PHYSICAL PROPERTIES, NUTRITIVE VALUE AND ACCEPTABILITY OF SOYBEAN CHEESE (*TOFU)* AMONG BOARDING SECONDARY SCHOOL STUDENTS IN KADUNA METROPOLIS, NIGERIA

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ZARIA, NIGERIA

AUGUST, 2019

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BEING A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES AHMADU BELLO UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER DEGREE IN HOME ECONOMICS

DEPARTMENT OF HOME ECONOMICS,
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ZARIA, NIGERIA

AUGUST, 2019

DECLARATION

I declare that this thesis titled: "Physical Properties, Nutritive Value and Acceptability of Soybeans Cheese *Tofu* Among Boarding Secondary Students in Kaduna Metropolis Nigeria", was conducted by me in the Department of Home Economics, Ahmadu Bello University Zaria, under the Supervision of Professor S. L. Ajayi and Professor T. O. Ojo. The Information derived from the literature has been duly acknowledged in the text and a list of references provided.

_____ _____

Ummi Ahmed Umar Date
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CERTIFICATION

This thesis titled the Physical Properties, Nutritive Value and Acceptability of Soybean Cheese (*Tofu)*Among Boarding Secondary School Students in Kaduna Metropolis, Nigeria. By Ummi Umar Ahmed meets the regulations governing the award of Master's Degree in Education (M.Ed). Departmentof Home EconomicsAhmadu Bello University, Zaria and is approved for its contribution to knowledge and literarily presentation.

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DEDICATION

This research work is dedicated to my Father AlhajiShehuAdamu.

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OPERATINAL DEFINITION OF TERMS

Tofu: Soybean cheese known as *(wara)* in the northern part of Nigeria is made by coagulating soymilk and then pressing the resulting curd to soft white block.

Soft *Tofu*:It is a fresh boiled soybean cheese curd *(wara)* that holds its shape depending on the amount of water that has been pressed out from the curd it is soft and firm.

Fried *Tofu*:It is firmer soybean cheese curd *(wara)* which excess water has been removed when pressed; it is seasoned and deep fried.

Dried *Tofu*: It is an extra firm form of soybeans cheese curd *(wara)* which excess amount of liquid has been pressed out; it is sliced thinly and baked dried, this type of *Tofu* can be crispy.

SupplementaryValue of Protein: It is the combination of plant and animal protein food in such a way that the animal protein supplies the essential amino acid lacking in plant protein.

Complementary Value of Protein: It is the combination of two or more incomplete protein foods, such that one of them will be supplied by the other.

Malnutrion: A disease condition that occur as a result of taking inadequate nutrient

ABSTRACT

The study was carried out to determine the physical property, nutritive value and acceptability of soybean cheese (*Tofu)* among boarding secondary school students in Kaduna metropolis Nigeria. The study was guided by five (5) objectives, five (5) research questions. The population for the study was four thousand six hundred and six (4,606) out of which ten (10) panelist were selected from each school making a total number of thirty (30) panelist were selected as sample for the study. The instrument used for collecting data were three laboratory analysis on proximate composition of *Tofu,* score card for scoring test, six scouring hedonic scale for*Tofu*, experimental design was used for the study, all chemical were analyzed using percentage and mean while research question were answered using mean and standard deviation. The result of the proximate analysis of three forms of soybean cheese(*Tofu)*Soft Fried and Dried were found to contain: Moisture: (STB) or soft *Tofu* 9.64±0.02%, (FTF) or fried *Tofu* 4.21±0.01%, (DTB) or dried *Tofu* 6.20±0.2%, Ash: (STB) or soft *Tofu* 3.35±0.01%, (STB) or soft *Tofu*3.32±0.01%, (DTB) or dried *Tofu* 3.77±0.01%, Protein: (STB) or soft *Tofu*29.77±0.02%, (FTF) or fried *Tofu*20.47±0.01%, (DTB) or dried *Tofu*21.44±0.01%, Fat: (STB) or soft *Tofu* 23.25±0.01%, (FTF) or fried *Tofu* 24.24±0.02%, (DTB) or dried *Tofus*19.72±0.00%, Carbohydrates: (STB) or soft *Tofu* 33.91±0.01%, (FTF) or fried *Tofu*47.71±0.01%, DTB or dried *Tofu* 48.80±0.1%, respectively. The result of mineral analysis was analyzed using (gm) of *Tofu* per (kg). (STB) or Soft *Tofu* has the highest composition of Sodium, Potassium, Calcium, and Phosphorus respectively, followed by (DTB) or dried *Tofu*. The result of Vitamins were analyzed as mg/L for Vitamin A, B, and C, the fried *Tofu* was found to be more in Vitamin A concentration than the two other forms of *Tofu*, Soft and Dried, but (FTF) or fried *Tofu* and (DTB) or Dried *Tofu* had similar concentration of Vitamin B and differs in Vitamin C concentration. While (STB) or Soft *Tofu,* have more

concentration. Soybean cheese(*Tofu)*is aplant protein that plays a significant role in the diet of a consumer.Furthermore, the study revealed the sensory evaluation of (STB) or Soft, (FTF) Fried and (DTB) or dried *Tofu*. The analyses on general acceptability of (STB) or Soft, (FTF) or Fried and (DTB) or dried *Tofu* are rated accepted among the panelist. Therefore any of the samples can be used in the absence of sufficient animal or to complement plants protein in the diet. It is therefore a useful strategy to overcome protein malnutrition disease among consumers.It is also recommended in school feeding program.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Legumes are nutritious and economical sources of protein for population of developing countries and play an important role in diet (Gavcia, et, al. 2009). Soybean Cheese (*Tofu)* it is made from legume plant is a soft cheese-like food made by coagulating soy milk and pressing the curd milk into block. Soymilk and *Tofu* are important non fermented soybean product. *Tofu* is an excellent source of high quality protein, lipids, carbohydrate, (Shurtleff and Aoyagi, 2007), also rich in calories, mineral and vitamins ((Habibullah, et, al. 2007). Soybean cheese (*Tofu)* is commonly used by vegetarians as a substitute for meat for healthy living (Habidullah et. al 2007). *Tofu* is also generally added to soups as low cost meat substitute by low income families in part of Nigeria (Odebunmi, et al, 2009).

Soybean crop entered Nigeria with an attempt to improve nutrient intake, especially the protein intake of the low income populace (Obatulu, 2006). Soybean has long been stable food of the human diet in Asian, especially as soymilk or *Tofu*, (Shurtfleff& Aoyagi 2007). Consumption of soybean product is increasing in Nigeria due to an increase in Asian immigrants, greater acceptance of soy foods populace increase by the recognition of its health benefits and nutritional fact. Several investigators such as (Pampluna and Roger 2004) have suggested that soy bean consumption may contribute to lower rates of diseases such as hormone dependant, cancers, high blood pressure, and osteoporosis.

Soybeans cheese (*Tofu)*also contain many of the essential amino acids that are deficient in most cereal grain based diets commonly fed as energy sources to poultry and swine (Bruce et, al. 2006). According to (Stein et al, 2008), It has a unique chemical composition of an average

diary matter basis. It contains macro nutrient, protein, carbohydrates and fats content compared to other crops and the second highest oil content among all the food legumes, the oil is higher in term of quality; it contains a high proportion of unsaturated fatty acid (Iwe, 2003). Soybean is a protein rich legume, it may therefore be a useful strategy to overcome protein malnutrition disease especially in rural areas where malnutrition is common (Murtala, et al, 2016).

In Kaduna metropolis, boarding secondary schools comprises of private, state, federal and technical schools, some are single sex schools while others are mixed (boys and girls) These schools are served with meal for breakfast, lunch and dinner using cheaper sources of food, their source of protein which includes meat, fish, beans and eggs are not sufficient to meet their daily protein requirement. The incorporation of soybean cheese (*Tofu)* into boarding secondary school meal as a source of protein with high nutritional value and health benefits will be a step forward towards promoting good health. Moreover,It has the potential to replace their daily protein intake since animal protein such as meat, fish eggs are expensive. Adding *Tofu* to student's diet can improve their overall well-being and help to protect them against serious health problem.

The health benefits and high nutritional facts of soybean cheese(*Tofu)* motivated the researcher to evaluate the physical properties and nutritive value of three forms of *Tofu*; soft, fried and dried, and its acceptability among boarding secondary school students in Kaduna metropolis. The Food and Agricultural Organization (F.A.O. 2009) stipulated that every individual is expected to consume 71grams of protein everyday to obtain good health. According to International Institute of Tropical Agriculture (IITA, 2007), the health of consumers is significantly better with soybean product; the evidence is that soybean cheese *(Tofu)* has a positive impact on consumer's health.

Processing soybean cheese *Tofu* into different forms such as fried, soft and dried will create variety and palatability into student boarder's diet; *Tofu* can be used in the absence of sufficient animal protein, this will help to prevent the occurrence of protein malnutrion disease.

1.2 Statement of the Problems

Livestock contribute to the major sources of protein for human consumption. Lives stock such as meat, chicken, fish, and eggs, the prices of such conventional lives stock has risen due to the fall in foreign exchange. According to the observation carried out by the researcher, most times students boarders in Kaduna Metropolis are not served with adequate protein in their meal, mean while protein calorie malnutrition disease problems are specially acute in terms of protein deficiency. There is need to seek for alternative source of high quality protein and Soybean cheese(*Tofu)* has the potential to supplement animal protein such as meat, fish, chicken, milk and egg in the diet. This will help to overcome proteinmalnutrition disease. Despite the high nutritional value of soybean cheese (*Tofu),* and its health benefits in relation to other legumes, lack of knowledge of its uses has limited its adoption and processing.

Fried Soybean cheese (*Tofu)* is the most commonly processed and consumed among the consumers because there is lack of awareness on the usage of soft and dried *Tofu*, when *Tofu*is made into different forms it will create variety into the diet. However the three forms of *Tofu*, Soft, Fried and Dried can be cooked and prepared into different dishes, they take on the flavour of what they are cooked in or marinated in, making it versatile, however they can be served as a dish, part of the main meal or as a snack.

In view of the health benefits and nutritional facts of soybean cheese*(Tofu)*, as a cheap source of plant protein, it can beused for animal supplement or to complement plant protein. This

gives the researcher reason to determine the physical properties, nutritive value and acceptability of three forms of soybean cheese (*Tofu),* among boarding secondary school students in Kaduna Metropolis.

1.3 Objectives of the Study

The major objectives of this research work are to assess the physical properties, nutritive value and acceptability of soybean cheese*Tofu* among boarding secondary school students in Kaduna Metropolis. The specific objectives were to:

1. determine the proximate composition of soybean cheese (*Tofu) S*oft, Fried and Dried
2. determine the sensory quality for texture on soybean cheese (*Tofu)*Soft, Fried andDried
3. determine the sensory quality for taste on soybeans cheese (*Tofu)*Soft ,Fried and Dried
4. determine the sensory quality for aroma on soybean cheese(*Tofu)*Soft, FriedandDried
5. determine the sensory quality forcolour on soybean cheese (*Tofu)* Soft, Fried andDried
6. determine the general acceptability of soybean cheese(*Tofu)*Soft Fried and Dried.

