DETERMINATION OF PROXIMATE COMPOSITIONS OF SELECTED VARIETIES OF GROUNDNUT

(Arachis hypogaea)

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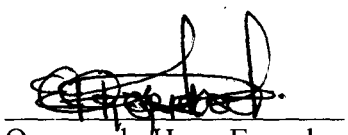
BEING A FINAL YEAR PROJECT SUBMITTED IN PARTAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING (B.ENG) DEGREE IN AGRICULTURAL AND BIO-RESOURCES ENGINEERING FEDERAL UNIVERSITY OF TECHNOLOGY,MINNA

FEBRUARY, 2010

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 Information derived from personal communications, published and unpublished work of others were duty referenced in the texts.



Onyeanula Hope Egoudo

22-02-2010

Date

CERTIFICATION

This project titled: "Determination of Proximate composition of selected groundnut verities (*Arachis Hypogea*)" by Onyeanula Hope Egoudo, 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 it's contribution to scientific knowledge and literary presentation.

Engr.Dr.A.A Balami
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Date

DEDICATION

This research work is specially dedicated to the Almighty God who gave me a huge success in this programme.

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Every human effort is inspired by God; therefore my in-depth gratitude goes to God almighty for making me what I am today. With God all things are possible, it is on this note that I am thus grateful to the almighty, the Omnipotent, the Omni-presence and the Omniscience God for making this project possible.

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ABSTRACT

The proximate composition of some selected groundnut varieties (*Arachis hypogaea*) were determined using standard methods. All the groundnut varieties were found to be rich in Lipid content (Kampala 43.93 ± 0.01, Samnut 23, 40.1±0.01, Samnut 10; 38.02±0.02, Samnut 22; 38.01±0.01 and Watauku (three month groundnut) 36.03 ± 0.023). Each of these groundnut varieties also had a considerable high amount of protein (Watauku 34.81%, Samnut 22 with 33.34%, Samnut 23 with 31.54%, Samnut 10 and Kampala both having 30.99%).Kampala had a significantly higher ($P<0.05$) Lipid content of 43.93% compared to orders while Samnut 10 and Kampala have similar ($P>0.05$) crude protein contents which is significantly different from the others. Based on the result of this study; the two local breeds of groundnut watauku and Kampala considered in this project work yielded more in terms of lipid and protein content compared to the hybrids considered (Samnut 10,Samnut 22,and Samnut 23). This lipid from groundnut can be important for several domestic and industrial purposes and applications while groundnut can, thus be considered as a good source of protein with high nutritional value, thereby reducing malnutrition.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Groundnut (*Arachis hypogaea*) also known as groundnut is one of the most important agricultural products with a high emerging level of use in the world today. These agricultural products over the years have been under exploited in the regions of which they are produced especially in the developing countries. Groundnut is a very important oil seed and food crop.

Groundnut otherwise known as Ekpa in the south west part of the country, Geda amongst the Hausas and Okpa amongst the Igbos is generally cultivated world wide; some of the countries which leads in groundnut production are china, having a share of 37.5% of overall world production followed by India (roughly 19%) then Nigeria (roughly 11%) (Wikipedia, 2008).

The multifunctional uses of groundnut in Nigeria makes it necessary to determine the proximate composition of this valuable agricultural product; such that extensive studies can be conducted in order to determine and discover more areas of which groundnut crop is relevant, so as to also increase it's cultivation and consumption.

Groundnut makes an important contribution to the diet in Nigeria and many other countries today. It characteristically contained high level of oil and protein with low level of moisture, ash and carbohydrate; this makes it a potential source of edible oil. The high protein 38.61% of the defatted groundnut makes it a good cake for human consumption and useful as animal feeds, fish baits etc.

Groundnut is not a good source of crude fiber which is said to reduce the rate of disease, since it is not easily and totally digestible by the acid and enzymes in alimentary canal (digestive tract) of animals as well as human beings.

1.2 Description of Groundnut

Groundnut is an annual crop belonging to the family of Leguminasea that has many varieties growing in different areas of the world, the groundnut pods are more or less elongated pods and they contain between 1 – 6 seeds which are surrounded by a thick fibrous shell (Ojo Negros Research group, 2008). The two major varieties of groundnut are virgina runner and Spanish Valencia.

Amongst several studies carried out on groundnut according to Atasie et al,(2009)experimental analyze *En Arachide*,(French) groundnut has a proximate composition of 5.80% moisture-content, 3.08% ash, 3.70% crude fiber, 38.61% crude protein, 11.81% carbohydrate and 47% fat content, which is similar to the proximate composition determined by FAO food and agricultural organization (1986) and NAS (1980). These attributes makes groundnut highly nutritive as the high level of oil and protein with low level of moisture ash and carbohydrate makes a potential source of edible oil and a good source of protein.

According to FAO (1986), groundnut is rated the second most important source of vegetable oil in the world. (Salunkhe and Desai, 1986) indicated that Africa contributes more than half of the total world production of groundnut on the farm plot in Nigeria which is about 750Kg per hectare of decorticated nuts (NSPRL, 2002). Some of the economic importance of groundnut are; the processing of groundnut into a number of edible products such as oil, groundnut butter and several groundnut confectionaries. Oil extracted from groundnut is used industrially for the manufacture of soaps, pomade, cosmetics, shaving cream, lubricants and synthetic fiber (Woodroof, 1983).

As an important crop in sub African, it is important to study the proximate composition of groundnut so as to determine the major constituent of its nutritive value. The nutritive value of groundnut may increase or decrease depending on the methods in which it is processed. Cooking

of groundnut has been reported to reduce the concentration of some of its important nutritive contents such as lipids, protein, crude fiber, vitamins and minerals (Wikipedia, 2007). In most regions of the tropics and sub tropic, Groundnut is a very important food and oil crop and its method of processing ought to be such that it will preserve the nutritional value of this agricultural material. Groundnut is processed in different forms of food, for large numbers of people in the developing countries providing significant amount of nutrients; in particular, lipid and proteins.

Several studies carried out on the proximate composition of groundnut kernels and defatted cakes of groundnut; an under exploited nuts, largely consumed by western and most population in Africa, (Weiss, 1978, Bansel et al 1993: Pancholly et al, 1978; Ahmed and Young, 1982). They showed these nuts are good source of lipids and proteins and the defatted cakes could be used as protein supplements in human nutrition, because of the shortage of food proteins throughout the whole world. Groundnut has attracted the interest of Africans as a potential source of protein for human as well as animal's consumption. It was shown that groundnut from four different sources contained fair amount of protein and its products. Mineral element analysis revealed K, Mg, Cu and Mn. Fe and P were present in the nutritional significant amount in all samples; moreover K, was found in high level.

1.3 Statement of Problem

The cost, insufficient availability and poor preservation and storage ideas of some nuts due to their seasonal productivity, e.g. cashew nut, walnut etc., which are mostly eaten as food these days has force people to look out for other alternatives. This research work tries to unveil groundnut as a better substitute to the above mentioned nuts of which the inexpensiveness, ready availability, multipurpose usages and better preservation and storage means makes it a better

alternative as it is even highly nutritious (good source of protein) has rich source o it other important usages, such as soup thickener, pap, sauce etc.,

1.4 Justification of Study

1. In Nigeria there is little information on the proximate composition of groundnut. Therefore the study on the determination of the proximate composition of groundnut is an important attempt to provide objective measures resulting to meaningful databank on the proximate composition of groundnut. These data generated will generally aid food industries to select appropriate methods to adopt while processing groundnut, which will result to preservation of its nutrient after processing, hence the need for this study.
2 Groundnut is regarded as a major source of protein in human nutrition and is readily available in many markets in Nigeria; hence it is important to conduct research for the proximate compositions.

1.5 Objectives

1. The main objective of this study is to determine the proximate composition of selected varieties of groundnut.
2. To compare the differences between two local groundnut breeds and three selected hybrids of groundnut so as to generate information on the proximate composition of these groundnut varieties.
3. To run a statistical analysis on the results obtained from these different groundnut varieties (Comparing the Local breads and the selected hybrids).

1.6 Scope of Study

The scope of this work is limited to the determination of the proximate composition of different groundnut varieties. The proximate compositions to be determined are: moisture content, crude protein, crude fibre lipid content, Ash content and carbohydrate.

CHAPTER TWO

2.0 LITRATURE REVIEW

2.1 Historical Background and Evaluation of Groundnut

Groundnut, *Arachis hypogaea* is also known as groundnuts, earthnuts, goobers, goober peas, pindas, Jack nuts, pinders and manila nut (Wikipedia, 2008). Groundnut is a high leguminous annual crop widely grown in the tropical and subtropical regions and the warm areas of the temperate region of the world (Weiss, 1983). Groundnut is grown as an annual crop principally for its edible oil and protein rich Kernels seeds borne in pods which develops and matures below the soil surface. Groundnut is an herbaceous plant of which there are two major varieties, (The erect or bunchy type and the runner or spreading type). The erect or bunchy variety is common in the United States. It grows 30-40cm high and does not spread. The runner or spreading variety is the most common in West Africa. It is shorter and spreads along the ground for 30-60cm (Asiedu, 1992). Groundnut seeds which are rich source of edible oil and protein has the percentage of (45-55%) and (25-28%) respectively (Asiedu1992). About two third of the world production of groundnut is used for oil and the remaining one third is consumed as food (Asiedu, 1992).

