

CHAPTER ONE

1.1 INTRODUCTION

Food is any substance consumed to provide nutritional support for the body (Aguilera and David, 1999). Its components include water, carbohydrate, lipids, proteins, enzymes, vitamins, minerals, colours, flavours and food additives and it is ingested by an organism and assimilated by the organism's cell in an effort to produce energy, maintain life, or stimulate growth (Davidson, 2006).

The right to food is a human right derived from the International Covenant on Economic, Social and Cultural Rights (ICESCR), recognizing the “right to an adequate standard of living, including adequate food” as well as the “fundamental right to be free from hunger”. Almost all foods are of plant or animal origin. Other foods not from animal or plant sources include various edible fungi especially mushrooms used in the preparation of fermented and pickled foods like alcoholic drinks, leavened bread etc, water, salt and also blue–green algae such as spirulina (Campbell, 1998).

Many plants or plant parts are eaten as food. There are around 2,000 plant species which are cultivated for food, and many have several distinct cultivar. Seeds of plants are a good source of food for animals including humans, because they contain the nutrients necessary for the plant’s initial growth, including many healthful fats, such as omega fat. In fact, the majority of foods consumed by human beings are seed-based food (Carpenter and Finely, 2005).

Edible seeds include cereals (maize, wheat, rice etc), legumes (beans, peas, lentil etc) and nuts. Oilseeds are often pressed to produce rich oils-sunflower, flaxseed etc. Seeds are typically high in unsaturated fats and, in moderation are considered a health food, although not all seeds are edible. Large seeds, such as those from lemon, pose a choking hazard, while seeds from apples and cherries contain poison (cyanide) (Carpenter and Finely, 2005).

Fruits are the ripened ovaries of plants, including the seed within. Many plants have evolved fruits that are attractive as a food source to animals, so that animal will eat the fruits and excrete the seeds some distance away. Fruits therefore make up a significant part of the diet of most cultures. Some botanical fruits, such as tomatoes, pumpkin, and eggplants are eaten as vegetables (Davidson, 2006).

Vegetables are a second type of plant matter that is commonly eaten as food. These include root vegetables (potatoes and carrots), leaf vegetable (spinach and lettuce), stem vegetable (bamboo shoot and asparagus), and inflorescence vegetable (globe artichokes and broccoli) (Campbell, 1998).

Animals are used as food either directly or indirectly by the products they produce. Meat is an example of a direct product taken from an animal, which comes from muscle system or from organs. Food products produced by animals include milk produced by mammary glands which in many cultures is drunk or processed into dairy products (cheese, butter etc). In addition, birds and other animals lay eggs, which are often eaten and bees produce honey, reduced nectar from flowers which is a popular sweetener in many cultures. Some cultures consume blood, sometimes in the form of blood sausage, as a thickener for sauces, or in cured, salted form in time of food scarcity, and others use blood in stews such as civet (Lawrie and Lawrie, 1998).

Traditionally, food was obtained through agriculture. With increasing concern in agribusiness over multinational corporations owning the world food supply through patents on genetically modified food, there has been a growing trend toward sustainable agricultural practices. This approach, partly fueled by consumer demand, encourages biodiversity, local self-reliance and organic farming methods (Magdoff et al., 2000). Influences on food production include international organizations (example the World Trade Organization and Common Agriculture Policy), National Government Policy (or law) and war (Mason, 2005).

Animals, specifically humans, have five different types of taste; sweet, sour, salty, bitter and *Umani*. As animals have evolved, the tastes that provide the most energy (sugar and fats) are the most pleasant to eat while others such as bitter, are not enjoyable (McGee, 2004).

Water, while important for survival, has no taste. Fats on the other hand, especially saturated fats, are thicker and rich and are thus considered more enjoyable to eat. Sweetness is almost always caused by a type of simple sugar such as glucose or fructose or disaccharide such as sucrose, a molecule combining glucose and fructose (Mead, 1997). Sourness is caused by the taste of acids, such as vinegar in alcoholic beverages. Sour foods include citrus, specifically lemons, limes and to a lesser degree oranges (Mead, 1997).

Saltiness is the taste of alkali metal ions such as Na and K. It is found in almost every food in low to moderate proportions to enhance flavour, although to eat pure salt is regarded as highly unpleasant. Other than enhancing flavour, its significance is that the body needs and maintains a delicate electrolyte balance which is the kidney's function (McGee, 2004).

Bitterness is a sensation often considered unpleasant, characterized by having a sharp, pungent taste. Dark, unsweetened chocolate, caffeine, lemon, rind, and some types of fruits are known to be bitter. *Umani*, the Japanese word for delicious, is the least known in western popular culture, but has a long tradition in Asian cuisine. *Umani* is the taste of glutamates especially monosodium glutamates or MSG (Mead, 1997). It is characterized by savory, meaty, and rich in flavor. Meat and other animal by-products, also mushrooms, salmon are described as having this taste.

Many cultures have a recognizable cuisine, a specific set of cooking traditions using various spices or a combination of flavours unique to that culture, which evolves over time. Many cultures have as well diversified their foods by means of preparation, cooking methods, and manufacturing. This also

includes a complex food trade which helps the culture to economically survive by way of food, not just by consumption.

While many foods can be eaten raw, many also undergo some form of preparation for reasons of safety, palatability, texture, or flavour. At the simplest level, this may involve washing, cutting, trimming, or adding other food or ingredients such as spices. It may also involve mixing, heating or cooling, pressure cooking, fermentation, or combination with other foods. Some preparation is done to enhance the taste or aesthetic appeal. Other preparations may help to preserve the food. Others may be involved in cultural identity, thus a meal is made up of food which is prepared to be eaten at a specific time and place (McGee, 2004).

The term ‘cooking’ encompasses a vast range of methods, tools and combinations to improve the flavour or digestibility of food. Cooking technique, known as culinary art, generally requires the selection, measurement, and combining of ingredients in an ordered procedure in an effort to achieve the desired result. The diversity of cooking world-wide is a reflection of the myriad nutritional, aesthetic, agricultural, economic, cultural and religious considerations that affect it (Carpenter and Finely, 2005). Cooking requires applying heat to a food which usually, though not always, chemically changes the molecules, thus changing its flavor, texture, appearance, and nutritional properties (McGee, 2004).

Certain cultures highlight animal and vegetable foods in their raw state (raw foodism). Salads consisting of raw vegetable or fruits are common in many cuisines. Sashimi in Japanese cuisine consists of raw sliced fish or other meat, and sushi often incorporates raw fish or sea food. Steak tartare and salmon tartare are dishes made from diced or ground raw beef or salmon, mixed with various ingredients and served with baguettes, brioche or frits (Smith, 2007).

Early food processing techniques were limited by available food preservation, packaging and transportation. This mainly involved salting,

curing, curdling, drying, pickling, fermenting and smoking (Jango-Cohen, 2005).

Food manufacturing arose during the industrial revolution in the 19th century. This development took advantage of new mass markets and emerging new technology, such as milling, preservation, packaging, labeling, and transportation (Jango-Cohen, 2005). At the start of the 21st century, a two-tier structure has arisen with a few international food processing giants controlling a wide range of well-known food brands. There also exists a wide array of small local or national food processing companies (Jango-Cohen, 2005).

Advanced technologies have also come to change food manufacture. Computer-based control system, sophisticated processing and packaging methods, and logistics and distribution advances can enhance product quality, improve food safety and reduce costs (Humphery, 1998). The World Bank reported that the European Union was the top food importer in 2005, followed at a distance by the U.S.A and Japan. Food is now traded and marketed on a global basis. The variety and availability of food is no longer restricted by the diversity of locally grown food or the limitations of the local growing season (Smith, 2007).

Food marketing and retailing brings together the producer and the consumer. It is the chain of activities that brings food from “farm gate to palate” (Humphery, 1998). The food marketing system is the largest direct and indirect non-government employer in the United States (Humphery, 1998). It was reported on March 24, 2007, that consumers worldwide faced rising food prices. Reasons for this development include changes in the weather and dramatic changes in the global economy, including higher oil prices, lower food reserves, and growing consumer demand in China and India (Howe and Devereux, 2004). However, the Food and Agriculture Organization projects that consumers still have to deal with more expensive food until at least 2018 (FAO, 2010).

Food deprivation leads to malnutrition and ultimately starvation. This is often connected with famine, which involves the absence of food in entire communities. This can have a devastating and widespread effect on human health and mortality. Rationing is sometimes used to distribute food in times of shortage (Howe and Devereux, 2004).

Starvation is a significant international problem. Approximately 815 million people are undernourished, and over 16,000 children die per day from hunger-related causes (Humphery, 1998). Food deprivation is regarded as a deficit need in Maslow's hierarchy of needs and is measured using famine scales (Messer et al., 1998).

Food aid can benefit people suffering from a shortage of food. It can be used to improve people's lives in the short term, so that a society can increase its standard of living to the point that food aid is no longer required (Kripke, 2005). International efforts to distribute food to the neediest countries are often coordinated by the World Food Programme (Kripke, 2005). Food borne illness, commonly called "food poisoning", is caused by bacteria, toxins, virus, parasites and prions. Roughly seven million people die of food poisoning each year, with about 10 times as many suffering from a non-fatal version (Messer *et al.*, 1998). Food borne illness could be by cross-contamination of ready-to-eat food from other uncooked foods or improper temperature control, improper storage, toxic substances inherent in food regularly eaten, and even storage in an unsafe container. In more recent years, a greater understanding of the causes of food-borne illness has led to the development of more systematic approaches such as the Hazard Analysis and Critical Control Point (HACCP), which can identify and eliminate many risks. Some people have allergies or sensitivities to foods which are not problems to most people. This occurs when a person's immune system mistakes a certain food protein for a harmful agent and attacks it. About 2% of adults and 8% of children have a food allergy.

Healthwise, human diet was estimated to cause perhaps around 35% of cancer in a human epidemiological analysis by Richard Doll and Richard Peto, (1981) (<http://www.niaid.nih.gov/publications/pdf/foodallergy.pdf>).

In fact between the extremes of optimal health and death from starvation or malnutrition, there is an array of disease states that can be caused or alleviated by changes in diet. Deficiencies, excesses, and imbalances in the food we eat can produce negative impacts on health.

1.2 SCOPE OF THE STUDY

The various food stuffs were bought at various markets around the Eastern States of Nigeria

1.3 AIMS AND OBJECTIVES OF RESEARCH

The aims and objectives of this research are:

- i To estimate the nutrients and antinutrients components of the major classes of food eaten in Eastern Nigeria, listed in Table 1.1
- ii To ascertain the quality of the food samples as well as compare the levels of nutrients and anti-nutrients with local and international standards for food.

1.4 SPECIFIC AIMS

- i To determine the proximate compositions of the food samples
- ii Evaluate the mineral compositions of the food samples
- iii To determine the antinutritional factors in the food samples
- iv To determine toxic metals in the food samples
- v To determine the physicochemical properties of the oils
- vi To compare these parameters with both local and international standards.

TABLE 1.1: Major groups of food eaten in Eastern Nigeria

S/No	IGBO NAME	ENGLISH NAME	SCIENTIFIC/BOTANIC NAME
1	Vegetables		
1.	Ugu	Pumpkin	<i>Telfaira occidentalis</i>
2.	Oha	African rose wood	<i>Pterocarpus mildoreadi</i>
3.	Onugbu	Bitter leaf	<i>Vernonia amygdaline</i>
4.	Inine oyibo	Green Amaranth	<i>Amaranthus hybridus</i>
5.	Arira	Bushmallow	<i>Corchorus olitorius</i>
6.	Akwukwo anara	Garden-egg leaf	<i>Solanum melongena</i>
2	Fruits		
7.	Chowanchop	Soursop	<i>Annona muricata</i>
8.	Oroma	Orange	<i>Citrus sinensis</i>
9.	Udala	Starapple	<i>Chysophullum albidum</i>
10.	Mangolo	Mango	<i>Mangifera indica</i>
11.	Ogili	Wild mango	<i>Klainedoxa gabonensis</i>
12.	Icheku	Tamarind	<i>Dialium indum</i>
3.	Cereal		
13.	Osikapa	Rice	<i>Oryza sativa</i>
14.	Oka	Maize/Corn	<i>Zea mays</i>
4.	Carbohydrate		
15.	Ji Abana	Water yam	<i>Dioscorea alata</i>
16.	Iyoh	Sweet yam	<i>Discorea dumentorum</i>
17.	Ogbagada	Yellow yam	<i>Discorea ayensis</i>
18.	Akpu	Cassava	<i>Manihot utilissima</i>
19.	Garri	Processed cassava	<i>Manihot dulcis</i>
20.	Nduku	Sweet potatoe	<i>Capsicum annum</i>
21.	Ede	Cocoa yam	<i>Colocassi sagittifolium</i>
5.	Oil & Fats		
22	Mmanu nri	Palm oil	<i>Elaeis guineensis (oil)</i>
23	Mmanu opapa	Groundnut oil	<i>Arachis hypogaeae (oil)</i>
6.	Proteins		
24	Anu ewu	Goat meat	<i>Capri hirus</i>
25	Anu efi	Beef	<i>Bos indicus</i>

26	Anu okuko	Chicken	<i>Gallus domesticus</i>
27	Anu tolotolo	Turkey	<i>Melleagris gallopavo</i>
7.	Fish		
28	Okporoko	Cod	<i>Gadus morhua</i>
29	Alila	Cat fish	<i>Siluri formes</i>
30	Hosu	Mackerel	<i>Maccarello (lacento)</i>
8.	Legumes/pulses		
31	Agwa	Beans	<i>Phase olus vulgria</i>
32	Okpa	Chick peas	<i>Cicer aritinum</i>
33	Soyabeans	Soyabean	<i>Glycine Max</i>
34	Ukwa	Bread fruit	<i>Atocarpus communis</i>
9.	Nuts		
35	Opapa	Groundnut	<i>Arachis hypogeal</i>
36	Oji Igbo	Colanut	<i>Cola nitida</i>
37	Agbi inu	Bitter cola	<i>Garcine kola</i>
38	Aki oyibo	Coconut	<i>Cocos nucigera</i>
10.	Seeds		
39.	Ogbono	Ducanut	<i>Irvingia gabonensis</i>
40.	Egwusi	Melon seed	<i>Citrullus lanatus</i>

1.5 IMPORTANCE OF STUDY

It is usually a concern over the chemical composition or contamination of foods and the effect this has on its value to the consumer that generates the need for analysis. The quality of food is based on the natural composition, the

balance between the nutrient and antinutrient composition (Woodget and Cooper, 1995).

Our food should be our medicine according to Hippocrates, 447-368BC (Serge, 2007). In spite of the modern technology which we frequently mistake for civilization, many people today are very unhealthy because the body is commonly weakened by either too much food or too little nutrition (German, 2007). Currently, life expectancy has dropped to a global average of 75years. There is no doubting the fact that excessive processing; cooking and refining natural products for food had contributed to the rapid fall in life expectancy (Don, 2008).

A persons' diet is a complicated thing, a smorgasbord of cultural influences, ingrained habit and personal preferences. Understanding what happens when someone takes a drug, an area in which metabolomics is a more established tool. "A drug has a limited number of active molecules, but foods have thousands of molecules that work together and have subtle effects" (Serge, 2007).

Metabolomics is an interdisciplinary study of metabolites which are small molecules connected by the complex web of biochemical reactions called metabolism. Ultimately, metabolomics aims to make sense of the relationship between food and health (German, 2007). Nutrition experts are eyeing metabolomics as a potential tool for formulating diet guidelines. The field is not very ready yet, but its momentum is building towards making that possible (German, 2007). Thus, the analysis of these food samples eaten in Eastern Nigeria will enable us know and compare the compositions of such foods and with the aid of nutritional and biochemical knowledge, know what to eat, how to eat it, what to avoid or eat moderately either because it can make one ill or has little food value.

1.6 LITERATURE REVIEW

Food chemistry is the study of chemical processes and interactions of all biological and non-biological components of food (Serge, 2007). The biological substances include such items as meat, poultry, lettuce, beer, and milk as examples. It is similar to biochemistry in its main component such as carbohydrates, lipids and protein, but it also includes areas such as water, vitamins, minerals, enzymes, food additives, flavours and colours. This discipline also encompasses how products change under certain food processing technique and ways either to enhance or to prevent them from happening.

1.6.1 HISTORY OF FOOD CHEMISTRY

Food chemistry's history dates back as far as the late 18th century when many famous chemists were involved in discovering chemicals important in foods, including Carl Wilhelm Scheele (Isolated maleic acid from apples in 1785) and Sir Humphery Davy, who published the first book on agricultural and food chemistry in 1813 titled Elements of Agricultural Chemistry, in a course of lectures for the Board of Agriculture in the United Kingdom which served serve as a foundation for the profession world-wide. In 1874, the Society of Public Analysts was formed, with the aim of applying analytical methods to the benefit of the public (Serge, 2007). Its early experiments were based on bread, milk and wine. It was also out of concern for the quality of food supply, mainly food adulteration and contamination issues that would first stem from intentional contamination to later with chemical additives by the 1950's. The development of colleges and universities worldwide, most notably in the United States, expanded food chemistry as well with research of the dietary substances, most notably the single grain experiment during 1907-1911. Additional research by Harvey W. Wiley at the United States Department of Agriculture during the late 19th century played a key factor in the creation of the United States Food and Drug Administration in 1906. The American Chemical Society established their

agricultural and food chemistry division in 1908 while the Institute of Food Technologists established their food chemistry division in 1995.

1.6.2 SOURCES OF FOOD

The natural origins of human foods are biologically diverse, ranging widely in texture and composition from nutmeg to oysters. The extremely complex endogenous composition of food is made even more complex in the modern environment where so many extrinsic, additional items –additives such as antioxidants, contaminants from agriculture such as herbicides and industrial adulterants such as hydrocarbons from petroleum, may also be present. This extends the quantitative range of analyses practiced by food analysts from the gram amounts encountered in proximate analysis to pictogram and even lower amounts of highly toxic contaminants, example PCBs. To cover more than 12 orders of magnitude requires an enormously diverse armoury of techniques (Key *et al.*, 1997). The food we eat could come from plants, animals and neither plant nor animal

1.6.3 Plant Sources of Food

- a Grasses and their grains, including barley, cereal, corn or maize, oats, rice, rye, sugarcane, wheat.
- b Fruits as oranges, apple, mango, pawpaw, star apples.
- c Herbs and spices as nutmeg, coriander, cinnamon, black pepper.
- d Legumes as beans, peas, lentils.
- e Roots as cassava, potatoes
- f Tubers as yam
- g Nuts as coconut, groundnut, walnut
- h Seeds like melon seed
- i Vegetables as lettuce (leaf vegetable), carrot (root vegetable), broccoli (flower vegetable)

1.6.4 Animal Sources of Food

- a Dairy product, example milk
- b Egg, including roe and caviar
- c Insects, including honey
- d Meat, including beef, goat, lamb, mutton, pork
- e Offal, including blood
- f Poultry, including chicken, turkey, duck, goose, guinea fowl
- g Seafood, including finfish such as salmon and tilapia and shellfish as mollusks and crustaceans
- h Snails
- i Games, this includes all animals hunted for food

1.6.5 Sources From Neither Plants Nor Animals

- a Salt
- b Mushrooms
- c Water, including mineral water and spring water (<http://chemistrydaily.chemistry.com//food>)

1.7 NUTRIENTS

Classically, water, carbohydrate, proteins, fats, minerals and vitamins are considered as nutrients; there is still no unanimity concerning fibre and phytochemical. Even though these food components are necessary for good health, they are not nutrients in the strict sense.

1.8 NUTRIENTS IN FOOD

There are six major classes of nutrients: carbohydrates, fats, minerals, proteins, vitamins and water. These nutrient classes can be categorised as either

macronutrients (needed in relatively large amounts) or micro nutrients (needed in smaller quantities). The macronutrients include carbohydrates (including fibre), fats, protein and water. The micronutrients are minerals and vitamins.

The macronutrients (excluding fibre and water) provide structural material (amino acids from which proteins are built and lipids from which cell membranes and some signaling molecules are built) and energy. Some of the structural materials can be used to generate energy internally, and in either case, it is measured in Joules or kilocalories. Carbohydrates and proteins provide 17kJ approximately (4kcal) of energy per gram, while fats provide 37kJ (9kcal) per gram, (Berg *et al.*, 2002), though the net energy from either depends on such factors as absorption and digestive effort which vary substantially from instance to instance. Vitamins, minerals, fibre and water do not provide energy, but are required for other reasons. A third class of dietary material, fibre (i.e. non-digestible material such as cellulose), is also required for both mechanical and biochemical reasons, although the exact reasons remain unclear (Jurgens, 2001).

Molecules of carbohydrate and fats consist of carbon, hydrogen and oxygen atoms. Carbohydrates range from simple monosaccharides (glucose, fructose, and galactose) to complex polysaccharides (starch). Fats are triglycerides, made of assorted fatty acid monomers bound to glycerol backbone. Some fatty acids, but not all, are essential in the diet. They cannot be synthesized in the body. Protein molecules contain nitrogen atoms in addition to carbon, oxygen and hydrogen. The fundamental components of protein are nitrogen containing amino acids, some of which are essential in the sense that humans cannot make them internally. Some of the amino acids are convertible (with the expenditure of energy) to glucose and can be used for energy production just as ordinary glucose in a process known as gluconeogenesis. By breaking down existing protein, some glucose can be produced internally; the remaining amino acids are discarded, primarily as urea in urine. This occurs normally only during prolonged starvation. Other micronutrients include

antioxidants and phytochemicals, which are said to influence (or protect) some body systems. Most foods contain a mix of some or all of the nutrient classes, together with other substances, such as toxins of various sorts. Some nutrients can be stored internally (example, the fat soluble vitamins), while others are required more or less continuously. Poor health can be caused by a lack of a required nutrient, for example both salt and water (both absolutely required) will cause illness or even death in excessive amounts.

1.8.1 Carbohydrate

Carbohydrates may be classified as monosaccharides, disaccharides, or polysaccharides depending on the number of monomer (sugar) units they contain. They constitute a large part of foods such as rice, noodles, bread and other grain-based products. Monosaccharides, disaccharides, and polysaccharides contain one, two and three or more sugar units, respectively. Polysaccharides are often referred to as complex carbohydrates because they are typically long, multiple branched chains of sugar units. Traditionally, simple carbohydrates were believed to be absorbed quickly, and therefore raise blood-glucose levels more rapidly than complex carbohydrates. This, however, is not accurate (Otto, 1993; Crapo and Reavan, 1977; Crapo et al, 1980; Jenkins et al, 1986). Some simple carbohydrates (example fructose) follow different metabolic pathways (example fructolysis) which result in only a partial metabolism to glucose, while many complex carbohydrates may be digested at essentially the same rate as simple carbohydrate (Otto, 1993).

1.8.2 Dietary Fibre

Dietary fibre is a carbohydrate (or a polysaccharide) that is incompletely absorbed in humans and in some animals. Like all carbohydrates, when it is metabolized it can produce four calories (kilocalories) of energy per gram. However, in most circumstances it accounts for less than that because of its limited absorption and digestibility. Dietary fibre consists mainly of cellulose, a

large carbohydrate polymer that is indigestible because humans do not have the required enzymes to disassemble it. There are two subcategories: soluble and insoluble fibre. Whole grains, fruits (especially plums, prunes and figs) and vegetables are good sources of dietary fibre.

There are many health benefits of a high-fibre diet. Dietary fibre helps reduce the chance of gastro-intestinal problems such as constipation and diarrhoea by increasing the weight and size of stool and softening it. Insoluble fibre, found in whole wheat flour, nuts and vegetables, especially stimulates peristalsis – the rhythmic muscular contractions of the intestines which move digesta along the digestive tract. Soluble fibre, found in oats, peas, beans and many fruits, dissolves in water in the intestinal tract to produce a gel which slows the movement of food through the intestines. This may help lower blood glucose levels because it can slow the absorption of sugar.

Additionally, fibre, perhaps especially that from whole grains, is thought to possibly help lessen insulin spikes and therefore reduce the risk of type 2 diabetes. The link between increased fibre consumption and a decreased risk of colorectal cancer is still uncertain (Pampalene-Roger, 2005).

1.8.3 Fat

A molecule of dietary fat typically consists of several fatty acids (containing long chains of carbon and hydrogen atoms), bonded to a glycerol. They are typically found as triglycerides (three fatty acids attached to one glycerol backbone). Fats may be classified as saturated or unsaturated depending on the detailed structure of the fatty acids involved. Unsaturated fats have some of these carbon atoms double-bonded, so their molecules have relatively fewer hydrogen atoms than a saturated fatty acid of the same length.

Unsaturated fats may be further classified as monounsaturated (one double-bond) or polyunsaturated (many double-bonds). Furthermore, depending on the location of the double-bond in the fatty acid chain, unsaturated

fatty acids are classified as omega-3 or omega-6 fatty acids. Trans fats are a type of unsaturated fat with trans-isomer bonds; these are rare in nature and in foods from natural sources: they are typically created in an industrial process called (partial) hydrogenation.

There are nine kilocalories in each gram of fat. Fatty acids such as conjugated linoleic acid, catalpic acid, eleostearic acid and punicic acid, in addition to providing energy, represent potent immune modulatory molecules. Saturated fats (typically from animal sources) have been a staple in many cultures for millennia. Unsaturated fats (example vegetable oil) are considered healthier, while trans fats are to be avoided. Saturated and some trans fats are typically solid at room temperature (such as butter or lard), while unsaturated fats are typically liquids (such as olive oil or flax seed oil). Trans fat are very rare in nature, and have been shown to be highly detrimental to human health, but have properties useful in the food processing industry, such as rancidity resistance (Nicklas, 2002).

1.8.4 Essential Fatty Acids

Most fatty acids are non-essential, meaning the body can produce them as needed, generally from other fatty acids and always by expending energy to do so. However, in humans, at least two fatty acids are essential and must be included in the diet. An appropriate balance of essential fatty acids –Omega 3 and Omega 6 fatty acids – seems also important for health, although definitive experimental demonstration has been elusive (Nelson and Cox, 2000). Both of these ‘Omega’ long-chain polyunsaturated fatty acids are substrates for a class of eicosanoids known as prostaglandins, which have roles throughout the human body. The amount and type of carbohydrate consumed, along with some types of amino acid, can influence processes involving insulin, glucagons and other hormones; therefore the ratio of Omega-3 versus Omega-6 has wide effects on

general health, and specific effects on immune function and inflammation, and mitosis (i.e. cell division) (Nelson and Cox, 2000).

1.8.5 Protein

Proteins are the basis of many animal body structures (example, muscles, skin and hair). They also form the enzymes that control chemical reactions throughout the body. Each molecule is composed of amino acids, which are characterized by inclusion of nitrogen and sometimes sulphur (these components are responsible for the distinctive smell of burning protein, such as the Keratin in hair). The body requires amino acids to produce new proteins (protein retention) and to replace damaged proteins (maintenance). As there is no protein or amino acid storage provision, amino acids must be present in the diet. Excess amino acids are discarded, typically in the urine. For all animals, some amino acids are essential (an animal cannot produce them internally) and some are nonessential (the animal can produce them from nitrogen-containing compounds). About twenty amino acids are found in the human body and about ten of these are essential and, therefore, must be included in the diet. A diet that contains adequate amounts of amino acids (especially those that are essential) is particularly important in some situations: during early development and maturation, pregnancy, lactation, or injury (a burn, for instance). A complete protein source contains all the essential amino acids; an incomplete protein source lacks one or more of the essential amino acids (Jurgens, 2001; Nelson and Cox, 2000).

It is possible to combine two incomplete protein sources (examples rice and beans) to make a complete protein source, and characteristic combinations are the basis of distinct cultural cooking traditions. Sources of dietary protein include meats, tofu and other soy-products, eggs, legumes and dairy products such as milk and cheese. Excess amino acids from protein can be converted into glucose and used for fuel through a process called gluconeogenesis. The amino

acids remaining after such conversion are discarded (Nelson and Cox, 2000).

1.8.6 Minerals

Dietary minerals are the chemicals required by living organisms, other than the four elements carbon, hydrogen, nitrogen and oxygen that are present in nearly all organic molecules. The term “mineral” is archaic, since the intent is to describe simply the less common elements in the diet. Some are heavier than the four just mentioned, including several metals, which often occur as ions in the body. Some dietitians recommend that these be supplied from foods in which they occur naturally or at least as complex compounds, or sometimes even from natural inorganic sources (such as calcium carbonate from ground oyster shells). Some minerals are absorbed much more in the ionic forms found in such sources. On the other hand, minerals are often artificially added to the diet as supplements; the most famous is iodine in iodized salt which prevents goiter (Jurgens, 2001).

1.8.7 Macrominerals

Many elements are essential in relatively high quantities; they are usually called “bulk minerals”. Some are structural, but many play a role as electrolytes (Nelson and Cox, 2001). Elements with recommended dietary allowance (RDA) greater than 200mg/day are referred to as macrominerals. Calcium, a common electrolyte, but also needed structurally (for muscle and digestive system health, bone strength, some forms neutralize acidity, may help clear toxins, provide signaling ions for nerve and membrane functions). Chlorine; as chloride ions, is a very common electrolyte. Phosphorus, required component of bones; essential for energy processing (Corbridge, 1995). Potassium, a very common electrolyte for healthy heart and nerves. Sodium, a very common electrolyte; not generally found in dietary supplements, despite being needed in large quantities, because the ion is very common in food; typically as sodium chloride, or common salt. Excessive sodium consumption can deplete calcium and magnesium leading to

high blood pressure and osteoporosis. Sulphur, for three essential amino acids and therefore many proteins (skin, hair, nails, liver and pancreas). Sulphur is not consumed alone, but in the form of sulphur-containing amino acid.

1.8.8 Trace minerals

Many elements are required in trace amounts, usually because they play a catalytic role in enzymes (Lippard and Berg, 1994). Some trace mineral elements with Recommended Daily Allowance (RDA) <200mg/day are; cobalt, required for biosynthesis of vitamin B₁₂ family of coenzymes. Animals cannot biosynthesize B₁₂, and must obtain this cobalt-containing vitamin in the diet. Copper, is a required component of many redox enzymes, including cytochrome C oxidase. Chromium, required for sugar metabolism. Iodine, required not only for the biosynthesis of thyroxine, but probably for other important organs as breast, stomach, salivary glands, thymus. For this reason iodine is needed in larger quantities than others in this list, and sometimes classified with the macrominerals. Iron, required for many enzymes, and for hemoglobin and some other proteins. Manganese, for processing of oxygen. Molybdenum, required for xanthine oxidase and related oxidases. Nickel, is present in urease. Selenium, required for peroxidase (antioxidant proteins). Vanadium, zinc, are required for several enzymes such as carboxypeptidase, liver alcohol dehydrogenase, and carbonic anhydrase (Lippard and Berg, 1994).

1.8.9 Vitamins

Like some minerals, some vitamins are recognized as essential nutrients, necessary in the diet for good health. (Vitamin D is the exception; it can be synthesized in the skin, in the presence of UVB radiation). Certain vitamin-like compounds that are recommended in the diet such as carnitine are thought useful for survival and health, but these are not “essential” dietary nutrients because the human body has some capacity to produce them from other

compounds. Moreover, thousands of different phytochemicals have recently been discovered in food (particularly in fresh vegetables), which may have desirable properties including antioxidant activity (Shils, 2005). Vitamin deficiencies may result in disease conditions, including goiter, scurvy, osteoporosis, impaired immune system disorders, among many others (Shils, 2005). Excess levels of some vitamins are also dangerous to health (notably vitamin A) and for at least one vitamin B6 toxicity begins at levels not far above the required amount.

1.8.10 Water

Water is excreted from the body in multiple forms; including urine and faeces, sweating and by water vapour in the exhaled breath. Therefore it is necessary to adequately rehydrate to replace lost fluids. Early recommendation for the quantity of water required for maintenance of good health suggest that 6-8 glasses of water daily is the minimum to maintain proper hydration.

However, the notion that a person should consume eight glasses of water per day cannot be traced to a credible scientific source (Heinz, 2003). The original water intake recommended in 1945 by the Food and Nutrition Board of the National Research Council read: “An ordinary standard for diverse persons is 1 milliliter for each calorie of food. Most of this quantity is contained in prepared foods” (Food and Nutrition Board, 1945). More recent comparisons of well known recommendations on fluid intake have revealed large discrepancies in the volumes of water we need to consume for good health (Bellego, 2010). Therefore, to help standardize guidelines, recommendations for water consumption are included in two recent European Food Safety Authorities (EFSA) documents 2010: (i) food-based dietary guidelines and (ii) Dietary reference values for water or adequate daily intakes (ADI).

These specifications were provided by calculating adequate intakes from measured intakes in populations of individuals with “desirable Osmolarity

values of urine and desirable water volumes per energy unit consumed” (EFSA, 2010). For healthy hydration, the current EFSA guideline recommends total water intakes of 2.0L/day for adult females and 2.5L/day for adult males. These reference values include water for drinking water, other beverages, and from food. About 80% of our daily water requirement comes from the beverages we drink, with the remaining 20% coming from food (Armstrong et al., 2005). Water content varies depending on the type of food consumed, with fruits and vegetables containing more than cereals, for example (FAO Corporate Document Repository, 2010). These values are estimated using country-specific food balance sheet published by the Food and Agriculture Organization of the United Nations. Other guidelines for nutrition also have implications for the beverages we consume for healthy hydration, for example; the World Health Organization (WHO) recommend that added sugars should represent no more than 10% of total energy intake.

The EFSA panel also determined intake for different populations. Recommended intake volumes in the elderly are the same as for adults as despite lower energy consumption, the water requirement of this group is increased due to a reduction in renal concentrating capacity. Pregnant and breast feeding women require additional fluids to stay hydrated. The EFSA panel proposes that pregnant women should consume the same volume of water as non-pregnant women, plus an increase in proportion to the higher energy requirement, equal to 300ml/day. To compensate for additional fluid output, breast feeding women require an additional 700ml/day above the recommended intake values for non-lactating women. For those who have healthy kidney, it is somewhat difficult to drink too much water, but (especially in warm humid weather and while exercising) it is dangerous to drink too little. While over hydration is much less common than dehydration, it is also possible to drink far more water than necessary which can result in water intoxication, a serious and

potentially fatal condition (Farrel and Bower, 2003). In particular, large amounts of de-ionized water are dangerous (EFSA, 2010).

1.9 MACRO MINERALS OF INTEREST IN THE STUDY

1.9.1 Potassium

Potassium is widely distributed in foods and is rarely deficient in the diet. However, some diuretics used in the treatment of hypertension deplete potassium. The mineral is also lost during sustained vomiting or diarrhea or chronic use of laxatives. Symptoms of potassium deficiency include weakness, loss of appetite, muscle cramps, and confusion. Severe hypokalemia (low blood potassium) may result in cardiac arrhythmias. Potassium-rich foods, such as bananas or oranges, can help replace losses of the mineral, as can potassium chloride supplements, which should be taken only under medical supervision.

Potassium is important for normal muscle and nerve responsiveness, heart rhythm, and, in particular, intracellular fluid pressure and balance. Approximately 8 percent of the potassium that the body takes in through food consumption is retained; the rest is readily excreted (John, 2009). The recommended daily allowance (RDA) of potassium for an average healthy person to maintain healthy body function is about 2000mg (Recommended daily allowances (Nap. eduhttp://www.nap.ed/openbook).

1.9.2 Phosphorus

Phosphorus is a mineral that is vitally important to the normal metabolism of numerous compounds. About 70 percent of phosphorus combines with calcium in bone and tooth structure, while nitrogen combines with most of the remaining 30 percent to metabolize fats and carbohydrates. Phosphorus is the principal element in the structure of the nucleus and cytoplasm of all tissue cells. It is also a universally distributed component of

skeletal, nerve, and muscle tissues. A reduced concentration of phosphate in the blood serum is a disorder known as hypophosphatemia (Sharma, 2006).

Phosphorus deficiency may cause bone diseases such as rickets in children and osteomalacia in adults. An improper balance of phosphorus and calcium may cause osteoporosis. Dietary sources of phosphorus include milk products, egg yolk, legumes, nuts, and whole grains (Sharma, 2006). The recommended daily allowance of phosphorus for an average healthy person to maintain body function is between 700-1280mg (Nap. edu<http://www.nap.ed/openbook>).

1.9.3 Magnesium

Magnesium is a mineral that is essential to a variety of cellular metabolic actions and sometimes has the ability to replace a portion of body calcium. It is also required for the synthesis of parathyroid hormone. About three-fourths of the mineral found in the body is associated with calcium in the skeleton and smooth dentine formation, with the remainder contained in soft tissues and body fluids. Magnesium forms positive ions in solution and is essential for the electrical breakdown of nutrient and other materials within the cells; it is also important for stimulation of muscles and nerves (John, 1999).

Magnesium deficiencies are noted in chronic kidney disease, malabsorption disorders, malnutrition, and conditions of acidosis (excess of acid), including diabetic coma. Symptoms of deficiency include weakness, laziness, and convulsive seizures. Treatment requires a replacement of magnesium. The best food sources of magnesium include cereals, legumes, meats, and milk and other dairy products (John, 1999). The recommended daily allowance of magnesium for an average person to maintain healthy body function is between the range 375-420mg(Nap.edu<http://www.nap.ed/openbook>).

1.9.4 Sodium

Sodium is an element that functions with chlorine and bicarbonate to maintain a balance of positive and negative ions (electrically charged particles) in body fluids and tissues (Srilakshmi, 2006).

The human body contains about 1.8g Na/kg fat body weight, most of which is present in extracellular fluids. The content in serum normally is about 300-355mg/100ml. Since sodium is the chief cation of the cellular fluid, the control of body fluid, the osmolarity and therefore body fluid volume is largely dependent on sodium to other ions (Srilakshmi, 2006).

The most frequently observed sodium deficiency occurs when excessive heat causes heavy perspiration, thus reducing body water and sodium to the extent that gross dehydration affects normal activity patterns. Symptoms may include feelings of weakness, apathy, and nausea as well as cramps in the muscles of the extremities. Taking additional salt in tablet form is a preventive measure, and persons may use increased amounts of table salt on their food to supplement sodium lost during dehydration and sweating (Challem, 1997). The recommended daily allowance of sodium for an average person to maintain healthy body function is between 500-2400mg(Nap.edu<http://www.nap.ed/openbook>).

1.9.5 Calcium

Calcium is the most abundant mineral in the body. The body of an adult normally contains about 1200g of calcium. A small quantity of calcium is always present in the blood stream, where among others; it helps prevent serious hemorrhages (Clifford, 1971).

The efficiency with which calcium is absorbed may be influenced by the body's need for calcium. During pregnancy, lactation and adolescence when calcium needs are greatest, absorption efficiency is as high as 50 percent. Also when calcium intakes are low, the body adapts, by absorbing a greater of the

dietary calcium available and excreting less (Srilakshmi, 2006). The recommended daily allowance of calcium for an average healthy person to maintain healthy body function is between 800-1300mg, as the case may be (Nap. edu <http://www.nap.ed/openbook>).

1.10 MICRO MINERALS OF INTEREST IN THE STUDY

1.10.1 Copper

Copper is essential to life and is the third largest amount of transition metal, after iron and zinc. Larger amounts of copper are, however, toxic. About 900ug-2mg of copper is required daily in the diet and its deficiency in animals result in the inability to use iron in the liver (Sharma, 2006). Hence animals suffer from anaemia and a drop in high density lipoprotein (HDL) or good cholesterol. Copper deficiency is uncommon in healthy people but people with Menke's syndrome are unable to absorb copper normally and it may become severely deficient. Deficiency can also occur in people taking zinc supplement as it interferes with copper absorption (Sharma, 2006).

Copper helps convert dietary iron into haemoglobin, which carries oxygen in the blood. It is also vital a part of the antioxidant enzymes superoxides dismutase. The synthesis of some hormones requires copper, as do collagen which holds muscle tissues together and make the skin appear soft and prosinase (the enzymes that put pigment into the skin) (Sharma, 2006). An inherited condition known as Wilson's disease can also result in an excess buildup of copper within the body. This disease has several symptoms including confusion, dementia, and difficulty in moving, phobias, speech inpairment, jaundice, tremors, vomiting blood, and weakness (Petersdorf et al., 1991).

1.10.2 Iron

The average quantity of iron in the human body is about 4.5g of which approximately 65 percent is in the form of hemoglobin, which transports

molecular oxygen from the lungs throughout the body; one in the various enzymes that control intracellular oxidation; and most of the rest stored in the body (liver, spleen, bone marrow) for future conversion to hemoglobin. Red meat, egg yolk, carrots, fruits, whole wheat and green vegetables contribute most of the 10-20 milligrams of iron required each day by the average adult. For the treatment of hypochromic anemias (caused by iron deficiency), any of a large number of organic or inorganic iron (usually ferrous compounds) are used (John, 2009). The level of iron recommended in human as RDA ranges between 14-18mg (Nap edu<http://www.nap.ed/openbook>). Too much iron can result in hemochromatosis in those genetically vulnerable to this condition, or other potentially dangerous iron overload conditions (Manoguerra *et al.*, 2005).

1.10.3 Zinc

Zinc is an essential trace element in the human body, where it is found in high concentration in the red blood cells as an essential part of the enzyme, carbonic anhydrase, which promotes many reactions relating to carbondioxide metabolism. Zinc is a component of some enzymes that digest protein in the gastrointestinal tract. Zinc functions in the hemosycotypsin of snails' blood to transport oxygen in a way analogous to iron in the haemoglobin of human blood (Sharma, 2006). The recommended daily allowance for an average healthy person to maintain healthy body function ranges between 10-15mg (Nap edu<http://www.nap.ed/openbook>). Zinc is important for good health. It helps maintain immune function, helps cells divide and repair and help metabolize carbohydrates for body to use for energy. Zinc is needed for sense of taste and smell (Bowler *et al.*, 2007). According to the National Institutes of Health, USA, zinc toxicity starts at between 35-40mg daily (Dobson *et al.*, 2004). Gastro intestinal and urinary complications are the most common side effects of zinc toxicity.

1.10.4 Manganese

Manganese (Mn) is a mineral that is found in several foods including nut, legumes, seeds, tea, whole grains, and leafy green vegetable. It is considered an essential nutrient, because the body requires it to function properly. Manganese is used for prevention and treatment of manganese deficiency, a condition in which the body doesn't have enough manganese. It is also used for weak bone (osteoporosis), a type of "tired blood" (anaemia), and symptoms of premenstrual syndrome (PMS) (Dobson, *et al.*, 2004). Manganese in high levels in food or water can cause changes in the brain which cause brain injury (Agency for Toxic Substance and Disease Registry United States Public Health Service, 1992) (Bowler *et al.*, 2007).

1.11 OTHER HEAVY METALS IN FOOD

Heavy metals are natural components of the earth's crust. They cannot be degraded or destroyed. To a small extent they enter our bodies via food, drinking water and air (<http://www.lenntech.com/heavymetals.htm>).

As trace elements, some heavy metals are essential to maintain the metabolism of the human body. However at higher concentrations, they can be toxic. Heavy metals are dangerous because they tend to bioaccumulate. Bioaccumulation means an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment (<http://www.lenntech.com/heavymetal.htm>).

1.11.1 Cadmium

Human uptake of cadmium takes place mainly through food. Foodstuffs that are rich in calcium can greatly increase the cadmium concentration in human bodies. Examples are liver, mushrooms, shellfish, mussels, cocoa powder and dried seaweed. An exposure to significantly higher cadmium

levels occur when people smoke. Tobacco smokes transport it through the rest of the body where it can increase effects by potentiating cadmium that is already present from cadmium – rich food. Cadmium is first transported to the liver through the blood. There, it is bonded to proteins to form complexes that are transported to the kidneys. Cadmium accumulates in kidney, where it damages filtering mechanisms. This causes the excretion of essential proteins and sugars from the body, further causing kidney damage. Other health effects that can be caused by cadmium are reproductive failure and possibly even infertility, damage to the central nervous system, damage to the immune system, possibly DNA damage or cancer development (Meulenbelt *et al.*, 2001).

1.11.2 Lead

Lead is one out of four metals that have the most damaging effects on human health. It can enter the human body through uptake of food (65%), water (20%) and air (15%). Foods such as fruits, vegetables, meats, grains, sea foods, soft drinks and wine may contain significant amounts of lead. Lead fulfils no essential functions in the human body, it can merely do harm after uptake from food, air or water. It can cause several unwanted effects such as disruption of the biosynthesis of haemoglobin and anaemia, a rise in blood pressure, kidney damage, miscarriages and subtle abortions, disruption of nervous systems, brain damage, decline in fertility of men through sperm damage, diminished learning abilities of children (Watts, 2009).

1.11.3 Arsenic

Humans may be exposed to arsenic through food, water and air. Exposure may also occur through skin contact with soil or water that contains arsenic. Levels of arsenic in food are fairly low, as it is not added due to its toxicity. But levels of arsenic in fish and sea food may be high, because fish absorb arsenic from the water they live in. Luckily this is mainly the fairly

harmless organic form of arsenic, but fish that contain significant amounts of inorganic arsenic may be a danger to human health. A very high exposure to inorganic arsenic can cause infertility and miscarriages with women, and it can cause skin disturbances, declined resistance to infections, heart disruptions, DNA damage and brain damages. Organic arsenic can cause neither cancer, nor DNA damage. But exposure to high doses may cause certain effects to human health, such as nerve injury and stomach aches (Ball, 1982).

1.11.4 Nickel

Nickel is found in several foods including nuts, dried beans and peas, soyabeans, grains. The body needs nickel but in very small amounts. Nickel is a common trace element in multiple vitamins. Nickel is used for increasing iron absorption thus preventing iron poor blood (anaemia), and treating weak bones (Ellenhorn, 1997). Nickel is an essential nutrient in some chemical processes in the body but its precise functions in the body are not known. Nickel toxicity is usually not a problem unless several grains are ingested from nondietary sources, or unless there is a natural tendency to retain too much nickel, which could lead to asthma, and other cardiac symptoms as a result of nickel interfering with vitamin E activity. However, nickel is quite toxic in its gaseous form of nickel carbonyl, and it has the potential to cause cancer of the sinuses, throat and lungs (Ellenhorn, 1997).

1.11.5 Mercury

Humans risk ingesting dangerous levels of mercury when they eat contaminated food especially fish, plant and water. Since mercury is odourless and accumulates in the muscles of fish and other foods, it is not easy to detect and cannot be avoided by trimming off the skin or other parts. Once in the human body, mercury acts as a neurotoxin, interfering with the brain and nervous system. Exposure to mercury can be particularly hazardous for pregnant

women and small children. Even in low doses, mercury may affect a child's development, delaying walking and talking, shortening attention span and causing learning disabilities. In adults, mercury poisoning can adversely affect fertility and blood pressure regulation and can cause memory loss, tremors, vision loss and numbness of fingers and toes. A growing body of evidence suggests that exposure to mercury may also lead to heart disease. Mercury is probably the most toxic non-radioactive metal in the environment. It is a poison!. It is highly toxic to humans and any amount is harmful to the cells and tissues of human beings (Sue, 2006). WHO, (2001) declared there is no safe level of mercury for human being, in other words, mercury is so poisonous that no amount of mercury absorption is safe.

1.11.6 Cobalt

Cobalt is a naturally occurring element that can be found in rocks, soil, water, plants and animals. It exists in non-radioactive and radioactive forms. Non-radioactive cobalt exists as a steel- gray, shiny metal and is used in producing alloys used for manufacturing. Radioactive cobalt is used in sterilizing medical equipment, irradiating food, treating cancer patients and for manufacturing plastics. Cobalt is beneficial for humans because it is part of vitamin B₁₂, which aids in the formation of normal red blood cells and maintains nerve tissue. Cobalt is therefore used in treating anemia in order to help produce red blood cells. Food sources of cobalt include green leafy vegetables, meat, liver, milk, oyster and clams. The total daily intake of cobalt is variable and may be as much as one milligram, but almost all will pass through the body unabsorbed except that in Vitamin B₁₂. The radioactive version of cobalt, cobalt-60 or cobalt -57, can cause cell damage by gamma rays which penetrate the body. Cobalt salts, cobalt metal powder and cobalt containing dusts can be breathed in which will cause damage to our respiratory

system. Breathing cobalt can cause asthma, pneumonia and inflammation of the nasopharynx and wheezing (Ellenhorn, 1997).

1.12 PHYTOCHEMICALS

Phytochemicals are sometimes referred to as phytonutrients and these terms are often used interchangeably. They could be said to be any chemical or nutrient derived from a plant source. However, in common usage they have a more limited definition. They are usually used to refer to compounds found in plants which are not required for normal functioning of the body but which nonetheless have a beneficial effect on health or an active role in the amelioration of disease. Thus, they differ from what are traditionally termed nutrients in that they are not a necessity for normal metabolism and their absence will not result in a deficiency disease; at least not on the timescale normally attributed to such phenomena.

A minority claims that many of the diseases afflicting the people of industrialized nations are the result of those people's lack of phytonutrients in their diets (Beecher, 2003). What is beyond dispute is that phytonutrients have many and various salubrious functions in the body. For example, they may promote the function of the immune system, act directly against bacteria or viruses, reduce inflammation, or are associated with the treatment and/or prevention of cancer, cardiovascular diseases or any other malady affecting the health or well-being of an individual (<http://chemistrydaily.com/chemistryfood>).

1.13 Antinutrients

Antinutrients are some phytochemicals which are natural or synthetic compounds that interfere with the absorption of nutrients (Beecher, 2003). Nutrition studies focus on those antinutrients commonly found in food sources and beverages. One common example is phytic acid, which forms insoluble

complexes with Ca, Zn, Fe and Cu (Cheryan and Rackis, 1980). Proteins can also be antinutrient such as the trypsin inhibitors and lecithins found in legumes (Gilani *et al*, 2005). These enzyme inhibitors interfere with digestion. Another particularly widespread form of antinutrients are the flavonoids which are a group of polyphenolic compounds that include tannins (Beecher, 2003).

These compounds chelate metals such as Fe and Zn and reduce the absorption of these nutrients; they also inhibit digestive enzymes and may also precipitate proteins. Polyphenols such as tannins have anticancer properties, so drinks such as green tea that contain large amounts of these compounds might be good for the health of some people despite their antinutrient properties (Chung *et al*, 1998). Antinutrients are found at some level in almost all foods for a variety of reasons. However, their levels are reduced in modern crops, probably as an outcome of the process of domestication (Hortz and Gibson, 2007).

Nevertheless, the large fraction of modern diet that comes from a few crops, particularly cereals, has raised concerns about the effects of the antinutrients in these crops on human health (Cordian, 1999).

The possibility now exists to eliminate antinutrients entirely using genetic engineering; but since these compounds may also have beneficial effects, such genetic modifications could make the foods more nutritious but not improve people's health (Welch and Graham, 2004).

1.14 ANTI-NUTRIENTS OF INTEREST IN THIS STUDY

1.14.1 Saponins

Saponins are steroid or triterpenoid glycosides, which are characterized by their bitter or astringent taste, foaming properties and their hemolytic effect on red blood cells (Khalil and Eladaway, 1994). They are widely distributed in the plant kingdom, being found in over 500 genera (Agarwal and Rastogi, 1974). Among plants grown for food, the presence of saponins in legumes such as soya and pea is particularly important. Saponins have been shown to possess

both beneficial (cholesterol lowering) and deleterious (cytotoxic permeability of the intestine) properties and to exhibit structure dependent biological activities (Price *et al.*, 1987; Oakenful and Sidhu, 1989).

When eaten, saponins are practically not poisonous to warm blooded animals, but they are dangerous when injected into the blood stream and quickly haemolyse red blood cells (Applebaum *et al.*, 1969). High saponin level has been associated with gastroenteritis manifested by diarrhea and dysentery (Awe and Sodipo, 2001). High levels of saponin in feed affect feed intake and growth rate in poultry (Sim, *et al.*; 1984; Potter, *et al.*; 1993; Dei, *et al.*, 2007). Reduction in feed intake has been ascribed to the bitter taste of saponins (Cheeke, 1971) and due to the irritating taste (Oleszek *et al.*, 1994). Saponin in excess also causes hypocholestromia because it binds cholesterol, making it unavailable for absorption (Soetan and Oyewole, 2009).

Saponin-protein complex formation can reduce protein digestibility (Potter *et al.*, 1993; Shimoyamada *et al.*, 1998).

1.14.2 Tannins

The name tannins was derived from their ability to tan leather and not based on a class of compound with a common basic structure (Finar, 2001).

Any plant polyphenolic substance with a molecular weight greater than about 500 can be considered to be tannins. The two distinctive groups are the hydrolysable tannins, which are esters of gallic acid and also glycosides of these ester so called because they may be readily hydrolyzed into a mixture of carbohydrate and phenols, and condensed tannins, which are complex flavonoid, polymers. Other nutritional effects which have been attributed to tannins include damage to the intestinal tract, toxicity of tannins absorbed from the gut, and interference with the absorption of iron, and possible carcinogenic effect (Osagie, 1998). Butler, (1989) has suggested that tannins play a major role in the plants defense against fungi and insects.

Tannins in fruits impose an astringent taste that affect palatability, reduce food intake and consequently body growth. It also binds to both exogenous and endogenous proteins including enzymes of the digestive tract, thereby affecting the utilization of protein (Bagepallis *et al.*; 1992; Aleto, 1993; Sotelo *et al.*, 1995). Tannin protein complexes are insoluble and the protein digestibility is decreased (Carnovale *et al.*, 1991).

Studies on rats, chicks and livestock revealed that high tannin in diet adversely affects digestibility of proteins and carbohydrates as well, thereby reducing growth, feeding efficiency, metabolizable energy and bioavailability of amino acids (Aletor, 1993; De-Brayne *et al.*; 1999; Dei *et al.*, 2007). Infact, dietary tannins are said to reduce feed efficiency and weight gain especially in chicks (Armstrong *et al.*, 1974; Dei *et al.*, 2007). From medicinal point of view, polyphenol to which tannin belongs has been reported to act as antioxidant by preventing oxidative stress that causes diseases such as coronary heart disease, some types of cancer and inflammation (Tapiero *et al.*, 2000).

1.14.3 Phytic Acid

Phytic acid, a hexaphosphate derivative of inositol is an important storage of phosphorus in plants (Fig. 1.1). It is insoluble and cannot be absorbed in the human intestines. Phytic acid has 12 replaceable hydrogen atoms with which it could form insoluble salts with metals such as calcium, iron, zinc, and magnesium. The formation of these insoluble salts renders the metals unavailable for absorption into the body (Bello *et al.*, 2008; Muhammed *et al.*, 2011). Studies by Nwokolo and Bagg (1977) have shown that in the chicken there is a significant inverse relationship between phytic acid and the availability of calcium, magnesium, phosphorus and zinc in feedstuffs like soya beans, kernel seed, rapeseed and metals. Phytates can also affect digestibility by chelating with calcium, binding with substrate or protocolytic enzyme.

Fisher and Bender (1970) reported that phytic acid was one of the substances which made iron insoluble and consequently poorly absorbed in the body.

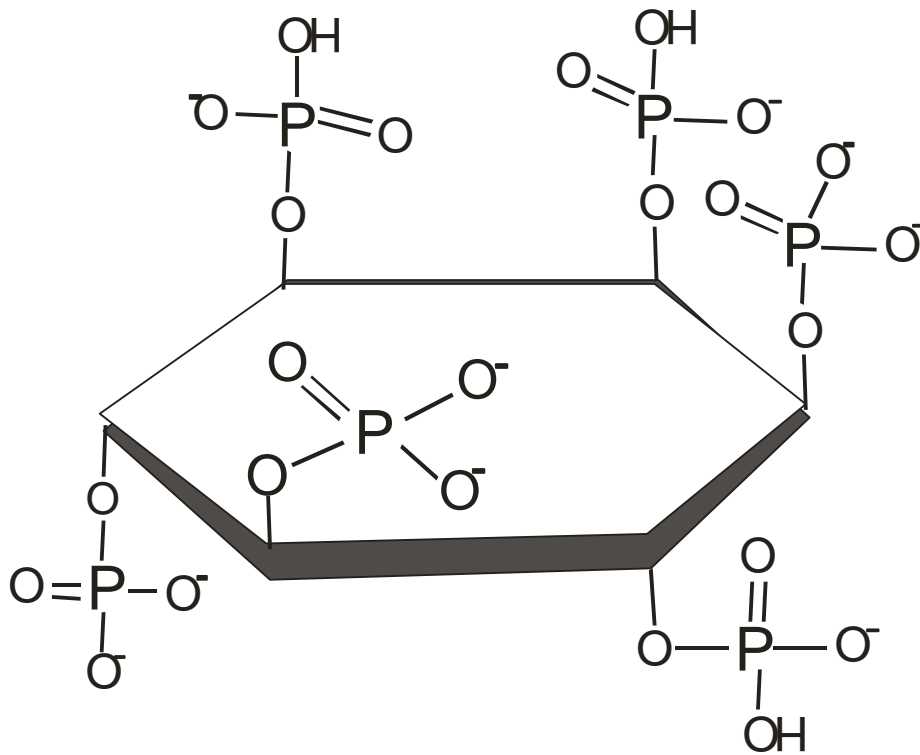


Figure 1.1: Phytate ion

According to Oke, (1969) a phytic diet of 1-6% over long period decreases the bioavailability of mineral elements in monogastric animal. Phytic acid also has a negative effect on amino acid digestibility thereby posing problems to non-ruminant animals due to insufficient amount of intrinsic factors phytase necessary to hydrolyse the phytic acid complexes (Makkar and Becker, 1998). Phytates are also associated with nutritional diseases such as rickets and osteomalacia in children and adult respectively (Akinyeye *et al.*, 2011).