1.4 Research Questions

The study sought to answer the following research questions;

1. what is the proximate composition of soybean cheese(*Tofu)* Soft, Fried andDried?
2. what is the sensory quality for texture on soybean cheese (*Tofu)*Soft, Fried and Dried?
3. what is the sensory quality for taste on soybean cheese*(Tofu)*Soft, Fried and Dried?
4. what is the sensory quality for aroma on soybean cheese (*Tofu)*Soft, Fried and Dried?
5. what is the sensory quality forcolour on soybean cheese (*Tofu)*Soft,Fried and Dried*?*
6. what is the general acceptability of soybean cheese(*Tofu)* Soft, Fried and Dried?

1.5 Basic Assumptions

The study was based on the following assumptions:

1. it is assumed that the opinion of the panelist students boarders will be used to judge the sensory qualities of soybean cheese (*Tofu)* soft, fried and dried
2. it is assumed that soybean cheese (*Tofu)* will be accepted as suitable supplement to animal protein among boarding secondary school students in Kaduna metropolis.

1.6 Significance of the Study

The result of the study will be significant to meal program planners of boarding secondary schools within Kaduna metropolis. It will also be suitable for different groups of people such as: home makers, vegetarians, and those people who have health ailment diseases such as: heart diseases, cancer, obesity and osteoporosis. Federal, State government and farmers, will also benefit from the result of the study.

The study will be of benefit to Meal planners feeding program of boarding secondary schools when budgeting for their student's protein requirement. Soybean cheese (*Tofu) c*an be a supplement for animal protein in their meal,and it contains all the nine essential amino acid that the body needs, such as fats, proteins and wide varieties of vitamins and minerals, it is also a cheap source of protein with many health benefits.

The studies will benefits home makersbecause it will meet the nutritional needs of the family members. Due to the present economic situation many poor and middle income Nigerians cannot afford animal protein such as fish, meat, chicken and eggs in their diet because they are expensive. The tendency is to fall back to plant protein food such as soybean cheese (*Tofu)* to supplement the protein requirement for the body needs. This will help to promote good health among members of the family. It can also serve as a source of income for homemakers.

The nutritional fact in soybean cheese *Tofu* can replace animal protein for vegetarians and vegans for their protein requirement to maintain a healthy living.The health benefits of soybean cheese *Tofu* will assist people with heart diseases: to reduce the level of bad cholesterol and as a result maintaining the level of good cholesterol, helps in weight loss and prevention of obesity (Pampluna and Roger 2004).

Soybeans cheese (*Tofu)* helps in preventing cancer cell growth,being an amazing source of protein and minerals like selenium will help in preventing hair fall and promote hair growth, Soybean cheese (*Tofu)* reduces the urinary loss of calcium and increases mineralization and bone density therefore, prevent Osteoporosis (Pampulana and Roger 2014). The study will assist federal and state government to reduce susceptibility to malnutrition there by promoting good and healthy members in the society.

The findings of the study will assist farmers by providing reliable information that will be used in increasing income and welfare of the population consequently, enhancing Agricultural productivity of soybean.

1.7 Delimitation of the Study

1. The study is delimited to the assessment of physical properties nutritive value and acceptability of soybean cheese (*Tofu)* Soft, Fried and Dried.
2. The study is also delimited to three boarding secondary schools within Kaduna Metropolis. Queen Amina College Kakuri, Government Girls Boarding Secondary School Kawo, and Government Technical College Malali.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter will be reviewed and treated under the following sub-headings:

2.1 The Historical Background of Soybean cheese (*Tofu)*

2.2 Types of Soybean Cheese (*Tofu)* Soft, Fried and Dried

2.3 Nutritional Composition of Soybean Cheese (*Tofu)*

2.4 Health Benefits of Soybean Cheese (*Tofu)*

2.5 Review of Related Empirical Studies

2.6 Summary of Reviewed Related Literature

2. 1 The Historical Background of Soybean Cheese (*Tofu)*

Thescientific name for the soybean is (Glycine max), is part of the botanical family (leguminosae), the soybean plant has a slightly woody stalk that reaches a height of 30-36 inches and (76-91cm), the entire plant is covered with greenish hair, the leave grow in group of three and fall off as the bean mature, the soybean plant produces (papilionaceous) butterfly shaped flowers that are white, red or purple, the pods grow from 1-2 inches (2.5-5cm) in length each holding two or three seeds, which become soybean. Soy seed is either round or oval and are similar in size to peas, their colour is usually yellow but they may also be green, purple brown or a mixture of colours. Nigerian food scientists have discovered the high nutritional content or value of this crop and they are now creating awareness and advertising to people on the uses of this crop, soybean is a legume that grows in the tropical, subtropical and temperate climate, approximately half of the world soybean are produced in the developed world. It is believed that soybean is one of the oldest crops grown by man.

The countries that are leading in producing soybean areUnited States of America, Brazil, China, Indonesia and Russia. The crop is also grown in Argentina, Canada, Columbia, Japan, Mexico, Nigeria, Paraguay, South Korea, Taiwan and Thailand. According to F.A.O (2005) showed that Soybean was grown on an average of 1.16 million hectares with an average production of 1.16 million tons in (2005). Africa Countries with largest area of production were Nigeria (601,000 Ha) South Africa (150, 000 Ha), Uganda (144,000 Ha). Nigerian Soybean Production increased from about 2000,000 tons in 1995. The 1995 crop was worth an estimate $ 60 million. Nigeria is the largest producer of soybean for food in the west and central Africa (Iwe, 2003). Since the soybean production, consumption and acceptability have continued to increase. The number of soybean farmers also increased tenfold to about 500,000 though the entire soybean they produce is being used domestically.

OsunDahunsiet al. (2007) stipulated that acceptability of soybean product has been enhanced by modification of processing method. According to International Institute of Tropical Agriculture (IITA 2007), it has average protein content of 40% and 20% oil content, it is the only plant source that contain all the essential ammo acids.

*Tofu*is one of the most important and popular food product in east and eastern state of Asian countries and is gaining an increasing popularity in western countries as well develop ones, it has become the world's most popular soy food product (Gissen, 2004). Soy milk is made by soaking soybean in excess water, drain and grinding with additional water extracting the raw soymilk from the pulp residue (Okara) and cooking the soymilk, (Shurfleff&Aoyagi 2007). *Tofu* is an unfermented soy product also known as soybean curd and is a soft cheese food made by curdling fresh hot milk with a coagulant which is either salt ($CaCl_2$, $CaSO_4$or an acid (commercial citric acid or lemon), the coagulant produces a protein gel which trap water, soy

lipids and other constituents in the matrix forming curds, the curds are then pressed into solid curd.

Soy milk and *Tofu*, are digestible and nutritive products, which also serve as inexpensive protein and unsaturated fatty acid source for man, soybean cheese (*Tofu)* is a good source of protein, carbohydrate, low in fat and rich in vitamins and minerals element content. The incorporation of *Tofu* in to diet could be an important means of preventing chronic diseases and cardiovascular diseases (Pampluna and Roger. 2004). Soybean(*Tofu)* was introduced to Nigeria due to an increase in Asia immigrants, greater acceptance of soy foods by the general populace and the increase recognition of its health benefits especially by those who wish to reduce the consumption of meat.

InNigeria, *Tofu* is produced at house hold level using various types of coagulants, such as steep water from *akamu*, alum, tamarind, lemon juice and commercial citric acid. The yield and quality of *Tofu* is influenced by soybean varieties, soybean quality and processing conditions of the coagulants (Oboh and Omotosho 2005).

2.2 Types of Soybean Cheese (*Tofu*) Soft, Fried and Dried

Soybean cheese*Tofu* differs from each other based on the amount of water pressed out to form the curdwhich can be split into various categories such as: soft, fried, and dried.

1. **Soft*Tofu:*** depending on the amount of water that is extracted from the bean curd, it is soft and silky. Fresh*Tofu* is usually immersed in water to maintain its moisture content (Shurtleff& Aoyagi. 2007). Soft *Tofu* is boiled and season ready to serve, can be used in making savoury dishes, gravies, salad, smoothies, liquid drinks, snacksand as a whole meal.

2. **Fried*Tofu*:** this type of firm *Tofu* is produced with coagulant using concentrated soymilk; liquid was squeezed out using heavy weights object such as stone or iron. The bean curd hold it shape making it readyfor slicing, cubing or triangle and can be infused in flavour before deep fried in hot oil until it develop a golden browncolour with crispy surface that are light and airy in their core,*Tofu* can be served with a sauce, or further cooked in liquid; is also added to hot pot dishes or included as part of vegetarian dish (Shurtleff&Aoyagi, 2007).

3. **Dried*Tofu*:**dried (*Tofu)* is rather an extra firm variety with a large amount of liquid pressed out, it contains the least amount of moisture of all fresh *Tofu* and has firmness of fully cooked meat. (Shurffle&Aoyagi 2007), when sliced thinly, the bean curd is baked in the oven for 10 to 20 minutes using medium temperature, This *Tofu* can crumble easily and it can stay long in storage.Items that can be added to improve the taste can be mixed directly into curdling soy milk when is being produced to improve the flavour such as:

    i. **Sweets:** in order to produce this form of *Tofu*, sugar, fruit acids and flavoringsare mixed into soy milk prior to curdling.

    ii. **Egg**: whole beaten egg is incorporated into the soy milk curd, spices and condiment are added to improve taste and flavour and then fry. *Tofu* has a pale golden colour that can be attribute to the addition of egg, this *Tofu* has a fuller texture and flavour than soft *Tofu*, which can be attributed to the presence of egg fat and protein (Shurtleff&Aoyagi, 2017).

    iii. **Condiments and Seasonings**: condiment and seasoning are added to soybean*Tofu* to improve the taste such as seasoning cube, salt, thyme, curry.

iv. **Vegetables:** vegetables such as onion, pepper, cabbage, carrot, cucumber, carrot and lettuce can be used for garnishing.

Soybean cheese(*Tofu)* production creates some edible by products; the products aremade from the protein-oil film, or "skin," which forms over the surface of boiling soy milk in an open shallow pan, the left over solids from pressing soymilk is called okara. It contains high quality protein and fibre, can be used in many different recipes. The fibre protein and starch which has been extracted from ground soaked soybean after removing the milk. it is mainly used as animal feeds in most *Tofu)* producing countries; ways of using okara include sauce, stew, soups, as thickener in preparing meat balls, sausage or burger, mix okara with cheese chopped vegetable and seasonings to spread for bread , it was also used as an ingredient for vegetarian diet (INTSOY 2008).