In Nigeria, the leading producing states of groundnut includes Niger, Kano, Jigawa, Zamfara, Kebbi, Sokoto, Kastina, Kaduna, Adamawa, Yobe, Taraba, Plateau, Nassarawa, Bauchi, and Gombe as shown in table 2.1. It is estimated that over two million hectares are planted to groundnut in Nigeria (National Agriculture Extension and Liaison Services, 2004).

Table 2.1 Improved varieties of groundnut in Nigeria

States	Varieties	Remarks
Adamawa	Samnut 10,16,19 and 21	High yield, multiple
Bauchi	Samnut 14,18 and 21	Drought resistant tolerant multiple
Benue	Samnut 19,11,16 and 21	High yield multiple
Borno	Samnut 14,17,18 and19	Drought resistant tolerance
Gombe	Samnut 14,18 and 21	Drought resistance tolerant, Multiple
Jigawa	Samnut 10,14,18,19	Haulm, drought and Rosette tolerant
Kaduna	Samnut 10,11,20 and 21	High yield, multiple
Kano	Samnut 10,14,18 and 19	Haulm, Drought and rosette tolerant
Kastina	Samnut 10 ,14,18 and 19	Haulm, Drought and Rosette tolerant
Kebbi	Samnut 10,14,18 and 19	Haulm, Drought and Rosette tolerant
Niger	Samnut 10,16,20 and 21	High yield, Multiple
Taraba	Samnut 10,11,16 and 21	High yield, Multiple
Plateau	Samnut 10,16 and 20	High yield, Multiple
Nasarawa	Samnut 10,11,16 and 20	High yield, Multiple
Kwara	Samnut 10,16 and 20	High yield, Multiple
Other state	Samnut 10,11,16,20 and 21	Rossette,Rust and leaf spot resistant

Source; National agriculture extension and liason service, 2004

2.2 Description of Groundnut Cultivars

Thousands of groundnut cultivars are grown, with four major cultivar Groups, being the most popular ; Spanish ,Runner, Virginia, and Valencia .There are also Tennessee Red and Tennessee White groups. Certain cultivars groups are preferred for particular uses because of differences in flavor, oil content, size, shape, and disease resistance. For many uses the different cultivar are interchangeable (Wikipedia, 2008). Most groundnuts marketed in the shell are of the Virginia type, along with some Valencia's selected for large size and the attractive appearance of the shell. Spanish groundnuts are used mostly for groundnuts candy, salted nuts and groundnut butter. Most Runners are used to make groundnuts butter (Wikipedia, 2008).

The various types are distinguished by branching Habit and branch length. There are numerous varieties of each type of groundnuts. There are two main growth forms, bunch and runner. Bunch types grow upright, while runner types grow near the ground. Each year new cultivars of groundnuts are bred and introduced. Introducing a new cultivar may mean change in the planting rate, adjusting the planters, harvest, dryer, cleaner, seller and method of marketing (Wikipedia. 2008).

2.2.1 Spanish group

The small Spanish types are grown in South Africa and in the southwestern and south eastern. U.S. prior to 1940. 90% of the groundnut grown in Georgia, USA were Spanish types, but the trend since then has been larger seeded, higher yielding and more diseases resistant cultivars. Spanish groundnuts have higher oil content than other types of groundnuts and in the U.S are now primarily grown in Oklahoma and Texas (Wikipedia, 2008).

Cultivar of the Spanish group include; Dixie Spanish, improved Spanish 2B, GFA Spanish, Argentine, Spantex, Spanette, Shuffers Spanish, Natal common (Spanish) white kernels varieties,

Starr, Comet, Florispan, Spanhoma, Spanoross, Olin, Tamspan 90, AT 9899-14, Spanco Wilco I, GG2, GG4 and TMV2 (Wikipedia, 2008).

2.2.2 Runner type

Runner have become the dominate type because of their attractive size range which make them useful for a varieties of product. Since 1940 the south eastern U.S region has seen a shift to production of runner group groundnuts. This shift is due to good flavor, better, roasting characteristic and high yield when compared to Spanish type leading to food manufactures" preference for use in groundnuts butter salting. Georgia's production is now almost 100% Runner type (Wikipedia, 2008).

Cultivar of Runner include south eastern, 56-15 Dixie runner, early runner, Virginia bunch 67, Bradford runner, Egyptian Giant (also known as Virginia Bunch and Giant), Rhodesian Spanish Bunch (Valencia and Virginia Bunch), North Caroline Runner 56-15,Virugard, Georgia Green, Tamrun 96, Flavor 458, Tamrun O L01 ,Tamrun O L02 and AT-180 (Wikipedia,2008).

2.2.3 Virginia group

Virginia variety is the largest kernel and account for the groundnut roasted and eaten as in shelled. The larger kernels are sold as salted groundnut. They are also used in confectionery products. The large seeded Virginia Group groundnuts are grown in the following U.S States: Virginia, North Carolina, Tennessee, Texas, New Mexico, Oklahoma and part of Georgia. They are increasing in popularity due to demand for large groundnuts for processing, particularly for salting, and roasting in the shell (Wikipedia, 2008).

Virginia Group groundnut are either bunch or running in growth habit. The bunch type is upright to spreading, it attains a height of 45 to55cm (18 to 22 inches) and a spread of 70 to 80cm (28 to 30 inches), and with 80 to 90cm (33 to 36 inches) rows that seldom covers the ground. The pods are borne with 5 to 10cm of the base of the plant. Cultivar of Virginia type of groundnut includes

NC7, NC9, NC10C, NC-V11, VA93B, NC12C, VA-C92R Gregory, VA98R, Perry, Wilson, Hull, AT VC-2 and Shulamit (Wikipedia, 2008).

2.2.4 Valencia group

Valencia Group groundnuts are coarse, and they have heavy reddish stems and large foliage. The Valencia types usually have three or more small kernels to a pod. They are sweet groundnuts and are usually roasted and sold in the shell. They are excellent for fresh use as boiled groundnuts. They are comparatively tall having a height of 127cm (50 inches) and a spread of 76cm (30 inches). Groundnuts pods are borne on pegs arising from the main stem and the side branches. Most of the pods are clustered around the base of the groundnut plant and only a few are found several inches away .The Valencia type's seed are oval and tightly crowded into the pod (www.lanra.uga.edu)

2.2.5 Tennessee Red and Tennessee White Groups

These are alike, except for the colour of the seed. The plants are similar to Valencia types, except that the stems are green to greenish brown, and the pods are rough, irregular and have a smaller portion of kernels (Wikipedia, 2008).

2.3 Characteristics of Groundnuts:

Groundnut pod is about 12.5-75mm in length and roughly cylindrical in shape. The shell of the pod comprises 20-30 percent of the whole nut and may be separate from kernels. The kernels consist of two cotyledons (halves) and the germ enveloped in a thin brown, purple or white skin called testa. The testa consistitute about 4-5% of the kernel, the cotyledon constitute the bark. The seed range of round 92 -94% of the weight, the testa protect the seed against pest and disease. The cotyledons are storage organs which supply food to the germ during germination.

A fully matured pod can often be difficult to split open with the pressure of the finger, meanwhile an immature pod can be splitted easily revealing the white inside surface of which appears also to be spongy in texture. These criteria may help in assessing the certain stages of the harvesting of groundnut. Harvesting at the proper time ensures that a high percentage of matured pods have attained their greatest weight or physiological maturity.

2.4 Cultivation of Groundnut:

Arachis hypogaea is a leguminous root crop grown in the semi desert regions of the world. It produces grains in pods beneath the surface of the earth and its root characterized by root nodules which houses nitrogen fixing bacteria and nitrogen requirement by fixing and converting atmospheric nitrogen into nitrate essential for growth of plants (Wikipedia, 2008).

Groundnut is cultivated in loose sandy loamy soil. The ideal soil for groundnut has been defined as a well drained, light colored friable, loose sandy loam, well supplied with calcium and moderate amount of organic matter (Ojos Negros Research group, 2008). Groundnut has however widely spread and it is so popular in peasant agriculture. For its ease in production, it can be found growing on a wide range of soil types. An opinion expressed in West Africa that groundnut will grow on soil too light for rice, too poor for cassava and too dry for maize. Sandy soil and loamy soil are more suitable than clay; roots and peg can easily penetrate them and allow easier percolation of rainfall (Asiedu, 1992). The orange veined, yellow petaled, and paelike flower of the *Arachis hypogaea* is born in auxiliary clusters above the ground following self pollination, the flower fades and withers. The stalk at the base of the ovary, called the pedicel, elongates rapidly and turns downward to bury the fruits several inches in the ground where they complete their development; when the seed is matured the coat (mesocarp) changes colour from white to a reddish brown. The entire plant including most of the roots is removed

from the soil during harvesting and its pod act as nutrient absorption. The fruit have wrinkled shells that are constricted between pairs of the one to four (usually two) seed per pod. The mature seeds resemble other legume seed such as beans, but they have paper- thin seed coats rather than the usually hard legume seed coats (Wikipedia, 2008).

