DETERMINATION OF THE PROXIMATE COMPOSITIONS AND PHYSICOCHEMICAL PROPERTIES OF GUINEA CORN

BY

ABUBAKAR ISAH

2003/14815EA

DEPARTMENT OF AGRICULTURAL AND BIORESOURCES ENGINEERING

SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGER STATE

NOVEMBER, 2008

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BEING A FINAL YEAR PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING (B. ENG.) DEGREE IN AGRICULTURAL AND BIORESOURCES ENGINEERING

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DECLARATION

I hereby declare that this project is a record of a research work that was undertaken and written by me. It has not been presented before for any degree or diploma or certificate at any University or Institution. Information derived from personal communications, published and unpublished works of others were duly referenced in the text.

Abubakar Isah

2003/14815EA

20/11/08

Date

CERTIFICATION

This project entitled "Determination of the Proximate Compositions and Physicochemical Properties of Guinea Corn" by Abubakar Isah meets the regulations governing the award of the degree of Bachelor of Engineering (B. ENG.) of the Federal University of Technology, Minna, and it is approved for its contribution to scientific knowledge and literary presentation.

Engr. Dr. O. Chukwu	Date
Supervisor	
	25/11/2008
Engr. Dr. (Mrs.) Z. D. Osunde	Date
Head of Department	
	19-11-08
External Examiner	Date

DEDICATION

This project is dedicated to Almighty Allah, who gave me the strength to complete this work successfully and to the entire Abubakar's family.

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I give gratitude to the Almighty Allah to whom all praises are due for giving me the good health, strength, wisdom and seeing me through the completion of this project work and the academic pursuit.

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ABSTRACT

In this work, some physical and chemical properties of two cultivated varieties of guinea corn were studied. The physical properties are pericarp colour, kernel size, 1000-kernel weight and moisture content. Laboratory standard procedure for food analysis of Association of Official Analytical Chemists (AOAC) were followed to obtain chemical compositions from the two varieties of guinea corn such as oil, crude fibre, ash and protein. The results show that brown variety contains (5.03 %) oil, (2.33 %) crude fibre, (1.87 %) ash and (10.80 %) protein while the white variety contains (3.03 %) oil, (1.97 %) crude fibre, (1.97 %) ash and (10.00%) protein. Nitrogen free extract were found to be (1.66 %) and (73.97 %) for brown and white samples respectively. The amylose contents are (35.00 %) for brown and (21.67 %) for white. The amylograms obtained from the starch were typical of most normal, non waxy cereals. Mineral contents such as calcium potassium and phosphorus were also determined for brown guinea corn (0.14 %, 0.19 %, and 0.16 %), and for white guinea corn (0.27 %, 0.21 %, and 0.12 %) respectively. The carbohydrate and energy values are obtained to be (72.12 %) and (374.07 %) for brown and (73.98 %) and (363.10 %) for white.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Guinea corn is a cereal crop commonly known as grain sorghum which belongs to the general class of sorghum. It has been an important staple food in the semi arid tropics of Asia and Africa for centuries. This crop is still the principal source of energy, protein, vitamins and minerals for millions of the poorest people in Africa, (Okafor and Aniche., 1987). Grain sorghum appears to have arrived in America as Guinea corn from West Africa with the slave traders about the middle of nineteenth century. Although sorghum arrived in Latin America through the slave trade by navigators playing the trade route in the sixteenth century, the crop did not become important until the present century.

The kernel of sorghum varies in colour, shape, size and certain anatomical components. The principal anatomical components are pericarp, germ or embryo and endosperm. The kernels of sorghum and pearl millet are of the caryopsis type, in which the pericarp is completely fused to the endosperm (Subramanian *et al.,* 1986). Nutritionally, sorghum protein, as other cereal proteins, is limited in amino acids, lysine, threonine, tryptophan. The colour of sorghum grains varies from white to dark brown depending on the phenolic pigments presents. Anthocyanogens have been detected in yellow millo and red kafir sorghum but not in white waxy or yellow endosperm varieties. Brown kernel sorghum grains usually have high tannin contents. These are referred by farmers as they are less liable to bird damage. However, these pigments may be transferred to grits or to starch and gluten during milling causing bitterness of grain and finished products. (Ihekoronye and Goddy, 1985).

Some well known cereals include sorghum, pearl millet, finger millet, foxtail millet, common millet, little millet, guinea corn, kafir corn, Millo, rice, wheat and millo maize (Brink *et al.*, 2006). Sorghum is grown in harsh environment where other crop grows or yields poorly. Sorghum is grown with a limited supply of water and usually without application of any fertilizer or other inputs by a multitude of small holder farmers. Therefore, and because it is mostly consumed by disadvantaged groups, it is often referred to as coarse grain or poor peoples crop. It is not usually traded in the international markets or even in local markets in many countries. The farmer seldom therefore has an assured market in the event of surplus production. Sorghum is mainly prepared in different ways as human food; it is frequently mixed with other cereals, dried cereals, legumes, crude sugar or spices for various preparations.

1.2 Statement of the Problem

Nigeria and many other countries in Africa have little information about guinea corn and about the nutritional composition of guinea corn. Although it is sold in the markets, most Africans do not know its importance to human diet.

1.3 Objectives of the Study

The objectives of this study are:

1. To determine the proximate composition of guinea corn.
2. To determine the physicochemical properties of guinea corn.

1.4 Justification of the Study

Guinea corn production has turned into a commercial business and has become an important sector of the agriculture in the tropics and semi arid region of Africa. Man has been able to maintain and eat these crops in his diet as they provide certain essential nutritional requirements. Nigeria is blessed with tropical climate which favours the production of guinea corn, millet and

maize crops. These are staple foods of the people. Food occurs in many forms as; cereals, milk, poultry and poultry products, fruits, vegetables, fish and sea food, sugar and sugar products (Marion, 1979). It is therefore essential to know the natural values of foods and their desirable nutritional needs for human diets.

Hence, qualifying and quantifying such nutritional values in produced guinea corn is of great importance to both the producers and the consumers, it is to be noted that the ultimate in food supply chain is not only to increase in the production but, how to get what is produced to the consumers in the form that is desirable (Olorunda and Aworh, 1983). Therefore the analysis of the proximate composition and physicochemical properties of guinea corn will provide a guide to both the producers and the consumers to carefully eliminate or prevent the physical, chemical biological and environmental factors that may cause guinea corn to lose completely its nutrients.

1.5 Scope of the Study

The scope of this project work is limited to the analysis of the proximate composition (energy value protein, oil, crude fibre, total ash, nitrogen extract, amylose, calcium, potassium and phosphorus) and the physicochemical properties (pericarp colour, 1000 kernel weight, moisture content and kernel size) of guinea corn in the laboratory.

CHAPTER TWO

2.0 LITERATURE REVEW

2.1 Guinea Corn Production

Sorghum grain is the fifth most important cereal in the world after wheat, rice, maize and barley. In Africa it comes second after maize in terms of production. According to FAO (1970) estimates, the average world production of sorghum grain in 1999 - 2003 amounted to 57.7 million tonnes per year from 42.6 million hectares.