2.3 Nutritional Composition of Soybean Cheese (*Tofu)*

Soybean cheese *Tofu* is rich in high quality protein, low in saturated fats and cholesterol free. It is also a good source of vitamins and mineral elements. *Tofu* also contains isoflavones which is a naturally occurring heterocyclic phenol mainly in soybean and its products (Gissen, 2004). The nutritional composition of *Tofu* is described below:

i. **Proteins:** *Tofu*is an excellent source of protein,proteins are polypeptides which are formed as a result of condensation of amino acids, of the twenty amino acids utilized in protein synthesis, only ten can be synthesized in the human system which are the non essential amino acids while the other eleven must be necessarily be derived from food products (essential amino acids) making the essential amino acids a very important component of human diet, essential amino acids are isoleucin, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, valine, (for adults)

arginnine and histidine are added to list for infants, the non essential amino acids that the body can synthesis are referreds to as dispensable amino acids, they are alanione, argine, asparagines, aspartic acid, cystein, glutamic acid, glutamine, glycerine, praline and tyrosine, due to the fact that *Tofu* as a food product that contain all the essential amino acids, it is regarded as a rich quality protein. (Gissen, 2004)

ii. **Lipids:** Lipids are organic compound that are poorly soluble in water but readily dissolved in organic solvents, they are polymers of fatty acids, and represent a concentrated energy supply in the diet as well as an efficient form of energy storage in the body, fatty acids can group in to two, saturated and unsaturated fatty acids, human being can biosynthesis many fatty acids including the saturated and unsaturated but cannot synthesis all of the necessary types of the unsaturated fatty acids which implies these unsaturated fatty acids must necessarily be sourced from the diet, those unsaturated fatty acids are called essential fatty acids.*Tofu* contains low saturated fatty acids and has relatively higher unsaturated fatty acid content, this makes *Tofu* a good nutritional source of the polyunsaturated fatty acids, also is cholesterol free, although cholesterol is the major sterol in the body and is a structural component of cell membranes and plasma lipoproteins elevated of serum cholesterol results in a higher risk of cardiovascular disease, hence the fact that*Tofu* was cholesterol free reduces the occurrence of such diseases. (Pampluna, 2004)

iii. **Carbohydrates**: *Tofu*contains carbohydrate and sugar, sugar are often called carbohydrates, the word (hydrate and carbon) with general formula $(CH_2O)n$ n=3 carbohydrates polymers of monosaccharide and disaccharides; they serve as the immediate source of the energy in the body. Glycogen is the polysaccharide form in

which carbohydrates are stored in our bodies, it is vitality important because it is a store house of energy in molecular form, (Gissen, 2004).

iv. **Vitamins**: Vitamins are organic molecules in the diet that either cannot be synthesized in humans or are syntheses at a rate less than consistent with health. They generally serve as precursors of certain co-factors or coenzymes necessary for enzymatic reactions in the body,*Tofu* contains a number of vitamins which includes water soluble vitamins and fat soluble vitamins such as vitamin C, thiamin, vitamin A, riboflavin, niacin,panthothenic acid.(Liu k, 2000)

v. **Mineral Elements:** Mineral elements are organic component in the body, they are classified into two, macro-elements and micro- elements, the macro-element includes sodium (Na) ,potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), phosphorus (p), chlorine (Cl) and sulphur (s). the micro-elements or trace elements are copper (Cu), manganese (mn), zinc (Zn), iodine (I), fluorine (F), copper (Cu), to a large extent, *Tofu*contains quite a lot of the macro –elements, the mineral composition of *Tofu* include calcium, iron, magnesium, phosphorus, potassium, sodium, zinc, copper sand manganese, which assist in the normal functioning of the body and maintenance of good health. (Gissen, 2004).

2.4 HealthBenefits of Soybeans Cheese *(Tofu)*

Soybeans cheese (Tofu) has dietary and therapeutic indications, medical personnel therefore, use or recommend it because of its healing properties (Pamplunaand Roger 2004), and they areattesting that:

1. Soybean cheese (*Tofu)* reduces the urinary loss of calcium and increases mineralization and bone density and so, prevent osteoporosis and resulting stroke.

2. Men who regular eat *Tofu* enjoy the risk of prostate cancer and heart attack.
3. Eating *Tofu* help women to maintain hormonal balance because of its isoflavones (vegetable estrogens), the benefits derived are as follows: regulation of the menstrual cycle in pre-menopausal women, relief from the symptoms of menopause, reduced breast and uterus cancer risk, stomach, prostrate and lungs cancers.
4. With extremely low cholesterol and fat content, *Tofu* is an amazing food that helps in weight loss and prevention of obesity in an effective manner, the pepsin present in fermented*Tofu* prevents the blending and deposition of certain fatty acids in the cells thereby helping in burning fat and controlling of obesity.
5. Regular consumption of *(Tofu)* and its product derivatives reduces total blood cholesterol.

The National Cancer Institute of the United State, according to Pampluna et al, (2004), is dedicating a great deal of attention to the anti carcinogenic effects of soybean and its derivation, that daily consumption of soybean products reduce the risk of breast, colon, rectal, stomach, prostrate and lungs cancer.

Teenagers can supplement soybean cheese (*Tofu)*with animal protein, because adolescent undergoes physiological changes, require energy and nutrient-dense foods for optimal development of hormonal, muscular, circulation of blood and reproductive system. In teens, calcium intake must be accompanied by physical activity to optimize bone-calcium integrations and that adolescence is the best time to increase bone density to thwart later life bone fragility and osteoporosis. Without calcium, vitamin D and Phosphorous, adult of all ages risk bone degeneration. So,*Tofu* remains essential.

2.5 Review of Related Empirical Studies

Research studies have been conducted by many researchers on issue of soybean product, this study was geared towards the physical property, nutritive valueand acceptability of soybean cheese *Tofu*among boarding secondary school students in Kaduna Metropolis. Habibullah, et al, (2007), carried out a research on proximate composition of mung bean. The objective of the study was to determine the proximate and mineral composition of two varieties of mung bean MI and NM-92. The data for the study were analyzed using standard method. The result of the study for the proximate analysis, shows the of contents of MI were found to be Moisture: 9.4%, Ash:3.9%, Protein:23.7%, Fat:1.9%,Fibre: 6.8 and Carbohydrate 54.9% respectively. While in NM-92 were found to be Moisture: 8.3%, Ash: 3.0%, Protein: 20.8%, Fat: 2.2%, Fibre: 7.1% and Carbohydrate 58.9% respectively. The data revealed that M1 had relatively higher value of moisture, ash and protein while NM-92 was found to be a bit superior in fat, fiber and carbohydrate content. The food energy value of MI (340 kcal/100g) and NM-92 was found to be a bit superior in fat, fibre and carbohydrate content. The result of the mineral analysis showed that MI contained relatively higher content of Na(22mg/100g), k(1443mg/100g), Ca (216mg /100g), Mg (204 mg/100g), P (374 mg/100g), Fe (11.34mg/100g), Zn (1.88 mg/100g) as compared to NM-92 was rich in Cu (1.92mg/100g), MN (1.49 mg /100g) and (2.64 mg/mg) in comparison to MI. The result of the study of Habibulah, et al, (2007), research work was in good comparison with the present study in terms of nutritional composition of mug bean compared with the present study on soybean cheese (*Tofu)*.

UgwuandNwake, (2011), conducted a research on: assessment of soybean product, acceptability and consumption in Orumba South local government area, the objectives of the studies were:

(1) assess the level of soybean products acceptability and consumption in the study area

(2) describe the socio-economic characteristics of soybeans farmer's producers and marketers

(3) identify and describe the various types of soybean product and their uses in the study areas

(4) assess the knowledge base on the people in the locality about processing and utilization of soybean product in the study area.

Literature on soybean processes into different product such as soy milk, soybean meal/cake, fortification of soybean with flour, soy oil refining. Random sampling was used to select 180 respondents for the study area. Mean, frequency and percentage scale were used to answer demographic all statistical analysis of data collected was analyzed by analysis of variance (Anova).The result of the study revealed that the people have positive attitude towards the consumption of soybean product and its acceptability, because of its high nutritive value which has been known to the people through various educational media. A major difference in the work of Ugwuand Nwoke (2011), was that they conducted a research on assessment of soybean product and its acceptability among consumers in Orumba South Local Government Area Anambra State Nigeria, while the present research deals with physical properties, nutritive value of soybean cheese *Tofu* and its acceptability among boarding secondary school students in Kaduna metropolis. The work of Ugwuand Nwoke were so elaborated that it dealt with soybean processing into different product such as soymilk, soybean oil, soymeal/cake, soybean flour fortification, while the present research deals with three forms of*Tofu*, soft, fried and dried, the study is similar in terms of acceptability among consumers,.

Nsiulapwa and Mwambungu, (2014), conducted a study on Nutritional value of different processed Soybean seed. The objective of the study was to determine the nutritional and anti-trypsin content of raw soybean seed in comparison to the solvent extracted and steam cooked soybean.

The result of the study revealed the moisture content of solvent extracted soybean seeds (SES) (6.7±0.25%) was significantly higher than Raw soybean seed Meal (RSSM) and Extruded Full-fat Soybean seeds (EFFS) at p- value of ($P<0.05$). EFFS seeds had lower ash content (4.4±0.1% as compared to the SES and RSSM, SES had significantly very low crude fat content (2.7±0.2%) than EFFS and RSSM ($P<0.05$). SES had higher crude protein content (48.9±0.6%) than EFFS and RSSM had significant higher calcium content (1.81±0.007%) than EFFS and SES seeds at ($P<0.05$). There was a significant difference in phosphorus content among all the soybean seeds with RSSM having the highest content (0.96±0.1) and EFFS seeds having the lowest (0.59±0.06%), at ($P<0.05$).

The similarities between the study of Nsiulapwa and Mwambungu (2014), and the present research is that, they both analyzed the proximate composition, vitamins and minerals of processed soybean. The differences between the work of Nsiulapwa and Mwanbungu (2014), was that the ant- nutritional factor of soybean was also analyzed while the present study dealt with proximate composition, sensory quality and acceptability of soybean cheese *Tofu* among boarding secondary student within Kaduna Metropolis. The study was carried out in Ndola, Zambia while the present study was carried out in Kaduna Nigeria.

Oboh and Omotosho, (2005), conducted a research on: the effect of coagulants on the nutritive value and vitro multienzyme, protein digestibility of *(Tofu*), the objective of the study was in two categories:to investigate the effect of the various types of coagulant (alum, calcium

chloride and steep water) on the yield and nutritional quality of *Tofu* and toascertain the vitro multienzyme protein digestibility of *Tofu* produced by using the various coagulant (alum, calcium chloride and steep water). Analysis of product was carried out using sample analysis of the nutrient composition (ash, fat, moisture, carbohydrates and crude fiber of the *Tofu* was determined using the standard AOAC which is similar with the present study.

In vitro protein digestibility, experimental survey design was carried out; the in vitro digestibility was calculated using the regression equation. The analysis of the three replicates were used and expressed as a mean standard error (S.E). A one-way analysis of variance (Anova) was used. A Significant difference was accepted at $p< 0.05$ level. This was similar to the present study.

The result in the study of Obohand Omotosho(2005), revealed that there was no significance difference ($p>0.05$) in the *Tofu* yield by each of the coagulant. However alum gave the highest amount of *Tofu* (18.3%), while calcium chloride gives the least yield of *Tofu*. chloride (15.1%) and alum (13.3%) coagulated *Tofu*. The calcium chloride and alum which are pure salt without any protein content. Furthermore, it could also be speculated that acidic medium created by the water from fermented pap have created a better coagulating environment for the protein present in the soy milk than the salt.