The spacing between rows to row and plant to plant in groundnut planting varies with the groundnut type sown. Groundnuts seed are generally planted at a depth of 4 to 5cm. Water uptake are the first phase immediately after sowing in the soil to return the dry seed to active growth. The moisture deflects during vegetative phase which is beneficial to increase water use efficiency because of the complex interactions between the soil and the plant water status.

The length of growing season required for different types of groundnut varies widely, but it takes Virginian and runner groundnut in general one to six weeks longer to mature than Valencia and Spanish groundnut when groundnut pod are harvested too early, the pods will be unripe but if they are harvested late the pods will snap off at the stalk and will remain in the soil (IITA, 2005).

2.4.1 Climatic condition required for groundnut growth

Climatic conditions such as temperature and rain fall significantly influences groundnut production. Warm and moist conditions are very favorable than cool and wet climate which result to slow germination and seedling disease (FAO, 1998). They require five months of warm weather and an annual rainfall of 500-1000mm (20-40 inches) or equivalent in irrigation water. Temperature is a major environmental factor that determines the rate of crop developments. Temperatures above 35°C inhabit the growth of groundnut, the optimum temperature is about 30°C while for emergence, and the soil temperature above 20°C is needed. Long period of rainfall immediately prior to harvest may result to bad yield and deterioration of the quality of groundnut (Wikipedia, 2008).

Delay in maturity of groundnut may occur also as a result of late season drought-stress. Several methods have been described for determining the maturing of the groundnut crop: that is shelling out maturity hull-scarp, maturity testing method. The prevailing attitude amongst the groundnut production specialist is that the hull-scarp method which is not accurate for the Virginia and the Spanish type of groundnut and may predict a harvest time that is too early(Wikipedia,2008).

2.5 Compositions of Groundnut

The proximate and chemical compositions of groundnut are shown in tables 2.2 and 2.3.

Table 2.2: Proximate Composition of Groundnut

Constituent	Testa(g)	Germ(g)	Cotyledon(g)
Moisture	9.01	-	3.9-13.2
Protein	11.0-13.4	26.5-27.8	21.4-36.4
Oil	0.5-1.9	39.4-43.0	35.4-54.2
Total carbohydrate	48.3-52.2	-	6.0-24.9
Reducing sugar	1.0-1.2	7.9	0.1-0.4
Sucrose	-	12.0	1.9-6.4
Starch	-	-	0.9-5.3
Crude fibre	21.4-34.9	1.6-1.8	1.6-1.9
Ash	1.9-4.6	1.9-3.2	1.8-3.1

Source: http:/www.appropedia.org,Cobb and Johnson(1973),NDDB(1982).

Table 2.3: Chemical Composition of Groundnut Shell, Haulms and Oil Cake

Constituent	Percentage
Shell:	
Cellulose	65.7
Carbohydrate	21.2
Protein	7.3
Minerals	4.5
Lipids	1.2
Haulms:	
Protein	8.30-15.0
Lipids	1.39-2.88
Crude fibre	22.11-35.35
Carbohydrate	38.06-46.95
Minerals	9.0-17.04
Moisture	7.13-10.0
Oil cake:	
Moisture	8-10
Oil	0.7-6
Crude protein	45-60
Carbohydrate	22-30
Mineral matter	4-5.7
Crude fibre	3.8-7.5

Source: http:/www.appropedia.org

2.6 Uses of Groundnuts

Groundnut account for two-third of the total groundnut usages in Nigeria. The following recipe can be prepared from groundnuts; groundnut biscuits, kunnun gyada, groundnut porridge with rice, groundnut stew, Dakwa, Kulikuli, groundnut cake, groundnut butter, baked groundnut, Turnbrown and Kanyah (Alabi, 2007). Popular confectioneries ;includes salted groundnuts, groundnut butter, (sand witches, candy bars, and cups), groundnut brittle and shelled nut (plain/roasted). Salted groundnut are usually roasted in oil and packed in retail size, plastic bags or hermetically sealed cans, dry roasted, salted groundnuts are marketed in significant quantities. The primary use of groundnut butter is in the home (usually used by the Igbo's for traditional occasions and festive occasions as traditional rights), but larger quantities are also used in the commercial manufacture of sand witches, candy and bakery product. Boiled groundnut is the

preparation of raw, unshelled green groundnut boiled in brine and typically eaten as snacks in most Africans countries where most groundnut are grown .More recently, groundnut can be fried, where they can be eaten both shelled and nut. Also groundnuts are used in cosmetics, nitroglycerin, plastic, dyes and paints (Wikipedia, 2008).

Groundnuts are common ingredients in the Peruvian Creole cuisine reflecting the marriage of native ingredients and ingredients introduced by Europeans. In one example groundnut are roasted along with hot pepper (both native to South Americans) blended with roasted onions garlic, and oil (all of European origin) to make a smooth sauce poured over boiled potatoes. This dish is especially famous in the city of Arequiopa and is known as "papas con ocopoa". It is well documented that Arabs cuisine makes extensive use of groundnut and paste of almonds, pine nut and other nuts combined with rice, meats, and vegetables to arrive to dishes like rice pilaf (Wikipedia, 2008).

Although the groundnut is not a nut, it may be argued that the Spanish used the groundnut along with local Peruvian ingredients to emulate their ancestral cuisine, in the absence of almonds and pine nut. Groundnuts are also widely used in the south-east Asian cuisine, particularly Indonesia, where it is typically made into a spicy sauce. Common Indonesia groundnut-based dishes includes gado-gado, pecel, karedok and ketoprak, all vegetable salads mixed with groundnut sauce, and the groundnut –based dipping sauce for sanitary. Boiled groundnut are a popular Chinese snacks and appetizer, it is also used in the Mali meat stew maafe and in many sauce for South America meat dish, especially rabbits (Wikipedia, 2008).

Groundnut oil is often used in cooking, because it has mild flavor and burns at a relatively high temperature. Groundnut are also very widely sold for garden bird feeding, low grade or culled groundnut not suitable for the edible market are used in the production of groundnut oil, seed and feed, although some owners of pet hook bills avoids these kinds for that reason.

Groundnuts have a variety of industrial end uses. Paint, varnish, lubricating oil, leather dressing furniture polish, insecticides and nitroglycerin are made from groundnut oil. Soap is made from saponified oil, and many cosmetics contain groundnut oil and its derivatives. The protein portion of the oil is used in the manufacture of some textiles fibers. Groundnut shells are often put to use in the manufacture of plastic, wall board, abrasive and fuel. They are also used to make cellulose (used in rayon and paper) and mucilage (glue). Groundnut plant tops are used to make hay. The protein cake (oil cake meal) residues from oil processing are used as an animal feed and as a soil fertilizer. Groundnut can also be used like other legumes and grains to make lactose-free milk – like beverages, groundnut milk (Wikipedia, 2008).

George Washington carver, one of many USDA researchers is often credited with investigating three hundred different uses of groundnuts (which contrary to popular belief, did not include groundnut butter but did include salted groundnuts). Carver encourage cotton farmers in the south to grow groundnut instead of ,or in addition to cotton, because cotton has depleted so much nitrogen from the soil, and one of groundnut's properties as a legume is to put nitrogen back into the soil (a process known as nitrogen fixation) (Wikipedia,2008).

2.7 Relationship Between Groundnut, Root Crop and Leguminous Crop

Groundnut is a leguminous crop, whose seeds borne in pods which develops and mature below the soil surface. Thus, crops to be considered to be similar should also possess similar properties to groundnuts examples of which are:

1. Soya beans (*Glycine Max*): soybeans are an important annual and leguminous plant that has become a major source of vegetable protein and oil for human and animal consumption and also for industrial usage. Soybeans are a major oil seed crop; it provides approximately 60% of vegetable protein and 30% oil in the world. Soybeans come in

various combinations of red, yellow, green, brown and black and it differs in size and shapes. It can be grown in fairly wide range of climates and soils. Soils with a normal pH of 7 and fair degree of water retention capacity are however better suited, for its cultivation .it grows well in sandy-loam to clay soil. Hand book of Agriculture by ICRA (ICAR, 2002).

2. Tiger nut (*Cyperus esculentus*): These are fruit from perennial plant which, like the potatoes plants, seed out underground runner. It is shunned as a weed in the majority of warm countries because of its creeping rapidly expanding roots. Tiger nut is esteemed for its nutritional content, as its nutty almond-like taste. These rhizomes are acorn-sized and chestnut brown to blackish-brown with wrinkled skin (Innvista, 2008). The grown tuber germinates into a plant producing several tubers bunched together directly beneath it, the plant and a few stragglers some distance away. The most appropriate soil texture for tiger nut is the sandy-loam (Ojos Negros Research group, 2008).

2.8 Nutritional Characteristics of Groundnut

The nutritional constituent contained in groundnut has contributed immensely to the energy and healthy nature of human body. According to (Wikipedia, 2008), groundnut have longed been recognized for their health benefits, groundnut are a rich source of protein (roughly 30 grams per cup after roasting),prior to 1990 the PER method of protein evaluation considered groundnut protein along with soy protein an incomplete protein, containing relatively low amino acids cysteine and methionine (but high in lysine), and it was advised to be sure that a diet or meal with groundnut as a staple also include complementary food such as whole grains like corn and wheat, which are adequate in methionine but limited by lysine. Protein combining has been largely discredited, since 1990 the gold standard for measuring protein quality is the protein

digestibility corrected amino acid score (PDCAAS) and by this criterion groundnut protein and other legume protein is the nutritional equivalent of meat and egg for human growth and health. Example of an extremely nutritious groundnut-based food to restore health in starving –mal-nutritious children is plumpy' nut. Table 2.4 shows the value of different nutrients in 100grams groundnut.