The production in Sub-Saharan Africa was 19.0 million tonnes per year from 22.8 million hectares. The main producing countries are the United States (12.0 million tonnes per year in 1999 - 2003 from 3.2 million hectares); India (7.6 million tonnes per year from 9.8 million hectares); Nigeria (7.6 million tonnes per year from 6.9 million hectares); Mexico (6.0 million tonnes per year from 1.9 million hectares); Sudan (3.4 million tonnes per year from 5.3 million hectares); Argentina (3.0 million tonnes per year from 840,000 hectares); Australia (1.9 million tonnes per year from 690,000 hectares); and Burkina Faso (1.3 million tonnes per year from 1.4 million hectares) (Brink *et al.*, 2006).

In Sub-Saharan Africa, annual production of sorghum grains increased from around 10 million tonnes from 13 million hectares in the early 1960s to about 20 million tonnes from 25 million hectares in the early 2000 which can be attributed to large area being cultivated in tropical Africa. Most sorghum is grown for home consumption (except for beer production).

In Nigeria sorghum malting has become a major industry for lager and stout beer brewing and for malt beverages, using about 15,000 tonnes of sorghum annually. Breakfast is also made from it that is similar in quality but much cheaper than wheat or maize product and supplies food for

several millions of people during the most difficult months of the year when other food resources are scarce.

2.2 Processing of Guinea Corn

Guinea corn grain is handled in traditional ways. The plants are usually cut with a knife tied into sheaves, sun-dried often in panicles and stored under cover or granaries above or below to prevent insect attack. Good yields are normally 300 - 600 kg/ha, in United State, but more than 1,000kg/ha has been recorded. In some areas in Africa, yields may drop below 500kg/ha and on extremely poor soils may be merely 150-200kg/ha. Guinea corn plant shatters easily when they are mature; so much of the grain is lost between harvesting and processing. Also, threshing and decorticating guinea corn take a great deal of time and current method often contaminates the final product with sand. Traditionally, the grains are threshed by beating or tramping, and it is decorticated in a mortar, (National Research Council (NRC), 1996). The traditional techniques used include decorticating (usually by pounding followed by winnowing using calabash or sometimes sifting) malting, termination, roasting, flaking and grinding. The productivity of this work is very low. It takes nearly one hour to decorticate or thresh just one or two bags of guinea corn paddy. Moreover, in order to obtain a quality product, all dirt and sand must be eliminated. Thus, mechanizing the processing and the cleaning of guinea corn is essential both to reduce the painstaking work and to improve the quality and availability of the marketed product

In general industrial method of processing guinea corn is not as well developed as the methods used for processing wheat and rice. Custom milling has recently been introduced in several African countries. In Nigeria alone, where about 80 percent of guinea corn is now custom milled into whole flour, over 2 - 5 million tonnes of guinea corn have been processed in this way (Olatunji *et al.*, 1989).

2.3 Storage of Guinea Corn

The objective of storage is to preserve as much as possible the value of the grain for its intended future use. This means either retaining harvest or preserving as much as possible the food value of the grain for as long as possible

Methods used for storing guinea corn are influenced by the value of the crop, the quantity stored and environmental conditions. Storage containers vary from small traditional on farm or domestic containers to silos which are sometimes found in large farms. Storage could be before or after threshing, guinea corn is hung on trees or raised platforms or simply heaped on the ground either arranged in a special way mostly radially round a shade or just a heap, sometimes bundled together and stored in a living houses. The threshed grains are stored in gourds, calabashes, pits, rhombus, kerosene tins, thick polythene bags and sacks. The mouth is sealed to prevent insects attack (Ajisegiri, 2002).

2.4 Uses of Guinea Corn

- Used for producing food resembling rice
- Used to make thick or thin porridge
- Roasted at the drought stage or popped.
- Used to make pancake, dumplings or cous cous.
- Used to make cloudy beers and no-alcoholic fermented beverages.
- Used as a food for livestock feeding
- The plant residues are used for roofing, fencing, weaving and as fuel
- The red pigment is used traditionally to cure anaemia.
- It is used along with other flours or starches to make bread,
- The seeds and stalks are fed to cattle and poultry

- It can be cooked in various forms with meat, fish, legumes or vegetables for man.

2.5 Nutritional Qualities of Foods Prepared from Guinea Corn

It is a known fact that when a grain is processed, some nutrients must be removed and the removal of any proportionate part of any constituent of a seed will affect the nutritional quality of what is left. Consequently, the nutritional effect of milling probably depends as much on the amount of material removed as on the method used to remove it. It is therefore difficult to compare different reports involving different preparative techniques. Reichert and Youngs, (1977) reported that traditionally decorticated sorghum or guinea corn contained more oil and ash tan abrasively decorticated grains but the protein content was similar. Pushpamma, (1990) reported that decortications reduced total protein and lysine by about 9 and 21 percent respectively, but that it also improved the utilization of the remaining protein. The loss of minerals was minimal. Decortications improved the biological availability of nutrients and consumer acceptability (Wall and Paulls, 1978).

Whether the removal of nutrients (and anti - nutritional factors) is on balance beneficial is a question that must always be analyzed carefully. Organoleptic factors must also be considered. What is actually done is not always nutritionally for the best, and what is best in one type of diet is not always what is best for another (Rooney *et al.*, 1986).

Germination leads to considerable changes in the nutritive quality of a grain and there will obviously be some changes because of the loss of dry matter. But for more important changes such as increased enzyme activity, the conversion of starch to sugars, result from the growing process (Odunfa and Adeyele, 1987).

2.6 Physical and Chemical Properties of Guinea Corn

The physical and chemical properties of guinea corn are reviewed below:

Pericarp Colour

Pericarp is the outermost structural component of the caryopsis and is composed of three sub layers, namely epicarp, mesocarp and endocarp. In the guinea corn caryopsis, the epicarp is composed of thick, elongated rectangular cells on the outer surface. Often a pigment is present in the epicarp. The mesocarp, the middle part, is the thickest layer of the guinea corn pericarp. The endocarp is the innermost sub layer of the grain (Okeiyi and Futrell, 1983).

Kernel Weight

Weight (actually mass) is the measurement of the heaviness of a mass of given substance. It is a scalar quantity because it has only magnitude and no direction and used to determine the quantity of matter in a substance.

Kernel Size

Kernels are generally spherical but vary in size and colour, with common colours as white, bronze and brown. The caryopsis can be rounded, bluntly pointed and 4 to 8mm in diameter (Brink *et al.*, 2006). The grain is partially covered with glumes, large grains with carotene and xanthophylls increase the nutritive value. The relative distribution of the kernel components varies. In the guinea corn kernel distribution by weight is pericarp 69%, endosperm 84% and germ 10% (Hubbard *et al.*, 1950).

Moisture Content

Moisture content is the amount of water present per given weight of sample. In other words, moisture content is the loss in weight of the sample during drying. High moisture content grain

deteriorates fast due to the fact that high moisture content results in a high equilibrium relative humidity (> 70%) of the inner seed air inside the grain (Chukwu, 2008). Moisture is removed in order to know the storage ability of the product at its certain moisture content, by so doing, improve the shelf life and eliminate or reduce oxidative rancidity, microbial activities and other infestation. It is the most important physical factor that contributes to gain losses (FAO, 1970).

