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THE USE OF RIPE PLANTAIN IN THE PREPARATION OF OFAM; A TYPICAL LOCAL DISH PRODUCED IN GHANA

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DECLARATION

STUDENT'S DECLARATION

I, JEMIMA EVELYN ANDOH-NARTEY, declare that this thesis with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted either in part or whole, for another degree elsewhere.

SIGNATURE…….....

DATE ……

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of thesis as laid down by the University of Education, Winneba.

NAME OF SUPERVISOR: ABENA SEKYERE (MRS.)

SIGNATURE…….....

DATE ……

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I am grateful to Almighty God for His guidance and protection. Secondly, to my supervisor, Abena Sekyere for her supervisory guidance. Secondly, to my husband, Mr. Perry Isaac Akrofie Nartey for his financial support and motivation.

DEDICATION

I dedicate this work to my Dad, Mr. Francis Kwabena Andoh and Mother, Mrs. Mercy Akosua Andoh for their love and support financially, spiritually and morally.

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ABSTRACT

In Ghana, plantain surpluses have to be exported, processed or go to waste. A reduction in moisture content potentially increases shelf life and hence prevents excessive post-harvest loss and that drying is an alternative to a developing country like Ghana where there is deterioration due to poor storage, weather conditions and processing facilities. To this effect this study investigated the use of ripe plantain in the preparation of ofam a typical local dish produced in Ghana. The study objectives were to investigate the various methods used in the preparation of ofam as a traditional dish, ascertain the shelf-life of ofam on the local and international market, assess important criteria such as packaging structure, taste, colour, flavor, types of flour used in preparation, cooking mode and texture of ofam and examine the acceptability of the variety of ingredients used to prepare Ofam. This study adopted the experimental study design. The population for the study were one hundred and eighty (180). A sample size of 120 was selected for the study using random sampling method. The main instruments used to gather primary data were questionnaires and sensory evaluation. The data gathered was analysed statistically using Statistical Package for Social Sciences (SPSS) software version 16. The study revealed that 60.9% of the respondents affirmed that the shelf life of ofam is 1-2 weeks. Moreover, there is the need to create publicity regarding the importance of plantain consumption, encourage restaurant operators to include ofam in their menu and promote the local consumption of ofam. Moreover, 96.3% of the respondents agreed that Plantain is known to be low in sodium. The study finding shows that 93.6% of the respondents agreed that Plantains contains very little fat and no cholesterol. Finally, the packaging structure of cassava flour ofam and corn dough ofam was preferred compared to rice flour and corn flour ofam. The study concluded that, there is the need to invest in medical and laboratory research to unravel the numerous hidden advantages of consuming ofam.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

A study conducted by Stover and Simmonds, (1987), revealed that Plantains are valuable starchy staples in Ghana. They provide not only a rich source of dietary energy but also contribute to providing good quality diet and rural income. Plantain is rich in nutrients like potassium, which revitalizes muscle power; help maintain body fluid balance and mental function. Plantains are used as *Fufu, Ampesi* and as snack (Ortiz and Vuylsteke, 1996). They could also be processed into *Tatale, Kakro*, ofam and *Apetie.* Recently ripe plantain are being used for porridge. All the plantain cultivars in Ghana are susceptible to black Sigatoka disease and other pests except a cooking banana. The fear that the disease could wipe out the susceptible cultivars, efforts are being made to prepare for any eventuality.

New hybrids, resistant/tolerant to the disease have been introduced into the country. Two of the hybrids that have been evaluated and accepted by consumers were released to farmer. Cooking plantain is common among the Ghanaian dishes. Ofam or Bodogo, a product from diversify senescent plantain is a locally made sweet dish prepared from over ripe plantain when it is almost at its deteriorating state, and local flour such as cassava, corn, and rice. It is a derivative dish mostly patronized by our indigenous folks, and has been identified as a product with various sensorial qualities.

Plantain (Musa paradisiaca), constitutes the fourth most important global food commodity after rice, wheat and maize (Frisson & Sharrock, 1999; Bakry *et al.,* 2002). This starchy crop grows in tropical areas where it is mainly used to shade cocoa and coffee (Carmara, 1984; Koffi, 2007;) and constitutes an inexpensive source of calories for millions of people in Africa, the Caribbean, Latin America, Asia and the Pacific(IITA, 1998; Tchango-Tchango *et al.,* 1999; Akubor *et al.,* 2003; FAO, 2005).

It contributes significantly to food and income security of people engaged in its production and/ or trade, particularly in developing countries. Plantains are a member of the banana family. They are a starchy, low in sugar variety that is cooked before serving as it is unsuitable raw. It is used in many savory dishes somewhat like a potato would be used and is very popular. It is usually fried or baked. A plantain is one of the less sweet cultivated varieties of the genus *Musa*. Plantains are typically eaten cooked, sometimes along with their leaves and fibers, and are usually large, angular and starchy, in contrast to common or "dessert" bananas, which are typically eaten raw and without the peel, usually being smaller, more rounded and sugary; however, there is no formal scientific distinction between plantains and bananas. Plantains are a major food staple in Ghana and some parts of western and Central Africa countries (Akubor *et al.,* 2003).

Plantains contain more starch and less sugar than bananas and are therefore usually cooked or otherwise processed before being eaten. They are always cooked or fried when eaten green. At this stage, the pulp is hard and the peel often so stiff that it has to be cut with a knife to be removed. Mature plantains can be peeled like typical dessert bananas; the pulp is softer than in immature, green fruit and some of the starch has been converted to sugar(Akubor et al., 2003). They can be eaten raw, but are not as tasty in that state as dessert bananas, so are usually cooked. When mature, yellow plantain is fried, they tend to caramelize, turning a golden-brown color. They can also be boiled, baked, microwaved or grilled over charcoal, peeled or still in the peel. An average plantain has about 220 calories and is a good source of potassium and dietary fiber. Plantains are a staple food in the tropical regions of the world, the tenth most important staple that feeds the world. Plantains are treated in much the same way as potatoes and with a similar neutral flavour and texture when the unripe fruit is cooked by steaming, boiling or frying (Tchango *et al.,* 1999).

Plantains fruit is all year round, which makes the crop a reliable all-season staple food, particularly in developing countries with inadequate food storage, preservation and transportation technologies. In Africa, plantains and bananas provide more than 25 percent of the carbohydrate requirements for over 70 million people. The plantain however does not stand high winds well, and plantain plantations are therefore liable to destruction by hurricanes (Akubor *et al.,* 2003). The plantain ripens, it becomes sweeter and its colour changes from green to yellow to black, just like bananas. Green plantains are firm and starchy, and resemble potatoes in flavor. Yellow plantains are softer and starchy, but sweet. Extremely ripe plantains have softer, deep yellow pulp that is much sweeter than the earlier stages of ripeness (Tchango *et al.,* 1999).

Plantains in the yellow to black stages can be used in sweet dishes. Steam-cooked plantains are considered a nutritious food for infants and the elderly. A ripe plantain is used as food for infants at weaning; it is mashed with a pinch of salt. The sap from both the fruit peel and the entire plant can stain clothing and hands, and can be very difficult to remove. In Ghana, plantains are boiled and blended with water and sugar to make porridge.

Figure 1.1: Ripe Plantain Fruit

Plantain is a major source of carbohydrate in diets of people from Latin America, through most of Africa and from countries of South-east Asia (Marriott and Lancaster, 1983). It is estimated that 60 million people in West Africa derive more than 25% of their carbohydrate intake from plantain (Oritz and Vuylsteke, 1996). In Ghana, they have a higher

contribution to the Agricultural Gross Domestic Product (AGPD) than cereals (MOFA, 2006). According to Lescot (2000) its per capita annual consumption is higher than maize and yam. Annual production in Ghana is about 1.8 million metric tons of which only 0.5 tonnes is exported (Lescot, 2000). Several varieties of plantain are cultivated in West Africa. These are classified as French Horn Plantain, False Horn Plantain, or the True Horn Plantain (Ahiekpor, 1996). The local names of the subvarieties of French Horn plantain include Apempa, Oniaba and Nyeretiaapem. That of the False Horn are Borodewuo, Apantu pa, Borodesebo and Osoboaso while the True Horn sub varieties comprise Asamienu and Aowin. All these native varieties are classified as triploids with Musa as the genomic group. Pest and diseases have affected the production of these native varieties, the most notable being the fungal disease Black Sigatoka (Mycosphaerellafijiensis) (Stover and Simmonds, 1987; Swennen, 1990).

Yield losses due to the disease are highly significant ranging from 20 to 50%. Under very severe conditions yield losses may be as high as 80% (Hemeng and Banful, 1994). In view of this, new hybrids were introduced from Honduras in 1994 to supplement the landraces. The Tetraploid hybrids are high yielding and disease tolerant. The Tetraploids are produced when female fertile triploid landraces of plantain are crossed to diploid accessions of Musa acuminata or Musa balbisiana that are resistant to black Sigatoka disease. Ogazi (1982) reported that over 80% of the crop is harvested during the period of September to February, and that there is much wastage during this period as some of the products do not store for a long period. This results in seasonal unavailability and limitations on the use by urban populations. Therefore, there is a need to develop preservation methods for this crop. Air-drying is considered to be one of the simplest and most economical ways of commercially processing fruit and vegetables (Brennan et al., 1990). Air-drying could be considered as appropriate to developing countries as the product, suitably packaged, can be

stored for several months without the risk of spoilage and can be milled into flour and rehydrated for a variety of uses (Marriott and Lancaster, 1983).

In hot-air drying of plantain, enough water must be removed to lower the water activity to a level which inhibits the growth of microorganisms and reduces the rate at which enzymatic and non-enzymatic reactions occur. Thus, one of the primary requirements in using hot-air drying is to understand the phenomena involved in the drying process, to be able to predict drying times, establish the distribution of moisture throughout the solid pieces during drying and the influence of the processing variables such as air temperature and velocity, pre-treatment and the size of the pieces on drying behaviour (Johnson et al., 1998). Pre-treatments have been used commercially to accelerate the drying of fruits. Dipping fruits for several seconds in pre-treatment solutions greatly reduces the drying time (Radler, 1964). They are applied to the surface of the fruit by dipping; resulting in a coating which apparently breaks down the circular fruit surface, resulting in a reduced resistance to moisture loss and this increases the drying rate (Ponting and McBean, 1970).

Pre-treatments also lead to the bleaching of the plantain to prevent browning of its flour. Functional property has been defined by Matil (1971) as those characteristics that govern the behaviour of nutrients in food during processing, storage, and preparation as they affect food quality and acceptability. Some of the important functional properties that influence the utility of most starchy staples, such as plantain, include the drying characteristics, water binding capacity, swelling power, solubility, emulsion capacity, oil absorption capacity, whip ability, foam stability and viscosity Though drying has been widely used to promote food preservation as the reduction of moisture content brings down microbial activity and extends product life one must consider the other changes that accompany drying, even more so in the case of cellular materials, which may be greatly

affected by the dehydration process. Therefore, the study investigated the use of ripe plantain in the preparation of ofam, a typical local dish produced in Ghana.