Table 2.4: Nutritional value of groundnut

Nutrients	Content (mg)
Calcium	93
Carbohydrate	16.13
Copper	11.44
Fat	49.24
Fibre	8.5
Iron	4.58
Magnesium	168
Manganese	1.934
Phosphorus	376
Potassium	705
Protein	25.80
Sodium	18
Water	6.50
Zinc	3.27

Source:www.appropedia.org

2.8.1 Nutritional benefits of eating groundnut

Groundnut and groundnut product are very beneficial in the treatment of hemophilia and other such inherited blood disorder. People suffering from nose bleeding also benefit from eating groundnut and it is also helpful in reducing excessive menstruation bleeding in women (Ernahrungswiss, 1987).

Five main nutrients required by the body to maintain and repair the tissues namely food, energy, protein, phosphorus, thiamin and niacin. These five nutrients are found in good quantity in groundnut.

Groundnuts are in rich vitamins and contains at least thirteen different types of vitamins that includes vitamin A, B, C, and E; along with this ,groundnut are also rich in twenty six essential minerals like calcium, iron, zinc, boron, these help in brain function and development and also help maintain strong bones(Ernahrungswiss,1987).

It is recommended that growing children, expecting women and nursing mothers consume roasted groundnut with jaggery and goat's milk. It is said to provide resistance and immunity against dangerous infections like hepatitis and also tuberculosis.

Groundnuts are rich in anti-oxidant and a chemical called resveratrol. These help in reducing the risk of contracting; cardiovascular disease, cancer risk and anti-ageing, thus keeping the body young and fit (Ernahrungswiss, 1987).

2.8.2 Health concern in eating groundnut

The most common health concern in groundnut consumption is allergies. Although many people enjoy foods made with groundnuts, some people have mild to severe allergic reactions. For people with groundnut allergy, exposure can cause fatal anaphylactic shock meanwhile for those individuals eating a single groundnut or just breathing the dust from groundnuts can cause a fatal reaction (Ernahrungswiss, 1987).

2.9 Proximate Composition of Groundnut

The proximate composition of food or crop is used in the analysis of biological material as the decomposition of human consumable goods into it major constituent (Wikipedia, 2008). The proximate composition of food refers to the precise constituent contained in that food materials, in terms of the nutritional value of the agricultural product which are of great benefits in determining the class of which the agricultural product fall into as well as finding a suitable substitute for the product in terms of shortage and price inflation (usually noticeable in developing countries) (Atasie et al,2009).The proximate composition of groundnut to be discussed in this work includes

I. Crude protein (CP)

II. Crude fibre (CF)

III. Nitrogen free extract (NFE)

IV. Ash (total ash)

V. moisture content (MC)

VI. Fat /Lipid content /ether extract (EE)

VII. Carbohydrates

i. Crude protein (CP)

The term crude protein includes all nitrogenous compounds in a feed. The crude protein content or equivalent of a feed is calculated by first determining its nitrogen content and then multiplying the result by 6.25. On average, the nitrogen content of natural protein is approximately 16%. This is the approximate amount of protein in food that is calculated from the determined nitrogen content by multiplying by a factor (as 6.25 for many foods and 5.7 for wheat) derived from the average percentage of nitrogen in the food proteins and that may contain an appreciable error if

nitrogen is derived from non-protein material or from a protein of unusual composition (Merriam-Webster's medical dictionary, 2008). According to (Online medical dictionary htm, 1997) crude proteins are incomplete proteins which lack essential amino acids (Mottron, 1979).

ii. Crude fibre (CF)

According to (Online medical dictionary. htm, 1997), crude fibre is the indigestible parts of plant-base food. It can also be said to be that part of food that goes undigested after being taken and it constitute major parts of some foods. Although some parts of the crude fibre are said to be soluble, while the others are not; therefore it is important in the evaluation of the amount of fiber digested by the body and passed out (excreted) of a particular food sample.

Crude fibre is that portion of the plant materials which is not ash or which dissolves in boiling solution of 1.25% H_2SO_4 or 1.25% NaOH .Crude fibre was originally thought to be indigestible portion of any main food. It is known however that fibre consists of cellulose which can be digested to a considerable extent by both ruminant and non-ruminants. The interest of fibre in food and feed has increased, based on the notice of number of serious illness associated with diet low in fibre (AOAC, 1998).

iii. Nitrogen free Extract (NFE)

It is defined as the quantity of nitrogen contained in agricultural products. The value is usually obtained by the titration of the agricultural products against an alkali (AOAC, 1998)

iv. Ash (total ash)

These are inorganic compounds which appear in food analysis; they are substances left behind when the carbon, hydrogen, nitrogen, and organic compounds have all burn off. The ash content of a biological material like groundnut is analytical term for the inorganic residues that remains after the organic matter has been burnt off. The organic component of food is burnt in air. The residues are ash which is consisting of the inorganic components in form of their oxides.

The ash are not usually the same as the inorganic matter present in the original food since there may be losses due to volatilization of chemical interaction between the constituents. The ash may however contain materials or organic origin such as sulphur and phosphorus from proteins and some loss of volatile material in the form of sodium, chlorine, potassium, phosphorus and sulphur which will take place during ignition. The ash content is thus not truly representative of the inorganic material in the food either quantitatively. The value is useful in assessing the quality or grading certain edible materials. An adult may have over 1kg of calcium in is body, where as of chromium he has only 5-10mg and of copper 150mg (National Research Council, 1996). It was obtained after ashing (exposing the product in a furnace at high temperature of 350°C then increasing it to 550°C) (AOAC, 1998).

v. Moisture content (MC)

This is referred to as the percentage of water in agricultural products and is usually mathematically obtained as the ratio of the loss in weight to the actual weight all multiplied by 100% after the agricultural product has been heated at a temperature of 105°C for a period of 24 hours.

According to (Ihekoronye and Patrick, 1985), the state of water activity in food is described by the relationship between moisture of the product and the relative humidity of the air surrounding it. The ratios of these two parameters are called "water activities" (aw). The relative humidity corresponds to each specific moisture content of the product is called equilibrium relative humidity (AOAC, 1998).

vi. Lipid content/Ether extracts (EE)

Lipid is the next predominant nutrient to water and carbohydrate in diet; some of the dietary sources of these nutrients are readily identified as visible fat and oil. Lipids may be classified as fat and oil in solid and liquid state respectively at room temperature. The primary one is a

triglyceride; a triglyceride contains three fatty acids that are esterified to the three hydroxyl alcoholic glycerol. It produces energy much greater than carbohydrates (say about 2.5 times the amount produced by the carbohydrates) which are energy giving food (N.Shakuntala Manay, (2006); Foods facts and principles).

Fatty acid has general formula: R-COOH.R-group contains carbon and hydrogen in it, if the carbon atoms are bonded together with a single bond C-C, the compound is saturated, if the carbon atoms are bonded together with double bonds C=C, the compound is unsaturated. The fatty acids that are unsaturated can react with oxygen to reproduce undesirable flavor (Mottran. 1979).

vii. Carbohydrate

The name carbohydrate is derived from French word hydrate de carbon. Carbohydrates are normally occurring organic compounds containing carbon, hydrogen and oxygen, with the hydrogen and oxygen present in the ratio 2:1, as in water. The general molecular formula for carbohydrate is $C_xH_{2y}O_y$ (where x and y are positive integers). Carbohydrate can be classified into two as shown below.

1. Simple sugar: These are sugars that are crystalline in nature; they are water soluble and have a sweet taste. They consist of the monosaccharide and disaccharides sugars. Examples of the monosaccharide sugars include glucose, galactose, and mannose fructose. The disaccharides are obtained by the condensation of two monosaccharide sugars resulting in the elimination of a molecule of water shown below (Mottran, 1979).

$$2C_6H_{12}O_6 \xrightarrow{\text{condensation}} C_{12}H_{22}O_{11} + H_2O$$

Monosaccharide disaccharide water

Examples of disaccharide include sucrose (cane sugar), lactose (milk sugar) and maltose (malt sugar).

2. Complex sugar: These are a group of carbohydrate composed of very long chains of monosaccharide linked together by condensation, i.e. elimination of one molecule of water for every bond formed between two monosaccharide molecules.

Examples include starch and cellulose (Mottran, 1979).

CHAPTER THREE

3.0 Materials and Methods

The samples of groundnut used to carry out the proximate composition test were some selected improved hybrids of groundnut samples obtained from the seed unit, IAR Samaru Amadu Bello University, Zaria Nigeria are (samnut 10, samnut 22 and samnut 23) while the local groundnut samples were obtained from Minna Central Market Niger State are (watauku and kampala groundnut).

The test was carried out under approved standard laboratory condition and procedure.

3.1 Materials

3.1.1 Reagent and Apparatus

In the course of the practical work carried out in the study, reagents and apparatuses used are listed below.