1.14.4 Oxalates

Oxalates are salts or esters of oxalic acid, crystalline solids that are slightly soluble in water, strongly acidic and poisonous.

The importance of oxalic acid in limiting the utilization of dietary calcium was first realized in 1918 when McClugage and Mendel showed that dogs retained less calcium from spinach than carrots (Oke, 1969). Since these observations many studies have been made with laboratory animals and human subjects showing that dietary calcium is poorly utilized from oxalate rich foods (Davies, 1979). Also according to Ladeji *et al.*, (2004), oxalate can bind to calcium present in food thereby rendering calcium unavailable for normal physiological and biochemical roles such as the maintenance of strong bone, teeth, cofactor in enzymatic reaction, nerve impulse transmission and as clotting factor in the blood. The calcium oxalate which is insoluble may also precipitate around soft tissues such as the kidney, causing kidney stones which are associated with blockage of renal tubules (Oke, 1969; Blood and Radostti, 1989).

Oxalic acid (or its salts) is widely distributed in the plant kingdom, although its nutritional significance is limited to relatively few plants and forages. It is a dicarboxylic acid which forms an insoluble calcium salt with a molar stoichiometry. When this is formed in the intestine a fraction of dietary Ca is rendered unavailable for absorption. In view of this, the importance of the oxalate content of an individual plant product in limiting total dietary calcium

availability is of significance only when the ratio, oxalate: calcium is greater than 1. Since under these circumstances the oxalate has the potential to complex not only the calcium contained in the plant but also that derived from other food sources (Davies, 1979; Chai and Liebman, 2004).

1.14.5 Alkaloids

Alkaloids are a group of mildly alkaline compounds, mostly of plant origin and of moderate molecular complexity. Even in very small amounts, the alkaloids produce strong physiological effects on the body. They contain nitrogen atoms that are structurally related to those of ammonia (John, 1999). Nearly 3000 alkaloids have been recorded; the first to be prepared synthetically (1886) was one of the simplest, called coniine, or 2 propylpiperidine, $C_5H_{10}NC_3H_7$ (John, 1999). It is highly poisonous; less than 0.2g is fatal. Some 30 of the known alkaloids are used in medicine. For example, atropine, obtained from belladonna, causes dilation of the pupils; morphine is a painkiller; quinine is a remedy for malaria; nicotine is a potent insecticide; and reserpine is a valuable tranquilizer (John, 1999). Alkaloids are usually found in the seeds, roots, leaves, or bark of plants, and generally occur as salts of various plant acids, example acetic, oxalic, citric, maleic, tartaric acid etc. Although alkaloids are natural plant compounds having a basic character and containing at least one nitrogen atom in a heterocyclic ring, most alkaloids also contain oxygen.

1.15 NUTRITIONAL VALUES OF VEGETABLES, FRUITS AND SEEDS

Vegetables are known to be important sources of protective foods (Nnamani *et al.*, 2009; Sheela *et al.*, 2004). They have also been reported to be good sources of oil, carbohydrates, minerals as well as vitamins (Adenipekun and Oyetunji, 2010). The potassium content of most leafy vegetables is good in the control of diuretic and hypertension complications (George, 2003). George (2003) ascertained that the proteins in vegetables are superior to those in fruits

but inferior to those in grains. Vegetable fats and oils are known to lower blood lipids thereby reducing the occurrences of disease associated with damage of the coronary artery (Adenipekun and Oyetunji, 2010). Crude lipids in vegetables range from 4.20-4.80% (Ekpo, 2007). Protein contents of leafy vegetables range from 20.48-41.66% (Roger *et al.*, 2005), and according to Pearson (1976), plant food that provides more than 12% of their calorific values from protein are considered good source of protein.

Moisture contents of most leafy vegetables range from 78.78-81.77% (Abidemi *et al.*, 2009; Chimma and Igyor, 2007; FAO, 1990), while the ash content accepted for edible vegetables in Nigeria ranges from 1.5-2.0% (Abidemi *et al.*, 2007; Lucas, 1988).

Fruits are nature's gift to mankind. They are chief sources of vitamins, minerals and proteins. Their constituents are essential for normal physiological wellbeing and help in maintaining healthy state through development of resistance against pathogens (Bal, 1997). Many reports on some lesser known seed fruits indicate that they could be good sources of nutrient for both man and livestock (Elemo *et al.*, 2002; Adekunle and Ogerinde, 2004). Many fruits have been identified, but lack of data on their chemical compositions has limited the prospect of their utilization (Baumer, 1995). Moisture content typical of most fresh fruits at maturity is usually high, between 4.0g/100g-90.96g/100g (Umoh, 1998). Although some fruits/parts have relatively low moisture content, which are within the acceptable range for a good keeping period, the relatively low moisture content is an indication that some fruits will have high shelf life especially when properly packaged against external conditions (Eka, 1987).

Fruits and Seeds, especially seeds, have crude fat range between 0.78g/100g-40.0g/100g (Umoh, 1998). These lipids are essential because they provide the body with maximum energy; approximately twice that for an equal amount of protein or carbohydrate and facilitate intestinal absorption and transportation of fat-soluble vitamins A, D, E and K (Dreon *et al.*, 1990). Those

with high lipid contents are comparable with those of soybean oil, locust bean and cotton seed; 19.10g/100g, 20.30g/100g and 14.05g/100g, crude fat, respectively (Obioha, 1992). These can be commercially exploited and classified as oil seed (Ayodele *et al.*, 2000). Those with low lipid content are comparable to that of cereals like maize; 4.6g/100g and millet 4.0g/100g (Obioha, 1992). The crude protein range of most fruits and seeds is between 4.54g/100g and 34.09g/100g (Bello *et al.*, 2008). Proteins are essential components of the diet needed for survival of animal and humans; their basic function in nutrition is to supply adequate amounts of required amino acids (Pugalenthi *et al.*, 2004). Crude protein in melon seed is about 32.8g/100g (Achinewu, 1983); 21-34g/100g reported for cowpea (Adewusi and Falade, 1996). High fibre contents are desirable more in adult foods than in infant or pre-school nutrition (Eromosele and Eromosele, 1993). The content of crude fibre in most Nigerian fruits and seeds range between 1.23g/100g to 14.57g/100g (Bello *et al.*, 2008).

The ash contents of most commonly consumed fruits and seeds are within the range 1.63g/100g to 8.53g/100g (Oluyemi *et al.*, 2006) while the carbohydrate contents of most fruits and seeds are in the range 7.90g/100g to 71.94g/100g (Bello *et al.*, 2008).

1.16 NUTRITIONAL COMPOSITIONS OF ROOTS AND TUBERS

As with all crops, the nutritional composition of roots and tubers varies from place to place depending on the climate, the soil, the crop variety and other factors (Raspier and Coursey, 1967). The main nutrient supplied by roots and tubers is dietary energy provided by carbohydrates. The protein content is low (one to two percent) and in almost all root crop proteins, as in legume proteins, sulphur-containing amino-acids are the limiting amino acid (WHO, 1985; FAO, 1970). Cassava, sweet potato and yam contain some vitamin C and yellow varieties of sweet potato, yam and cassava contain beta-carotene or provitamin

A. Roots and tubers are deficient in most vitamins and minerals but contain significant amounts of dietary fiber. The physical properties of starch grains influence the digestibility and processing qualities of root crops. The starch granules of some varieties of cocoyam are very small, about one tenth those of potato, which improves the starch digestibility, making these varieties more suitable for the diets of infants and invalids. (Raspier and Coursey, 1967). In addition to starch and sugar, root crops also contain some non-starch polysaccharides including cellulose, pectins and hemicelluloses as well as other associated structural proteins and lignins, which are collectively referred to as dietary fibre. The role of dietary fibre in nutrition has aroused a lot of interest in recent years. Some epidemiological evidence suggests that increased fibre consumption may contribute to a reduction in the incidence of certain diseases, including diabetes, coronary heart disease, colon cancer, and various digestive disorders. The fibre appears to act as a molecular sieve, trapping carcinogens which would otherwise have been recirculated into the body. It also absorbs water, thus producing soft and bulky stools. Sweet potatoes is a significant source of dietary fiber as its pectin content can be as high as 5 percent of fresh weight or 20 percent of the dry matter at largest (Collins and Walter, 1982).

The protein content and quality of roots and tubers are variable; that of yam and potato is highest being approximately 2.1 percent on a fresh weight basis. The protein contribution of these foods to the diet in developing countries, corrected by the amino-acid protein quality is, on a worldwide average only 2.7 percent provided mainly by potato and sweet potatoes. However these starch staples do provide a much greater proportion of the protein intake in Africa (FAO, 1987) ranging from 5.9 percent in East and Southern Africa to a maximum of 15.9 percent in humid West Africa, supplied mainly by yam and cassava. In order to maximize their protein contribution to diet, roots and tubers should be supplemented with a wide variety of other foods, including cereals.

To some extent, the protein content of root crops is influenced by variety, cultivation practice, climate, growing season and location (Woolfe, 1987). In potato, the addition of nitrogen fertilizer increases the protein content (Eppendorfer *et al.*, 1979; Hoff *et al.*, 1971) while in the case of sweet potato the protein content could vary from 2.0 to 7.5 percent depending on the cultivar and treatment.

Cassava protein is lower in total essential amino-acids than the other root crops but recently Adewusi *et al.*, (1988) found the cassava flour used as a component in animal feeding trials was a more effective replacement for wheat than either sorghum or maize. The content of protein in yam varies between 1.3 and 3.3 percent (Francis *et al.*, 1975) but based on the quantity consumed by an adult in West Africa, about 0.5 to 1kg/day, it can contribute about six percent of the daily protein intake (FAO, 1987). Food containing about 5 percent of total energy provided by utilizable, balanced protein can sustain health if it can be eaten in sufficient quantities to meet energy requirement (Abrahamson, 1978). All root crops exhibit very low lipid content. These are mainly structural lipids of the cell membrane which enhance cellular integrity, offer resistance to bruising and help to reduce enzymic browning (Mindy and Mueller, 1977) and have limited nutritional importance. The content ranges from 0.12 percent in banana to about 2.7 percent in sweet potato. The lipid may probably contribute to the palatability of the root crops. Potassium is the major mineral in most root crops while sodium tends to be low. This makes some root crops particularly valuable in the diet of patients with high blood pressure, who have to restrict their sodium intake. In such cases the high potassium to sodium ratio may be an additional benefit (Meneely and Battarblee, 1976). However, high potassium foods are usually omitted in diet of people with renal failure (McLay *et al.*, 1975).

As root crops are low in phytic acid relative to cereals, those minerals liable to inactivation by dietary phytic acid are more available than in cereals.

This is especially important for iron, which has been found to be 100 percent available in banana (Marriot and Lancaste, 1983). In addition, the high vitamin concentration in some root crops may help to render soluble the iron and make it more available than in cereals and other vegetable foods. In the United Kingdom, the iron supply from potato ranks third of all individual food sources, accounting for up to seven percent of the total household dietary iron intake. True *et al.*, (1978) found that 150g of potatoes will supply 2.3 to 19.3 percent of the dietary requirement for iron recommended by Food and Nutrition Board of the National Research Council of America. There is some doubt about the availability of calcium and phosphorus in cocoyam owing to the oxalate content. Over 96 percent of zinc in potato is available due to low levels of phytate. Yam can supply a substantial portion of manganese and phosphorous requirement of adults and to a lesser extent the copper and magnesium (Villareal, 1970). The high content of calcium oxalate crystals, about 780mg per 100g in some species of cocoyam, *Colocasia* and *Xanthosoma*, has been implicated in the acidity or irritation caused by cocoyam. Oxalate also tends to precipitate calcium and makes it unavailable for use by the body. Oke, (1967) has given an extensive review of the role of oxalate in nutrition, including the possibility of oxalurea and kidney stones. The acidity of high oxalate cultivars of cocoyam can be reduced by peeling, grating, soaking and fermenting during processing. The edible, mature, cultivated yam does not contain any toxic principles. However, bitter principles tend to accumulate in immature tuber tissues of *Dioscorea rotundata* and *D. cayenensis*. They may be polyphenols or tannin-like compounds (Coursey, 1983). Wild forms of *D. dumetorum* do contain bitter principle, and hence are referred to as bitter yam. Bitter yams are not normally eaten except at times of food scarcity. They are usually detoxified by soaking in a vessel of salt water in cold or hot fresh water or in a stream. The bitter principle has been identified as the alkaloid, dihydrodioscorine, while that of the Malayan species, *D. hispida*, is dioscorine (Bevan and Hirst, 1958). There

are water soluble alkaloids which on ingestion produce severe and distressing symptom (Coursey, 1967).

1.17 NUTRITIONAL VALUES OF MEAT

Meats such as poultry, pork, beef and fish contain essential nutrients such as protein and iron. People who do not eat meat can still get these nutrients from other food sources, but must eat a combination of plant-based foods in order to get the same nutrients found in one serving of meat. A serving size for most types of meat and fish is about 84.9g or roughly the size of a deck of playing cards (Layne, 2011).

Meat and fish are complete sources of protein, containing the nine amino acids that the body requires but cannot make for itself. Protein serves several important functions in the body, including tissue growth and repair. Meat and fish also contain heme iron, which is more useful to the body than non-heme iron, the type of iron found in plant-based foods (Layne, 2011). Iron is essential for healthy muscle growth and blood oxygenation. The Recommended Dietary Allowance (RDA) for iron is about 8mg per day for men, 18mg for women and 10mg for children (Layne, 2011). Depending on the type and cut, meats can be high in fat and cholesterol. The University of Kentucky Cooperative Extension Service recommends that only about 30 percent of daily calories should come from fat and that people should not consume more than 200mg of cholesterol per day (Layne, 2011). According to the vegetarian resource group, only about 10 percent of daily calories should be from protein sources. Over consumption of protein may contribute to kidney disease. A 3oz (84.9g) serving of beef sirloin contains about 170 calories, 22g of protein, 1.5mg of iron, 7g of fat and 76mg of cholesterol (Layne, 2011). Turkey is the highest-protein poultry with about 23g per 30z serving (84.9g), followed by duck with 20g and chicken with 18g. Poultry is leaner than most cuts of beef and pork, but also contains less iron. The National Institute of Health's Medline Plus Program, USA 2011,

recommends fish as a lean protein alternative to red meat. For example, a serving of pink salmon contains only about 127 calories, 4g of fat and 57mg of cholesterol. Most types of fish contain about 20 to 25g of protein and 0.33mg of iron per serving. Fish also contains omega-3 fatty acids, which support brain and neural development (Layne, 2011).

1.18 NUTRITIONAL VALUES OF NUTS AND KOLA NUTS

Nuts are very likely nature's perfect, bite-sized, convenient, power snack. They have many unique and healthy benefits and taste oh-so-good. High in protein, fiber, antioxidants and monounsaturated fat. Monounsaturated fats protect from chronic heart disease and help to keep the belly flat. The protein in nuts helps you feel full longer, which results in you eating less. Recent studies have shown that consuming one ounce of nuts daily reduces the risk of developing diabetes.

The FDA (2010) recommends a daily serving of 28.3g of nuts. The common nuts around us include; cashew nuts; a one ounce(28.3g) serving is about 18nuts with 4g protein, 160 calories and 8g monounsaturated fat. Cashews are rich in selenium, magnesium, phosphorus and iron.

Groundnuts; not actually a nut, but a legume, though often thought of as a nut. A one ounce serving (28.3g), is about 28nuts with 7g protein, 170 calories and 7g monounsaturated fat, with total fat of 14g (2g saturated, 4 unsaturated). Peanuts are a good source of vitamin B3; promoting healthy skin, vitamins and zinc; renewing tissue, potassium (muscle) and vitamin B6 (immunity) (FDA, 2010). Nuts also are recommended as part of the DASH diet (Dietary Approaches to Stop Hypertension), a dietary plan clinically proven to significantly reduce blood pressure. The DASH diet is supported by the National Heart, Lung, and Blood Institute USA and recommends 4 to5 serving per week from its "nuts, seeds and legumes" grouping(Jayeola,2001).

Women in Harvard School of Public Study who reported eating 5 times 28.3g (1 ounce) of nuts/peanuts per week reduced their risk of Type 2 Diabetes by almost 30 percent compared to those who rarely or never ate nuts. Women in the study who ate five table spoons of peanut butter each week reduced their risk for Type 2 Diabetes almost 20 percent (Blades, 2000.).

Researchers at Brigham and Women's Hospital and the Harvard school of Public Health found three times as many people trying to lose weight were able to stick to a Mediterranean-style moderate-fat weight loss diet that included nuts, peanuts and peanut butter versus the traditionally recommended low fat diet (Blades, 2000). Nuts are cholesterol free and unless salt is added to nuts, they naturally contain, at most, just a trace of sodium (Blades, 2000). Colanut and bitter kola are traditional plants which are often eaten as snacks especially among the elderly in Nigeria. Kolanut belong to the plant family sterculiaceae, having about 125 species of trees native of the tropical rain forest of Africa (Leakey, 2001).

Kola nuts contain large amounts of caffeine and theobromine and are therefore used as a stimulant (Attfield, 1863). They produce a strong state of euphoria and wellbeing, enhance alertness and physical energy, elevate mood, increase tactile sensitivity, suppress appetite and hunger and are used as an aphrodisiac. The caffeine in the nuts also acts as a bronchodilator, expanding the bronchial air passages; hence kolanuts are often used to treat whooping cough and asthma (Blades, 2000). Bitter kola (*Garcinia cola*) is also known as African wonder nut, these nuts were chewed as a masticatory substance, to stimulate the flow of saliva (Leakey, 2001) but are now widely consumed as snack in West and Central Africa.

Bitter cola is also rich in caffeine and theobromine and is also believed to be an aphrodisiac. Unlike other kola nuts however, bitter kola is believed to clean the digestive system, without side effects such as abdominal problems, even when a lot of nuts are eaten (Onochie and Stanfield, 1960). In folk medicine, bitter kola

is dried, ground and mixed with honey to make a traditional cough mixture. They have been found to be rich in minerals like potassium, calcium, magnesium, iron, phosphorus and even zinc and also contain fiber, carbohydrate, very little protein (Odebunmi et al., 2008).

Raw coconut is a rich source of carbohydrate, dietary fibre, fat, protein and minerals. One cup of raw coconut contains 282.9 calories, 12g of total carbohydrate and 7g of dietary fibre. Fat accounts for 224 of these calories, while carbohydrate account for 49.7 and protein for the remaining 9.2 of the calories. Based on a 2000 calories-a-day diet, these measurements represent 4 percent for dietary fibre. The total fat content is 26.8g which represent a large 41 percent of the recommended daily value. Of these 26.8g of fat, 23.8g are from saturated fat and the remainder is from healthy, unsaturated fats. Coconut contains little vitamins. Raw coconut is also a rich source of manganese, selenium, copper, potassium, magnesium, and iron. The fibre in coconut is good for those suffering from constipation, the organic iodine content of coconut helps in preventing simple goiter and researches have suggested that coconut helps in reducing the viral load of HIV (Lifestyle.ilovindia.com/lounge/benefits-of-coconut-1718). The major nutritional disadvantage of coconut flesh is its high saturated fat content, mostly found in animal-derived foodstuffs. Saturated fat can raise the cholesterol level, increase risk of cardiovascular disease and high consumption of saturated fat can also increase the risk of developing Type 11 Diabetes

(Lifestyle.ilovindia.com/lounge/benefits-of-coconut-1718).

1.19 NUTRITIONAL VALUES OF CEREALS AND LEGUMES

Humans have been enjoying grain foods for at least the past 10,000 years. Grain foods, which include cereals, are dietary staples for many cultures around the world. Current research around the world is discovering many and varied health benefits that whole grain cereal foods can offer, particularly in reducing

the risk of diseases such as coronary heart disease, cancer and diabetes (Jacob and Meyer, 1998). Whole grains include whole meal or whole grain breads or crisp breads, dark 'seedy' breads, whole grain break-fast cereals, wheat germ, brown rice, puffed whole grains, bulgur, popcorn and oatmeal. Refined cereals include sweet rolls, cake, deserts, white bread, pasta, muffins, sweet or savoury biscuits, refined grain breakfast cereals, white rice, pancakes, waffles and pizza (Jacob, 1988). Whole grain cereals provide a rich source of many essential vitamins, minerals and phytochemicals, carbohydrates, protein, high fibre (both soluble and insoluble) and resistant starch.

Legumes are the plants in which the seeds grow in pods. When a pod splits into two halves, the seeds are attached to one of the valves. For example, peas, beans, lentils, lupins, even peanuts are common grain legumes. The seeds of the grain legumes are known as pulses.

Beans contain carbohydrates and they are high in foliate, phosphorus, potassium, zinc, calcium and selenium. Soybeans and other beans are packed with saponins which is an anti-inflammatory compound helping the immune system to protect you against cancer. Saponins lower the cholesterol level. This factor is responsible for the high nutritional value of legumes (Jacob, 1988).

Corn or maize is one of the most popular cereals in the world. It forms the staple food of numerous peoples in different countries.

Corn is rich in phosphorous, magnesium, manganese, zinc, copper, iron and selenium. It also has small amounts of potassium. It has traces of vitamins A and E but more of vitamin B, B6, niacin, riboflavin and foliate.

The calorific value of most cereals lies between 330 and 350 calories per 100g, the calorific value of corn being 342 calories per 100g (Jacob and Meyer, 1998). There are a number of health benefits of corn, apart from the fact that it provides necessary calories for daily metabolism of the body and maintaining low cholesterol and prevention of neural-tube defects at birth, its high fibre content ensures that it plays a role in prevention of digestive ailments like

constipation and hemorrhoids as well as colorectal cancer. The antioxidants present in corn also act as anti-cancers and prevent Alzheimer's disease (Seneff et al., 2011).

Rice is a good source of phosphorous and iron (Jacob, 1998). It also contains some amounts of calcium. Most of the nutrients and minerals in rice are concentrated in the outer brown layers known as husk and germs. Hence brown rice, which is rice from which only husk has been removed, is the most nutritious type of rice. Unfortunately, many consumers prefer pseudo cosmetic preferences and demand white rice or polished rice, in which the germ and bran have been removed. Rice contains vitamin B in small quantities. There is no other food item that provides energy to the world as provided by rice. It is not wrong to say that most of the people in the world are able to do their daily activities due to rice. Rice has about 345 calories per 100g. Further, it is very easy to digest rice and hence most of these calories are absorbed by the body. Health benefits of rice include providing fast and instant energy, good bowel movement, stabilizing blood sugar levels and providing essential source of vitamin B1 to human body (Jacob, 1988).

Carbohydrate content in most cereals and legumes are within the range of 14-70%, protein with 5-50 percent, fat between 1 to 30 percent, crude fiber between 1 to 6 percent, and moisture between 5 to 20 percent (Ruales, 1992; Chauhan et al, 1992; Gopalan et al, 1985; Sanchez-marquin, 1983).

The ground, powdered soy-bean products are excellent and provide a flour substitute for cooking and cakes but overcooking of the beans may destroy saponins.

- Legumes have relatively low quantities of the essential amino acid, methionine.

They are high in essential amino acid lysine but grains are low in lysine and high in methionine. Hence a combination of grains and legumes is

the best combination of balanced diet for example, tofu with rice, beans with corn tortillas, wheat bread and peanut butter.

Legumes are low in sugar and high in protein. Soybeans, garbanzo beans etc contain the flavonoids, which work as the female hormone estrogen, providing women, some relief from menopause symptoms, such as hot flashes.

- Beans contain a sugar called oligosaccharide which our digestion can't break down. So, they cause intestinal gas or flatulence. Cooking beans with a pinch of asafetida can prevent flatulence.
- Legumes have significant amounts of fiber to prevent constipation and help improve digestive health and as well do not contain cholesterol, thus, they prevent heart diseases.
- Most legumes contain small purines, compounds that may be harmful to individuals who are prone to gout or kidney stones. Purines can be a problem because they break down into uric acid, the substance that collects to become kidney stones and creates crystals in the joints of people with gout (Jacob, 1988; Jacob and Meyer, 1998).

1.20 PALM OIL

Palm oil is derived from the flesh of the fruit of oil palm species *E. guineensis*. In its virgin form, the oil is bright orange-red due to the high content of carotene. It also resists oxidation and high heat levels, making it popular for use in frying foods. Since it is approximately 50 percent saturated, it remains semisolid at room temperature. According to the American Palm Oil Council, its supplements can serve as powerful antioxidants that are able to help rid your body of harmful free radicals in the bloodstream. These free radicals, essentially harmful chemicals, can lead to an increased risk of developing heart disease and other cardiac conditions (www.nutritionfacts.com/---/nutritionfacts-palmoil.htm).

Vegetable oils provide a number of nutrients the body needs including essential fats and vitamins. Most vegetable oils contain primarily polyunsaturated and monounsaturated fats. It is usually a combination of refined canola, corn, cottonseed, soyabean, sesame, sunflower etc or any of the oil alone. Infact, there are many types of vegetable oils of which palm oil is inclusive (Cock and Rede, 1986).

1.21 PROXIMATE COMPOSITIONS OF FOOD

Amoo, (2004) (Personal communication) has defined proximate analysis as the routine analysis of food which involves determination of moisture content, ash content, crude protein, fat content, crude fibre and carbohydrate by difference.

Moisture content is one of the most commonly measured properties of food materials. It is important to food scientists for a number of different reasons.

- a. Legal and labeling requirement; there are legal limits to the maximum or minimum amount of water that must be present in certain types of food.
- b. Economic. The cost of many foods depends on the amount of water they contain. Water is an inexpensive ingredient, and the manufacturers often try to incorporate as much as possible in a food, without exceeding some maximum legal requirement.
- c. Microbial stability, the propensity of microorganisms to grow in foods depends on their water content. For this reason many foods are dried below some critical moisture content.
- d. Food quality, the texture, taste, appearance and stability of foods depend on the amount of water they contain.
- e. Food processing operations, a knowledge of the moisture content is often necessary to predict the behaviour of foods during processing, example mixing, drying, flow through a pipe or packaging.

It is therefore important for food scientists to be able to reliably measure moisture contents. A number of analytical techniques have been developed for this purpose, which vary in their accuracy, cost, speed, sensitivity, specificity, ease of operation, etc. The choice of an analytical procedure for a particular application depends on the nature of the food being analysed and the reason the information is needed (Pearson, 1976).

1.21.1 Properties of Water in Food

A water molecule consists of an oxygen atom covalently bound to two hydrogen atoms (H₂O). Each of the hydrogen atoms has a small positive charge (δ⁺), while the oxygen atom has two lone pairs of electrons that each has a small negative charge (δ⁻). Consequently, water molecules are capable of forming relatively strong hydrogen bonds with four neighbouring water molecules. The strength and directionality of these hydrogen bonds are the origin of many of the unique physicochemical properties of water. The development of analytical technique to determine moisture contents in foods depends on being able to distinguish water from the other components in the food. Characteristics of water that are most commonly used to achieve this: its relatively low boiling point; its high polarity; its ability to undergo unique chemical reactions with certain reagents; its characteristic physical properties (density, compressibility, electrical conductivity and refractive index) (Pearson, 1976). Despite having the same chemical formula, the water molecules in a food may be present in a variety of different molecular environments depending on their interaction with the surrounding molecules. The water molecules in these environments normally have different physicochemical properties.

Bulk water is free from any other constituents, so that each water molecule is surrounded only by other molecules. It therefore has physicochemical properties that are the same as those of pure water; example, melting point, boiling point, density, compressibility, heat of vaporization,

electromagnetic absorption spectra. Capillary or trapped water; capillary water is held in narrow channels between certain food components because of capillary forces. Trapped water is held within spaces within a food that is surrounded by a physical barrier that prevents the water molecules from easily escaping e.g., an emulsion droplet or a biological cell. The majority of these types of water is involved in normal water–water bonding and so it has physicochemical properties similar to that of bulk water. Physically bound water; a significant fraction of the water molecules in many foods are not completely surrounded by other water molecules, but are in molecular contact with other food constituents, are often significantly different from normal water–water bonds and so this type of water has different physicochemical properties than bulk water e.g. melting point, boiling point, density, compressibility, heat of vaporization, electromagnetic absorption spectra.

In chemically bound water, some of the water molecules present in a food may be chemically bonded to other molecules as water of crystallization or as hydrates, e.g. $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$. These bonds are stronger than the normal water–water bond and therefore chemically bound water has very different physicochemical properties to bulk water, e.g.; lower melting point, high boiling point, higher density, lower compressibility, higher heat of vaporization, different electromagnetic absorption spectra.

Foods are heterogeneous materials that contain different proportions of chemically bound, physically bound, capillary trapped or bulk water. In addition, foods may contain water that is present in different physical states: gas, liquid or solid. The fact that water molecules can exist in a number of different molecular environments, with different physicochemical properties, can be problematic for the food analyst trying to accurately determine the moisture content of foods. Many analytical procedures developed to measure moisture content are more sensitive to water in certain types of molecular environments. This means that the measured value of the moisture content of a

particular food may depend on the experimental technique used to carry out the measurement (Pearson, 1976).

1.21.2 Ash Content

The ash content is a measure of the total amount of minerals present within a food, whereas the mineral content is a measure of the amount of specific inorganic components present within a food, such as Ca, Na, K and Cl. Determination of the ash and mineral contents of foods is important for a number of reasons;

- a. Nutritional Labeling: The concentration and type of mineral present must often be stipulated on the label of a food.
- b. Quality: The quality of many foods depends on the concentration and type of minerals they contain, including their taste, appearance, texture and stability.
- c. Microbiological stability: High mineral contents are sometimes used to retard growth of certain micro organisms.
- d. Nutrition: Some minerals are essential to a healthy diet example, calcium, phosphorus, potassium and sodium whereas others can be toxic, example lead, mercury, cadmium and aluminum.
- e. Processing: It is often important to know the mineral content of foods during processing because this affects the physicochemical properties of foods(Pearson *et al.*, 1981).

Ash is the inorganic residue remaining after water and organic matter have been removed by heating in the presence of oxidizing agents, which provides a measure of the total amount of minerals within a food. Analytical techniques for providing information about the total mineral content are based on the fact that the minerals can be distinguished from all the other components within a food in some measurable way. The most widely used methods are

based on the fact that minerals are not destroyed by heating, and that they have a low volatility compared to other food components. The three main types of analytical procedures used to determine the ash content of foods are based on this principle; dry ashing, wet ashing and low temperature plasma dry ashing. The method chosen for a particular analysis depends on the reason for carrying out the analysis, the type of food analysis and the equipment available. Ashing may also be used as the first step in preparing samples for analysis of specific minerals, by atomic spectroscopy or other various traditional methods (Pearson et al., 1981).

1.21.3 Crude Fibre

Amoo (2004) has defined crude fibre of foods as the washed, dried, organic residue that remains after boiling the defatted food material successively with dilute tetraoxosulphate (vi) acid and dilute sodium hydroxide solutions. Often there is much confusion about the difference between dietary fiber (soluble fiber) and crude fiber, or what is now referred to as insoluble fiber. Most crude fiber contains one-seventh to one – half dietary fiber. Crude fiber contains lignin, which is found in the tissues of plants and cellulose basically a plant's skeleton. Crude fiber is needed in our food. They are expelled by the body and aids in maintaining regular intestinal peristalsis (bowel movements) (Pampalene-Roger, 2005).

1.21.4 Fat Content

Lipids are usually defined as those components that are soluble in organic solvents (such as ether, hexane or chloroform), but are insoluble in water. This group of substances includes triacylglycerols, diacylglycerols, monoacylglycerols, free fatty acids, phospholipids, sterols, carotenoids and

vitamins A and D (John, 2009). The lipid fraction of a fatty food therefore contains a complex mixture of different types of molecules. Even so, triacylglycerols are the major component of most foods, typically making up more than 95 to 99% of the total lipids present. Triacylglycerols are esters of three fatty acids and a glycerol molecule. The fatty acids normally found in foods vary in chain length, degree of unsaturation and position on the glycerol molecule. Consequently, the triacylglycerol fraction itself consists of a complex mixture of different types of molecules. Each type of fat has a different profile of lipid present which determines the precise nature of its nutritional and physicochemical properties (John, 2009). The term fat, oil and lipid are often used interchangeably by food scientists although sometimes the term fat is used to describe those lipids that are solid at the specified temperature, whereas the term oil is used to describe those lipids that are liquid at the specified temperature (Pampalene-Roger, 2005). It is important to be able to accurately determine the total fat content of food for a number of reasons:

- a. Economic; not to give away expensive ingredients.
- b. Legal; to conform to standards of identity and nutritional labeling laws
- c. Health; development of low fat foods
- d. Quality
- e. Processing

The principal physicochemical characteristics of lipids used to distinguish them from the other component of foods are their solubility in organic solvents,

and the analytical techniques based on these principles are solvent extraction (John, 1999). The fact that lipids are soluble in organic solvents but insoluble in water provides the food analyst with a convenient method of separating the lipid components in foods from water soluble components, such as proteins, carbohydrates and minerals. In fact, solvent extraction techniques are one of the most commonly used methods of isolating lipids from foods and of determining the total lipid content of foods (John, 1999).

1.21.5 Total Protein

In Kjeldahl method, a food is digested with a strong acid so that it releases nitrogen which can be determined by a suitable titration technique. The amount of protein present is then calculated from the nitrogen concentration of the food. It is usually considered to be the standard method of determining protein concentration. Because the Kjeldahl method does not measure the protein content directly, a conversion factor (f) is needed to convert the measured nitrogen concentration to a protein concentration. A conversion factor of 6.25 (equivalent to 0.16g nitrogen per gram of protein) is used for many applications, however, this is only an average value, and each protein has a different conversion factor depending on its amino-acid composition. The Kjeldahl method can conveniently be divided into three steps; digestion, neutralization and titration (Arogundade et al., 2004).

1.21.6 Total Carbohydrate

The carbohydrate consists of sugars (monosaccharides and oligosaccharides) and polysaccharides (starch and the non-starch polysaccharides); pectin, soluble and insoluble dietary fibre, example cellulose

and hemicellulose. Total Starch (TS) is sub-divided into Digestible Starch (DS), Resistant Starch (RS) and Dietary Fibre (DF) (Coultate, 2002).

1.21.7 Carbohydrate Content By Difference In Proximate Analysis

In a 1990 Report, total carbohydrate was calculated as the residue by difference from the total of fat, protein, moisture/solids, ash and fibre value. A review of collaborative studies of these parameters was made to determine the likely precision of the process. The procedure was judged as having poor precision among laboratories and high variability (Horwitz et al, 1990).

Even so, the “by difference” method was used in 2002 for the proximate analysis of Nigerian oil seed (Onyeike and Acheru, 2002), and Menzes et al., (2004) averred that most composition databases contain total carbohydrate data calculated by the “difference” method.

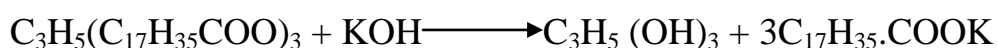
1.22 PHYSICOCHEMICAL PROPERTIES OF OIL

1.22.1 Acid Value

Acid value indicates the proportion of free fatty acid in the oil or fat and may be defined as the number of milligrams of caustic potash required to neutralize the acid in one gram of the sample (Sharma, 2006). Some of the deterioration that occurs during storage of either the raw material from which the fat or oil is produced, or in the fat itself after extraction, leads to hydrolysis of triglycerides to yield free fatty acid (Asiedu, 1989). The amount of free fatty acid present therefore gives an indication of the age and quality of the fat.

1.22.2 Saponification Value

The saponification value of an oil or fat is defined as the number of grammes of potassium hydroxide required to neutralize the fatty acids resulting from complete hydrolysis of 1 gramme of sample (Pearson, 1976).



The esters of the fatty acids of low molecular weight require the most alkali for saponification, so that the saponification value is inversely proportional to the mean of the molecular weights of the fatty acids in the glycerides present. As many oils have somewhat similar values, the saponification value is not, in general as useful for identification purposes as the iodine value (Pearson et al., 1991)

1.22.3 Peroxide Value

The peroxide value is usually used as an indicator of deterioration of fats and oils. As oxidation takes place, the double bonds in the unsaturated fatty acids are attacked, forming peroxides. These decompose to produce secondary oxidation products which cause rancidity. The peroxide value is not a measure of oxidation since the compounds formed are unstable and oxidation proceeds further. However, it may be used to estimate oxidation (Asiedu, 1989).

1.22.4 Free Fatty Acid

As the name suggests, free fatty acids are the unattached fatty acids present in a fat. Some unrefined oil may contain as much as several percent fatty acids. The levels of free fatty acids are reduced in the refining process. Fully refined fats and oils usually have a free fatty acid content of less than 0.1%. Oils and fats contain more or less fatty acids according to the conditions of manufacture, age, and storage. The glycerides are hydrolysed to a small degree by enzymes, air, and possibly bacteria. The increase in free fatty acid is generally accompanied by a rancid odour, although the odour itself is not due to acidity (Asiedu, 1989).

1.22.5 Iodine Value

The iodine value of an oil or fat is defined as the weight of iodine absorbed by 100 parts of weight of the sample. The glycerides of the unsaturated fatty acid present (particularly of oleic acid series) unite with a definite amount of

halogen. The iodine value is therefore a measure of the degree of unsaturation. It is constant for a particular oil or fat, but the exact figure obtained depends on the particular techniques employed. The iodine value is often the useful and easily determined figure for identifying oil or at least placing it into a particular group. It should also be noted that for natural oils and fats the less unsaturated fat with low iodine value are solid at room temperature, or conversely, oils that are more highly unsaturated are liquids (showing there is a relationship between the melting points and iodine value) (Pearson et al., 1991).

CHAPTER TWO

2.0 MATERIALS AND METHODS

2.1 Materials

Food stuffs which include:

1. Vegetables: pumpkin (ugu), African rose wood (oha), bitter leaf (onugbu), green amaranth (inine oyibo), bushmallow (arira), garden egg leaf (akwukwo anara).
2. Fruits: soursop (chowanchop), orange (oroma), starapple (udala), mango (mangolo), wildmango (ugili), tamarind (icheleku).
3. Cereals: rice (osikapa), white and yellow corn (oka).
4. Roots/tubers: water yam (ji abana), sweet yam (iyoh), yellow yam (ogbagada), cassava (akpu), garri (gari), red and white potato (nduku) and cocoyam (ede).
5. Oil: red oil (mmanu nri), groundnut oil (mmanu opapa).
6. Meat: goat meat (anu ewu), beef (anu efi), chicken (anu okuku) and turkey (anu tolotolo).
7. Fish: cod (okporoko), catfish (alila) and horse fish (hosu).
8. Legumes/pulses: white and brown beans (agwa), chickpeas (okpa), soyabeans and breadfruit (ukwa).
9. Seeds: ducanut seed (ogbono) and melon seed (egwusi).
10. Nuts: groundnut (opapa), kolanut (oji), bitter cola (agbi inu) and coconut (aki oyibo).

2.2 APPARATUS

Magnetic stirrer, Whatman filter paper, centrifuge, volumetric flask, pipette, clinical flask, test-tubes, hot plate, manual grinder/blender, micro Kjeldahl apparatus, Adam AFP – 800L – top loading weighing balance, temperature regulated oven, Edwards high vacuum pump, soxhlet extractor,

muffle furnace (digital temperature controller), spectrophotometric ultro spec. 3100C, 240 flame spectrophotometer, Atomic Absorption (240FSAA).

2.3. SAMPLE COLLECTION

The selected food stuffs were bought from various markets within the Eastern States of Nigeria and were identified at the Department of Botany and School of Agriculture, Federal College of Education (Technical) Asaba.

2.4 SAMPLE PREPARATION

The eaten parts of the food samples were exposed and were crushed raw, then the required quantity taken for analysis.

2.5 PROXIMATE ANALYSIS

The proximate analyses of the samples were carried out in triplicate using various suitable methods as follows:

2.5.1 Determination of Moisture Content

The determination of moisture content was carried out according to AOAC (2000). Two grammes of each of the samples were weighed into a preheated, cooled and weighed silica dish. They were then dried in 105° C temperature regulated oven for 24 hours to a constant weight. The dishes and the content were allowed to cool in desiccators before weighing and the moisture determined as percetage moisture given by:

% moisture = weight of samples before drying -

$$\frac{\text{Weight of sample after drying} \times 100}{\text{Weight of sample taken (g)}}$$

2.5.2 Determination of Ash Content

For the determination of ash content, the method of AOAC, (2000) was also used. Crucibles were thoroughly washed, cleaned and placed in a hot air circulation oven for 2 hours and cooled to room temperature in desiccators.

Two grammes of each of the samples were weighed in a silica crucible. The crucibles were heated in a muffle furnace for 3-5 hours at 600⁰C. They were cooled in a desiccator and weighed to completion of ashing. To ensure completion of ashing, the samples were heated again in the furnace for half an hour more, cooled and weighed. This was repeated till the weight became constant (ash became white/greyish white).

The ash content was calculated as

$$\text{Ash} = \frac{\text{Weight of ashed sample} \times 100}{\text{Weight of sample taken}}$$

2.5.3 Determination of Percentage Lipid

Each ground sample (2g) was exhaustively extracted with 200ml petroleum ether (60-80⁰) for 3 hours by the use of the soxhlet apparatus. The solvent was later removed by distillation under reduced pressure by the use of the rotatory evaporator(AOAC, 2000). The percentage lipid was calculated as follows

$$\begin{aligned} \% \text{ Lipid} &= \frac{\text{Weight of Lipid} \times 100}{\text{Weight of Sample}} \\ &= \frac{\text{Weight of flask and lipid} - \text{weight of flask} \times 100}{\text{Weight of sample}} \end{aligned}$$

2.5.4 Determination of Crude Protein

The protein content of each sample was estimated from the determination of the total Nitrogen by the Kjeldahl method, which involved three major steps using microkjeldahl apparatus.

Step 1

Digestion: 0.5g of each sample was placed in a digestion flask; 20ml of concentrated H₂SO₄ was added with one tablet of selenium catalyst.

The mixture was digested on an electrothermal heater for 5 hours in a fume cupboard until a clear/colourless solution was obtained. The flask was allowed to cool, after which the solution was diluted with distilled water to 50ml and 5ml of this was transferred into the Kjeldahl distillation flask.

Step 2

Distillation: 10ml of boric acid was pipetted into a 100ml conical flask (the receiver flask) and 5 drops of bromocresol green and 1 drop of methyl red indicators added to produce a light pink/orange color. 50% NaOH was continually added to the digested sample until the solution turned cloudy which indicated that the solution had become alkaline.

The distillation was carried out into the boric acid solution. Exactly 40 drops of distillate were allowed to reach the boric acid (receiver flask).

Step 3

Titration: The ammonia received in the boric acid was titrated with 0.01MHCl. The blue colour then changed to orange and the titre value was taken.

Calculations

$\%N = \text{Titre value} \times \text{Molarity of acid} \times \text{atomic mass of N} \times 4$

$\% \text{ protein} = \%N \text{ above} \times 6.25$ where 6.25 is a correction factor

2.5.5 Determination of Crude Fibre

Two grammes of moisture and fat-free of each of the food sample was treated with 200ml of conc. H₂SO₄. After filtration with Whatman paper No. 4 and washing, the residue was treated with 1.25% NaOH. It was filtered, washed with hot water and then 1% HNO₃ and again with hot water. The residue was ignited and the ash weighed. Loss in weight gave the weight of crude fiber (Chopra and Kanwar, 1991, Mazumder and Majunder, 2003).

$$\text{Crude fiber (\%)} = \frac{(c-b) - (d-b) \times 100}{a}$$

Where: a = weight of sample

b= weight of crucible

c =initial weight of crucible containing tissue sample before
ignition

d = final weight of crucible containing ash after ignition

2.5.6 Determination of Carbohydrate

Determinations of available carbohydrate in the food samples were calculated by “difference method” as described by James, (1995).

% carbohydrate = 100 – (% lipid + %ash +%moisture+ %protein + %crude fiber)

2.6 Determination of Energy Values of Food Samples

The energy values were calculated using the Water Factor method as reported by Onyeike et al., (2000). Here, the value of protein content is multiplied by 4; that of lipid by 9 and that of total carbohydrates by 4. The sum of these values was expressed in KJ/g sample.

2.7 Analysis of Specific Metals

Procedure: The sample was weighed (0.5g) in the conical flask. 10cm³ of concentrated trioxonitrate (v) acid was added and heated until fumes reduce. Concentrated H₂SO₄ (10cm³) was added and heated for 20 minutes until the liquid turned colourless. The clear solution was made up to mark in a 100ml volumetric flask.

Standardization: Five concentrations of each metal solution with 0.1M HCl were prepared so as to bracket the expected metal concentration of the sample. Each standard was aspirated in turn into the flame and its respective absorbance was recorded.

Analysis: The atomizer was rinsed by aspirating the deionized water into the flame and the instrument was adjusted to zero absorbance. Each sample solution was aspirated and the absorbance of each was taken. Five readings were taken for each sample and the average absorbance reading was taken.

Calculation: The concentration of each metal was calculated by referring to the appropriate calibration curve drawn by the in-built computer interface. The concentrations were equally read out from the print-out from the computer.

2.8 DETERMINATION OF TOTAL PHOSPHOROUS CONTENT

Step 1 The sample (2g) was digested using acid-mixture (containing 650ml conc. HNO₃; 80ml perchloric acid, 20ml conc. H₂SO₄) in a flask.

- The flask was heated until a clear digest was obtained.

Step 2 A Portion of diluted digested sample was collected and 1ml of H₂SO₄ and 0.4g of ammonium persulphate added.

- It was boiled for 30-40 minutes or until total volume was about 10ml.
- It was made up to 50ml with distilled water and then tested for total phosphorous content.

Step 3 To above solution, one drop of phenolphthalein indicator was added and 8ml of combined reagent and was mixed of thoroughly. Combined reagent is a mixed of 50ml 5N sulphuric acid, 5ml of potassium antimonyl tartarate solution, 15ml ammonium molybdate solution and 30ml ascorbic acid solution.

Step 4 The above solution was left to stand for 10 minutes for colour development. Absorbance was measure at 880nm using a reagent blank to zero the spectrophotometer.

- The samples absorbance was determined against standard and the concentration of the sample was calculated.

$$\text{Concentration of sample} = \frac{\text{Absorbance of sample} \times \text{concentration of standard}}{\text{Absorbance of standard}}$$

(AOAC, 2000).

The Phosphorous Standard

The standard stock solution was prepared by dissolving and diluting exactly 4.394g of dried potassium dihydrogen phosphate with 0.05ml HCl and one liter distilled water.

2.9 DETERMINATION OF ANTINUTRIENTS

2.9.1 Alkaloid Determination

For all the food samples, 1g was weighed into a 250ml beaker and 200ml of 20% acetic acid in ethanol was added and covered and allowed to stand for 4 hours at 25⁰C. This was filtered with filter paper No.42 and the filtrate was concentrated using a water bath to one quarter of the original volume. Concentrated ammonium hydroxide was added drop- wise to the extract until the precipitate was collected and washed with dilute NH₄OH (1% ammonia solution), then filtered with pre–weighed filter paper. The residue on the filter paper was the alkaloid, which was dried in the oven at 105⁰C. The alkaloid content was calculated and expressed as a percentage of the weight of the sample analysed (Harborne, 1993; Obadoni and Ochuka, 2001)

Calculation:

%weight of alkaloid =

$$\frac{\text{Weight of filter paper with residue} - \text{weight of filter paper} \times 100}{\text{Weight of sample analysed}}$$

2.9.2 Determination of Saponin

Exactly 1.0gramme of the food sample was put in 20% acetic acid in ethanol and allowed to stand in a waterbath at 50⁰C for 24 hours. This was filtered and the extract was concentrated using waterbath to one quarter of the original volume. Concentrated NH₄OH was added drop-wise to the extract until the precipitate was collected by filtration and weighed. The saponin content was weighed and calculated in percentage (Obadoni and Ochuka, 2001).

Calculation:

% saponin content =

$$\frac{\text{Weight of filter paper + residue} - \text{weight of filter paper} \times 100}{\text{Weight of sample analysed}}$$

2.9.3 Determination of Tannin

The Follin- Dennis titration method as described by Pearson (1976) was used. To 2g of each of the crushed food sample in a conical flask was added 100ml of petroleum ether and covered for 24 hours.

The samples were then filtered and allowed to stand for 15minutes allowing petroleum ether to evaporate. It was then re-extracted by soaking in 100ml of 10% acetic acid in ethanol for 4 hours. The samples were then filtered and the filtrate was collected. 25ml of NH_4OH were added to the filtrate to precipitate the alkaloids. The alkaloids were heated on electric hot plate to remove some of the NH_4OH still in solution. The remaining volume was measured to be 33ml. 5ml of this was taken and 20ml of ethanol was added to it. It was titrated with 0.1M NaOH using phenolphthaleine as indicator until pink endpoint was reached.

Tannin content was then calculated in % ($c_1v_1 = c_2v_2$) molarity

Calculation:

C_1 = conc. of tannic acid

C_2 = conc. of base

V_1 = volume of tannic acid

V_2 = volume of base

$$\text{Therefore } C_1 = \frac{C_2 V_2}{V_1}$$

$$\% \text{ of tannic acid content} = \frac{C_1 \times 100}{\text{Weight of sample analysed}}$$

2.9.4 Phytate Determination

Phytate contents were determined using the method of Young and Greaves (1940). Two grammes of each of the food samples were weighed into

different 250ml conical flasks. Each sample was soaked in 100ml of 2% concentrated HCl for 3 hours. The samples were then filtered. 50ml of each filtrate was placed in 250ml beaker and 100ml distilled water added to each sample. 10ml of 0.3% ammonium thiocyanate solution was added as indicator and titrated with standard iron (iii) chloride solution which contained 0.00195g iron per ml. The percentage phytic acid was calculated using the formula:

$$\text{Phytic acid (\%)} = \frac{\text{titre Value} \times 0.00195 \times 1.19 \times 100}{2}$$

Where 1.19 is a conversion factor

2.9.5 Determination of Oxalate

The total content of oxalate in the food samples was determined according to the precipitating method of Dye (1956).

The extraction was done by boiling 1g of each of the samples in 40ml of water for 30 minutes in a reflux condenser. 10ml of 20% Na₂CO₃ was added to each of the samples and boiled for another 30 minutes. The liquid extract was filtered and washed with hot water till wash-water showed no alkaline reaction.

The combined water-wash and filtrate was concentrated to a small volume and cooled. HCl (1:1) was added drop-wise with constant stirring until the final acid concentration after neutralization was about 1% at which stage a heavy precipitate appeared, which was allowed to flocculate. Extract was carefully filtered into 250ml flask, made up to mark and kept overnight.

Supernatant liquid was filtered through a dry filter paper in a dry beaker. An aliquot of the filtrate in a 400ml beaker was diluted with water to 200ml and reacidified with acetic acid. 10ml of a 10% calcium chloride (CaCl₂) solution was added to the medium and stirred very well to induce calcium oxalate precipitate to appear and left to settle overnight. The clear supernatant liquid was carefully decanted off through Whatman No.42 filter paper.

The precipitate was dissolved in HCl (1:1). Solution was made basic by adjusting the pH with ammonium hydroxide solution. The content was boiled

and allowed to settle overnight. Oxalic acid was determined by titrating against 0.05N KMNO₄ solution.

1ml of 0.05N KMNO₄ = 0.00225 anhydrous oxalic acid

$$\text{Oxalic acid (\%)} = \frac{\text{Titre value} \times 0.00225}{2}$$

2.10 DETERMINATION OF THE PHYSICOCHEMICAL PROPERTIES OF THE OILS

2.10.1 Determination of Saponification Value

20cm³ of 0.5M ethanolic KOH was collected using a pipette and added to two separate 250cm³ conical flasks labeled A and B, where A is reaction vessel and B control vessel. Into the reaction vessel A, 2.0g of the oil sample was added. Both vessels were heated and allowed to reflux for 45 minutes with occasional shaking. It was then cooled to room temperature and 2-3 drops of phenolphthalein indicator was added and then titrated with 0.5M H₂SO₄ from the burette until the pink colour disappeared. The titre values for both A and B vessels were recorded.

Calculation:

$$\text{Saponification value} = \frac{(b-a)\text{cm}^3 \times M \times 56.1}{\text{Weight of sample}}$$

Where a = titre value

b = blank titre value

M = molarity of acid used (AOAC 1990)

2.10.2 Determination of Acid Value

One gramme of the oil sample was weighed into a conical flask. 50ml of 95% v/v alcohol was added and 1ml of phenolphthalein indicator and the resulting solution was titrated with 0.1M KOH solution.

Calculation:

$$\text{Acid value} = \frac{\text{Titre}(\text{cm}^3) \times 56.1}{\text{Weight of sample used}}$$

Free fatty acid was calculated from the same titration i.e.

1ml 0.1M KOH = 0.282gramme oleic acid
= 0.025gramme palmitic acid
= 0.020gramme lauric acid

2.10.3 Determination of Peroxide Value

Five gramme of the oil sample was placed in a 250ml conical flask. 30cm³ of a mixture of 3 volumes of glacial acetic acid and 2 volumes of chloroform was added, swirled until it dissolved. 0.5cm³ of saturated KI solution was added. The solution was allowed to stand for one minute and the 30cm³ of water was added and titrated gradually with continuous and vigorous shaking with 0.01M Na₂S₂O₃ solution until the yellow colour disappeared. 0.5ml of starch indicator was further added and the titration continued with shaking until the blue colour just disappeared (acm³). The above operation was repeated without the oil sample (bcm³).

Calculation:

$$\text{Peroxide value} = \frac{(a-b) \times 10}{W}$$

Where a = Titre sample (cm³)

b = Titre blank (cm³)

w = weight of sample (g)

2.10.4 Determination of Ester Value

The ester value is the number of milligramme (mg) of KOH required to saponify the esters present in 1g of the oil sample.

Calculation:

Ester value = saponification value – acid value

2.10.5 Determination of Iodine Value

Two boiling tubes were labelled A and B, into A (sample), 2.6cm³ of oil was added and into B (control), 2.0cm³ of chloroform was added. From a burette, 5.0cm³ of Wij's solution was added into each tube and mixed thoroughly. The tubes were left to stand for 5 minutes (in the dark). 5cm³ of

7.5%w/v KI was added to tubes A and B and titrated to a straw colour using 0.1M Na₂S₂O₃ solution. Three drops of starch indicator was added to the solutions and the titration continued until a colourless end point was observed. The titre values for both A and B were noted.

Calculation:

$$\text{Iodine value} = \frac{(B-A) \times 0.01269 \times 100}{\text{Weight (mg) of sample}}$$

B= Blank (control) titre

A = Sample titre

Wij's Solution Preparation

8.5grammes of I₂ crystals and 7.8g of iodine trichloride were dissolved in separate portions of about 450ml of glacial acetic acid. The solutions were mixed and made up to 1litre.

2.11 STATISTICAL ANALYSIS OF RESULTS

Data obtained from the experiments were analysed using bar charts, the Statistical Package for Social Science (SPSS) software for windows version 17 (SPSS Inc., Chicago, Illinois, USA). All the data were expressed as mean plus or minus standard deviation. The limit of significance was set at P<0.05. Data obtained were subjected to test of significance (ANOVA and students T-test) to determine if significant difference exists between the mean of the test groups.