A major difference in the work of Oboh and Omotosho (2005), they conducted a research on the effect of types of coagulant on the nutritive value and in vitro multienzyme protein digestibility on*Tofu,* while the present research deals with proximate composition, sensory quality and acceptability of soybean*Tofu*.The work of Oboh and Omotosho (2005),uses three kinds of coagulants in the preparation of *Tofu*, calcium chloride, alum, water from fermented pap. While the present research deals with only one coagulant commercial citric acid, the

research work of Oboh and Omotosho (2005),was conducted in Akurewhile the present research was conducted inKaduna. The study is similar to the present study in term of using soybean product and its acceptability among consumers.

Obatolu, (2008), conducted a research on: the effect of different coagulants on yield and quality of *Tofu* from soy milk, the objective of the study is to compare soymilk with four indigenous coagulants in term of chemical, texture, colour and sensory attributes with coagulated *Tofu*. While the present research deals with nutritive value and sensory quality and acceptability of soybeans cheese (*Tofu)*. coagulant used for the studywere Epsom salt, lemon juice, alum and steep water of fermented maize while the present study uses commercial citric acid as coagulant.

The result of the analysis ofObatolu, (2008), indicated that ($p \geq 0.05$) increased from 44.5 to 51.7g/100g, respectively, in soybean grain to soy milk. Calcium and magnesium contents increase and decreased significantly ($p \geq 0.05$), in *Tofu* coagulated with calcium sulphate and Epsom salt respectively.The result of the findings shows that *Tofu* quality is affected by the type of coagulant used in curdling soy milk; the study was similar in terms of sensory evaluation, texture, aroma, taste and liking.

The research ofUwaoma (2005) was on: economics of small scale soybean processing firm in Anambra State, the objectives of the study were to:

(1). identify the technologies being used for small scale soybean processing; describe the socio economics and institutional factors that influence the choice of technology used for small scale soybean processing.

(2). determine the technical efficiency of small scale soybean processing firms.

(3). examines the value added by processing firms

(4). assess the profitability of small scale soybean processing firms and the factors that affect it, to identify the constraints of small scale soybean processing firms.

(5). assess the level of gender participation on small scale soybean processing.

The statistical tools for the study were descriptive statistic, multi-nominal logic, stochastic frontier production function, profit function, scale and value addition were used in analyzing the data, to answer research questions and hypothesis, through the use of structural pre-tested questionnaire. The result of the study of Uwaoma, (2005), indicates that, local machine were the predominant technology used in processing soymilk and soyflour. The socio economic factors that significantly affect the choices of processing, and the technology being used by the firm for both soymilk and soy flour respectively, where age, income, level of education and house hold size, however it has a negative effect, cost of purchasing and processing, machine technology, age of the firm, availability of spare parts and technicians were the significant factors in choosing the technology for use. The capital influenced technical efficiency in soy flour processing in the study area, the study also indicated that processing soybean into soymilk and soy flour were profitable respectively, the research also indicated that cost of soybeans, labour, packaging power supply and cost of petrol/diesel, significantly affect the profit of soymilk and soy flour respectively, it was observed that male and females were more predominant as they account for 74% and 69% for soymilk and soy flour processing respectively.

The differences in the research work of Uwaoma, (2005), was to identify the technology used for small scale soybean processing firm while the present research deals with nutritive value, sensory quality and acceptability of *Tofu*, Uwaoma, (2005), elaborates on the literature of soybean product, soymilk and soyflour while the present research focus only on three forms of

soybean cheese *Tofu*, fried, soft and dry, the research work fails to specify its total population and sample size used. The similarities between Uwaoma, (2005) studies with the present study were that they both use soybean product. Percentage and mean were used to determine the objectives of the study and also the population for the study was in agreement with the present study.

2.6 Summary of Reviewed Literature

Empirical studies were on the work of Habibullah, (2007)- Proximate composition of two varieties of mug bean, Ugwu and Nwake(2011)- Conducted a research on assessment of soybean product, acceptability and consumption in Orumba South Local Government Area of Anambra State, NSiulapwa and Mwambungu (2014)- Nutritional value of different processed soybean seed, Oboh&Omotosho (2014) -Effect of type of coagulant on the nutritive value and sinvitro - multienzyme protein digestibility of *Tofu*, Obotolu, (2008)- Effect of different coagulants on the yield and quality of *Tofu* from soymilk, Uwaoma, (2015)- Economics of small scale soybean processing firm.

Six empirical studies were revealed and from the studies, the researcher observed that, research work have been conducted on soybean product but none of the studies laid emphasis in the areaof physical properties, nutritive valueand acceptability of soybean cheese (*Tofu)*among boarding secondary school students in Kaduna Metropolis, therefore this study will seek to fill in the gap that is noted.

CHAPTER THREE

MATERIALS AND METHODS

This chapter described the materials and methods that was adopted in carrying out the study; this chapter is presented in the following sub-headings:

3.1Research Design

3.2 Area of the Study

3.3Population for the Study

3.4Sampling and Sampling Technique

3.5 Instrument for Data Collection

3.6 Sources of Raw Materials Used for the Production of Soybean Cheese (*Tofu)*

3.7Ingredients and Method Used for the Production of Soybean Cheese*(Tofu)*

3.8 Flow Chart for Soybean Cheese(*Tofu)* Production

3.9Procedure for Data Collection

3.10Procedure for Data Analysis

3.1 Research Design

The researcher adopted experimental research design for the study.

3.2 Area of the Study

The preparation of three forms of*Tofu*: Soft, Fried and Dried was carried out in the food laboratory of Home Economics Department, Faculty of Education,Ahmadu Bello University Zaria, Nigeria.

3.3 Population for the Study

The population for this study is four thousand six hundred and six (4,606),it comprised of students of three boarding secondary schools in Kaduna metropolis. Government Girl's Secondary School Kawo, Government Technical College Malali, and Queen Amina College, Kakuri, the details of the target population of the study are represented in the Table 3.1

Table 3.1 Population for the Study

S/No	Boarding Secondary Schools	Number of Students
1	Government Girls Secondary School, Kawo	1,216
2	Government Technical College, Malali	1,000
3	Queen Amina College, Kakuri	2,390
	Total	**4,606**

Source: field Survey, Education Zones, 2017

3.4 Sampling and Sampling Technique

A convenience sampling technique was adopted for the selection of panel of judges, the samples was selected according to the researcher's conveniences without necessary referring to the representativeness of the sample of the population, this technique provides that the panelist have the same characteristics feature which exist and are required in all population Uzoagulu(2011). For the sensory quality, ten (10) panelists were selected from each category of the population which make a total number of thirty (30) panelists were utilized for the study.

Table 3.2 Sample Size of the Study

S/No	Boarding Secondary Schools	Panel Of Judges (Students)
1	Government Girls Secondary School Kawo	10
2	Government Technical College Malali	10
3	Queen AminaKakuri	10
	Total	**30**

Source: Field study 2017

3.5 Instrument for Data Collection

The instrument that was used for data collection was three. Laboratory analysis on proximate composition of soybean cheese (*Tofu).* Standard Method of the Association of Official Analytical Chemists AOAC, was used to determine the proximate parameters: moisture, ash and crude fat, crude protein and carbohydrate contents in each sample. Moisture content was determined by heating 2g of each sample to a constant weight in a crucible placed in an oven maintained at 105C. The ash content was determined by the incineration of 5g samples placed in a muffle furnace maintained at 550C for 5-8 hours. The crude protein (% total nitrogen × 6.2) was determined by Kjeldahl method, using 2g of the sample in a soxhlet apparatus using nhexane as the total percent of: moisture, ash, fat and protein from 100. Triplicate determination was made were the average and standard deviation was reported. The mineral composition (Na, k, Ca and P) were determined on aliquots of the solution of ash by using Flame Emission Spectrophotometer. Concentrations of vitamins were determined using UV- visible Spectrophotometer A. O.A C (2010),

*(*App iii-viii, Pg 58-62).

Standardize instrument was adopted Ihekoroye and Ngodi (1985), Score cardwas used for scoring test on soybean cheese (*Tofu),*the instrument consists of two section, (Section A)

Sensory evaluation of soybean cheese(*Tofu),* was assessedusing scouring keys (parameters) which include: Texture: very crispy- 5, moderately crispy- 4, crispy -3, moderate crumbly-1. Taste:very tasty-5, moderately tasty-4, tasty- 3, moderately flat- 1. Aroma: Very pleasing-5, moderately pleasing- 4, pleasing -3, moderately displeasing-2, displeasing 1.colour: golden brown-5, moderately brown-4, brown-3, Pale-2, very pale-1, (App ii, pg 51-53). (Section B) general acceptability of soybean cheese *Tofu,*which was assessed using score card of six point hedonic scale which include: Extremely like – 6, Very much liked - 5, Moderately liked- 4, Slightly liked- 3, moderatelydisliked- 2 and disliked- 1. (App ii, pg 55).

3.6 Sources of Material Used for the Production of Soybean Chees*e* (*Tofu*)s

Soybean was bought from kawo market Kaduna. it was sorted, washed and cleaned before processing, (coagulant) citric acid was of industrial grade, it was bought from grocery store in Kaduna, all other ingredients were obtained in the market such as vegetable oil, and seasonings (salt, seasoning cube, pepper) these materials were combined to make three forms of*Tofu*: Soft, Fried and Dried.

3.7 Ingredient and Method Used For the Production of Soybean Cheese(*Tofu)*

Phase 1: Preparation of Soybean Cheese (*Tofu*) Soft, Fried and Dried.

Ingredients:

1. Soybean = 1kg
2. Citric acid (commercial) = 1 TSB spoon (diluted with 250ml of water)
3. Water =10 liters
4. Seasoning (salt, pepper, curry and thyme) to taste
5. Vegetable oil 2 cups =500mlfor fried (*Tofu)*

Method:

1. Pick and clean soybean, soak in water for two hours.
2. Wash and drain off the water, rinse well and drain the water again.
3. Mill into a smooth paste (add water while milling), dilute with four liters of water in to a watery consistency
4. Strain with a fine sieve or muslin cloth to get the soymilk
5. Pour the soymilk in a sauce pan, and bring to boil, to $100^{O}C$
6. Reduce temperature to $85^{O}C$, add diluted citric acid (do not stir), soymilk will start to coagulates, cover and allow to set
7. Turn the coagulated bean curd *Tofu* into a fine muslin cloth in a colander and allow the water to drain off very well and tight the cloth and press down with a heavy object such as (stone) to remove excess water from the soybean curd *Tofu*, allow it to solidify
8. Cut soybean curd *Tofu* into desired sizes using knife.

- **Soft soybean cheese (*Tofu*):**is ready to serve for consumption at this point; season if desired with salt, curry and thyme, garnished with vegetables such as: (pepper, cucumber, onion and cabbage). If not in use soft *Tofu*, stored in fresh water or refrigerate for future use.
- **For fried soybean cheese (*Tofu*)*:***

9. Cut fresh *Tofu*into desired sizes, season with salt, curry, thyme, pepper and seasoning cube,Heat oil deep fry until golden brown
10. Drain oil, serve hot or cold.