3.1.2 Reagents

1. Distilled water
2. Ethanol
3. Hydrochloric acid (Hcl)
4. Sodiumhydroxide (NaOH) solution
5. Tetra oxo sulphate (VI) acid (H_2SO_4)
6. Methyl orange indicator and Methyl Red indicator (Mixed indicator)
7. Petroleum ether
8. Boric acid (H_3BO_3)
9. Phenol
10. Vegetable Oil (Anti foaming agent)

11. Sodium tetraoxosulphate (VI) acid (Na_2SO_4)
12. Bromocresol green
13. Methylated Spirit
14. Kjeldahl catalyst tablets

3.1.3 Apparatuses

1. Water distiller
2. Conical flask
3. Beaker
4. Desicator
5. Crucibles
6. Filter paper
7. Muffle furnace
8. Oven
9. Buncher funnel
10. Pipette
11. Flat bottom flask
12. Thimbles
13. Boiling tubes
14. Spatula
15. Soxhlet extractor
16. Analytical balance Machine (Weigh Balance)
17. Electric hot plate
18. Kjeldahl digestion block
19. Petrish dish

20. Markham's apparatus

21. Kjeldahl flask

22. Round bottom flask

23. Ground nut

Plates 1-6 shows the shelled and unshelled groundnut hybrids namely:- Samnut 10, Samnut 22 and Samnut 23 while plate 7 and 8 shows the local varieties of groundnuts namely:- Watauku and Kampala groundnut.

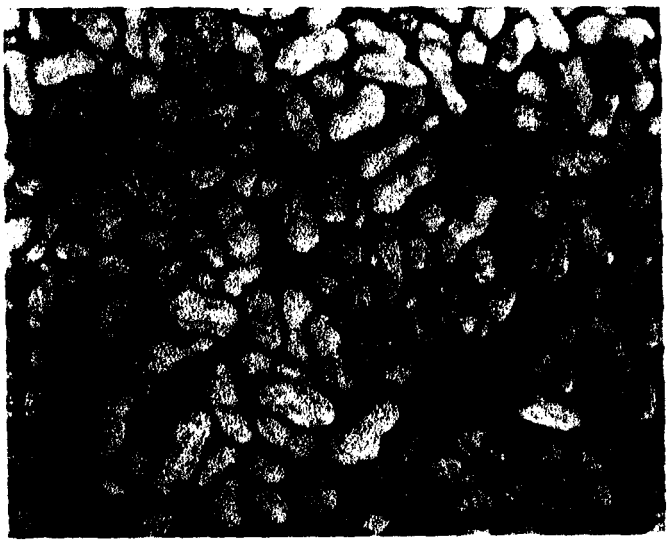

PLATE 5. SAM NUT 10 (UNSHELLED).

PLATE 6. SAM NUT 10 (SHELLED).

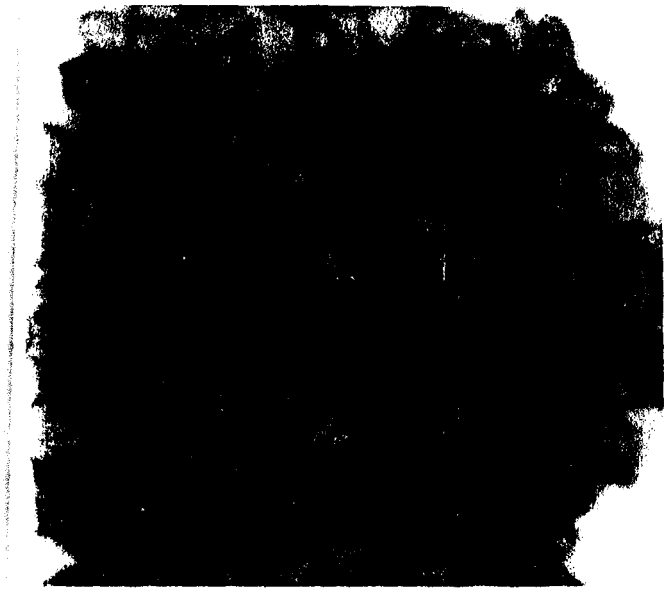

PLATE 3 SAM NUTS 22 (SHELLED).

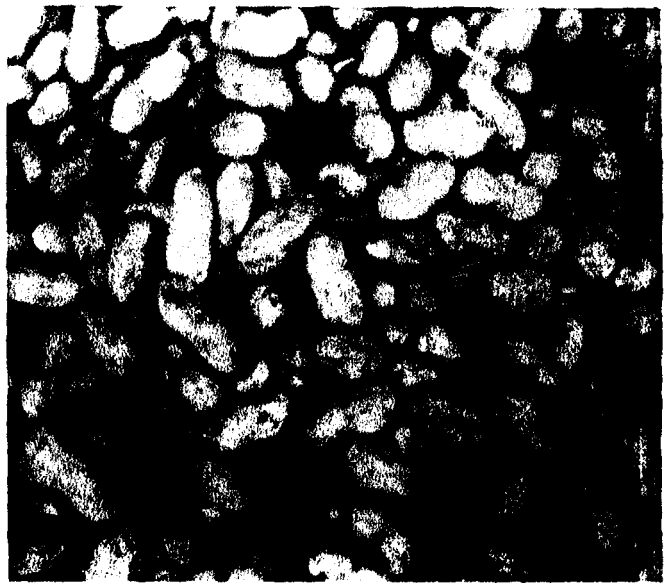

PLATE 4 SAM NUTS 22 (UNSHELLED).

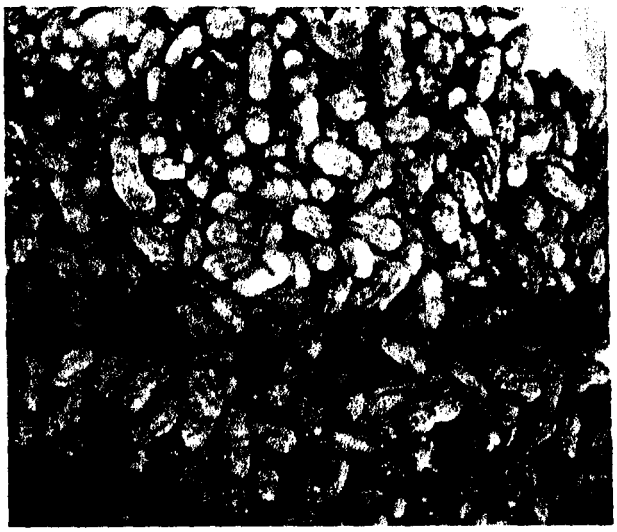

PLATE 5 .SAM NUT 23 (UNSHELLED).

PLATE 6 .SAM NUTS 23 (SHELLED)

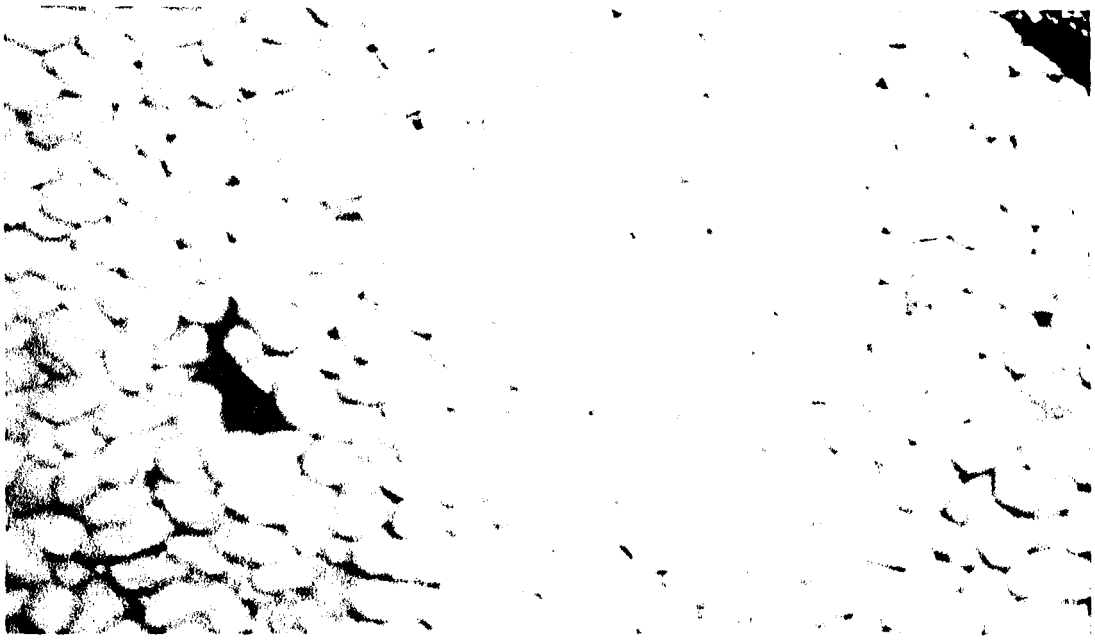

Plate 7: Wata Uku (shelled)