Crude Fibre Content

This is the component of food that cannot be broken down by human digestive enzymes. The most important role of fibre is to slow the rate at which carbohydrates are digested or absorbed. There are two types of fibre: water soluble and water insoluble fibres. Vegetable, wheat and most grain fibres are the best source of the water insoluble cellulose, hemicelluloses, and lignin. Fruits, oats and legumes are the best source of the water soluble fibres. Obviously a balanced diet should include food sources of both soluble and insoluble fibers (Thomas, 1992).

Protein Content

A certain percentage of protein undergoes a constant process of breakdown and resynthesis. This carries a certain mystique as "body building" food. It is an essential structural component of all cells. Protein is equally important for maintaining the output of essential secretions such as digestive enzymes and peptide hormones; they are used to synthesize the plasma proteins which are essential for maintaining osmotic value, transporting substances through the blood and maintaining immunity. Lack or inadequate and weak protein intakes increase urinary loss of calcium and thus may accelerate the bone demineralization associated with the aging process (Thomas, 1992).

Ash Content

This is an inorganic compound which appears in food analysis. It is the substance left behind when the carbon, hydrogen and nitrogen (organic compounds) have all been burnt off by excess oxygen. In other words, ash of biological materials is an analytical term for the inorganic residue that remains after the organic matter has be burnt off. An adult may have over 1kg of calcium in his body whereas of chromium he has only 5 - 10mg and of copper 150mg (National Research Council (NRC), 1996).

Carbohydrates

The chief metabolic role of carbohydrates in the diet is for energy production; the human body can adapt to a wide range of carbohydrates level in the diet. Any carbohydrates in excess of that needed for energy is converted to glycogen for long-term storage, while diet low in carbohydrates result in high steady state levels of some of the enzymes involved in gluconeogenesis, fatty acid oxidation and amino acid catabolism (Thomas, 1992).

Fat Content

The fat contents of biological materials is a substance found in plant and animal tissues, insoluble in water but soluble in common organic solvents such as benzene ether, petroleum and chloroform (NRC, 1996). The essential fats are need for maintaining the function integrity of membrane structure, for fat metabolism and transport and for synthesis of prostaglandins while high fat intakes are associated with increased risk of colon, breast, and prostate cancer (Thomas, 1992).

Amylose Content

Amylose is a glucose polymer (homopolysaccharide) in starch which serves as stored fuel in plant, animal and bacterial cells. The former consists of long, unbranched chain of D-glucose

residues connected by (α 1 - 4) linkage. Such chains vary in molecular weight from a few thousands to more than a million. Amylose may be widely distributed in the vegetable kingdom occurring in grains, fruits tubers, roots, seeds and stems. It is a reducing carbohydrate and gives pure blue colour with iodine helic state (David and Michael, 2007).

Energy value

This is the energy requirement of the body, the energy of much of the food we eat is converted to ATP and other high energy compounds, which are in turn utilized by the body to drive biosynthetic pathways, genetic nerve impulse and power muscle contracts. It is generally the energy content of food described in terms of calories, which is kilocalories of heat energy released by combustion of the food in the body (Thomas, 1992).

Mineral Content

These are elements which are found in small amounts less than 5mg and are called the trace elements and are probably working as catalysts or in a small capacity. Though their presence in the body is small, but they are still required. Examples of some important trace elements are; the elements which occur in the body in large amounts are called macro elements. They include; calcium, sodium, iron and magnesium.

All the elements enter into the fluids, cells and other structures of the body and may be needed in definite amounts for the proper functioning of these fluids, cells and structures (Thomas, 1992). Calcium is the most abundant mineral in the body. Most of the calcium is in the bone but a small amount of calcium outside of the bone functions in a number of essential processes. It is required by many enzymes mediates, some hormonal contractility and human neuromuscular activities. Certain population groups in this country do not have adequate calcium intake especially low income children and adult women and they are the particular group in highly need of calcium. It

is also known that excess protein in the diet may upset calcium balance by causing more rapid excretion of calcium and it is known that calcium is necessary for bone formation.

Phosphorus is a universal constituent of living cells and for that reason is almost always present in adequate amounts in the diet. Uncontrolled metabolic acidosis can lead to excessive phosphate loss in the urine. Its deficiency causes a muscle weakness which may eventually lead to rickets formation.

Potassium is one of the important minerals in human diet which is usually required in a large quantity in heart muscles. It also helps in balancing of acid and base in the human body. Deficiency of potassium retards growth, leads to severe paralysis and even tenany (Ogieva, 1998).

2.7 Physicochemical Evaluation of Guinea Corn

The physicochemical evaluation of guinea corn is shown in Table 2.1, 2.2, 2.3 and 2.4.

Table 2.1: Physical Properties of Guinea Corn.

Component	**Fraction**
% of kernel weight	100%
Diameter (mm)	20 – 30
Type	Caryopsis
Colour	White
Shape	Spherical

Sources: USDA 2006

Table 2.2: Nutritional Composition of Guinea Corn

Component	**Nutrient Content %**
Protein	2.3
Ash	1.67
Oil	3.6
Carbohydrate	73.8

Source: Hubbard *et al.*, 1950

Table 2.3: Mineral and Vitamin Composition of Guinea Corn

Component	**Nutrient Content (mg)**
Phosphorus	287
Magnesium	171
Calcium	15
Iron	4.2
Zinc	2.5
Copper	0.44
Manganese	1.15
Potassium	138
Thiamin	0.24
Riboflavin	0.14
Niacin	2.9
Ascorbic acid	0

Source: Bioline, 2008

Table 2.4: Essential Amino Acid Composition per 100g Edible Protein of Guinea Corn

Component	**Nutritional Content (mg)**
Tryptophan	124
Lysine	229
Methionine	169
Phynylalanine	546
Threonine	346
Valine	561
Leucine	1491
Isoleucine	433
Linoleic acid	1305
Oleic acid	946
Palmitic acid	407

Source: USDA, 2006

CHAPTER THREE

3.0 Materials and Methods

3.1 Materials

The guinea corn samples used to determine the physicochemical properties and the nutritional contents were obtained from Mokwa Modern Market in Niger State, Nigeria. They were decorticated using hand. The tests analysis were carried out in two Institutes (General Laboratory, NCRI, Baddegi, Niger State and Food Sciences Laboratory, Institutes of Agricultural Research, ABU, Zaria, Kaduna State) under the supervision of Mr. Yakubu Mohammed, Mr. Tijani Mohammed, Mr. Ayuba (General Laboratory, NCRI, Baddegi); Mr. Adegbe Edward, Mr. S. Bala (Food Science Laboratory, IAR, Zaria), and Mr. Saidu Zegi (Department of Agricultural and Bioresources Engineering, F.U.T, Minna) between 19th May to 21st August, 2008.