CHAPTER THREE

3.0 RESULTS AND DISCUSSION

3.1 PROXIMATE, ANTINUTRITIONAL, MINERAL ANALYSIS AND ENERGY VALUE RESULTS OF THE FRUIT SPECIES

Table 3.1: Proximate compositions of some fruit samples (g/100g)

Sample	Moisture content	Ash content	Crude fat	Crude protein	Carbohydrate	Crude fibre
Citrus sinensis (orange)	17.50± 2.04	20.10±0.25	9.00±0.00	4.54±0.03	38.86±0.001	10.00±0.00
Chrysophyllum albidum (starapple)	14.17±1.18	25.00±0.00	10.00±0.00	31.48±0.03	11.02±0.00	8.33±2.36
Mangifera indica (mango)	45.33±0.24	10.00±0.00	2.00±0.00	6.98±0.03	29.69±0.02	6.00±0.00
Annona muricata (soursop)	6.17±1.03	6.83±0.24	1.00±0.00	27.98±0.00	34.19±0.01	23.83±3.60
Dialium indum (tamarind)	14.6±0.47	3.50±0.00	3.00±0.00	18.13±0.00	50.37±0.01	10.33±0.47
Klainedoxa gabonensis (wildmango)	5.00±0.00	3.67±0.47	17.67±2.06	10.54±0.41	59.55±2.20	3.57±0.16

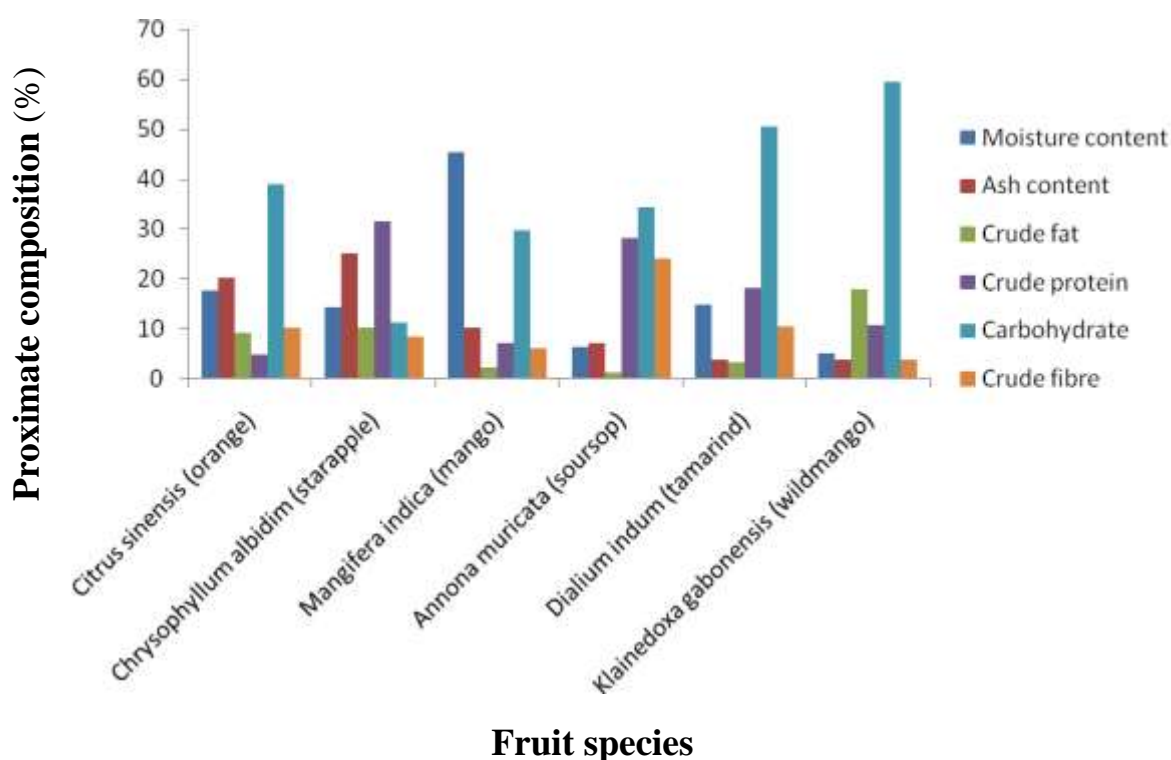


Fig.3.1: Proximate compositions of some fruit samples

The proximate compositions of the fruit samples in percent are shown in Table 3.1 and Figure 3.1. The moisture content ranged between 5.0 ± 0.00 for wild mango and 45.33 ± 0.24 for mango. Mango was significantly higher ($P > 0.05$) in moisture content than the other fruit species and multiple comparison of the moisture content of these fruit samples with each other showed also that the differences in mean were significant at 0.05 level ($P > 0.05$). The values were low but agreed with 4.00-90.66 reported by Umoh, (1998) for fresh fruits at maturity and are still within the acceptable range for a good keeping period. The relatively low moisture could be due to variation in nutritional compositions of food with climate, place, soil and different agricultural practices and the technique used to estimate the moisture content. Low moisture was also an indication that these fruit samples would have high shelf life especially when properly packaged against external conditions (Eka, 1987). The propensity of micro organisms to grow on foods depends on their water content. For this reason, many foods are dried below some critical moisture contents to stabilize microbial growth and hence reduce food spoilage, thus improving food quality (Pearson, 1976).

The ash content ranged between 3.5 ± 0.00 for tamarind and 25.0 ± 0.00 for starapple. Ash content should not exceed 5% in fresh foods (FNB, 1974), though the foods were analysed raw, they were not very fresh from farm. Starapple and orange were significantly higher ($P > 0.05$) in ash content than other fruit species in the group and other mean differences observed were also significant ($P > 0.05$) but not significant for tamarind (3.50) and wildmango (3.67) in multiple comparison. Since percentage ash gives an idea about the inorganic content of the samples, thus fruits like starapple and orange could replace or provide certain minerals in the diet of the Easterners in Nigeria. Healthwise, the quality of food depends on the concentration and type of minerals they contain. High mineral contents are sometimes used to retard

growth of certain microorganisms in food. Some minerals are essential to a healthy diet whereas others can be toxic (Pearson et al., 1981).

Crude fat ranged from 1.0 ± 0.00 for Soursop to 17.67 ± 2.06 for wild mango. The results agreed with 0.78-40.00 obtained by Dreon et al., (1990). The mean difference observed for fat content of the fruit species were significant ($P > 0.05$) but multiple comparison showed the difference in mean were insignificant for orange/starapple, mango/soursop, mango/tamarind and soursop/tamarind. Though wild mango(17.67) was a fruit, its fat content are comparable with those of soyabean oil, locust bean and cotton seed (19.10, 14.05 and 20.30 respectively) as reported by Ayodele et al., (2000), and thus could be classified as oil seeds and could as well be commercially exploited. The recommended daily intake (RDI), of total lipids is 31g while the acceptable macronutrient distribution range (AMDR), value of total lipid is between 20-35g (Dietary Reference Intakes for Macronutrient, 2002/2005) (www.nap.edu). The values obtained are below RDI and AMDR, thus the fruits should be supplemented or complemented with other foods or be recommended as low fat foods. Acceptable Daily Intake (ADI) or Recommended Daily Intakes (RDI) for humans is defined as an estimate of the amount of a chemical that can be ingested daily over lifetime without appreciable risk to health while Acceptable Macronutrient Distribution Range (AMDR) is the range of intake for a particular energy source that is associated with reduced risk of chronic disease while providing intakes of essential nutrients (WHO, 2001).

Lipids are essential because they provide the body with maximum energy approximately twice that for an equal amount of protein or carbohydrate and facilitate intestinal absorption and transportation of fat soluble vitamins A, D, E and K (Dreon et al., 1990). Those with low lipids such as soursop, mango and tamarind could be recommended as part of weight reducing diets for the Easterners in Nigeria since the knowledge of fat content of a food helps in the development of low fat foods.

Crude protein ranged between 4.5 ± 0.03 for orange and 31.4 ± 0.03 for starapple. The values were within the range 4.54 – 34.09 reported by Pugalenthii et al., (2004) for most fruits and seeds. The values agreed well with 5-35g AMDR of proteins, and fairly with RDI which is between 9-56g for different age brackets, but could be required in amount as high as 71g during pregnancy and lactation. Proteins are essential component of the diet, needed for survival of animals and humans; their basic function in nutrition and health is to supply adequate amounts of required amino acids (Pugalenthii et al., 2004). The protein in starapple 31.45 compared well with that of melon seed 33.8 (Achinewu, 1983), thus would surely enhance growth and maintenance of tissue, and would no doubt, complement protein from cereals and other plant foods that are known to be low in protein in the diet of the Easterners. The mean difference of crude protein values for the fruit species were significant ($P > 0.05$).

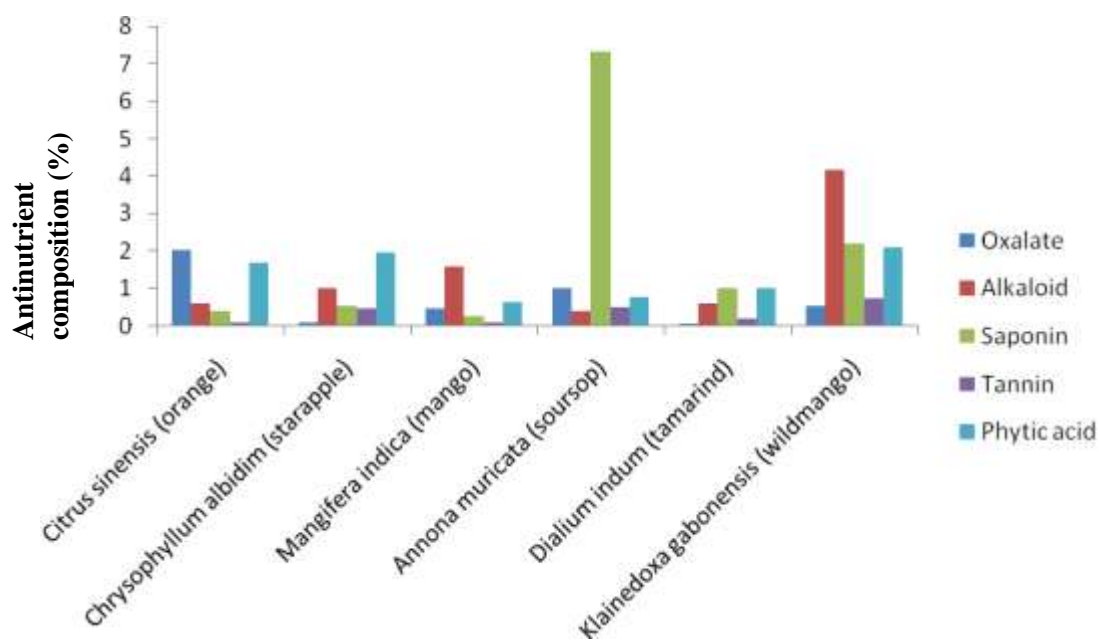
The crude fibre ranged between 3.57 ± 0.16 for wild mango and 23.83 ± 3.60 for soursop. These values agreed to some extent with 1.23 - 14.57 reported for most Nigerian fruits (Bello et al., 2008). RDI value of fibre is between 19-38g, varying for ages from 1- >70years, thus the fruits are considered low in fibre content except soursop. The fibre content of soursop is significantly higher ($P > 0.05$) than other fruit species analysed and other mean differences were significant at 0.05 level. High fibre is desirable in adult diet. It promotes the wave-like contraction that moves food through the intestine, it also expands the inside walls of the colon, easing the passage of waste, thus making it an effective anti-constipation agent. It also lowers risk of various cancers, bowel disease and improves general health and wellbeing. Presence of high fibre improves glucose tolerance and is beneficial in treating maturity on-set diabetes (Eromosele and Eromosele, 1993), thus incorporating this fruit (soursop) in our diet could be of tremendous benefit to the Easterners of Nigeria, especially diabetics. The low levels of fibre in wild mango and mango may be desirable in their incorporation in weaning diets. Emphasis has been placed on the

importance of keeping fibre intake low in the nutrition of infants and preschool children (Eromosele and Eromosele, 1993). High fibre levels in weaning diets can lead to irritation of the gut mucosa, reduced digestibility, vitamin and mineral availability.

The carbohydrate contents of the fruit samples ranged between 11.02 ± 0.00 for starapple and 59.55 ± 2.20 for wild mango. The values fall within the range 7.00-71.94 reported for most commonly consumed fruits (Bello *et al.*, 2000). When compared with the conventional sources of carbohydrate, example cereals and tubers, between 60-90 percent (Adewusi *et al.*, 1995), they are low. The AMDR for carbohydrates is between 45-65g while RDI is from 60-130g but could be as high as 175g and 210g during pregnancy and lactation respectively. Thus values obtained were also low when compared with these standards. Low carbohydrate foods (especially starapple) could be ideal for diabetic and hypertensive patients requiring low sugar diets. According to Anjali, (2007), our carbohydrate intake should not exceed 50-60% RDI which is best derived from complex carbohydrates found in grains, fruits, vegetables, even nuts and seeds. Most of the values were insignificantly different but there was significance in mean difference between some members in the fruit species ($P > 0.05$) in multiple comparisons.

Table 3.2: Antinutrient compositions of some fruit samples (g %)

Sample	Oxalate	Alkaloid	Saponin	Tannin	Phytic acid
Citrus sinensis (orange)	2.04± 0.01	0.60±0.01	0.40 ± 0.00	0.11±0.01	1.69±0.01
Chrysophyllum albidim (starapple)	0.10± 0.00	1.00±0.00	0.53 ± 0.09	0.46±0.01	1.98±0.01
Mangifera indica (mango)	0.48±0.00	1.59 ±0.01	0.27 ± 0.13	0.10±0.00	0.64±0.00
Annona muricata (soursop)	1.02 ±0.01	0.40 ± 0.00	7.33 ± 0.24	0.50±0.01	0.78±0.01
Dialium indum (tamarind)	0.06± 0.07	0.60 ± 0.01	1.00 ± 0.00	0.20±0.00	1.00±0.00
Klainedoxa gabonensis (wildmango)	0.55±0.01	4.18 ± 0.01	2.19 ± 0.01	0.73±0.02	2.10±0.08



Fruit species

Fig. 3.2: Antinutrient compositions of some fruit samples

Table 3.2 and Figure 3.2 showed the levels of antinutritional factors in percent of the fruit species.

Oxalate ranged between 0.10 ± 0.00 for starapple and 2.04 ± 0.01 for Orange. The values were similar to that reported by Bello et al., (2008); and Agunbiade, (2010). Thus starapple had the least oxalate content while Orange had the highest. The mean difference among the fruit species were significant ($P>0.05$) except for mango/wildmango in multiple comparison. About 45g of oxalate had been reported to be toxic to mature sheep (Muhammed *et al.*, 2011). Thus the levels of oxalate in the fruit samples, with the exception of Orange might not play important role in their nutritive values because they were low. Munrio and Bassir, (1989) had also reported that the possibility of oxalate poisoning in Nigeria from consumption of local fruits was as remote as it was in other parts of the world. At present, it seems unlikely that many, if any, phytochemical will become recognized as essential nutrients in the near future and be accorded RDI levels. On the contrary, they are very much likely to feature in future dietary guidelines in which their important role in maintaining optimum health will be stressed (Ivor, 2000). A recent, valuable contributions to the phytochemical debate has been made by Wahlqvist *et al.*, who have proposed developing a food-based Index of Preferred Phytochemical Intake (IPPI) (Wahlqvist et al., 1998). Under this proposal, IPPI foods known to be good sources of a particular class of beneficial phytochemicals are aggregated, thereby providing for optimum intake and synergy, but at the same time avoiding potential toxicity from excessive intakes.

Phytic acid ranged from 0.64 ± 0.00 for mango to 2.10 ± 0.08 for wild mango. Phytic acid was highest in wild mango and least in mango. According to Oke, (1997), a phytate diet of 1-6% over a long period decreased the bioavailability of mineral elements in monogastric animals. Phytate has also been associated with nutritional diseases such as rickets and osteomalacia in children and adults, respectively. Thus a fruit like wild mango with high phytic

acid level should not be consumed in large quantity over a long period of time by both children and adults in Eastern Nigeria. Multiple comparison showed the difference in mean was significant ($P>0.05$) except in tamarind/orange.

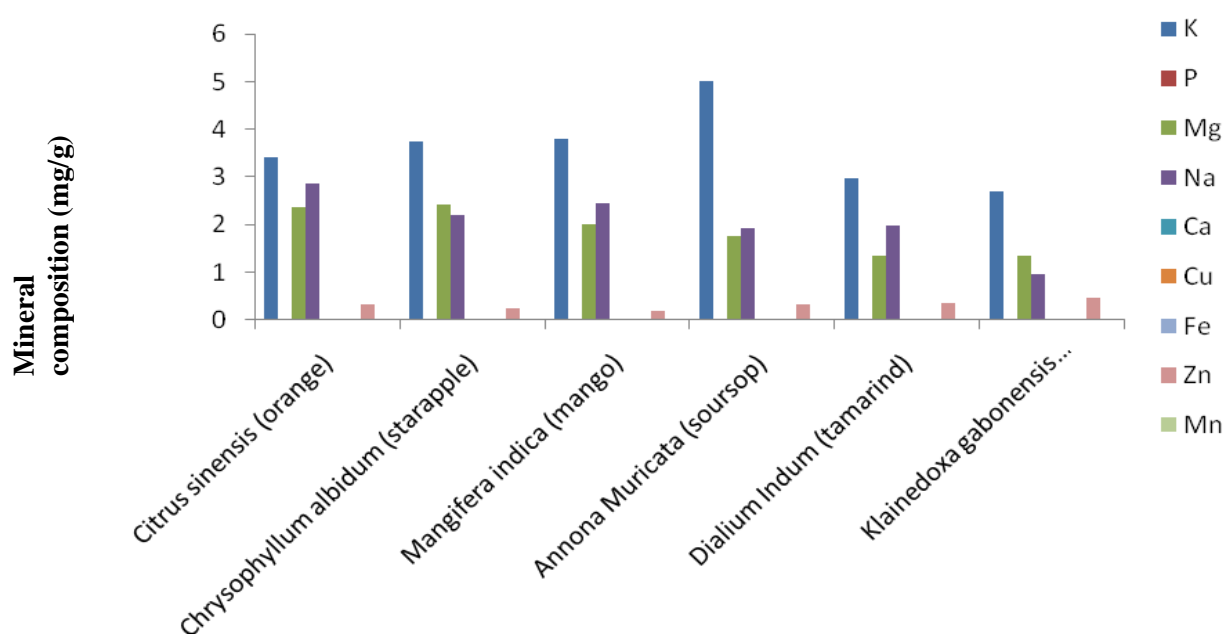
Tannin ranged between 0.10 ± 0.00 for mango and 0.73 ± 0.02 for wild mango. Tannin content was significantly low ($P>0.05$) though multiple comparison showed the difference in values of mango/orange was insignificant. Its presence in food has been reported to act as antioxidants by preventing oxidative stress that causes diseases such as coronary heart disease, some type of cancer and inflammation (Tapiero et al., 2000).

Saponin levels ranged between 0.27 ± 0.13 for mango and 7.33 ± 0.24 for soursop. Saponin was significantly high in Soursop ($P>0.05$) compared with the other fruit species in the group and least in Mango. Comparison of one with each of all the fruit species showed insignificant difference in the following pairs: tamarind/starapple, orange/starapple, orange/mango and starapple/mango. Saponin in fruit has been associated with gastroenteritis manifested by diarrhea and dysentery, although it has been reported also that it reduces body cholesterol (Awe and Sodipo, 2001). Fruits like soursop and wild mango rich in saponin could be recommended in the diet of Easterners in Nigeria with high cholesterol levels but in moderate quantity to avoid diarrhea and dysentery associated with it.

Alkaloids levels ranged between 0.4 ± 0.00 for soursop and 4.18 ± 0.01 for wild mango. Alkaloid in wild mango was significantly higher ($P>0.05$) than that for other fruit species sampled and could be tapped for many medicinal purposes since alkaloids are known to have antimicrobial properties (Evans, 2005).

Table 3.3: Mineral compositions of some fruit samples in mg/g

	K	P	Mg	Na	Ca	Cu	Fe	Zn	Mn
<i>Citrus sinensis</i> (orange)	3.40±0.00	0.002±0.00	2.38±0.00	2.86±0.00	0.002±0.00	0.004±0.00	0.002±0.00	0.32±0.00	ND
<i>Chrysophyllum albidum</i> (starapple)	3.75±0.00	0.042±0.00	2.42±0.00	2.20±0.00	0.002±0.00	0.004±0.00	ND	0.24±0.00	0.02±0.00
<i>Mangifera indica</i> (mango)	3.80±0.00	0.006±0.00	2.02±0.00	2.46±0.00	0.020±0.00	0.002±0.00	0.04±0.00	0.20±0.00	ND
<i>Annona Muricata</i> (soursop)	5.00±0.00	0.012±0.00	1.76±0.00	1.94±0.00	0.020±0.00	0.002±0.00	0.02±0.00	0.32±0.00	ND
<i>Dialium Indum</i> (tamarind)	2.96±0.00	0.002±0.00	1.34±0.00	1.98±0.00	ND	0.002±0.00	0.004±0.00	0.36±0.00	ND
<i>Klainedoxa gabonensis</i> (wildmango)	2.70±0.00	0.006±0.00	1.34±0.00	0.96±0.00	0.004±0.00	0.004±0.00	0.04±0.00	0.46±0.00	0.02±0.00



Fruit species

Fig.3.3: Mineral compositions of some fruit samples

The mineral composition of the fruit species in mg/g are reported in Table 3.3 and Figure 3.3.

Potassium was found to be the most abundant element in all the fruit species than all the other minerals analysed, ranging from 2.70 in wild mango to 5.00 for soursop. The RDI of potassium is 2000mg/day or more, thus none of

the fruits analysed showed up to that and should be eaten with other foods or its supplements taken. But large doses of potassium may cause stomach upsets, intestinal problems or heart rhythm disorders. Manganese showed the lowest values for the fruit samples; ranging from 0 to 0.02 and not up to the 5mg RDI, though excesses may hinder iron absorption and was not detected in Orange, mango, soursop, and tamarind. Magnesium was detected in all the fruit species; ranging from 1.34 for both Tamarind and Wild mango to 2.42 for Starapple and not up to RDI (350mg), but doses larger than 400mg may cause stomach problems and diarrhea. Sodium was also present in all the fruit species; ranging from 0.96 for wild mango to 2.86 for orange and values are below RDI of sodium which is 2400mg. Calcium, RDI 1000mg was not detected in tamarind but in trace amounts in the other fruit species ($P < 0.05$). Iron (Fe), RDI (15mg) was not detected in starapple, but in trace amounts in others and copper, RDI (2mg) was found in trace amounts also in all the fruit species while zinc, RDI (15mg) was the most abundant micro mineral found in reasonable quantity in all the fruit species. Comparison among the fruit species showed that for most of the minerals, differences in mean were insignificant while the values of some pairs for phosphorous were significant ($P > 0.05$) in multiple comparison.

The presence of K in high percentage supported literature report that it is richly distributed in foods and is rarely deficient in the diet. Potassium is also important for normal muscle and nerve responsiveness, fluid pressure and balance (John, 2009). Though some diuretics used in treatment of hypertension deplete potassium, it is also lost during sustained vomiting or diarrhea or chronic use of laxatives. Orange, starapple, mango, tamarind, wild mango and especially soursop are all recommended in adequate amounts to replace potassium loss. However, high potassium foods are usually omitted in diets of people with renal failure (McLay et al., 1975).

The fruits were also rich in Mg and Na, especially orange and starapple. Magnesium is an essential mineral for a variety of cellular metabolic actions

and sometimes has the ability to replace a portion of body calcium (Sharma, 2006).

Calcium, copper and iron were generally in very low quantities in the fruit species while Zn was fairly present in all the fruit species. All the fruits showed values below recommended values and must be supplemented in our diets or eaten with other foods.

Table 3.4: Energy values of some fruit samples

Samples	KJ/g
Citrus sinensis (orange)	1,081.66
Chrysophyllum albidum (starapple)	1,105.08
Mangifera Indica (mango)	699.89
Annona muricata (soursop)	737.38
Dialium Indium (tamarind)	1,279.34
Klainedoxa gabonensis (wildmango)	1,776.50

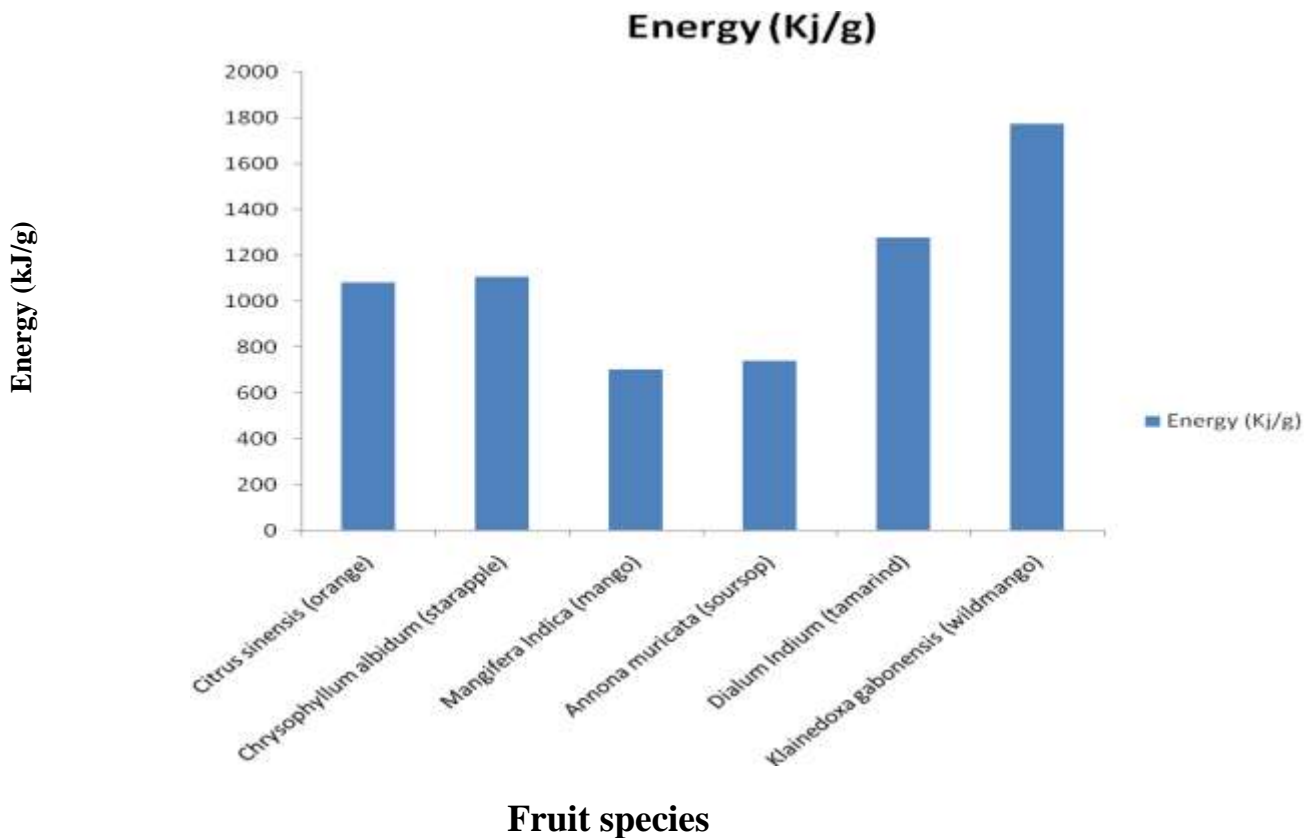


Fig.3.4: Energy values of some fruit samples

The energy values of the fruit species in kJ/g are reported in Table 3.4 and Figure 3.4. The values ranged from 699.89 ± 0.01 in mango to 1776.50 ± 0.30 in wild mango. Wild mango showed highest calorific value while mango showed the lowest calorific value. All the fruit species were high in energy and are good sources of energy, although none has up to the 2000 calorie or 8500kJ/g RDA. This meant that these fruits must be consumed with other foods and in greater quantity to attain the RDA.

3.2 PROXIMATE, ANTINUTRITIONAL, MINERAL ANALYSIS AND ENERGY VALUE RESULTS OF THE VEGETABLE SPECIES

Table 3.5: Proximate compositions of some vegetable samples in g/100g

	Moisture content	Ash content	Crude fat	Crude protein	Crude fibre	Carbohydrate
<i>Telfaira occidentalis</i> (pumpkin)	4.17±0.24	10.00±0.00	7.00±0.82	11.97±0.08	6.33±1.25	60.53±0.46
<i>Pterocarpus mildbreadi</i> (African rose wood)	0.97±0.05	1.50±0.00	5.33±0.94	13.00±0.11	6.90±0.45	72.30±1.43
<i>Vernonia Amygdaline</i> (bitter leaf)	9.67±0.27	1.83±0.24	4.33±0.47	11.75±0.17	8.87±0.19	63.55±0.46
<i>Amaranthus hybridies</i> (green amaranth)	9.67±0.47	3.83±0.06	2.50±0.41	7.42±0.30	13.33±0.13	63.25±0.67
<i>Corchorus olitorices</i> (bushmallow)	19.67±0.47	3.83±0.24	9.33±1.25	8.63±0.00	10.00±0.00	48.54±1.25
<i>Solanum melongena</i> (garden egg leaf)	10.00±0.00	5.00±0.00	14.33±2.06	14.25±0.00	4.23±0.20	52.19±1.96

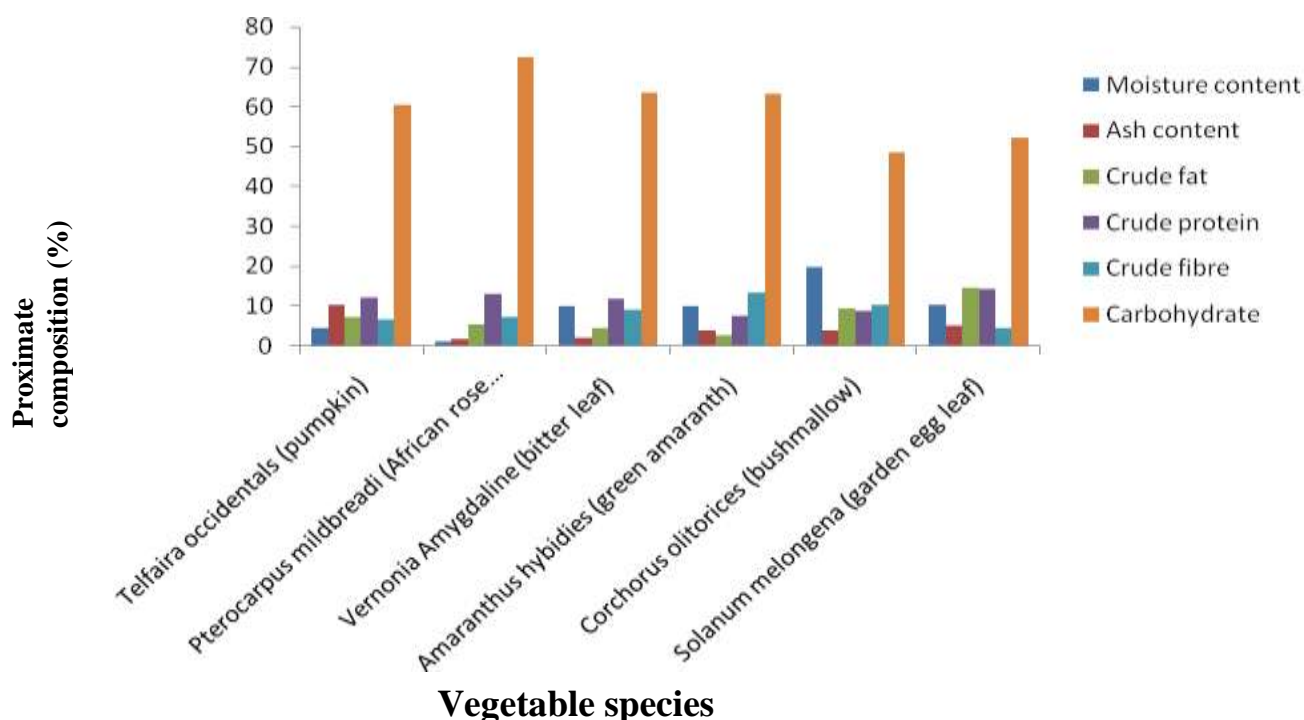


Fig.3.5: Proximate compositions of some vegetable samples

The proximate compositions in percent of the vegetable samples are reported in Table 3.5 and shown in Figure 3.5.

The moisture content ranged between 0.97 ± 0.05 for african rose wood and 19.67 ± 0.047 for bush mallow. Bushmallow was significantly high ($P>0.05$) in moisture content than others in the vegetable group but multiple comparisons showed insignificant difference in the pairs: bitterleaf/green amaranth, green amaranth/garden egg and garden egg/bitter leaf. The values were low compared to that obtained by other workers (Abidemi et al., 2009; Chimma and Igyor, 2007). The relatively low moisture content could be due to water loss during the period between harvest and sale, the analytical technique used, season, and variation in nutritional composition of foods due to other factors. Low moisture values are an indication that these vegetables samples, especially african rose wood, would have high shelf life especially when properly kept against external conditions (Eka, 1987).

The ash content ranged from 1.5 ± 0.00 for african rose wood to 10.00 ± 0.00 for pumpkin. The value for pumpkin (10.00) was significantly high ($P>0.05$) among the group, while the pair, green amaranth/bushmallow showed insignificant difference in multiple comparison, others did not exceed 5% ash content expected for most fresh foods (FNB, 1974). These values fell within the range (1.5-12.0) obtained by Abidemi et al, (2009), and according to Lucas, (1988); this was the acceptable range for edible vegetables in Nigeria. Though the ash contents were generally low in the vegetable species, pumpkin and garden egg vegetables are thus recommended in the diet as a rich source of minerals, among these vegetable species and could be used to treat diseases associated with mineral loss in the body.

The crude fat ranged between 2.50 ± 0.41 for green amaranth and 14.33 ± 2.00 for garden egg. The values did not exceed 25-35g AMDR for total fat, thus are low fat foods. These values fairly agreed with that reported by Ekpo (2007). The value for garden egg leaf was significantly higher ($P>0.05$) than others, but

insignificant difference were observed for many pairs in multiple comparison. The fat in garden egg could be extracted to complement other vegetable oil, since vegetable fats are known to lower blood lipids, thereby reducing the occurrence of diseases associated with damage of the coronary artery (Adenipekun and Oyetuji, 2010).

Crude protein ranged from 7.42 ± 0.30 for green amaranth to 14.25 ± 0.00 for garden egg leaf. Garden egg leaf had the highest protein content whereas green amaranth had the least. AMRD for protein is (5-35g) while RDI is between 9-46g and even higher in pregnancy and lactation (71g), thus the values agreed fairly with the standards. These values also agreed with that reported for edible vegetables (Nnamani et al., 2009) but slightly higher than that reported by Abidemi et al., (2009). According to Pearson, (1976), plant foods that provide more than 12% of its caloric value from protein are considered good sources of protein. Thus vegetables such as african rose wood (13.0) and garden egg leaf (14.25) might be considered good sources of protein and could be used as supplements for major protein foods. According to George, (2003), proteins in vegetables are superior to those in fruit but inferior to those in grains. The mean difference in crude protein for the vegetables were significant ($P > 0.05$) while multiple comparison showed an insignificant difference in bitterleaf/pumpkin.

Crude fibre ranged between 4.23 ± 0.20 for garden egg leaf and 13.33 ± 0.13 for green amaranth. The values are low compared with 19-38g RDI of fibre, thus should be taken in larger quantity. These values were a little higher when compared with the results by Ekpo, (2007) and Abidemi et al., (2009) for edible vegetables but the high fibre content in these vegetable species especially green amaranth (Figure 3.5), had many health benefits, especially in adult diet as reported by Eromosele and Eromosele, (1993). Multiple comparisons showed that difference in mean of the fibre content for most of the vegetable pairs were insignificant.

The carbohydrate content of the vegetable species ranged between 48.5 ± 1.25 for bush mallow and 72.30 ± 1.42 for african rose wood. The values agreed well with AMDR for carbohydrate (45-65g), though RDI is between 60- 130g. All the vegetables showed high values of carbohydrate ($P>0.05$) and are thus considered as carbohydrate rich foods and could be recommended to vegetarians especially African rosewood.

Table 3.6: Antinutrient compositions of some vegetable samples (g %)

Samples	Oxalate	Alkaloid	Saponin	Tannin	Phytic acid
<i>Telfaira occidentalis</i> (pumpkin)	2.06±0.02	5.01±0.01	3.22±0.01	0.78±0.01	1.28±0.09
<i>Pterocarpus mildbreadi</i> (african rose wood)	1.73±0.01	4.95±0.01	7.52±0.01	0.83±0.01	1.80±0.00
<i>Vernonia Amygdaline</i> (bitter leaf)	0.46±0.02	3.87±0.02	4.73±0.03	0.63±0.01	1.35±0.04
<i>Amaranthus hybridus</i> (green amaranth)	0.92±0.01	4.25±0.01	5.32±0.01	0.65±0.02	0.60±0.01
<i>Corchorus olitorius</i> (bushmallow)	0.87±0.01	5.42±0.01	6.71±0.01	0.43±0.01	0.92±0.01
<i>Solanum Melongena</i> (garden egg leaf)	1.94±0.01	3.21±0.01	5.11±0.01	0.38±0.01	2.37±0.05

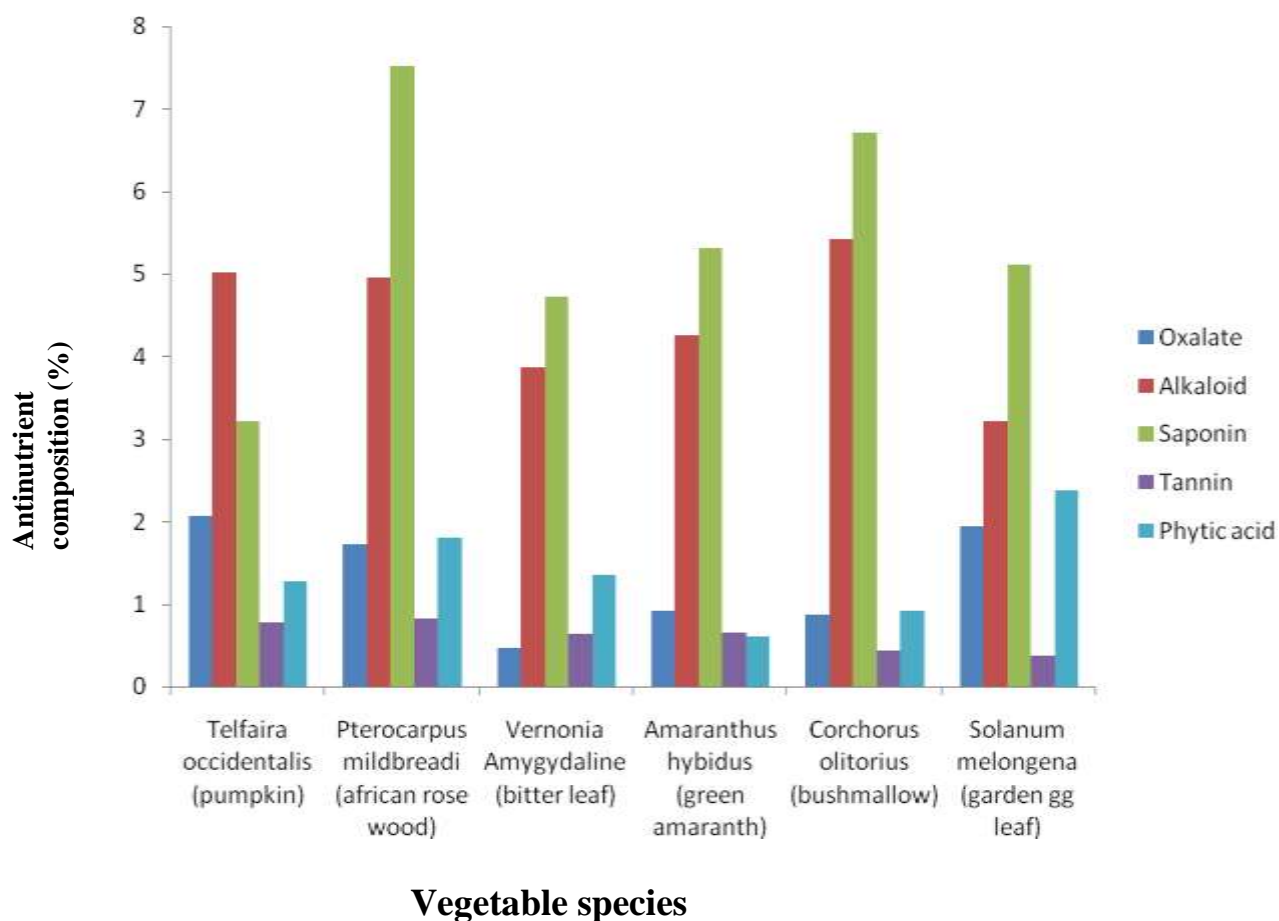


Fig.3.6: Antinutrient compositions of some vegetable samples

The antinutritional compositions of the vegetable species are reported in Table 3.6 and Figure 3.6. Oxalate level ranged between 0.46 ± 0.00 for bitter leaf and 2.06 ± 0.02 for pumpkin. Figure 3.6 showed that oxalate was detected in all the vegetables but highest in pumpkin and least in bitter leaf. Reports indicated that the greatest sources of phytochemicals were fruits and vegetables (Willet, 2002; Liu, 2004; Alter and Adeogun, 1995). Pumpkin which is a commonly consumed vegetable in Eastern Nigeria was rich in oxalate, though toxic level for oxalate is 25g% (Oke, 1966; Munrio and Bassir, 1969). It has been suggested that pumpkin should be consumed moderately since cooking in some cases, does not affect or drastically reduce the content of some of these phytochemicals (Liu, 2004; Onyeka and Nwambekwe, 2007). Many studies have been made with laboratory animals and human subjects showing that dietary calcium is poorly utilized from oxalate rich foods. Oxalate binds to calcium present in food, thereby rendering calcium unavailable for normal physiological and biochemical roles such as the maintenance of strong teeth and bone. The calcium oxalate which is insoluble may also precipitate around soft tissues such as the kidney; causing kidney stones which are associated with blockage of renal tubules (Oke, 1969; Blood and Radostti, 1989; Ladeji et al., 2004). The mean difference of oxalate content of the vegetables were significant at 0.05 level.

Alkaloid levels ranged between 3.21 ± 0.01 for garden egg leaf and 5.42 ± 0.01 for bushmallow. Figure 3.6 showed that alkaloid was the second in quantity after saponin in the vegetable species. Bushmallow showed the highest value while garden egg leaf showed the least. The difference in mean values of oxalate for all the vegetable samples were significant ($P > 0.05$). The levels of alkaloid in the vegetable species showed that they possessed some antimicrobial properties and might contribute to medicinal values of such foods (Evans, 2005).

Saponins ranged between 3.22 ± 0.01 for pumpkin and 7.52 ± 0.001 for african rose wood. Figure 3.6 showed that saponin was high in all the vegetable species, except pumpkin ($P > 0.05$). Saponins have been shown to possess both beneficial (cholesterol lowering) and deleterious properties and to exhibit structural dependent biological activities (Price et al., 1987). Saponin-protein complex formation can reduce protein digestibility (Potter et al., 1993; Shimoyamada et al., 1998). Although some saponins have been shown to be highly toxic under experimental conditions, acute saponin poisoning is relatively rare both in animals and man (Osagie, 1998). Saponin in excess also causes hypercholesterolemia because it binds cholesterol making it unavailable for absorption (Soetan and Oyewole, 2009).

Tannins ranged between 0.38 ± 0.01 for garden egg leaf and 0.83 ± 0.01 for african rose wood. All the vegetable species contained tannin but African rose wood had the highest content while garden egg leaf had the least. The values agreed fairly with that reported for green leafy vegetables (Onyeka and Nwambekwe, 2007). The presence tannin has been reported to contribute to the bitter taste of these green leaves (Onyeka and Nwambekwu, 2007). This also ascertains its natural bitter taste, in that tannin is a very bitter astringent compound found in plants. The effects of tannin vary, depending on the content and type, which in turn is dependent on characteristics such as type of digestive tract, feeding behaviour, and body size and detoxification mechanism. Levels of tannin above 5% of a diet are often lethal (Giner-Chavez, 1996). Nutritional effects which have been attributed to tannins include damage to the intestinal tract, toxicity of tannins absorbed from the gut, and interference with the absorption of iron, and possible carcinogenic effect (Osagie, 1998). Tannin-protein complexes are insoluble and the protein digestibility is decreased (Carnovale et al., 1991). Medicinally, polyphenols to which tannin belongs have been reported to act as antioxidant by preventing oxidative stress that causes diseases such as coronary heart disease, some types of cancer and inflammation

(Tapiero et al., 2000). The difference in mean obtained for tannin in all the vegetable species were insignificant.

The values of phytic acid ranged between 0.60 ± 0.01 for green amaranth and 2.37 ± 0.05 for garden egg leaf. Phytic acid was found highest in garden egg leaf and least in green amaranth among the vegetable species. The mean difference in phytic acid content were significant ($P > 0.05$). All the vegetables contained reasonable amount of phytic acid (Figure 3.6). According to Oke, (1969), a phytic diet of 1-6% over a long period decreased the bioavailability of mineral elements. It also has a negative effect on amino acid digestibility, thereby posing problems to non-ruminant animals due to insufficient amount of intrinsic factor phytase necessary to hydrolyse the phytic acid complex (Makkar and Becker, 1998). Therefore, vegetables like garden egg leaf and African rose wood, with high phytic acid contents, should be taken in moderate quantity and should not be recommended for individuals suffering from diseases associated with lack of minerals such as Ca, Mg, Fe and even zinc, (since phytic acids have 12 replaceable hydrogen atoms with which it could form insoluble salts with these metals and thus render these metals unavailable for absorption into the body) (Bello et al., 2008; Muhammed et al., 2011).

Table 3.7: Mineral compositions of some vegetable samples (mg/g)

Samples	K	P	Mg	Na	Ca	Cu	Fe	Zn	Mn
<i>Telfaira occidentalis</i> (pumpkin)	3.30±0.00	0.004±0.00	1.54±0.00	1.510±0.00	ND	ND	0.02±0.00	0.42±0.00	ND
<i>Pterocarpus milbreadi</i> (African rose wood)	2.80±0.00	0.012±0.00	1.56±0.00	1.512±0.00	ND	ND	0.02±0.00	0.44±0.00	0.02±0.00
<i>Vernonia amygdaline</i> (bitter leaf)	2.96±0.00	0.006±0.00	1.62±0.00	1.344±0.00	0.004±0.00	0.022±0.00	0.02±0.00	0.36±0.00	0.04±0.00
<i>Amaranthus hybridus</i> (green amaranth)	3.00±0.00	0.006±0.00	1.34±0.00	1.102±0.00	0.004±0.00	0.020±0.00	ND	0.24±0.00	ND
<i>Corchorus olitorius</i> (bushmallow)	3.90±0.00	0.004±0.00	1.76±0.00	1.108±0.00	0.002±0.00	0.002±0.00	ND	0.56±0.00	ND
<i>Solanum melongena</i> (garden egg leaf)	2.96±0.00	0.012±0.00	1.56±0.00	1.100±0.00	ND	0.004±0.00	0.02±0.00	0.22±0.00	0.02±0.00

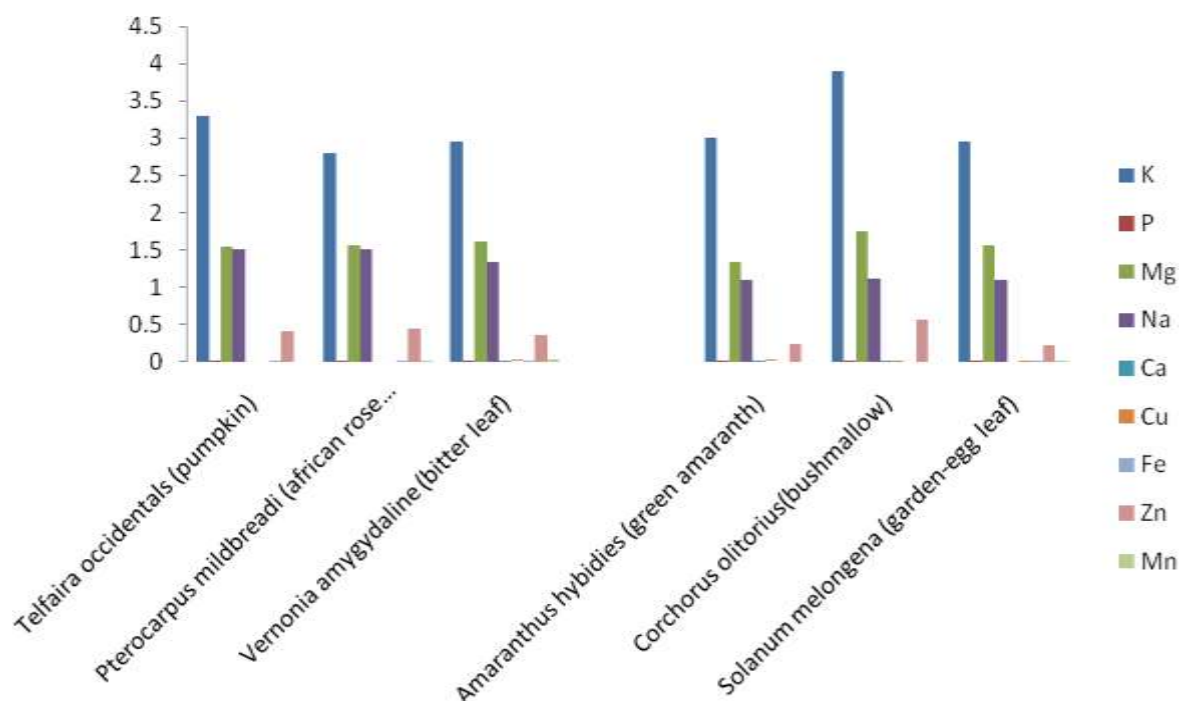


Fig. 3.7: Mineral compositions of some vegetable samples

The mineral composition of the vegetable species in mg/g are shown in Table 3.7 and Figure 3.7. Potassium was found to be the most abundant in all the vegetable species, ranging from 2.80 for African rose wood to 3.90 for bushmallow, thus below RDI of potassium (>2000mg). This again confirmed the fact that potassium was widely distributed in foods and was rarely deficient in the diet (John, 2009). Magnesium was second abundant mineral in all the vegetable species, being highest in bushmallow (1.76) and least in green amaranth (1.34), thus below 350mg RDI of magnesium. It was an essential mineral to a variety of cellular metabolic actions and sometimes had the ability to replace a portion of body calcium. These vegetables (especially when combined) are important in cases of magnesium deficiencies noted in chronic kidney disease, malabsorption disorders, malnutrition and conditions of acidosis (excess acid), including diabetic coma. Sodium was found as the third abundant mineral in the vegetable species, ranging from 1.100 for garden egg leaf to 1.512 for african rose wood. RDI of sodium is >1500mg. Sodium is important in its function with chlorine and bicarbonate to maintain a balance of positive and negative ions in body fluids and tissue (Sharma, 2006).

Zinc was the fourth abundant mineral in all the vegetable species ranging from 0.22 for garden egg leaf to 0.56 for bushmallow. The values are below RDI of zinc (15mg). Zinc is an essential trace element in the human body, where it is found in high concentration in the red blood cells, as an essential part of the enzyme carbonic anhydrase, which promotes many reactions relating to carbondioxide metabolism. Phosphorous was the fifth abundant mineral, found in trace amounts in all the vegetable species, though the values are below RDI for phosphorous (1000mg), thus should be supplemented in such foods. Calcium, RDI (1000mg), copper, RDI (2mg) and iron, RDI (15mg), were present in all the vegetable species in very low quantities. Calcium was not detected in pumpkin, African rose wood and garden egg leaf, copper was not detected in pumpkin and African rose wood. Iron was not detected in green

amaranth and bushmallow and manganese, RDI (5mg) was not detected in Pumpkin, Green amaranth and Bushmallow. The difference in value obtained for mineral contents of the vegetable species were insignificant. All the minerals showed values below standards and should be supplemented in our diets.

Table 3.8: Energy values of some vegetable samples

Samples	KJ/g
Telfaira occidentals (pumpkin)	1,500.25
Pterocarpus mildbreadi (African rose wood)	1,483.97
Vernonia Amygdaline (bitter leaf)	1,445.72
Amaranthus hybridies (green amaranth)	1,297.01
Corchorus olitorius(bushmallow)	1,328.76
Solanum melongena (garden egg leaf)	1,676.33

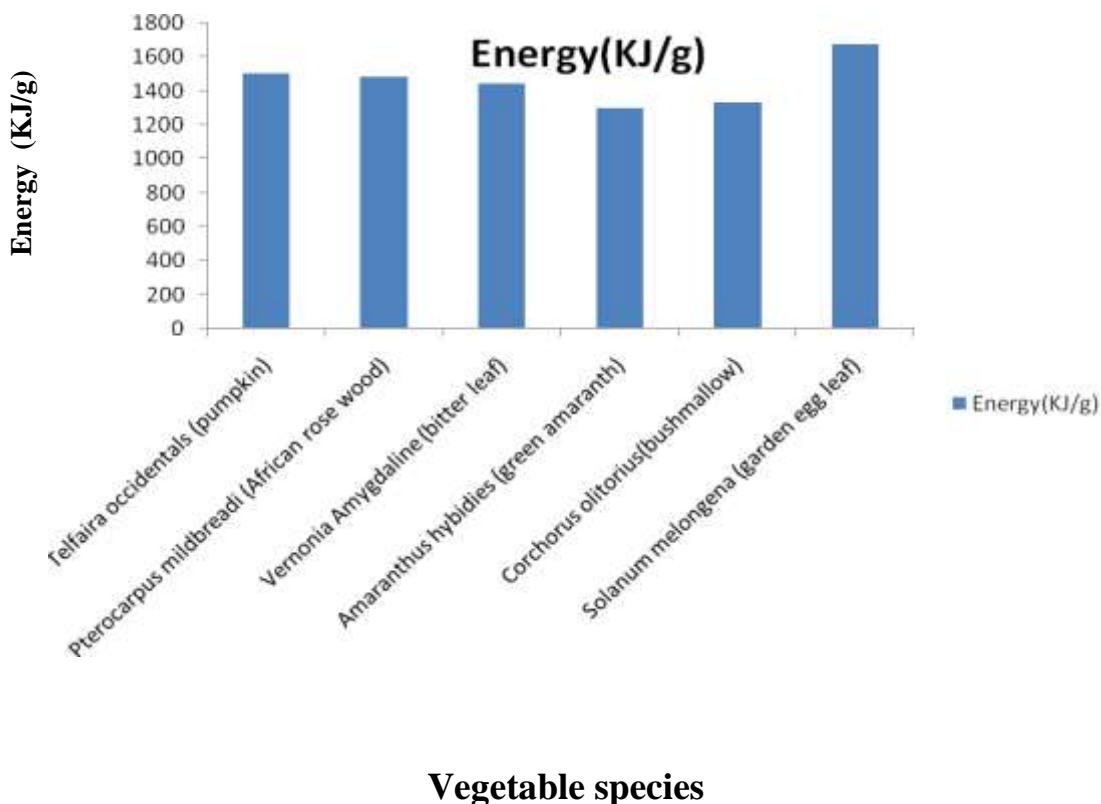


Fig.3.8: Energy values of some vegetable samples

Table 3.8 and Figure 3.8 showed the energy values of the vegetable species in kJ/g. The values ranged between 1297.01 ± 0.61 for green amaranth and 1676.33 ± 10.70 for Garden egg leaf. Garden egg leaf ranked highest in energy value while green amaranth ranked least. Generally they are all good sources of energy. They must not be eaten alone but with other foods or as mixed vegetables to make up to the 2000calories or 8500kJ/g RDA of energy (Jurgens, 2001).

3.3 PROXIMATE, ANTINUTRITIONAL, MINERAL ANALYSIS AND ENERGY VALUE RESULTS OF THE CEREAL SPECIES

Table 3.9: Proximate compositions of some cereal samples (g/100g)

Samples	Moisture content	Ash content	Crude fat	Crude protein	Crude fibre	Carbohydrate
<i>Oryza sativa</i> (rice)	1.17 ± 0.24	3.17 ± 0.47	7.00 ± 0.82	2.90 ± 0.06	6.00 ± 0.00	79.76 ± 0.87
<i>Zea mays</i> (corn)						
White	5.00 ± 0.00	4.17 ± 0.47	13.33 ± 1.25	2.00 ± 0.00	9.80 ± 0.16	65.70 ± 1.41
Yellow	2.92 ± 0.12	4.17 ± 0.47	12.33 ± 1.25	4.19 ± 0.00	13.43 ± 0.05	62.96 ± 0.86

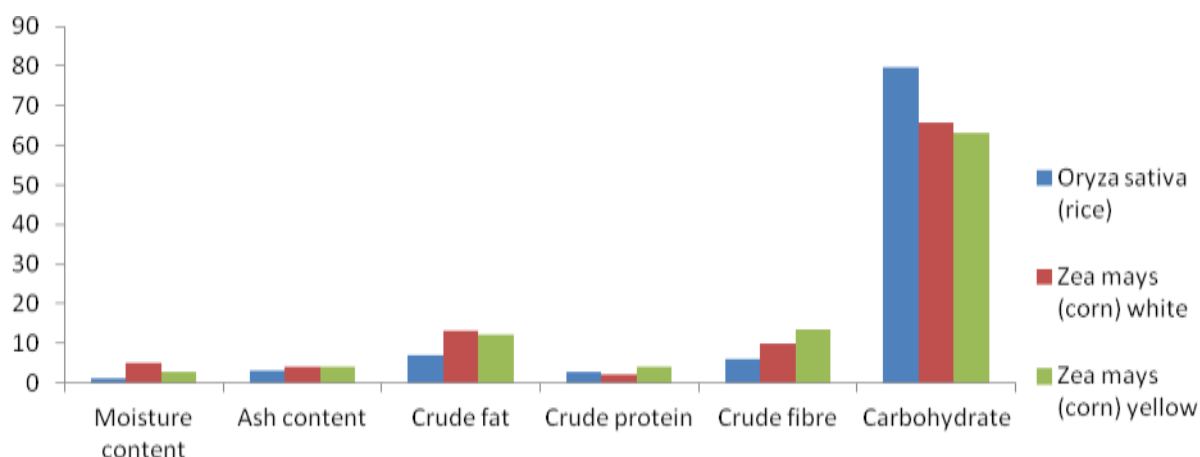


Fig. 3.9: Proximate composition of some cereal samples

The proximate compositions of the cereal species in g% are reported in Table 3.9 and Figure 3.9. The moisture contents ranged between 1.17 ± 0.24 for rice and 5.0 ± 0.00 for white corn. The values fairly agreed with the moisture contents expected for most cereal and legumes (Sanchez-marquin, 1983; Raules, 1992). The differences in moisture content could be attributed to different handling/storage methods, after harvests, the moisture content determination technique used, and the cereal specie analysed. Thus the low moisture content found for especially rice and yellow corn was an indication that these cereals could be stored for quite a long time. The different values of mean obtained for the cereals were significant ($P > 0.05$).