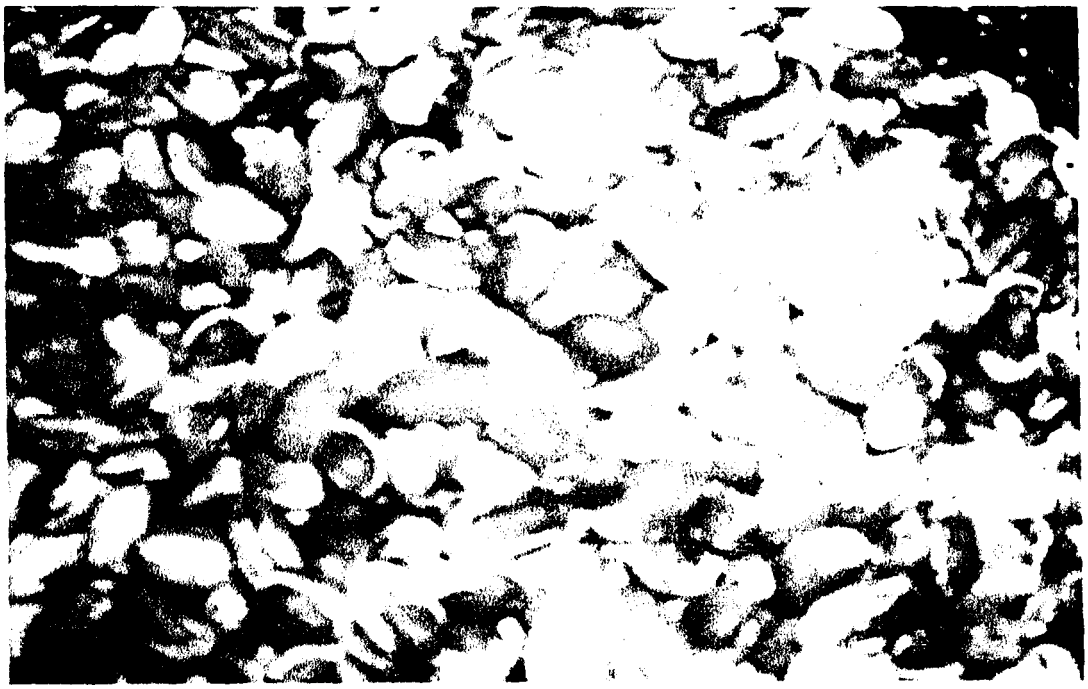

Plate 8: Kampala (shelled)

3.2 METHODS

3.2.1 Determination of Moisture Content

Moisture Content is one of the most important and widely used measurements in samples that absorb and retain water. Moisture content is the amount of moisture (water) present per given weight of sample. Moisture content removal from biological material helps to inactivate or prevent the activities of fungi (Microbial growth), Oxidative rancidity and other infestation. (Mottran, 1979).

Moisture content is check in order to preserve the oil, there by promoting shelf life (Mottran, 1979).

Principles:-

This is based on weight loss as a result of drying the sample to a constant weight in an oven or air – dry at specific temperature and time.

No reagent is required.

Apparatus:

Oven

Petrish dish

Procedure:-

A well labeled petrish dish is cleaned and oven dried and it's weight taken as (W_1)

5g of groundnut samples was added into the petrish dish and its weight was taken as (W_2).

The dish and the groundnut sample were transferred to the thermosetting oven at 105°C for about 24hours. The dish was removed from the oven and the weight was taken as W_3. Further drying was done for an hour to ensure that constant Weight has been achieved (AOAC, 1998).

$$\%Moisture\,Content = \frac{Loss\,in\,weight}{weight\,of\,sample\,before\,drying} \times 100$$

$$\%Moisture\,Content = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where

W_1 = Weight (g) of empty petrish dish

W_2 = Weight (g) of petrish dish plus groundnut samples

W_3 = Weight (g) of empty petrish dish and groundnut sample after oven dried.

(AOAC,1998).

3.2.2 Determination of crude fibre content

Principles:-

Crude fibre is determined as that fraction remaining after digestion with standard solution of tetraoxosulphate (VI) acid and sodium hydroxide under carefully controlled condition (AOAC, 1998).

Reagents:-

Tetraoxosulphate (VI) acid (0.5M)

Sodium hydroxide (0.2M)

Apparatus:-

Beaker

Round bottom flask

Filter paper

Spatula

Procedure:-

The weight of the round bottom flask was taken as (W_4). 5g of groundnut sample was put into 500ml round bottom flask and the weight was taken as (W_5). 200ml of 1.25% H_2SO_4 was added

to the sample and was heated gently for about 30minutes, and then it was filtered off using filter paper. The residue was put back into the round bottom flask with the aid of a spatula.

200ml of 1.25% NaOH and few drops of anti foaming agent was added to the residues and heated again for about 30 minutes. It was filtered, and then rinsed four times with hot distilled water and once with 10% Hcl, it was rinsed again four times with hot distilled water then twice with methylated spirit and three times with petroleum ether. The residue was dried in the oven at about 105°C, then cooled in the desiccator and weighed (AOAC, 1998).

$$\%Crude\,fibre\,(CF) = \frac{W_6 - W_4}{W_5 - W_4} \times 100$$

Where

W_4 = Weight (g) of round bottom flask

W_5 = Weight (g) of round bottom flask plus groundnut sample

W_6 = Weight (g) of round bottom flask plus residues (AOAC, 1998).

2.2.3 Determination of Crude Protein

The accepted standard method for the determination of nitrogen content in any sample involves complete digestion of the sample in hot concentrated acids in the presence of an appropriate catalyst. The catalyst is to convert all nitrogen in the nitrogenous materials in the sample into ammonium ion upon the addition of alkali to the digest. Ammonia is released which may either be distilled out of the sample and determined by simple acid-base titration or the ammonia can react with appropriate reagent such as phenol and sodium hypochlorite to give a coloured derivates which can be measured with calorimeter or spectrophotometer (AOAC, 1998).

The Kjeldahl digestion is usually performed by heating the sample with H_2SO_4 containing substances which promote oxidation of organic matter by increasing the boiling point

of the acid (K_2SO_4 or $NaSO_4$ and Se or Cu). Which increase the state of oxidation of organic matter. These reagents here are referred to as digestion catalyst. It is necessary to digest the sample for certain period until you obtain a clear solution to ensure accurate results (AOAC, 1998).

Principles:-

The Determination of Crude Protein Involves three stages which include digestion, distillation and titration as outlined in AOAC (1998).

Reagents:-

Kjeldahl catalyst tablet

Boric acid

Mixed indicator

NaOH

Apparatus:-

Kjeldahl flask

Digestion (Stage one)

2g of wet groundnut sample was poured into a 500ml kjeldahl flask. 20ml of concentrated H_2SO_4 was added to the sample along with one kjeldahl catalyst tablet. 2g of dry groundnut sample was poured into another 50ml micro kjeldahl flask and 5ml of concentrated H_2SO_4 with half kjeldahl catalyst tablet was added into the micro kjeldahl flask and its weight taken as (W_7). The groundnut sample was heated for 15 minutes with the aid of a heater at 50°C. The heat was later increased to 105°C and the sample was left boiling for about 30 minutes again. During the heating process the round bottom flask was rotated at intervals until the mixture was digested (digest becomes light green or grey white). The heating was continued for a few minutes to

ensure complete digestion. The sample was allowed to cool after heating and it was washed and then filtered. The digest was made up of 100ml distillation.

Distillation (stage two)

5m of 20% boric acid (H_3BO_3) was placed into 100ml conical flask (as a receiving flask). H_3BO_3 as an acid will trap down the ammonical vapour from the digest. 3 drops of mixed indicator was added. H_3BO_3 and the indicator can be prepared together but in this case the mixed indicator was the mixture of 0.19g bromocresol green and 0.132g methyl red in 200ml of alcohol.

The receiving flask was placed so that the tip of the condenser tube is placed below the surface of the boric acid. 10ml of 40% NaOH was added and 50ml was now distilled out about 50ml into the receiving flask.

Titration and calculations (stage three)

The distillate is titrated with standard mineral acid (0.01M HCL or 0.025M H_2SO_4), a blank was titrated with the acid also.

Sample Titre :- T_1

Blank Titre :- T_2

Control Titre :- $T = T_1 - T_2$

Digestion = $H_2SO_4 + 2NH_3 \rightarrow (NH_4)_2SO_4$

Nitrogen is converted to ammonia and react with H_2SO_4 to form $(NH_4)_2SO_4$.

3.2.4 Determination of lipid/Fats Content

By definition, fat are mixtures of various glyceride of fatty acid which are soluble in certain organic solvent. Extraction is carried out with soxhlet apparatus, ether or petroleum ether. Lipid is also known as fats and oil. These fats and oil can be found in animals where as oil are found both in animals and plant (Mottran, 1979).

Examples of fats are, animal source fats, lards while oil found in animals include cod liver oil, sebaceous fluid etc., plant source of oil include palm oil ground nut oil, cotton seed oil, shea butter oil etc., (Mottran 1979).

Principles: - The free fat lipid is extracted by the use of Soxhelt apparatus with petroleum ether. It involves the continuous extraction of the fat content with 40/60°C petroleum ether in a convenient extractor (Soxhlet extractor). The other extraction is based on the principle than the non polar components of a sample which are easily extracted into organic solvent (AOAC, 1998).

Reagents

Ammonia

Petroleum ether

Apparatuses

Soxhlet extractor

Roundbottom flask

Burner

Procedure:-

A dry thimble that is fat free was weighed as (W_8). 5g of groundnut sample meshed was added into the thimble and closed with cotton wool to ensure that there was no escape during heating and the weight of the thimble and groundnut sample in it was taken as (W_9).