3.2 Instruments and Reagents

3.2.1 Instruments / Apparatuses

The instruments / apparatuses and reagents used for the analyses are:

1. Crucibles/silica dishes
2. Muffle Furnace, made in England with the Serial number of 4399
3. Sensitive electric weighing balance with the sensitivity of 0.001g and manufactured in Switzerland and serial number: 1+52764.
4. Pipette
5. Conical flasks
6. Desiccators
7. Standard mesh sieve

8. Beakers,
9. Water bath,
10. Filter papers
11. Bunsen burner
12. Thimbles
13. Clean white cotton wool
14. Soxhlet extractor
15. Condenser
16. Hot air dry oven
17. Flame photometer
18. Spectrophotometer, Produced in England, by B. Bran Scientific and Instrument Company, with the sensitivity of 722 – 2000g
19. Micro Khjeldal digestion block with the Serial number of 44103 and made in England.

3.2.2 Reagents

1. Petroleum ether,
2. Tetraoxosulphate VI acid
3. Sodium hydroxide solution
4. Calcium chloride
5. Calcium hydroxide
6. Ammonium chloride solution
7. Potassium cyanide
8. Calcium indicator

9. Methyl orange indicator
10. Buffer solution
11. Standard calcium solution
12. Standard amylose solution,
13. Ammonium molybdate solution
14. Antimony potassium solution
15. Ascorbic acid solution
16. Distilled water
17. Potassium iodine
18. Ethanol
19. Hydroxylamine
20. Potassium ferrocyanide solution
21. Triethanolamine solution.

3.3 Physicochemical Properties

Determination of Pericap Colour

Light transmission was passed through a container and the sample of guinea corn and the colour was determined by the reflex activity and absorptive capacity of the sample.

Determination of Kernel Size

Standard sieve digestion was used by passing the sample through the sieve of number 7, 8 and 10 of USA standard (Brennan *et al.*, 1981) and the size was recorded.

Determination of 1000 Kernel Weight

1000 kernels of guinea corn grains were counted and weighed using electronic weighing balance and the weight was calculated from the relation:

$$\text{Weight} = \frac{\text{mass from the scale (kg)}}{\text{Number of calculated grains}}$$

Determination of Moisture Content of Guinea Corn

Based on weight loss air oven method was used. The weight of the crucible / dish was taken. 2.0g of the ground sample was put into the dish and weighed. The dish and the sample were placed in an oven at 80^0C for 12 hours. The sample was removed and cooled in the desiccators and reweighed. The percentage moisture content was calculated as:

$$\%\ \text{moisture content} = \frac{\text{loss in weight due to drying}}{\text{weight of sample taken}} \times 100$$

3.4 Proximate Composition

Determination of Crude Fibre

The procedure outlined in AOAC (1980) was used in determining the crude fibre. The weight of a conical flask was taken. 2.0g of the sample was put into the conical flask and weighed. Concentrated H_2SO_4 and NaOH was added to the conical flask and heated to boil for 30 minutes. The residue was washed three times and NaOH was added then put in muffle furnace at 600^0C for 6 hour it was the removed and cooled in desiccators and reweighed. The percentage crude

$$\text{fibre is \% crude fibre} = \frac{\text{weight loss of sample}}{\text{weight of sample}}$$

Determination of Crude Protein

The procedure outline in AOAC (1980) was used in determining crude protein 1.0g of the sample was taken 5mls and 0.5m of NaOH and H_2SO_4 were added. The content was thoroughly mixed and allowed to settle for 15 minutes and filtered. 5ml of the filtrate was put in to a clean

conical flask and 5ml of distilled water was added with 2 drops of methyl orange indicator and shake thoroughly. This was titrated against 0.5m of H_2SO_4

$$\text{Therefore percentage nitrogen in the sample} = \frac{\text{corrected titre (ml)} \times 14 \times 5}{1000 \times 70 \times \text{weight of sample (g)}} \times 100$$

And percentage crude protein = percentage nitrogen x 6.25

Determination of Total Ash

The procedure outlined in AOAC (1980) was used to determine the total ash content of the sample. The weight of the crucible / dish was taken 2.0g of sample was added to the crucible and weighed. The dish and content were placed on the furnace and the temperature was set to 500^0C for 16 hours until the sample was completely ashed. The ash in crucible / dish was removed to cool in desiccators, then re-weighed and the percentage ash was calculated as:

$$\text{Percentage ash} = \frac{\text{total weight of extracted ash}}{\text{weight of sample}} \times 100$$

Determination of Fat (Oil) Content

The procedure outlined in AOAC (1980) was used in determining the fat content. An extraction flask (thimble) was cleaned, cooled in desiccators and weighed. 3.0g of the sample was taken into the extractor, covered with clean white cotton wool. Petroleum ether was poured into the flask. The extractor with the thimble plus sample is fixed into the flask, which inserted in Bunsen burner and heated for about 6 hours. The extraction flasks were removed from the water bath, and the collected solvent in thimble, and were allowed to be cooled for 1hour in desiccators and weighed.

$$\text{The percentage fat} = \frac{\text{weight of ether(oil)}}{\text{weight of sample}} \times 100$$

Determination of Carbohydrates Content

The procedure outlined in AOAC (1980) was used in determining the carbohydrate content. This was calculated by difference. The sum or total of the moisture, fat, protein and ash contents were subtracted from 100 to give carbohydrates content as:

Carbohydrate content = 100 (% protein + % moisture + % fat + % ash).

Determination of Energy Value

The food energy value of the sample was determined according to the method described by (Osborn, 1972). The energy value (kcal/100g) is equal to (4 × protein) + (9 × fat) + (4 × carbohydrate).

Determination of Nitrogen Free Extract

The content of nitrogen free extract of the sample was determined according to the method described in the Laboratory Manual for Nutrition Research as 100 − (moisture content + crude protein + crude fat + crude fibre)

Determination of Amylose

Procedure: Robyl and Bemis (1967) guideline was followed. 100mg of defatted sample was weighed into a 100ml volumetric flask and 1ml 96% ethanol and 9ml 1N NaOH were added to the flask and swirled gently to dissolve the sample. This was stored over night at room temperature. The solution was made to 100ml with distilled water, shaken vigorously and allowed to stand for 30 minutes to allow particles settle. 5ml of the supernatant was pipetted into a 100 ml beaker and 30ml of distilled water was added adjusted to P^H of 10.2 with HCL. To the solution, 1ml of iodine reagent was added and mixed thoroughly and allowed to settle for 30 minutes and then made to about 100ml with water. The absorbance of the blue complex was then read at 600nm against the blank solution and the percentage amylose was calculated.

Determination of Potassium

The AOAC (1980) guideline was followed. Wet oxidation of plant tissue for the determination of mineral was used. The digestion mixture is acid mixture contending 750ml conc. Nitric acid; 150ml conc. sulphuric acid and 300 ml of 60.62% perchloric acid.

1.0g of ground sample was weighed into the digestion tube and 5ml of the digested mixture was added and swirled gently and placed in a fume cupboard over night. It was digested for 2 hrs at 150 - 200^{0}C using Gerhardt digester and cooled and about 30ml of distilled water was added to the tube and mixed vigorously. Potassium was determined by aspirating through photometry and the reading was recorded and percentage potassium was calculated.