1.2 Statement of the Problem

A study conducted by Dankye *et al.,* (2007), hold that production of plantain is seasonal whilst consumption is all year round and therefore there is the need to cut down on post-harvest losses by processing them into forms with reduced moisture content or prepare traditional dishes like ofam. Plantain has however been having an increasing surplus production since 2001. It is estimated that in 2010, there will be a surplus of 633,000 Mt and in 2015 about 852,000 Mt. This means that these surpluses have to be exported, processed or go to waste (Dankye *et al.,* 2007). A reduction in moisture content potentially increases shelf life and hence prevents excessive post-harvest loss and that drying is an alternative to a developing country like Ghana where there is deterioration due to poor storage, weather conditions and processing facilities. As solution to post-harvest losses and wastage of over-ripe plantain fruits are transformed into a traditional dish called Ofam or Abodongo in Ghana using empiric process. This process brings out the different sensorial characteristics of plantain depicting a true indigenous dish due to various local spices and flour used in its production.

The traditional dish is more and more introduced in rural habitant and recently is widely proposed in the urban markets. Nevertheless, consumers always complain about its sensorial qualities. The present study aimed to identify, through a survey, consumers' preferential, characteristics about ofam or abodongo. It will also look at its important criteria (packaging structure, taste, colour, flavor, types of flour used in its preparation, cooking mode and texture).

The ingredients in the preparation of this product is purely natural and all processes are free from artificial additives which poses less health risk, and its less expensive as compared to the foreign cake made up of wheat, sugar, margarine, eggs, and other artificial additives. This study is also going to take into an account the choice of ofam; then, for each criteria, the precise preferential characteristics expected. Although ofam has all this nutritional and sensorial qualities, it is not patronized unlike kenkey, gari, kaklo, plantain chips to mention a few, it is to this that the researcher want to come out with various recipes to encourage the intake of ofam as a local snack and to promote its market both locally and internationally.

1.3 Purpose of the Study

The primary purpose of the study is to investigate the use of ripe plantain in the preparation of ofam a typical local dish produced in Ghana.

1.4 Specific Objectives of the Study

The specific objectives of the study includes;

1. To investigate the various methods used in the preparation of ofam as a traditional dish.
2. To ascertain the shelf-life of ofam on the local and international market.
3. To assess important criteria such as packaging structure, taste, colour, flavor, types of flour used in preparation, cooking mode and texture of ofam.
4. To examine the acceptability of the variety of ingredients used to prepare Ofam.

1.5 Research Questions

The following research questions will be used for the study,

1. What are the various methods used in the preparation of ofam as a traditional dish?
2. What is the shelf-life of ofam on the local and international market?
3. How can important criteria such as packaging structure, taste, colour, flavor, types of flour used in preparation, cooking mode and texture of ofam be assessed?
4. What is the acceptability of the variety of ingredients used to prepare Ofam?

1.6 Significance of the study

The result of the study will address the need to encourage the consumption of traditional dishes (ofam and bodogo) by marketing it in various regions and introducing it in snack menus in restaurants and school children menus. It will also help to package and market the product internationally, and skills cooking competitions organized in the food industry.

1.7 Scope of the Study

The study will be focused on the use of local ingredients and over-ripe plantain. It will also seek to solve the wastage of plantain when it is in abundance and in season to improve food security and income generation in the urban areas. Moreover, the study will be geographically focused on the Accra Metropolis. The study is theoretically, empirically and conceptually limited in scope to the following research objectives including to investigate the various methods used in the preparation of ofam as a traditional dish, to ascertain the shelf-life of ofam on the local and international market, to assess important criteria such as packaging structure, taste, colour, flavor, types of flour used in preparation, cooking mode and texture of ofam, and to encourage and promote the consumption of ofam in the local and international markets.

1.8 Organization of the rest of the Study

This study consists of five Chapters, Chapter one deals with the background to the study, the statement of the problem, research questions and objectives of the study, significance and organization of the study. In Chapter two the researcher reviewed related literature whiles chapter three deals with the research methodology used in the study. Other aspects of chapter three describes the research design, the population sample and sample procedures, data gathering instruments and data collection procedures of the study, methods of data analysis. Chapter four describes the research findings and the discussion of the main findings and chapter five presents the summary of the findings, conclusions and recommendations and suggestions for further research.

CHAPTER TWO

LITERATURE REVIEW

Introduction

The chapter contains the theoretical, empirical and conceptual literatures relating to the health benefits of consuming plantain, and effective preparation of ofam, a traditional delicacy in Ghana. The gathering of literature is focused on the objectives of the study.

2.1 The Variety of ingredients used to prepare Ofam

Musa, a plant genus of extraordinary significance to human societies, produces the fourth most important foodin the world today (after rice, wheat, and maize), bananas and plantains. Musa species grow in a wide range of environments and have varied human uses, ranging from the edible bananas and plantains of the tropics to cold hardy fiber and ornamental plants. They have been a staple of the human diet since the dawn of recorded history. These large, perennial herbs, 2–9 m (6.6–30 ft) in height, evolvedin Southeast Asia, New Guinea, and the Indian subcontinent, developing in modern time's secondary loci of genetic diversity in Africa, Latin America, and the Pacific. Musa species attained a position of central importance within Pacific societies: the plant is a source of food, beverages, fermentable sugars, medicines, flavorings, cooked foods, silage, fragrance, rope, cordage, garlands, shelter, clothing, smoking material, and numerous ceremonial and religious uses. With the exception of atoll islands, banana and plantain are ideally suited for traditional Pacific island agroforestry, for interplanting in diversified systems, and for plantation-style cultivation in full sun. Although mostly consumed locally in the Pacific region, the fruit enjoys a significant worldwide export market. Not considered invasive, Musa nonetheless is a persistent plant that competes relatively well with other species with-in managed

agroforestry settings. Many cultivars are par- ticularly susceptible to certain pests and diseases, making monocrops or even backyard banana plantings relatively challenging and requiring high labor inputs to maintain them in healthy, productive condition. Local or indigenous selections are generally more useful and tolerant of local conditions, and have lower input requirements (compost, fertilizer, water) to obtain satisfactory yields. However, the Pacific's indigenous banana and plantain cultivars as a whole are highly sensitive to nematode, insect, and viral infestations. Some disease-resistant hybrids have been developed in recent years.

2.1.2 Botanical Description

Preferred scientific name Musa species there are five taxonomic sections in the genus Musa, two of which contain edible bananas. Family Musaceae (banana family)Common names banana, dessert banana, plantain, cooking banana (English) Pacific islands aga‘ (ripe banana) (Chamorro) chotda (Chamorro, Guam, Northern Marianas) fa‘i (Samoa) leka, jaina (Indian derivation) (Fiji) mai‘a (Hawai‘i) maika, panama (New Zealand: Maori) meika (Cook Islands) meika, mei‘a (French Polynesia) siaine (introduced cultivars), hopa (native) (Tonga) sou (Solomon Islands) te banana (Kiribati) uchu (Chuuk) uht (Pohnpei) usr (Kosrae) Fe‘i banana cultivars have a host of common names in dif- ferent islands. Other regions Banane, bananier (France) Banane, Bananen, Bananenpisang, Bananenstaude (German) banano (plant), plátano, platanero (plantain), guineo (dessert banana) (Spain, Latin America) chotda banana (plant), banana no tsubomi (flower) (Japan) djantoong (plant), jantungpisang (flower) (Indonesia, Malaysia) pisang, getang (Indonesia) saging (Philippines) barbaro, zapolete (Mexico) (Marriott and Lancaster, 1983).

2.1.2.1 Size of Plantain

Plantain is a large, perennial, monocotyledonous herb 2–9 m (6.6–30 ft) in height that arises from large, subterranean rhizomes (usually called "corms"). Flowers Upon flowering, the true stem or growing point emerges from the center of the tightly rolled bunch of leaves. This odd-looking "flower cluster" is actually an elongated, plump, purple to green "bud" (sometimes called the "bell" or "heart"), which at first displays large female flowers (whose ovaries ripen into fruit). As the "bud" elongates, it exposes semicircular layers of female flowers, then neutral flowers, and finally small, generally non-functional (with no viable pollen) male flowers. Each group of flowers is arranged radially on the stem in nodal clusters. Each flower cluster is borne on a prominence on the stem bearing (Dankye *et al.,* 2007).

2.1.3 Species

Profiles for Pacific Island Agroforestry the fruit (peduncle) and covered by a bract. About 12–20 flowers are produced per cluster. Collectively, the flowering parts and fruit are referred to as the bunch. Individual clusters of fruits are known as hands, and individual fruits are known as fingers (Dankye *et al.,* 2007).

Important factors that contribute to the desirability of banana fruits, sterility has impeded progress in breeding programs. Through natural somatic (vegetative) mutation, hybridization, and selection over many thousands of years, considerable genetic variability has arisen within the cultivated bananas, giving rise to more than 1000 varieties worldwide. There is a great diversity of banana varieties in the Pacific, particularly in Papua New Guinea and the Solomon Islands. There is much global concern that some varieties are becoming increasingly rare and that the important

diversity of banana is being eroded. Due to problems with male and female fertility among many of the desirable parents (e.g., the Cavendish subgroup is virtually sterile), breeding programs have only recently developed useful cultivars. Also, many natural and artificially bred hybrids are susceptible to important dis- eases and pests. The edible bananas of the world belong to the Eumusa section of the genus Musa, except for the Fe‘i group, which belong to the Australimusa section. The Fe‘i bananas are characterized by erect bunches, pink-red to purple sap and deep yellow or orange colored fruit pulp.

2.1.4 Leaves of Plantain

The entire above-ground portion of the plant is not a true woody trunk, as in other trees, but a “false trunk” or “false stem” that consists of leaves and their fused petiole bases, referred to as a pseudostem. The pseudostem supports a canopy consisting of 6–20 (or more) leaves. Fruit Musa fruits are variable in size, shape, and color. They are generally elongate-cylindrical, straight to strongly curved, 3–40 cm (1.2–16 in) long, and 2–8 cm (0.8–3 in) in diameter. The fruit apex is important in variety identification; it may be tapered, rounded, or blunt. The skin is thin and tender to thick and leathery, and silver, yellow, green, or red in color. Inside the ripe fruit, the flesh ranges from starchy to sweet, and in color from white, cream, yellow, or yellow-orange to orange. Bananas also vary in peel thickness. Some varieties have a thin peel and are more susceptible to damage in transport, whereas others have a comparably thicker peel (the Fe‘i variety ‘Karat’ and others, for example). Seeds Cultivated varieties are typically seedless. When seeds are present, they vary among species in shape and morphology. Seeds of Musa balbisiana, parent of many commer- cial edible banana varieties, are dark brown, ovoid, about 4 mm

(0.2 in) long, with a conspicuous white, powdery endosperm. Rooting habit Plants have numerous (200–500) fibrous roots. In well drained, deep, and fertile soils, roots may extend 1.5 m (5 ft) deep and 4.9 m (16 ft) laterally. In dry, shallow, or rocky soils, roots of Musa may not compete well; otherwise, Musa is an average to good competitor (Dankye *et al.,* (2007).