The ash content ranged between 3.17 ± 0.47 for rice and 4.17 ± 0.47 for both white and yellow corn. The values did not exceed 5% ash expected (FNB, 1974). The values were slightly higher than that reported by Goplan *et al.*, (1985), Chauhan *et al.*, (1992). This could be because the mineral content (ash) was actually expected to be higher in whole cereals used. The ash content was higher and of the same value in the two corn species but lower for rice. The importance of high mineral content (ash) in food has been emphasized (Pearson *et al.*, 1981). There was no significant difference in the mean values obtained for the cereal species.

The crude fat ranged between 7.00 ± 0.82 for rice and 13.33 ± 1.25 for white corn. The values agree with that reported for most cereals and legumes (1-30%) (Raules, 1992; Sanchez-marquin, 1983), but were below AMDR (20-35g) expected, so can be recommended for the formulation of low fat foods for Easterners wishing to control weight and weight associated diseases but not recommended alone as balanced food for a healthy person. The antioxidants present in corn act as anti-cancers and prevent Alzheimer's disease. Corn also helps in maintaining low cholesterol levels and helps in preventing neural tube defects at birth (Seneff *et al.*, 2011).

Benefits of rice include providing fast and instant energy, good bowel movement and stabilizing blood sugar levels (Shils, 2005). The values obtained as fat content for the cereal samples were significant ($P>0.05$) while multiple comparison showed that, that of white corn/yellow corn were insignificant.

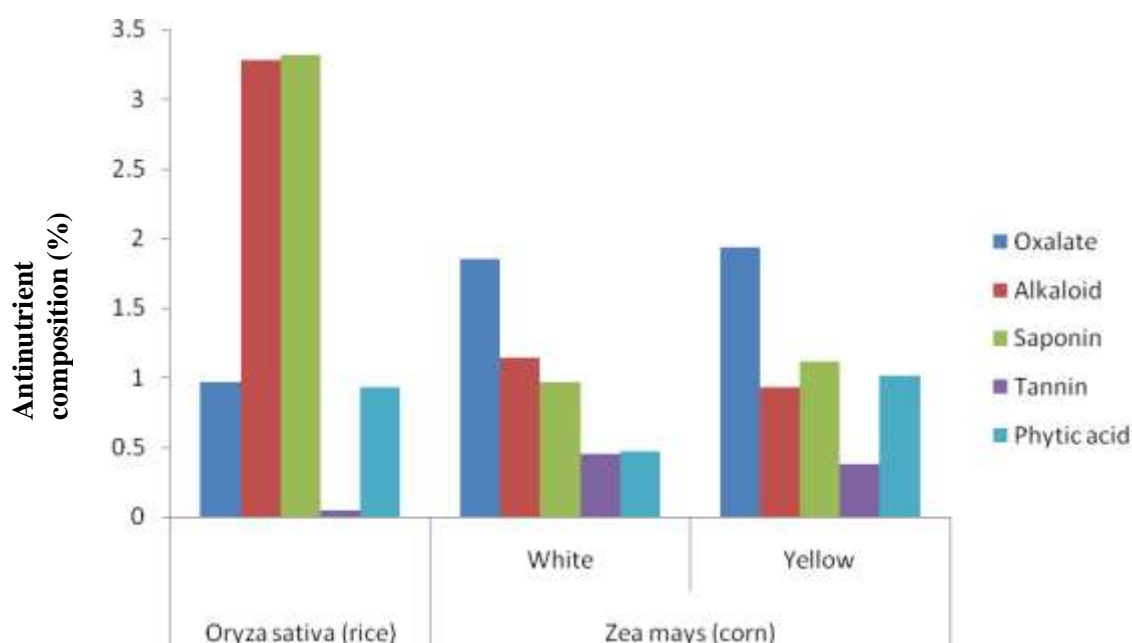
Crude protein ranged between 2.00 ± 0.00 for white corn and 4.19 ± 0.00 for yellow corn. The values are low when compared with AMDR (5-35g) and even lower for the RDI (9-46g). The values were also not up to 12%, thus according to Pearson (1976), they are not good sources of protein and must be eaten with other rich sources of protein for a balanced diet. The yellow corns which are normally harder than the white corn are better source of protein than the preferred white corn. The mean differences for the cereals species were significant ($P>0.05$).

Crude fibre ranged between 6.00 ± 0.00 for rice and 13.43 ± 0.05 for yellow corn. These values were low compared to RDI (19-38g) of fibre and thus should be supplemented in such diet. The importance of fibre in human diet has been reported (Emoresele and Eromosele, 1993). Thus yellow corn had more fibre than the white corn and rice had the least. The mean differences were significant ($P>0.05$).

Carbohydrate contents ranged between 62.96 ± 0.86 for yellow corn and 70.76 ± 0.87 for rice. The values met the AMDR for carbohydrates stated earlier but still below RDI values and should be eaten with other foods. The values fall within the range reported by Raules, (1992) and Sanchez-marouquin, (1983) for most cereals and legumes (14-70%). Rice had the highest carbohydrate content as shown in Figure 3.9 while white corn had the least carbohydrate content. There is no other food item that provides energy to the world as provided by rice (Jacob, 1998). The differences in mean obtained were significant at the 0.05 level.

Table 3.10: Antinutrient compositions of the cereal samples (g %)

Samples	Oxalate	Alkaloid	Saponin	Tannin	Phytic acid
<i>Oryza sativa</i> (rice)	0.97±0.01	3.28±0.01	3.32±0.01	0.05±0.02	0.93±0.00
<i>Zea mays</i> (corn)					
White	1.85±0.01	1.14±0.02	0.97±0.01	0.45±0.02	0.47±0.01
Yellow	1.93±0.01	0.93±0.02	1.11±0.01	0.38±0.01	1.01±0.01



Cereal species

Fig. 3.10: Antinutrient compositions of some cereal samples

The antinutritional compositions of the cereal species in g% are reported in Table 3.10 and Figure 3.10. Oxalate ranged between 0.97 ± 0.01 for rice and 1.93 ± 0.01 for yellow corn. Oxalate was highest in yellow corn and found least in rice. Oxalate was thus found in all the cereal species, but none was up to 25g% reported as toxic level (Oke 1966; Munrio and Bassir, 1969). The implications of oxalate rich food have been reported by Ladeji et al., (2004); Oke, (1967); Blood and Radostti, (1989). There were significant differences in means obtained ($P > 0.05$).

Alkaloids ranged between 0.93 ± 0.02 for yellow corn and 3.28 ± 0.01 for rice. Rice had the highest alkaloid content while yellow corn had the least value among the cereal species. The high levels of alkaloid in rice suggested high antimicrobial activities and might contribute to the medicinal value of such food (Evans, 2005). The mean differences were significant at the 0.05 level.

Saponin ranged between 0.97 ± 0.01 for white corn and 3.32 ± 0.01 for rice. Saponin was found highest in rice among the cereal species and least in white corn. The importance of saponin as anti-inflammatory compound had been reported (Jacob and Meyer, 1988), helping the immune system to protect humans against cancer. Saponin also lowers cholesterol levels (Jacobs, 1998). Other negative effects of high saponin diets have been reported (Applebaum et al., 1969; Awe and Sodipo, 2001; Sim et al., 1984; Potter et al., 1993 and Dei et al., 2007). The difference in mean were also significant ($P>0.05$).

Tannin ranged between 0.05 ± 0.02 for rice and 0.45 ± 0.02 for white corn. Tannin was shown to be highest in white corn and least in rice. The tannin content of the cereal species were generally low ($P>0.05$). The effects of tannin vary, depending on other factors mentioned earlier (Giner-Chavez, 1996). The values obtained for the cereal species in this work are still far below 5% that could be lethal (Giner-Chavez, 1996). Tannin acts as antioxidant (Tapeiro et al., 2000). Negative attributes of tannin in term of nutrition have been reported (Osagie, 1998).

Phytic acid ranged between 0.47 ± 0.01 for white corn and 1.04 ± 0.01 for yellow corn. The values were low ($P>0.05$) except for white corn which was up to 1% which is within the range 1-6% which could decrease the bioavailability of mineral elements if the food was consumed over a long period (Oke, 1969). Generally, Alkaloid and Saponin are antinutrients found in large quantities among the cereal species analysed, while tannin and phytic acids were generally low among the cereal species

Table 3.11: Mineral compositions of some cereal samples (mg/g)

Samples	K	P	Mg	Na	Ca	Cu	Fe	Zn	Mn
<i>Oryza sativa</i> (rice)	3.42±0.00	0.012±0.00	2.56±0.00	1.58±0.00	ND	0.002±0.00	0.004±0.00	0.44±0.00	ND
<i>Zea mays</i> (corn)									
White	2.96±0.00	0.008±0.00	2.90±0.00	0.96±0.00	0.004±0.00	0.004±0.00	0.020±0.00	0.26±0.00	0.02±0.00
Yellow	2.44±0.00	0.044±0.00	2.70±0.00	1.70±0.00	0.006±0.00	0.010±0.00	0.04±0.00	0.46±0.00	ND

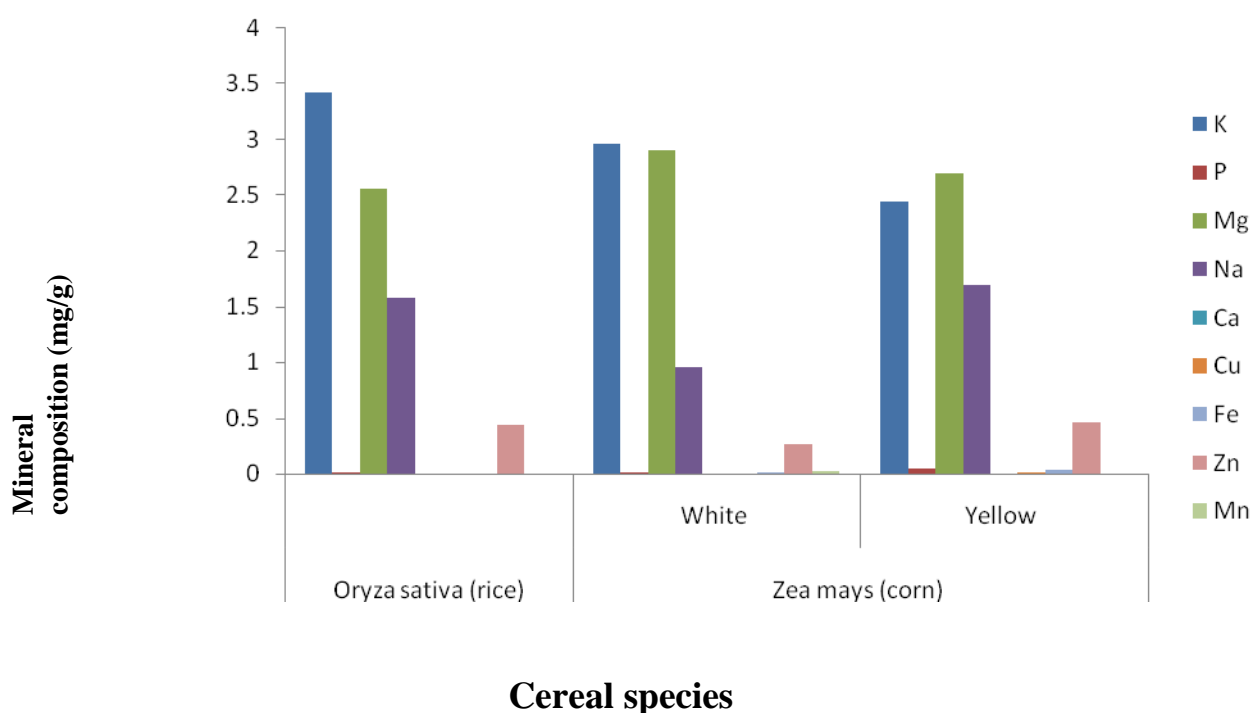


Fig.3.11: Mineral compositions of some cereal samples

The mineral composition of the cereal species in mg/g are reported in Table 3.11 and Figure 3.11. Potassium, (RDI, >2000mg), was found to be the most abundant in all the cereal species, with rice having the highest value (3.42) and yellow corn the least value (2.44). This confirmed again the literature report that potassium was widely distributed in foods and was rarely deficient in the diet (Sharma, 2006).

Magnesium, (RDI, 350mg), was the second most abundant mineral found among the cereal species, ranging from 2.56 for Rice to 2.90 for White corn. It has ability to replace calcium in cases of calcium deficiency. Thus, these cereals were good sources of magnesium.

Sodium, (RDI, 2400mg) was found to be the third most abundant mineral among these cereals ranging from 0.96 for white corn to 1.70 for yellow corn, and its importance as a major mineral cannot be over emphasized. Zinc, (RDI, 15mg), was fairly present in all the cereals, between 0.26 for white corn and 0.46 for yellow corn. Phosphorous, (RDI, 100mg), copper, (RDI, 2mg), calcium, (RDI, 1000mg) and manganese, (RDI, 5mg) were very low in the cereals but manganese was not detected in rice and yellow corn and calcium not also detected in rice. None of the cereals had up to the RDI value and thus should be supplemented in these foods but minerals, K, Mg, and Na were the abundant major minerals found among the cereal species studied while Zn, though low was most abundant micromineral and others in very minute quantities.

Table 3.12: Energy values of some cereal samples

Samples	E(KJ/g)
<i>Oryza sativa</i> (rice)	1,672.97
<i>Zeamays</i> (corn) White	1,660.77
Yellow	1,613.17

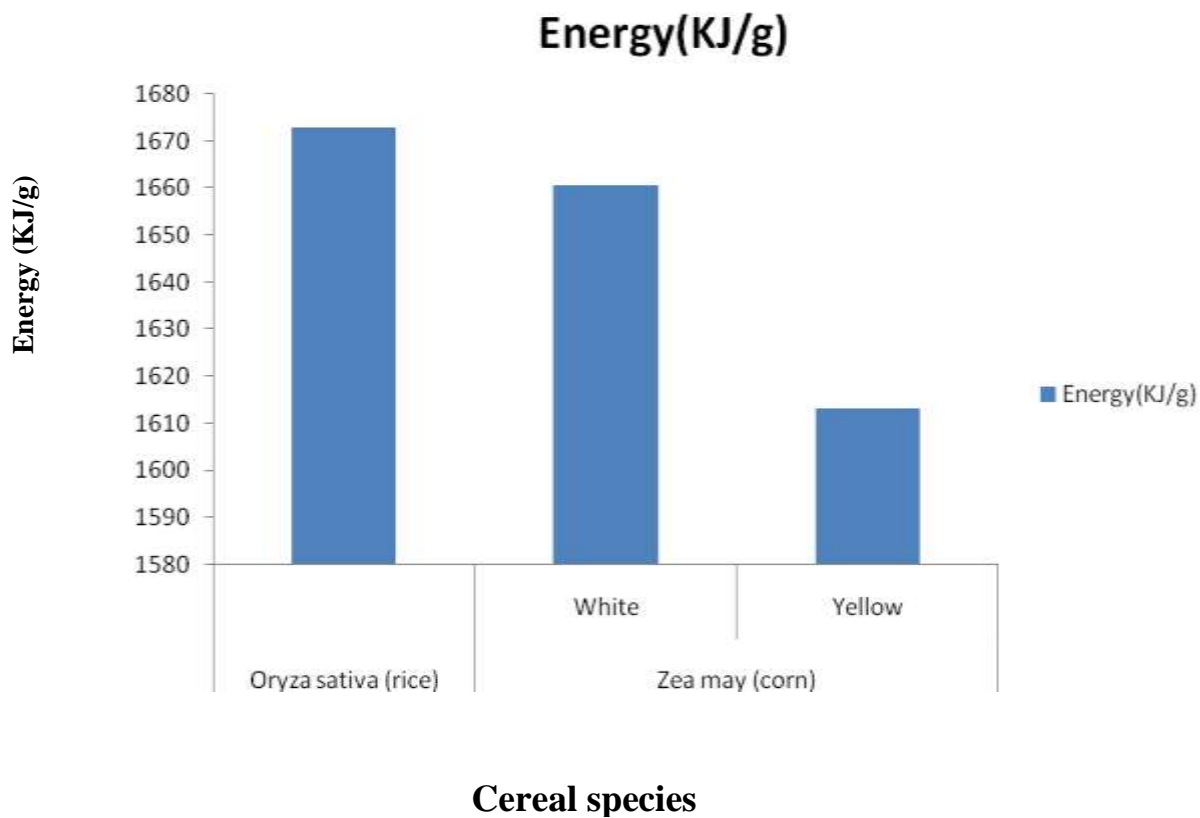


Fig. 3.12: Energy values of some cereal samples

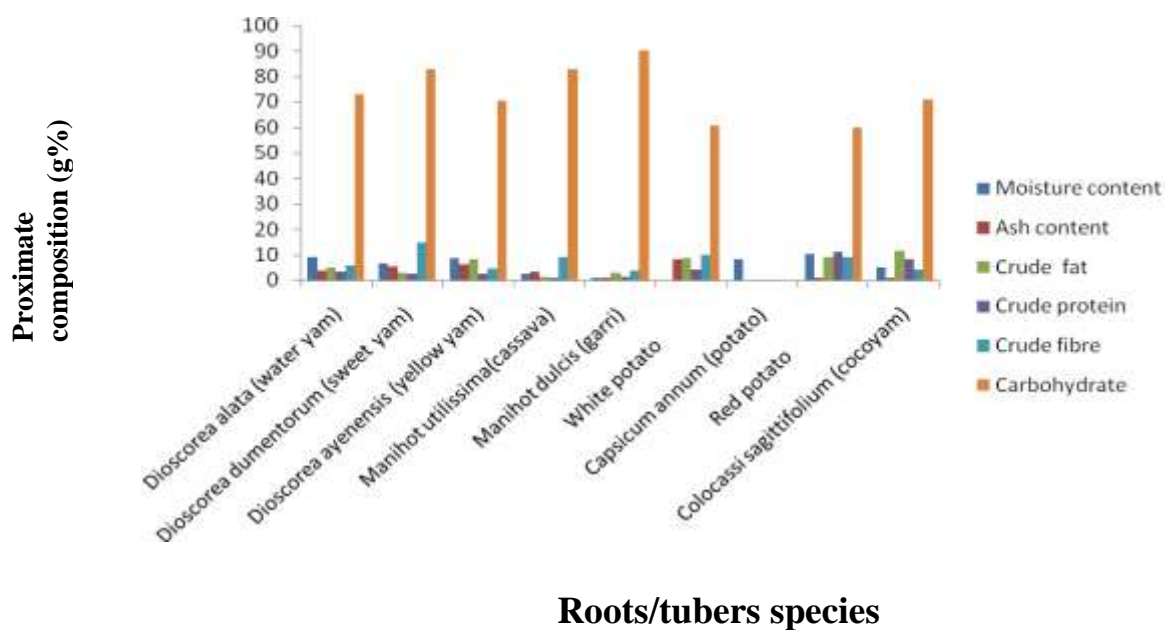
The energy values of the cereal species are reported in Table 3.12 and Figure 3.12. The values ranged between 1613.17 ± 7.86 for yellow corn and 1672.97 ± 3.48 for rice. The values were slightly higher compared to that reported by Jacob and Meyer, (1998). Rice showed the highest calorific value, followed by white corn and then yellow corn. Generally, all the cereals are of high energy but not up to the 2000kcal or 8500kJ/g RDA, so must be combined and consumed with other food classes to make a complete or balanced diet.

3.4 PROXIMATE, ANTINUTRITIONAL, MINERAL ANALYSIS AND ENERGY VALUE RESULTS OF THE ROOTS/TUBERS SPECIES

Table 3.13: Proximate compositions of some roots/tubers (g /100g)

	Moisture content	Ash content	Crude fat	Crude protein	Crude fibre	Carbohydrate
<i>Dioscorea alata</i> (water yam)	9.17±1.18	3.67±0.47	5.00±0.82	3.08±0.12	5.93±0.09	73.15±0.91
<i>Dioscorea dumenforum</i> (sweet yam)	6.50±0.00	5.33±0.47	3.00±0.82	2.35±0.03	14.93±0.09	82.81±0.72
<i>Dioscorea ayenensis</i> (yellow yam)	8.50±0.00	6.00±0.00	8.00±0.82	2.62±0.01	4.49±0.03	70.39±0.83
<i>Manihot Utilissima</i> (cassava)	2.50±0.41	3.47±0.41	1.27±0.41	0.95±0.03	9.00±2.16	82.81±2.12
<i>Manihot dulcis</i> (garri)	0.83±0.24	0.67±0.24	3.00±0.82	1.36±0.01	3.83±0.24	90.31±1.04
White <i>Capsicum annum</i> (potato)	8.17±0.24	8.33±2.36	8.67±0.47	4.10±0.37	10.00±0.00	60.73±0.83
Red <i>Colocassi sagittifolium</i> (cocoyam)	10.33±0.47	0.83±0.24	9.00±0.82	11.20±0.16	8.83±0.24	59.81±1.02
	5.00±0.00	0.83±0.24	11.33±0.94	8.06±0.98	3.93±0.42	70.85±2.27

Fig. 3.13: Proximate compositions of some roots/tubers species.



The proximate compositions of some roots/tuber species in g% are shown in Table 3.13 and Figure 3.13. The moisture content ranged between 0.83 ± 0.24 for garri and 10.33 ± 0.47 for red sweet potato. Garri had the least moisture content while red sweet potato had the highest. These values agreed with that reported by Frederick, (2008) but the nutritional compositions of roots and tubers may also vary depending on the climate, the soil, the crop variety and other factor (Raspier and Coursely, 1967).

The ash content ranged between 0.67 ± 0.24 for garri and 8.33 ± 2.36 for white sweet potato. Garri had the least ash content whereas white sweet potatoes had the highest. The values agreed with 1-5% expected for fresh foods which could be as high as 12% in some processed foods (FNB, 1974).

The ash contents in all the species were generally low, except in white sweet potato (8.33), yellow yam (6.00), and to some extent sweet yam (5.33) that were significantly higher ($P > 0.05$) than the other species.

The crude fat ranged between 1.27 ± 0.41 for cassava and 11.33 ± 0.94 for cocoyam. Cocoyam gave the highest fat content while cassava gave the least. The values are low compared with AMDR for total fat (20-35g). According to Mindy and Mueller, (1977), all root crops exhibit low lipid contents and these are mainly structural lipids of the cell membrane which enhance cellular integrity, offer resistance to bruising and help to reduce enzyme browning and have limited nutritional importance.

Crude protein ranged between 0.95 ± 0.03 for cassava and 11.20 ± 0.16 for red sweet potato. The protein content was highest in red sweet potatoes and least in cassava. The values are low compared with AMDR (5-35g) and even lower compared with RDI (9-46g), varying for different age groups (Dietary Reference Intakes for Macronutrients, 2002/2005. www.nap.edu). To some extent, the protein content of root crops is influenced by variety, cultivation practice, climate, growing season and location (Woolfe, 1987). In potato, the addition of nitrogen fertilizer increases the protein content (Eppendorfer et al., 1979; Hoff *et al.*, 1971). The protein values for yams agreed with that reported by Francis *et al.*, (1975) (1.3-3.3%) but the protein content of potato did not agree with the result of Eppendorfer et al., (1979); the values were higher which could be due to nitrogen fertilizer added during the cultivation or geographic position and climate. Food containing about 5 percent of total energy provided by utilizable, balanced protein can sustain health if it can be eaten in sufficient quantities to meet energy requirements (Abrahamson, 1978). Thus red sweet potato (11.20%), cocoyam (8.06%) of protein content could supply protein which could sustain health of humans. Although cassava protein was low (0.95%) in total essential amino-acids than other root crops, recently Adewusi et al., (1988) found that cassava flour used as a component in animal feeding trials was a more effective replacement for wheat than either sorghum or maize. In order to maximize the protein contribution of these commonly eaten foods to

diet, they should be supplemented with a wide variety of other foods, including cereals.

The crude fibre content ranged between 3.83 ± 0.24 for garri and 14.93 ± 0.09 for sweet yam. Sweet yam showed the highest fibre content. The values agree with that reported by Kadashi, (2005) but were low compared with the RDI (19-38g) for total fibre. Apart from sweet yam, sweet potato showed high fiber content. This confirmed the fact that it was a significant source of dietary fibre as its pectin content could be as high as 5 percent of fresh weight (Collins and Walter, 1982). The role of fiber and its importance in nutrition had aroused a lot of interest in recent years. Some epidemiological evidence suggest that increased fibre consumption may contribute to a reduction in the incidence of certain diseases, including diabetes, coronary heart disease, colon cancer, and various digestive disorders (Collin and Walter, 1982).

The carbohydrate content ranged between 59.8 ± 1.02 for red sweet potato and 90.31 ± 1.04 for garri. Garri had the highest carbohydrate content whereas red sweet potatoes showed the least. The values agreed well with AMDR (45-65g), but fairly with 60-130g RDI for total digestible carbohydrate. From Figure 3.13, the main nutrient supplied by roots/tubers is dietary energy provided by carbohydrate (WHO, 1985; FAO, 1970). Thus, the roots/tubers were all good energy giving foods. The detrimental roles of a high carbohydrate diet have been reported in nutrition example in Alzheimer's disease (Seneff *et al.*, 2011). The mean difference of the proximate compositions of roots/tubers were significant ($P > 0.05$).

Table 3.14: Antinutrient compositions of some of roots and tubers (g %)

	Oxalate	Alkaloid	Saponin	Tannin	Phytic acid
<i>Dioscorea alata</i> (water yam)	1.82±0.01	0.85±0.01	0.92±0.01	0.53±0.02	1.42±0.02
<i>Dioscorea Dumentorum</i> (sweet yam)	2.93±0.01	0.73±0.01	0.78±0.01	0.48±0.01	1.32±0.02
<i>Dioscorea ayenensis</i> (yellow yam)	3.07±0.01	0.84±0.02	0.87±0.01	0.32±0.01	0.92±0.01
<i>Manihot utilissima</i> (cassava)	0.29±0.03	2.46±0.38	1.87±0.26	1.03±0.06	1.07±0.31
<i>Marrihot dulcis</i> (garri)	1.27±0.01	0.87±0.01	0.88±0.01	0.27±0.01	0.92±0.01
White	1.44±0.01	1.07±0.01	1.23±0.01	0.36±0.01	1.31±0.01
<i>Capsicum annum</i> (potato)					
Red	1.77±0.001	1.05±0.01	0.66±0.02	0.24±0.02	1.47±0.01
<i>Cololassi sagittifolium</i> (cocoyam)	1.27±0.01	1.44±0.01	0.86±0.02	0.14±0.02	2.68±0.00

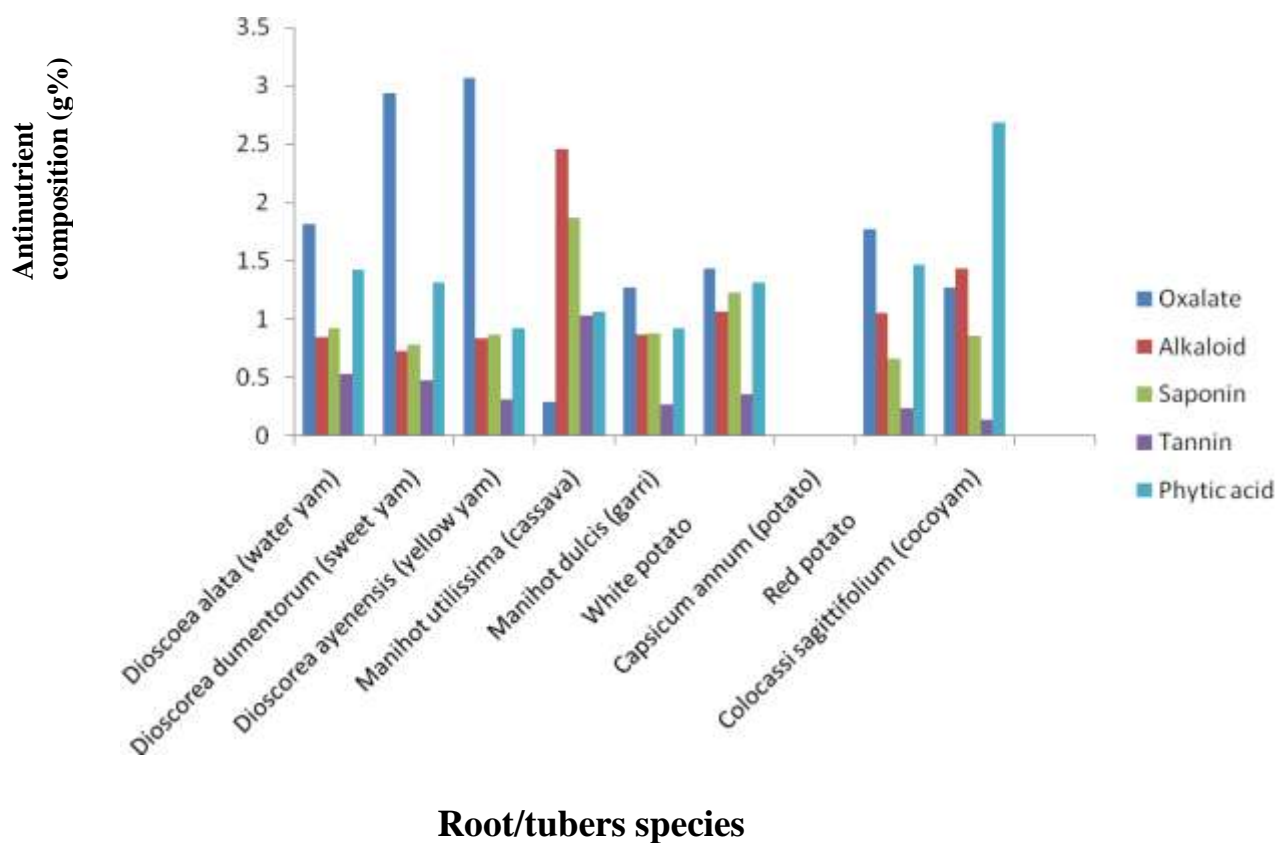


Fig. 3.14: Antinutrient compositions of some roots/tubers

The antinutrient compositions of some roots/tubers species are reported in Table 3.14 and shown in Figure 3.14. Oxalate ranged between 0.29 ± 0.03 for cassava and 3.07 ± 0.01 for yellow yam. Yellow yam showed the highest oxalate content whereas cassava showed the least. The yellow yam, though is not commonly eaten but are well known and eaten in most parts of Imo State of Nigeria and commonly called Ogbagada. Oke, (1969) has given an extensive review of the role of oxalate in nutrition, including the possibility of oxalurea and kidney stones. The acidity of high oxalate cultivars of some cocoyam could be reduced by peeling, grating, soaking and fermenting during processing. The importance of oxalic acid in limiting the utilization of dietary calcium has been reported (Ladeji *et al*, 2004).

Alkaloids ranged between 0.73 ± 0.01 for sweet yam and 2.46 ± 0.38 for cassava. Alkaloid was found highest in cassava and least in sweet yam ($P>0.05$). The high content of alkaloid in cassava suggested some antimicrobial properties. In some yam, bitter principles have been identified as alkaloid dihydrodioscorine (Bevan and Hirst, 1958). All the root/tuber species contained reasonable quantities of alkaloid and it has been shown that even in very small amounts, the alkaloids produce strong physiological effects on the body (John, 2009).

Saponin content ranged between 0.78 ± 0.01 for sweet yam and 1.87 ± 0.26 for cassava. Saponin was found highest ($P>0.05$) in cassava and least in sweet yam. Cassava is commonly eaten in Eastern Nigeria and this showed highest content of saponin. Though there were health benefits associated with saponin, saponins are characterized by their bitter or astringent taste and foaming properties and their haemolytic effect on red blood cells (Khalil and Eladaway, 1994). High levels of saponin in feed (especially if mixed with cassava flour) could affect feed intake and growth rate in poultry (Sim *et al.*, 1984; Potter *et al.*, 1993; Dei *et al.*, 2007). Thus reduction in feed intake has

been ascribed to the bitter taste of saponins (Cheeke, 1971) and due to the irritating taste (Oleszek et al., 1994).

Tannin content ranged between 0.14 ± 0.02 for cocoyam and 1.03 ± 0.06 for cassava. Cassava showed the highest tannin content while cocoyam showed the least. Studies on rats, chicks and livestock revealed that high tannin levels in diet adversely affect digestibility of proteins and carbohydrates, thereby reducing growth, feeding efficiency, metabolizable energy and bioavailability of amino acids (Aletor, 1993; De-Bruyne et al., 1999, Dei *et al.*, 2007). Though Tannin (Giner-Chavez, 1996) level above 5% of a diet is often lethal, feeds of livestock, chicks etc made from cassava flour should not be fed over a long period of time.

Phytic acid content ranged between 0.92 ± 0.01 for yellow yam and garri and 2.68 ± 0.00 for cocoyam. Cocoyam showed the highest phytate ($P > 0.05$) content while yellow yam and garri showed the least. The interspecies all showed phytic acid level above one percent except yellow yam and garri (both 0.92). According to Oke, (1969) a phytic diet of 1.6% over a long period decreased the bioavailability of mineral elements.

All the species should be eaten in moderate quantity or with mineral supplements to avoid diseases associated with mineral deficiencies in the body due to mineral depletion.

Table 3.15: Mineral compositions of some roots and tubers (mg/g)

	K	P	Mg	Na	Ca	Cu	Fe	Zn	Mn
<i>Dioscorea alata</i> (water yam)	2.92±0.00	0.0022±0.00	2.44±0.00	1.518±0.00	0.002±0.00	0.002±0.00	ND	0.41±0.00	0.02±0.00
<i>Dioscorea dumetorum</i> (sweet yam)	3.34±0.00	0.0076±0.00	1.82±0.00	1.342±0.00	ND	0.002±0.00	0.002±0.00	0.24±0.00	0.02±0.00
<i>Dioscorea ayenensis</i> (yellow yam)	2.16±0.00	0.0036±0.00	2.36±0.00	2.96±0.00	0.002±0.00	0.004±0.00	0.002±0.00	0.32±0.00	ND
<i>Manehat utilisima</i> (cassava)	3.56±0.00	0.006±0.00	1.56±0.00	1.54±0.00	ND	ND	0.04±0.00	0.56±0.00	0.002±0.00
<i>Marrihot dulcis</i> (garri)	3.56±0.00	0.052±0.00	2.56±0.00	2.38±0.00	0.002±0.00	0.004±0.00	0.020±0.00	0.36±0.00	0.02±0.00
White <i>Capsicum annum</i> (potato)	3.84±0.00	0.0082±0.00	2.82±0.00	2.66±0.00	0.020±0.00	0.004±0.00	0.040±0.00	0.38±0.00	0.002±0.00
Red <i>Colocassi sagiltifolium</i> (cocoyam)	2.60±0.00	0.0136±0.00	2.42±0.00	1.410±0.00	0.020±0.00	0.004±0.00	0.060±0.00	0.32±0.00	ND
	2.98±0.00	0.0022±0.00	1.36±0.00	1.410±0.00	0.020±0.00	0.022±0.00	0.04±0.00	0.36±0.00	0.04±0.00

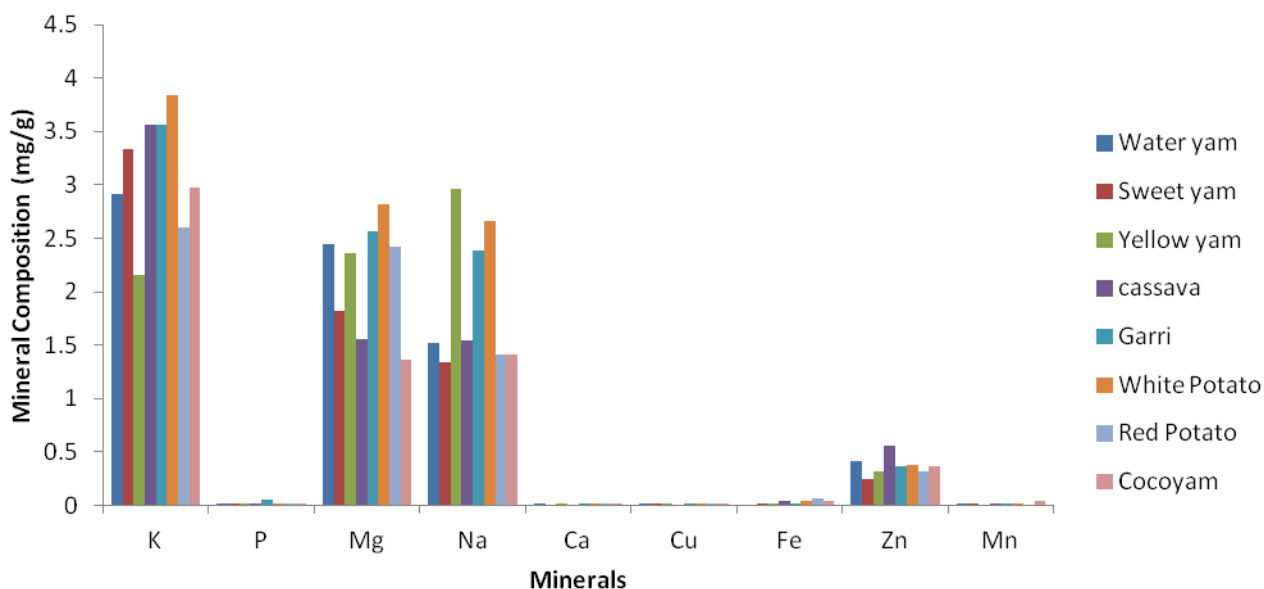
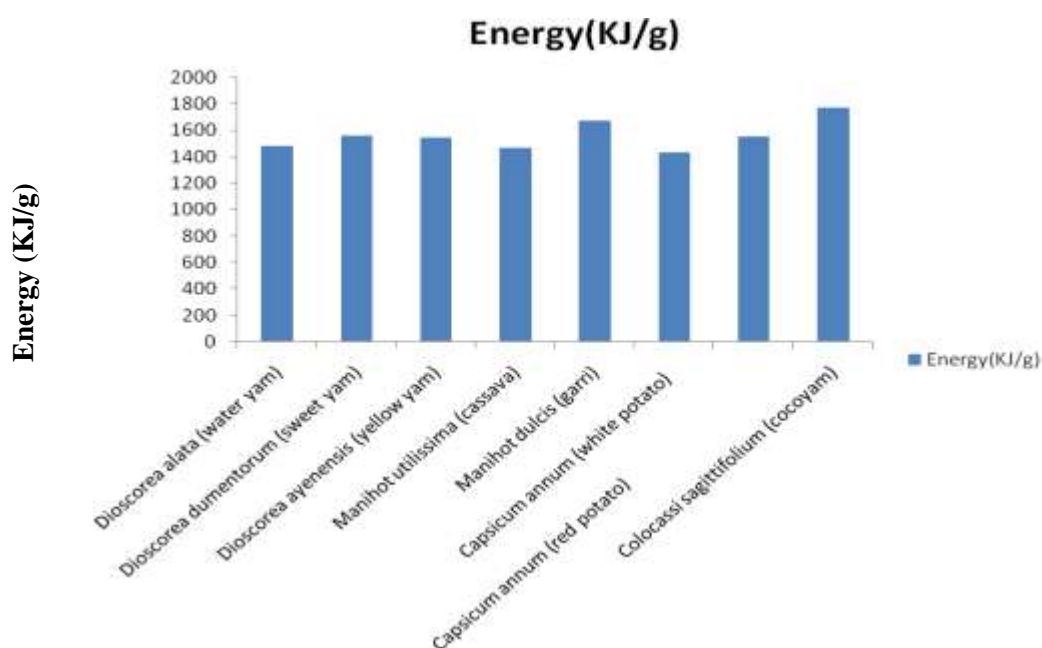


Fig. 3.15: Mineral compositions of some roots/tubers

The mineral composition of some root/tuber species in mg/g are reported in Table 3.15 and Figure 3.15. Potassium, (RDI,2000-3500mg) was high in all the species, being highest in white sweet potatoes (3.84) and least in yellow yam (2.16). This again confirmed the fact that potassium was widely distributed in foods and was rarely deficient in diet. These rich Potassium foods must be omitted in diets of people with renal failure (McLay *et al.*, 1972), especially white sweet potato. Magnesium,(RDI,350mg) was the next most abundant mineral in the root/tuber species, being highest in white sweet potato (2.82) and least in cocoyam (1.36), and such foods could be recommended in cases of magnesium deficiencies and even calcium deficiencies since magnesium could replace some portion of body Calcium (John, 2009). Sodium, (RDI,>1500mg), was found as the third abundant in the root species, with 2.96 in yellow yam and 1.34 in sweet yam. All the root/tuber species could supply appreciable quantity of sodium needed in human diet. Zinc, (RDI, 15mg), was fairly and evenly distributed in all the root/tuber species but phosphorous, (RDI, 1000mg), calcium, (RDI, 1000mg), copper, (RDI, 2mg), iron,(RDI, 15mg) and manganese,(RDI, 5mg), were in trace amounts. Iron was not detected in water yam, copper not detected in cassava, calcium not detected in sweet yam and cassava and manganese not detected in yellow yam. None of the root/tuber species showed up to RDI of these minerals and should be supplemented in our diets or eaten in adequate amounts and the differences in their mean values were insignificant.

Table 3.16: Energy values of some roots/ tubers

Sample		kJ/g
Dioscoea alata (water yam)		1,487.16
Dioscorea dumentorum (sweet yam)		1,562.47
Dioscorea ayenensis (yellow yam)		1,547.17
Manehat utilisissima (cassava)		1,472.48
Marrihot dulcis (garri)		1,673.14
	White	1,433.74
Capsicum annum (potato)		
	Red	1,551.42
Colocarsi sagiltifolium (cocoyam)		1,774.84



Roots/tubers species

Fig. 3.16: Energy values of some roots/ tubers

The energy values of the root/tuber species are reported in Table 3.16 and in Figure 3.16. The values ranged between 1433.74 ±3.30 for white sweet potato and 1774.84±1.19 for cocoyam. Cocoyam ranked highest in calorific values and white sweet potato ranked least. They all showed high calorific values but below 8500kJ/g RDI of calories and must be combined with other foods for a balanced diet.

3.5 PROXIMATE, ANTINUTRITIONAL, MINERAL ANALYSIS AND ENERGY VALUE RESULTS OF THE OIL SPECIES

Table 3.17: Proximate compositions of red and groundnut oils (g/100g)

Samples	Moisture content	Ash content	Crude fat	Crude fibre
<i>Elaeis guineensis</i> oil (red oil)	4.80±0.16	0.13±0.008	94.97±1.70	0.10±0.00
<i>Arachis hypogel</i> oil (groundnut oil)	4.17±0.12	0.14±0.008	95.69±1.70	0.00±0.00

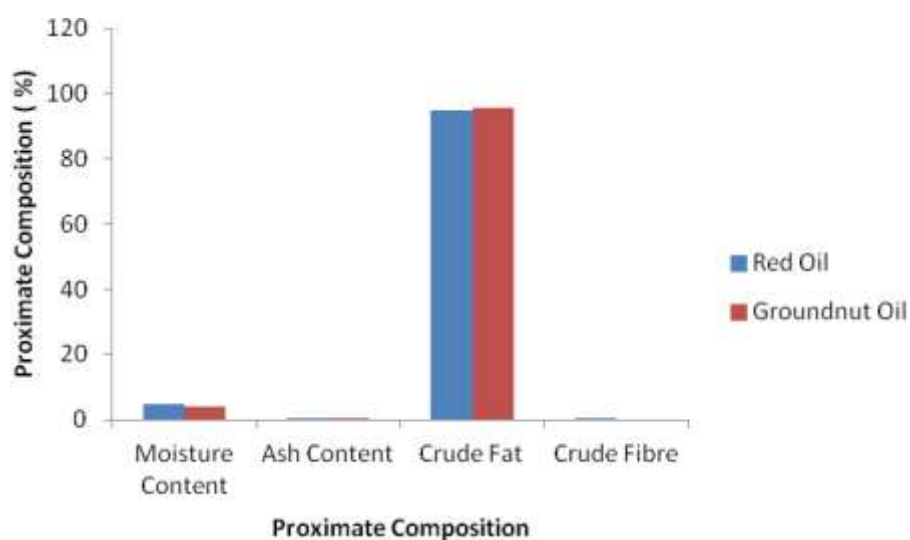


Fig. 3.17: proximate compositions of red and groundnut oils

The proximate composition of the oil samples in g% are reported in Table 3.17 and in Figure 3.17. The moisture content was slightly higher in red oil (4.80 ± 0.16) than in groundnut oil (4.17 ± 0.12). Ash content for both oil were approximately of the same value 0.13 ± 0.008 for red oil and 0.14 ± 0.008 for groundnut oil, thus did not exceed 5% expected for fresh foods. Crude fat was a little higher in red oil (38.30 ± 1.70) than in groundnut oil (35.67 ± 1.70), but both met the RDI, (30-31g) and the AMDR, (20-35g) total fat. Fibre was not detected in groundnut oil but very low (0.10 ± 0.00) for red oil (below 19-38g, RDI) and should be supplemented in such diet.

Table 3.18: Antinutrient compositions of red and groundnut oil (g %)

Samples	Oxalate	Alkaloid	Saponin	Tannin	Phytic acid
<i>Elaeis guineensis</i> oil (red oil)	0.12±0.01	0.81±0.01	0.54±0.02	0.32±0.01	0.76±0.01
<i>Arachis hypogel</i> oil (groundnut oil)	0.41±0.01	0.85±0.02	0.64±0.05	0.18±0.02	0.21±0.01

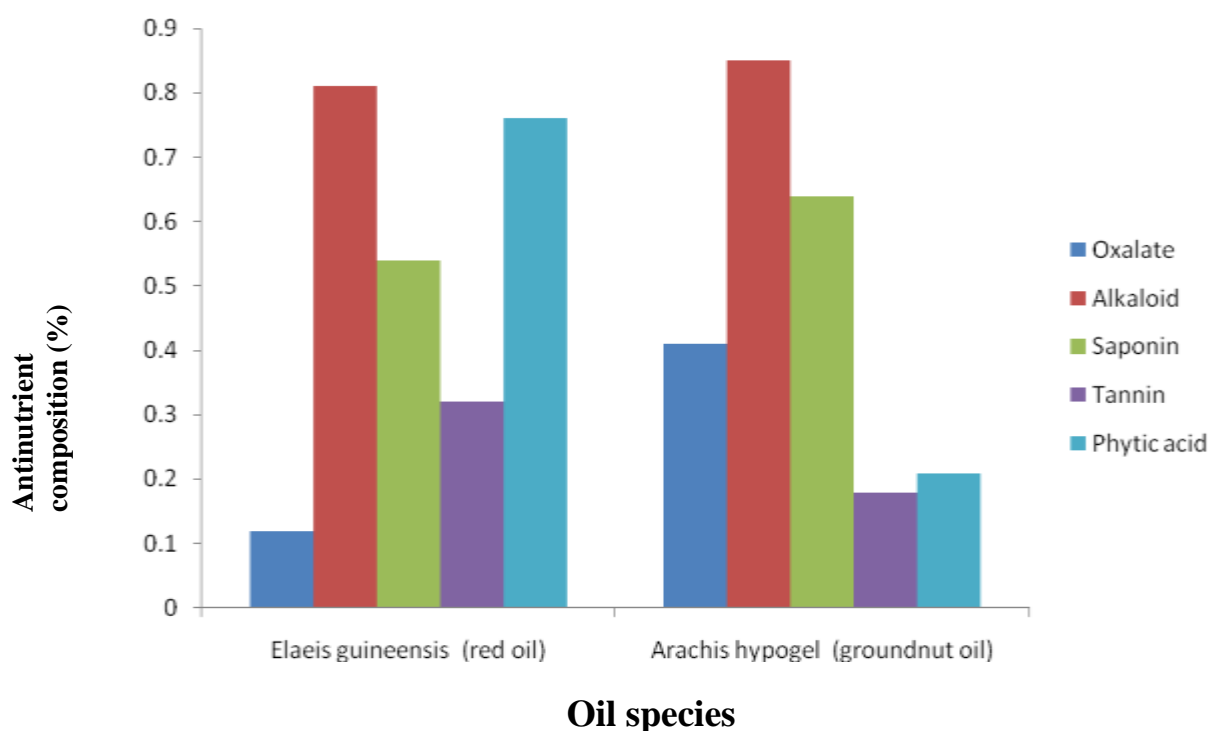


Fig. 3.18: Antinutrient compositions of red and groundnut oils

The antinutrient compositions of the oil samples in (g %) are reported in Table 3.18 and in Figure 3.18. Oxalate content was slightly higher in groundnut oil (0.41 ± 0.01) than in red oil (0.12 ± 0.01). Alkaloid was found a little higher in groundnut oil (0.85) than in red oil (0.81). Saponin in red oil was lower (0.54 ± 0.02) than in groundnut oil 0.64 ± 0.05 . Tannin was found slightly higher in red oil (0.32 ± 0.01) than in groundnut oil (0.18 ± 0.02). Phytic acid was higher (0.76 ± 0.01) for red oil than for groundnut oil (0.21 ± 0.01). The content of antinutrients in both oil samples did not vary as such and

the values are generally low for all the antinutrient tested, and thus might not play an important role in their nutritive values unless if consumed excessively over a period of time. The students t-test showed that the difference in the mean values obtained were significant ($P>0.05$).

TABLE 3.19: Mineral compositions of red and groundnut oils (mg/g)

	K	P	Mg	Na	Ca	Cu	Fe	Zn	Mn
Elaeis guineensis oil (red oil)	6.22±0.00	0.048±0.00	9.42±0.00	18.36±0.00	23.62±0.00	0.036±0.00	5.42±0.00	8.24±0.00	1.66±0.00
Arachis hypogel oil (groundnut oil)	5.66±0.00	0.056±0.00	10.40±0.00	17.64±0.00	24.44±0.00	0.048±0.00	10.40±0.00	6.44±0.00	2.18±0.00

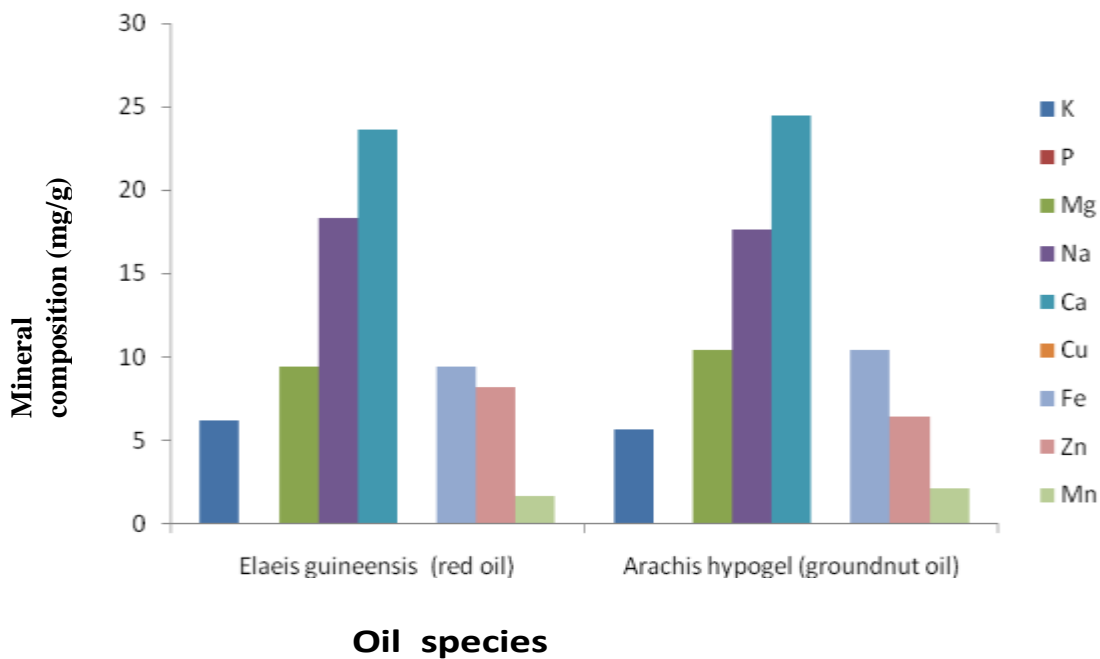


Fig. 3.19: Mineral compositions of red and groundnut oils

The mineral composition of the oil samples in mg/g are reported in Table 3.19 and in Figure 3.19.

Calcium, (RDI, 1000mg), was found most abundant in the oil species, being higher (24.44 ± 0.00) for red oil and lower (23.62 ± 0.00) for groundnut oil. The second most abundant mineral was sodium, (RDI, >1500mg), being higher for red oil (18.36 ± 0.00) than for groundnut oil (17.64 ± 0.00). Magnesium, (RDI, 350mg) and Fe, (RDI, 15mg), were the third most abundant minerals found equal in quantity in both oil species 9.42 and 10.40 respectively. Zinc, (RDI, 15mg), a trace mineral was the fourth most abundant mineral and was a little higher for red oil (8.24 ± 0.00) than for groundnut oil (6.44 ± 0.00). Potassium, (RDI, 2000-3500mg), was the fifth abundant, found higher in red oil (6.22) than in groundnut oil (5.66). Manganese, (RDI, 5mg), ranked sixth in abundance being higher in groundnut oil (2.18) than in red oil (1.66). Copper, (RDI, 2mg) and phosphorous, (RDI, 1000mg), were found in trace amounts. Both oils did not meet the recommended values for the minerals and should be supplemented in such foods while mean differences were all insignificant.

Generally, the oil samples were rich in mineral and hence excellent sources of mineral since all the micro and macro mineral selected which are essential mineral required for human welbing were present.

3.6 PROXIMATE, ANTINUTRITIONAL, MINERAL ANALYSIS AND ENERGY VALUE RESULTS OF THE MEAT SPECIES

Table 3.20: Proximate compositions of some meat samples in g/100g

	Moisture content	Ash content	Crude fat	Crude protein	Crude fibre	Carbohydrate
Bos indicus (beef)	7.27±0.04	0.43±0.01	7.0±0.82	34.67±1.25	0.21±0.01	50.52±1.29
Melleagris gallopardo (turkey)	6.63±0.12	0.55±0.02	5.93±0.25	52.53±0.04	0.13±0.01	34.22±0.29
Caprihircus (goat meat)	6.20±0.13	0.45±0.02	7.40±0.13	42.00±0.82	0.33±0.01	43.60±0.59
Gallus domesticus (chicken)	7.10±0.08	0.95±0.02	11.20±0.08	37.70±1.25	0.43±0.01	42.65±1.10

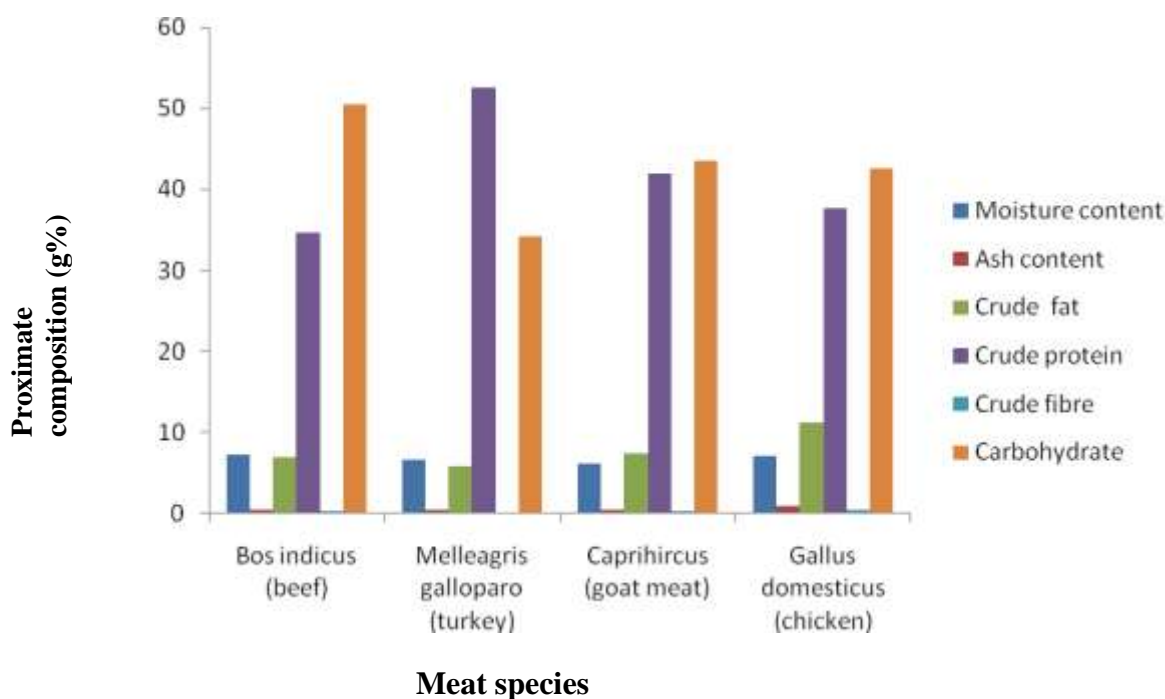


Fig. 3.20: Proximate compositions of some meat species

The proximate composition of the meat species in g% are reported in Table 3.20 and Figure 3.20. The moisture content ranged between 6.20 ± 0.13 for goat meat and 7.27 ± 0.04 for beef. Beef showed the highest moisture content (7.27) followed by chicken (7.10), turkey (6.63) and least in goat meat (6.20).