Determination of Calcium

Calcium was determined by ethlene -dia-mono-tetra-acetic acid (EDTA) titration method and the value obtained was recorded and the percentage calcium was calculated

Determination of Phosphorus

The AOAC (1980) guideline was followed

Procedure: Mix about 10ml of (25g ammonium molybdate and 0.61g antimony potassium and add 250ml concentrated sulphuric acid and dissolve in 250ml distilled water) also add 22g of ascorbic acid mix in 250 ml distilled water, mixed thoroughly. Then 10ml of the solution was added and allowed to stand for 1 hour. The absorbance was read at 882nm with a spectrophotometer and the percentage phosphorous was then calculated.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Results

4.1.1 Physical Properties

The physical properties of guinea corn are presented in Table 4.1. Each parameter is the mean of three replicate determinations.

Table 4.1: Physical Properties of Guinea Corn

Cultivar	*Pericarp colour*	*1000kernel weight (g)*	*Moisture (%)*	*Kernel size (%) 7μm*	*Kernel size (%) 8μm*	**Kernel size (%) 10μm**
Guinea corn	brown	0.353	10.09	74.10	24.60	1.30
Guinea corn	white	0.346	11.04	72.80	25.10	2.10

4.1.2 Discussion on Physical Properties

The pericarp colours brown and white were observed in the guinea corn used. The kernel size with a diameter between 7 and 8 μm has the higher percentage. Preferably, the grain should be ground before use. The weight of the kernel was higher than that of pearl millet and acha, but less than that of wheat and maize (Kent, 1982; Akingbala, 1982).

The moisture content shows slight differences which are less than the moisture content of maize, wheat and acha (14,12,14) but greater than that of rice and pearl millet (9,10) (Ihekoronye and Ngoddy, 1985; Abdulkadir, 2007).

4. 1.3 Proximate Nutritional Composition.

The proximate compositions of guinea corn are presented in Table 4.2. Each parameter is the mean of three replicate determinations.

Table 4.2: Nutritional Composition of Guinea Corn

Component	*Nutritional Content (%)*	**Nutritional Content (%)**
	Brown	**White**
Oil	5.03	3.03
Crude protein	10.80	10.00
Crude fibre	2.33	1.97
Ash	1.87	1.97
Nitrogen free extract	71.66	73.97
Carbohydrate	72.12	73.98
Energy value	374.07	363.10
Amylose	35.00	21.67
Calcium	0.14	0.27
Potassium	0.19	0.21
Phosphorus	0.16	0.12

4.1.4 Discussion on Proximate Nutritional Composition

The proximate chemical composition and energy content of the two species of guinea corn are presented in the Table 2.4.There were differences in the amylose and calcium contents between the two species. The amylose content of the brown guinea corn is higher than that of white

guinea corn which is also greater than the report in the earlier study of (USDA, 2006). The calcium content from this study is less than the previous study (www.Blackherbals, 2008.)

The energy values of both species are less compared to the study of Oyenuga (1968). The oil content reported in this study of both grains are higher than those of wheat are rice but less than of maize but ash contents are les than those of rice, wheat and maize (Oyenuga 1968).The mineral composition varies for the two crops and are lower than that reported in the study on sorghum and millet (FAO 1968).Though this may be due to environmental conditions prevailing in the growing region.

Generally, high fibre content and poor digestibility of nutrients are other characteristics of guinea corn which severely influence consumers acceptability and this nutrient may be considerably diminished by the presence of tannin. Although white guinea corn does not contain tannins as brown and has a nutritional value similar to that of maize which means that white guinea corn has good digestibility as maize, and brown guinea corn is very good for farmers as a choice for plantation because of it tannin contents and little or low rodents attack which favours, the farmers yield and in the production of local traditional alcohol *burukutu* (USDA, 2006).

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The evaluation of some physical and chemical properties of guinea corn (brown and white) revealed some basic differences between the two species. A 1000 kernel weight showed that the grain of guinea corn is higher than those of maize and wheat. The mineral contents were lower than the previously reported values for cereals generally. The colour of the grain varies depending on the phenolic pigment present.

Thus, in formulating animal feed or for human consumption it would be better to mix the two species of guinea corn with protein rich food so as to obtain the optimum dietary requirement needed by the body.

5.2 Recommendations

- Decorticating, parboiling, malting or steeping in alkali solutions is recommended to reduce tannin content in guinea corn grain.
- Since guinea corn grain does not contain gluten, it is recommend to mix it with wheat when used for leavened products.
- There is need also for the consumers and animal feed processors to always mix guinea corn with protein rich foods to enhance dietary requirements.

REFERENCES

Abdulkadir, J. A. (2007). Analysis of the nutritional content of acha (*Digitaria exilis* and *Digitaria iburua*).Unpublished B. Eng. Project, Department of Agricultural Engineering, Federal University of Technology, Minna, Niger State, Nigeria. pp. 4 – 26.

Ajisegiri, E.S. A. (2002). Post harvest technology development in Nigeria. Unpublished lecture note, Department of Agricultural Engineering, Federal University of Technology, Minna, Niger State, Nigeria. pp. 57 – 60.

Akingbala J.O (1982). Effects of physicochemical properties of sorghum starch and endosperm in the quality of a traditional African food. Phd dissertation, Tecas A&M, University College Station, TX, USA.

Akingbala J.O, Rooney L.W, and Faublon J.M (1981). physical, chemical and sensory evaluation of ogi from sorghum of did rent Kernel characteristics, *Journal food Science* 46: 1532-1536.

AOAC. (1980). official methods of analysis of the AOAC (13th edition) association of Official analytical chemists Washington, DC, USA, pp. 858.

Brennan, J. C, Butler, J. R, Cowell, N. O and Lilly, A.E. V. (1981). Food engineering operation (2nd edition) applied science publishers Limited London, UK. pp.1 – 50.

Brink, M., Purseglove, E., Belay, G., and Lemmens, R. H. (2006). Plant Resources of Tropical Africa 1 Cereals and Pulses. Prota Foundation/ Backhuys Publishers Wageningeon, Netherlands. Pp 169 – 174.

Chukwu, O. (2008). Agricultural Engineering Concepts. Unpublished Lecture note on processing and storage of food crops problems and prospect, Department of Agricultural Engineering, Federal University of Technology, Minna, Niger State, Nigeria.

David, L. N, and Michael, M. C. (2007). Principle of biochemistry. (4th edition) published by W. H. Freeman and Company, New Yolk pp. 248 – 255.

FAO. (1968). Food composition table for use in Africa US Department of Health, Education and welfare public health service, Washington DC pp. 6 – 10.

FAO. (1970). Amino acid content of food and biological data on proteins FAO nutritional studies, food and agricultural organization of the United Nations, Rome, pp.285 – 289.

http: //www.blackherbals. Com/sorghum and millet I African nu.htm, Retrieved on 07/ 06/ 2008.

http://www. bioline. Org. / maize, rice and millet in Human Nutrition. Retrieved on 03/ 06/ 2008.