2.1.5 Contribution of Plantain to the Ghanaian Economy

Of the total contribution of all crops to the Agricultural Gross Domestic Product (AGDP) of 64%, plantain is next to roots and tubers and contributes 9% while cereals' and other crops contribute 7% and 2% respectively thereby emphasizing the importance of plantain in the economy of Ghana (Dankye *et al.,* 2007).

2.2 Importance and Benefits of Plantain Consumption

Plantains are among the cheapest foods to produce in Ghana. Among the staple foods, plantains have the second highest per capita consumption after cassava. Plantains are also important sources of food particularly in the Ashanti, Brong Ahafo and Eastern regions. Plantain is known to be low in sodium (Chandler, 2015). It contains very little fat and no cholesterol; therefore it is useful in managing patients with high blood pressure and heart disease. They are free from substances that give rise to uric acid therefore, they are ideal for patients with gout or arthritis. Due to the low sodium and protein content, plantain is used in special diets for kidney disease sufferers. The capacity of the plantain to neutralize free hydrochloric acid suggests its use in peptic ulcer therapy (Gowen, 2005). A fully ripe plantain mixed with milk powder is especially recommended for ulcer patients. The low lipid and high palatability combination is ideal for the diet of obese people (Gowen, 2005).

The plantain plant has also some medical properties. The leaves can be pounded and applied to the wound to suppress bleeding. They are also very important sources of rural income (Ortiz and Vuylsteke, 2006). They are attractive to farmers due to their low labour requirement for production compared with cassava, maize, rice and yam (Marriott and Lancester, 2003).

2.2.1 Supply and Demand of Plantain

A biological production of 85% is assumed for the production available for human consumption. There is a positive correlation between national consumption and the population. As the population increases so is the consumption of plantain. This means that plantain will remain an important staple for many Ghanaians in the years ahead. Plantain has however been having an increasingly surplus production since 2001. This means that these surpluses have to be exported, processed or may go to waste. Considering the export and value added potential of plantain, these surpluses could be cosmetic. There is therefore the need for processing into various products to curtail the surpluses (Marriott and Lancester, 2003).

2.2.3 Drying of Plantain

Earliest investigations on drying theory have been those of Lewis (1921) and Sherwood (1929). Sherwood classified general mechanisms of drying under the following three cases.

1. Evaporation of water takes place at the solid surface and the resistance to the internal diffusion of liquid is small as compared with the total resistance to the removal of vapour from surface.

2. Evaporation of water takes place at the solid surface and the resistance to the internal diffusion of liquid is great as compared with the resistance to the removal of vapour from the surface.

3. Evaporation of water takes place in the interior of the solid and the resistance to the internal diffusion of liquid is great as compared with the total resistance to the removal of vapour. He further explained that drying of a particular material need not be restricted to one of the above cases. The drying resistance of very wet solids is similar to the evaporation of the liquid from the liquid surfaces. This is an example of the first case and the rate of drying is usually constant. As drying proceeds the liquid content decreases and the mechanism of drying changes usually to one of the other two cases. The rate of drying decreases with an initial period of constant rate of drying and the moisture at which drying rate starts falling is called critical moisture content. Thus when the moisture content of a material is less than the critical moisture content, no constant rate period appears. It should be noted that the drying rate also depends on air velocity, air humidity and the temperature of drying air. Sherwood also classified the periods of drying rate as follows:

    1. Constant rate period
    2. First falling rate period
    3. Second falling rate period

The constant rate period is not a characteristic of normal agricultural drying. It is seasonally well established that drying of all agricultural products practically takes place in the falling rate period (Charkraverty, 2013). The process of drying should be approached from two points of view; the equilibrium rate relationship and the drying rate relationship. The equilibrium rate relationship is established when the food product is exposed to a continual supply of air at constant temperature and humidity, with a fixed partial pressure for the

vapour. The product will lose moisture by evaporation or gain moisture from the air until the vapour pressure of the moisture of the product equals the fixed partial pressure of the vapour. The food product and the gas are then in equilibrium and the moisture content of the solid is in equilibrium with the surrounding conditions. This is known as equilibrium moisture content. In the drying rate relations, there are the constant-rate period and falling-rate period. In constant rate period, the rate of evaporation under any given set of air conditions is independent of the solid and is essentially the same as the rate of evaporation from a free liquid surface under the same conditions. The rate of drying during this period is dependent upon the:

a) Difference between the temperature of the wetted surface at constant air velocity and relative humidity.

b) Difference in humidity between air stream and wet surface at constant air velocity and temperature.

c) Air velocity at constant air temperature and humidity.

The food product is entirely dried in the falling rate period. The falling-rate period starts after the constant drying rate period and corresponds to the drying cycle where all the surface is no longer wetted and the wetted surface continually decreases until, at the end of this period, the surface is dry. The cause of falling off in the rate of drying is due to the inability of the moisture to be conveyed from the centre of the body to the surface at rates comparable with the moisture evaporation from its surface to the surrounding. The falling rate period is characterised by increasing temperature both at surface and within the solid. Furthermore, changes in air velocity have much smaller effect on the period than during the constant-rate period. The falling-rate period of drying is controlled largely by the product and is dependent upon the movement of moisture within the material from the centre to the surface by liquid diffusion (Minkah, 2007).

2.2.4 Goodness-of Fit Statistics for thin layer drying models

Thin-layer drying models are evaluated and compared by using statistical measures. Consequently, the quality of the fitted models is evaluated. Some of these measures can be described as follows:

2.2.5 Effective Moisture Diffusivity

In general, drying of foods takes place in two periods, a constant rate period and falling rate period. After a short heating period a constant rate period followed by a falling rate period which is the dominating period during drying process. The mechanism of moisture movement within a hygroscopic solid during the falling rate period can be represented by effective moisture diffusion phenomena which include liquid diffusion, vapour diffusion and other possible mass transfer mechanisms. Effective moisture diffusivity is used to represent an overall mass transport property of water in food materials (Dadali *et al.,* 2007). During drying it is assumed that diffusivity, explained with Fick's diffusion equation, is the only physical mechanism to transfer water to the surface (Ozbek and Dadali, 2007). Effective moisture diffusion which is affected by composition, moisture content, temperature and porosity of the material is used due to limited information on the mechanism of moisture movement during drying and complexity of the process (Afzal and Abe, 1998).

Doymaz and Akgun (2005) reported effective moisture diffusivity values in the range of 0.3 to 1.1 x 10-8m2/s in a temperature range of 50 to 110oC and stressed that the values increased with increasing temperature. Doymaz *et al.,* (2005) on analysis of the drying kinetics of the white Mulberry reported that moisture diffusivities were affected by pretreatments. The diffusivity of heat shocking and ethyl oleate treatments in his work increased up to three times that of the natural fruit. Kingsly *et al.,* (2007) reported values in

the ranged from 1.68 to 2.84 x 10-9 m2/s for thin layer drying characteristics of organically produced tomatoes. The moisture diffusivity increased as drying air temperature was increased and due to the influence of blanching on internal mass transfer of tomato during drying, blanched samples had higher moisture diffusivity values. The temperature dependence of the effective diffusivity was represented by an Arrhenius relationship (Madamba *et al.,* 1996, Sanjuan *et al.,* 2003) through which activation energy could be derived. Kingsly et al. (2007) reported activation energy values of 21.1 and 22.41 kJ/mol for untreated and blanched samples respectively, for the tomato slices.

2.2.6 Rehydration

One of the quality parameters of dried food is their ability to reconstitute, that is, their ability to return to their original shape and appearance upon soaking in water (Kordylas, 1990). Kordylas asserts that dried food may be converted to the humid form by the addition of water. Thus the food is soaked in water until enough water is taken by the pieces. He further stressed that the rate of rehydration is dependent on the temperature of soak water, hence the warmer the water the shorter the soaking time.

Rehydration behaviour was studied in grapes by Gabas *et al.,* (1999), Nameko and Shitake (2000) by using different process parameters, like immersion time and water temperature. These researchers reported and affirmed that temperature increases rehydration rate due to decreased viscosity of the immersion medium and effect of temperature on the structure of food material. Most studies to assess the water intake rate by food materials were based on Fick's laws of diffusion using appropriate experimental equations (Hsu, 2013). To simplify the mode of water absorption and solute outflow, a non-exponential empirical equation was proposed by Peleg (1988), which has been successfully applied to milk powder, rice, dasheen

leaves, cherry tomato and various legumes (Maharaj and Sankat, 2000; Sopade and Obekpa, 1990).

Loss in the ease of rehydration is caused by physical shrinkage and distortion of cells and capillaries, but much also results from chemical or physiological changes at the colloidal level (Potter and Hotchkiss, 1998). According to Potter and Hotckiss (2008) heat and salt concentration effect from water removal can partially denature proteins, which cannot fully reabsorb water and become less hydrophilic. Sugars and salt escape from damaged cells in to the water used to reconstitute rehydrated foods, resulting in loss of tugor. These and other chemical changes make reabsorption of water by dried products somewhat less in original water content and contribute to altered texture.

2.2.7 Ascertaining the Shelf-life of Ofam on the Local and International Market.

Effects of Drying on plantain food

Several factors will influence the nutritional content of the food and the type and level of losses due to processing. These include the genetic make-up of the plant or animal, the soil in which it is grown, use of fertilizer, prevailing weather, maturity at harvest, packaging, storage conditions and method of preparation for processing. The storage conditions and handling after processing are also important to the nutritive value of the food (Morris *et al.,* 2006). There are two processes occurring during drying, the addition of heat and the removal of moisture from the food. Heating can be both beneficial and detrimental to nutrient content of foods. It generally improves the digestibility of foods, making some nutrients more available. A typical example is the protein in legumes, which is made more digestible by heating because of the inactivation of anti-nutrients such as trypsin inhibitors (Morris *et al.,* 2006).

According to Fellows (2000) all products undergo changes during drying and storage that results in the reduction in their quality compared to fresh material. The physical and chemical changes occurring during drying or processing will improve certain characteristics of the final product, but in most cases, a loss of nutrients and organoleptic properties has been reported (Karel and Young 1989; Nykanen and Nykanen, 1987; Garcia *et al.,* 1988; Paakkonen *et al.,* 1989).The proper handling of these reactions ensures that the product has a high nutritional value as well as significant extended shelf life. Drying method and the physiochemical changes that occur during drying seem to affect the quality properties of the dehydrated product. More specifically, drying method and processing conditions affect significantly the color, texture, nutritional content, density and porosity and sorption characteristics of the material. So the raw material may end up as a completely different product depending on the type of drying method and conditions applied (Krokida and Maroulis, 2001).