For dried soybean cheese (*Tofu)*:

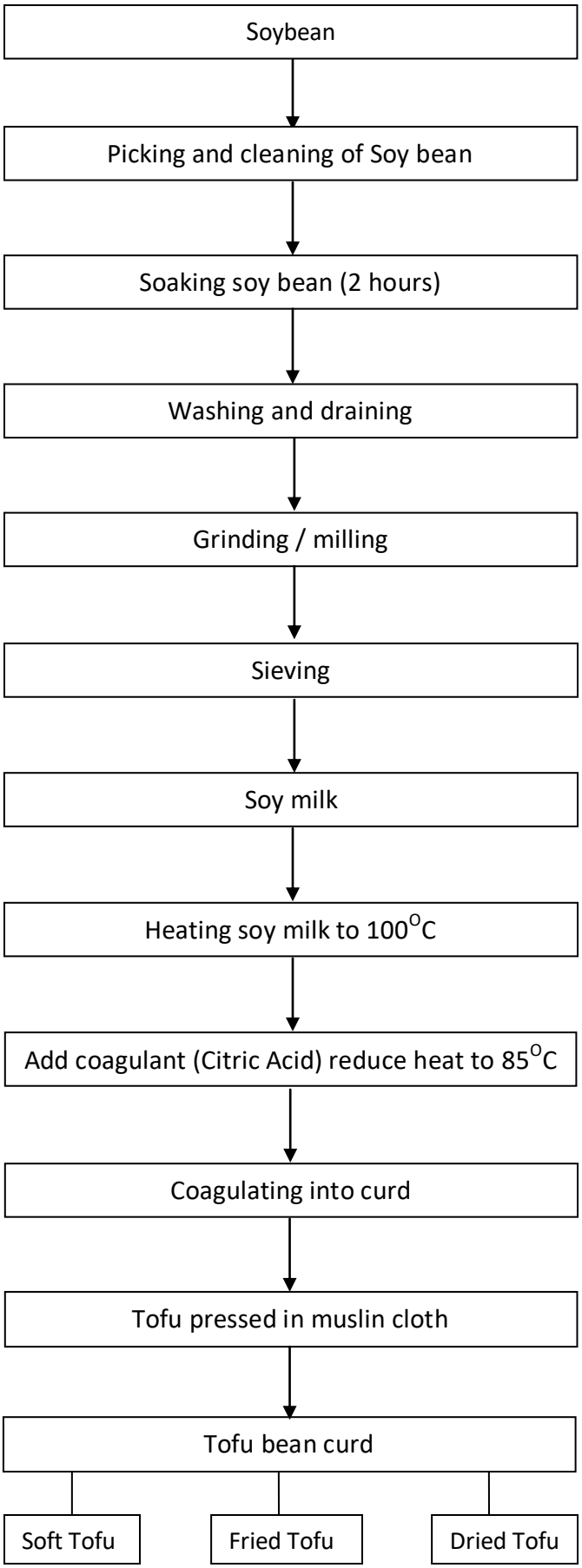
11. Press out excess water from the bean curd to make it firmer than soft and fried*Tofu* and Cut the bean curd *Tofu* into a fine thin slice pieces and season, arrange in a greased oven tray evenly
12. Bake in a low heat for 20-30 minute and check *Tofu*, if dried, the colour changes in to golden brown
13. Dried *Tofu* is ready to serve

- Dried *Tofu*: is crispy in texture and can be served as snack or used in making savory dishes, it stays longer in storage.

Phase 2: Equipment Used for Producing Soybean Cheese (*Tofu)*:

1. Food processing machine (milling machine or blender)
2. Sauce pan
3. Frying pan
4. Slotted cooking spoon
5. Colander or strainer
6. Sieve or muslin cloth
7. Chopping board
8. Knife
9. Two bowls
10. Stove
11. Tray
12. Heavy objects (stone or iron)
13. Measuring cup
14. Measuring spoon

3.8 Flow Chart for Soybean Cheese (*Tofu*) Production



3.9 Procedure for Data Collection

The researcher collected a letter of identification from the department of Home Economics Education, Ahmadu Bello University,Zaria to carry out the research workwhich was taken to Ministry of Education Kaduna State. Letter of permission was given to the researcher from the ministry to conduct the research work which was taken to the sample boarding secondary schools within Kaduna metropolis. The researcher with the help of one research assistance personally administered the score card to the panelist (student boarders) with the coded samples of soybean cheese *Tofu, (*STB) or Soft*Tofu*, (FTF) or fried*Tofu*, and (DTB),or dried*Tofu*.Following the objectives of the study the panelist were required to taste each of the coded sample rinse their mouth with water and chew carrot to be able to distinguish between the samples and write their score for each attributes on the rating scale that was provided for them, choices in qualities that was evaluated include texture, aroma, taste, colour and general acceptability. The opinions gotten from the scoring tablesformed the primary data for the study and the exercise lasted for two days.

3.10 Procedure for Data Analysis

All chemical analysis on samples, answered to research questions on sensory evaluation and general acceptability were answered using percentage, mean and standard deviation at p-value ≤ 0.05 level of significance.

DecisionRules

For sensory evaluation and general acceptability in research questions a mean score above 2.50 was regarded as accepted while a mean score below 2.49 was rejected and concluded that no significant difference exist between the three samples or otherwise.

CHAPTER FOUR

PRESENTATION AND ANALYSIS OF DATA

In this chapter, the researcher presented the results of data collected for analysis and discussion. The presentation was done under the following sub-headings:

4.1 Answers to Research Questions

4.2 Summary of Major Findings

4.3 Discussion of Major findings

4.1 Answers to Research Questions:

In this section, research questions one to five are answered.

4.1.1 Research Question One: What is the Proximate Composition of Soybean Cheese*Tofu* Soft, Fried and Dried?

Table 4.1 Proximate Composition of Soybean Cheese*Tofu*

S/N	Samples Names	% Moisture	% Ash	% Protein	% fat	%CHO
1	Soft (*Tofu*) (STB)	9.64±0.02[a]	3.35±0.01[a]	29.77±0.02[a]	23.25±0.01[a]	33.91±0.01[a]
2	Fried(*Tofu)*(FTF)	4.21±0.01[b]	3.32±0.01[a]	20.47±0.01[b]	24.24±0.02[b]	47.71±0.01[b]
3	Dried*(Tofu)* (DTB)	6.20±0.02[c]	3.77±0.01[b]	21.44±0.01[b]	19.72±0.00[c]	48.80±0.01[b]

All values expressed as means ± SD on dry weight basis. *Values on the same row followed by the same letter are not significantly different ($p \leq 0.05$). n = 3
Source: Field Study, 2017

Table 4.1 shows the result of the proximate analysis of three forms of *Tofu* contained Moisture: (STB) or soft *Tofu*FTF or fried *Tofu* 9.64± 0.02 %, FTF or fried *Tofu* 4.21±0.01 and DTB or dried *Tofu* 6.2s0±0.02 % respectively. The (STB) or soft *Tofu* appears to have the highest

moisture that is statistically significantly higher than in (FTF) and (DTB). The Ash content in the sample ranged between STB or soft *Tofu*3.35±0.10%, FTF or fried *Tofu* 3.32±0.01 % and DTB or dried *Tofu* 3.77± 0.01%. The ash content of (STB) and (FTF) were statistically significantly lower than that of (DTB) The Protein content analysis ranges from STB or soft *Tofu*29.77±0.02, FTF or fried *Tofu* 20.47±0.01 and DTB or dried *Tofu* 21.44±0.01%. The Fat content recorded for the three forms of *Tofu* ranges from STB or soft *Tofu*23.25±0.01%, FTF or fried *Tofu* 24.24±0.02 and DTB or dried *Tofu*19.72±0.00 respectively. The (FTF) have the highest Fat content of 24.24±0.02% and the least (DTB) 19.72±0.00%. The carbohydrate content of the three forms of *Tofu* ranges from STB or soft *Tofu*33.19±0.01 and FTF of fried *Tofu* 47.71±0.01 and DTB or dried *Tofu*48..80 ±0.01 respectively. (DTB) and (FTF) were higher in carbohydrate content than STB which have the list. The analysis indicated that all the three forms of *Tofu*have appreciable amount of nutrients.

Table 4.2 Mineral Analysis of soy bean cheese *(Tofu*)

S/N	Sample Name	Na (mg/g)	K (mg/g)s	Ca (mg/g)	P (mg/g
1.	soft *(Tofu*)(STB)	1.67±0.03[a]	18.0±0.12[a]	10.50±0.	3.47±0.03[a]
2.	fried(*Tofu*) (FTF)	1.40±0.06[b]	2.10±0.06[b]	1.77±0.03[b]	0.43±0.03[b]
3.	dried(*Tofu*) (DTB)	1.13±0.03[c]	2.13±0.03[b]	1.30±0.06[c]	0.23±0.03[c]

All values expressed as means ± SD on dry weight basis. *Values on the same row followed by the same letter are not significantly different ($p \leq 0.05$). n = 3
Source: Field study,2017.

Table 4.2 indicates that in all the four mineral elements analyzed using (gm) of *Tofu* per (kg). The result of the sodium (Na) analysis ranges from STB or soft *Tofu* 1.67± 0.03 %, FTF or fried *Tofu*1.40±0.06% and DTB or dried *Tofu*1.13± 0.03%. The (STB) or soft *Tofu* have the highest sodium followed by (FTF) or fried *Tofu* and (DTB) or dried *Tofu*. The potassium (k),

composition ranges from (STB) or soft *Tofu*18.0± 0.12%, (FTF) or fried *Tofu*2.10±0.06% and DTB or dried *Tofu* 2.13±0.03% respectively. The (STB) or soft *Tofu*, have the highest potassium followed by (FTF) or fried *Tofu* and (DTB) or dried *Tofu*. The calcium (Ca) analysis ranges from (FTF) or fried *Tofu*10.50±0.06%,(FTF) or fried *Tofu* 1.77±0.03% and (DTB) or dried *Tofu*1.30±0.06%. The (STB) or soft*Tofu*appears to be the highest with calcium (Ca), followed by (FTF) or fried *Tofu* and (DTB) or dried *Tofu*, Phosphorus (P) analysis ranges from STB or soft *Tofu*3.47±0.03%,(FTF) or dried *Tofu* 0.43±0.03% and(DTB) or dried *Tofu* 0.24±0.03%. (STB) have the highest phosphorus content followed by (FTF) or fried *Tofu* and (DTB) or dried *Tofu*. The (STB) or soft *Tofu* appears to have the highest composition of sodium, potassium, calcium and phosphorus.