Hubbard, J. E, Hall, H .H and Earle, F. R. (1950). Composition of the component parts of sorghum kernel, cereal chem. 27: 415 – 420.

Ihekoronye, P.O and Goddy, N. (1985).Integrated food science and Technology for the tropics.Macmillian pp. 249-252.

Kent, N.L (1982).Technology of cereals (3rd edition) Pergamon Press London, UK, pp. 277-295.

Laboratory Manual for Agronomic Studies in Soil, Plant and Microbiology, National Cereal Research Institutes, Badeggi, Niger State, Nigeria. pp. 55 – 69.

Reichert, R .D and Young's, C.G (1977). Dehulling Cereal Grains and Grain Legumes for Developing Countries. 11 Chemical Composition of Mechanically and Traditionally dehulled Sorghum and Millet. Cereal chem. 55:174-178.

National research council (NRC) (1996), lost crops of Africa, Vol.I Grains National Academy Press, Washington, dc. pp. 59-72, 251272.

Odunfa, S. A, and Adeyele, S. (1987). Sugar changes in fermenting sorghum during preparation of ogi- baba gruel. J. Food Agric. 2: 95 – 98.

Ogieva E. (1998). 30 January. Comprehensive agricultural sci. (sure bet for WASSCE) Okesuna High School Lagos, Nigeria. pp. 332 – 337.

Okafor, N. and Aniche, G.N. (1987). Studies on the brewing of Lagos bear Nigerian sorghum. J. Food science technology. 24:131-134.

Okoyi, E.C and Futrell, M F. (1983). Evaluation of protein quality of formulations of sorghum grain flour and legumes seeds. Nutr.Rep. Int 28: 451 – 461.

Olatunji, O.Adesina, A.A and Koleoso, O.A. (1989). Uses of sorghum as composite flour in baking paper presented at the symposium on the current status and potential of industrial uses of sorghum in Nigeria, Kano, Nigeria 4 - 6 December.

Olorunda, A.O, and Aworh, C.C. (1983).A qualitative assessments of post harvest of perishable vegetable in Nigeria marketing system, *journal of science* 17 (1): pp. 41 – 47.

Osborn, T.B. (1972). The vegetable proteins. (2nd edition) Longmans and Green, New York, USA.

Oyenuga, V.A. (1968). Nigeria food ands feeding stuffs their chemistry and nutritive value (3rd edition). Ibadan University press, Nigeria.

Pushpamma, P. (1990). Importance of sorghum as food in Asia in G. Ejeta, West Lafayette Indiana, Etats – Unis, Purdue University, pp. 229 – 241.

Marion, L Field (1979). Fundamental of food microbiology Published by Avi publishing company ING pp. 110 - 112.

Rooney L.W, Kirleis, A.W, and Murphy, D.S. (1986). Traditional food from sorghum: their production, evaluation and nutritional value, adv. Cereal sci. technology pp 317-353.

Robyl, J.F, and Bemis, S. (1967).Use of the Autoamalyser for data nine the blue value of the amylase –iodine complex and total carbohydrate by phenol Sulphuric acid. Manual

biochemistry 19:56-60.

Subramanian, V, Jambuna, and Ramaiah, C.D. (1986). Physical and chemical characteristics of pearl millet grains and their relationship to rot quality *Journal of Food science.*, 51:1005-1020.

Thomas, D. (1992). Biochemistry with clinical correlations (3rd edition) Hahnemann University, School of Madinec Philadelphia, Pennsylvania New York pp. 1095, 1113-1118.

USDA. (2006). National Nutrient Database for Standard Reference, Release 19 (2006).

Wall, J. S, and paulls, I.W. (1978). Corn and sorghum grain proteins adv. Cereal Sci. Technology, pp. 135 - 219.

APPENDICES

APPENDIX A

An AOAC (1980) guideline for determining nutritional parameters was followed. The routine analysis of foods is termed the proximate analysis. It is used for confirming a suspected nutrient element deficiency and also in monitoring the plant nutrient status in order to determine the concentration of each tested nutrient is adequate. In this form the dried material is grounded into powder to pass though a sieve of particular mash and then stored in a dry container.

For elemental analysis, the organic matter in the plant has to burn away leaving the nutrients to be analyzed in inorganic forms. Determinations are usually made on dry sample except moisture determination and the result are reported in terms of dry or wet bases weight of the sample. Some determinations on proximate composition are as follows;

A_1. Pericap colour; the colour of the guinea corn grain determine by the reflectivity and absorptive character by the view transmission of light.

A_2. 1000 kernel weight; in equipment are, sensitive electric weighing balance, and flat container. Procedure; cant 1000 grain of the food product sample in three different container, determine the weight of each counted grain, find the average and express the result as grain per 1000 kernels.

A_3. Kernel size pass the grains sample into a view of different mesh size, shake vigorously locate the mesh with high percentage grain retain.

A_4. Moisture; empty metallic dish was dry in an oven at 80^0C for 20 minutes, removed and cooled in a desiccators and weight (W_0). Take some gram of the sample into the dish and weigh (W_1), the dish with the sample inside is then dried in an oven at 110^0C for 24 hours, removed

quickly transfer into a desiccators to cool and weigh the dry sample with the can (W_2). The loss in weight of the sample during drying is the moisture content (%) = $\left(\frac{w_1 - w_0}{w_2 - w_0}\right) \times 100$

A_5. Ash; wash a silica dish in a water bath, hold in a hot Bunsen burner for a minute, transfer to desiccators and allow to cool then weigh (W_0) take about (3 to 5) g of the food sample into the dish and weight (W_1) take the dish containing the sample to a Bunsen burner inside a fume cupboard, heat for 2-4 hours. The transfer into a muffle furnace heat to about 500^0C for 48 hours. Removed the sample and transfer into desiccators to cool and weigh (W_2).

$$\text{Ash content (\%)} = \left(\frac{w_1 - w_0}{w_1 - w_0}\right) \times 100$$

A_6. Fat; dry 250mls extraction flask in the oven at 110^0C for a minute, allow to cool in the desiccators and weigh (W_0). Take 2 to 3gm of the sample into pours thimble and covered the thimbles mouth with a white clean cotton wool. Pour about 200ml of petroleum ether into the dry 250mls extraction flask and then place covered pours thimble into the heating mantle and heat for about (5-6) hours. Carefully removed the pours thimble and collect the extracted ether on the top container and remove the extraction flask from the water bath. Oven dry at 110^0C for 24hours, cooled in a desiccators and weigh (W_2).

$$\text{The fat content (\%)} = \left(\frac{w_2 - w_1}{w_2 - w_0}\right) \times 100$$

A_7. Crude fibre; weigh about (1-2) gm of the grounded sample into a 1 litre conical flask and weigh (W_1) add 150ml preheated H_2SO_4 and heat to boil for 30 minute. Then filter sing vacuum pump. And the residue was wash for bout 3 time with hot water (distilled), the residue is scrape back into a 1 litre conical flask, add 150 ml of preheated KOH and heat to boil, add some drop of antifoaming agent continue to boil for about 30 minutes then filter. Wash with hot distilled water

and using acetone / methylated spirit. Transfer into an oven to dry at 130^0C for an hour and weigh (W_2). Take it into a muffle furnace for ash at 600^0C, cooled in desiccators and weigh the ash (W_3)

$$\text{Crude fibre (\%)} = \left(\frac{w_2 - w_3}{w_1} \right) \times 100$$

A_8. Crude protein; principle: the nitrogen of protein and other compounds are transformed into ammonium sulphate by acid digestion with boiling sulphuric acid. The acid digest is cooled, diluted with water, and made strongly basic with sodium hydroxide. The released ammonia is distilled into a boric acid solutions or standard sulphuric acid solution.