2.3 Empirical Literature

Heat not only vaporizes water during drying but causes loss of volatile components from the food and as a result most dried foods have less flavour than the original material. This invariably occurs to at least a small degree (Potter and Hotchkiss, 1998). The extent of volatile matter loss depends on the temperature and moisture content of the food and on the vapor pressure of the volatiles and their solubility in water vapor. Volatiles which have a high relative volatility and diffusivity are lost at the early stages of drying. The open porous structure of dried food allows access to oxygen, which is a second cause of aroma loss to oxidize of volatile components and lipid storage. Complete prevention of flavor loss is yet proven virtually impossible, and so methods of trapping and condensing the evolved vapours from the drier and then adding them back to the dried products are sometimes employed (Potter and Hotchkiss, 2008). Additional techniques involve addition to dried products of

essence and flavour preparation derived from other sources as well as methods of minimizing flavour loss by incorporating gums into certain liquid foods prior to drying.

The effect of food processing on nutrient content will depend on the sensitivity of the nutrient to the various conditions prevailing during the process. The nutrient retention may vary with a combination of conditions, such as the characteristics of the food being processed, and the concentration of the nutrient in the food. For example, sensitivity of vitamin C to heat varies with pH. It should be noted that the macronutrient and vitamin content of foods are more likely to be affected by processing than the mineral content. In considering the effects of processing on nutrient content of specific foods, it should be considered whether the food is one that serves as a worthwhile source of a particular nutrient. The losses of protein (amino acids) during blanching of green peas, for instance, might be of more relevance to the diet than that of vitamin C from the same source (Morris *et al.,* 2006).

Heating is a major processing procedure to stabilize food for extended storage by inactivating enzymes and microbial spores. However, its effects on the nutritional value of products cannot be overemphasized. The nutritional quality of food is diminished with processing because of nutrient sensitivity to heat, pH, oxygen or a combination of these factors (Kramer, 2007). According to Bender (2006), storage and most processing procedures such as cooking and drying have very little effect on the carbohydrate content of most foods. Mild heating improves the digestibility of proteins and carbohydrates. However, damage can be caused if inappropriate temperature or processing times are used (Erbersdobler, 2005). The effect of drying on protein is expressed as a decrease in the digestibility and biological value of the protein (Karel, 2005). Heating does not generally change the total dietary fibre content (Jones *et al.,* 1990), however, heat treatment cause insoluble dietary fibre content to increase

as a result of the complexing of its components with protein and amino acids (Matalas *et al.,* 2001).

Wet processing such as cooking and blanching may also change some fibre properties for example, the amount of soluble fibre in fruit may increase by partial breakdown of pectin (Arthey and Ashurt, 2001). Lipid quality is affected by dehydration. The peroxides formed when the lipids react with proteins and vitamins, or decompose to secondary products promote off flavors, strong odours and organoleoticrancidity (Karel, 2005). The exclusion of oxidizing agents is an important consideration while drying food. The stability and degradation rate of vitamins such as ascorbic acid, thiamine and riboflavin are highly affected by temperature, moisture, pH, ionic strength and metal traces. Because it is practically heat sensitive at high moisture contents, heating and oxidation may destroy considerable amounts of ascorbic acid during the drying of fruits and vegetables (Crapiste, 2005).

While riboflavin is relatively stable, significant losses of beta carotene may occur. The carotene content of vegetables is decreased as much as 80% if processing is accompanied without enzyme inactivation. The best commercial method will permit drying with losses in the order of five percent of carotene (Salunkhe, 2014). The fat soluble vitamins are mostly contained within the dry matter of the food and hence are not concentrated during drying. However, as water is removed, heavy metals catalysts become more reactive and hence increase the rate of oxidation. Fat soluble vitamins are lost by the interaction with the peroxides formed thereof (Fellow, 2000).

Nagra and Khan (2009) have observed that generally, processing leads to losses in vitamin A. Mulokozi and Svanberg (2003) studying the effect of traditional open sun drying and solar

cabinet drying on carotene content and vitamin A activity of green leafy vegetables observed that solar drying resulted in significant retention of carotene and vitamin A.

Plantain is relatively high in calories at 125 per cup. One cup cooked plantain yields a trace of fat, 2.3g dietary fiber, 465 mg potassium, 26 mcg folate, 10.9 mg vitamin C, 909 IU vitamin A, 32 mg magnesium and 3H carbohydrate. They are known to be a great source of calcium, vitamins A, B1, B2, B3, B6, C and minerals such as potassium and phosphorus. Plantains are useful in managing patients with high blood pressure and heart diseases because they are low in sodium, very little fat and no cholesterol. They are also ideal for patients with gout or arthritis because they are free from substances that give rise to uric acid.

The effect of food processing on nutrient content will depend on the sensitivity of the nutrient to the various condition prevailing during the process. The nutrient retention may vary with a combination of conditions such as the characteristics of the food being processed and the concentration of the nutrient in the food and for example, sensitivity of vitamin C to heat vitamin with PH. It should be noted that the macronutrient and vitamin content are more likely to be affected by processing than the nutrient content in considering the effects of processing the nutrient content of specific foods, it should be considered where of a particular nutrient. The losses of protein (amino acid) during blanching of green peas, for instance mighty be more relevance to the diet that of vitamin C from the same source (Cmorri *et al.* 2006).

Heating is a major processing procedure to stabilizer food for extended stores by inactivating enzymes and microbial spores. However, its effects on the nutritional value of product cannot be over emphasized the nutritional quality of food is diminished with processing because of

nutrient sensitivities to heat PH, oxygen or a combination of these factors (Kramer 2010). According to Bender (2006), storage and most processing procedures such as cooking and drying have very little effect on the carbohydrate content of most foods mild heating improve the digestibility of proteins and carbohydrate. However, damage can cause if inappropriate temperature or processing times are used (Erbersdobler, 2005).

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Ramanaand Taylor (1994) argue that textural behaviour of a food product of product is related to its structure. These characteristics depend on the chemical and biophysical characteristics of the product and colour of the food are important cause at quality deterioration. The nature and extent of size reduction each affect the texture of rehydrated vegetables and fruits (Fellows, 2000). The loss of texture in these products is caused by the gelatinization of starch, crystallization of cellulose and localized variation in the moisture content during drying which set up internal stresses (Achata and Okos 1995) These rapture cracks, compress and permanently distort the relative rigid cells to give the food a shriveled appearance (Akonor, 2007)

Green plantain count as starchy vegetables in a diabetes diet and are relatively high in carbohydrate, prepare them without added fat, sugar or salt, and they are one of the best starchy vegetables options, according to the America Diabetes Association (ADA). A one-half cup serving of sliced plantain either cooked or raw, has about 24 grams of carbohydrate if you chose fried green plantain, a one-half cup serving has about 29 grams of carbohydrate, along with almost y gram of added fat.

The glucemic index helps estimate how much a particular food is likely to increase your blood sugar level, with foods having score of 55 or less being low on the glycemic index and unlikely to cause a large increase in blood sugar and those food having score above 75 being more likely to cause species in blood sugar levels. Green plantain has a glycemic index of 40.

CHAPTER THREE

RESEARCH METHODOLOGY

Introduction

In this chapter an attempt was made to look at the research design, target population, data sources, sampling procedures (size and technique), data collection instruments and data analysis.

3.1.1 Materials

3.1.2 Source of materials

The ripe plantain was bought from the Makola market in Greater Accra to ensure non-adulteration of the ripe plantain. All ingredients used were purchased from the Makola market.

3.2 Sample Preparation

3.2.1 Sensory Analysis

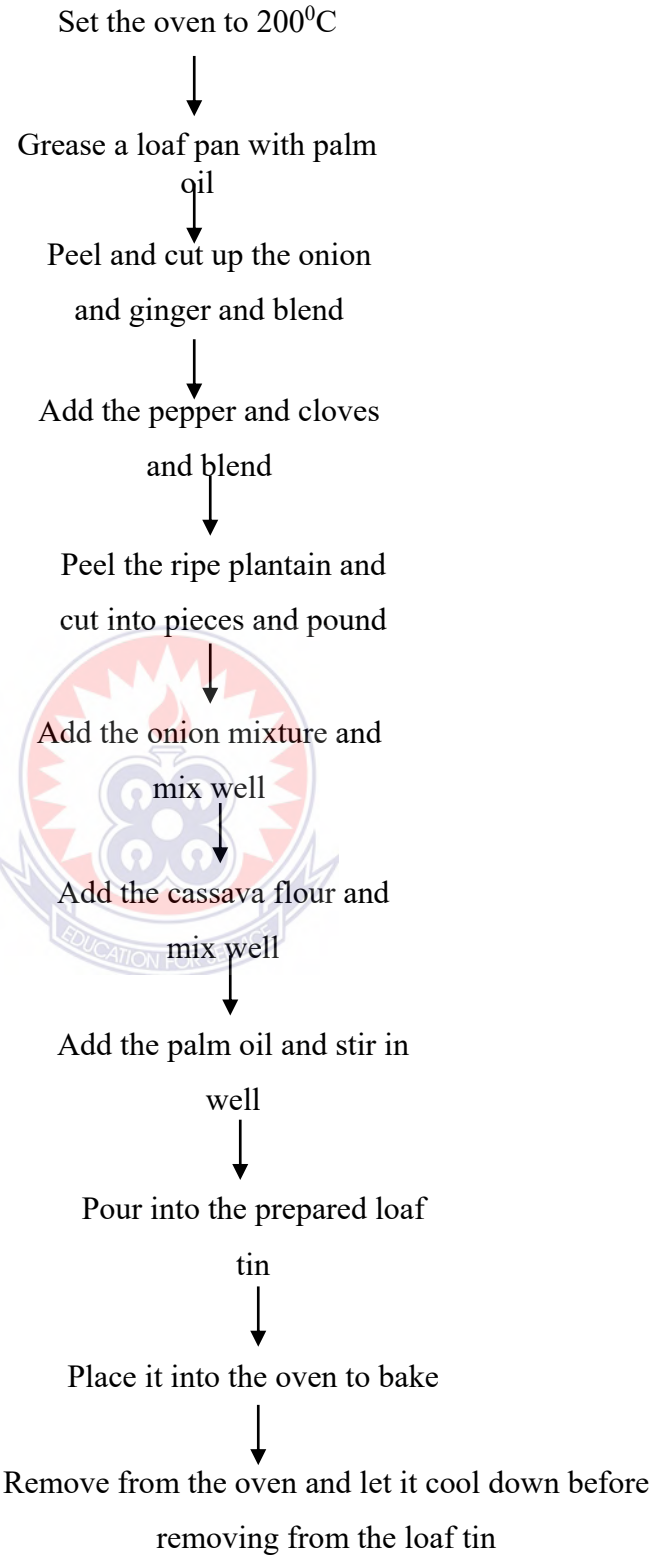
Four different samples were evaluated; sample 1 contains blended ripe plantain mixed with red onions (shallots), Chilly pepper (dried), Fresh ginger, garlic, Nutmeg, Crayfish Powder, Maggie shrimp, Salt, Baking Powder and corn dough. Sample 2 contains grinded ripe plantain mixed with red onions (shallots), Chilly pepper (dried), Fresh ginger, garlic, Nutmeg, Crayfish Powder, Maggie shrimp, Salt, Baking Powder and corn flour. Sample 3 contains grinded ripe plantain mixed with red onions (shallots), Chilly pepper (dried), Fresh ginger, garlic, Nutmeg, Crayfish Powder, Maggie shrimp, Salt, Baking Powder and rice flour. Sample 4 contains grinded ripe plantain mixed with red onions (shallots), Chilly pepper (dried), Fresh ginger, garlic, Nutmeg, Crayfish Powder, Maggie shrimp, Salt, Baking Powderand cassava flour (Konkente). The four samples were baked and given to 10 panelists.