Table 4.3 Vitamins Analysis of Soybean Cheese (*Tofu)*

S/N	Sample Name	Vitamin A (g/L)	Vitamin B (g/L)	Vitamin C (g/L)
1.	Soft(*Tofu*)(STB)	9.23±0.00[a]	8.75±0.01[a]	0.67±0.01[a]
2.	fried(*Tofu*) (FTF)	10.66±0.01[b]	12.71±0.01[b]	0.61±0.00[b]
3.	dried*(Tofu)* (DTB)	4.51±0.00[c]	12.67±0.01[b]	0.55±0.00[c]

*Values on the same row followed by the same letter are not significantly different ($p \leq 0.05$). n = 3

Source: Field study, 2017

Table 4.3 shows the composition on vitamins analysis on three forms of soybean cheese (*Tofu)*. The analysis was done using (g/L), the result shows that vitamin A, (mg/L) ranges from (STB) or soft *Tofu*9.23±0.009%,(FTF) or fried *Tofu* 10.66±0.01% and DTD or dried *Tofu* 4.51± 0.00 %. This shows a significant difference between the three forms of *Tofu*, (FTF) with the highest content, followed by (STB), the least was (DTB). For the result of the analysis of vitamin B ranges from(STB) or soft *Tofu*8.75± 0.01,(FTF) or fried *Tofu* 12.71± 0.01 and(DTB) or dried

Tofu 12.67± 0.01 % respectively. The (FTF) and (DTB) have the highest content than (STB). For vitamin C analysis ranges from 0.67 ± 0.01 %, 0.61 ± 0.00 % and 0.55 ± 0.00 %, The (STB) was significantly higher than (FTF) and (DTB)

4.1.2 Research Questions Two: What are the sensory Qualities of texture on soybean cheese (*Tofu*)?

Table 4.4: Mean Rated Texture Preference of Soft, Fried and Dried *Tofu*

Tofu Samples	N	Mean	SD	SEM
STB	30	2.17	0.91	0.17
FTF	30	3.50	0.68	0.12
DTB	30	5.00	0.00	0.00
Total	90	3.56	1.33	0.14

STB- Soft tofu, FTF- Fried tofu, DTB- Dried tofu, N- Number of respondents, SD- Standard deviation, SEM- standard error of mean

Table 4.4 showsthe panelist means responses on the texture of *Tofu* samples. The analysis indicated that the means score of (STB) or soft *Tofu* analysis indicated that the mean scores of (STB) or soft *Tofu* is 2.17 out of 5 points. (FTF) or fried *Tofu* scored 3.50 while (DTB) or dried *Tofu*scores 5.00 points. The *Tofu* with the best texture was (DTB) or dried *Tofu* followed by (FTF) or fried Tofu. The (STB) or soft *Tofu* did not score up to the bench mark for texture of 2.50.

4.1.3 Research questions Three:What are the sensory qualities of taste on soybean cheese *Tofu?*

Table 4.5: Mean Rated Taste Preference of Soft, Fried and Dried *Tofu*

Tofu Samples	N	Mean	SD	SEM
STB	30	3.70	1.12	0.20
FTF	30	4.47	0.68	0.12
DTB	30	3.10	1.18	0.22
Total	90	3.76	1.15	0.12

STB- Soft tofu, FTF- Fried tofu, DTB- Dried tofu, N- Number of respondents, SD- Standard deviation, SEM- standard error of mean

Table 4.5 showsthe panelist mean responses on sensory evaluation of taste on *Tofu*samples. The analysis indicated the mean score for taste of (STB) or soft *Tofu* was 3.70 out of 5 point, (FTF) or fried *Tofu* score 4.47 while (DTB) or dried *Tofu* score 3.10. The*Tofu*with the best taste was (FTF) or fried *Tofu*, followed by (STB) or Soft *Tofu*and the least was (DTB) or dried *Tofu*. The result indicated that all the three samples of *Tofu* were statistically accepted at 3.76 total mean score out of 5 points.

4.1.4 Research questions Four: What are the sensory qualities of Aroma on soy bean cheese (*Tofu)*?

Table 4.6: Mean Rated Aroma Preference of Soft, Fried and Dried Tofu

Tofu Samples	N	Mean	SD	SEM
STB	30	3.80	1.29	0.24
FTF	30	4.13	0.78	0.14
DTB	30	2.87	1.25	0.23
Total	90	3.60	1.24	0.13

STB- Soft *Tofu*, FTF- Fried *Tofu*, DTB- Dried *Tofu?*, N- Number of respondents, SD- Standard deviation, SEM- Standard error of mean.

Table 4.6 shows the panelist responses mean scores on aroma of *Tofu* samples. The analysisindicated that the mean score of (STB) or soft *Tofu* is 3.80 out of 5 points.(FTF) or fried *Tofu*scored 4.13 while DTB or dried *Tofu* scored 2.87 points. The (FTF) or fried *Tofu* appears to have the highest aroma sensory quality as perceived by the panelist. This implies that all the three forms of *Tofu*were statistically accepted. With total mean score of 3.60.

ResearchQuestions Five: What are the sensory qualities of Colour on soybean cheese *Tofu*?

Table 4.7: Mean Rated Colour Preference of Soft Tofu, Fried Tofu and Dried Tofu

Tofu Samples	N	Mean	SD	SEM
STB	30	1.70	0.53	0.10
FTF	30	4.20	0.55	0.10
DTB	30	4.10	1.02	0.19
Total	90	3.33	1.37	0.14

STB- Soft tofu, FTF- Fried tofu, DTB- Dried tofu, N- Number of respondents, SD- Standard deviation, SEM- standard error of mean.

Table 4.7 shows panelist responses mean scores on *Tofu* samples. The analysis indicated that the mean score for colour of (STB) or soft *Tofu,* was 1.70 out of 5 points, this was below the bench mark of 2.50; therefore the panel of judges did not find it acceptable. (FTF) or fried *Tofu* scored a mean of 4.20 and (DTB) or dried *Tofu* scored mean of 3.33. Both were acceptable to the panelist but fried *Tofu* is more acceptable.

4.1.4 Research Questions five: What is the general acceptability of soybean cheese (*Tofu)*

Table 4.8: Mean Rated Acceptability of Soft, Fried and Dried *(Tofu)*

Tofu Samples	N	Mean	SD	SEM	Decision point
STB	30	4.40	0.91	1.00	Accepted
FTF	30	5.80	0.55	0.10	Accepted
DTB	30	4.33	1.45	0.26	Accepted
Total	90	4.84	1.25	0.13	

STB- Soft tofu, FTF- Fried tofu, DTB- Dried tofu, N- Number of respondents, SD- Standard deviation, SEM- standard error of mean

Table 4.8 shows the panelist mean responses scores on general acceptability of *Tofu* samples, the analysis indicated the mean score for general acceptability of (STB) or soft *Tofu* was 4.40 and (FTF) or fried *Tofu*have 5.80 while (DTB) or dried *Tofu* 4.33 The best acceptable sample was (FTF) or fried *Tofu* with 5.80 means score acceptability. Generally all the three forms of *Tofu* were accepted among boarding secondary school students within Kaduna Metropolis. Means total score of 4.84 out of 6

4.3 Summary of Major Findings

The followings are the summary of the major findings of the study:

The study revealed the result of the proximate composition of three forms of Soybean cheese *Tofu* Soft, Fried and Dried.All the three forms of *Tofu* contain appreciable amount of macro nutrient. Four mineral elements were determined using mg/L of *Tofu* per kg, (STB) or soft *Tofu*

have the highest composition of sodium, potassium, calcium and phosphorus, this composition was followed in a distant composition rate of (FTF) or fried *Tofu*. The (DTB) or dried*Tofu*has the least mineral composition. On vitamins analysis on samples on *Tofu*, was determined using mg/L. The analysis shows that (FTF) or Fried was found to be more in vitamin A concentration, significantly higher than the two other forms of *Tofu*. (FTF) or fried *(Tofu*) and(DTB) or dried *(Tofu*) have similar concentration of vitamin B and differ in vitamin C concentration while(STB) or soft *Tofu* has more concentration than others.

The study revealed the rated score for texture. The (DTB) or dried *Tofu* appears to have the highest texture sensory quality, followed by (FTF) or Fried*Tofu*, and the least (STB) or soft *Tofu*.The findings on rated taste indicated that the (FTF) or fried *Tofu* appears to have the highest taste sensory quality followed by (DTB) or dried *Tofu* and the least (STB) or soft *Tofu*. The findings on rated aroma indicated that (FTF) or fried *Tofu* appears to have the highest aroma sensory quality and all the three forms of *Tofu* are statistically accepted. The findings on rated score for colour indicated that (DTB) or dried *Tofu* appears to have the highest sensory quality of colour followed by (FTF) or fried *Tofu* and the least was(STB) or soft *Tofu*.

The study revealed the general acceptability rated scores on three forms of *Tofu*. The (FTF) or fried *Tofu* appears to have the highest acceptability level as perceived by the panelist. The result also implies that all the three forms of *Tofu* were rated to be accepted among boarding secondary school students within Kaduna metropolis.

4.4 Discussion of major Findings

The result of the major findings of the research work shows the proximate composition of soybean cheese (*Tofu)* soft, fried and dried, which contains appreciable amount of nutrientswhich

include carbohydrates, proteins, fats and micro-nutrients vitamins such as vitamin A, vitamin B, and vitamin C. Minerals includes Phosphorus, Calcium and Sodium and Potassium in different variations, *Tofu* should be included in daily dietary pattern of every house hold for maintaining healthy living.

The result of the proximate composition analysis indicated the moisture content of (STB) or soft*Tofu* was 9.64±0.02% and (FTF) or fried *Tofu* was 4.21± 0.01% while DTB or dried *Tofu* have 6.2±0 ±0.02% of moisture content. This shows that (FTF) or fried *Tofu* and (DTB) or dried *Tofu* contain less moisture content compared to (STB) or soft *Tofu*. This result was in agreement with Nsiulapwa and Mwambugu (2014) who found lower moisture content in raw bean seed EFFS 4.4 ±01%, was significantly lower than in the processed one. RSSM 5.3±02% and SES 6.7±01%. The main advantage of having lower moisture content was that preservation period is increased to less risk of microbial deterioration and spoilage when stored longer. The present study on proteins analysis for three forms of *(Tofu)*,(STB) or soft *Tofu*29.77± 0.01%, FTF or fried *Tofu* 20.47 ±0.01% and(DTB) or dried *Tofu* 21.44± 0.01%. This result is in line with the study ofNsiulpwa and Mwanbugu (2014) thatfound the crude protein in processed and raw soybean seed ranges from 48.9± 0.6%, 37.6± 0.8% and 48.±9 0.6%, respectively. This indicated that soybean product contain appreciable amount of protein which can be used in the absence of sufficient animal protein in the diet. The present study was in agreement with the findings. The highest fat content found in this study was found in (FTF) or fried *Tofu* 24.24±0.02% followed by (STB) or soft *Tofu* 23.25± 0.01% and (DTB) or fried *Tofu*, 19.72± 0.00%. Fat tend to release more energy than any other source, hence the availability of fat lead to higher metabolize energy content than any other source of nutrient. The present study is in agreement with Nsiulapwa and Mwambungu (2014), which indicated that there was no significance difference between fat

content of raw bean seed and processed soybean seed meal; all varieties can be used as a good source of energy for the body.