Ash content ranged between 0.43 for beef and 0.9 for chicken. Chicken showed the highest ash content (0.95) followed by turkey (0.55), then goat meat (0.45) and lastly 0.43 for beef. All the meat species showed ash content not exceeding 5% expected for fresh foods (FNB, 1974).

Crude protein ranged between 34.67 ± 1.25 for beef and 52.53 ± 0.04 for turkey. Turkey was the highest in protein content (53.53) followed by goat meat (42.00), then chicken (37.70) and the least in protein was beef (34.67). The values of protein in the meat species met the RDI of protein, (9-56g) and AMDR, 5-35g, hence were good sources of protein. Just like fish, meats are complete sources of protein, containing all the nine amino acids that the body requires, but cannot make for itself. Protein serves several important functions in the body, including tissue growth and repairs. Meats also contain heme iron, which is more useful to the body than non-heme iron found in plant based foods (Layne, 2011). Turkey was the highest protein containing poultry (Layne, 2011). This value of (52.52%) was in agreement with literature protein content of turkey, and the mean difference between the protein values of all the meats analysed were significant ($P > 0.05$).

Crude fat ranged between 5.93 ± 0.25 for turkey and 11.20 ± 0.08 for chicken. Fat was found highest in chicken (11.20), followed by goat meat (7.40), then beef (7.0) and lastly in turkey (5.93). The values did not meet the AMDR of 20-35g total fat and should be eaten with other foods to make a balanced diet. All the values obtained as fat content were significant at 0.05 level, but multiple comparison of the meat species showed that the difference in mean of beef/turkey, beef/goat meat, and turkey/beef were insignificant.

Depending on the type and cut, meat can be high in fat and cholesterol (Layne, 2011).

Fibre contents ranged between 0.13 ± 0.01 for turkey and 0.43 ± 0.01 for chicken. The fibre content was low in all, being highest in chicken (0.43), followed closely by goat meat (0.33), then beef (0.21) and lastly turkey (0.13). All contain fibre content below 19-38g, which is the RDI of total fibre. There was no significant difference between fibre content of beef/turkey while other values were significant ($P > 0.05$).

Carbohydrate contents ranged from 34.22 ± 0.29 for turkey to 50.52 ± 1.29 for beef. The meat species are all high in carbohydrates, being highest in beef (50.52), followed by goat meat (43.60), closely by chicken (42.65) and lastly 34.22 for turkey. The values fairly agreed with AMDR of 45-65g but below 60-130g, RDI for total digestible carbohydrate. The mean differences obtained as carbohydrate content were all significant ($P > 0.05$), while comparison of goat meat/chicken was not significant.

The meat species are generally rich in all food nutrients as seen in Figure 3.21 except ash, which was quite low in all. A study released in 2007 by the World Cancer Research Fund reported “strong evidence that red meat and processed meats are causes of bowel cancer” and recommends people to eat less than 500 grammes of cooked red meat weekly, and as little processed meat as possible. The report also recommended that average consumption in population should not exceed 300grammes per week. The report further stated that this goal “corresponds to the level of consumption of red meat at which the risk of colorectal cancer can clearly be seen to rise.” It should be noted, though, the 2007 report from the World Cancer Research Fund defined red meat as “Beef, Pork, Lamb, and Goat from domesticated animals”(2007 Report by the World Cancer Research Fund). Lean beef with high selenium and vitamin B₁₂ content may actually lower the risk of colon cancer. The Harvard School of Public Health also recommended that consumers should eat red meat sparingly as it

had high levels of saturated fat and that the consumption of processed meats especially, is associated with higher incidence of coronary heart disease and diabetes mellitus (USDA, 2010).

Table 3.21: Antinutrient compositions of some meat samples in g%

Sample	Oxalate	Alkaloid	Saponin	Tannin	Phytic acid
<i>Bos indicus</i> (beef)	0.32±0.01	0.74±0.01	0.73±0.01	0.24±0.03	0.28±0.01
<i>Melleagris gallopavo</i> (turkey)	0.52±0.01	0.94±0.01	0.82±0.001	0.24±0.02	0.25±0.01
<i>Capri hircus</i> (goat meat)	0.33±0.02	0.11±0.01	0.48±0.01	0.32±0.01	0.20±0.02
<i>Gallus domesticus</i> (chicken)	0.42±0.01	0.84±0.01	0.55±0.02	0.24±0.02	0.20±0.01

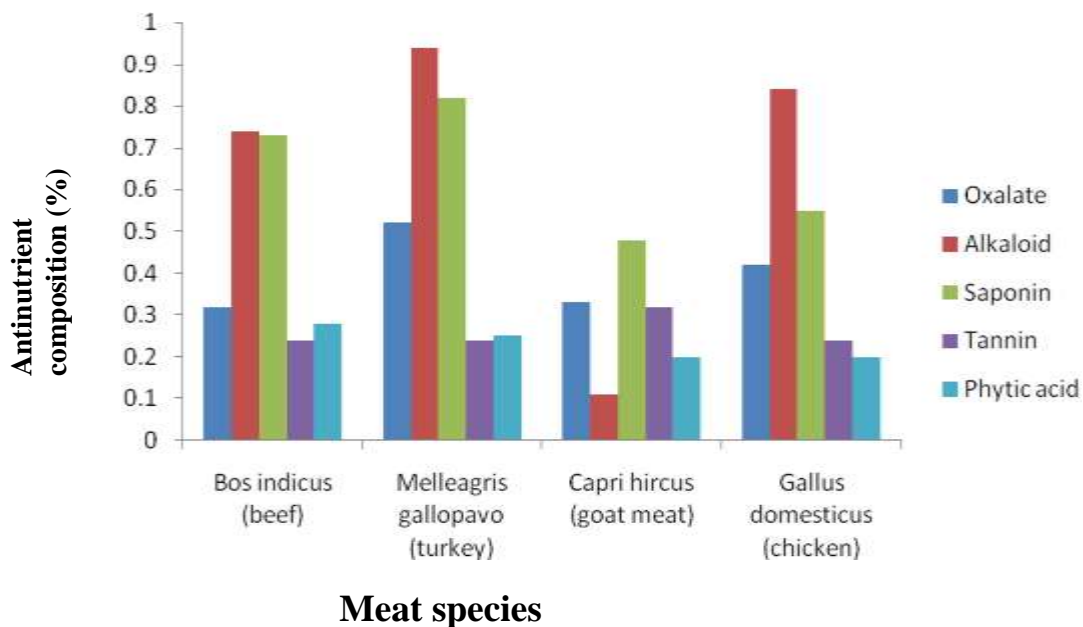


Fig. 3.21: Antinutrient compositions of some meat samples

The antinutrient composition of the meat species in % are shown in Table 3.21 and Figure 3.21.

All the five antinutritive factors analysed were present, but low. Oxalate ranged between 0.32 ± 0.01 for beef and 0.52 ± 0.01 for turkey. The values were significantly different from each other ($P > 0.05$) except the values of goat meat/beef which was insignificant in multiple comparison. Turkey had the highest oxalate content (0.52), followed by chicken (0.42), then goat meat (0.33) and lastly beef (0.32).

Alkaloid ranged between 0.11 ± 0.01 for goat meat and 0.94 ± 0.01 for turkey. Alkaloid was significantly low ($P > 0.05$) in goat meat (0.11) than it was in the other meat species (Fig 3.22). Thus turkey had the highest alkaloid content (0.94), followed closely by chicken (0.84), then beef (0.74) and lastly goat meat (0.11).

Saponin ranged between 0.48 ± 0.01 for goat meat and 0.82 ± 0.001 for turkey. Turkey showed the highest saponin content (0.82) followed by beef (0.73), then chicken (0.55) and lastly goat meat (0.48).

There were significant differences ($P > 0.05$) in the saponin content obtained for all the meat species.

Tannin ranged between 0.24 for turkey, chicken and beef and 0.32 for goat meat. Infact all the meat species show roughly the same quantity of tannin. Multiple comparison showed insignificant difference in beef/turkey,beef /chicken and chicken/turkey values of tannin content while other pairs were significant ($P > 0.05$).

Phytic acid was also estimated to be almost in the same quantities in all the meat species ranging from 0.20 for goat meat and chicken to 0.28 for beef. The mean differences were significant ($P > 0.05$) except in the pair, goatmeat/chicken which was insignificant. Generally the levels of antinutrients in meat species analysed were low and might not play important role in their nutritive values.

Table 3.22: Mineral compositions of some meat samples in mg/g

Sample	K	P	Mg	Na	Ca	Cu	Fe	Zn	Mn
<i>Bos indicus</i> (beef)	11.66±0.00	0.0044±0.00	9.82±0.00	18.98±0.00	22.02±0.00	0.078±0.00	9.82±0.00	9.66±0.00	1.84±0.00
<i>Melleagris gallopardo</i> (turkey)	10.84±0.00	0.054±0.00	9.66±0.00	20.64±0.00	20.38±0.00	0.562±0.00	9.66±0.00	8.48±0.00	1.86±0.00
<i>Capri hircus</i> (goat meat)	11.26±0.00	0.028±0.00	10.24±0.00	24.36±0.00	11.98±0.00	0.038±0.00	10.24±0.00	8.38±0.00	1.96±0.00
<i>Gallus domesticus</i> (chicken)	9.66±0.00	0.056±0.00	12.64±0.00	22.46±0.00	16.44±0.00	0.034±0.00	12.64±0.00	7.76±0.00	0.84±0.00

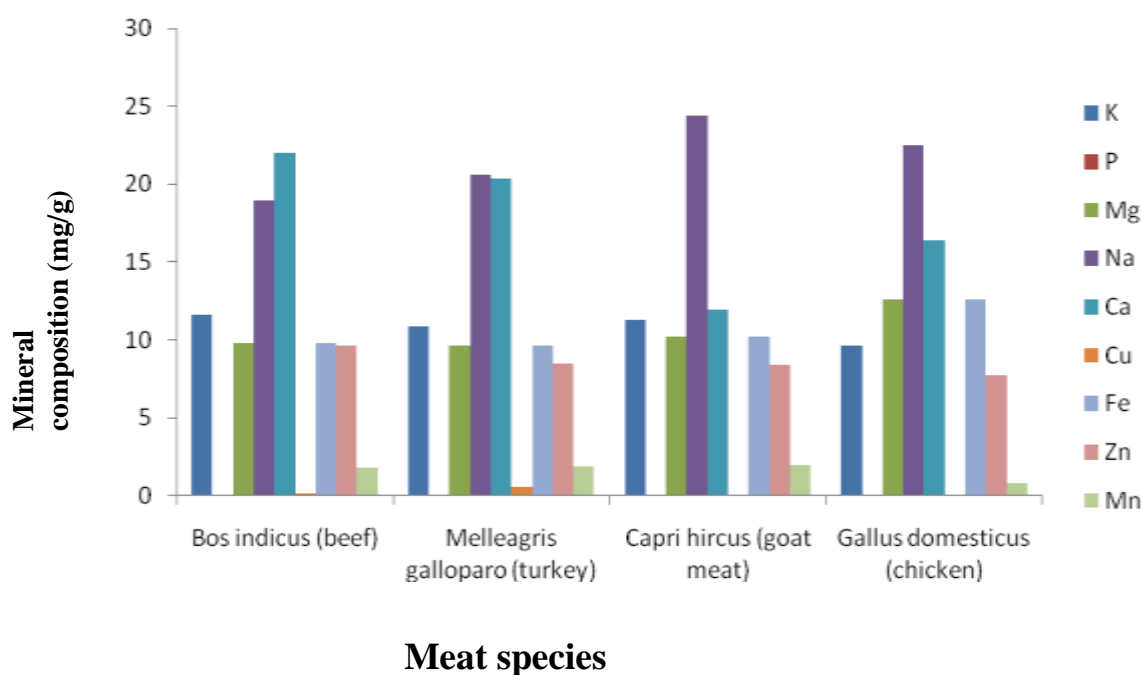


Fig.3.22: Mineral compositions of some meat samples

The mineral composition of the meat species in mg/g are shown in Table 3.22 and Figure 3.22.

All the meat species showed presence of all the macro and micro minerals tested. Sodium, (RDI,>1500mg) was the most abundant metal (Fig 3.23) in all the meat species ranging from 18.98 ± 0.00 for beef to 24.36 ± 0.00 for goat meat. Calcium, (RDI,1000mg), was detected as the second most abundant metal ranging from 11.98 ± 0.00 for goat meat to 22.02 ± 0.00 in beef.

Potassium, (RDI, >2000mg), was the third most abundant, ranging from 9.66 ± 0.00 in chicken to 11.66 ± 0.00 for beef. Magnesium, (RDI, 350mg), and iron, (RDI, 15mg), were found in equal amounts in all the meat species ranging from 9.66 ± 0.00 for turkey to 12.64 ± 0.00 for chicken and were the fourth most abundant minerals. Zinc, (RDI, 15mg), was the fifth most abundant mineral. Although a micro mineral, it is high in all the meat species ranging from 7.76 ± 0.00 for hicken to 9.66 ± 0.00 for beef.

Manganese, (RDI, 5mg), ranked the sixth among minerals determined in the samples, ranging from $0.84 + 0.00$ for chicken to $1.96+ 0.00$ for goat meat. Copper, (RDI, 2mg), was found in trace amounts and also phosphorous, (RDI, 1000mg). None of the meat species met the recommended values and should be supplemented in such foods. The mean differences were all insignificant at 0.05 levels. Generally the meats are all mineral rich food hence excellent sources of dietary minerals.

Table 3.23: Energy values of some meat samples (kJ/g)

Sample	kJ/g
Bos indicus (beef)	1,715.85
Melleagris gallopardo (turkey)	1,701.70
Capri hircus (goat meat)	1,739.74
Gallus domesticus (chicken)	1,793.84

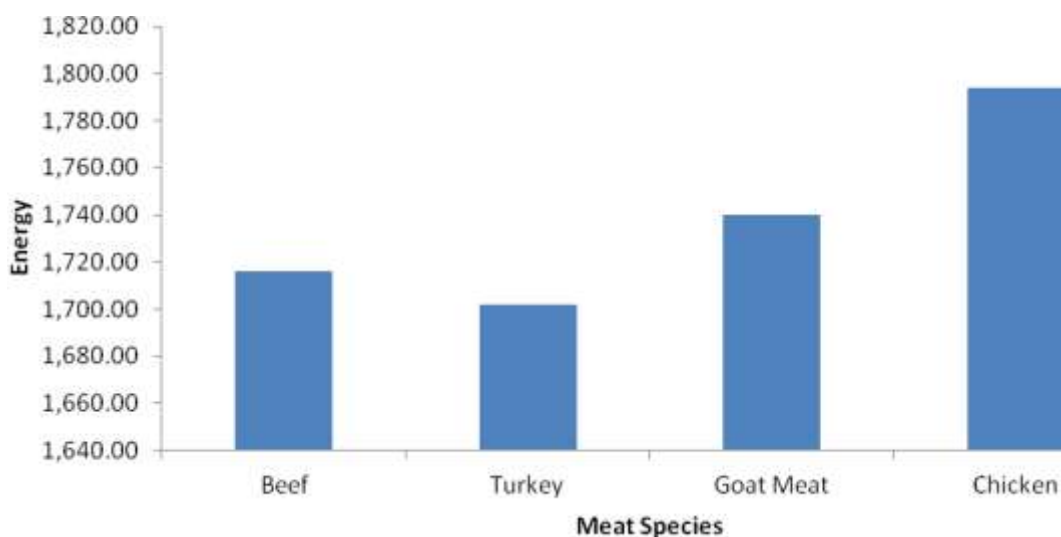


Fig. 3.23: Energy values of some meat samples

The energy values of some meat species in kJ/g are shown in Table 3.23 and Figure 3.23. The values ranged between 1701.70 ± 0.87 for turkey and 1793.84 ± 0.16 for chicken. Chicken (1793.84) showed the highest calorific value, followed by goat meat (1739.74), then beef (1715.85) and lastly turkey (1701.70), but none of the meat specie showed up to 2000calories/8500kJ/g RDA, thus must be combined with other food sources for a balanced diet.

3.7 PROXIMATE, ANTINUTRITIONAL, MINERAL ANALYSIS AND ENERGY VALUE RESULTS OF THE FISH SPECIES

Table 3.24: Proximate compositions of some fish samples in g/100g

Samples	Moisture contents	Ash Content	Crude Fat	Protein	Crude Fibre	Carbohydrate
<i>Gadus Morhua</i> (cod)	5.70±0.08	0.94±0.02	9.33±0.04	31.40±0.08	0.53±0.04	52.09±0.10
<i>Siluri formes</i> (catfish)	2.77±0.041	0.82±0.01	8.17±0.17	42.43±0.04	0.67±0.01	45.14±0.14
<i>Maccarello</i> (mackerel)	1.17±0.13	0.47±0.01	6.49±0.16	48.00±0.82	0.75±0.02	34.21±0.84

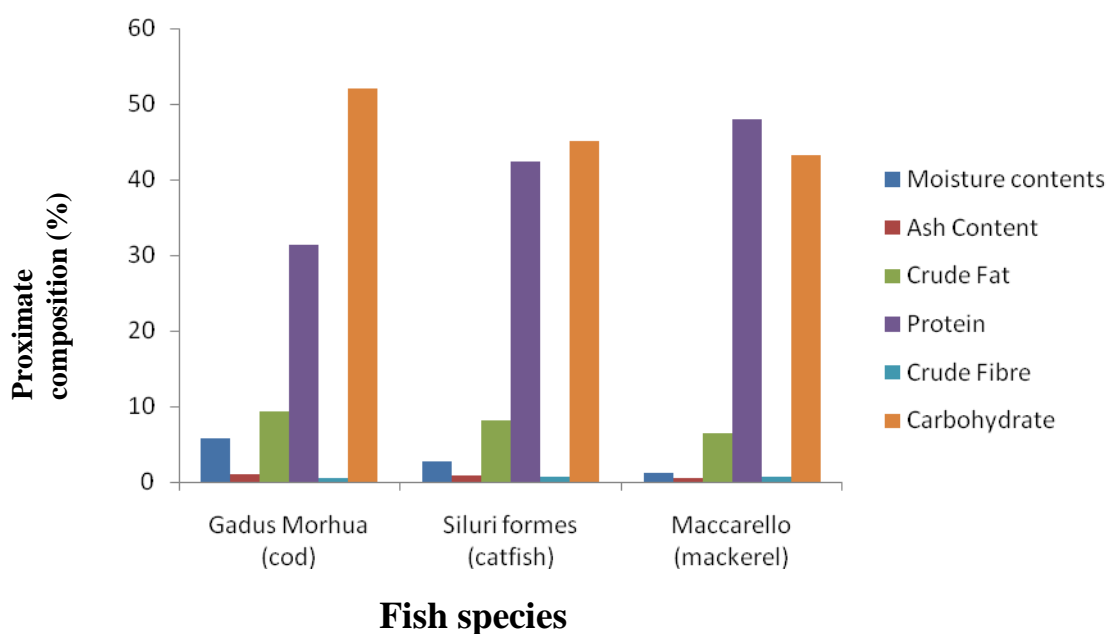


Fig. 3.24: Proximate compositions of some fish samples

The proximate compositions of some fish species in g% are shown in Table 3.24 and Figure 3.24. The moisture content ranged between 1.17 ± 0.13 for mackerel to 5.70 ± 0.08 for cod. Cod showed the highest moisture content (5.70), followed by catfish (2.77) and then mackerel (1.17). The differences in the moisture values were all significant ($P > 0.05$).

The ash content ranged between 0.47 ± 0.01 for mackerel and 0.94 ± 0.02 for cod. Cod showed the highest value for ash content (0.94) followed by catfish (0.82) and lastly mackerel (0.4). None exceeded 5% expected ash content in fresh foods and the differences in means of the ash contents were significant at the 0.05 level.

Crude fat ranged between 6.49 ± 0.10 for mackerel and 9.33 ± 0.04 for cod. Fat content was highest in cod (9.33), followed by catfish (8.17) and least in mackerel (6.49). Their fat contents were low compared with the 20-35g AMDR of total fat and the mean values obtained were all significant ($P > 0.05$). Depending on the type, fish contain omega-3 fatty acids, which support brain and neural development (Layne, 2011). The National Institute of Health's Medlin Plus Program recommends fish as a lean protein alternative to red meat (Layne, 2011).

Protein content ranged between 31.40 ± 0.08 for cod and 48.00 ± 0.82 for mackerel. Mackerel showed the highest protein content (48.00), followed by catfish (42.43) and then 31.40 for cod. The values agreed well with AMDR for proteins, (5-35g) and even RDI, (9-46g). The differences in the mean values of protein obtained were all significant ($P > 0.05$).

The fishes are good sources of protein. This has been confirmed by literature that fish is a complete source of protein, containing the nine amino acids that the body requires, but cannot make for itself (Layne, 2011). But according to the Vegetarian Resources Group, only about 10 percent of daily calories should be from protein sources since over consumption of protein may contribute to kidney disease (Layne, 2011).

Crude fibre ranged between 0.53 ± 0.04 for cod and 0.75 ± 0.02 for mackerel. Mackerel had (0.75), followed by catfish (0.67) and then 0.53 for cod, but the values are low compared with RDI values, (19-38g) of total fibre. Comparison of the mean differences showed they were significant ($P > 0.05$).

Carbohydrate content ranged between 43.21 ± 84 for mackerel to 52.09 ± 0.10 for cod. The values agreed well with AMDR, (45-65g) for carbohydrate but below 130g which is the RDI value, but the mean differences were insignificant. The fishes were good sources of major food nutrients.

Table 3.25: Antinutrient compositions of some fish samples in g %

Samples	Oxalate	Alkaloid	Saponin	Tannin	Phytic acid
<i>Gadus Morhua</i> (cod)	0.31±0.01	0.71±0.01	0.86±0.03	0.43±0.01	0.28±0.01
<i>Siluri formes</i> (catfish)	0.19±0.01	0.87±0.01	0.28±0.06	0.20±0.01	0.47±0.01
<i>Maccarello</i> (mackerel)	0.93±0.01	0.56±0.01	0.43±0.01	0.31±0.02	0.31±0.01

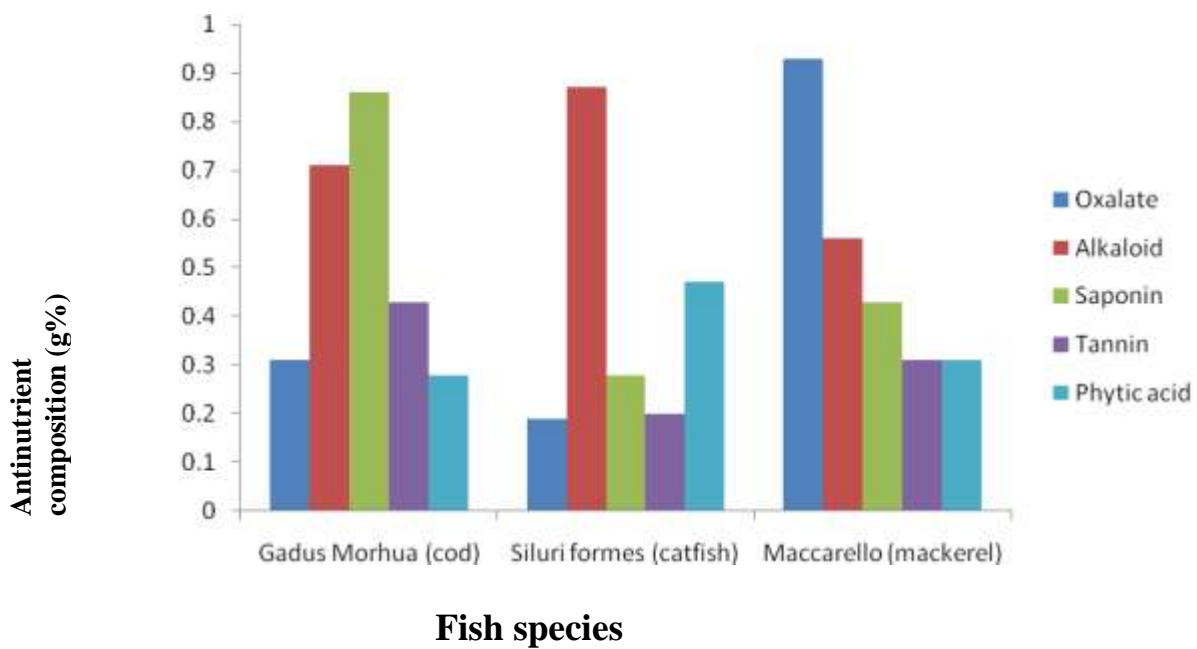


Fig. 3.25: Antinutrient compositions of some fish samples

The antinutritional compositions of the fish species in g% are shown in Table 3.25 and Figure 3.25. Oxalate ranged between 0.19 ± 0.01 for catfish and 0.93 ± 0.01 for mackerel. Oxalate content of mackerel was significantly high ($P > 0.05$). Alkaloid ranged between 0.56 ± 0.01 for mackerel and 0.87 ± 0.01 for catfish. Alkaloid was highest in catfish (0.87), followed by cod (0.71) and least in mackerel (0.56). There is a significant difference in the values obtained ($p > 0.05$). Saponin ranged between 0.28 ± 0.06 for catfish and 0.86 ± 0.03 for cod. Cod had the highest saponin content (0.56) followed by mackerel (0.43) and lastly 0.28 for catfish. The differences in the mean of the saponin contents were significant ($P > 0.05$). Tannin ranged between 0.20 ± 0.01 for catfish and 0.43 ± 0.01 for cod. Cod had the highest tannin content (0.43) followed by mackerel (0.31) then catfish (0.20), and the values were all significant ($P > 0.05$). Phytic acid ranged between 0.28 for cod and 0.47 for catfish while mackerel had (0.31). Comparison of the means showed a significant difference ($P > 0.05$) in the phytate content.

Generally, the antinutrients were found very low in all the fish species; none exceeding 1%. This is a good indication that fishes are low in phytonutrients because they are not of plant origin, although they feed on some plants, hence pose less problems associated with these antinutrients, which though have some health benefits.

Table 3.26: Mineral compositions of some fish samples in mg/g

Samples	K	P	Mg	Na	Ca	Cu	Fe	Zn	Mn
<i>Gadus Morhua</i> (cod)	13.08	0.08±	9.82±	18.64±	29.96±	0.248±	9.82±	7.46±	1.72±
<i>Siluri formes</i> (catfish)	10.84±	0.032±	10.24±	16.88±	31.62±	0.468±	10.24±	0.04±	1.76±
<i>Maccarello</i> (mackerel)	10.64±	0.042±	8.66±	16.64±	35.64±	0.368±	8.66±	0.04±	0.98±

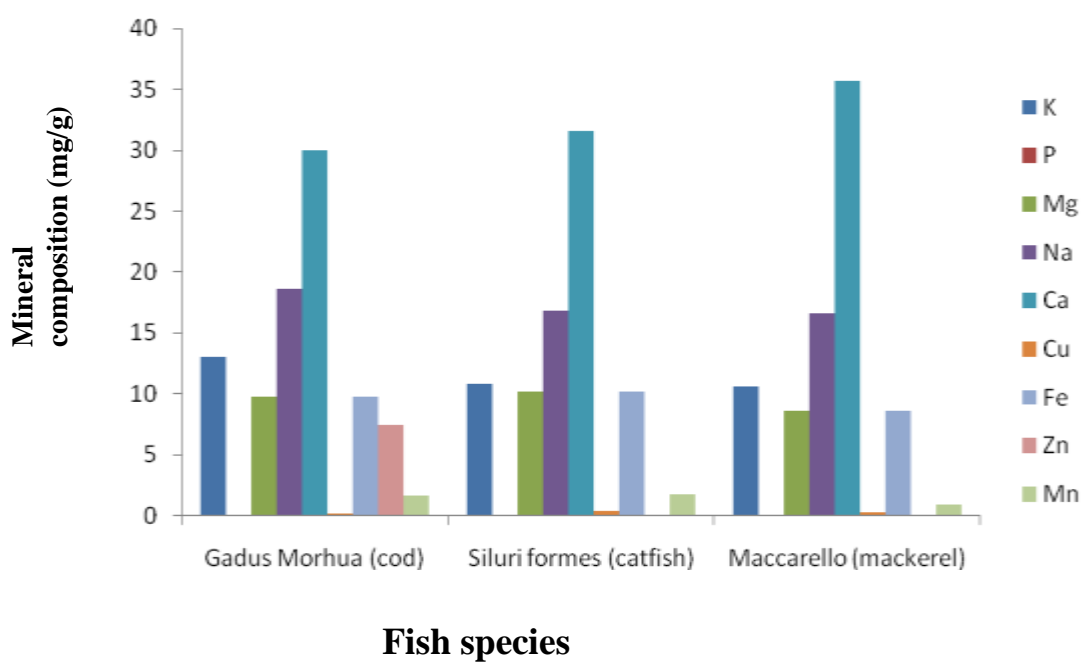


Fig. 3.26: Mineral composition of some fish samples

The mineral compositions of some fish species in mg/g are shown in Table 3.26 and Figure 3.26. All the fish species contain all the macro and micro minerals tested, except manganese which was absent in cod. Calcium, (RDI, 1000mg) was the most abundant mineral in all the fish species, ranging from 29.96 ± 0.00 for Cod to 35.64 ± 0.00 for mackerel. Hence they are all excellent sources of calcium mineral which is the most abundant mineral in the body (Srilakshmi, 2006) and a small quantity of calcium is always present in the blood stream, where among others, it helps prevent serious haemorrhages. Sodium, (RDI, >1500mg), was the second abundant mineral, ranging from 16.64 ± 0.00 for mackerel to 18.64 ± 0.00 for cod. Sodium was the chief cation of the cellular fluid, responsible for the control of body fluid, the osmolarity, therefore, body fluid volume was largely dependent on sodium compared to other ions (Srilakshmi; 2006). Potassium, (RDI, > 2000mg) was the third abundant mineral ranging from 10.64 ± 0.00 for mackerel to 13.08 ± 0.00 for cod. This also showed that potassium is widely distributed in all food and is rarely deficient in our diet. The differences in means were significant ($P > 0.05$). Magnesium, (RDI, 350mg) and iron, (RDI, 15mg), were found in equal amounts in all the fish species and were the fourth abundant minerals. Fish contains heme iron, which is more useful to the body than non-heme iron, the type of iron found in plant-based foods (Layne, 2011). Iron is essential for healthy muscle growth and blood oxygenation. Zinc, (RDI, 15mg), was insignificantly ($P < 0.05$) higher (7.46 ± 0.00) in cod, then mackerel (0.04 ± 0.00) and catfish (0.04 ± 0.002). Thus cod was a good source of zinc. Phosphorous, (RDI, 1000mg), was found in all the fish species, ranging from 0.032 for catfish to 0.08 for cod. The fish species were all low in phosphorous. Copper, (RDI, 2mg), was detected in low quantities in all the fish species, ranging from 0.248 for cod to 0.468 for catfish. There was no significant difference in the values obtained for phosphorous ($P < 0.05$).

Manganese, (RDI, 5mg), was present in catfish (1.76), mackerel (0.98) and cod (1.72). Compared with RDI of manganese, the fishes were good sources of manganese. Thus the fish species are reasonably good sources of dietary minerals since none of these major mineral required in the diet was not detected, though none met the RDI values.

Table 3.27: Energy values of some fish samples (kJ/g)

Sample	kJ/g
Gadus Morhua (cod)	1,776.50
Siluri formers (catfish)	1,799.87
Maccearello (mackerel)	1,795.20

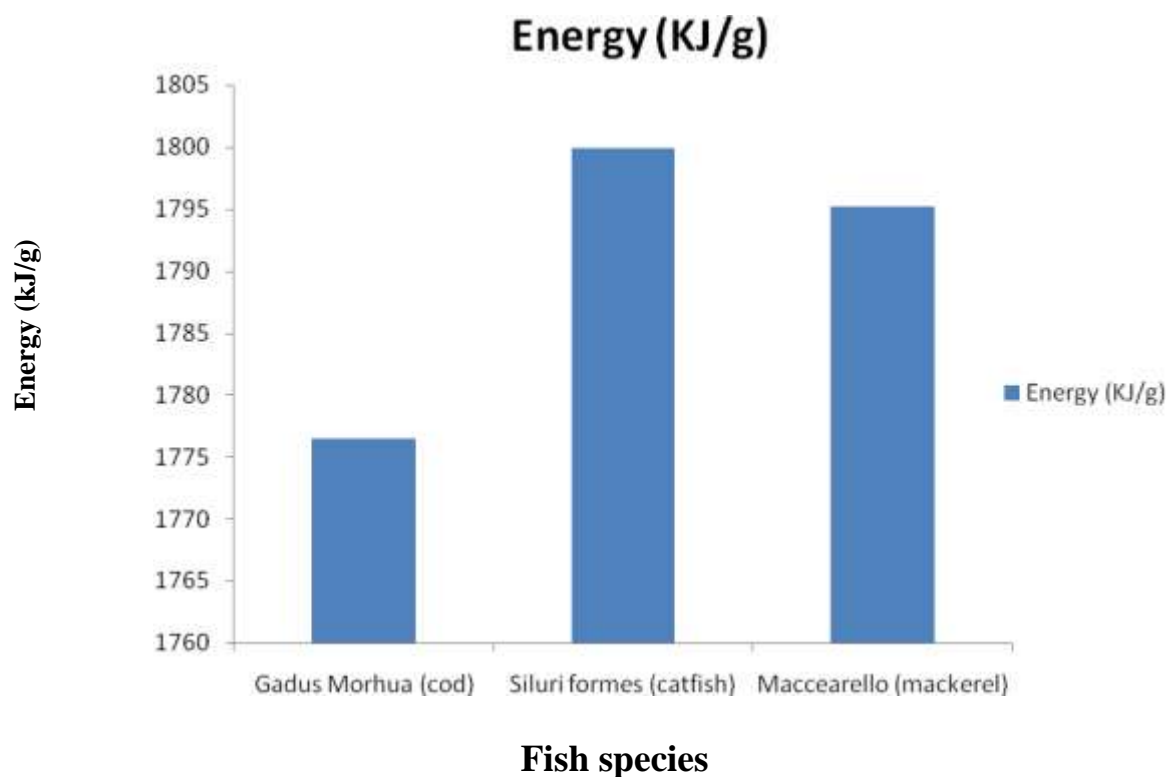


Fig. 3.27: Energy values of some fish samples

The energy values of the fish species in kJ/g are shown in Table 3.27 and Figure 3.27. The values ranged between 1776.50 for cod and 1799.87 for catfish, thus catfish showed the highest calorific value, followed by mackerel (1795.20) and lastly cod. All must be eaten with other food sources to make up the 8500kJ/g RDI of calories and for a balanced diet (Recommended daily allowances:10th Edition”.Nap.eduhttp://www.nap.ed/openbook).

3.8 PROXIMATE, ANTINUTRITIONAL, MINERAL ANALYSIS AND ENERGY VALUE RESULTS OF SOME LEGUMES/PULSES SPECIES

Table 3.28: Proximate compositions of some legumes/pulses in g/100g

		Moisture content	Ash	Crude fat	Protein	Crude Fibre	Carbohydrate
<i>Phaseolus Vulgria</i> (beans)	White	4.80±0.08	0.61±0.01	6.40±0.61	64.30±1.24	0.11±0.01	24.08±1.27
	Brown	3.20±0.08	0.67±0.01	6.50±0.14	52.40±0.08	0.14±0.01	37.09±0.44
<i>Ciceraritinum</i> (chick pea)		0.67±0.04	0.92±0.01	9.40±0.12	11.76±0.39	0.27±0.01	76.98±3.92
<i>Glycine Max</i> (soyabean)		0.87±0.02	0.87±0.01	11.40±0.08	42.70±1.70	0.63±0.00	43.53±1.77
<i>Artocarpus Communis</i> (breadfruit)		0.39±0.02	0.82±0.01	12.20±0.13	27.00±0.82	0.46±0.03	59.13±0.88

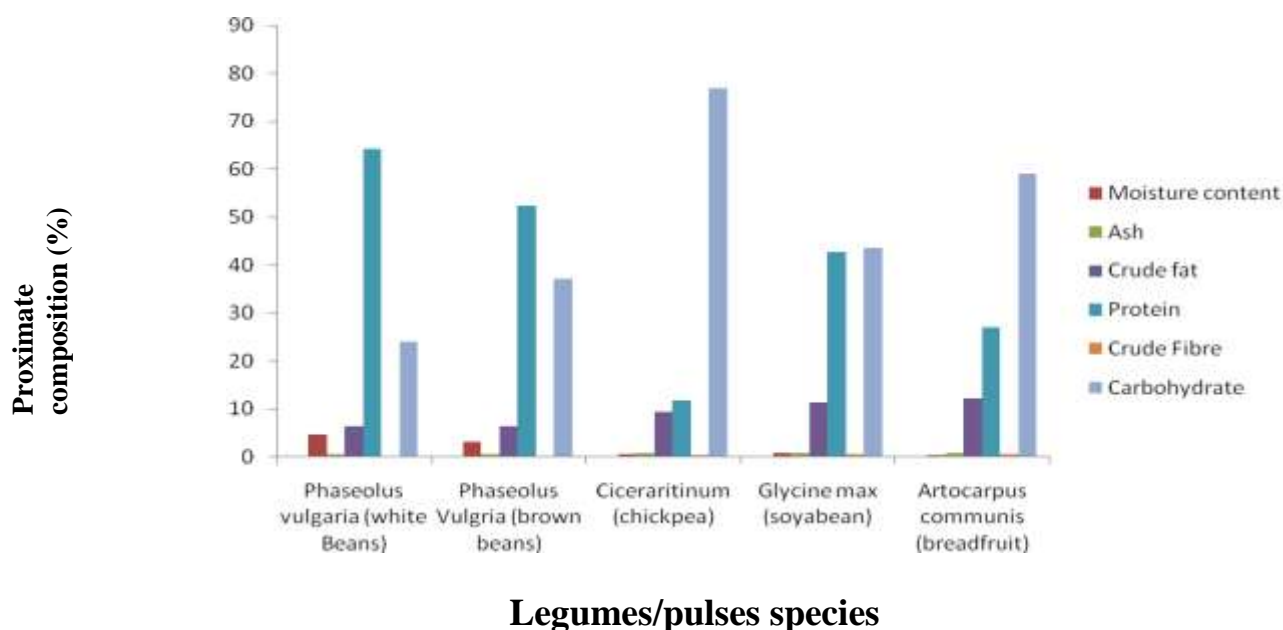


Fig. 3.28: Proximate compositions of some legumes/pulses

The proximate compositions of legume/pulses in g% are shown in Table 3.28 and Figure 3.28. The moisture content ranged between 0.39 ± 0.02 for bread fruit and 4.80 ± 0.08 for white beans. The values agreed fairly with that reported in literature (Chauhan et al., 1992; Gopalan et al., 1985; Ruales, 1992) for most cereals and legumes but significantly higher in white and brown beans ($P > 0.05$). The variations in nutritional composition of foods depending on the climate, the soil, and other factors, have been extensively discussed (Raspier and Coursey, 1967) and as well by the analytical technique and storage handling used (Pearson, 1976). White beans (4.80) showed the highest moisture content, followed by brown beans (3.20), and then soyabeans (0.87), chick peas (0.67) and least was bread fruit (0.39). Low moisture content was an indication that these legumes/pulses could be stored for a longer time before deterioration (Eka, 1987). The ash content ranged between 0.61 ± 0.01 for white beans to 0.92 ± 0.01 for chick peas. The ash content appeared to be roughly of same quantities ($P > 0.05$) in all the legumes/pulses analysed (1%); being highest in chick peas (0.92) followed by soyabeans (0.87), breadfruit (0.82), then brown beans (0.67) and lastly, white beans (0.61) and did not exceed 5% expected for fresh foods (FNB, 1974). Fat content ranged between 12.20 ± 0.13 for bread fruit and $6.40 \pm$ for white beans. The fat content was highest in bread fruit, then soyabeans (11.40), chickpea (9.40), brown beans (6.50) and lastly 6.40 for white beans. The differences in mean values of fat were significant ($P > 0.05$) though multiple comparison showed insignificant difference in the pair (white beans/brown beans). The values obtained for the fat content were in agreement with that reported by Ruales, (1992), Sanchez, (1983) for most cereals and legumes but were below AMDR, (20-35g) for total fat, so should be combined with other foods to achieve the required nutrient values. All the legumes analysed, contained reasonable quantities of fat which could be classified and exploited for commercial uses, especially soybeans and bread fruit (Ruales, 1992).

The protein content ranged between 11.76 ± 0.39 for chick pea and 64.30 ± 1.24 for white beans. These values agreed with the range 5-50 percent obtained for most legumes (Ruales, 1992), but that of white and brown beans were a little higher ($P > 0.05$). These foods are no doubt highly proteinous and all show far above 12% protein except chickpea (11.76). The protein content was highest in white beans (64.30), followed by brown beans (52.40), soyabean (42.70), bread fruit (27.00) and lastly chickpea (11.76) and they all met the AMDR (5-35g), except chickpea and fairly with RDI, (9-46g) for proteins. Legumes have relatively low quantities of the essential amino acid, methionine but high in essential amino acid lysine but grains are low in lysine, and high in methionine, hence a combination of grains and legumes is the best combination of balanced diet; for example beans with corn, tofu and rice (Jacob, 1988). Crude fibre ranged between 0.11 ± 0.01 for white beans to 0.63 ± 0.00 for soyabeans. Soyabeans showed the highest fibre content, (0.63), followed by bread fruit (0.46), chick pea (0.27), brown beans (0.14) and least (0.11) for white beans. These values are quite low compared to that (1-6%) reported by Ruales, (1992); Chauhan et al., (1992) and still low compared with RDI of total fibre (19-38g). The mean differences for all legumes/pulses were significant ($P > 0.05$). This low fibre content has been confirmed by literature report, that legumes contain just right amount of fibre to prevent constipation when eaten and help improve digestive health (Jacob and Meyer, 1998). The difference may also be due to analytical technique used and as well variation in nutritional composition of food with factors such as climate, soil, and place, as reported earlier. Carbohydrate contents ranged between 24.08 ± 1.27 for white beans and 76.98 ± 3.92 for chick pea. Chick pea showed the highest carbohydrate content (76.98), followed by bread fruit (59.13), soyabean (43.53), then brown beans (37.09) and 24.08 for white beans. The values agree with the range 14-70% reported for most cereals and legumes (Sanchez, 1983) but chick pea (76.98)

was slightly higher ($P>0.05$). The values met AMDR (45-65g), though below RDI (60-130g) for total digestible carbohydrate. Figure 3.29 showed that legumes/pulses species analysed were not only rich in carbohydrate but also rich in protein, but low in fibre content. Thus they are recommended in diets of children and infants for maximum growth and development, especially beans (white and brown), soyabean and bread fruit.

Table 3.29: Antinutrient compositions of samples of some legumes/pulses (g %)

		Oxalate	Alkaloid	Saponin	Tannin	Phytic Acid
<i>Phaseolus Vulgria</i>	White	0.42±0.02	0.43±0.01	0.96±0.01	0.25±0.01	0.11±0.01
(beans)	Brown	0.32±0.01	0.83±0.01	0.92±0.01	0.18±0.01	0.19±0.001
<i>Ciceraritinum</i>		0.20±0.02	1.43±0.01	1.84±0.01	0.27±0.02	0.32±0.02
(chick pea)						
<i>Glycine Max</i>		0.16±0.03	1.63±0.01	2.40±0.08	0.23±0.02	0.16±0.02
(soyabean)						
<i>Artocarpus communis</i>		0.23±0.01	2.13±0.04	2.70±0.08	0.14±0.00	0.31±0.01
(breadfruit)						

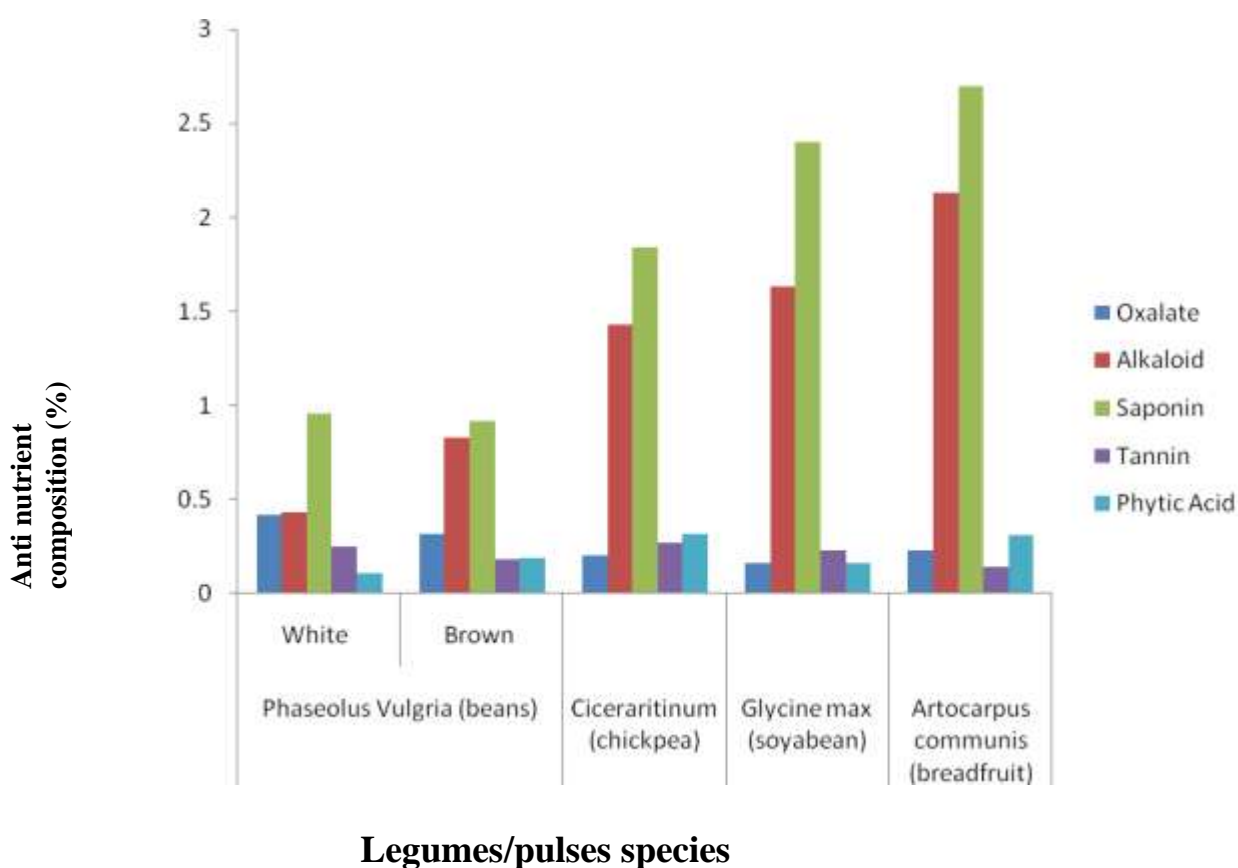


Fig. 3.29: Antinutrient compositions of some legumes/pulses

The antinutritional compositions of some legumes/pulses in g% are shown in Table 3.29 and Figure 3.29. Oxalate ranged from 0.16 ± 0.03 for soyabeans to 0.42 ± 0.02 for white beans. All contain oxalate in almost equal amounts and are low, and might not play a major role in their nutritive value when compared with the toxic dose of 25g, (Oke, 1966), unless if the foods are eaten alone for a

very long period. The mean differences in oxalate values were significant at 0.05 levels except for the pairs, soyabeans/chickpea and chickpea/breadfruit in multiple comparisons.

Alkaloids ranged between 0.43 ± 0.01 for white beans and 2.13 ± 0.01 for bread fruit. Breadfruit showed the highest alkaloid value, followed by soyabean (1.63), chick pea (1.43), brown beans (0.83) and then white beans (0.43).

Alkaloids were more in the legumes/pulses species (all mean differences were significant at 0.05 level) than oxalate and this could add to their effectiveness and potentials as medicine. Saponin ranged between 0.92 ± 0.01 for brown beans and 2.70 ± 0.08 for bread fruit. Bread fruit showed highest saponin content (2.70), followed by soyabeans (2.40), chick pea (1.84), white beans (0.96) and lastly brown beans (0.92) and values were all significant ($P > 0.05$) in multiple comparison except for whitebeans/brownbeans in which the difference in their saponin contents was insignificant. They are good sources of saponin. This has been confirmed by literature that soyabeans and other beans are packed with saponins which are anti inflammatory compounds that help our immune system to protect us against cancer (Jacob, 1988).

Tannins ranged between 0.14 ± 0.00 for bread fruit and 0.27 ± 0.00 for chick pea. Tannins were highest in chick peas (0.27), followed by white beans (0.25), soyabeans (0.23) and then brown beans (0.18) and bread fruit (0.14) having the least tannin content. Tannins were low and uniformly distributed in all the legumes/pulses species. Multiple comparisons showed insignificant differences in mean oxalate content of some pairs (Appendix 2)

Phytic acid ranged between 0.11 ± 0.01 for white beans and 0.32 ± 0.02 for chick pea. There was also a uniform distribution of phytic acid in all the legumes/pulses species ($P > 0.05$). The values are still low compared to 1-6% reported to decrease mineral bioavailability when eaten over a long period (Oke, 1969).

TABLE 3.30: Mineral compositions of some legumes/pulses in mg/g

	K	P	Mg	Na	Ca	Cu	Fe	Zn	Mn
<i>Phaseolus Vulgria</i> White (beans)	10.64±0.00	0.060±0.00	10.24±0.00	18.42±0.00	20.36±0.00	0.058±0.00	10.24±0.00	0.06±0.00	0.70±0.00
<i>Ciceraritinum</i> Brown (chick pea)	10.22±0.00	0.038±0.00	22.46±0.00	22.44±0.00	22.24±0.00	0.284±0.00	22.46±0.00	0.04±0.00	0.98±0.00
<i>Glycine Max</i> (soyabean)	9.84±0.00	0.064±0.00	8.44±0.00	18.84±0.00	18.64±0.00	0.386±0.00	8.44±0.00	0.06±0.00	1.84±0.00
<i>Artocarpus communis</i> (bread fruit)	10.66±0.00	0.084±0.00	7.82±0.00	16.96±0.00	18.64±0.00	0.280±0.00	7.82±0.00	0.08±0.00	1.06±0.00
	8.24±0.00	0.072±0.00	8.42±0.00	14.24±0.00	12.36±0.00	0.056±0.00	8.42±0.00	0.08±0.00	0.88±0.00

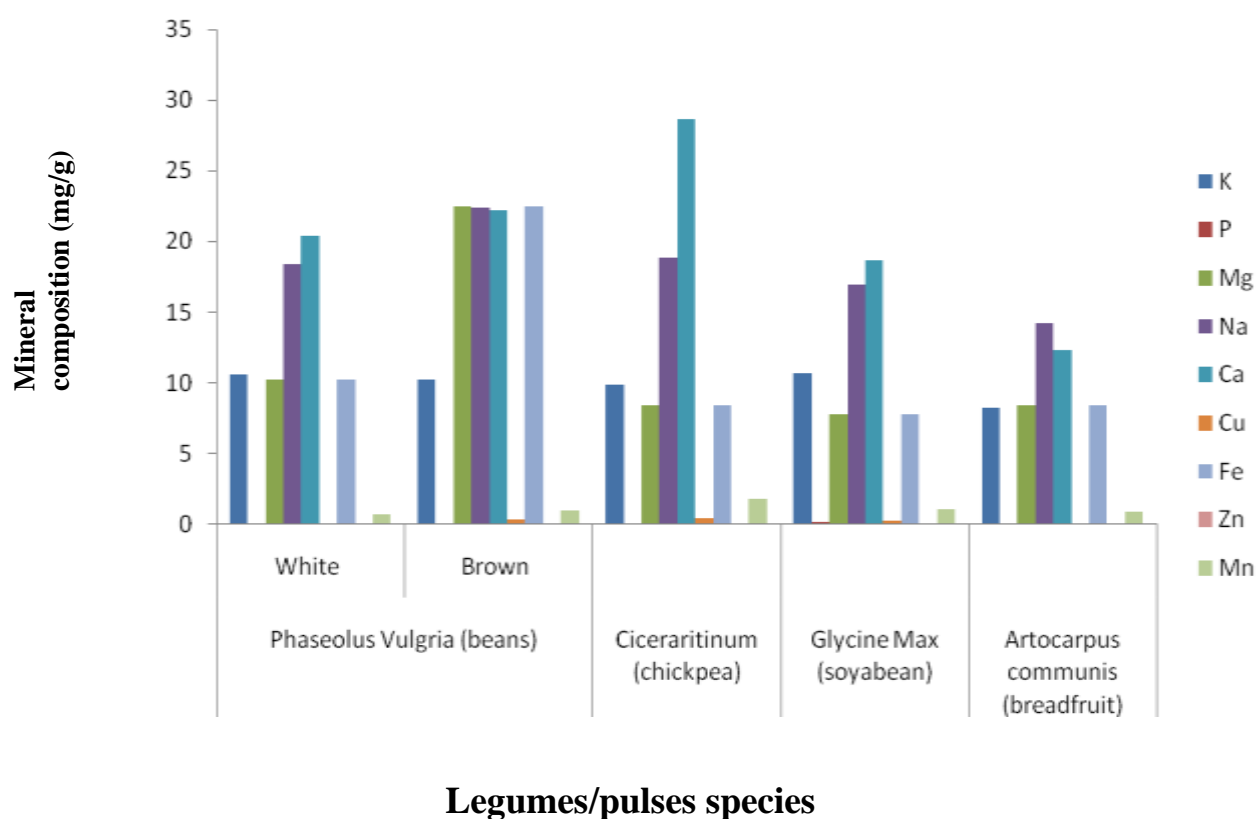


Fig. 3.30: Mineral compositions of some legumes/pulses

The mineral compositions of the legumes/pulses in mg/g are shown in Table 3.30 and Figure 3.30.

Calcium, (RDI, 1000mg), was the most abundant mineral in all the legumes/pulses species sampled, with 12.36 ± 0.00 for bread fruit to 28.64 ± 0.00 for chick pea. Magnesium, (RDI, 350mg), and iron, (RDI, 15mg), were the third abundant minerals with 7.82 ± 0.00 for soyabean to 22.46 ± 0.00 for brown beans. Sodium, (RDI>1500mg), was the second abundant mineral with 14.24 ± 0.00 for bread fruit to 22.44 ± 0.00 for brown beans.

Potassium, (RDI,>2000mg), ranked the fourth abundant mineral with 8.24 ± 0.00 for bread fruit to 10.66 ± 0.00 for soyabean.

Manganese, (RDI, 5mg), was the fifth abundant with 0.70 ± 0.00 for white beans to 1.84 ± 0.00 for chick pea.

Phosphorous, (RDI, 1000mg), zinc, (RDI, 15mg), and copper, (RDI, 2mg), were the least abundant and showed roughly the same quantities in all the legumes/pulses species. The values obtained were below recommended values and should be supplemented in such diets and the differences in mean for magnesium and phosphorous in the legume/pulses were significant ($P>0.05$) while others were insignificant.

The legumes/pulses are generally rich in minerals and are recommended in cases of mineral deficiency diseases, very high in calcium, excellent sources of Ca, high in Na (not very ideal for hypertensive patient), rich in Fe and could be recommended in the treatment of hypochronic anemias (Caused by iron deficiency) (John, 2009).