The samples were stored in a food warmer prior to the sensory evaluation. They were served in disposable plates for the selected panelists. The panelists were given guided questionnaires based on taste, texture, and flavor (Larmond, 1977). The observation ranged between 1 to 5, this scale of measurement is called the likers scale where;

1. Extremely liked
2. Liked
3. Satisfactory
4. Not liked
5. Detest

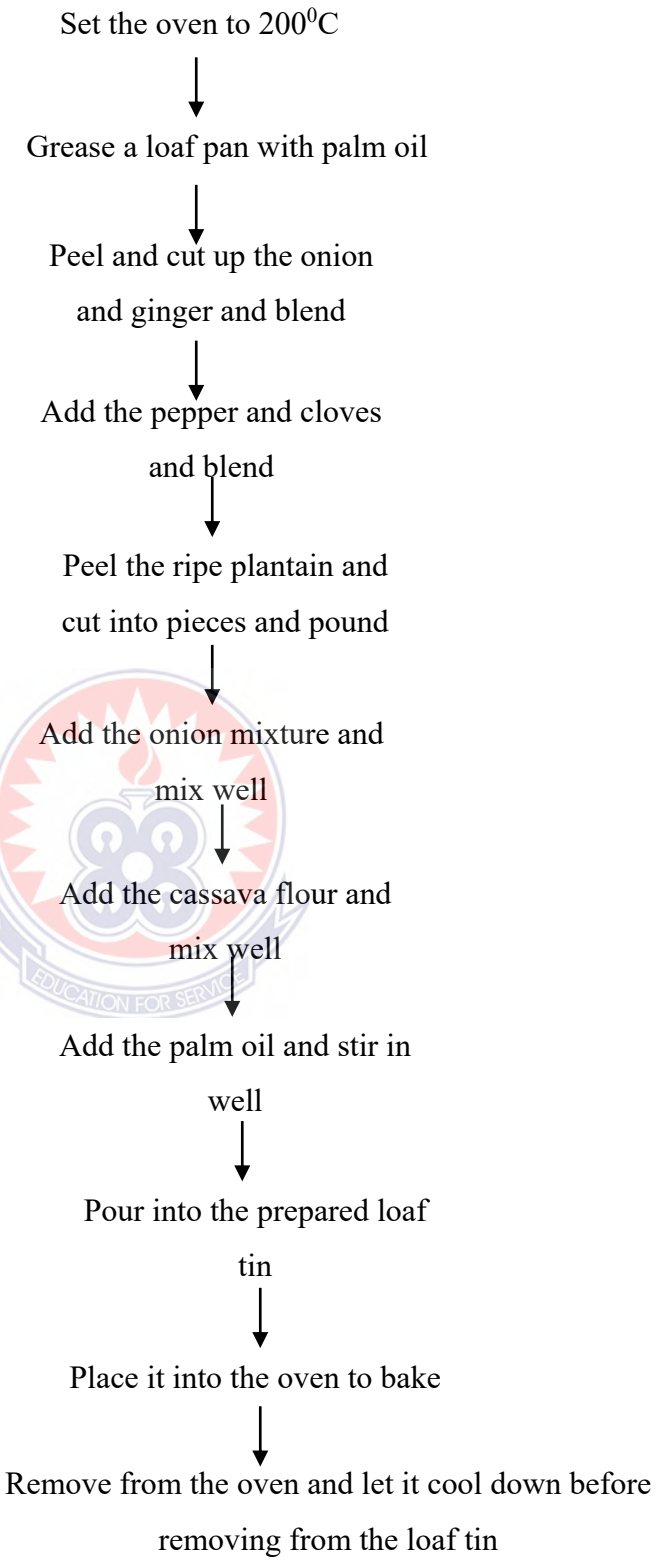
3.3 Flow Chart for preparing the 4 samples of ofam

3.3.1 Flow Chart for Preparing Rice Flour Ofam



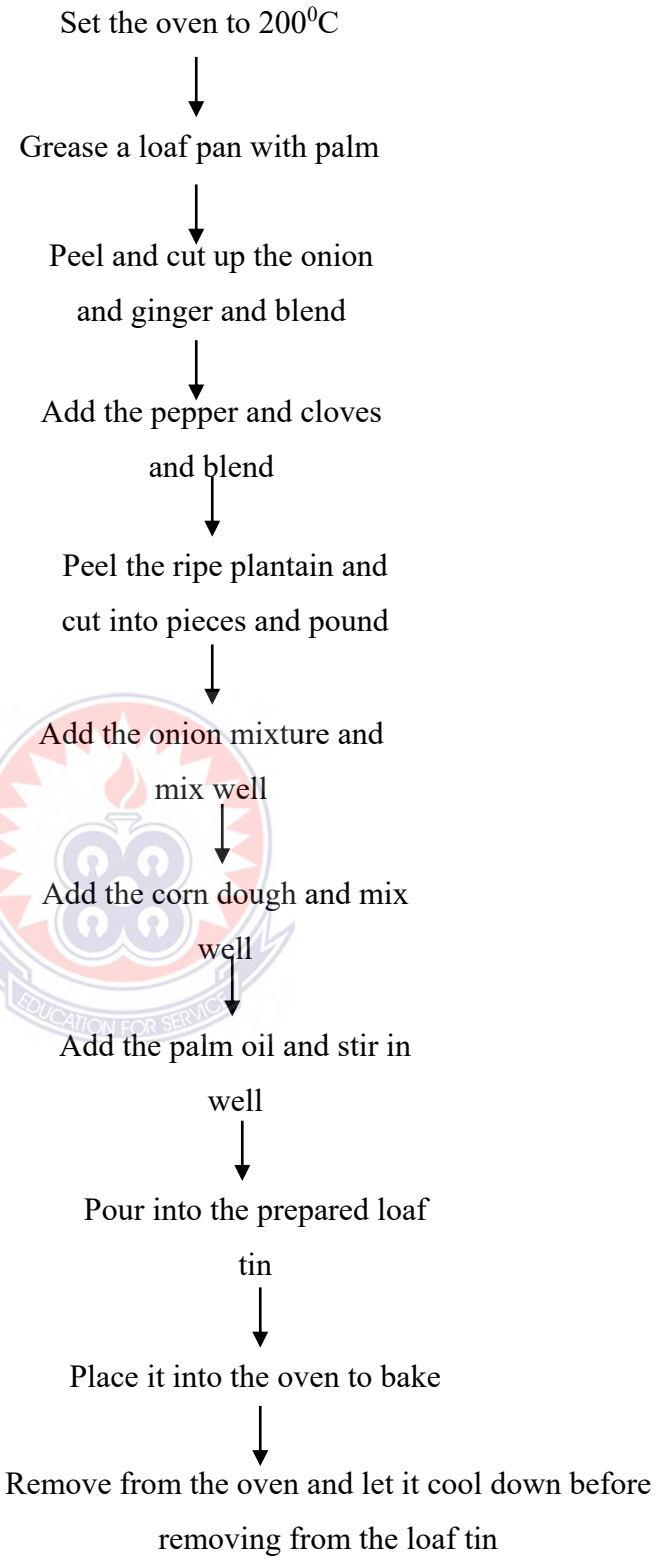
Source: Authors construct (2016)

3.3.2 Flow Chart for Preparing Cassava Flour Ofam



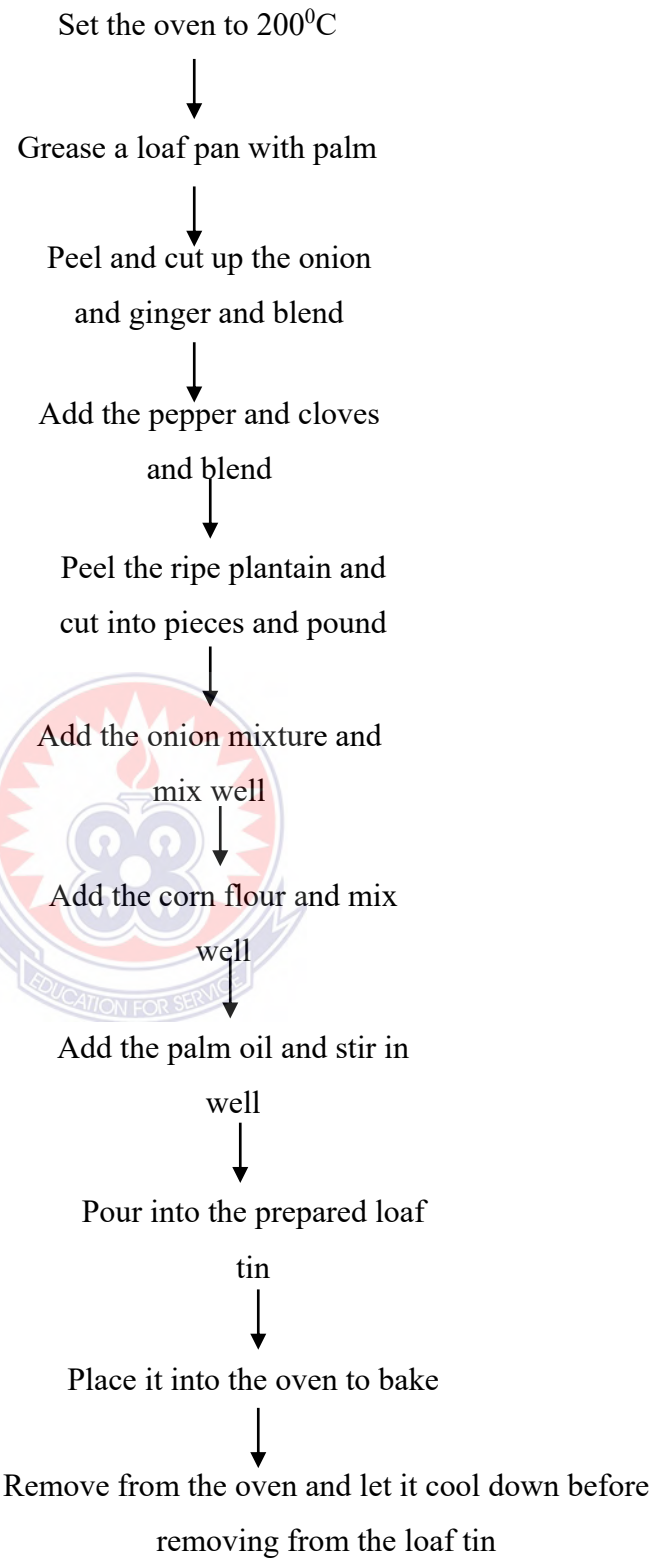
Source: Authors construct (2016)