The content of the total carbohydrate values of soft, fried and dried *Tofu* investigated in this study seem to be more equal to the most common pulses used for the purpose of food which is in line with Habibullah, et. al, (2007) and Oboh and Omotosho (2015). The result on investigated mineral found on Soybean cheese, soft, fried and dried *Tofu* appear to be rich source of sodium, potassium, calcium and phosphorus and was observed that the three forms of *Tofu* can fulfill the micro nutrients deficiency as well. The mineral contents were in good comparison with Nsielupwaand Mwanbugu (2014), who found Calcium and Phosphorus in raw and processed raw soybean seed. Habibullah.et al (2007), The result reported on mineral analysis revealed that varieties of mug bean raw and processed appear to be a rich source of Potassium, Calcium, which can be used to fulfill micro nutrients deficiency among consumers.

The study revealed the general acceptability of three forms of *Tofu*, soft, fried and dried, was rated accepted among boarding secondary school students in Kaduna Metropolis. This was in conformity with Nwoke and Ugwu (2011), study's that consumers have positive attitude towards the consumption of soybean products and its acceptability because of its high nutritive value, health benefit which has been made known to the people through various educational media.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter is presented under the following sub-headings;

5.1 Summary

5.2 Conclusion

5.3 Contribution to knowledge

5.4 Recommendation

5.5 Suggestion for Further Studies

5.1 Summary

This study was conducted to assess the physical property,nutritive value, and acceptability of soybean cheese *Tofu* among boarding secondary schools in Kaduna metropolis. The study tested as well the proximate composition of three forms of soybean cheese (*Tofu)* soft, fried and dried. The study was structured in to five main chapters.

Chapter one introduced the study and the general background of the study, the statement of the problems, objectives of the studies, research question, significance of the study, other aspects of the chapter were basic assumption and delimitations of the study.

Chapter two presents the detailed literature reviewed; these include the historical background of soybean cheese *Tofu*, types of soybean cheese (*Tofu),* nutritional composition of soybean cheese *Tofu),* and a reviewed of empirical studies among others.

Chapter three discussed the study's materials and method used for the study. This included a description of the research design, the instrument for data collection, source of raw material used for making soybean cheese (*Tofu),* ingredient and methods used for the

preparation, instrument for data collection, procedure for data collection and procedure for data analysis.

Chapter four presented the statistical analysis of the data in line with the study's objectives, research questions along with discussion of the result obtained from the test of the study's analysis of the related data, it was found that the three forms of *Tofu*Soft, Fried and Dried, containedappreciable amount of nutrients: carbohydrate, proteins, fats, vitamin and minerals which should be included in daily dietary pattern of every household. In respect of sensory quality of three forms of *Tofu,* they were rated to be adequate in their texture, taste, aroma, colour and general acceptability.

Chapter five presented the overall summary, discussions, conclusion, contribution to knowledge and suggestion for further studies as well as recommendation of the research work.

5.2 Conclusion

From the result of the research work, it can be concluded that: The three forms of Soybean cheese (*Tofu)* Soft, Fried andDried, contain appreciable amount of nutrients, especially protein, fats and carbohydrate. They contained elements such as calcium, potassium, vitamin A, vitamin B and C, which is advised to be included in daily dietary pattern of every household. However the three forms of Soybean cheese (*Tofu)* soft, fried and dried were rated accepted among boarding secondary student within Kaduna Metropolis. Therefore, it may be a useful strategy for boarding secondary school feeding program. Processing soybean (*Tofu)* in to different forms such as fried, soft and dried will enable the students to accept the incorporation of *Tofu* into their diet in the absence of sufficient animal protein or to complement plant protein.*Tofu* usage will help to overcome protein malnutrition deficiency disease among consumers.

5.3 Contribution to Knowledge

The study will contribute to knowledge in the following ways:

Based on the result of the proximate analysis of three forms of soybean cheese (*Tofu)*, Soft, fried and dried. All The three forms*Tofu*contained adequate nutrients. it hascontribute varieties of dishes on dietary patterns for every household and equally provided additional varieties that could be used in school feeding program, being a cheap source of plant protein, any of the T*ofu* can be used, in the absence of sufficient animal protein or to complement plant protein in the diet; this will reduce the risk of protein malnutrition deficiency diseases among consumers.

5.4 Recommendations

Based on the research findings; the following recommendations were made:

1. The food specialist and extension workers should be sent to boarding secondary schools within the state to educate the meal program feeding planners on the nutritional fact and health benefits of soybean cheese (*Tofu);* this can be done on regular training and retraining program for school meal planners and cook.
2. In view of the nutritional value, health benefits and acceptability associated with the Three forms of soybean cheese (*Tofu)*, among consumers, it should be introduced into Nigeria diet; its intake should be encouraged in homes. This can be done through mass media electronic and print, workshops, seminars, conferences, journal,

3. Farmers should be encouraged to cultivate soybean or to engage on soybean production, this will enhance the use of *Tofu;* this can be done through mass media electronic and print, seminars and workshops.

5.5 Suggestion for Further Studies

The researcher further suggests that:

- More studies should be carried out on comparative study on the nutritive value, sensory quality and acceptability of soybean cheese (*Tofu)* and Meat within the consumers in Kaduna Metropolis, Nigeria

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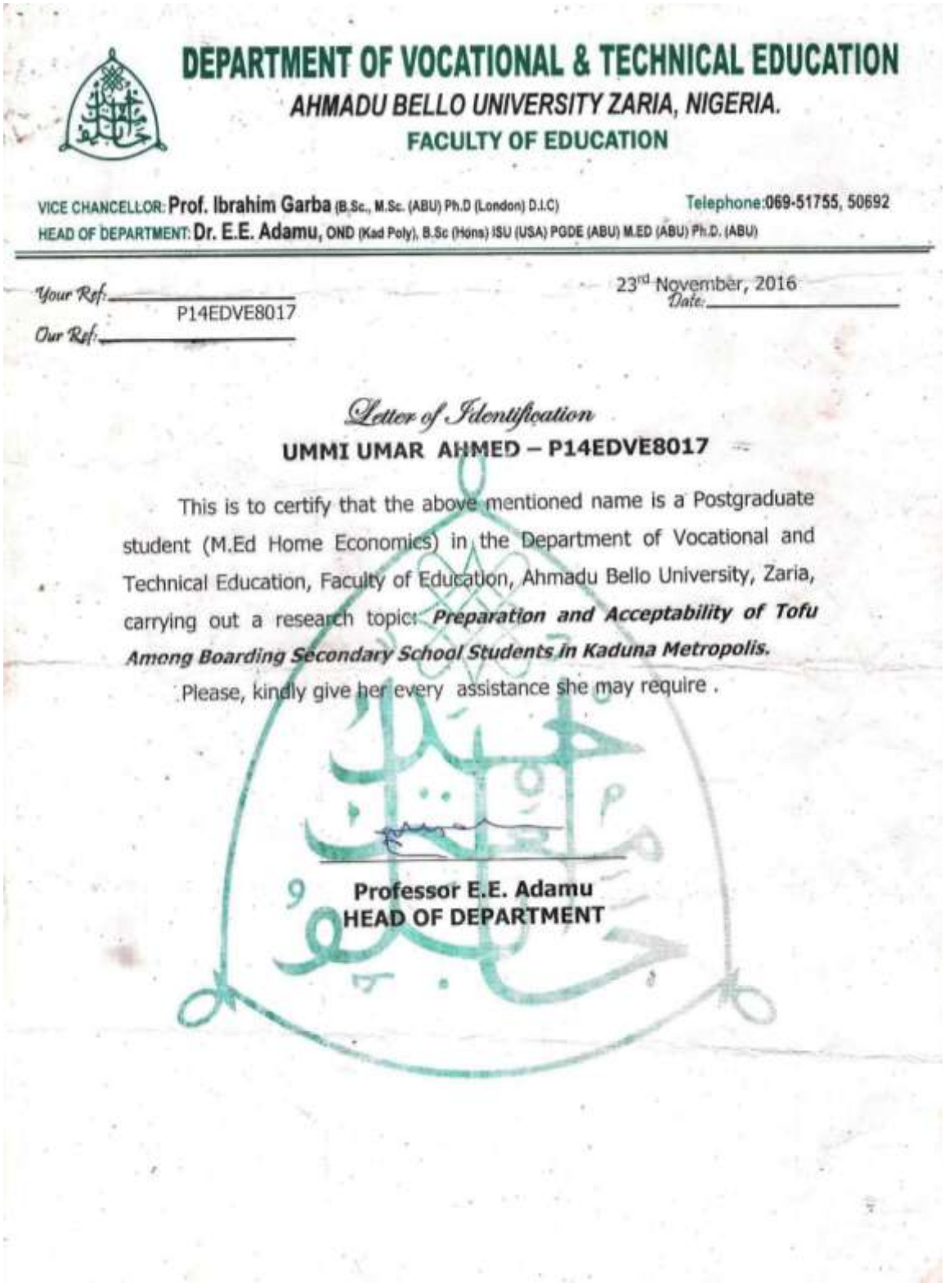
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APPENDIXI



DEPARTMENT OF VOCATIONAL & TECHNICAL EDUCATION
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Your Ref: _____ *Date:* 23rd November, 2016
Our Ref: P14EDVE8017

Letter of Identification

UMMI UMAR AHMED – P14EDVE8017

This is to certify that the above mentioned name is a Postgraduate student (M.Ed Home Economics) in the Department of Vocational and Technical Education, Faculty of Education, Ahmadu Bello University, Zaria, carrying out a research topic: ***Preparation and Acceptability of Tofu Among Boarding Secondary School Students in Kaduna Metropolis.***

Please, kindly give her every assistance she may require .

Professor E.E. Adamu
HEAD OF DEPARTMENT

Appendix II

PRODUCT SCORE CARD

SCORING CARD FOR ASSESSING THE PHYSICAL PROPERTIES AND ACCEPTABILITY OF SOYBEAN CHEESE (*TOFU)* AMONG BOARDING SECONDARYSTUDENTS IN KADUNA METROPOLIS, NIGERIA

SECTION A: Sensory Quality Test for Soybean Cheese(*Tofu)*

Instruction:-

Before you, are coded samples of three forms of Soybean cheese (*Tofu)* STB, FTF and DTB. Please check and evaluate the quality attributes of the samples and record your opinion in the scoring card with the corresponding numbers to represent your observation.

Scoring keys.