TABLE 3.31: Energy values of some legumes/pulses in kJ/g

Sample		kJ/g
<i>Phaseolus vulgria</i> (beans)	White	1,741.95
	Brown	1,774.97
<i>Cicerartitinum</i> (chick pea)		1,916.28
<i>Glycine Max</i> (Soyabean)		1,901.79
<i>Artocarpus communis</i> (bread fruit)		1,931.46

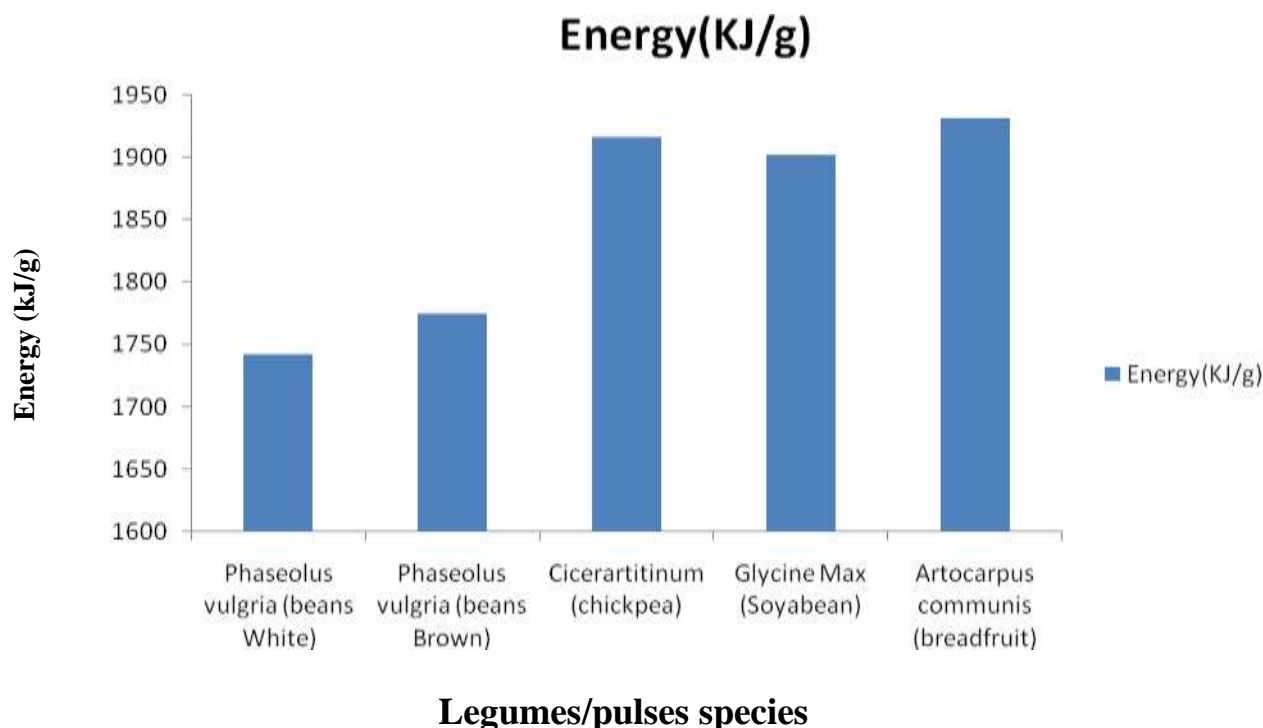


Fig.3.31: Energy values of some legumes/pulses

The energy values of some legumes/pulses in kJ/g are shown in Table 3.31 and in Figure 3.31. The values ranged between 1741.95 \pm 1.02 for white beans and 1931.46 \pm 0.63 for bread fruit. Bread fruit showed the highest calorific value, followed closely by chick pea (1916.28) then soyabeans (1901.79), 1774.97 for brown beans and the least calorific value was observed for white beans (1741.95). All did not meet the RDI of calories (8500kJ/g), thus were not adequate alone and should be eaten with other foods to make up the RDI of calories.

3.9 PROXIMATE, ANTINUTRITIONAL, MINERAL ANALYSIS AND ENERGY VALUE RESULTS OF SOME NUT SPECIES

Table 3.32: Proximate compositions of some nut samples (g/100g)

Samples	Moisture content	Ash	Fat	Protein	Fibre	Carbohydrate
<i>Arachis hypogel</i> (groundnut)	0.97±0.01	0.93±0.02	9.43±0.12	13.83±0.22	0.61±0.01	82.71±0.26
<i>Cola nitida</i> (colanut)	1.91±0.01	1.14±0.02	8.40±0.13	22.00±0.82	0.42±0.01	66.13±0.67
<i>Garcine kola</i> (bitter cola)	2.82±0.02	1.32±0.01	4.20±0.08	7.00±0.82	0.52±0.01	84.00±0.82
<i>Cocos nucigera</i> (coconut)	2.94±0.01	1.46±0.02	3.80±0.08	4.20±0.08	0.42±0.02	87.00±0.00

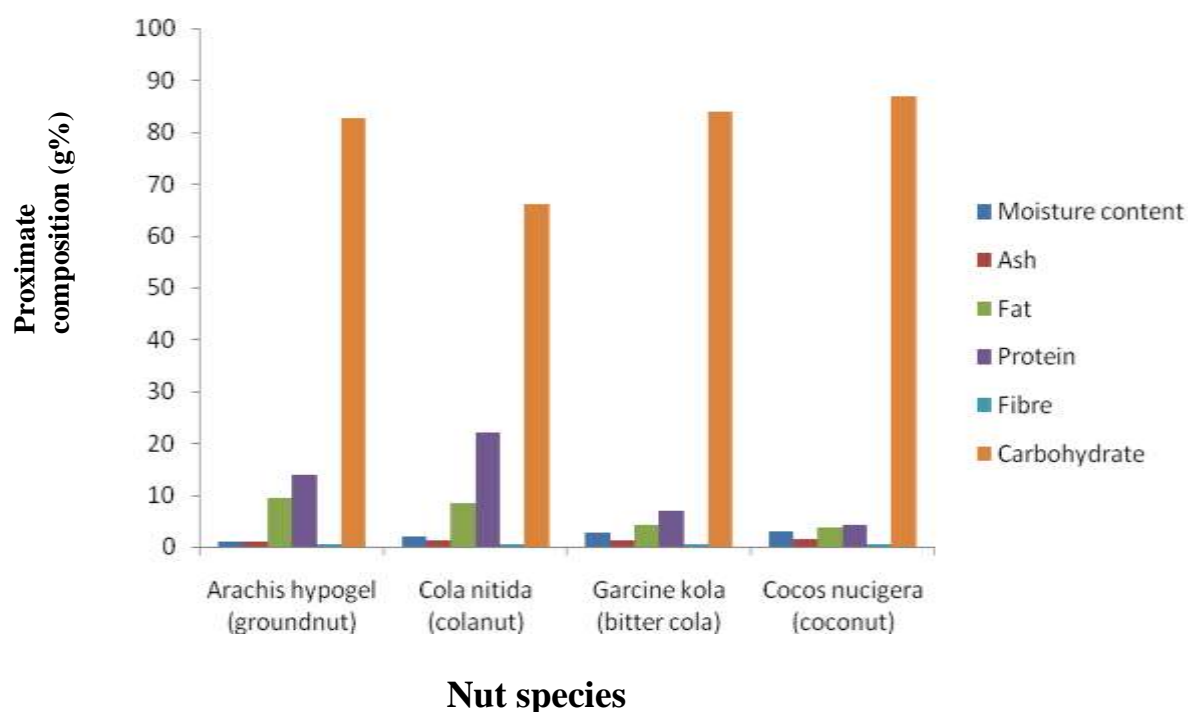


Fig. 3.32: Proximate compositions of some nuts

The proximate composition of the nut species are shown in Table 3.32 and Figure 3.32. The moisture content ranged between 0.97 ± 0.01 for groundnut and 2.94 ± 0.01 for coconut. Coconut showed the highest moisture content while groundnut showed the least. The mean difference of the moisture contents of the nuts were significant ($P > 0.05$). The ash content ranged between 0.93 ± 0.02 for groundnut and 1.46 ± 0.02 for coconut. Coconut showed the highest ash content while groundnut showed the least, an indication that coconut was rich in minerals than the rest of the nut species. The values did not exceed 5% ash content expected for fresh foods and all the values were very significant ($P > 0.05$). Fat content ranged between 3.80 ± 0.08 for coconut and 9.43 ± 0.12 for groundnut. Groundnut showed the highest fat content while coconut showed the least. The nuts were low in fat and the values were below AMDR of 20-35g for total fat while the mean differences were all significant at the 0.05 level. Nuts are cholesterol free and rich in monounsaturated fats that protect humans from chronic heart diseases and help to keep belly flat.

Crude protein ranged from 4.20 ± 0.08 for coconut to 22.00 ± 0.82 for colanut. Colanut showed the highest protein content while coconut showed the least. The protein content of colanut was significantly higher ($P > 0.05$) than the rest in the nut species sampled followed by groundnut (13.83), bitter cola (7.00) and then coconut (4.20). The values fairly agreed with AMDR, (5-35g) and RDI, (9-46g) for proteins. Both groundnut and colanut are good sources of protein since they contain up to 12% protein (Pearson, 1976), while bitter cola and coconut were not regarded as good sources of protein and must not be eaten alone but must be combined with other protein sources for a balanced diet.

Fibre content ranged between 0.42 ± 0.01 for colanut and coconut and 0.61 ± 0.01 for groundnut. Groundnut showed the highest fibre content while colanut and coconut showed the least. All the nut species contained some amount of fibre but the values were very low when compared with 19-38g RDI of fibre. The

mean difference in fibre contents of the nuts were insignificant for colanut/coconut while others were significant ($P>0.05$). The carbohydrate content ranged between 66.13 ± 0.67 for colanut and 87.00 ± 0.00 for coconut. The values agreed with the AMDR, (45-65g) and fairly with 60-130g, RDI for total digestible carbohydrate. All the nuts showed large nutrient composition of carbohydrate (Figure 3.33) and were all carbohydrate rich foods, followed by proteins and then fat while the other food compositions were low.

Nuts have many unique and health benefits. Nuts are recommended as part of DASH DIET, a dietary plan clinically proven to significantly reduce blood pressure. Colanut and bittercola, enhance alertness and physical energy, elevate mood, increase tactile sensitivity, suppress appetite and hunger and are used as an aphrodisiac (Attfield, 1865). The caffeine in nuts also acts as a bronchodilator, expanding the bronchial air passages; hence kolanuts are often used to treat whooping cough and asthma (Blades, 2000). Bitter kola is believed to clean the digestive system, without side effects such as abdominal problem (Onochie and Standfield, 1960).

Table 3.33: Antinutrient compositions of some nut samples (g %)

Samples	Oxalate	Alkaloid	Saponin	Tannin	Phytic acid
<i>Arachis hypogel</i> (groundnut)	0.33±0.02	2.40±0.17	2.74±0.01	0.32±0.01	0.41±0.01
<i>Cola nitida</i> (colanut)	0.87±0.01	0.86±0.02	6.97±0.01	0.26±0.02	0.53±0.02
<i>Garcine kola</i> (bitter cola)	0.32±0.01	0.33±0.02	0.42±0.01	0.98±0.01	0.92±0.01
<i>Cocos Nucigera</i> (coconut)	0.52±0.02	0.88±0.01	0.91±0.01	0.44±0.01	0.14±0.02

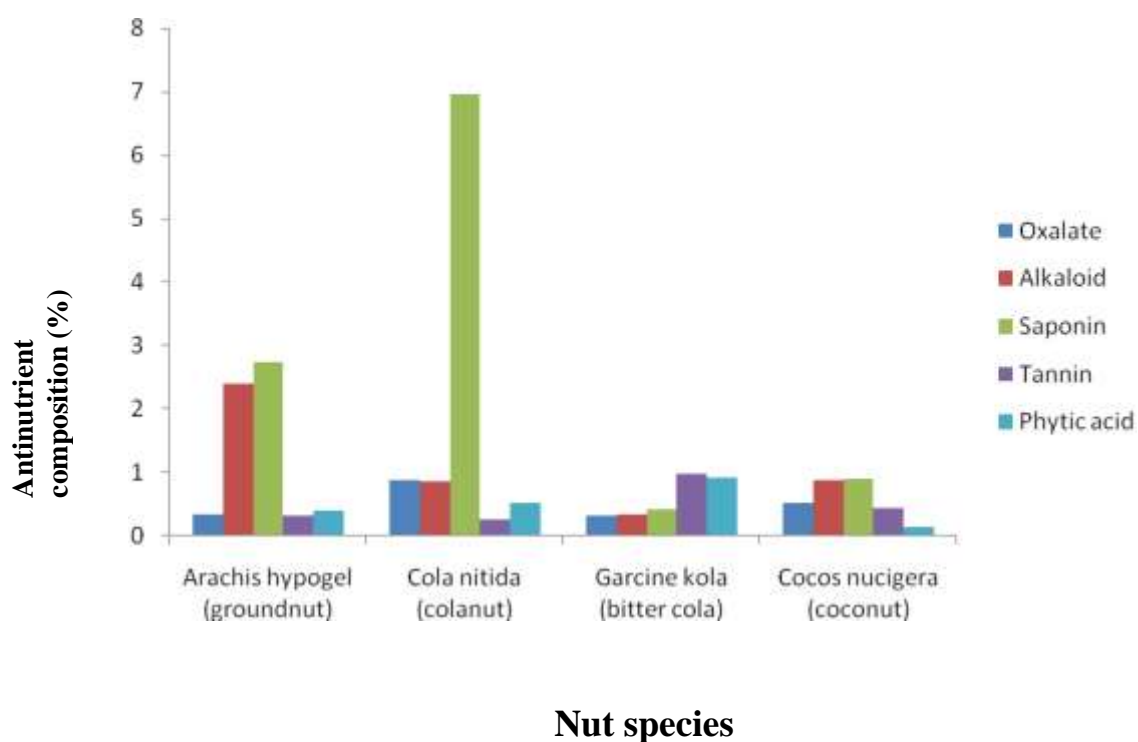


Fig. 3.33: Antinutrient compositions of some nuts

The antinutritional composition of the nut species in g% are shown in Table 3.33 and Figure 3.33. Oxalate ranged between 0.32 ± 0.01 for bitter cola and 0.87 ± 0.01 for colanut. Colanut had the highest oxalate content, followed by coconut (0.52), groundnut (0.33) and then 0.32 for bitter cola. The mean differences in the oxalate contents of the nuts were all significant ($P > 0.05$) except the pair, groundnut/bitter cola which were insignificant. All the nut species contained oxalate but none was up to 25g% reported as toxic dose (Oke, 1966). Alkaloids ranged between 0.33 ± 0.02 for bitter cola and 2.40 ± 0.17 for groundnut.

All the nut species contained some quantities of alkaloid with groundnut showing the highest content, followed by coconut, colanut and then bitter cola. The value for groundnut (2.40) was significantly higher ($P > 0.05$) than the rest of the nuts in the group, but insignificant difference in mean of the alkaloid was seen in the pair, colanut/coconut. This high alkaloid content of groundnut suggests high antimicrobial properties and thus highly medicinal values (Evans, 2005). Saponin ranged between 0.42 ± 0.01 for bitter cola and 6.97 ± 0.01 for colanut. All the nut species contained some quantity of saponin with colanut having the highest (6.97), followed by groundnut (2.74), 0.91 for coconut and then 0.42 for bitter cola. The saponin value for colanut (6.97) was significantly higher ($P > 0.05$) than the rest in the nut group. The very high level of saponin suggests presence of anti-inflammatory compounds, helping the immune system to protect humans against cancer. Thus foods like colanut are rich sources of saponin and are beneficial in prevention of cancer. Saponins also lower the cholesterol level in humans (Jacob, 1988).

But other negative effects of saponin have been reported earlier according to Awe and Sodipo, (2001); Oleszek et al., (1994); Sim *et al.*, (1984) and Potter et al., (1993). Saponin in excess also causes hypocholesterolemia because it

binds cholesterol making it unavailable for absorption (Soetan and Oyewole, 2009).

Tannins ranged between 0.26 ± 0.02 for colanut and 0.98 ± 0.01 for bitter cola. Tannin was highest in bitter cola (0.98), followed by coconut (0.44) then groundnut (0.32) and least in colanut (0.26). All the tannin values were significant ($P > 0.05$) thus, tannin was generally low and did not vary much among the nut species analysed. Phytic acid contents ranged between 0.41 ± 0.02 for colanut and 0.92 ± 0.01 for bitter cola. Bitter cola showed the highest value for phytic acid, followed by colanut (0.53), then groundnut (0.41) and lastly coconut (0.14). The mean differences in phytic contents of the nut species were all significant ($P > 0.05$). None of the nut species had over 1% phytic acid except bitter cola (0.92) that is very close to 1%. Therefore consumption of Bitter cola over a long period of time according to Oke (1969) could decrease the bioavailability of mineral elements. Phytate rich diet has been associated with nutritional disease such as rickets and osteomalacia in children and adult respectively (Akinyeye et al., 2011).

Table 3.34: Mineral compositions of some nut samples (mg/g)

Samples	K	P	Mg	Na	Ca	Cu	Fe	Zn	Mn
<i>Arachishypogael</i> (groundnut)	8.62±0.00	0.102±0.00	6.38±0.00	15.04±0.00	14.44±0.00	0.028±0.00	6.38±0.00	0.102±0.00	1.86±0.00
<i>Cola nitida</i> (colanut)	10.24±0.00	0.062±0.00	8.64±0.00	14.86±0.00	16.62±0.00	0.064±0.00	8.64±0.00	0.062±0.00	1.62±0.00
<i>Garcine kola</i> (bitter cola)	10.66±0.00	0.024±0.00	11.84±0.00	13.84±0.00	18.42±0.00	0.106±0.00	11.24±0.00	0.024±0.00	0.82±0.00
<i>Cocos nucigera</i> (colanut)	10.82 ±0.00	0.040±0.00	10.28±0.00	18.64±0.00	10.24±0.00	0.224±0.00	10.28±0.00	0.040± 0.00	0.76±0.00

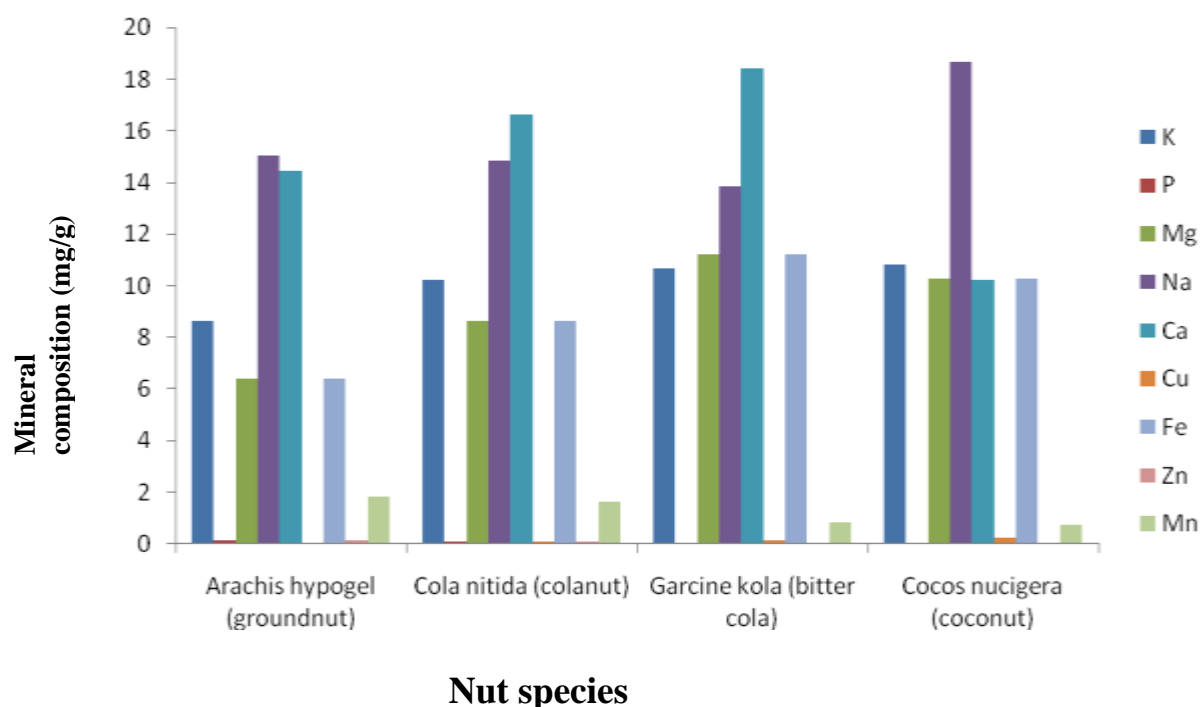


Fig. 3.34: Mineral compositions of some nuts

The mineral compositions of the nut species in mg/g are shown in Table 3.34 and Figure 3.34.

Potassium, (RDI, >2000mg), was found in all the nut species ranging from 8.62 in groundnut to 10.82 in coconut and was the third most abundant mineral. The content of potassium in all the nut species analysed seem to be the same ($P < 0.05$) and thus uniformly distributed in the nut species. The nut species are rich sources of sodium, (RDI, >1500mg), ranging from 13.84 for bitter cola to 18.64 for coconut, and is the most abundant mineral, while calcium, (RDI, 1000mg), was the second abundant among the nut species ranging from 10.24 for coconut to 18.42 for bitter cola. Copper, (RDI, 2mg), was found in trace amounts in all the nut species ranging from 0.028 for groundnut to 0.224 for coconut and ranked seventh. Iron, (RDI, 15mg), was the most abundant trace element among the nut species and ranked fourth with magnesium, (RDI, 350mg), being highest in bitter cola (11.24) and least in groundnut (6.38). Zinc, (RDI, 15mg) and phosphorous, (RDI, 1000mg), were the fifth abundant minerals, found in the same quantities in all the nut species, being highest in groundnut (0.102) and least in coconut (0.024) while manganese, (RDI, 5mg), was highest in groundnut (1.86) and least in coconut (0.76), and sixth abundant element. The values obtained were below RDI of the minerals, although the values for iron were close to its RDI, all should be eaten in larger quantity or be supplemented in such diets. The mean differences in the mineral contents of the nut species were all insignificant except for magnesium and phosphorous ($P > 0.05$). Nuts are generally rich sources of minerals as seen in Table 3.35. All the macro and micro mineral analysed were present in some quantities and none was absent. The contents of calcium, sodium, potassium, magnesium and even iron suggested that nuts were rich sources of dietary minerals and these are recommended for mineral deficiencies. The high contents of sodium made these nuts unsuitable for hypertensive patients. Potassium was high in all the nut species and should be omitted in diets of people with renal failure (McLay *et*

al., 1972). Calcium was the most abundant mineral in the body and these nuts were rich sources of calcium for maintenance of good health. The average quantity of iron in the human body was about 4.5g of which approximately 65 percent is in the form of haemoglobin, which transports molecular oxygen from the lungs throughout the body (John, 1999). Thus the nut species analysed were also rich sources of iron when taken in adequate quantity.

Table 3.35: Energy values of some nut samples in kJ/g

Samples	kJ/g
<i>Arachis hypogaeal</i> (groundnut)	2,129.55
<i>Cola nitida</i> (colanut)	1,819.00
<i>Garcine kola</i> (Bitter cola)	1,708.50
<i>Cocos nucigera</i> (coconut)	1,695.75

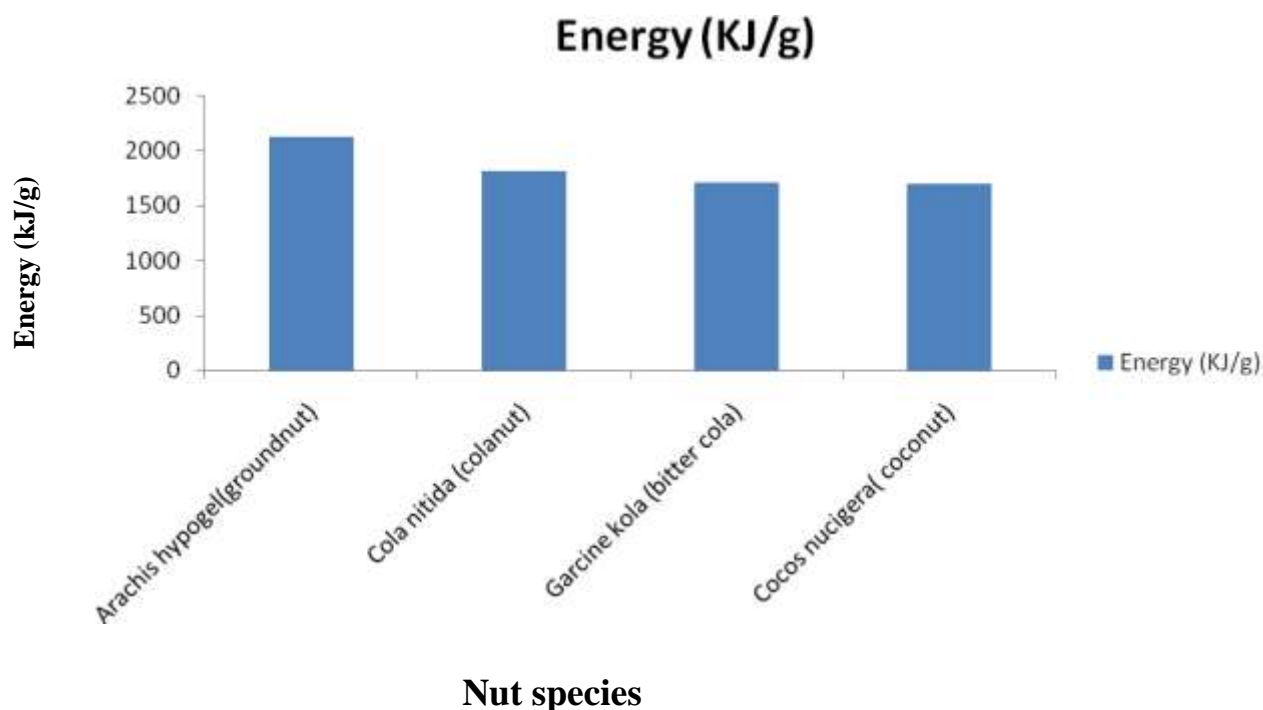


Fig. 3.35: Energy values of some nuts

The energy values of the nut species in kJ/g are shown in Table 3.35 and Figure 3.35. The values ranged between 1695.75 \pm 0.00 for coconut and 2129.55 \pm 41.57 for groundnut. Groundnut showed the highest calorific value, followed by colanut (1819.00), then bitter cola (1708.50) and lastly coconut (1695.75). The values were below standard recommended daily intake of calorie (8500kJ/g), thus do not make a complete diet and should be eaten with other food sources.

3.10 PROXIMATE, ANTINUTRITIONAL, MINERAL ANALYSIS AND ENERGY VALUE RESULTS OF SOME SEED SPECIES

Table 3.36: Proximate compositions of some seed samples (g/100g)

Samples	Moisture content	Ash	Fat	Protein	Fibre	Carbohydrate
<i>Irvingia gabonensis</i> (ducanut seed)	4.84±0.14	1.22±0.01	9.20±0.08	4.62±0.06	0.84±0.04	79.00±0.00
<i>Citrullus lanatus</i> (melon seed)	5.40±0.08	1.46±0.03	15.45±0.16	5.93±0.02	0.62±0.01	71.12±0.29

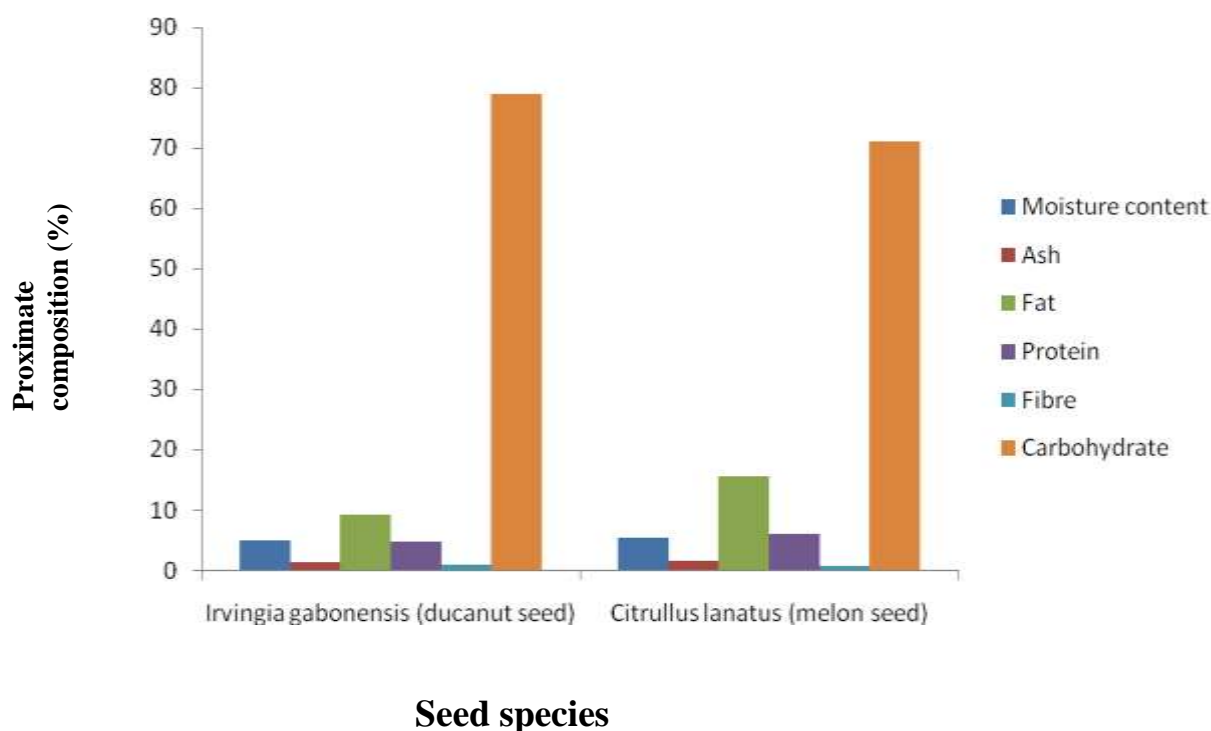


Fig. 3.36: Proximate compositions of some seeds

The proximate compositions of some seed species in percent are shown in Table 3.36 and Figure 3.36. The moisture content ranged between 4.84 ± 0.14 for ducanut seed and 5.40 ± 0.08 for melon seed, thus melon seed showed a higher percentage of moisture than ducanut and the mean difference in the values were significant ($P > 0.05$). These values fall within the range reported for most seeds (Umoh, 1998). The ash content for Melon seed (1.46) is slightly higher than that for Ducanut seed (1.22) and the mean difference was significant ($P > 0.05$). These values were slightly lower than that reported by Oluyemi et al., (2006) for most fruits and seeds but did not exceed 5% ash content expected for fresh foods (FNB, 1974). The slight differences in the value could be due to variation in nutritional composition of food from place to place, depending on the climate, soil, and other factors (Raspier and Coursely, 1967). The fat content for melon seed (15.45) was higher than that for Ducanut seed (9.20). The difference in their fat content was significant ($P > 0.05$). The values of the fat content agreed with that 0.78-40.0 reported for most seeds (Dreon et al., 1990). The values were low compared with 20-35g, which is the AMDR for total fat. These lipids are essential because they provide the body with maximum energy. The value of fat content obtained for melon seed (15.45) compares well with that reported for cotton seed (14.05) and could be commercially exploited and classified as oil seeds (Ayodele et al., 2000). The crude protein value was higher in melon seed (5.93) and lower in ducanut seed (4.62) and mean difference in the protein content of the seeds were significant ($P > 0.05$). These values agree with the crude protein range reported for most fruits and seeds (Pugalenthi et al., 2004), but were low compared with 5-35g AMDR and RDI, (9-46g) for proteins. Proteins are essential components of the diet needed for survival of animals and humans; their basic function in nutrition is to supply adequate amounts of required amino acids. The fibre content was found slightly higher in ducanut seed (0.84) than in melon seed (0.62) and the difference in mean was found significant ($P > 0.05$). These values are low compared with that reported for most

Nigerian fruits and seeds (Bello et al., 2008) and still below 19-38g, which is the RDI for fibre. The low fibre contents of these seeds made them ideal in infant formulations (Eromosele and Eromosele, 1993).

Carbohydrate content was higher in ducanut seed (79 percent) than in melon seed (71.12). These values are in agreement with that expected for most Nigerian seeds (Bello et al., 2008) although that for melon (79.00) was a little higher ($P > 0.05$). The carbohydrate values obtained met the AMDR (45-65g), though its on the high side and fairly agreed with 60-130g RDI for total digestible carbohydrate. Generally, among the seeds, carbohydrate was the major food composition, followed by fat, then moisture and protein and finally ash content.

Table 3.37: Antinutrient compositions of some seeds in g %

Samples	Oxalate	Alkaloid	Saponin	Tannin	Phytic Acid
<i>Irvingia gabonensis</i> (ducanut seed)	0.20 ± 0.01	0.72± 0.01	0.84±0.01	0.85±0.01	0.31±0.01
<i>Citrullus lanatus</i> (melon seed)	0.40±0.02	1.54±0.01	1.74±0.01	0.42±0.01	0.64±0.03

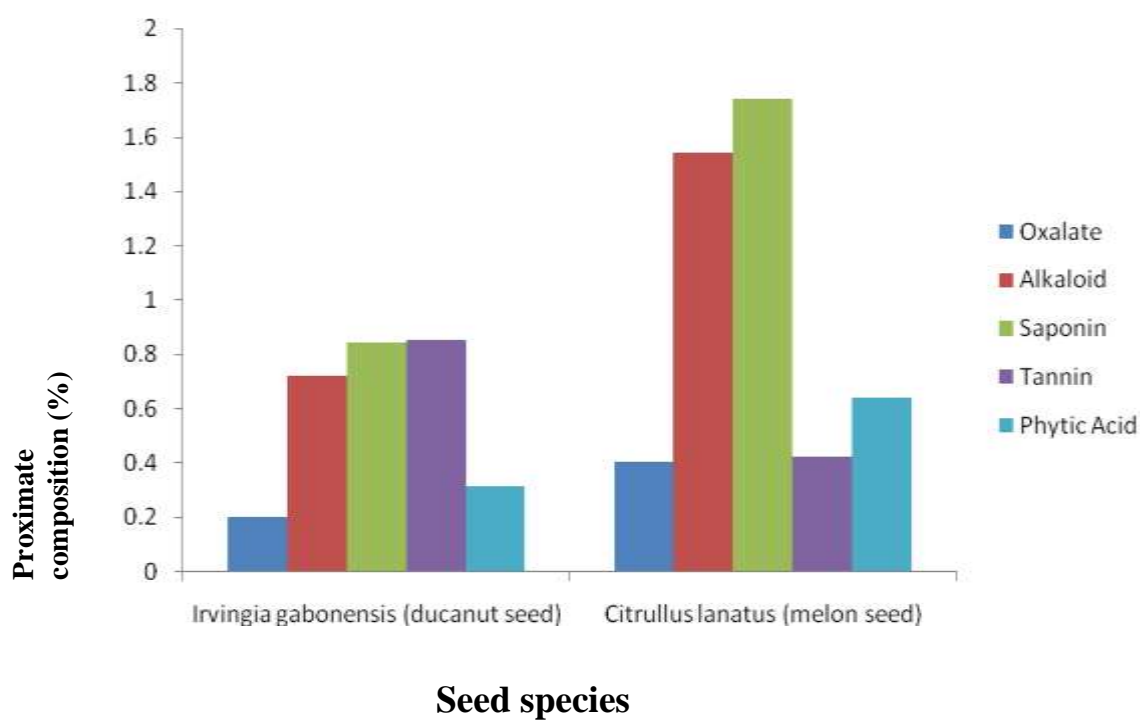


Fig. 3.37: Antinutrient compositions of some seed species

The antinutrient composition of some seed samples in g% are shown in Table 3.37 and Figure 3.37. Oxalate was found higher in melon seed (0.40) than in ducanut seed (0.20), but these values were very low and thus might not play important role in their nutritive value when compared to that reported for toxic levels (Muhammed et al., 2011). The alkaloids were higher in melon seed (1.52) than in ducanut seed (0.72). Both contained alkaloids but melon seed showed more antimicrobial properties than ducanut seed and hence more medicinal values. The saponins were found higher in melon seed (1.74) than in ducanut seed (0.84). Saponins are practically not poisonous to warm blooded animals but are dangerous when injected into the blood stream where they quickly haemolyse red blood cells (Applebaum *et al.*, 1969). But acute saponin poisoning is relatively rare both in animals and man (Osagie, 1998). Tannin was found higher in ducanut (0.85) than in melon seed (0.42), both contained tannin but the levels were very low compared to 5 percent reported to be lethal (Giner-Chavez, 1996). The presence of tannin in food has been reported to be beneficial to health by acting as antioxidant which helps to prevent diseases such as some type of cancer and inflammation (Tapiero *et al.*, 2000). Phytic acid was higher in melon seed (0.64) than in ducanut seed (0.31). None of the seeds was found to contain up to 1% phytic acid. The mean differences obtained for all the antinutrients of the seed samples were significant ($P>0.05$).

Table 3.38: Mineral compositions of some seed samples (mg/g)

Samples	K	P	Mg	Na	Ca	Cu	Fe	Zn	Mn
<i>Irvingia Gabonensis</i> (ducanut seed)	5.01±0.00	0.028±0.00	3.88±0.00	8.44±0.00	6.42±0.00	0.213±0.00	3.88±0.00	0.028±0.00	0.382±0.00
<i>Citrullus lanatus</i> (melon seed)	5.20±0.00	0.031±0.00	3.43±0.00	9.32±0.00	6.21±0.00	0.191±0.00	3.43±0.00	0.031±0.00	0.220±0.00

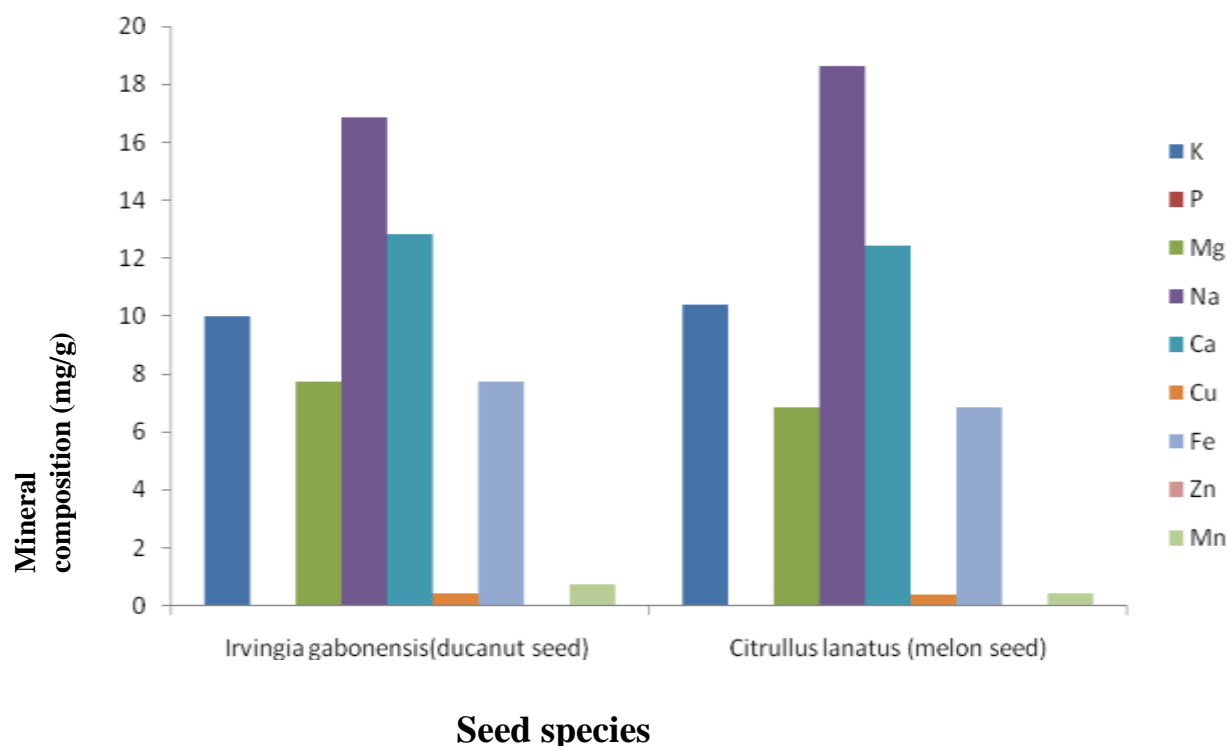


Fig. 3.38: Mineral compositions of some seed samples

The mineral compositions of the seed species in mg/g are presented in Table 3.38 and Figure 3.38. Potassium, (RDI, >2000mg), was found slightly higher in melon seed (10.40) than in ducanut seed (10.02), and the third most abundant mineral in the seeds. Sodium, (RDI, >1500mg), was found most abundant in the seed species, 18.64 for melon seed and 16.88 for ducanut seed. Calcium, (RDI, 1000mg) was the second most abundance mineral with ducanut seed having 12.84 while melon seed have 12.42. The Calcium content of both seeds was

almost the same ($P>0.05$). Magnesium, (RDI, 350mg) and iron, (RDI, 15mg) showed almost the same values and were the fourth abundant minerals, (7.76) for ducanut seed and (6.86) for melon seed. Phosphorous, (RDI, 1000mg) and zinc, (RDI, 15mg), were also in equal quantities in both seed species (0.056 and 0.062) for ducanut seed and melon seed respectively. Manganese, (RDI, 5mg), was slightly higher in ducanut seed (0.764) than in melon seed (0.440) and the fifth abundant. Copper, (RDI, 2mg), was found higher in ducanut seed (0.426) than in melon seed (0.382). Apart from iron, with values close to the RDI values, the seeds did not meet the RDI for these minerals and should be supplemented in such diets. The mean differences in the values of all minerals in both seeds were insignificant. The importance of these minerals in our diet have been reported by Clifford (1971) and Srilakshmi (2006). Both seeds were generally rich in macro and micro minerals. None of the seeds showed absence of any of the nine minerals tested. They can thus be recommended as mineral rich foods, useful in cases of mineral deficiencies especially Na, Ca, K, Mg deficiencies. But the high content of Na makes them not ideal for hypertensive patients.

Table 3.39: Energy values of some seed samples

Samples	Energy(kJ/g)
<i>Irvingia gabonensis</i> (ducanut seed)	1,772.25
<i>Citrullus lanatus</i> (melon seed)	1,900.60

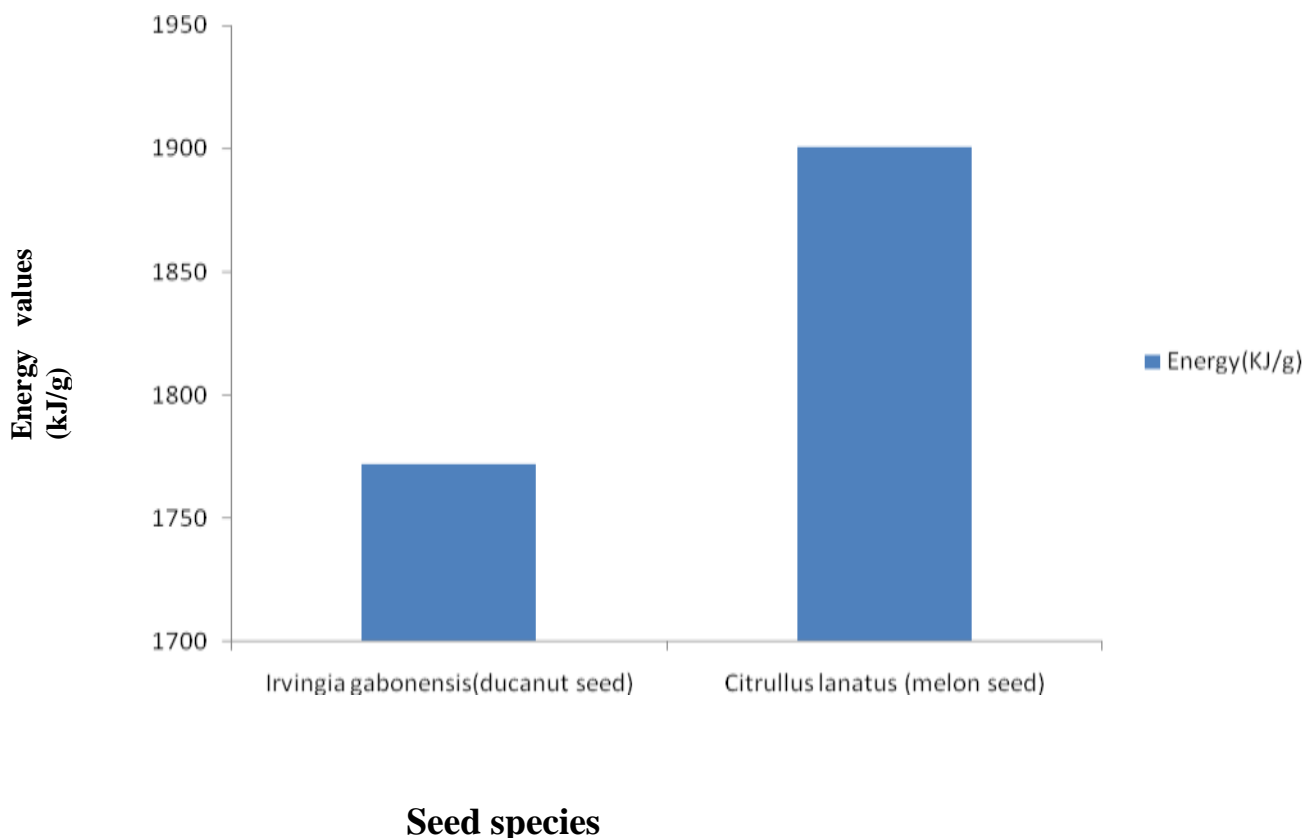


Fig. 3.39: Energy values of some seed species

The energy values of some seed species in kJ/g are shown in Table 3.39 and Figure 3.39. Melon seed showed a higher calorific value (1900.60) than ducanut seed (1772.25). Both seed species are high in calories but still have to be supplemented and/or combined with other foods to meet up with the RDA of calories (8500kJ/g) and to make for a balanced diet.

3.11 SOME HEAVY METAL ANALYSIS RESULTS OF THE FOOD SAMPLES

TABLE 3.40: Heavy metal compositions of some vegetable samples

Samples	Pb	Cd	Co	Ni	Hg	As
1. Vegetables						
i. <i>Telfaira occidentalis</i> (pumpkin)	0.00±0.00	0.04 ± 0.00	0.00 ±0.00	0.62 ±0.00	1.60 ±0.00	0.00 ±0.00
ii. <i>Pterocarpus mildbreadi</i> (African rose wood)	0.02±0.00	0.56 ± 0.00	0.00 ±0.00	0.22 ±0.00	0.00 ±0.00	0.02 ±0.1100
iii. <i>Vernonia amygdaline</i> (Bitter leaf)	0.08±0.00	0.16 ± 0.00	0.04 ±0.00	0.00 ±0.00	0.80 ±0.00	0.20 ±0.00
iv. <i>Amaranthus hybridus</i> (green amaranth)	0.00±0.00	0.00 ± 0.00	0.00 ±0.00	0.24 ±0.00	0.40 ±0.00	0.36 ±0.00
v. <i>Corchorus olitoris</i> (bushmallow)	0.36±0.00	0.06 ± 0.00	0.20 ±0.00	0.56 ±0.00	0.00 ±0.00	0.00 ±0.00
vi. <i>Solanum melongena</i> (garden-egg leaf)	0.24±0.00	0.60 ± 0.00	0.00 ±0.00	0.22 ±0.00	0.00 ±0.00	0.02 ±0.00

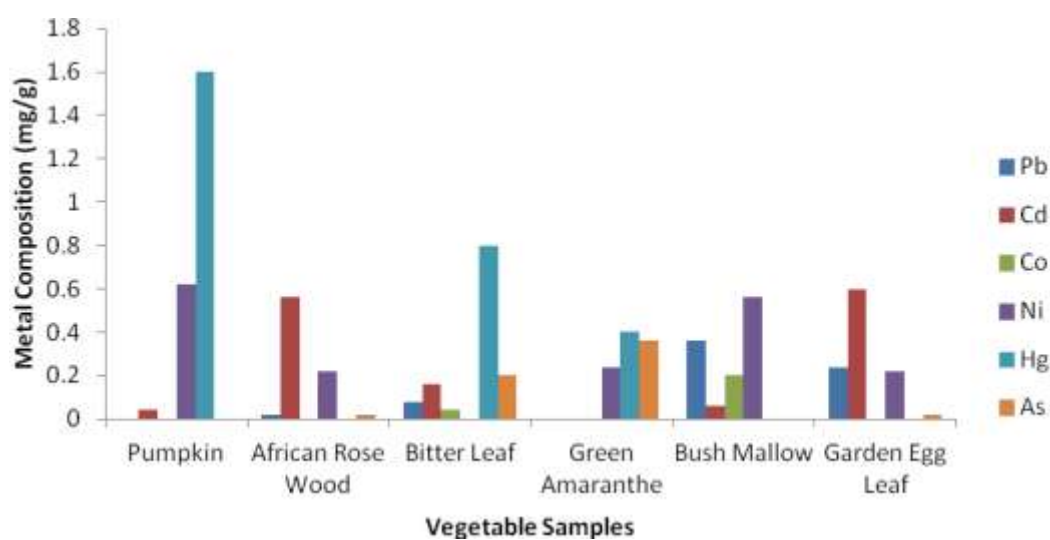


Fig. 3.40: Heavy metal compositions of some vegetable samples

Table 3.40 and Figure 3.40 showed the heavy metal (trace mineral) composition of some vegetable samples in mg/g. Lead ranged between 0.00 for pumpkin and 0.36 for bushmallow. Though the levels are low (<1mg), lead fulfils no essential function in the human body but merely does harm after uptake from food, air or water and thus not required in the food (WHO, 2001).

Cadmium ranged between 0.00 for green amaranth and 0.60 for garden egg leaf. Garden egg and African rose wood showed higher values of cadmium ($P<0.05$) within the vegetable samples but all have cadmium levels below one milligramme. According to WHO, (2001), cadmium has no essential function in the body, but an exposure to significantly high cadmium levels occurs with smokers. Tobacco smoke transports cadmium into the lungs. Blood transports it through the rest of the body where it can increase effect by potentiating cadmium that is already present from cadmium rich food. It is first transported to the liver through the blood, there, it is bonded to proteins to form complexes that are transported to the kidney, where it accumulates and damages filtration mechanism (Meulenbelt *et al.*, 2001).

Cobalt ranged between 0.00 for pumpkin, african rose wood and green amaranth and 0.20 for bush mallow. Cobalt is beneficial to humans because it is part of vitamin B₁₂, which aids in the formation of normal red blood cell and maintains nerve tissue. None of the vegetables had up to one milligramme of cobalt which is the recommended daily intake. Nickel ranged between 0.00 for bitterleaf and 0.62 for pumpkin. The levels of nickel in the vegetable sample were all below one milligramme, which is the recommended daily intake, though products containing nickel may cause skin rash in case of allergies (Petersdorf *et al.*, 1991). Nickel is a common trace element in multiple vitamins, used for increasing iron absorption, preventing iron-poor blood (anemia) and treating weak bones (osteoporosis). Mercury ranged between 0.00 for African rose wood, bushmallow and garden-egg leaf and 1.60 for pumpkin. The level of mercury is significantly high in pumpkin (1.6) and bitter leaf (0.80) ($p<0.05$)

within the vegetable group. The WHO declared, there is no safe level of mercury for human beings-in other words, mercury (Hg) is so poisonous that no amount of mercury absorption is safe (WHO, 2001).

Thus, vegetables as Africa rose wood, bushmallow and garden-egg leaf could be consumed as Hg-free foods though there are variations in nutritional compositions of food due to climate, soil, agricultural activities and so on as quoted earlier. Arsenic ranged between 0.00 for pumpkin and bushmallow and 0.36 for green amaranth. The results confirmed the literature that levels of arsenic in food are very low and it is usually not added due to its toxicity (Ball, 1982), though the organic forms of arsenic found in some fishes are fairly harmless.

TABLE 3.41: Heavy metal compositions of some fruit samples

	Samples	Pb	Cd	Co	Ni	Hg	As
2.	Fruits						
i.	<i>Annonia muricata</i> (soursop)	1.60±0.00	0.28 ± 0.00	0.00 ±0.00	0.36 ±0.00	0.28 ±0.00	0.00 ±0.00
ii.	<i>Citrus Sinensis</i> (orange)	0.00±0.00	0.42 ± 0.00	0.00 ±0.00	0.30±0.00	0.24 ±0.00	0.00 ±0.00
iii.	<i>Chrysophyllum albidum</i>	0.66±0.00	0.00 ± 0.00	0.00 ±0.00	0.46 ±0.00	0.36 ±0.00	0.00 ±0.00
iv.	<i>Mangifera indica</i> (Mango)	0.42±0.00	0.00 ± 0.00	0.00 ±0.00	0.56 ±0.00	0.88 ±0.00	0.00 ±0.00
v.	<i>Dialium indium</i> (tamarind)	0.00±0.00	0.00 ± 0.00	0.00 ±0.00	0.24 ±0.00	0.76 ±0.00	0.00 ±0.00
vi.	<i>Klainedoxa gabonensis</i> (wildmango)	0.46±0.00	0.00 ± 0.00	0.00 ±0.00	0.32 ±0.00	0.40 ±0.00	0.00 ±0.00

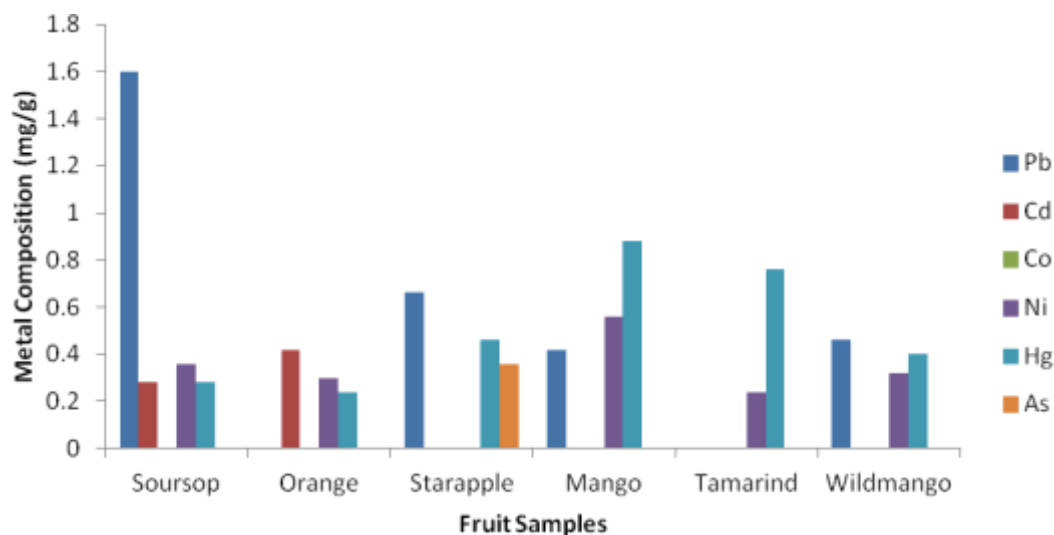


Fig.3.41: Heavy metal compositions of some fruit samples

Table 3.41 and Figure 3.41 showed the concentration of some heavy metals in some fruit samples in mg/g. Lead ranged between 0.00 for orange and tamarind and 1.60 for soursop. The values for lead were higher in soursop than other fruit species analysed ($P>0.05$) and not detected in orange, and tamarind. Lead has been shown to fulfil no essential function in the human body and thus not required in the food. Cadmium ranged between 0.00 for starapple, mango, tamarind and wild mango and 0.42 for orange. Cadmium was not detected in almost all the fruits samples analysed except soursop (0.28) and orange (0.42). Though the levels are low, according to WHO, (2001), it has not essential function in the human body.

Cobalt was not detected in all the fruit samples analysed but it is recommended in the diet in at least one milligram as RDI and its essential functions have been stated earlier. Nickel ranged between 0.24 for tamarind and 0.56 for mango. All the fruit samples contained Ni below 1mg (<1mg) which is the RDI of Ni as an essential trace mineral.

Mercury was found highest in mango (0.88) and least in orange (0.24). Though the levels are low, it has been declared that there is no safe level of mercury for

humans, thus not required in our diet (WHO, 2001). Arsenic was not detected in all the fruit species analysed.