Equipments; micro kjeldahl nitrogen digestion ad distillation apparatus; kjeldahl flask 650ml, Erlenmeyer flask 500ml, and two burette. Reagent (for acid/alkali) titration method;

Potassium sulphate, copper sulphate, coal. H_2SO_4, NaOH solution, methyl red indicator solution e.t.c.

Procedure: Transfer carefully about 2gm of the prepared sample, accurately weighted to the kjeldahl flask. Add about 10gm of potassium sulphate, about 0.5g of copper sulphate and 25 or more of conc. Sulphuric acid. Transfer for heating below the boiling point of acid until frothing ceases. Increase heat until acid boil vigorously, and digest for about 2 hour for a complete oxidation, then cool the content of the flask and transfer quantitative to a round-bottom flask with water of about 200ml. an dada few pieces of pumice stone to prevent bumping and NaOH solution sufficient to make the solution alkaline to form a layer below an acid layer, mixed by shaking the content until all the ammonia has passed over into the standard H_2SO_4 solution. Then titrate with the standard NaOH solution. Blank determination was also carried out using all reagents in the someway and quantities but without the material to be tested. Therefore, total nitrogen, percent by weight (on moisture free basis)

$$\frac{0.014(B-A)N\times 100}{w(100-m)/100} = grams/100grams$$

Therefore crude protein (%) = nitrogen (%) x 6.25

A_9. Carbohydrate; organic mater (100) – (protein + moisture content + fat + ash) %

A_{10}. Energy value; by Osborne (1972);

E.V (Kcal/100g) = (4 x protein) + (9 x fat) + (4 x carbohydrate).

A_{11}. Nitrogen free extract = 100 - (moisture content + (crude protein) + (crude fat) + (crude fibre) Laboratory Manual for nutrition research.

A_{12}. Determination of amylose, amylase standard; prepared by dissolving 100mg of amylase in 100ml distilled water in a 100mlvolumetric flask giving it a concentration of 1mg/ml.

Iodine reagent; prepared by dissolving 2mg of potassium iodide and 0.2g of iodine in 75ml of distilled water and making up to 100ml in a 100ml volumetric flask.

Procedure; 100mg of defatted sample by ether extraction , weighed into a 100ml volumetric flask an 1 ml 95% ethanol and 9ml 1N NaOH added to the flask and swirled gently to dissolve the sample, incubate the flask over night at room temperature. Make a solution up to 100ml with distilled water shake vigorously and allow standing for 30 minute. Also 5ml of the supernatant into a 100ml beaker add 30ml of distilled water. Liquor was subjected in the 100ml beaker to ph 10.2 with 0.1 NH_3CL. To the liquor add 1ml of iodine reagent and mix thoroughly. Allow to stand for 3 minute, and then make up to 100 ml with distilled water. For the amylase standard prepare as precisely described. Read the absorbance of the blue complex at 600nm with a spectrophotometer.

Calculate percentage amylase $= \frac{1\times 100\times 100\times Asp}{Astd\times \text{wt of sample(mg)}}$

Where 1 is concentration of amylase (1 mg/ml)

100 is the total volume made up

100 is percentage

Asp is absorbance of sample

Astd is absorbance of standard.

Mineral (potassium, calcium and phosphorus)

Digestion mixture (wet oxidation); acid mixture containing 750ml. Concentric acid, 150ml conc. Sulphuric acid and 300ml (60-62) % of per chloric acid.

Procedure; weigh about 1.0g of grounded sample into a digestion tube 5ml of digestion mixture was added. Swirl gently and place in fume cupboard over night. Them digest at (150-200^{0}C) for 2 hours, cooled and add 30ml of distilled water and mix vigorously. Sodium was determine by aspirating through a flare photometer and mg by ethylene di-amino tetra acetic acid (E.D.T.A) titration method

A_{13}. Determination of potassium was digests through flame photometer using a stock solution of 10ppm potassium (k) as follows; warm the flame photometer for about 15 minutes, and set the meter at zero, aspirant blank solution and obtain maximum deflection (100% emission) with the 10 ppm solution. Then aspirate sample solution and record your reading as (x), by conversion

$$\frac{50}{100} \times \frac{75}{1} \times \frac{100}{10^6} = 0.0038$$

The potassium (%) = the instrumental reading × the conversion factor (0.0038)

A_{14}. Determination of calcium by EDTA method,

Reagents

- Cyanide solution by dissolving 1g of potassium cyanide (KCN) and make up to 100ml with distilled water
- Hydroxyl ammonium chloride solution ; dissolving 5g of salt an make up to 100ml with distilled water by
- Potassium ferrocyanide solution by dissolving 4g of analar grade of the salt with distilled water to make up 100ml
- Triethanolamine was used as concentration.
- Eriochrome black T indicator; by dissolving 0.2g of EBT in 50ml methanol
- Sodium hydroxide 10% solution by dissolving 10g of analar grade NaOH in 80ml of distilled water to make 100ml
- Standard EDTA solution and standard calcium solution.

Procedure; against standard solution of calcium; 2ml of the solution was put into a 250 ml wide neck flask and make up to 100ml with distilled water than add 10 drops each of KCN, hydroxyl mine hydrochloride, and triethanolamine e and 10 ml of 10% NaOH solution to raise ph to 12 or slightly higher. Check the Ph with ph meter. Add pinch of calcium indicator and titrate with the EDTA solution. The colour of the solution changes from bright green fluorescence to pink fluorescence at the end points.

Then percentage calcium is. Calculated as $\frac{0.4z}{10} \times \frac{75}{1} \times \frac{1}{1000} \times \frac{100}{1} = 0.3z$

Where Z is the EDTA titre,

75 is the volume of digest,

1000 is to convert Mg to gram.

APPENDIX B

The results in chapter four were calculated as follows:

B_1. For 1000 kernel weight;

Let W_1, W_2, and W_3, be the weight of the three weighed samples containing 1000 kernel each.