3.3.3 Flow Chart For Preparing Corn Dough Ofam



Source: Authors construct (2016)

3.3.4 Flow Chart for Preparing Corn Flour Ofam



Source: Authors construct (2016)

3.4 Research Design

This study adopted the experimental study design. The researcher used the experimental study method because among the various research designs, experimental research designs are frequently regarded as using both quantitative and qualitative research and a combination of both approaches (Bryman, 2004). These types of research approach were used because they eventually aid the researcher to make judgement about the effectiveness, relevance or desirability of the variables. Moreover, the researcher used closed and open ended questions because they helped the researcher to gather factual information from respondents. Qualitative research is useful for studies at the individual level, and to find out, in depth, the ways in which people think or feel. The researcher used both qualitative and quantitative approach because quantitative approach helped to gather information that could be easily analysed using statistical means whiles qualitative information can be easily evaluated using thematic analysis.

3.5 Population

The targeted group for the research includes plantain sellers, farmers, civil servants and restaurant operators of ofam, 10 were chosen as panelists for sensory evaluation. The population for the study were one hundred and eighty (180).

3.6 Sampling Procedures and Sample Size

According to the Krejcie & Morgan (1970), table of determining sample size, a population of 180 requires a sample size of 120. Therefore, random sampling method would be used to select 120 respondents for the study.

Table 3.1: Sample Size Technique

Individuals/Groups	Number of people
Civil servants (Ofam consumers)	42
Plantain farmers	35
Plantain sellers	11
Restaurant operators	22
Panelists for sensory evaluation	10
Total	120

3.7 Instruments for Data Collection

The main instruments used to gather primary data were questionnaires, interviews and sensory evaluation. The questionnaire was structured to consist of closed ended and open ended type of questions in order to elicit feedback from respondents. The questionnaire was divided into five sections. Section 1 contains the demographic information of the respondents, which contains the age, gender and occupation of the respondents. The second section investigated the various methods used in the preparation of ofam as a traditional dish. The third section ascertained the shelf-life of ofam on the local and international market. The section 5 assessed the important criteria such as packaging structure, taste, colour, flavor, types of flour used in preparation, cooking mode and texture of ofam and the section 6 encouraged and promoted the consumption of ofam in the local and international markets. These were the main areas around which data gathered from the respondents were analyzed. Likert scale type was used as categories mainly ranging from strongly disagree, disagree, neutral, agree to strongly agree. Personal observations were also made throughout the data collection period. The researcher used the likert type scale because the scale had variables

that helped the respondents to provide responses suitable for the study. The data gathered was analysed statistically using Statistical Package for Social Sciences (SPSS) software version 16. Tables and figures were used to present the results of the study.

Primary data was collected through a field survey of plantain sellers, farmers and consumers of ofam. Data was collected through the use of a well-designed questionnaire and interview guide administered to participants in their homes and markets. Questionnaires were filled out by participants and the researcher had to take the questionnaires back the same day of distribution.

3.7.1 Interview

The researcher obtained information from the plantain farmers and sellers using face to face interview. Using interview guide enhanced the outcome of the study by retrieving important data needed, of which satisfactory response were not obtained through questionnaire. These interviewed participants were chosen purposively. However, the researcher used tape recorder to record what interviewee said and later coded the responses and analysed using thematic analysis.

3.8 Pilot Testing

The researcher conducted a pilot study to assess the authenticity of the research instruments. The pilot questionnaires were given to 10 people (5 farmers and plantain sellers and 5 customers) to answer to correct errors like repetition of questions and typographical mistakes and the avoidance of double questions.

3.9 Data Analysis

The data analysis involved reducing the raw data into a manageable size, developing summaries and applying statistical inferences. The following steps were taken to analyze the data for the study. The data collected was edited to detect and correct, possible errors and omissions that were likely to occur, to ensure consistency across respondents. Raw data obtained from a study is useless unless it is transformed into information for the purpose of decision making (Emery & Couper, 2003).

The questionnaire data collected were then coded to enable the respondents to be grouped into limited number of categories. The SPSS version 16 was used to analyse the primary data. Data was presented in tabular form, graphical and narrative forms. In analyzing the quantitative data, descriptive statistical tools such as frequencies, percentages, tables and charts were used to present the results of the study.

3.10 Ethical Consideration

The consideration of some ethical issues is vital for the completion of research project as well as to make a credible research report. Saunders *et al.,* (2009) have described that to ensure the validity, reliability and quality of the research report, the researcher must follow and maintain relevant ethical issues during the completion of research project. The researcher has to follow and maintain relevant ethical issues. All ethical issues were followed and maintained by the researcher include- honesty, integrity, acknowledgment, confidentiality, objectivity and fairness. The researcher has acknowledged all previous works that have been used in this research report. In similar ways, the researcher followed and maintained other relevant ethical during the collection of primary and secondary data and information from the parties involved in this study.

CHAPTER FOUR

ANALYSIS OF DATA AND DISCUSSION OF RESULTS

4.1 Demographic Information of the Respondents

This section contains a chart, tables, frequencies and percentages that depicts the gender, age and occupation of the respondents.

Figure 4.1 depicts the gender of the respondents

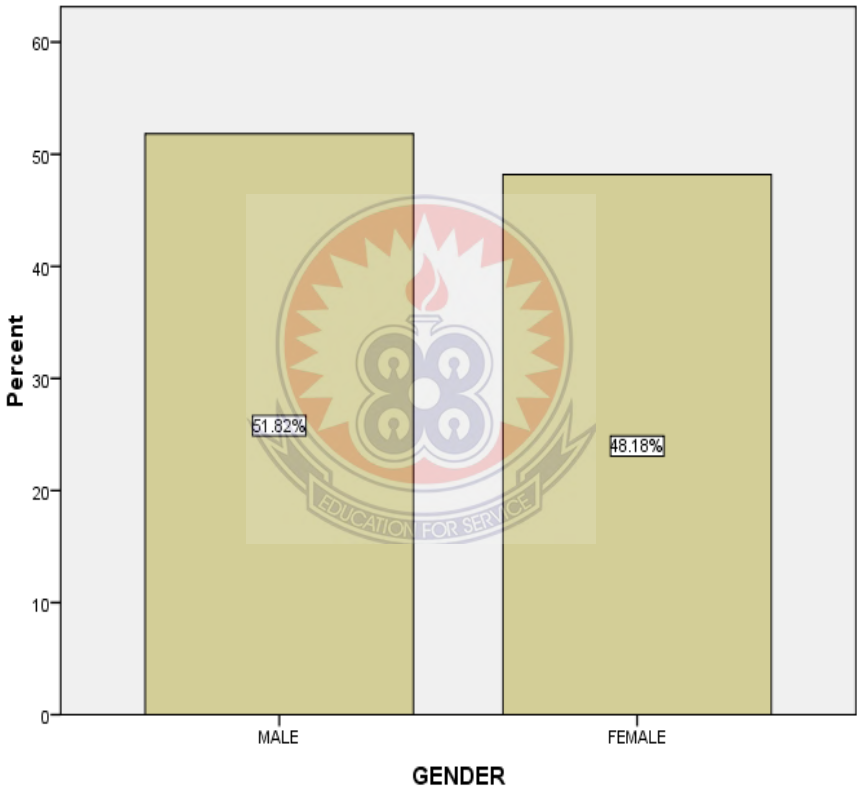


Figure 4.1: Gender of the Respondents

Source: Field survey, (2016)

Figure 4.1 shows that 51.8% of the respondents were males whiles 48.2% were females.

Table 4.1: Age range of the Respondents

Age range of the respondents (Years)	Frequency	Percent
18-25	16	14.5
26-35	23	20.9
36-45	43	39.1
46-55	19	17.3
ABOVE 56	9	8.2
Total	110	100.0

Source: Field survey, (2016)

Table 4.1 indicates that 39.1% of the respondents were between the ages range 36-45 years, 20.9% were between the ages ranges 26-35 years, 17.3% were between the age range 26-35 years, 14.5% were between the age range 18-25 years whiles 8.2% were above 56 years.

Table 4.2: Occupation of the respondents

Occupation of the respondents	Frequency	Percent
Civil servant	42	38.2
Plantain farmer	35	31.8
Plantain seller	11	10.0
Restaurant operator	22	20.0
Total	110	100.0

Source: Field survey, (2016)

Table 4.2 shows that 38.2% of the respondents were civil servants, 31.8% were plantain farmers, 20% were restaurant operators whiles 10% were plantain sellers.

4.1 The Various Methods used in the Preparation of Ofam as a Traditional Dish.

Practical Preparation of Ofam

Source: Field survey, (2016)

Ofam is basically a spicy ripe plantain cake. It's a great way of using over ripe plantains which would soak up too much oil when fried or will be too soft when boiled. Nonetheless a perfectly ripe plantain can also be used. This savoury plantain cake can be enjoyed as breakfast, lunch, as a side or afters after meals. It's just great either way.

INGREDIENTS:

- 2 ripe plantain (over ripened)
- ½ medium size red onion (shallots is a great option)
- Tiny piece of Kpakposhito or scotch bonnet pepper (to your taste)
- 20g Fresh ginger (about thumb size or to your taste)
- 4 Cloves
- 1 Small Calabash Nutmeg
- 1 Cup Self Raising Flour
- 1 Tsp Crayfish Powder or 1 Maggie shrimp
- ½ Tsp Salt

- 1 Tsp Baking Powder
- 1 - 3 Tbsp Palm Oil
- Loaf tin

METHOD:

1. Set the oven to 200ºC.
2. Grease a loaf pan with palm oil.
3. Peel and cut up the onion and ginger. Place in a food processor or blender, traditionally it is grinded in an earthen ware mortar shown in the picture. If you own a mortar and pestle it is better to use it as the flavour and texture you get from it is lovely. Add the scotch bonnet pepper and cloves and grind/blend the mixture until smooth.

Source: Field survey, (2016)

- ✓ Now add the salt and Crayfish or Maggie shrimp to taste.