TABLE 3.42: Heavy metal compositions of some cereal samples

Samples	Pb	Cd	Co	Ni	Hg	As
3. Cereals						
i. <i>Oryza sativa</i> (rice)	0.36±0.00	0.00 ± 0.00	0.02 ±0.00	1.08±0.00	0.64 ±0.00	0.20 ±0.00
ii. <i>Zea mays</i> (white corn)	0.44±0.00	0.04 ± 0.00	0.02 ±0.00	1.06±0.00	0.60 ±0.00	0.06 ±0.00
iii. <i>Zea mays</i> (yellow corn)	1.68±0.00	0.02 ± 0.00	0.06 ±0.00	0.44±0.00	0.62 ±0.00	0.00 ±0.00

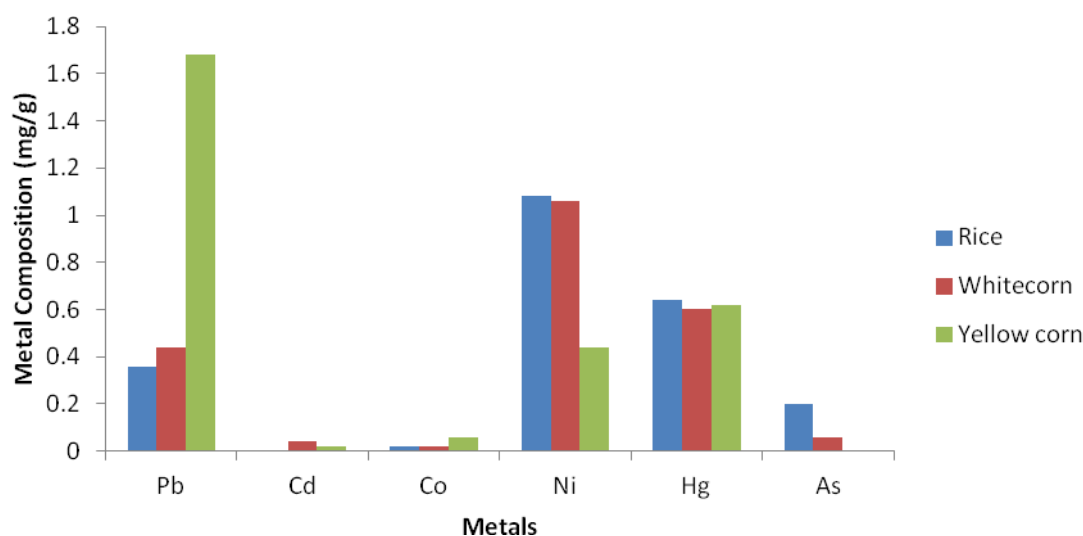


Fig. 3.42: Heavy metal compositions of some cereal samples

Table 3.42 and Figure 3.43 showed the heavy mineral concentrations in the cereal samples. Rice showed the least value for lead content, (0.36) while yellow corn showed the highest (1.68). The lead content of yellow corn was significantly ($P < 0.05$) higher than the other cereal species and this could be due to variation in nutritional composition of food due to climate, soil, agricultural practices, storage, handling process etc cited earlier.

Cadmium was found very low in all the cereal samples. It was not detected in rice, in white corn (0.04) while low in yellow corn (0.02). Cadmium is not

required in the food in any amount since it has no known useful function. Nickel was found highest in rice (1.08) and least in yellow corn (0.44). Only yellow corn showed Ni (0.44) below 1mg (<1mg) required as RDI whereas rice (1.08) and white corn (1.06) showed levels above the RDI and thus such food must be taken with caution to avoid problems associated with excess intake of Nickel, though it is an essential trace mineral.

Mercury was found highest in rice (0.64) and least in white corn (0.60). The distribution of mercury metal in the cereal species was uniform and almost in equal amount ($P < 0.05$). But there is no safe level of mercury and thus these foods pose a danger to human as they are the most commonly consumed cereals. Arsenic ranged between 0.00 for yellow corn and 0.20 for rice. The arsenic levels are low but are toxic metals which are not required in the body and should be avoided (FNB, 1974).

TABLE 3.43: Heavy metal compositions of some root/tubers species

Samples	Pb	Cd	Co	Ni	Hg	As
4. Roots/tubers						
i. <i>Dioscorea alata</i> (water yam)	0.22±0.00	0.00 ± 0.00	0.04 ±0.00	0.22±0.00	0.84 ±0.00	0.00 ±0.00
ii. <i>Dioscorea dumentorum</i> (Sweet yam)	0.06±0.00	0.22 ± 0.00	0.08 ±0.00	0.06±0.00	0.80 ±0.00	0.00 ±0.00
iii. <i>Dioscorea ayensis</i> (yellow yam)	1.88±0.00	0.00 ± 0.00	0.02 ±0.00	0.00±0.00	0.94 ±0.00	0.80 ±0.00
iv. <i>Manihot utilissima</i> (cassava)	0.50±0.00	0.36 ± 0.00	0.04 ±0.00	1.00±0.00	1.08 ±0.00	0.00 ±0.00
v. <i>Manihot dulcis</i> (garri)	0.00±0.00	0.26 ± 0.00	0.18 ±0.00	0.46±0.00	1.84±0.00	0.06 ±0.00
vi. <i>Capsum annum</i> (red sweet Potato)	0.00±0.00	0.30 ± 0.00	0.00 ±0.00	0.42±0.00	1.86 ±0.00	0.16 ±0.00
vii. <i>Capsum annum</i> (white sweet Potato)	0.06±0.00	0.32 ± 0.00	0.00 ±0.00	0.40±0.00	1.96 ±0.00	0.00 ±0.00
viii. <i>Colocassia sagittifolium</i> (cocoyam)	0.16±0.00	0.44 ± 0.00	0.00 ±0.00	0.22±0.00	1.82 ±0.00	0.00 ±0.00

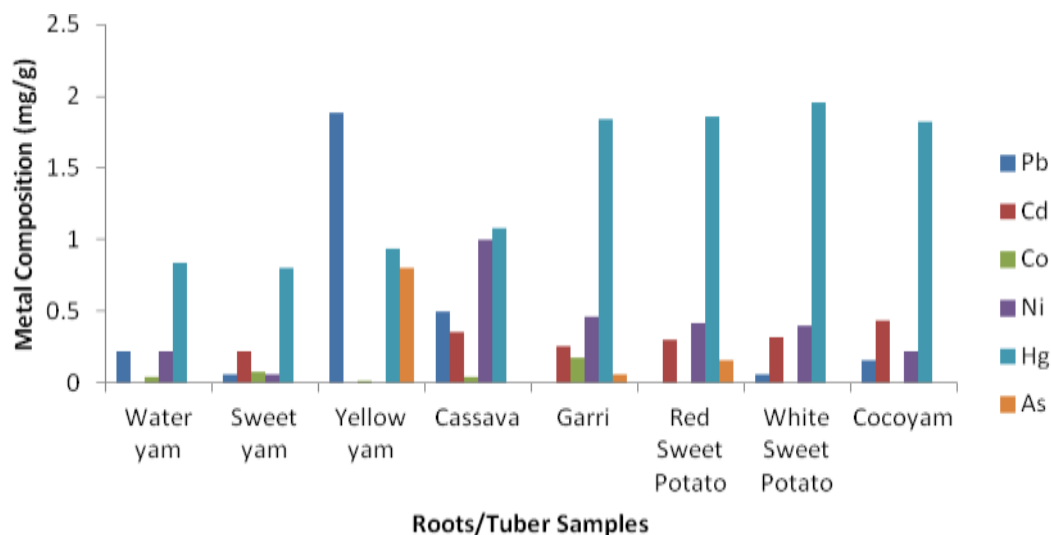


Fig. 3.43: Heavy metal compositions of some roots/tubers

Table 3.43 and Figure 3.43 showed the concentrations of heavy metals in some root/tubers species.

Lead ranged between 0.00 for garri and red sweet potato and 1.88 for yellow yam. Lead was thus not detected in garri and red sweet potato but significantly ($P < 0.05$) higher in yellow yam within the group. The levels of lead in all the samples, though low, are not required in the food since lead has no essential function in the body but rather poses a problem (WHO 2001). Cadmium was not detected in water yam and yellow yam but present in all other root/tubers analysed being 0.22 for sweet yam, 0.36 for cassava, 0.26 for garri, 0.30 for red sweet potato, 0.32 for white sweet potato and 0.44 for cocoyam. Though levels of cadmium were low, cadmium has no essential function in the body thus its presence in food poses a problem as earlier stated and cited.

Cobalt ranged between 0.00 for cocoyam, white sweet potato and red sweet potato and 0.18 for garri. None of the tuber species contain up to one milligram cobalt as RDI for cobalt.

Nickel was not detected in yellow yam and cassava but found in less than one milligram ($< 1\text{mg}$), required as RDI (FNB, 1974) in all other roots/tubers species analysed.

Mercury was found in all the roots/tubers species ranging from 0.80 for sweet yam to 1.96 for white sweet potato. Mercury levels were high ($P < 0.05$) in all the root/tubers species when compared with other metals analysed for this group and this poses a problem to humans since no amount or level of mercury is safe (WHO, 2001).

Arsenic was not detected in some of the roots/tubers species except in yellow yam (0.80), garri (0.06) and red sweet potato (0.16). This again supports the literature that arsenic is found low in most of the food and usually not introduced because of its toxicity.

TABLE 3.44: Heavy metal compositions of some oil samples

Samples	Pb	Cd	Co	Ni	Hg	As
5. Oil						
i. <i>Elaeis guineensis</i> (red oil)	0.06±0.00	0.00 ± 0.00	0.22 ±0.00	0.38±0.00	0.64 ±0.00	0.26 ±0.00
ii. <i>Arachis hypogel</i> (groundnut oil)	0.30±0.00	0.28 ± 0.00	0.36 ±0.00	0.96±0.00	0.60 ±0.00	0.00 ±0.00

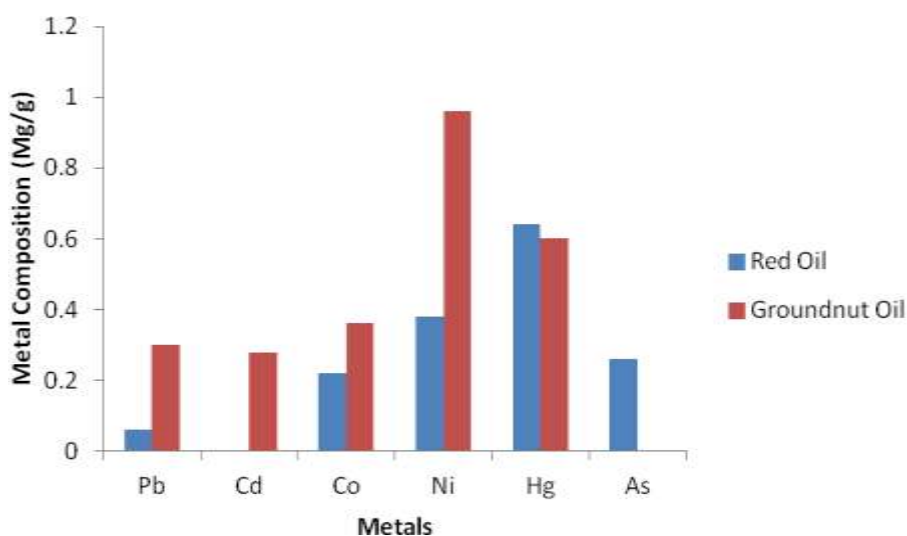


Fig. 3.44: Heavy metal compositions of some oil samples

Table 3.44 and Figure 3.44 showed heavy metal concentration in some oil samples in mg/g. Red oil contained lower concentration of lead (0.06) than groundnut oil (0.30). Cadmium was low in both oil samples, infact not detected in red oil and only 0.28 in groundnut oil. The Mercury level in red oil was slightly higher (0.64) than that groundnut oil 0.60 while arsenic was not detected in groundnut oil but 0.26 in red oil. Lead, Cd, Hg and As are not required in our foods because they have been shown to fulfil no essential function in the body (WHO, 2001), rather pose a problem as stated earlier.

Cobalt was detected in both oils and the values are below one milligram required as RDI while nickel values for both the oil species were found not exceeding (<1mg) required as the RDI (FNB, 1974)

TABLE 3.45: Heavy metal compositions of some meat samples

Samples	Pb	Cd	Co	Ni	Hg	As
6. Meat						
i. <i>Capri hircus</i> (goat meat)	0.84±0.00	0.30 ± 0.00	0.00 ±0.00	0.82±0.00	0.78 ±0.00	0.00 ±0.00
ii. <i>Bos indicus</i> (Beef)	0.76±0.00	0.00 ± 0.00	0.00 ±0.00	0.66±0.00	0.36 ±0.00	0.00 ±0.00
iii. <i>Gallus domesticus</i> (chicken)	0.48±0.00	0.48 ± 0.00	0.00 ±0.00	0.64±0.00	0.38 ±0.00	0.00 ±0.00
iv. <i>Melleagris gallopardo</i> (turkey)	1.02±0.00	0.66 ± 0.00	0.00 ±0.00	0.60±0.00	1.76 ±0.00	0.00 ±0.00

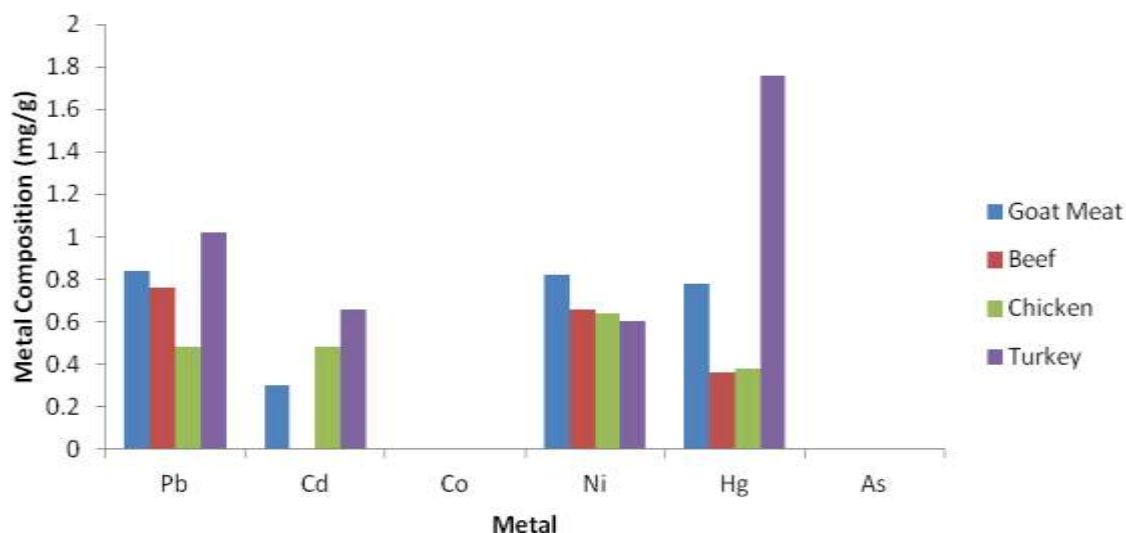


Fig. 3.45: Heavy metal compositions of some meat samples

Table 3.45 and Figure 3.45 showed the heavy metal concentration of some meat sample in mg/g. Arsenic was not detected in all the meat samples analysed. Mercury was highest in turkey (1.76) and least in beef (0.36). Lead was highest in turkey (1.02) and least in chicken (0.48) while cadmium was found highest in turkey (0.66) and not detected in beef. The mean differences obtained were all insignificant. Turkey seemed to be rich in heavy metals according to this research and this suggests that turkey intake should be with caution though nutritional composition of food could vary with place, climate, soil, and in this case animal handling, feeding and breeding and other practices (Aleto, 1993). Above all, these metals Cd, Hg, as are not safe for human consumption as cited earlier. Nickel ranged between 0.60 for turkey and 0.82 for goat meat thus the meat species contained <1mg required as RDI of nickel (FNB, 1974) while cobalt which is an essential trace heavy metal required in the body was not detected in all the meat species analysed.

TABLE 3.46: Heavy metal compositions of some fish samples

Samples	Pb	Cd	Co	Ni	Hg	As
7. Fish						
i. <i>Siluri formes</i> (cat fish)	0.02±0.00	0.00 ± 0.00	0.00 ±0.00	0.38±0.00	0.36 ±0.00	0.00 ±0.00
ii. <i>Maccarello</i> <i>lacento</i> (mackerel)	0.00±0.00	0.00 ± 0.00	0.62 ±0.00	0.00±0.00	0.20 ±0.00	0.00 ±0.00
iii. <i>Gadus morhua</i> (cod)	0.02±0.00	0.00 ± 0.00	0.00 ±0.00	0.00±0.00	0.24 ±0.00	0.00 ±0.00

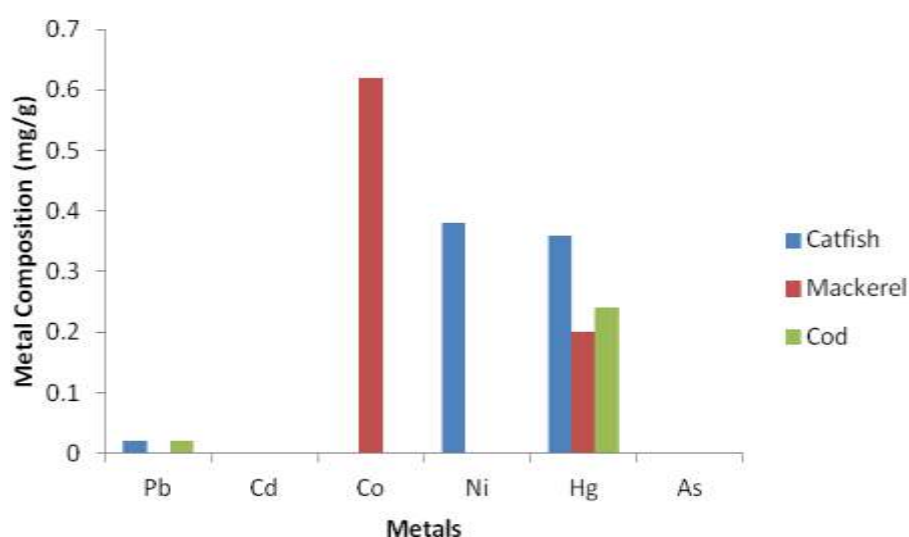


Fig. 3.46: Heavy metal compositions of some fish samples

Table 3.46 and Figure 3.46 showed the heavy metal compositions of some fish samples in mg/g. Arsenic and cadmium were not detected in any of the fish species analysed. Lead was not detected in mackerel but was found in equal amounts ($p < 0.05$) in catfish (0.02) and cod (0.02). Mercury ranged between 0.20 for mackerel to 0.38 for catfish.

The levels of lead and mercury were low but their presence in foods does not provide any useful benefit in the body but rather accumulates to toxic levels that are detrimental to health. Nickel was not detected in mackerel and cod but in low amount in catfish (0.38) and still below one milligram required as RDA

value. Cobalt was not detected in catfish and cod but present in mackerel (0.62) though not up to one milligram required as RDI of cobalt.

TABLE 3.47: Heavy metal compositions of some legumes/pulses

Samples	Pb	Cd	Co	Ni	Hg	As
8. Legumes/Pulses						
i. <i>Phaseolus vulgria</i> (white beans)	0.16±0.00	0.33 ± 0.00	0.00 ±0.00	0.68±0.00	1.66 ±0.00	0.22 ±0.00
ii. <i>Phaseolus vulgria</i> (brown beans)	0.22±0.00	0.44 ± 0.00	0.06 ±0.00	0.48±0.00	0.36 ±0.00	0.16 ±0.00
iii. <i>Ciceraritinum</i> (chickpea)	0.00±0.00	0.38 ± 0.00	0.00 ±0.00	0.56±0.00	0.48 ±0.00	0.04 ±0.00
iv. <i>Glycine max</i> (soyabeans)	0.00±0.00	0.40 ± 0.00	0.24 ±0.00	0.44±0.00	0.22 ±0.00	0.02 ±0.00
v. <i>Artocarpus communis</i> (breadfruit)	0.04±0.00	0.00 ± 0.00	0.66 ±0.00	0.84±0.00	0.68 ±0.00	0.06 ±0.00

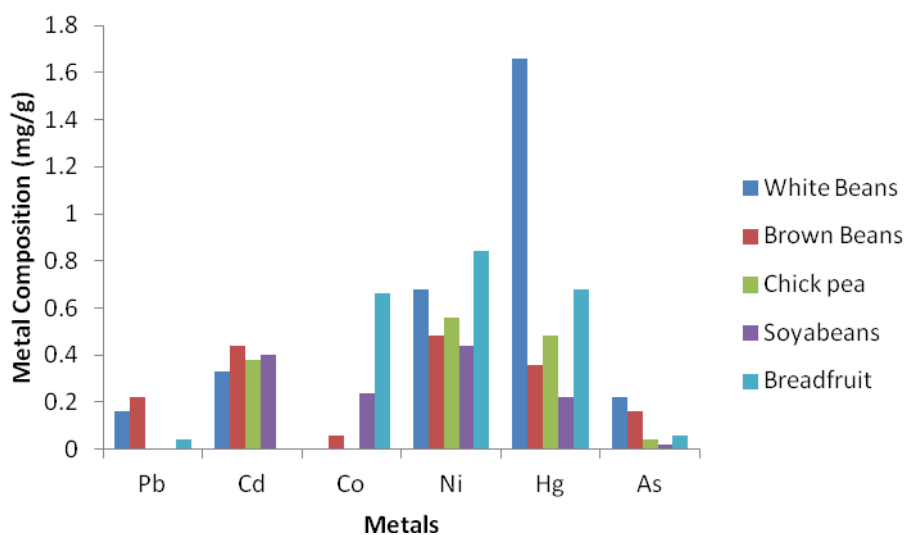


Fig. 3.47: Heavy metal compositions of some legumes/pulses

Table 3.47 and Figure 3 47 showed the heavy metal compositions of some legumes/pulses species in mg/g.

Lead was not detected in chickpea, and soyabean but present in white beans (0.16), brown beans (0.22) and breadfruit (0.04). Cadmium was found present in all the legume species except breadfruit ranging from 0.33 for white beans to 0.44 for brown beans.

Mercury was found present in all the legume/pulses species being highest ($P < 0.05$) in white beans and least in soyabeans (0.22). Arsenic ranged between 0.02 in soyabeans and 0.22 in white beans and was found present in generally low quantities in all the legumes/pulses species analysed. Cobalt was not detected in white beans and chickpea but present in brown beans (0.06), soyabeans (0.24), and bread fruit (0.66). Though present, but not up to 1mg required as RDI value of cobalt. Nickel was present in all the species of legumes analysed, ranging from 0.44 for soyabeans to 0.84 for breadfruit. The values were below one milligram required as RDI of nickel. The mean differences observed for all the minerals in the legume/pulses species were all insignificant.

TABLE 3.48: Heavy metal compositions of some nut samples

	Samples	Pb	Cd	Co	Ni	Hg	As
9.	Nuts						
i.	<i>Arachis hypogel</i> (groundnut)	0.02±0.00	0.00 ± 0.00	0.34 ±0.00	0.00±0.00	0.24 ±0.00	0.02 ±0.00
ii.	<i>Cola nitida</i> (colanut)	0.00±0.00	0.22 ± 0.00	0.11 ±0.00	0.20±0.00	0.36 ±0.00	0.16 ±0.00
iii.	<i>Garcine kola</i> (bitter cola)	0.00±0.00	0.24 ± 0.00	0.00 ±0.00	0.60±0.00	0.80 ±0.03	0.00 ±0.00
iv.	<i>Cocos nucigera</i> (coconut)	0.64±0.00	0.94 ± 0.00	0.00 ±0.00	0.24±0.00	0.64 ±0.35	0.00 ±0.00

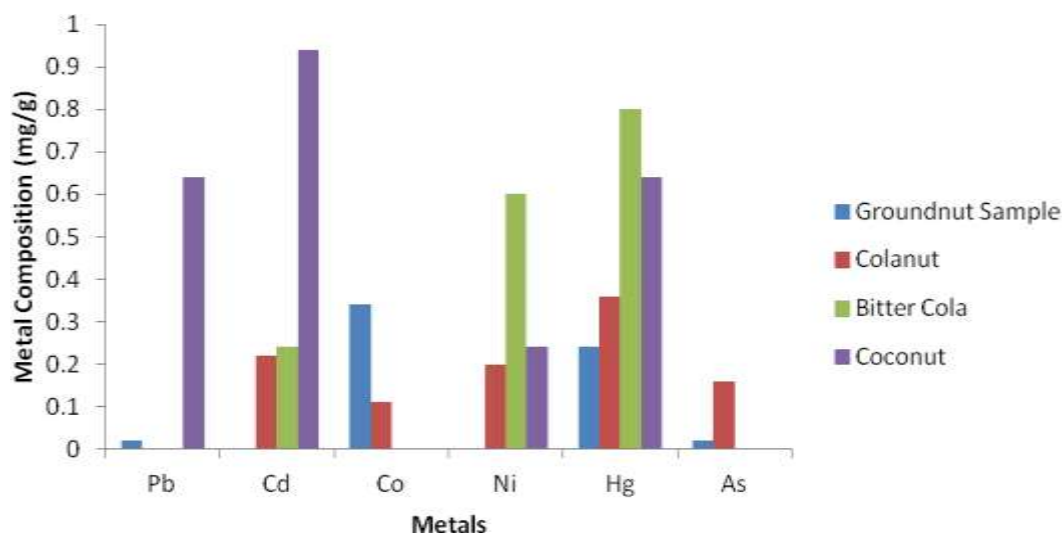


Fig. 3.48: Heavy metal compositions of some nut samples

Table 3.48 and Figure 3.48 showed heavy mineral composition of some nut samples in mg/g. Lead was found only in groundnut (0.02) and coconut (0.64) and not detected in colanut and bittercola. Cadmium was present in colanut (0.22), bitter cola (0.24) and coconut (0.94) and not detected in groundnut. Mercury was found present in all the nut species ranging from 0.24 for groundnut to 0.80 for bitter cola. Arsenic was not detected in bitter cola and coconut but present in groundnut (0.02) and colanut (0.16). Cobalt was not found in bitter cola and coconut but present in very low amount when compared with the RDI value of one milligram in colanut (0.11) and groundnut (0.34). Nickel ranged between 0.20 for colanut and 0.60 for bitter cola and was not detected in groundnut. Thus, colanut (0.20), bittercola (0.60) and coconut (0.24) contain nickel below one milligram which is required as the RDI value of nickel. The mean differences were all insignificant.

TABLE 3.49: Heavy metal compositions of some seed samples

Samples	Pb	Cd	Co	Ni	Hg	As
10. Seeds						
i. <i>Irvingia gabonensis</i>	0.20±0.00	0.00 ± 0.00	0.00 ±0.00	0.00±0.00	0.88 ±0.00	0.00 ±0.00
ii. <i>Citrullus lanatus</i> (melon seed)	0.36±0.00	0.00 ± 0.00	0.00 ±0.00	0.00±0.00	0.00 ±0.00	0.00 ±0.00

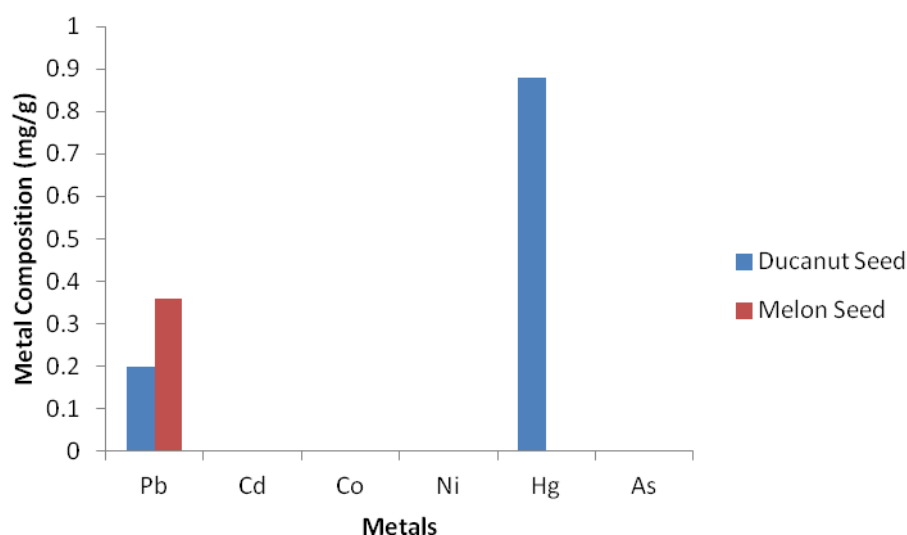


Fig. 3.49: Heavy metal compositions of some seed samples

The heavy metal composition of some seeds samples in mg/g are shown in Table 3.49 and Figure 3.49. Arsenic, nickel, cobalt and cadmium were not detected in both the seed samples. Mercury was found only high in ducanut seeds and not detected at all in melon seed ($P < 0.05$) while both seeds contain small amounts of lead,(0.20), for ducanlt seed and (0.36) for melon seed.

From Table 3.40 to 3.49, the presence of heavy metals was seen to persist in all the major classes of foods eaten by Easterners in Nigeria. Cadmium, Lead and arsenic which are not even required by the human body because they simply fulfill no essential function, rather pose problems, were found present in the

food samples, whereas mercury which has been declared to be unsafe no matter how minute its presence in food, was found most abundant in all the food group except for few vegetables, where it was not detected. These results supported the fact that, heavy metals are natural components of the earth's crust and also that environmental pollution (land/soil and water pollution) by chemical, metallurgical, agricultural practices etc as well has affected our environment (land and water), thus poses serious health challenges.

3.12 RESULTS OF THE PHYSICOCHEMICAL ANALYSIS OF THE OIL SAMPLES

Table 3.50: Physicochemical Properties of some Oil Samples

Sample	Free fatty acid	Oleic acid	Palmitic acid	Lauric acid	Saponification value	Peroxide value (mg/g)	Esther value	Iodine value (mg/g)
<i>Elaeis guineensis</i> (red oil)	47.00±5.57	0.47±0.006	0.042±0.005	0.033±0.004	4.21±0.00	18.66±2.36	89.28±11.68	63.40±0.00
<i>Arachis hypogel</i> (groundnut oil)	2.82±0.00	0.03±0.00	0.003±0.00	0.002±0.00	21.97±1.62	0.19±0.05	5.16±0.00	58.50±1.62

Table 3.50 showed the physicochemical properties: free fatty acid, oleic acid, palmitic acid, lauric acid, saponification value, peroxide value, ester value and iodine values of some oil samples commonly consumed in Eastern Nigeria.

The acid values in mg/g: oleic acid ranged between 0.03 in groundnut oil and 0.47 for red oil. Palmitic was found to be (0.042) for red and (0.003), in groundnut oil while lauric acid was found to be (0.033), for red oil and (0.002), for groundnut oil. Differences in their means were significant ($P>0.05$). All the values were lower than that reported by Agatemor (2006). Esuoso and Odetokun, (1995) have reported that the acid values of oils suitable for edible purposes should not exceed 4.0mg/g. This showed that the oils were safe for human consumption. The acid value and free fatty acid values are used as

indicator of the edibility of the oil. The peroxide value was found to be (18.66), for red oil and much lower (0.19) for groundnut oil ($P>0.05$). Oils with peroxide values ranging from 20 to 40.00mg/ g oil are considered rancid (Cock and Rede, 1986). The peroxide values obtained were below this range, the oils were therefore considered to be stable. The peroxide value is usually used as an indicator of deterioration of fats and oils (Asiedu, 1989).

The iodine values ranged between 58.50 for groundnut oil and 63.40 for red oil. The iodine value is a measure of the unsaturation of fats and oil. Higher iodine value indicates higher unsaturation (Knothe, 2002). The values were low compared with iodine values of well refined oils usually between 80-90mg/g or more, depending on the technique employed. Thus natural oil and fat as these analysed are usually less unsaturated (highly saturated), with low iodine values and are solid at room temperature. The mean differences in the iodine values were all significant ($P>0.05$). Saponification values were found to be (4.21), for red oil and (21.97), for groundnut oil, giving a negative value for Ester value calculated for red oil (-89.29) and (5.16), for groundnut oil. T-test analysis also showed a significant difference in the saponification values. The negative value indicates that the red oil has little or no ester value and thus not very suitable in soap making unlike the groundnut oil. Other reasons for reduction may be due to activities of microbes while extent of reduction may be associated with varying levels of the types of fatty acid present in the samples (Aletor et al; 1990).

CHAPTER FOUR

CONCLUSION

From the results and discussions of this research it has been found that:

- i. The various food species eaten in Eastern Nigeria are rich in nutrients and can serve as potential sources of nutrients for man and livestock.
- ii. The major nutrients that contribute to the calorific values of foods are carbohydrate, followed by protein and closely by fat.
- iii. The moisture content was generally low for all the food groups due to variation in nutritional composition of food, possibly as a result of climate and/or storage methods.
- iv. Fibre was low in all the food groups that are the major sources of protein in the diet of the Easterner (fish, meat, legume/pulses) and the oils, and therefore must be supplemented in such diets since the importance of fibre in food involved ameliorating and preventing digestive diseases and colon cancer.
- v. The various food species eaten in Eastern Nigeria contained substantial amounts of anti-nutrients.
- vi. Saponin was the most abundant antinutrient found among the foods eaten in Eastern Nigeria while alkaloid was the second abundant phytonutrient.
- vii. All the food groups contained substantial quantities of macro and micro minerals required for optimal body function when taken adequately in right proportions.
- viii. Minerals like P, Zn, Mn, and Cu were in very low quantities in the foods analysed and should be supplemented in their diets.
- ix. Mercury was the most abundant toxic heavy metal present in the foods, followed by lead, cadmium and arsenic.

- x. The physicochemical properties of the oils showed that they were good for human consumption, but were essentially saturated, thus must be taken moderately.

The food species studied are endowed with nutrients for normal body functions, with antinutrients that provide numerous health benefits and heavy toxic metals that pose serious health problems.

4.2 RECOMMENDATION

There is need for more work to be done on the food classes studied, hence the following recommendations.

1. It is recommended that proteins in these food groups be analysed collectively and the various amino acids compared.
2. The fat be extracted, analysed collectively and tested for saturation and unsaturation.
3. The carbohydrates should be characterized further to ascertain the types of sugars present.
4. The effects of heat on the different phytonutrients (antinutrients) should be determined.
5. The effects of heat on the nutrients should also be studied.
6. Nutrition should be taught in Eastern schools, from primary school levels, as it is done presently in some countries, such as USA, Canada, England and Wales. The importance of a balanced diet, how to read chemical contents or labels on especially packaged foods, be able to know the Recommended Daily Allowances (RDA) of nutrients, calories should be stressed in the nutrition classes, so as to be able to discard and make good food choices and ultimately how to eat towards a healthy and longer life.
7. Though heavy metals are part of our earth's crust, waste management strategies should be enhanced in order to reduce the amount of toxic substances present in our land and water which harbour our foods.

8. People should not eat based on their personal preferences and ingrained habits or culture, but should eat rightly and moderately to avoid problems associated with overeating and improper eating.

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APPENDIX 1 LIST OF ACRONYMS

AAS: Atomic Absorption Spectrophotometer

ADI: Adequate Daily Intake

AMDR: Acceptable Macronutrient Distribution Range

AOAC: Association of Official Analytical Chemists

C: Carbohydrate

CF: Conversion Factor

DASH: Dietary Approach to Stop Hypertension

DF: Dietary Fibre

DS: Digestible Starch

EFSA: European Food Safety Authorities

EFSA: European Food Safety Authority

F: Fat

FDA: Food and Drug Authority

FAO: Food and Agriculture Organization

FNB: Food and Nutrition Board

g: Gramme

HACCP: Hazard Analysis and Critical Control Point

HDL: High Density Lipoprotein

ICESCR: International Covenant on Economic, Social and Cultural Rights

Mg: Milligram

ml: Millilitre

MSG: Monosodium Glutamate

O: Oxalate

P: Phytic acid

P: Protein

PCBs: PolyChloro Biphenyls

RDA: Recommended Dietary Allowance

RDI: Recommended Dietary Intake

RS: Resistant Starch

S: Saponin

T: Tannin

T: Tonnes

TS: Total Solid

UVB: Ultra Violet Blue

WHO: World Health Organization

APPENDIX 2
Descriptive, Anova, Multiple Comparison and T-test Analysis of the
Proximate, Antinutrient and Mineral Compositions of samples

2i: Proximate Composition (Moisture Content) of some Fruit Samples

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Citrus cinensis (Orange)	3	17.4967	.00577	.00333	17.4823	17.5110	17.49	17.50
Chrysophyllum albidim (Starapple)	3	14.1667	.01528	.00882	14.1287	14.2046	14.15	14.18
Magnifer indica (Mango)	3	45.3200	.01000	.00577	45.2952	45.3448	45.31	45.33
Annona Muricata (Soursop)	3	6.1600	.04359	.02517	6.0517	6.2683	6.11	6.19
Dalium indum (tamarind)	3	14.6000	.00000	.00000	14.6000	14.6000	14.60	14.60
Klainedoxa gabonensis (Wildmango)	3	5.0000	.00000	.00000	5.0000	5.0000	5.00	5.00
Total	18	17.1239	13.78920	3.25015	10.2667	23.9811	5.00	45.33

ANOVA

Observation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3232.411	5	646.482	1711276.462	.000
Within Groups	.005	12	.000		
Total	3232.416	17			

2ii: Proximate Composition (Ash Content) of some Fruit Samples

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Citrus cinensis (Orange)	3	20.3333	.28868	.16667	19.6162	21.0504	20.00	20.50
Chrysophyllum albidum (Starapple)	3	25.0000	.00000	.00000	25.0000	25.0000	25.00	25.00
Magnifera indica (Mango)	3	10.0000	.00000	.00000	10.0000	10.0000	10.00	10.00
Annona muricata (Soursop)	3	6.8333	.28868	.16667	6.1162	7.5504	6.50	7.00
Dialium indum (Tamarind)	3	3.5000	.00000	.00000	3.5000	3.5000	3.50	3.50
Klainedoxa gabonensis (Wildmango)	3	3.6667	.57735	.33333	2.2324	5.1009	3.00	4.00
Total	18	11.5556	8.50586	2.00485	7.3257	15.7854	3.00	25.00

ANOVA

Observation	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1228.944	5	245.789	2949.467	.000
Within Groups	1.000	12	.083		
Total	1229.944	17			

2iii: Proximate Composition (Crude Fat) of some Fruit Samples

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Citrus cinensis (Orange)	3	9.0000	.00000	.00000	9.0000	9.0000	9.00	9.00
Chrysophyllum albidim (Starapple)	3	10.0000	.00000	.00000	10.0000	10.0000	10.00	10.00
Magnifera indica (Mango)	3	2.0000	.00000	.00000	2.0000	2.0000	2.00	2.00
Annona muricata (Soursop)	3	1.0000	.00000	.00000	1.0000	1.0000	1.00	1.00
Dialium indum (Tamarind)	3	3.0000	.00000	.00000	3.0000	3.0000	3.00	3.00
Klainedoxa gabonensis (Wildmango)	3	17.6667	2.51661	1.45297	11.4151	23.9183	15.00	20.00
Total	18	7.1111	6.05746	1.42776	4.0988	10.1234	1.00	20.00

ANOVA

Observation	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	611.111	5	122.222	115.789	.000
Within Groups	12.667	12	1.056		
Total	623.778	17			

2iv: Proximate Composition (Crude Protein) of some Fruit Samples

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Citrus sinensis (Orange)	3	4.5400	.03464	.02000	4.4539	4.6261	4.50	4.56
Chrysophyllum albidum (Starapple)	3	31.4800	.03464	.02000	31.3939	31.5661	31.44	31.50
Magnifera indica (Mango)	3	6.9800	.03464	.02000	6.8939	7.0661	6.94	7.00
Annona muricata (Soursop)	3	27.9800	.03464	.02000	27.8939	28.0661	27.94	28.00
Dialium indum (Tamarind)	3	18.1300	.00000	.00000	18.1300	18.1300	18.13	18.13
Klainedoxa gabonensis (Wildmango)	3	10.5400	.50478	.29143	9.2861	11.7939	10.00	11.00
Total	18	16.6083	10.52848	2.48159	11.3726	21.8440	4.50	31.50

ANOVA

Observation	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1883.913	5	376.783	8708.379	.000
Within Groups	.519	12	.043		
Total	1884.432	17			

2v: Proximate Composition (Carbohydrate) of some Fruit Samples

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Citrus sinensis (Orange)	3	38.8400	.01000	.00577	38.8152	38.8648	38.83	38.85
Chrysophyllum albidum (Starapple)	3	11.0233	.01528	.00882	10.9854	11.0613	11.01	11.04
Magnifera indica (Mango)	3	29.6900	.02000	.01155	29.6403	29.7397	29.67	29.71
Annona muricata (Soursop)	3	34.1867	.01155	.00667	34.1580	34.2154	34.18	34.20
Dialium indum (Tamarind)	3	50.3867	.01528	.00882	50.3487	50.4246	50.37	50.40
Klainedoxa gabonensis (Wildmango)	3	59.5433	.00577	.00333	59.5290	59.5577	59.54	59.55
Total	18	37.2783	15.86597	3.73965	29.3884	45.1683	11.01	59.55

ANOVA

Observation	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	4279.391	5	855.878	4531119.865	.000
Within Groups	.002	12	.000		
Total	4279.393	17			

2vi: Proximate Composition (Crude Fibre) of some Fruit Samples

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Citris sinensis (Orange)	3	10.0000	.00000	.00000	10.0000	10.0000	10.00	10.00
Chrysophyllum albidim (Starapple)	3	8.3333	2.88675	1.66667	1.1622	15.5044	5.00	10.00
Magnifera indica (Mango)	3	6.0000	.00000	.00000	6.0000	6.0000	6.00	6.00
Annona muricata (Soursop)	3	23.6667	4.61880	2.66667	12.1929	35.1404	21.00	29.00
Dialium indum (Tamarind)	3	10.3333	.57735	.33333	8.8991	11.7676	10.00	11.00
Klainedoxa gabonensis (Wildmango)	3	3.5667	.11547	.06667	3.2798	3.8535	3.50	3.70
Total	18	10.3167	6.85731	1.61628	6.9066	13.7267	3.50	29.00

ANOVA

Observation	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	739.358	5	147.872	29.561	.000
Within Groups	60.027	12	5.002		
Total	799.385	17			

2vii: Antinutrient Composition (Oxalates) of some Fruit Samples

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Orange	3	2.0433	.01528	.00882	2.0054	2.0813	2.03	2.06
Starapple	3	.1000	.00000	.00000	.1000	.1000	.10	.10
mango	3	.5133	.02309	.01333	.4560	.5707	.50	.54
Soursop	3	1.0233	.01528	.00882	.9854	1.0613	1.01	1.04
tamarind	3	.5967	.01528	.00882	.5587	.6346	.58	.61
Wildmango	3	.5433	.01528	.00882	.5054	.5813	.53	.56
Total	18	.8033	.63377	.14938	.4882	1.1185	.10	2.06

ANOVA

Observation	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	6.825	5	1.365	5584.309	.000
Within Groups	.003	12	.000		
Total	6.828	17			

2viii: Antinutrient Composition (Alkaloids) of some Fruit Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Orange	3	.6300	.05196	.03000	.5009	.7591	.60	.69
Starapple	3	1.0000	.00000	.00000	1.0000	1.0000	1.00	1.00
Mango	3	1.5933	.01155	.00667	1.5646	1.6220	1.58	1.60
Soursop	3	.4000	.00000	.00000	.4000	.4000	.40	.40
Tamarind	3	.5967	.00577	.00333	.5823	.6110	.59	.60
Wildmango	3	4.1800	.01000	.00577	4.1552	4.2048	4.17	4.19
Total	18	1.4000	1.33940	.31570	.7339	2.0661	.40	4.19

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	30.492	5	6.098	12333.870	.000
Within Groups	.006	12	.000		
Total	30.498	17			

2ix: Antinutrient Composition (Saponins) of some Fruit Samples

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Orange	3	.4000	.00000	.00000	.4000	.4000	.40	.40
Starapple	3	.5333	.11547	.06667	.2465	.8202	.40	.60
Mango	3	.2667	.11547	.06667	-.0202	.5535	.20	.40
Soursop	3	7.3333	.28868	.16667	6.6162	8.0504	7.00	7.50
Tamarind	3	1.0000	.00000	.00000	1.0000	1.0000	1.00	1.00
Wildmango	3	2.1900	.01000	.00577	2.1652	2.2148	2.18	2.20
Total	18	1.9539	2.56412	.60437	.6788	3.2290	.20	7.50

ANOVA

Observation	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	111.550	5	22.310	1215.804	.000
Within Groups	.220	12	.018		
Total	111.770	17			

2x: Antinutritional Composition (Tannins) of some Fruit Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Orange	3	.1067	.01155	.00667	.0780	.1354	.10	.12
Starapple	3	.3967	.00577	.00333	.3823	.4110	.39	.40
Mango	3	.1000	.00000	.00000	.1000	.1000	.10	.10
Soursop	3	.4967	.00577	.00333	.4823	.5110	.49	.50
Tamarind	3	.2000	.00000	.00000	.2000	.2000	.20	.20
Wildmango	3	.7300	.02646	.01528	.6643	.7957	.71	.76
Total	18	.3383	.23468	.05531	.2216	.4550	.10	.76

ANOVA

Observation

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.934	5	.187	1245.933	.000
Within Groups	.002	12	.000		
Total	.936	17			

2xi: Antinutritional Composition (Phytic acid) of Fruit Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Orange	3	1.6933	.01155	.00667	1.6646	1.7220	1.68	1.70
Starapple	3	1.9767	.01528	.00882	1.9387	2.0146	1.96	1.99
Mango	3	.6400	.00000	.00000	.6400	.6400	.64	.64
Soursop	3	.7700	.02000	.01155	.7203	.8197	.75	.79
Tamarind	3	1.0000	.00000	.00000	1.0000	1.0000	1.00	1.00
WildMango	3	2.1000	.10000	.05774	1.8516	2.3484	2.00	2.20
Total	18	1.3633	.60032	.14150	1.0648	1.6619	.64	2.20

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	6.105	5	1.221	680.441	.000
Within Groups	.022	12	.002		
Total	6.127	17			

2xii: Mineral Composition (K) of some Fruit Samples

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Orange	3	3.4000	.00000	.00000	3.4000	3.4000	3.40	3.40
Starapple	3	3.7500	.00000	.00000	3.7500	3.7500	3.75	3.75
Mango	3	3.8000	.00000	.00000	3.8000	3.8000	3.80	3.80
Soursop	3	5.0000	.00000	.00000	5.0000	5.0000	5.00	5.00
Tamarind	3	2.9600	.00000	.00000	2.9600	2.9600	2.96	2.96
Wildmango	3	2.7000	.00000	.00000	2.7000	2.7000	2.70	2.70
Total	18	3.6017	.76105	.17938	3.2232	3.9801	2.70	5.00

ANOVA

Observation	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	9.846	5	1.969	.	.
Within Groups	.000	12	.000		
Total	9.846	17			

2xiii: Mineral Composition (P) of some Fruit Samples

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Orange	3	.0020	.00000	.00000	.0020	.0020	.00	.00
Starapple	3	.0413	.00115	.00067	.0385	.0442	.04	.04
Mango	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Soursop	3	.0107	.00115	.00067	.0078	.0135	.01	.01
Tamarind	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Wildmango	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Total	18	.0090	.01539	.00363	.0013	.0167	.00	.04

ANOVA

Observation	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.004	5	.001	1809.300	.000
Within Groups	.000	12	.000		
Total	.004	17			

2xiv: Mineral Composition (Mg) of Some Fruit Samples

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Orange	3	2.3800	.00000	.00000	2.3800	2.3800	2.38	2.38
Starapple	3	2.4200	.00000	.00000	2.4200	2.4200	2.42	2.42
Mango	3	2.0200	.00000	.00000	2.0200	2.0200	2.02	2.02
Soursop	3	1.7600	.00000	.00000	1.7600	1.7600	1.76	1.76
Tamarind	3	1.3400	.00000	.00000	1.3400	1.3400	1.34	1.34
Wildmango	3	1.3400	.00000	.00000	1.3400	1.3400	1.34	1.34
Total	18	1.8767	.45220	.10658	1.6518	2.1015	1.34	2.42

ANOVA

Observation	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	3.476	5	.695	.	.
Within Groups	.000	12	.000		
Total	3.476	17			

2xv: Mineral Composition (Na) of some Fruit Samples

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Orange	3	2.5600	.00000	.00000	2.5600	2.5600	2.56	2.56
Starapple	3	2.2000	.00000	.00000	2.2000	2.2000	2.20	2.20
Mango	3	2.4600	.00000	.00000	2.4600	2.4600	2.46	2.46
Soursop	3	1.9400	.00000	.00000	1.9400	1.9400	1.94	1.94
Tamarind	3	1.9800	.00000	.00000	1.9800	1.9800	1.98	1.98
Wildmango	3	.9600	.00000	.00000	.9600	.9600	.96	.96
Total	18	2.0167	.53947	.12715	1.7484	2.2849	.96	2.56

ANOVA

Observation	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	4.947	5	.989	.	.
Within Groups	.000	12	.000		
Total	4.947	17			

2xvi: Mineral Composition (Ca) of some Fruit samples

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Orange	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Starapple	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Mango	3	.0200	.00000	.00000	.0200	.0200	.02	.02
Soursop	3	.0200	.00000	.00000	.0200	.0200	.02	.02
Wildmango	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Total	15	.0080	.01014	.00262	.0024	.0136	.00	.02

ANOVA

Observation	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.001	4	.000	.	.
Within Groups	.000	10	.000		
Total	.001	14			

2xvii: Mineral Composition (Cu) of some Fruit Samples

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Orange	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Starapple	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Mango	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Soursop	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Tamarind	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Wildmango	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Total	18	.0000	.00000	.00000	.0000	.0000	.00	.00

ANOVA

Observation	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.000	5	.000	.	.
Within Groups	.000	12	.000		
Total	.000	17			

2xviii: Mineral Composition (Fe) of some Fruit Samples

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Orange	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Mango	3	.0400	.00000	.00000	.0400	.0400	.04	.04
Soursop	3	.0200	.00000	.00000	.0200	.0200	.02	.02
Tamarind	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Wildmango	3	.0400	.00000	.00000	.0400	.0400	.04	.04
Total	15	.0200	.01852	.00478	.0097	.0303	.00	.04

ANOVA

Observation	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.005	4	.001	.	.
Within Groups	.000	10	.000		
Total	.005	14			

2xix: Mineral Composition (Zn) of some Fruit Samples

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Orange	3	.3200	.00000	.00000	.3200	.3200	.32	.32
Starapple	3	.2400	.00000	.00000	.2400	.2400	.24	.24
Mango	3	.2000	.00000	.00000	.2000	.2000	.20	.20
Soursop	3	.3200	.00000	.00000	.3200	.3200	.32	.32
Tamarind	3	.3600	.00000	.00000	.3600	.3600	.36	.36
Wildmango	3	.4600	.00000	.00000	.4600	.4600	.46	.46
Total	18	.3167	.08602	.02028	.2739	.3594	.20	.46

ANOVA

Observation	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.126	5	.025	.	.
Within Groups	.000	12	.000		
Total	.126	17			

2xx: Mineral Composition (Mn) of some Fruit Samples

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Starapple	3	.0200	.00000	.00000	.0200	.0200	.02	.02
Wildmango	3	.0200	.00000	.00000	.0200	.0200	.02	.02
Total	6	.0200	.00000	.00000	.0200	.0200	.02	.02

ANOVA

Observation	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.000	1	.000	.	.
Within Groups	.000	4	.000		
Total	.000	5			

2xxi: Proximate Composition (Moisture Content) of some Vegetable Samples

Descriptives

Observation

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pumpkin	3	4.1667	.28868	.16667	3.4496	4.8838	4.00	4.50
African rose wood	3	.9667	.05774	.03333	.8232	1.1101	.90	1.00
Bitter leaf	3	9.6667	.57735	.33333	8.2324	11.1009	9.00	10.00
Green Amaranth	3	9.6667	.57735	.33333	8.2324	11.1009	9.00	10.00
Bushmallaw	3	19.6667	.57735	.33333	18.2324	21.1009	19.00	20.00
Garden Egg Leaf	3	10.0000	.00000	.00000	10.0000	10.0000	10.00	10.00
Total	18	9.0222	6.00417	1.41520	6.0364	12.0080	.90	20.00

ANOVA

Observation					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	610.678	5	122.136	674.368	.000
Within Groups	2.173	12	.181		
Total	612.851	17			

2xxii: Ash content of some Vegetable samples

Descriptives

Observation					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Pumpkin	3	10.0000	.00000	.00000	10.0000	10.0000	10.00	10.00
African Rose wood	3	1.5000	.00000	.00000	1.5000	1.5000	1.50	1.50
Bitter Leaf	3	1.8333	.28868	.16667	1.1162	2.5504	1.50	2.00
Greem Amaranth	3	3.8333	.28868	.16667	3.1162	4.5504	3.50	4.00
Bushmallow	3	3.8333	.28868	.16667	3.1162	4.5504	3.50	4.00
Garden Egg Leaf	3	5.0000	.00000	.00000	5.0000	5.0000	5.00	5.00
Total	18	4.3333	2.89523	.68241	2.8936	5.7731	1.50	10.00

ANOVA

Observation					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	142.000	5	28.400	681.600	.000
Within Groups	.500	12	.042		
Total	142.500	17			

2xxiii: Fat Content of some Vegetable Samples

Descriptives

Observation								
			Std.	95% Confidence Interval for Mean				
	N	Mean	Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Pumpkin	3	7.0000	1.00000	.57735	4.5159	9.4841	6.00	8.00
African rose wood	3	5.3333	1.15470	.66667	2.4649	8.2018	4.00	6.00
Bitter Leaf	3	4.3333	.57735	.33333	2.8991	5.7676	4.00	5.00
Green Amaranth	3	2.8333	.28868	.16667	2.1162	3.5504	2.50	3.00
Bushmallow	3	9.3333	1.52753	.88192	5.5388	13.1279	8.00	11.00
Garden Egg Leaf	3	14.3333	2.51661	1.45297	8.0817	20.5849	12.00	17.00
Total	18	7.1944	4.06976	.95925	5.1706	9.2183	2.50	17.00

ANOVA

Observation					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	258.736	5	51.747	27.196	.000
Within Groups	22.833	12	1.903		
Total	281.569	17			

2xxiv: Protein Content of some Vegetable samples

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pumpkin	3	12.0167	.02887	.01667	11.9450	12.0884	12.00	12.05
African Rose wood	3	12.9967	.13503	.07796	12.6612	13.3321	12.86	13.13
Bitterleaf	3	11.7533	.21362	.12333	11.2227	12.2840	11.63	12.00
Green Amaranth	3	7.4200	.36373	.21000	6.5164	8.3236	7.00	7.63
Bushmallow	3	8.6300	.00000	.00000	8.6300	8.6300	8.63	8.63
Garden Egg leaf	3	14.2500	.00000	.00000	14.2500	14.2500	14.25	14.25
Total	18	11.1778	2.46834	.58179	9.9503	12.4053	7.00	14.25

ANOVA

Observation	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	103.182	5	20.636	628.519	.000
Within Groups	.394	12	.033		
Total	103.576	17			

2xxv: Crude Fibre of some Vegetable Samples

Descriptives

Observations								
95% Confidence Interval for Mean								
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Pumpkin	3	6.3333	1.52753	.88192	2.5388	10.1279	5.00	8.00
African Rose Wood	3	6.6333	.32146	.18559	5.8348	7.4319	6.40	7.00
Bitter Leaf	3	8.8667	.23094	.13333	8.2930	9.4404	8.60	9.00
Green Amaranth	3	13.3000	.17321	.10000	12.8697	13.7303	13.20	13.50
Bushmallow	3	10.0000	.00000	.00000	10.0000	10.0000	10.00	10.00
Garden Egg Leaf	3	4.2267	.24111	.13920	3.6277	4.8256	4.00	4.48
Total	18	8.2267	3.06216	.72176	6.7039	9.7494	4.00	13.50

ANOVA

Observations					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	154.249	5	30.850	71.796	.000
Within Groups	5.156	12	.430		
Total	159.406	17			

2xxvi: Carbohydrate content of some Vegetable Samples

Descriptives

Observations								
			Std.		95% Confidence Interval for			
	N	Mean	Deviation	Std. Error	Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pumpkin	3	60.5300	.01000	.00577	60.5052	60.5548	60.52	60.54
African Rose wood	3	72.3000	.01000	.00577	72.2752	72.3248	72.29	72.31
Bitter leaf	3	63.5500	.01000	.00577	63.5252	63.5748	63.54	63.56
Green Amaranth	3	63.2500	.01000	.00577	63.2252	63.2748	63.24	63.26
Bushmallow	3	48.5367	.01528	.00882	48.4987	48.5746	48.52	48.55
Garden Egg Leaf	3	52.1933	.00577	.00333	52.1790	52.2077	52.19	52.20
Total	18	60.0600	8.04838	1.89702	56.0576	64.0624	48.52	72.31

ANOVA

Observations					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1101.199	5	220.240	1982158.320	.000
Within Groups	.001	12	.000		
Total	1101.200	17			