1. **Texture :**
   - Very crispy 5
   - Moderately crispy. 4
   - Crispy 3
   - Moderately crumbly 2
   - Crumbling 1
2. **Taste :**
   - Very tasty 5
   - Moderately tasty 4
   - Tasty 3
   - Moderately flat 2
   - Flat 1
3. **Aroma:**
   - Very pleasing 5
   - Moderately pleasing 4
   - Pleasing 3
   - Moderately displeasing 2

Displeasing 1

4. Colour:

Golden brown 5
Moderately brown 4
Brown 3
Moderately pale 2
Pale 1

Scoring Table 1: Sensory Quality Evaluation Test for Soybean Cheese (*Tofu)*

S/N	Variables	CHOICE SCALE	CODED SAMPLES OF SOYBEAN CHEESE *TOFU*				
			Scoring keys	STB	FTF	DTB	
1	Texture	Very crispy	5				
		Moderately crispy	4				
		Crispy	3				
		Moderately crumbly	2				
		Crumbly	1				
2	Taste	Very Tasty	5				
		Moderately Tasty	4				
		Tasty	3				
		Moderately flat	2				
		Flat	1				
3	Aroma	Very pleasing	5				
		Moderately pleasing	4				
		Pleasing	3				
		Moderately displeasing	2				
		Displeasing	1				
4	Colour	Golden brown	5				
		Moderately brown	4				
		Brown	3				
		Pale	2				
		Very Pale	1				

Section B: Six(6) Hedonic Scales for Soybean Cheese (*Tofu)*

Instruction:- Using 6 hedonic scale write your opinion and observation and overall acceptability of *Tofu* for the coded samples STB, FTF, DTB using the corresponding numbers to represent your observation.

Scoring keys:-

Like extremely	6
Like very much	5
Like moderately	4
Like slightly	3
Dislike moderately	2
Dislike	1

TABLE2: SIX(6) Hedonic Scales for Soybean cheese (*Tofu)*

S/N		Scale	Scoring keys	STB	FTF	DTB
1.	General acceptability	Like extremely	6			
		Like very much	5			
		Like moderately	4			
		Like slightly	3			
		Dislike moderately	2			
		Dislike	1			

Appendix III

PROCEDURES OF PROXIMATE ANALYSIS

1 :) Determination of Moisture content (AOAC 1980)

Aluminum or plastic dishes were washed and dried to a constant weight in an oven at 100°C. They were later removed and cooled in a dessicator and weighed (W1). 2grams of the grounded (powder) sample was placed in the weighed moisture dish (W2). The dish containing the sample was kept in an oven for about 3hours, the sample were removed and cooled in the dessicator and weighed W3.

The % of moisture was calculated as: $\frac{W2-W3 \times 100}{W2-W1}$

2 :) Determination of Ash content

Crucibles were cleansed and dried in the oven, after drying; they were cooled in the dessicator and weighed (W1). 2grams of the grounded (powder) sample was placed in the crucibles and weighed (W2). They were transferred into the Muffle Furnace for about 550° C, then removed and cooled in the dessicator and weighed (W3).

The % of Ash was calculated as: $\frac{W3-W1 \times 100}{W2-W1}$

3:) Determination of Fibre

2grams of the sample was placed in a beaker containing 1.2ml of H_2SO_4 per 100ml of solution and boiled for about 30minutes, the residue was filtered and wash with hot water, the residue was transferred to a beaker containing 1.2gram of NaOH per 100ml of solution and boiled for about 30minutes, the residue was washed with hot water and dried in an oven and weighed (C2), the weighed sample was incinerated in a Furnace for about 550°C, remove and allow to cool, and weigh (C3).

1

Appendix IV

The % of Fibre was calculated as: $\frac{C2-C3}{W} \times 100$

4:) Determination of Lipids (Fat)

- Dry 250ml clean boiling flask in oven, transfer into dessicator and allow cooling.
- Weigh empty filter paper and labeled W1
- Weigh 2gram of sample into labeled thimbles (filter paper). W2
- Fill the boiling flask with petroleum spirit or N-hexane.
- Assemble the soxhlet apparatus and allow refluxing for 8hours.
- Remove and transfer to an oven to dry.
- Transfer from the oven into a dessicator and allow cooling then weighing. W3

The % of Fat was calculated as: $\frac{W2-W3}{W2-W1} \times 100$

5:) Determination of Protein

Digestion:

- Weigh out 0.5- 2gram of sample into a kjeldahl flask.
- Add catalyst (copper) and 15ml conc. Sulfuric Acid (H_2SO_4).
- In the fume cupboard, heat till solution assumes a green colour.
- Cool and wash down any black particles showing at the mouth and neck of the flask with distilled water.
- After cooling, transfer the digest with several washings into 100ml with distilled water.

Distillation:

- Before use, steam through the Markham distillation apparatus for about 15minutes.

2

Appendix V

- Under the condenser, place a 100ml conical flask containing 10ml of Boric indicator.
- Pipette 10ml of the digest into the body of the apparatus via the small funnel aperture; wash down with distilled water followed by 10ml of 40% NaOH solution.
- Steam through for about 5-7 minutes to collect ammonium sulphate. (about 30-40ml)
- Removed the receiving flask and wash down the tip of the condenser into the flask.

Titration:

Titrate the solution in the receiving flask using N/100 (0.01N) hydrochloric acid and calculate the Nitrogen content and hence the Protein content of the sample.

NB: Always run a blank through along with the sample.

The % of protein was calculated as: Final reading –Initial reading-blank (0.2) x standard number of Nitrogen (1.4) divide by initial weight (0.5) x standard number of protein (6.25)

6:) Determination of Carbohydrate (CHO) (Pearson 1976)

By difference, in this method carbohydrate content is obtained by calculations having estimated all other fractions by proximate analysis i.e.

=100- (% of moisture + %Ash + %Protein + %Fat)

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Appendix VI

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Perchloric Acid Digestion (Wet Oxidation) of Plant Materials for P, Ca, Mg, Fe, Mn, Zn, and Cu

Apparatus

1. Pyrex Erlenmeyer flask, 125 ml
2. Whatman No 42 filter paper (9 cm)

Reagents

(A) Perchloric acid 60% AR
(B) HNO_3 conc. AR
(C) H_2SO_4 conc. AR

Procedure

1. Weigh 0.5 to 1.0 g of ground plant material (oven-dry, 60°C) into a 125-ml Erlenmeyer flask which has been previously washed with acid and distilled water.
2. Add 4 ml of perchloric acid, 25 ml conc. HNO_3 and 2 ml conc. H_2SO_4 under a fume hood.
3. Mix the contents and heat gently at low to medium heat on a hot plate under perchloric acid fume hood.
4. Continue heating until dense white fumes appear. (If any traces of carbon remain, allow the flask to cool and add 1-2 ml conc. HNO_3 and digest again to the fuming stage.
5. Finally, heat strongly (medium to high heat) for half a minute.
6. Allow to cool, then add 40-50 ml distilled water. Boil for half a minute on the same plate at medium heat.
7. Cool and filter the solution completely with a wash bottle into a 100 ml pyrex volumetric flask. Make up to mark with distilled water (use Whatman No 42 filter paper, 9 cm).
8. Store the solution for P and Fe determinations (colorimetry), Zn, Ca and Mg determinations (atomic absorption spectrometry).

References

1. Association of Official Analytical Chemists (A.O.A.C.) (1970). **Official Methods of Analysis**, Ed.11, Washington D.C.
2. Perkin-Elmer Corp. (1968) **Analytical Methods for Atomic Absorption Spectrometry**, Perkin-Elmer Corp., Norwalk, Connecticut.
3. Piper, C.S. (1944) **Soil and Plant Analysis**, Interscience Publishers, Inc. New York.

Appendix VII

Vitamin C (Ascorbic acid) Determination

The AOAC (2010) method of using 2,6- diclorophenol titrimetric method was used

Procedure:

i. 2g of sample was weighed and ground in to paste

ii. Add 100ml of distilled water to the paste in a volumetric flask. Then Filter to get a clear solution.

iii. Pipette 10ml into small flask in which 2.5ml acetone is added.

Iv. Titrate with indophenols solution (2,6- dichlorophenol indophenol) to get a faint pink colour which persists for 15sec (the acetone may be omitted if sulphur dioxide was known as to be present).

Calculation:

Vitamin C (mg/100ml) =20(v) x (c) v

Where v= ml indophenols.

C = mg vitamin C/ml indophenols.

Standardization of indophenols solution

Pipette 10ml of standard ascorbic acid solution into a small flask and titrate with indophenols solution unite a faint pink colour persisted for 15sec.

Appendix VIII

Vitamin A (retinol)
The AOAC, (2010) method was used

Procedure:

- Place in appropriate test tubes duplicated aliquots of 200ul of distilled water for blank, standard solution, a control serum and unknown sample. For a small sample like the slender tube such as 6 x 500mm or 10 x 75mm are recommended.
- Add 200ul of alcoholic KOH to all the tube and mix well on the vortex mixed for 10-20 seconds. Stopper all tube.
- Place the tube in a water bath at approximately 55-60 ^{O}C for 20 minutes; prepare a 1:1 mixture of xylene-kerosene while the samples are saponifying in the bath.
- After 20 minutes. Cool the sample to room temperature an add 200ul of xylene kerosene mixture. Extract retinol by vigorous mixing of each tube on the vortex for at least 30 seconds.
- Centrifuge for 5minute at 600-1000xg.
- Withdraw the xylem kerosene supernatant by means of Pasteur-pipette and place the sample extract in the spectrophotometer curvette. Read the optical absorbance at 328nm for retinol

Calculation;

Vitamin A (iu)= An/As x C x 100S

Vf _____x_____

W Va

Where An = absorbance of the test sample

As = absorbance of standard solution

C = concentration of standard solution

W = weight of sample used

Vf = total volume of the extract

Va = volume of the extract analyzed

Determination of thiamin (B1)

The AOAC, (2010) method was used

Procedure:

Take 2g of sample and add 75ml of 0.2NHCL, heat to boil for 30mins on a water bath

- Cool and add 5ml of enzyme solution and incubate at 32 ^{o}c overnight. Place this material in 100ml flask and make it up with distilled water.
- Filter the purity by passing through silicate column. Take 5ml of acidic KC1 eluate in a conical flask and add 15ml of isobutene and shake for 2mins.
- Allow it to separate and take the alcohol layer. Add 2g of sodium sulphur to isobutanol extract.
- Prepare the standard and blank taking 5ml each. Set the wavelength at 435mm, zero with blank and record the absorbance.

  Calculation:

$$\text{Thiamin (mg/g)} = \frac{x \times 1 \times 25 \times 100}{Y \times 5 \times V \quad \text{wt of sample}}$$

Where x = (reading of sample) – (reading of blank)

Y = (reading of standard) – (reading of blank)

V = volume of solution used for the test on the column.

PLATES

STEPS FOR TOFU PRODUCTION



Ingredients used in the preparation of soybean cheese *Tofu.*



STEP: 3. Sieving of Soymilk



STEP: 1. Soaking of Soybean



STEP: 4. Soymilk



STEP: 2. Grinding of Soybean





STEP3: Sieving of Soymilk **STEP:4. Soymilk**





STEP:5. Boiling of Soymilk **STEP:6. Pressed Soybean curd**





STEP:7. Cutting of Soft *(Tofu)*. **STEP:8. Preparation of soft (*Tofu).***





STEP:9. Frying of *(Tofu)* **STEP:10. Baked dried *(Tofu)*.**



Dried Tofu, Fried Tofu and Soft Tofu.



Assessing the three varieties of Tofu by the supervisors (soft, fried and dried).



Government Technical college Malali Kaduna.



Government Girls Secondary School Kawo



Queen Amina College Kakuri Field Study 2017