- ✓ Peel the plantains and cut up into pieces. I have shown below the different stages of ripeness you can use, either one gives a good result. Add to the onion mixture and grind/blend together. Ideally, you want a lumpy thick mixture. Over blending gives a very smooth runny mixture. The earthenware mortar or a food processor is great to give a good texture.

- ✓ Add the flour and mix well.

- ✓ Now add the palm oil and stir in well. I used 2 tbsp of palm oil here. But you can reduce or actually increase it to 3tbsp. The palm oil makes the Ofam moist.

- ✓ Add the baking powder and mix until well incorporated.

- ✓ Pour into the prepared loaf tin.
- ✓ Place it in the oven to bake.
- ✓ When it is thoroughly baked, a skewer inserted into the cake will come out clean.
- ✓ Remove from the oven and let it cool down before removing from the loaf tin.

- ✓ Serve the ofam with boiled eggs and nuts. It can be eaten as dessert, main meal, side dish or a snack. I had this for breakfast by adding some rocket salad and poached eggs. It was so yummy.

Source: Authors practical works (2016).

The effect of food processing on nutrient content will depend on the sensitivity of the nutrient to the various condition prevailing during the process. The nutrient retention may vary with a combination of conditions such as the characteristics of the food being processed and the concentration of the nutrient in the food and for example, sensitivity of vitamin C to heat vitamin with PH. It should be noted that the macronutrient and vitamin content are more likely to be affected by processing than the nutrient content in considering the effects of processing the nutrient content of specific foods, it should be considered where of a particular nutrient. The losses of protein (amino acid) during blanching of green peas, for instance mighty be more relevance to the diet that of vitamin C from the same source (Cmorri *et al.* 2006).

4.3 The shelf life of Ofam

Table 4.3 shows the shelf life of ofam

Table 4.3: The shelf life of Ofam

The shelf life of Ofam	Frequency	Percent
Less than 1 week	24	21.8
1-2 weeks	67	60.9
more than 3 weeks	19	17.3
Total	110	100.0

Table 4.3 depicts that 60.9% of the respondents affirmed that the shelf life of ofam is 1-2 weeks, 21.8% said that the shelf life of ofam is less than 1 week whiles 17.3% said that the shelf life of ofam is more than 3 weeks. The storage conditions and handling after processing are also important to the nutritive value of the food (Morris *et al.,* 2006). According to Bender (2006), storage and most processing procedures such as cooking and drying have very little effect on the carbohydrate content of most foods mild heating improve the digestibility of proteins and carbohydrate. However, damage can cause if inappropriate temperature or processing times are used (Erbersdobler, 2005).

4.4 Encouraging and Promoting the Consumption of Ofam

Table 4.4 assessed how manufacturers of ofam can encourage and promote the consumption of the delicacy in the local and international markets?

Table 4.4: Encouraging and Promoting the Consumption of Ofam

Encouraging and Promoting the Consumption of Ofam	Frequency	Percent
Creating publicity regarding the importance of plantain consumption	59	53.6
By encouraging restaurant operators to include ofam in their menu	30	27.3
By promoting the local consumption of ofam	21	19.1
Total	110	100.0

Source: Field survey, (2016)

Table 4.4 shows that 53.6% of the respondents affirmed that to encourage and promote the consumption of ofam, there is the need to create publicity regarding the importance of plantain consumption, 27.3% said that there is the need to encourage restaurant operators to include ofam in their menu whiles 19.1% said that there is the need to promote the local consumption of ofam. Plantains are among the cheapest foods to produce in Ghana. Among the staple foods, plantains have the second highest per capita consumption after cassava. Plantains are also important sources of food particularly in the Ashanti, Brong Ahafo and Eastern regions. Plantain is known to be low in sodium (Chandler, 2015). It contains very little fat and no cholesterol; therefore it is useful in managing patients with high blood pressure and heart disease. They are free from substances that give rise to uric acid therefore, they are ideal for patients with gout or arthritis. Due to the low sodium and protein content, plantain is used in special diets for kidney disease sufferers. The capacity of the plantain to

neutralize free hydrochloric acid suggests its use in peptic ulcer therapy (Gowen, 2005). A fully ripe plantain mixed with milk powder is especially recommended for ulcer patients. The low lipid and high palatability combination is ideal for the diet of obese people (Gowen, 2005).

4.5 The Benefits of Plantain Consumption

Table 4.5: The Benefits of Plantain Consumption

The Benefits of Plantain Consumption	1 Freq. (%)	2 Freq. (%)	3 Freq. (%)	4 Freq. (%)	5 Freq. (%)	Total Freq. (%)
Plantains are among the cheapest foods to produce in Ghana.	44 (40%)	61 (55.5%)	5 (4.5%)	-	-	110 (100%)
Plantain is known to be low in sodium.	58 (52.7%)	48 (43.6%)	4 (3.6%)	-	-	110 (100%)
Plantains contains very little fat and no cholesterol; therefore it is useful in managing patients with high blood pressure and heart disease.	46 (41.8%)	57 (51.8%)	3 (2.7%)	4 (3.6%)	-	110 (100%)
Due to the low sodium and protein content, plantain is used in special diets for kidney disease sufferers.	56 (50.9%)	47 (42.7%)	7 (6.4%)	-	-	110 (100%)

Source: Field survey, (2016)

Table 4.5 shows that majority 95.5% of the respondents agreed that Plantains are among the cheapest foods to produce in Ghana whiles 4.5% were neutral. Moreover, 96.3% of the respondents agreed that Plantain is known to be low in sodium whiles 3.6% were neutral. The

study finding shows that 93.6% of the respondents agreed that Plantains contains very little fat and no cholesterol; therefore it is useful in managing patients with high blood pressure and heart disease, 3.6% disagreed whiles 2.7% were neutral. Furthermore, 93.6% of the respondents agreed that due to the low sodium and protein content, plantain is used in special diets for kidney disease sufferer's whiles 6.4% were neutral. Plantain is relatively high in calories at 125 per cup. One cup cooked plantain yields a trace of fat, 2.3g dietary fiber, 465 mg potassium, 26 mcg folate, 10.9 mg vitamin C, 909 IU vitamin A, 32 mg magnesium and 3H carbohydrate. They are known to be a great source of calcium, vitamins A, B1, B2, B3, B6, C and minerals such as potassium and phosphorus. Plantains are useful in managing patients with high blood pressure and heart diseases because they are low in sodium, very little fat and no cholesterol. They are also ideal for patients with gout or arthritis because they are free from substances that give rise to uric acid.

4.6 Sensory Evaluation Report

The study selected 10 trained panellists for sensory evaluation

4.6.1 Assessing packaging structure, taste, colour, flavor, types of flour used in preparation, cooking mode and texture of ofam

Table 4.6: Sensory evaluation report for the cassava flour ofam

Sample 1= Cassava Flour ofam	1 Freq. (%)	2 Freq. (%)	3 Freq. (%)	4 Freq. (%)	Total Freq. (%)
Taste	6 (60%)	3 (30%)	1 (10%)	-	10 (100%)
Texture	7 (70%)	2 (20%)	-	1 (10%)	10 (100%)
Flavor	5 (50%)	2 (20%)	-	3 (30%)	10 (100%)
Colour	6 (60%)	4 (40%)	-	-	10 (100%)
Packaging structure	7 (70%)	3 (30%)	-	-	10 (100%)

1=Extremely liked, 2= liked, 3= satisfactory, 4= detest

Source: Field survey, (2016)

Table 4.6 indicates that 100% of the respondents liked the taste of the cassava flour ofam, 90% of the respondents liked the texture whiles 10% detested the texture of the cassava flour ofam. Furthermore, 70% of the respondents liked the flavour of the cassava flour ofam whiles 30% detested the flavour, 100% of the respondents liked the colour of the cassava flour ofam and 100% of the respondents liked the packaging structure of the cassava four ofam. Ramana and Taylor (1994) argue that textural behaviour of a food product of product is related to its structure. These characteristics depend on the chemical and biophysical characteristics of the

product and colour of the food are important cause at quality deterioration. The nature and extent of size reduction each affect the texture of rehydrated vegetables and fruits (Fellows, 2000). The loss of texture in these products is caused by the gelatinization of starch, crystallization of cellulose and localized variation in the moisture content during drying which set up internal stresses (Achata and Okos 1995).

Table 4.7: Sensory evaluation report for the Corn flour ofam

Sample 2: Corn Flour ofam	**1 Freq. (%)**	**2 Freq. (%)**	**3 Freq. (%)**	**4 Freq. (%)**	**Total Freq. (%)**
Taste	4 (40%)	2 (20%)	-	4 (40%)	10 (10%)
Texture	6 (60%)	3 (30%)	-	1 (10%)	10 (100%)
Flavor	3 (30%)	2 (20%)	-	5 (50%)	10 (100%)
Colour	2 (20%)	3 (30%	3 (30%)	2 (20%)	10 (100%
Packaging structure	5 (50%)	2 (20%)	-	3 (30%)	10 (100%)

1=Extremely liked, 2= liked, 3= satisfactory, 4= detest

Source: Field survey, (2016)

Table 4.7 indicates that 60% of the respondents liked the taste of the corn flour ofam whiles 40% detested the taste. Moreover, 90% of the respondents liked the texture of the corn flour

ofam whiles 10% detested. Also, 50% liked the flavour of the corn flour ofam whiles 50% detested. Furthermore, 80% liked the colour of the corn flour ofam whiles 20% detested. To add more, 70% liked the packaging structure of the corn flour ofam whiles 30% detested.

Table 4.8: Sensory evaluation report for the Corndoughofam

Sample 3= Corn Dough ofam	**1 Freq. (%)**	**2 Freq. (%)**	**3 Freq. (%)**	**4 Freq. (%)**	**Total Freq. (%)**
Taste	2 (20%)	1 (10%)	1 (10%)	6 (60%)	10 (100%)
Texture	7 (70%)	2 (20%)	-	1 (10%)	10 (100%)
Flavor	2 (20%)	2 (20%)	-	6 (60%)	10 (100%)
Colour	6 (60%)	4 (40%)	-	-	10 (100%)
Packaging structure	7 (70%)	3 (30%)	-	-	10 (100%)

1=Extremely liked, 2= liked, 3= satisfactory, 4= detest

Source: Field survey, (2016)

According to Table 4.8, majority 60% of the respondents disliked the taste of the corn dough ofam whiles 40% liked the taste. Moreover, 90% of the respondents liked the texture of the corn dough ofam whiles 10% disliked the texture. Also, 60% of the respondents disliked the flavour of the corn dough ofam whiles 40% liked the flavour. Furthermore, 100% of the respondents liked the colour of the corn dough ofam whiles 100% liked the packaging structure of the ofam.