Applying the formulae below no of sample

$$W_g = \frac{w_1 + w_2 + w_3}{\text{no of sample}}$$

For brown guinea corn:

$W_1 = 0.353$

$W_2 = 0.353$

$W_3 = 0.354$

$$\therefore W_g = \frac{0.353 + 0.353 + 0.352}{3} = 0.353(\text{g})$$

For white guinea corn:

$W_1 = 0.34$

$W_2 = 0.346$

$W_3 = 0.45$

$$\therefore W_g = \frac{0.345 + 0.346 + 0.345}{3} = 0.46(\text{g})$$

Also, let;

W_0 be the weight of empty container

W_1 be the weight of container and the sample

W_2 be the weight of sample

B_2. For moisture content (m.c) using the formular below:

$$\% \text{ moisture content} = \frac{w_1 - w_2}{w_1 - w_0} \times \frac{100}{1}$$

$\therefore$ *for brown guinea corn*, $w_0 = 80.336 \quad w_1 = 83.336 \; w_2 = 83.033$

$$\therefore \% \, m.c = \left(\frac{83.336 - 83.033}{83.336 - 80.336}\right) x \, \frac{100}{1} = 10.10\%$$

$\therefore$ *for white guinea corn*, $w_0 = 82.894 \quad w_1 = 85.894 \; w_2 = 85.563$

$$\therefore \% \, m.c = \left(\frac{85.894 - 85.563}{85.894 - 82.894}\right) x \, \frac{100}{1} = 11.03\%$$

B_3. For crude fibre, using the formular below.

$$\% \text{ crude fibre} = \frac{w_1 - w_2}{w_1 - w_0} \times \frac{100}{1}$$

$\therefore$ *for brown guinea corn*, $w_0 = 82.802 \quad w_1 = 85.802 \; w_2 = 85.732$

$$\therefore \% \, crude \, fibre = \left(\frac{85.802 - 85.732}{85.802 - 82.802}\right) x \, \frac{100}{1} = 2.33\%$$

$\therefore$ *for white guinea corn*, $w_0 = 80.617 \quad w_1 = 83.617 \; w_2 = 83.558$

$$\therefore \% \, crude \, fibre = \left(\frac{83.617 - 83.558}{83.617 - 80.617}\right) x \, \frac{100}{1} = 1.97\%$$

B_4. For fat oil using the formular below.

$$\% \text{ fat} = \frac{w_1 - w_2}{w_1 - w_0} \times \frac{100}{1}$$

$\therefore$ *for brown guinea corn*, $w_0 = 61.420 \quad w_1 = 64.420 \; w_2 = 64.269$

$$\therefore \% \, m.c = \left(\frac{61.420 - 64.269}{64.420 - 61.420}\right) x \, \frac{100}{1} = 5.03\%$$

$\therefore$ *for white guinea corn*, $w_0 = 63.324 \quad w_1 = 66.324 \; w_2 = 66.233$

$$\therefore \%\, fat = \left(\frac{66.324 - 66.233}{66.324 - 63.324}\right) x \frac{100}{1} = 3.03\%$$

B_5. For total ash, using the formular below.

$$\%\ \text{Ash} = \left(\frac{w_2 - w_2}{w_2 - w_0}\right) x \frac{100}{1}$$

$$\therefore \text{for brown guinea corn}, w_0 = 82.776 \quad w_1 = 85.766 \quad w_2 = 85.720$$

$$\therefore \%\, m.c = \left(\frac{85.766 - 85.720}{85.766 - 82.776}\right) x \frac{100}{1} = 1.87\%$$

$$\therefore \text{for white guinea corn}, w_0 = 82.791 \quad w_1 = 85.791 w_2 = 85.732$$

$$\therefore \%\, Ash = \left(\frac{85.791 - 85.732}{85.791 - 82.791}\right) x \frac{100}{1} = 1.97\%$$

B_6. For crude protein, following the procedure below,

Equation of reaction; $2NaOH + H_2SO_4 \quad NaSO_4 + 2H_2O$

Mass of acid used (mol) = M_A

Volume of acid used (cm^3) = V_A

Mass of base used (mol) = M_B

Volume of based used (cm^3) = V_B

$$\frac{M_A - V_A}{M_B V_B} = \frac{1}{2}$$

For brown guinea corn

Where MA = 0.5g

VA = 17.20 cm^3

M_B =?

V_B = 5cm^3

$$\frac{0.5x\ 17.20}{M_B x\ 5} = {}^1/_2$$

$$M_B = \frac{(0.5x17.20)x2}{(5)x1} = \frac{17.2}{5} = 3.44g/mol$$

But molar mass of NaOH = 40g

Therefore mass concentration of NaOH = 40 x 3.44

= 137.8g/cm^3

$\cong \frac{0.14g}{mol}$

% nitrogen in the sample = $\frac{corrected\ titre\ (ml) \times 14 \times 5 \times 100}{1000 \times 70 \times weight\ of\ smaple\ (g)}$

Therefore 1 g of the sample = $\frac{17.2 \times 14 \times 100}{1000 \times 70 \times 1} = 1.72$

There % nitrogen = 1.72

Percentage crude protein = 6.25 x % nitrogen

% crude protein = 6.25 x 1.72 = 10.75

≈ 10.8%

For white guinea corn using equation

Ma = 0.5g

VA = 16cm^3

M_B =?

V_B = 5cm^3

$\frac{0.5 \times 16}{M_B \times 5} = {}^1/_2$

$\therefore M_B = \frac{(0.5x16)x2}{(5)x1} = \frac{16}{5} = 3.2g/(mol)$

But molar mass of NaOH = 40g

Mass concentration of NaOH = 40g x 3.2 g/cm^3

$= 128 g/cm^3$

$= 0.13 g/mol$

Percentage nitrogen is the sample $= \frac{corrected\ litre\ (ml) \times 14 \times 5 \times 100}{1000 \times 70 \times weight\ of\ sample\ (g)}$

$\therefore 1\ g\ of\ the\ same = \frac{16 \times 14 \times 5 \times 100}{1000 \times 70 \times 1}$

$\therefore \%\ nitrogen = 1.6$

For white guinea corn

$\therefore percentage\ crude\ protein = 6.25 \times \%\ nitrogen$

$\therefore \%\ crude\ protein = 6.25 \times 1.6 = 10\%$

B_7. For energy value using the formular

(4×protein) + (9 × fat) + (4 ×carbohydrate).

For brown guinea corn

% energy value = (4 × 10.8) × (9 ×5.03) + (4 ×72.12) = 374.07

For white guinea corn

Energy value = (4×10) + (9 × 3.02) + (4 × 73.98) = 363.10

B_8. For carbohydrates, using the formular below

% carbohydrates = organic mater (100) – (% protein + % m.c + % fat + % ash)

For brown guinea corn

% carbohydrate = 100-(10.08 + 10.09 + 5.03 + 1.87) = 72.12%

For white guinea corn

% carbohydrate = 100-(10.00 + 11.04 + 3.02 + 1.96) = 73.98%

B_9. For nitrogen free extract using the formulae below.

100 - (m.c + crude protein + crude fat + crude fibre)

% calcium = 0.3 × 0.90 =0.27%

3_{13}. For phosphorus using the formulae below

$$\frac{50x}{100} x \frac{75}{1} x \frac{100}{10^6} = 0.75x$$

For brown guinea corn

% phosphorus = 0.75 × 0.21= 0.16%

For white guinea corn

% phosphorus =0.75 × 0.16 =0.12%