YOUR REF:
TEL: 031-20-46371/2
TOLL FREE: VODAFONE: 080011903 / MTN: 18206

SEKONDI-TAKORADI METROPOLITAN ASSEMBLY
P. O. BOX 74, SEKONDI
E-MAIL: info@stma.gov.gh
WEBSITE: www.stma.gov.gh

17TH OCTOBER, 2019

DATA ON FOOD HANDLERS WITHIN SEKONDI-TAKORADI METROPOLITAN ASSEMBLY-2019
ENVIRONMENTAL HEALTH DEPARTMENT

SN	SUB METRO	NUMBER
1	Takoradi	2,150
2	Sekondi	1,002
3	Essikado-Ketan	2,031
	TOTAL	5,183

METRO ENV. HEALTH OFFICER
(ABDUL-KARIM HUDU)