Table 4.9: Sensory evaluation report for the Rice flour ofam

Sample 4: Rice flourofam	**1 Freq. (%)**	**2 Freq. (%)**	**3 Freq. (%)**	**4 Freq. (%)**	**Total Freq. (%)**
Taste	4 (40%)	2 (20%)	-	4 (40%)	10 (10%)
Texture	6 (60%)	3 (30%)	-	1 (10%)	10 (100%)
Flavor	3 (30%)	2 (20%)	-	5 (50%)	10 (100%)
Colour	2 (20%)	3 (30%	3 (30%)	2 (20%)	10 (100%
Packaging structure	5 (50%)	2 (20%)	-	3 (30%)	10 (100%)

1=Extremely liked, 2= liked, 3= satisfactory, 4= detest

Source: Field survey, (2016)

Table 4.9 shows that 60% of the respondents liked the taste of the rice flour ofam whiles 40% detested the taste. Moreover, 90% of the respondents liked the texture of the rice flour ofam whiles 10% detested. Also, 50% liked the flavour of the rice flour ofam whiles 50% detested. Furthermore, 80% liked the colour of the rice flour ofam whiles 20% detested. To add more, 70% liked the packaging structure of the rice flour ofam whiles 30% detested. Heat not only vaporizes water during drying but causes loss of volatile components from the food and as a result most dried foods have less flavour than the original material. (Potter and Hotchkiss, 1998).

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

The primary purpose of the study was to investigate the use of ripe plantain in the preparation of ofam a typical local dish produced in Ghana. The ripe plantain was bought from the Makola market in Greater Accra to ensure non-adulteration of the ripe plantain. The red onions (shallots), Kpakposhito, Fresh ginger, garlic, Nutmeg, rice flour, corn dough, cassava flour, corn flour, Crayfish Powder, Maggie shrimp, Salt, Baking Powder, Palm Oil were purchased from the Makola market. Four samples of ofam were baked. Sample 1 contains rice flour, sample 2 contains cassava flour, sample 3 contains corn dough and sample contains corn flour. The four samples were baked and given to 10 panelists. The samples were stored in a food warmer prior to the sensory evaluation. This study adopted the experimental study design. The population for the study were one hundred and eighty (180). A sample size of 120 was selected for the study using random sampling method. The main instruments used to gather primary data were questionnaires, interviews and sensory evaluation. The data gathered was analysed statistically using Statistical Package for Social Sciences (SPSS) software version 16. Tables and figures were used to present the results of the study.

The study depicts that 60.9% of the respondents affirmed that the shelf life of ofam is 1-2 weeks. The study shows that 53.6% of the respondents affirmed that to encourage and promote the consumption of ofam, there is the need to create publicity regarding the importance of plantain consumption, 27.3% said that there is the need to encourage restaurant

operators to include ofam in their menu whiles 19.1% said that there is the need to promote the local consumption of ofam.

The study depicts that majority 95.5% of the respondents agreed that Plantains are among the cheapest foods to produce in Ghana. Moreover, 96.3% of the respondents agreed that Plantain is known to be low in sodium. The study finding shows that 93.6% of the respondents agreed that Plantains contains very little fat and no cholesterol; therefore it is useful in managing patients with high blood pressure and heart disease. Furthermore, 93.6% of the respondents agreed that due to the low sodium and protein content, plantain is used in special diets for kidney disease sufferers.

The study indicates that 100% of the respondents liked the taste of the cassava flour ofam, 90% of the respondents liked the texture whiles 10% detested the texture of the cassava flour ofam. Furthermore, 70% of the respondents liked the flavour of the cassava flour ofam whiles 30% detested the flavour, 100% of the respondents liked the colour of the cassava flour ofam and 100% of the respondents liked the packaging structure of the cassava flour ofam. The study shows that 60% of the respondents liked the taste of the corn flour ofam whiles 40% detested the taste. Moreover, 90% of the respondents liked the texture of the corn flour ofam whiles 10% detested. Also, 50% liked the flavour of the corn flour ofam whiles 50% detested. Furthermore, 80% liked the colour of the corn flour ofam whiles 20% detested. To add more, 70% liked the packaging structure of the corn flour ofam whiles 30% detested.

According to the study, majority 60% of the respondents disliked the taste of the corn dough ofam whiles 40% liked the taste. Moreover, 90% of the respondents liked the texture of the corn dough ofam whiles 10% disliked the texture. Also, 60% of the respondents disliked the

flavour of the corn dough ofam whiles 40% liked the flavour. Furthermore, 100% of the respondents liked the colour of the corn dough ofam whiles 100% liked the packaging structure of the ofam. The study depicts that 60% of the respondents liked the taste of the rice flour ofam whiles 40% detested the taste. Moreover, 90% of the respondents liked the texture of the rice flour ofam whiles 10% detested. Also, 50% liked the flavour of the rice flour ofam whiles 50% detested. Furthermore, 80% liked the colour of the rice flour ofam whiles 20% detested. To add more, 70% liked the packaging structure of the rice flour ofam whiles 30% detested.

5.2 Conclusions

The study concluded that the shelf life of ofam was 1-2 weeks. Moreover, to encourage and promote the consumption of ofam, there is the need to create publicity regarding the importance of plantain consumption, there is the need to encourage restaurant operators to include ofam in their menu and there is the need to promote the local consumption of ofam.

Also, most of the respondents consumed ofam because plantains are among the cheapest foods to produce in Ghana, plantain is known to be low in sodium, plantains contains very little fat and no cholesterol; therefore it is useful in managing patients with high blood pressure and heart disease and due to the low sodium and protein content, plantain is used in special diets for kidney disease sufferers.

The study concluded the taste of cassava flour ofam was preferred compared to corn flour, rice flour and corn dough ofam. Moreover, the texture of cassava flour, rice flour, corn dough and corn flour was equally preferred. Furthermore, the flavour of rice flour was preferred compared to cassava flour, corn dough and corn flour ofam. Also, the colour of cassava flour

ofam and corn dough ofam was preferred compared to rice flour and corn flour ofam. Finally, the packaging structure of cassava flour ofam and corn dough ofam was preferred compared to rice flour and corn flour ofam.

5.4 Recommendation

Based on the conclusion remarks stated above, the following recommendations were made;

- The Ministry of Agriculture should promote the cultivation of different varieties of plantain to improve food security in Ghana. Moreover, there is the need to provide adequate storage facilities to store plantain to enhance the shelf life of ofam.
- The ministry of health should create public awareness regarding the health benefits of consuming ofam to enhance public awareness and consumption.
- There is the need to invest in medical and laboratory research to unravel the numerous hidden advantages of consuming ofam. Moreover, banks and microfinance institutions should provide soft loans to farmers to improve the cultivation of plantain.
- There is the need to provide adequate storage facilities to improve the shelf life of ofam.

5.5 Suggestions for Further Research

- Based on the recommendations of the study, the researcher suggested that a similar study should be conducted to investigate the impact of providing soft loans to farmers and food security in Ghana.
- Moreover, there is the need to investigate the availability of storage facilities and the shelf life of ofam.

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Appendix A:

QUESTIONNAIRES FOR THE RESPONDENTS

Dear Participant,

The researcher is from University of Education, Winneba, Kumasi campus. She is conducting a piece of research on the use of ripe plantain in the preparation of Ofam, a typical local dish produced in Ghana. I respectfully request you to be part of this research by completing the attached questionnaire. Your anonymity and confidentiality are assured. It is my fervent hope that you will feel free to participate in the study and respond to the questions as objectively as possible. May I thank you in advance in anticipation of your valuable cooperation

SECTION A: Demographic Characteristics of the Respondents

1. Age

Below 18 years [ ] 18-25 years [ ] 26-35 years [ ] 36-45 years [ ] 46-55 years [ ] above 56 years [ ]

2. Gender of the respondents

Male [ ] Female [ ]

3. Occupation of the respondents

Civil servant [ ] Plantain farmer [ ] Plantain seller [ ] Restaurant operator [ ]

SECTION B: Various Method used in the Preparation of Ofam

4. What are the various methods used in the preparation of ofam as a traditional dish?

……

……

……

SECTION C: The shelf life of Ofam

5. What is the shelf-life of ofam on the local and international market?

Less than 1 week [ ] 1-2 weeks [ ] more than 3 weeks [ ]

SECTION D: Encouraging and Promoting the Consumption of Ofam

11. How can manufacturers of ofam encourage and promote the consumption of the delicacy in the local and international markets?

Creating publicity regarding the importance of plantain consumption [ ]

By encouraging restaurant operators to include ofam in their menu [ ]

By promoting the local consumption of ofam [ ]

SECTION E: The Benefits of Plantain Consumption

SA- Strongly agree, A-Agree, N-Neutral, D-Disagree, SD-Strongly Disagree

Importance and Benefits of Plantain Consumption	SA	A	N	D	SD
12. Plantains are among the cheapest foods to produce in Ghana.					
13. Among the staple foods, plantains have the second highest per capita consumption after cassava.					
14. Plantains are also important sources of food particularly in the Ashanti, Brong Ahafo and Eastern regions.					
15. Plantain is known to be low in sodium.					
16. Plantains contains very little fat and no cholesterol; therefore it is useful in managing patients with high blood pressure and heart disease.					
17. Due to the low sodium and protein content, plantain is used in					

special diets for kidney disease sufferers.					
18. They are attractive to farmers due to their low labour requirement for production compared with cassava, maize, rice and yam.					

Appendix B:

QUESTIONNAIRES FOR THE PANELISTS FOR SENSORY EVALUATION

SECTION F: Assessing packaging structure, taste, colour, flavor, types of flour used in preparation, cooking mode and texture of ofam

Please use the following Likert scale to evaluate the taste, colour, texture,flavor and packaging structure of the various forms of ofam.

1=Extremely liked, 2= liked, 3= satisfactory, 4= not liked, 5= detest

Sample 1= cassava flour of am Please use the following Likert scale to evaluate the taste, colour, texture, flavor and packaging structure of the cassava flour ofam	**1**	**2**	**3**	**4**	**5**
Taste					
Texture					
Flavor					
Colour					
Packaging structure					
Sample 2: corn flour of am Please use the following Likert scale to evaluate the taste, colour, texture, flavor and packaging structure of the corn flour ofam					
Taste					
Texture					
Flavor					
Colour					
Packaging structure					

Sample 3: Corn dough of am Please use the following Likert scale to evaluate the taste, colour, texture, flavor and packaging structure of the corn dough ofam					
Taste					
Texture					
Flavor					
Colour					
Packaging structure					
Sample 4: Rice flour of am Please use the following Likert scale to evaluate the taste, colour, texture, flavor and packaging structure of the rice flour ofam					
Taste					
Texture					
Flavor					
Colour					
Packaging structure					

Appendix C

INTERVIEW GUIDE FOR THE RESPONDENTS

What are the various methods used in the preparation of ofam as a traditional dish?

……

……

What is the shelf-life of ofam on the local and international market?

……

……

How can important criteria such as packaging structure, taste, colour, flavor, types of flour used in preparation, cooking mode and texture of ofam be assessed?

……

……

What is the acceptability of the variety of ingredients used to prepare Ofam?

……

……..……..