A round bottom flask of 500ml was weighed as (W_{10}). The round bottom flask was filled with petroleum ether up to two third of the flask. A soxhlet extractor was filled up with the reflux condenser and the burner turned on to heat the solvent in the round bottom flask (i.e. petroleum ether) which was allowed to boil gently for 6hours while the petroleum ether was siphoned for

the 6 hours of boiling over the barren. The reflux condenser was detached and the thimble was removed. The petroleum ether was distilled from the flask.

The round bottom flask containing the fat residues was dried in an air oven at 115^0C for 5 minutes. It was later cooled in the desiccator and its weight taken as W_{11}.

The thimble with sample was now placed in a beaker inside an oven at 50^0C and was dried to constant weight. It was left to cool in the desiccator and weighed.

$$\%of\ extracted\ lipid = \frac{W_{11} - W_{10}}{W_9 - W_8} \times 100$$

Where

W_8 = Weight (g) of dry thimble

W_9 = weight (g) of thimble and sample inside

W_{10} = weight (g) of round bottom flask

W_{11} = weight (g) of round bottom flask containing fat residues after heating (AOAC, 1998).

3.2.5 Determination of Ash Content

Principle:-

The organic component of food is burnt off in air and the residues are ash which consists of the inorganic components in form of their oxides. The ash is not usually the same as the inorganic matter present in the original material since there may be loss due to volatilization or chemical interaction between the constituents. The importance of the ash content is that it gives idea of the amount of the mineral elements present and the content of organic matter in the sample (Mottron, 1979)..

Apparatuses

Crucible

Muffle furnance

Desiccator

Procedure:-

A crucible was cleaned, dried and placed in the muffle furnace for about 15 minutes at 350°C. The crucible was removed and left to cool in the desiccator for about one hour and its weight was taken as W_{12}.

5g of groundnut sample was put into the crucible and the weight taken as W_{13}. The crucible with groundnut sample was placed inside the muffle furnace and the temperature of the muffle furnace was increased from 200°C to 450°C. This is to ensure complete ashing (sample being whitish in colour after burning shows complete ashing) (AOAC, 1998).

The crucible was left to heat for a reasonable period of 30 minutes. It was then removed with the evidence of complete ashing. It was left to cool for about 15 minutes and was moisten with few drops of distilled water. It was finally returned to the muffle furnace to heat for 10 minutes.

The sample was placed into the desicator to cool to room temperature. The crucible and its content were weighed after the whole processes under gone as W_{14}. The formular for determining total ash content is given as:

$$\% \ Ash = \frac{W_{14} - W_{13}}{W_{13} - W_{12}} \times 100$$

The ash could be preserved for the determination of mineral analysis in cases where it is needed.

W_{12} = Weight (g) of empty crucible

W_{13} = weight (g) of crucible plus groundnut sample

W_{14} = Weight (g) of crucible and groundnut sample after complete ashing (heating) (AOAC, 1998).

3.2.6 Determination of carbohydrate

The end product of digestion of carbohydrate is glucose and this is stored in plant as starch and glycogen. Carbohydrate can be generally referred to as the energy giving portion of food materials and it is present in reasonable amount in most food crops most especially grains and cereals such as rice, maize, millet, barley etc.,

Procedure

The determination of carbohydrate = 100% - (%protein + % Lipid + %ash + % crude fibre + % moisture content) (AOAC, 1998).

Where; %protein, % lipid, % ash, % fibre, % moisture content has been previously determined in the course of this study.

3.4 STATISTICAL ANALYSIS

One way analysis of Variance (ANOVA) of the proximate compositions (moisture content, crude fibre, crude protein, fat/lipid content, Ash content and carbohydrate) of the five different varieties of groundnut (Watauku, Kampala, Samnut 10, Samnut 22 and Samnut 23) was carried out using (SPSS, 2006).

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1 Presentation of Results

The results of the test carried out on five different varieties of groundnut namely: Watauku, Kampala (local groundnut breeds) and Samnut 10, Samnut 22 and Samnut 23 (hybrids) are shown in the table 4.1.

Table 4.1 Proximate composition of different varieties of groundnut

Proximate composition	Varieties of Groundnut				
	A	B	C	D	E
Moisture content	8.80 ± 0.02^{a}	8.01 ± 0.01^{c}	$7..97\pm0.01^{d}$	8.72 ± 0.02^{b}	7.47 ± 0.02^{e}
Crude fibre	12.01 ± 0.01^{e}	14.43 ± 0.02^{b}	13.92 ± 0.09^{d}	14.59 ± 0.01^{a}	14.20 ± 0.02^{c}
Crude protein	34.81 ± 0.01^{a}	30.99 ± 0.01^{d}	30.99 ± 0.01^{d}	33.34 ± 0.04^{b}	31.54 ± 0.12^{c}
Fat or Lipid	36.03 ± 0.23^{d}	43.93 ± 0.10^{a}	38.02 ± 0.02^{c}	38.01 ± 0.01^{c}	41.01 ± 0.01^{b}
Ash content	3.99 ± 0.01^{b}	2.51 ± 0.01^{d}	4.51 ± 0.01^{a}	2.99 ± 0.02^{c}	1.99 ± 0.01^{e}
Carbohydrate	4.39 ± 0.01^{b}	0.07 ± 0.01^{e}	4.52 ± 0.02^{a}	2.32 ± 0.04^{d}	3.87 ± 0.02^{c}

Key;

A = Watauku groundnut; B= Kampala groundnut

C = Samnut 10; D = Samnut 22; E = Samnut 23.

1. Each value is the average of six determinations
2. Different letter within the same row are significantly different ($P<0.05$).

4.2 Discussion of Results

Table 4.1 shows that there is significant difference ($p<0.05$) in the moisture contents, crude fibre, Ash content and carbohydrate in all the varieties. In crude proteins, there was no

significant different between samnut 10 and the Kampala groundnut, but they were significantly different from the other varieties (Watauku, Samnut 22 and Samnut 23).

Similarly, in Lipids, there was no significant difference ($P<0.05$) between the Samnut 10 and Samnut 22, but they were both significantly different from the other varieties. (Watauku, Kampala and Samnut 23; respectively.

It was observed that the crude protein from the five varieties of groundnut is between 30-35% (Watauku; 34.81±0.01, Kampala, 30.99±0.01, Samnut 10, 30.99±0.01, Samnut 22; 33.34±0.04 and Samnut 23; 31.54±0.12). This is similar to the reports of Nelson and Carols (1995) which indicated the protein content among 29 cultivars between 26.3% - 34.0%.

The fat/lipid content of the different varieties of groundnut in this research work was between 36.0% - 44.0% (Watauku; 36.03±0.23, Kampala 43.93±0.01, Samnut 10; 38.02±0.02, Samnut 22; 38.01±0.01 and samnut 23 = 41.01±0.01, which is similar to the reports of Nelson and Carols (1995) amongst 29 cultiver between 47.0% - 50.1%.

The fat content is important in diet as it promotes fat soluble vitamin absorption. It is a high energy nutrient and does not add to the bulk of the diet.

The results for the moisture content, Ash content, crude fibre and carbohydrate shown in Table 4.1 in course of this study has the percentage values of 7.5% - 9.0%, 2.0% - 5.0%, 12.0% - 15.0% and 0.01 – 5.0% respectively, with carbohydrate having the least percentage composition, followed by ash content, moisture content and crude fibre.

Although the crude fibre in this research work is quite high compared to the works NAS (1980) with percentage of 3.0 and Atasie (2009) with percentage value of 3.7±0.03. Reason is because the groundnut was undecortated during the test for crude fibre. The crude fibre in this result indicates the ability of groundnut to maintain internal distention for a normal peristaltic movement of interstinal tracts; a physiological role which crude fibre plays.

is because the groundnut was undecorated during the test for crude fibre. The crude fibre in this result indicates the ability of groundnut to maintain internal distention for a normal peristaltic movement of intestinal tracts; a physiological role which crude fibre plays.

Diet low in crude fibre is undesirable as it could cause constipation and that such diets have been associated with diseases of colon like piles, appendicitis and cancer.

The ash content from table 4.1 having a percentage range of 2.0% - 5.0%) with Watauku having a composition of 3.99±0.01, Kampala or Tiv groundnut 2.51±0.01, samnut 10; 4.5±0.01, samnut 22; 2.99±0.02 and samnut 23; 1.99±0.01 Indicates that the different varieties of groundnuts considered in this study contains minerals which can be determined from the ash content.

The ash content present in groundnut varieties is evidence that groundnut contains a high quantity of minerals; although in course of this project work the mineral was not identified and quantified.

The carbohydrate value by difference in this work is low, which similar to that of NAS (1980). Watauku groundnut has a percentage composition of 4.39±0.01, Kampala having 0.07±0.01, samnut 10; 4.52±0.02, samnut 22; 2.32±0.04) and samnut 23; 3.87±0.02 which shows that groundnut is more of a body building food

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Groundnuts characteristically contain high level of oil and protein with low level of moisture content, ash content and carbohydrate. This makes it a potential source of edible oil.

Groundnut is grown to meet the world demand for oil and protein and is showing increasing potentials as a good food source, especially in the developing countries where the lack of adequate protein can be a very serious dietary problem.

Watauku, with a crude protein of 34.8±0.01 showed to be a better source of protein compared to the other varieties used in this research work with a crude protein between 30.99 ± 0.01- 33.34 ± 0.04.

Similarly Kampala has a Lipid content of 43.93 ± 0.23 which is a better source of lipid compared to the other varieties considered in this research work with 36.03 ± 0.23 – 41.01 ± 0.01.

In general as observed from this research work, the local breeds (Watauku and Kampala) yielded higher protein and lipid/fat content compared to the three hybrids (Samnut 10, Samnut 22 and Samnut 23) considered in this research work and will therefore be a good source of protein and Lipids.

5.2 Recommendations

Groundnut has a very important role to play in improving the nutritional status of Nigerian diet; therefore it should be accorded more emphasis in the Nigeria food marketing system as both food crop and cash crop.

The Watauku groundnut being a very rich source of proteins compared to the other varieties in this research work and as such its defatted seeds can be used to prepare food, as snacks, paste and used in diets to prevent against some mineral deficiencies which will aid to fight against malnutrition especially protein-calorine, leading to a better nutritional and health in Nigeria and Africa as a whole. It is therefore expedient to increase the production of the Watauku groundnut variety in Nigeria.

The Kampala which is a very good and rich source of oil compared to the other varieties as the oil from these groundnuts should be extracted in commercial or large quantities as it can be used for both domestic and industrial uses.

Further work should be carried out on these five groundnut varieties considered in this research work in terms of their mineral and quantitative analysis, vitamins and also how to improve their protein and fat/lipid. The same should be done on their fresh samples also, determining a better way to process and preserve groundnut in order to maintain its proximate composition.

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APPENDIX

```
ONEWAY
  MC CF CP Fat AC CHO BY variety
  /STATISTICS DESCRIPTIVES
  /MISSING ANALYSIS
  /POSTHOC = DUNCAN ALPHA(.05).
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Oneway

```
[DataSet1] C:\Program Files\SPSS Evaluation\egoudo.sav
```

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Moisture Content	A-Watauku (3 mnths)	6	8.8067	.01862	.00760	8.7871	8.8262	8.79	8.83
	B-Kampala (3 mnths)	6	8.0067	.01033	.00422	7.9958	8.0175	8.00	8.02
	C-Samnut (10)	6	7.9667	.01366	.00558	7.9523	7.9810	7.95	7.98
	D-Samnut (22)	6	8.7233	.01862	.00760	8.7038	8.7429	8.70	8.74
	E-Samnut (23)	6	7.4700	.01549	.00632	7.4537	7.4863	7.45	7.48
	Total	30	8.1947	.51210	.09350	8.0034	8.3859	7.45	8.83
Crude Fibre	A-Watauku (3 mnths)	6	12.0133	.01366	.00558	11.9990	12.0277	12.00	12.03
	B-Kampala (3 mnths)	6	14.4300	.02366	.00966	14.4052	14.4548	14.40	14.45
	C-Samnut (10)	6	13.9167	.09309	.03801	13.8190	14.0144	13.80	14.00
	D-Samnut (22)	6	14.5933	.01033	.00422	14.5825	14.6042	14.58	14.60
	E-Samnut (23)	6	14.2000	.01789	.00730	14.1812	14.2188	14.18	14.22
	Total	30	13.8307	.95364	.17411	13.4746	14.1868	12.00	14.60
Crude Protein	A-Watauku (3 mnths)	6	34.8067	.00516	.00211	34.8012	34.8121	34.80	34.81
	B-Kampala (3 mnths)	6	30.9900	.00894	.00365	30.9806	30.9994	30.98	31.00
	C-Samnut (10)	6	30.9900	.00894	.00365	30.9806	30.9994	30.98	31.00
	D-Samnut (22)	6	33.3567	.04412	.01801	33.3104	33.4030	33.30	33.39
	E-Samnut (23)	6	31.5400	.12426	.05073	31.4096	31.6704	31.45	31.70
	Total	30	32.3367	1.53697	.28061	31.7628	32.9106	30.98	34.81
Fat or Lipid	A-Watauku (3 mnths)	6	36.0300	.22926	.09359	35.7894	36.2706	35.79	36.30
	B-Kampala (3 mnths)	6	43.9333	.10328	.04216	43.8249	44.0417	43.80	44.00
	C-Samnut (10)	6	38.0233	.02251	.00919	37.9997	38.0470	38.00	38.05
	D-Samnut (22)	6	38.0100	.00894	.00365	38.0006	38.0194	38.00	38.02
	E-Samnut (23)	6	41.0133	.01366	.00558	40.9990	41.0277	41.00	41.03
	Total	30	39.4020	2.81834	.51456	38.3496	40.4544	35.79	44.00
Ash Content	A-Watauku (3 mnths)	6	3.9967	.01366	.00558	3.9823	4.0110	3.98	4.01
	B-Kampala (3 mnths)	6	2.5133	.01366	.00558	2.4990	2.5277	2.50	2.53
	C-Samnut (10)	6	4.5100	.00894	.00365	4.5006	4.5194	4.50	4.52
	D-Samnut (22)	6	2.9933	.01862	.00760	2.9738	3.0129	2.97	3.01
	E-Samnut (23)	6	1.9900	.00894	.00365	1.9806	1.9994	1.98	2.00
	Total	30	3.2007	.94648	.17280	2.8472	3.5541	1.98	4.52
Carbohydrate	A-Watauku (3 mnths)	6	4.3867	.01366	.00558	4.3723	4.4010	4.37	4.40
	B-Kampala (3 mnths)	6	.0700	.00894	.00365	.0606	.0794	.06	.08
	C-Samnut (10)	6	4.5233	.01862	.00760	4.5038	4.5429	4.50	4.54
	D-Samnut (22)	6	2.3233	.04412	.01801	2.2770	2.3696	2.29	2.38
	E-Samnut (23)	6	3.8700	.02366	.00966	3.8452	3.8948	3.85	3.90
	Total	30	3.0347	1.70433	.31117	2.3983	3.6711	.06	4.54

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Moisture Content	Between Groups	7.599	4	1.900	7743.560	.000
	Within Groups	.006	25	.000		
	Total	7.605	29			
Crude Fibre	Between Groups	26.324	4	6.581	3344.028	.000
	Within Groups	.049	25	.002		
	Total	26.373	29			
Crude Protein	Between Groups	68.418	4	17.105	4866.607	.000
	Within Groups	.088	25	.004		
	Total	68.506	29			
Fat or Lipid	Between Groups	230.029	4	57.507	4492.752	.000
	Within Groups	.320	25	.013		
	Total	230.349	29			
Ash Content	Between Groups	25.975	4	6.494	36895.720	.000
	Within Groups	.004	25	.000		
	Total	25.979	29			
Carbohydrate	Between Groups	84.222	4	21.056	33742.927	.000
	Within Groups	.016	25	.001		
	Total	84.238	29			

Post Hoc Tests

Homogeneous Subsets

Moisture Content

Duncan[a]

Variety	N	Subset for alpha = .05				
		1	2	3	4	5
E-Samnut (23)	6	7.4700				
C-Samnut (10)	6		7.9667			
B-Kampala (3 mnths)	6			8.0067		
D-Samnut (22)	6				8.7233	
A-Watauku (3 mnths)	6					8.8067
Sig.		1.000	1.000	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 6.000.

Crude Fibre

Duncan[a]

Variety	N	Subset for alpha = .05				
		1	2	3	4	5
A-Watauku (3 mnths)	6	12.0133				
C-Samnut (10)	6		13.9167			
E-Samnut (23)	6			14.2000		
B-Kampala (3 mnths)	6				14.4300	
D-Samnut (22)	6					14.5933
Sig.		1.000	1.000	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 6.000.

Crude Protein

Duncan[a]

Variety	N	Subset for alpha = .05			
		1	2	3	4
C-Samnut (10)	6	30.9900			
B-Kampala (3 mnths)	6	30.9900			
E-Samnut (23)	6		31.5400		
D-Samnut (22)	6			33.3567	
A-Watauku (3 mnths)	6				34.8067
Sig.		1.000	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 6.000.

Fat or Lipid

Duncan[a]

Variety	N	Subset for alpha = .05			
		1	2	3	4
A-Watauku (3 mnths)	6	36.0300			
D-Samnut (22)	6		38.0100		
C-Samnut (10)	6		38.0233		
E-Samnut (23)	6			41.0133	
B-Kampala (3 mnths)	6				43.9333
Sig.		1.000	.840	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 6.000.

Ash Content

Duncan[a]

Variety	N	Subset for alpha = .05				
		1	2	3	4	5
E-Samnut (23)	6	1.9900				
B-Kampala (3 mnths)	6		2.5133			
D-Samnut (22)	6			2.9933		
A-Watauku (3 mnths)	6				3.9967	
C-Samnut (10)	6					4.5100
Sig.		1.000	1.000	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 6.000.

Carbohydrate

Duncan[a]

Variety	N	Subset for alpha = .05				
		1	2	3	4	5
B-Kampala (3 mnths)	6	.0700				
D-Samnut (22)	6		2.3233			
E-Samnut (23)	6			3.8700		
A-Watauku (3 mnths)	6				4.3867	
C-Samnut (10)	6					4.5233
Sig.		1.000	1.000	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 6.000.