2xxvii: Oxalate Composition of some Vegetable Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pumpkin	3	2.0633	.02082	.01202	2.0116	2.1150	2.04	2.08
African Rose wood	3	1.7267	.00577	.00333	1.7123	1.7410	1.72	1.73
Bitter Leaf	3	.4567	.02517	.01453	.3942	.5192	.43	.48
Green Amaranth	3	.9200	.01000	.00577	.8952	.9448	.91	.93
Bushmallow	3	.8700	.01000	.00577	.8452	.8948	.86	.88
Garden Egg Leaf	3	1.9400	.01000	.00577	1.9152	1.9648	1.93	1.95
Total	18	1.3294	.62458	.14721	1.0188	1.6400	.43	2.08

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	6.629	5	1.326	5681.910	.000
Within Groups	.003	12	.000		
Total	6.632	17			

2xxviii: Alkaloid Composition of some Vegetable Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pumpkin	3	5.0100	.01000	.00577	4.9852	5.0348	5.00	5.02
African Rose Wood	3	4.9500	.01000	.00577	4.9252	4.9748	4.94	4.96
Bitter Leaf	3	3.8667	.02082	.01202	3.8150	3.9184	3.85	3.89
Green Amaranth	3	4.2533	.01528	.00882	4.2154	4.2913	4.24	4.27
Bushmallow	3	5.4200	.01000	.00577	5.3952	5.4448	5.41	5.43
Garden Egg Leaf	3	3.2100	.01000	.00577	3.1852	3.2348	3.20	3.22
Total	18	4.4517	.77707	.18316	4.0652	4.8381	3.20	5.43

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	10.263	5	2.053	11546.006	.000
Within Groups	.002	12	.000		
Total	10.265	17			

2xxix: Saponin Composition of some Vegetable Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pumpkin	3	3.2233	.01528	.00882	3.1854	3.2613	3.21	3.24
African Rose wood	3	7.5233	.01528	.00882	7.4854	7.5613	7.51	7.54
Bitter Leaf	3	4.7267	.01155	.00667	4.6980	4.7554	4.72	4.74
Green Amaranth	3	5.3200	.01000	.00577	5.2952	5.3448	5.31	5.33
Bushmallow	3	6.7067	.01155	.00667	6.6780	6.7354	6.70	6.72
Garden Egg Leaf	3	5.1067	.01155	.00667	5.0780	5.1354	5.10	5.12
Total	18	5.4344	1.42415	.33568	4.7262	6.1427	3.21	7.54

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	34.478	5	6.896	42799.669	.000
Within Groups	.002	12	.000		
Total	34.479	17			

2xxx: Tannin Composition of some Vegetable Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pumpkin	3	.7767	.01528	.00882	.7387	.8146	.76	.79
African Rose wood	3	3.8267	5.20771	3.00667	-9.1100	16.7633	.81	9.84
bitter leaf	3	.6800	.01000	.00577	.6552	.7048	.67	.69
Green Amaranth	3	.6533	.02082	.01202	.6016	.7050	.63	.67
Bushmallow	3	.4300	.01000	.00577	.4052	.4548	.42	.44
Garden Egg leaf	3	.3800	.01000	.00577	.3552	.4048	.37	.39
Total	18	1.1244	2.18119	.51411	.0398	2.2091	.37	9.84

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	26.637	5	5.327	1.179	.375
Within Groups	54.242	12	4.520		
Total	80.879	17			

2xxxix: Phytic Acid Composition of some Vegetable Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pumpkin	3	1.2833	.10408	.06009	1.0248	1.5419	1.20	1.40
African Rose Wood	3	1.8000	.00000	.00000	1.8000	1.8000	1.80	1.80
Bitter Leaf	3	1.3500	.05000	.02887	1.2258	1.4742	1.30	1.40
Green Amaranth	3	.6033	.01528	.00882	.5654	.6413	.59	.62
Bushmallow	3	.9167	.01528	.00882	.8787	.9546	.90	.93
Garden Egg Leaf	3	2.3667	.05774	.03333	2.2232	2.5101	2.30	2.40
Total	18	1.3867	.59248	.13965	1.0920	1.6813	.59	2.40

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	5.933	5	1.187	415.564	.000
Within Groups	.034	12	.003		
Total	5.968	17			

2xxxii: Potassium composition of some Vegetable Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pumpkin	3	3.3000	.00000	.00000	3.3000	3.3000	3.30	3.30
African Rose wood	3	2.8000	.00000	.00000	2.8000	2.8000	2.80	2.80
Bitter Leaf	3	2.9600	.00000	.00000	2.9600	2.9600	2.96	2.96
Green Amaranth	3	3.0000	.00000	.00000	3.0000	3.0000	3.00	3.00
Bushmallow	3	3.9000	.00000	.00000	3.9000	3.9000	3.90	3.90
Garden Egg Leaf	3	2.9600	.00000	.00000	2.9600	2.9600	2.96	2.96
Total	18	3.1533	.37624	.08868	2.9662	3.3404	2.80	3.90

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2.406	5	.481	.	.
Within Groups	.000	12	.000		
Total	2.406	17			

2xxxiii: Phosphorus Composition of some Vegetable Samples

Descriptives

Observations								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pumpkin	3	.0000	.00000	.00000	.0000	.0000	.00	.00
African Rose Wood	3	.0100	.00000	.00000	.0100	.0100	.01	.01
Bitter Leaf	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Green Amaranth	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Bushmallow	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Garden Egg Leaf	3	.0100	.00000	.00000	.0100	.0100	.01	.01
Total	18	.0033	.00485	.00114	.0009	.0057	.00	.01

ANOVA

Observations					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.000	5	.000		
Within Groups	.000	12	.000		
Total	.000	17			

2xxxiv: Magnesium Composition of some Vegetable Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pumpkin	3	1.5400	.00000	.00000	1.5400	1.5400	1.54	1.54
African Rose Wood	3	1.5600	.00000	.00000	1.5600	1.5600	1.56	1.56
Bitter Leaf	3	1.6200	.00000	.00000	1.6200	1.6200	1.62	1.62
Green Amaranth	3	1.3400	.00000	.00000	1.3400	1.3400	1.34	1.34
Bushmallow	3	1.7600	.00000	.00000	1.7600	1.7600	1.76	1.76
Garden Egg Leaf	3	1.5600	.00000	.00000	1.5600	1.5600	1.56	1.56
Total	18	1.5633	.12765	.03009	1.4999	1.6268	1.34	1.76

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.277	5	.055	.	.
Within Groups	.000	12	.000		
Total	.277	17			

2xxxv: Sodium Composition of some Vegetable Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pumpkin	3	1.5100	.00000	.00000	1.5100	1.5100	1.51	1.51
African Rose Wood	3	1.5100	.00000	.00000	1.5100	1.5100	1.51	1.51
Bitter Leaf	3	1.3400	.00000	.00000	1.3400	1.3400	1.34	1.34
Green Amaranth	3	1.1000	.00000	.00000	1.1000	1.1000	1.10	1.10
Bushmallow	3	1.1000	.00000	.00000	1.1000	1.1000	1.10	1.10
Garden egg leaf	3	1.1000	.00000	.00000	1.1000	1.1000	1.10	1.10
Total	18	1.2767	.19091	.04500	1.1817	1.3716	1.10	1.51

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.620	5	.124	.	.
Within Groups	.000	12	.000		
Total	.620	17			

2xxxvi: Calcium Composition of some Vegetable Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Bitter Leaf	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Green Amaranth	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Bushmallow	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Total	9	.0000	.00000	.00000	.0000	.0000	.00	.00

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.000	2	.000	.	.
Within Groups	.000	6	.000		
Total	.000	8			

2xxxvii: Copper Composition of some Vegetable Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Bitter Leaf	3	.0200	.00000	.00000	.0200	.0200	.02	.02
Green Amaranth	3	.0200	.00000	.00000	.0200	.0200	.02	.02
bushmallow	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Garden Egg Leaf	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Total	12	.0100	.01044	.00302	.0034	.0166	.00	.02

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.001	3	.000	.	.
Within Groups	.000	8	.000		
Total	.001	11			

2xxxviii: Iron Composition of some Vegetable Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pumpkin	3	.0200	.00000	.00000	.0200	.0200	.02	.02
African Rose Wood	3	.0200	.00000	.00000	.0200	.0200	.02	.02
Bitter Leaf	3	.0200	.00000	.00000	.0200	.0200	.02	.02
Garden Egg Leaf	3	.0200	.00000	.00000	.0200	.0200	.02	.02
Total	12	.0200	.00000	.00000	.0200	.0200	.02	.02

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.000	3	.000	.	.
Within Groups	.000	8	.000		
Total	.000	11			

2xxxvix: Zinc Composition of some Vegetable Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Pumpkin	3	.4200	.00000	.00000	.4200	.4200	.42	.42
African Rose wood	3	.4400	.00000	.00000	.4400	.4400	.44	.44
Bitter Leaf	3	.3600	.00000	.00000	.3600	.3600	.36	.36
Green Amaranth	3	.2400	.00000	.00000	.2400	.2400	.24	.24
Bushmallow	3	.5600	.00000	.00000	.5600	.5600	.56	.56
Garden Egg Leaf	3	.2200	.00000	.00000	.2200	.2200	.22	.22
Total	18	.3733	.12098	.02851	.3132	.4335	.22	.56

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.249	5	.050		
Within Groups	.000	12	.000		
Total	.249	17			

2xL: Manganese Composition of some Vegetable Samples

Descriptives

Observations								
95% Confidence Interval for Mean								
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
African Rose Wood	3	.0200	.00000	.00000	.0200	.0200	.02	.02
Bitter Leaf	3	.0400	.00000	.00000	.0400	.0400	.04	.04
Garden Egg Leaf	3	.0200	.00000	.00000	.0200	.0200	.02	.02
Total	9	.0267	.01000	.00333	.0190	.0344	.02	.04

ANOVA

Observations					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.001	2	.000	.	.
Within Groups	.000	6	.000		
Total	.001	8			

2xLi: Proximate Composition (moisture content) of some Cereal Samples

Descriptives

Observations								
95% Confidence Interval for Mean								
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimu m	Maximu m
Rice	3	1.1667	.28868	.16667	.4496	1.8838	1.00	1.50
White Corn	3	5.0000	.00000	.00000	5.0000	5.0000	5.00	5.00
Yellow Corn	3	2.9167	.14434	.08333	2.5581	3.2752	2.75	3.00
Total	9	3.0278	1.66979	.55660	1.7443	4.3113	1.00	5.00

ANOVA

Observations						
	Sum of Squares	Df	Mean Square	F	Sig.	
Between Groups	22.097	2	11.049	318.200	.000	
Within Groups	.208	6	.035			
Total	22.306	8				

2xLii: Proximate Composition (Ash content) of some Cereal Samples

Descriptives

Observations								
95% Confidence Interval for Mean								
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Rice	3	3.1667	.57735	.33333	1.7324	4.6009	2.50	3.50
White corn	3	4.1667	.57735	.33333	2.7324	5.6009	3.50	4.50
Yellow Corn	3	4.1667	.57735	.33333	2.7324	5.6009	3.50	4.50
Total	9	3.8333	.70711	.23570	3.2898	4.3769	2.50	4.50

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2.000	2	1.000	3.000	.125
Within Groups	2.000	6	.333		
Total	4.000	8			

2xLiii: Proximate Composition (Crude fat) of some Cereal Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Rice	3	7.0000	1.00000	.57735	4.5159	9.4841	6.00	8.00
White corn	3	13.3333	1.52753	.88192	9.5388	17.1279	12.00	15.00
Yellow corn	3	12.3333	1.52753	.88192	8.5388	16.1279	11.00	14.00
Total	9	10.8889	3.17980	1.05993	8.4447	13.3331	6.00	15.00

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	69.556	2	34.778	18.412	.003
Within Groups	11.333	6	1.889		
Total	80.889	8			

2xLiv: Crude Protein of some Cereal Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Crude Protein	3	2.8967	.07506	.04333	2.7102	3.0831	2.81	2.94
White corn	3	2.0000	.00000	.00000	2.0000	2.0000	2.00	2.00
Yellow Corn	3	4.1933	.00577	.00333	4.1790	4.2077	4.19	4.20
Total	9	3.0300	.95573	.31858	2.2954	3.7646	2.00	4.20

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	7.296	2	3.648	1931.312	.000
Within Groups	.011	6	.002		
Total	7.307	8			

2xLv: Crude Fibre of some Cereal Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Rice	3	6.0000	.00000	.00000	6.0000	6.0000	6.00	6.00
White corn	3	9.8000	.20000	.11547	9.3032	10.2968	9.60	10.00
Yellow corn	3	13.4333	.05774	.03333	13.2899	13.5768	13.40	13.50
Total	9	9.7444	3.22068	1.07356	7.2688	12.2201	6.00	13.50

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	82.896	2	41.448	2869.462	.000
Within Groups	.087	6	.014		
Total	82.982	8			

2xLvi: Carbohydrate of some Cereal Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Rice	3	79.7600	.01000	.00577	79.7352	79.7848	79.75	79.77
White corn	3	65.7000	.01000	.00577	65.6752	65.7248	65.69	65.71
Yellow corn	3	62.9600	.01000	.00577	62.9352	62.9848	62.95	62.97
Total	9	69.4733	7.80570	2.60190	63.4733	75.4733	62.95	79.77

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	487.431	2	243.716	2437156.000	.000
Within Groups	.001	6	.000		
Total	487.432	8			

2xLvii: Oxalate Composition of some Cereal Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Rice	3	.9667	.00577	.00333	.9523	.9810	.96	.97
White corn	3	1.8167	.06658	.03844	1.6513	1.9821	1.74	1.86
Yellow corn	3	1.9333	.00577	.00333	1.9190	1.9477	1.93	1.94
Total	9	1.5722	.45820	.15273	1.2200	1.9244	.96	1.94

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1.671	2	.835	556.852	.000
Within Groups	.009	6	.002		
Total	1.680	8			

2xLviii: Alkaloid Composition of some Cereal Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Rice	3	3.2767	.01528	.00882	3.2387	3.3146	3.26	3.29
White corn	3	1.1467	.01155	.00667	1.1180	1.1754	1.14	1.16
Yellow corn	3	.9300	.02000	.01155	.8803	.9797	.91	.95
Total	9	1.7844	1.12318	.37439	.9211	2.6478	.91	3.29

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	10.091	2	5.045	19742.652	.000
Within Groups	.002	6	.000		
Total	10.092	8			

2xLix: Saponin Composition of some Cereal Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Rice	3	3.3200	.01000	.00577	3.2952	3.3448	3.31	3.33
White corn	3	.9700	.01000	.00577	.9452	.9948	.96	.98
Yellow corn	3	1.1067	.01155	.00667	1.0780	1.1354	1.10	1.12
Total	9	1.7989	1.14240	.38080	.9208	2.6770	.96	3.33

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	10.440	2	5.220	46980.100	.000
Within Groups	.001	6	.000		
Total	10.441	8			

2L: Tannin Composition of some Cereal Samples

Descriptives

Observations								
95% Confidence Interval for Mean								
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Rice	3	.5500	.02646	.01528	.4843	.6157	.52	.57
White corn	3	.4500	.02000	.01155	.4003	.4997	.43	.47
Yellow corn	3	.3800	.01000	.00577	.3552	.4048	.37	.39
Total	9	.4600	.07599	.02533	.4016	.5184	.37	.57

ANOVA

Observations						
	Sum of Squares	df	Mean Square	F	Sig.	
Between Groups	.044	2	.022	54.750	.000	
Within Groups	.002	6	.000			
Total	.046	8				

**2Li:
Phytic**

Acid Composition of some Cereal Samples

Descriptives

Observations								
95% Confidence Interval for Mean								
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Rice	3	.9300	.00000	.00000	.9300	.9300	.93	.93
White corn	3	.4700	.01000	.00577	.4452	.4948	.46	.48
Yellow corn	3	1.6100	.01000	.00577	1.5852	1.6348	1.60	1.62
Total	9	1.0033	.49674	.16558	.6215	1.3852	.46	1.62

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1.974	2	.987	14802.000	.000
Within Groups	.000	6	.000		
Total	1.974	8			

2Lii: Potassium Composition of some Cereal Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Rice	3	3.4200	.00000	.00000	3.4200	3.4200	3.42	3.42
White corn	3	2.9600	.00000	.00000	2.9600	2.9600	2.96	2.96
Yellow corn	3	2.4400	.00000	.00000	2.4400	2.4400	2.44	2.44
Total	9	2.9400	.42462	.14154	2.6136	3.2664	2.44	3.42

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1.442	2	.721		
Within Groups	.000	6	.000		
Total	1.442	8			

2Liii: Phosphorous Composition of some Cereal Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Rice	3	.0100	.00000	.00000	.0100	.0100	.01	.01
White corn	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Yellow corn	3	.0400	.00000	.00000	.0400	.0400	.04	.04
Total	9	.0167	.01803	.00601	.0028	.0305	.00	.04

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.003	2	.001	.	.
Within Groups	.000	6	.000		
Total	.003	8			

2Liv: Magnesium Composition of some Cereal Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Rice	3	2.5600	.00000	.00000	2.5600	2.5600	2.56	2.56
White corn	3	2.9000	.00000	.00000	2.9000	2.9000	2.90	2.90
Yellow corn	3	2.7000	.00000	.00000	2.7000	2.7000	2.70	2.70
Total	9	2.7200	.14799	.04933	2.6062	2.8338	2.56	2.90

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.175	2	.088		
Within Groups	.000	6	.000		
Total	.175	8			

2Lv: Sodium Composition of some Cereal Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Rice	3	1.5800	.00000	.00000	1.5800	1.5800	1.58	1.58
White corn	3	.9600	.00000	.00000	.9600	.9600	.96	.96
Yellow corn	3	1.7000	.00000	.00000	1.7000	1.7000	1.70	1.70
Total	9	1.4133	.34395	.11465	1.1490	1.6777	.96	1.70

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.946	2	.473	.	.
Within Groups	.000	6	.000		
Total	.946	8			

2Lvi: Calcium Composition of some Cereal Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
White corn	3	.00400	.000000	.000000	.00400	.00400	.004	.004
Yellow corn	3	.00600	.000000	.000000	.00600	.00600	.006	.006
Total	6	.00500	.001095	.000447	.00385	.00615	.004	.006

ANOVA

Observations					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.000	1	.000	.	.
Within Groups	.000	4	.000		
Total	.000	5			

2Lvii: Copper Composition of some Cereal Samples

Descriptives

Observations								
95% Confidence Interval for Mean								
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Rice	3	.00200	.000000	.000000	.00200	.00200	.002	.002
White corn	3	.00400	.000000	.000000	.00400	.00400	.004	.004
Yellow corn	3	.00600	.000000	.000000	.00600	.00600	.006	.006
Total	9	.00400	.001732	.000577	.00267	.00533	.002	.006

ANOVA

Observations					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.000	2	.000	.	.
Within Groups	.000	6	.000		
Total	.000	8			

2Lviii: Iron Composition of some Cereal Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Rice	3	.00400	.000000	.000000	.00400	.00400	.004	.004
White corn	3	.02000	.000000	.000000	.02000	.02000	.020	.020
Yellow corn	3	.04000	.000000	.000000	.04000	.04000	.040	.040
Total	9	.02133	.015620	.005207	.00933	.03334	.004	.040

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.002	2	.001		
Within Groups	.000	6	.000		
Total	.002	8			

2Lix: Zinc Composition of some Cereal Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Rice	3	.44000	.000000	.000000	.44000	.44000	.440	.440
White corn	3	.26000	.000000	.000000	.26000	.26000	.260	.260
Yellow corn	3	.46000	.000000	.000000	.46000	.46000	.460	.460
Total	9	.38667	.095394	.031798	.31334	.45999	.260	.460

ANOVA

Observations					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.073	2	.036	.	.
Within Groups	.000	6	.000		
Total	.073	8			

2Lx: Moisture Content of some Roots/tubers

Descriptives

Observations								
			Std.		95% Confidence Interval for Mean			
	N	Mean	Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Water Yam	3	9.1667	1.44338	.83333	5.5811	12.7522	7.50	10.00
Sweet Yam	3	6.5000	.00000	.00000	6.5000	6.5000	6.50	6.50
Yellow Yam	3	8.5000	.00000	.00000	8.5000	8.5000	8.50	8.50
Cassava	3	2.5000	.50000	.28868	1.2579	3.7421	2.00	3.00
Garri	3	.8333	.28868	.16667	.1162	1.5504	.50	1.00
Sweet Potato (white)	3	8.1667	.28868	.16667	7.4496	8.8838	8.00	8.50
Sweet Potato (red)	3	10.3333	.57735	.33333	8.8991	11.7676	10.00	11.00
Cocoyam	3	5.0000	.00000	.00000	5.0000	5.0000	5.00	5.00
Total	24	6.3750	3.24456	.66229	5.0049	7.7451	.50	11.00

ANOVA

Observations					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	236.458	7	33.780	95.378	.000
Within Groups	5.667	16	.354		
Total	242.125	23			

2Lxi: Ash Content of some Roots/tubers

Descriptives

Observations								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean			
					Lower Bound	Upper Bound	Minimum	Maximum
Water Yam	3	3.6667	.57735	.33333	2.2324	5.1009	3.00	4.00
Sweet Yam	3	5.3333	.57735	.33333	3.8991	6.7676	5.00	6.00
Yellow Yam	3	6.0000	.00000	.00000	6.0000	6.0000	6.00	6.00
Cassava	3	3.4667	.50332	.29059	2.2163	4.7170	3.00	4.00
Garri	3	.6667	.28868	.16667	-.0504	1.3838	.50	1.00
Sweet Potato (white)	3	8.3333	2.88675	1.66667	1.1622	15.5044	5.00	10.00
Sweet Potato (red)	3	.8333	.28868	.16667	.1162	1.5504	.50	1.00
Cocoyam	3	.6667	.57735	.33333	-.7676	2.1009	.00	1.00
Total	24	3.6208	2.85642	.58306	2.4147	4.8270	.00	10.00

ANOVA

Observations					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	168.153	7	24.022	19.703	.000
Within Groups	19.507	16	1.219		
Total	187.660	23			

2Lxii: Crude Fat Content of some Roots/tubers

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Water Yam	3	5.0000	1.00000	.57735	2.5159	7.4841	4.00	6.00
Sweet Yam	3	3.0000	1.00000	.57735	.5159	5.4841	2.00	4.00
Yellow Yam	3	8.0000	1.00000	.57735	5.5159	10.4841	7.00	9.00
Cassava	3	1.6000	.34641	.20000	.7395	2.4605	1.20	1.80
Garri	3	3.0000	1.00000	.57735	.5159	5.4841	2.00	4.00
Sweet Potato (white)	3	8.6667	.57735	.33333	7.2324	10.1009	8.00	9.00
Sweet Potato (red)	3	9.0000	1.00000	.57735	6.5159	11.4841	8.00	10.00
Cocoyam	3	11.1100	1.01799	.58774	8.5812	13.6388	10.00	12.00
Total	24	6.1721	3.40088	.69420	4.7360	7.6082	1.20	12.00

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	253.039	7	36.148	44.561	.000
Within Groups	12.979	16	.811		
Total	266.018	23			

2Lxiii: Crude Protein Content of some Roots/tubers

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Water Yam	3	3.0833	.14434	.08333	2.7248	3.4419	3.00	3.25
Sweet Yam	3	2.3467	.03512	.02028	2.2594	2.4339	2.31	2.38
Yellow Yam	3	2.6200	.01732	.01000	2.5770	2.6630	2.60	2.63
Cassava	3	.9533	.04163	.02404	.8499	1.0568	.92	1.00
Garri	3	1.3600	.02000	.01155	1.3103	1.4097	1.34	1.38
Sweet Potato (white)	3	4.1000	.45826	.26458	2.9616	5.2384	3.60	4.50
Sweet Potato (red)	3	11.2000	.20000	.11547	10.7032	11.6968	11.00	11.40
Cocoyam	3	8.0567	1.20101	.69341	5.0732	11.0401	6.68	8.89
Total	24	4.2150	3.44165	.70252	2.7617	5.6683	.92	11.40

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	269.000	7	38.429	179.057	.000
Within Groups	3.434	16	.215		
Total	272.434	23			

2Lxiv: Crude Fibre Content of some Roots/tubers

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Water Yam	3	5.9333	.11547	.06667	5.6465	6.2202	5.80	6.00
Sweet Yam	3	14.9333	.11547	.06667	14.6465	15.2202	14.80	15.00
Yellow Yam	3	4.4933	.01155	.00667	4.4646	4.5220	4.48	4.50
Cassava	3	9.0000	2.64575	1.52753	2.4276	15.5724	7.00	12.00
Garri	3	3.8333	.28868	.16667	3.1162	4.5504	3.50	4.00
Sweet Potato (white)	3	10.0000	.00000	.00000	10.0000	10.0000	10.00	10.00
Sweet Potato (red)	3	8.8333	.28868	.16667	8.1162	9.5504	8.50	9.00
Cocoyam	3	3.9333	.51316	.29627	2.6586	5.2081	3.50	4.50
Total	24	7.6200	3.75410	.76630	6.0348	9.2052	3.50	15.00

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	309.231	7	44.176	47.394	.000
Within Groups	14.914	16	.932		
Total	324.145	23			

2Lxv: Carbohydrate Content of some Roots/tubers

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Water Yam	3	73.1500	.01000	.00577	73.1252	73.1748	73.14	73.16
Sweet Yam	3	82.7467	.12741	.07356	82.4302	83.0632	82.60	82.83
Yellow Yam	3	70.4067	.01528	.00882	70.3687	70.4446	70.39	70.42
Cassava	3	86.2800	2.59815	1.50004	79.8258	92.7342	83.28	87.80
Garri	3	90.3133	.01528	.00882	90.2754	90.3513	90.30	90.33
Sweet Potato (white)	3	60.7133	.01528	.00882	60.6754	60.7513	60.70	60.73
Sweet Potato (red)	3	59.8100	.01000	.00577	59.7852	59.8348	59.80	59.82
Cocoyam	3	70.8500	.01000	.00577	70.8252	70.8748	70.84	70.86
Total	24	74.2838	10.82716	2.21009	69.7118	78.8557	59.80	90.33

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2682.696	7	383.242	453.030	.000
Within Groups	13.535	16	.846		
Total	2696.231	23			

2Lxvi: Oxalate Content of some Roots/tubers

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Water Yam	3	1.8300	.01000	.00577	1.8052	1.8548	1.82	1.84
Sweet Yam	3	2.9267	.01155	.00667	2.8980	2.9554	2.92	2.94
Yellow Yam	3	3.0700	.01000	.00577	3.0452	3.0948	3.06	3.08
Cassava	3	.2900	.03606	.02082	.2004	.3796	.25	.32
Garri	3	1.2700	.01000	.00577	1.2452	1.2948	1.26	1.28
Sweet Potato (white)	3	1.4300	.01000	.00577	1.4052	1.4548	1.42	1.44
Sweet Potato (red)	3	1.7700	.01000	.00577	1.7452	1.7948	1.76	1.78
Cocoyam	3	1.2667	.01155	.00667	1.2380	1.2954	1.26	1.28
Total	24	1.7317	.87206	.17801	1.3634	2.0999	.25	3.08

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	17.487	7	2.498	9670.341	.000
Within Groups	.004	16	.000		
Total	17.491	23			

2Lxvii: Alkaloid Content of some Roots/tubers

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Water Yam	3	.8533	.01155	.00667	.8246	.8820	.84	.86
Sweet Yam	3	.7267	.01528	.00882	.6887	.7646	.71	.74
Yellow Yam	3	.8367	.02082	.01202	.7850	.8884	.82	.86
Cassava	3	2.4567	.47057	.27168	1.2877	3.6256	2.18	3.00
Garri	3	.8667	.01528	.00882	.8287	.9046	.85	.88
Sweet Potato (white)	3	1.0733	.01528	.00882	1.0354	1.1113	1.06	1.09
Sweet Potato (red)	3	1.0500	.01000	.00577	1.0252	1.0748	1.04	1.06
Cocoyam	3	1.4367	.01528	.00882	1.3987	1.4746	1.42	1.45
Total	24	1.1625	.55933	.11417	.9263	1.3987	.71	3.00

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	6.750	7	.964	34.586	.000
Within Groups	.446	16	.028		
Total	7.196	23			

2Lxviii: Saponin Content of some Roots/tubers

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Water Yam	3	.9200	.01000	.00577	.8952	.9448	.91	.93
Sweet Yam	3	.7800	.01000	.00577	.7552	.8048	.77	.79
Yellow Yam	3	.8700	.05196	.03000	.7409	.9991	.84	.93
Cassava	3	1.8667	.32146	.18559	1.0681	2.6652	1.50	2.10
Garri	3	.8800	.01732	.01000	.8370	.9230	.86	.89
Sweet Potato (white)	3	1.2300	.01000	.00577	1.2052	1.2548	1.22	1.24
Sweet Potato (red)	3	.6600	.02000	.01155	.6103	.7097	.64	.68
Cocoyam	3	.8600	.02000	.01155	.8103	.9097	.84	.88
Total	24	1.0083	.37816	.07719	.8486	1.1680	.64	2.10

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	3.074	7	.439	32.704	.000
Within Groups	.215	16	.013		
Total	3.289	23			

2Lxix: Tannin Content of some Roots/tubers

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Water Yam	3	.5267	.02082	.01202	.4750	.5784	.51	.55
Sweet Yam	3	.4433	.05686	.03283	.3021	.5846	.38	.49
Yellow Yam	3	.3233	.01528	.00882	.2854	.3613	.31	.34
Cassava	3	1.0300	.07000	.04041	.8561	1.2039	.95	1.08
Garri	3	.2733	.01528	.00882	.2354	.3113	.26	.29
Sweet Potato (white)	3	.3567	.01528	.00882	.3187	.3946	.34	.37
Sweet Potato (red)	3	.2400	.02000	.01155	.1903	.2897	.22	.26
Cocoyam	3	.1467	.01155	.00667	.1180	.1754	.14	.16
Total	24	.4175	.26354	.05380	.3062	.5288	.14	1.08

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1.578	7	.225	184.006	.000
Within Groups	.020	16	.001		
Total	1.597	23			

2Lxx: Phytic Acid Content of some Roots/tubers

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Water Yam	3	1.4200	.02000	.01155	1.3703	1.4697	1.40	1.44
Sweet Yam	3	1.3233	.02082	.01202	1.2716	1.3750	1.30	1.34
Yellow Yam	3	.9167	.00577	.00333	.9023	.9310	.91	.92
Cassava	3	1.0667	.37859	.21858	.1262	2.0071	.80	1.50
Garri	3	.9300	.01000	.00577	.9052	.9548	.92	.94
Sweet Potato (white)	3	1.3100	.01000	.00577	1.2852	1.3348	1.30	1.32
Sweet Potato (red)	3	1.4733	.01155	.00667	1.4446	1.5020	1.46	1.48
Cocoyam	3	2.6800	.00000	.00000	2.6800	2.6800	2.68	2.68
Total	24	1.3900	.55002	.11227	1.1577	1.6223	.80	2.68

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	6.669	7	.953	52.733	.000
Within Groups	.289	16	.018		
Total	6.958	23			

2Lxxi: Potassium Content of some Roots/tubers

Descriptives

Observations	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Water Yam	3	2.9200	.00000	.00000	2.9200	2.9200	2.92	2.92
Sweet Yam	3	3.3400	.00000	.00000	3.3400	3.3400	3.34	3.34
Yellow Yam	3	2.1600	.00000	.00000	2.1600	2.1600	2.16	2.16
Cassava	3	3.5600	.00000	.00000	3.5600	3.5600	3.56	3.56
Garri	3	3.5600	.00000	.00000	3.5600	3.5600	3.56	3.56
Sweet Potato (white)	3	3.8400	.00000	.00000	3.8400	3.8400	3.84	3.84
Sweet Potato (red)	3	2.6000	.00000	.00000	2.6000	2.6000	2.60	2.60
Cocoyam	3	2.9800	.00000	.00000	2.9800	2.9800	2.98	2.98
Total	24	3.1200	.53636	.10948	2.8935	3.3465	2.16	3.84

ANOVA

Observations	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	6.617	7	.945	.	.
Within Groups	.000	16	.000		
Total	6.617	23			

2Lxxii: Phosphorous Content of some Roots/tubers

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Water Yam	3	.0022	.00000	.00000	.0022	.0022	.00	.00
Sweet Yam	3	.0076	.00000	.00000	.0076	.0076	.01	.01
Yellow Yam	3	.0036	.00000	.00000	.0036	.0036	.00	.00
Cassava	3	.0060	.00000	.00000	.0060	.0060	.01	.01
Garri	3	.0520	.00000	.00000	.0520	.0520	.05	.05
Sweet Potato (white)	3	.0082	.00000	.00000	.0082	.0082	.01	.01
Sweet Potato (red)	3	.0136	.00000	.00000	.0136	.0136	.01	.01
Cocoyam	3	.0022	.00000	.00000	.0022	.0022	.00	.00
Total	24	.0119	.01589	.00324	.0052	.0186	.00	.05

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.006	7	.001	.	.
Within Groups	.000	16	.000		
Total	.006	23			

2Lxxiii: Magnesium Content of some Roots/tubers

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Water Yam	3	2.4400	.00000	.00000	2.4400	2.4400	2.44	2.44
Sweet Yam	3	1.8200	.00000	.00000	1.8200	1.8200	1.82	1.82
Yellow Yam	3	2.3600	.00000	.00000	2.3600	2.3600	2.36	2.36
Cassava	3	1.5600	.00000	.00000	1.5600	1.5600	1.56	1.56
Garri	3	2.5600	.00000	.00000	2.5600	2.5600	2.56	2.56
Sweet Potato (white)	3	2.8200	.00000	.00000	2.8200	2.8200	2.82	2.82
Sweet Potato (red)	3	2.4200	.00000	.00000	2.4200	2.4200	2.42	2.42
Cocoyam	3	1.3600	.00000	.00000	1.3600	1.3600	1.36	1.36
Total	24	2.1675	.49740	.10153	1.9575	2.3775	1.36	2.82

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	5.690	7	.813	.	.
Within Groups	.000	16	.000		
Total	5.690	23			

2Lxxiv: Sodium Content of some Roots/tubers

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Water Yam	3	1.5180	.00000	.00000	1.5180	1.5180	1.52	1.52
Sweet Yam	3	1.3420	.00000	.00000	1.3420	1.3420	1.34	1.34
Yellow Yam	3	2.9600	.00000	.00000	2.9600	2.9600	2.96	2.96
Cassava	3	1.5400	.00000	.00000	1.5400	1.5400	1.54	1.54
Garri	3	2.3800	.00000	.00000	2.3800	2.3800	2.38	2.38
Sweet Potato (white)	3	2.6600	.00000	.00000	2.6600	2.6600	2.66	2.66
Sweet Potato (red)	3	1.4100	.00000	.00000	1.4100	1.4100	1.41	1.41
Cocoyam	3	1.4100	.00000	.00000	1.4100	1.4100	1.41	1.41
Total	24	1.9025	.62540	.12766	1.6384	2.1666	1.34	2.96

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	8.996	7	1.285	.	.
Within Groups	.000	16	.000		
Total	8.996	23			

2Lxxv: Calcium Content of some Roots/tubers

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Water Yam	3	.00200	.000000	.000000	.00200	.00200	.002	.002
Yellow Yam	3	.00200	.000000	.000000	.00200	.00200	.002	.002
Garri	3	.02000	.000000	.000000	.02000	.02000	.020	.020
Sweet Potato (white)	3	.02000	.000000	.000000	.02000	.02000	.020	.020
Sweet Potato (red)	3	.02000	.000000	.000000	.02000	.02000	.020	.020
Cocoyam	3	.02000	.000000	.000000	.02000	.02000	.020	.020
Total	18	.01400	.008731	.002058	.00966	.01834	.002	.020

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.001	5	.000	.	.
Within Groups	.000	12	.000		
Total	.001	17			

2Lxxvi: Copper Content of some Roots/tubers

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Water Yam	3	.00200	.000000	.000000	.00200	.00200	.002	.002
Sweet Yam	3	.00400	.000000	.000000	.00400	.00400	.004	.004
Yellow Yam	3	.00400	.000000	.000000	.00400	.00400	.004	.004
Garri	3	.00400	.000000	.000000	.00400	.00400	.004	.004
Sweet Potato (white)	3	.00400	.000000	.000000	.00400	.00400	.004	.004
Sweet Potato (red)	3	.00400	.000000	.000000	.00400	.00400	.004	.004
Cocoyam	3	.02200	.000000	.000000	.02200	.02200	.022	.022
Total	21	.00629	.006612	.001443	.00328	.00930	.002	.022

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.001	6	.000	.	.
Within Groups	.000	14	.000		
Total	.001	20			

2Lxxvii: Iron Content of some Roots/tubers

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Sweet Yam	3	.00200	.000000	.000000	.00200	.00200	.002	.002
Yellow Yam	3	.00200	.000000	.000000	.00200	.00200	.002	.002
Cassava	3	.04000	.000000	.000000	.04000	.04000	.040	.040
Garri	3	.02000	.000000	.000000	.02000	.02000	.020	.020
Sweet Potato (white)	3	.04000	.000000	.000000	.04000	.04000	.040	.040
Sweet Potato (red)	3	.06000	.000000	.000000	.06000	.06000	.060	.060
Cocoyam	3	.04000	.000000	.000000	.04000	.04000	.040	.040
Total	21	.02914	.020723	.004522	.01971	.03858	.002	.060

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.009	6	.001		
Within Groups	.000	14	.000		
Total	.009	20			

2Lxxviii: Zinc Content of some Roots/tubers

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Water Yam	3	.41000	.000000	.000000	.41000	.41000	.410	.410
Sweet Yam	3	.46000	.000000	.000000	.46000	.46000	.460	.460
Yellow Yam	3	.32000	.000000	.000000	.32000	.32000	.320	.320
Cassava	3	.56000	.000000	.000000	.56000	.56000	.560	.560
Garri	3	.36000	.000000	.000000	.36000	.36000	.360	.360
Sweet Potato (white)	3	.38000	.000000	.000000	.38000	.38000	.380	.380
Sweet Potato (red)	3	.32000	.000000	.000000	.32000	.32000	.320	.320
Cocoyam	3	.36000	.000000	.000000	.36000	.36000	.360	.360
Total	24	.39625	.077112	.015740	.36369	.42881	.320	.560

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.137	7	.020	.	.
Within Groups	.000	16	.000		
Total	.137	23			

2Lxxix: Manganese Content of some Roots/tubers

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Water Yam	3	.02000	.000000	.000000	.02000	.02000	.020	.020
Sweet Yam	3	.02000	.000000	.000000	.02000	.02000	.020	.020
Cassava	3	.00200	.000000	.000000	.00200	.00200	.002	.002
Garri	3	.02000	.000000	.000000	.02000	.02000	.020	.020
Sweet Potato (white)	3	.00200	.000000	.000000	.00200	.00200	.002	.002
Cocoyam	3	.04000	.000000	.000000	.04000	.04000	.040	.040
Total	18	.01733	.013320	.003139	.01071	.02396	.002	.040

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.003	5	.001	.	.
Within Groups	.000	12	.000		
Total	.003	17			

2Lxxx: T-Test for Moisture content

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
Observation	Red Oil	3	4.8000	.20000	.11547
	Groundnut Oil	3	4.1667	.15275	.08819

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
		F	Sig.	T	df	Sig. (2- tailed)	Mean Difference	Std. Err or Diff erence	95% Confidence Interval of the Difference	Lower	Upper
Observation	Equal variances assumed	.082	.789	4.359	4	.012	.63333	.14530	.22993	1.03674	
	Equal variances not assumed			4.359	3.741	.014	.63333	.14530	.21866	1.04800	

2Lxxxi: T-Test for Ash Content

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
Observation	Red Oil	3	.1300	.01000	.00577
	Groundnut Oil	3	.1400	.01000	.00577

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
				95% Confidence Interval of the Difference						
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Observation	Equal variances assumed	.000	1.000	-1.225	4	.288	-.01000	.00816	-.03267	.01267
	Equal variances not assumed			-1.225	4.000	.288	-.01000	.00816	-.03267	.01267

2Lxxxii: T-Test for Fat content

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
Observation	Red Oil	3	38.3333	2.08167	1.20185
	Groundnut Oil	3	35.6667	2.08167	1.20185

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Observation	Equal variances assumed	.000	1.000	1.569	4	.192	2.66667	1.69967	-2.05238	7.38572
	Equal variances not assumed			1.569	4.000	.192	2.66667	1.69967	-2.05238	7.38572

2Lxxxiii: T-Test for Oxalate

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	Df	Sig. (2- tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Observation	Equal variances assumed	.727	.442	-27.196	4	.000	-.28667	.01054	-.31593	-.25740
	Equal variances not assumed			-27.196	3.448	.000	-.28667	.01054	-.31788	-.25546

2Lxxxiv: T-Test for Alkaloid

Group Statistics

		Groups	N	Mean	Std. Deviation	Std. Error Mean
Observation	Red Oil		3	.8100	.01000	.00577
	Groundnut Oil		3	.8567	.02517	.01453

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	Df	Sig. (2- tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Observati on	Equal variances assumed	1.923	.238	-2.985	4	.041	-.04667	.01563	-	-.00326
									.09008	
	Equal variances not assumed			-2.985	2.616	.069	-.04667	.01563	-	.00749
									.10082	

2Lxxxv: T-Test for Saponin

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
Observation	Red Oil	3	.5400	.02000	.01155
	Groundnut Oil	3	.6167	.00577	.00333

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
				Mean					95% Confidence Interval of the Difference	
		F	Sig.	T	Df	Sig. (2- tailed)	Differenc e	Std. Error Difference	Lower	Upper
Observatio n	Equal variances assumed	1.730	.259	-6.379	4	.003	-.07667	.01202	-.11004	-.04330
	Equal variances not assumed			-6.379	2.331	.016	-.07667	.01202	-.12194	-.03139

2Lxxxvi: T-Test for Tannins

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
Observation	Red Oil	3	.3233	.01528	.00882
	Groundnut Oil	3	.1800	.02000	.01155

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Observation	Equal variances assumed	.082	.789	9.865	4	.001	.14333	.01453	.10299	.18367
	Equal variances not assumed			9.865	3.741	.001	.14333	.01453	.10187	.18480

2Lxxxvii: T-Test Phytic acid

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
Observation	Red Oil	3	.7633	.01528	.00882
	Groundnut Oil	3	.2100	.01000	.00577

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference		
		F	Sig.	T	df	Sig. (2- tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Observation	Equal variances assumed	.727	.442	52.494	4	.000	.55333	.01054	.52407	.58260
	Equal variances not assumed			52.494	3.448	.000	.55333	.01054	.52212	.58454

2Lxxxviii: Moisture Content of some Meat Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Beef	3	7.2667	.05774	.03333	7.1232	7.4101	7.20	7.30
Turkey	3	6.6333	.15275	.08819	6.2539	7.0128	6.50	6.80
Goat Meat	3	6.1667	.15275	.08819	5.7872	6.5461	6.00	6.30
Chicken	3	7.1000	.10000	.05774	6.8516	7.3484	7.00	7.20
Total	12	6.7917	.46015	.13284	6.4993	7.0840	6.00	7.30

ANOVA

Observations					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2.209	3	.736	49.093	.000
Within Groups	.120	8	.015		
Total	2.329	11			

2Lxxxix: Ash content of some Meat Samples

Descriptives

Observations								
95% Confidence Interval for Mean								
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Beef	3	.4333	.01528	.00882	.3954	.4713	.42	.45
Turkey	3	.5533	.03055	.01764	.4774	.6292	.52	.58
Goat Meat	3	.4533	.03055	.01764	.3774	.5292	.42	.48
Chicken	3	.9533	.03055	.01764	.8774	1.0292	.92	.98
Total	12	.5983	.22053	.06366	.4582	.7385	.42	.98

ANOVA

Observations					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.529	3	.176	232.484	.000
Within Groups	.006	8	.001		
Total	.535	11			

2xC: Crude Fat Content of some Meat Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Beef	3	7.0000	1.00000	.57735	4.5159	9.4841	6.00	8.00
Turkey	3	5.9333	.30551	.17638	5.1744	6.6922	5.60	6.20
Goat Meat	3	7.4333	.15275	.08819	7.0539	7.8128	7.30	7.60
Chicken	3	11.2000	.10000	.05774	10.9516	11.4484	11.10	11.30
Total	12	7.8917	2.12366	.61305	6.5424	9.2410	5.60	11.30

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	47.356	3	15.785	56.042	.000
Within Groups	2.253	8	.282		
Total	49.609	11			

2xCi: Crude Protein Content of some Meat Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Beef	3	34.6667	1.52753	.88192	30.8721	38.4612	33.00	36.00
Turkey	3	52.5333	.05774	.03333	52.3899	52.6768	52.50	52.60
Goat Meat	3	42.0000	1.00000	.57735	39.5159	44.4841	41.00	43.00
Chicken	3	37.6667	1.52753	.88192	33.8721	41.4612	36.00	39.00
Total	12	41.7167	7.14077	2.06136	37.1796	46.2537	33.00	52.60

ANOVA

Observations					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	549.557	3	183.186	129.231	.000
Within Groups	11.340	8	1.418		
Total	560.897	11			

2xCii: Crude fibre Content of some Meat Samples

Descriptives

Observations								
N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	
				Lower Bound	Upper Bound			
Beef	3	.1167	.01528	.00882	.0787	.1546	.10	.13
Turkey	3	.1267	.01528	.00882	.0887	.1646	.11	.14
Goat Meat	3	.3333	.01155	.00667	.3046	.3620	.32	.34
Chicken	3	.4267	.01528	.00882	.3887	.4646	.41	.44
Total	12	.2508	.13983	.04037	.1620	.3397	.10	.44

ANOVA

Observations					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.213	3	.071	341.480	.000
Within Groups	.002	8	.000		
Total	.215	11			

2xCiii: Carbohydrate Content of some Meat Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Beef	3	50.5167	1.58219	.91348	46.5863	54.4471	49.15	52.25
Turkey	3	34.2200	.35595	.20551	33.3358	35.1042	33.99	34.63
Goat Meat	3	43.6133	.72920	.42100	41.8019	45.4248	42.96	44.40
Chicken	3	42.6533	1.34931	.77902	39.3015	46.0052	41.53	44.15
Total	12	42.7508	6.11611	1.76557	38.8648	46.6368	33.99	52.25

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	401.510	3	133.837	107.448	.000
Within Groups	9.965	8	1.246		
Total	411.475	11			

2xCiv: Oxalate Content of some Meat Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Beef	3	.3167	.00577	.00333	.3023	.3310	.31	.32
Turkey	3	.5167	.01528	.00882	.4787	.5546	.50	.53
Goat Meat	3	.3300	.02646	.01528	.2643	.3957	.31	.36
Chicken	3	.4233	.01528	.00882	.3854	.4613	.41	.44
Total	12	.3967	.08542	.02466	.3424	.4509	.31	.53

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.078	3	.026	86.519	.000
Within Groups	.002	8	.000		
Total	.080	11			

2xCv: Alkaloid Content of some Meat Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Beef	3	.7433	.01528	.00882	.7054	.7813	.73	.76
Turkey	3	.9700	.01000	.00577	.9452	.9948	.96	.98
Goat Meat	3	.1133	.00577	.00333	.0990	.1277	.11	.12
Chicken	3	.8400	.01000	.00577	.8152	.8648	.83	.85
Total	12	.6667	.34421	.09936	.4480	.8854	.11	.98

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1.302	3	.434	3720.952	.000
Within Groups	.001	8	.000		
Total	1.303	11			

2xCvi: Saponin Content of some Meat Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Beef	3	.7267	.01528	.00882	.6887	.7646	.71	.74
Turkey	3	.8200	.02000	.01155	.7703	.8697	.80	.84
Goat Meat	3	.4767	.01528	.00882	.4387	.5146	.46	.49
Chicken	3	.5467	.03055	.01764	.4708	.6226	.52	.58
Total	12	.6425	.14442	.04169	.5507	.7343	.46	.84

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.226	3	.075	167.278	.000
Within Groups	.004	8	.000		
Total	.229	11			

2xCvii: Tannins Content of some Meat Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Beef	3	.2400	.02000	.01155	.1903	.2897	.22	.26
Turkey	3	.2367	.01528	.00882	.1987	.2746	.22	.25
Goat Meat	3	.3167	.01528	.00882	.2787	.3546	.30	.33
Chicken	3	.2433	.01528	.00882	.2054	.2813	.23	.26
Total	12	.2592	.03753	.01083	.2353	.2830	.22	.33

ANOVA

Observations					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.013	3	.004	16.111	.001
Within Groups	.002	8	.000		
Total	.015	11			

2xCviii: Phytic Acid Content of some Meat Samples

Descriptives

Observations								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Beef	3	.2767	.01528	.00882	.2387	.3146	.26	.29
Turkey	3	.2500	.01000	.00577	.2252	.2748	.24	.26
Goat Meat	3	.2000	.02000	.01155	.1503	.2497	.18	.22
Chicken	3	.1967	.01528	.00882	.1587	.2346	.18	.21
Total	12	.2308	.03777	.01090	.2068	.2548	.18	.29

ANOVA

Observations					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.014	3	.005	18.977	.001
Within Groups	.002	8	.000		
Total	.016	11			

2xCix: Potassium Content of some Meat Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Beef	3	11.6600	.00000	.00000	11.6600	11.6600	11.66	11.66
Turkey	3	10.8400	.00000	.00000	10.8400	10.8400	10.84	10.84
Goat Meat	3	11.2600	.00000	.00000	11.2600	11.2600	11.26	11.26
Chicken	3	9.6600	.00000	.00000	9.6600	9.6600	9.66	9.66
Total	12	10.8550	.78166	.22565	10.3584	11.3516	9.66	11.66

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	6.721	3	2.240	.	.
Within Groups	.000	8	.000		
Total	6.721	11			

2C: Phosphorous Content of some Meat Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Beef	3	.0044	.00000	.00000	.0044	.0044	.00	.00
Turkey	3	.0540	.00000	.00000	.0540	.0540	.05	.05
Goat Meat	3	.0280	.00000	.00000	.0280	.0280	.03	.03
Chicken	3	.0560	.00000	.00000	.0560	.0560	.06	.06
Total	12	.0356	.02207	.00637	.0216	.0496	.00	.06

ANOVA

Observations					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.005	3	.002	.	.
Within Groups	.000	8	.000		
Total	.005	11			

2Ci: Magnesium Content of some Meat Samples

Descriptives

Observations								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Beef	3	9.8200	.00000	.00000	9.8200	9.8200	9.82	9.82
Turkey	3	9.6600	.00000	.00000	9.6600	9.6600	9.66	9.66
Goat Meat	3	10.2400	.00000	.00000	10.2400	10.2400	10.24	10.24
Chicken	3	12.6400	.00000	.00000	12.6400	12.6400	12.64	12.64
Total	12	10.5900	1.25584	.36253	9.7921	11.3879	9.66	12.64

ANOVA

Observations					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	17.348	3	5.783	.	.
Within Groups	.000	8	.000		
Total	17.348	11			

2Cii: Sodium Content of some Meat Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Beef	3	18.9800	.00000	.00000	18.9800	18.9800	18.98	18.98
Turkey	3	20.6400	.00000	.00000	20.6400	20.6400	20.64	20.64
Goat Meat	3	24.3600	.00000	.00000	24.3600	24.3600	24.36	24.36
Chicken	3	22.4600	.00000	.00000	22.4600	22.4600	22.46	22.46
Total	12	21.6100	2.09823	.60571	20.2768	22.9432	18.98	24.36

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	48.428	3	16.143	.	.
Within Groups	.000	8	.000		
Total	48.428	11			

2Ciii: Calcium Content of some Meat Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Beef	3	22.0200	.00000	.00000	22.0200	22.0200	22.02	22.02
Turkey	3	20.3800	.00000	.00000	20.3800	20.3800	20.38	20.38
Goat Meat	3	11.9800	.00000	.00000	11.9800	11.9800	11.98	11.98
Chicken	3	16.4400	.00000	.00000	16.4400	16.4400	16.44	16.44
Total	12	17.7050	4.05028	1.16921	15.1316	20.2784	11.98	22.02

ANOVA

Observations					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	180.452	3	60.151	.	.
Within Groups	.000	8	.000		
Total	180.452	11			

2Civ: Copper Content of some Meat Samples

Descriptives

Observations								
95% Confidence Interval for Mean								
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Beef	3	.0780	.00000	.00000	.0780	.0780	.08	.08
Turkey	3	.5620	.00000	.00000	.5620	.5620	.56	.56
Goat Meat	3	.0380	.00000	.00000	.0380	.0380	.04	.04
Chicken	3	.0340	.00000	.00000	.0340	.0340	.03	.03
Total	12	.1780	.23226	.06705	.0304	.3256	.03	.56

ANOVA

Observations					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.593	3	.198	.	.
Within Groups	.000	8	.000		
Total	.593	11			

2Cv: Iron Content of some Meat Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Beef	3	9.8200	.00000	.00000	9.8200	9.8200	9.82	9.82
Turkey	3	9.6600	.00000	.00000	9.6600	9.6600	9.66	9.66
Goat Meat	3	10.2400	.00000	.00000	10.2400	10.2400	10.24	10.24
Chicken	3	12.6400	.00000	.00000	12.6400	12.6400	12.64	12.64
Total	12	10.5900	1.25584	.36253	9.7921	11.3879	9.66	12.64

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	17.348	3	5.783	.	.
Within Groups	.000	8	.000		
Total	17.348	11			

2Cvi: Zinc Content of some Meat Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Beef	3	9.6600	.00000	.00000	9.6600	9.6600	9.66	9.66
Turkey	3	8.4800	.00000	.00000	8.4800	8.4800	8.48	8.48
Goat Meat	3	8.3800	.00000	.00000	8.3800	8.3800	8.38	8.38
Chicken	3	7.7600	.00000	.00000	7.7600	7.7600	7.76	7.76
Total	12	8.5700	.71765	.20717	8.1140	9.0260	7.76	9.66

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	5.665	3	1.888	.	.
Within Groups	.000	8	.000		
Total	5.665	11			

2Cvii: Manganese Content of some Meat Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Beef	3	1.8400	.00000	.00000	1.8400	1.8400	1.84	1.84
Turkey	3	1.8600	.00000	.00000	1.8600	1.8600	1.86	1.86
Goat Meat	3	1.9600	.00000	.00000	1.9600	1.9600	1.96	1.96
Chicken	3	.8400	.00000	.00000	.8400	.8400	.84	.84
Total	12	1.6250	.47575	.13734	1.3227	1.9273	.84	1.96

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2.490	3	.830		
Within Groups	.000	8	.000		
Total	2.490	11			

2Cviii: Moisture Content of some Fish Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Cod	3	5.7000	.10000	.05774	5.4516	5.9484	5.60	5.80
Catfish	3	2.7667	.05774	.03333	2.6232	2.9101	2.70	2.80
Mackerel	3	1.1667	.15275	.08819	.7872	1.5461	1.00	1.30
Total	9	3.2111	1.99339	.66446	1.6789	4.7434	1.00	5.80

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	31.716	2	15.858	1297.455	.000
Within Groups	.073	6	.012		
Total	31.789	8			

2Cix: Ash Content of some Fish Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Cod	3	.9367	.02517	.01453	.8742	.9992	.91	.96
Catfish	3	.8233	.01528	.00882	.7854	.8613	.81	.84
Mackerel	3	.4700	.01000	.00577	.4452	.4948	.46	.48
Total	9	.7433	.21136	.07045	.5809	.9058	.46	.96

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.355	2	.178	551.586	.000
Within Groups	.002	6	.000		
Total	.357	8			

2Cx: Crude fat Content of some Fish Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Cod	3	9.3333	.05774	.03333	9.1899	9.4768	9.30	9.40
Catfish	3	8.1667	.20817	.12019	7.6496	8.6838	8.00	8.40
Mackerel	3	6.4000	.20000	.11547	5.9032	6.8968	6.20	6.60
Total	9	7.9667	1.28744	.42915	6.9771	8.9563	6.20	9.40

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	13.087	2	6.543	226.500	.000
Within Groups	.173	6	.029		
Total	13.260	8			

2Cxi: Crude Protein Content of some Fish Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Cod	3	31.4000	.10000	.05774	31.1516	31.6484	31.30	31.50
Catfish	3	42.4333	.05774	.03333	42.2899	42.5768	42.40	42.50
Mackerel	3	48.0000	1.00000	.57735	45.5159	50.4841	47.00	49.00
Total	9	40.6111	7.33407	2.44469	34.9736	46.2486	31.30	49.00

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	428.282	2	214.141	633.970	.000
Within Groups	2.027	6	.338		
Total	430.309	8			

2Cxii: Crude Fibre Content of some Fish Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Cod	3	.5367	.05508	.03180	.3999	.6735	.50	.60
Catfish	3	.6700	.01000	.00577	.6452	.6948	.66	.68
Mackerel	3	.7500	.02646	.01528	.6843	.8157	.72	.77
Total	9	.6522	.09833	.03278	.5766	.7278	.50	.77

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.070	2	.035	27.270	.001
Within Groups	.008	6	.001		
Total	.077	8			

2Cxiii: Carbohydrate Content of some Fish Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Cod	3	45.4267	11.46368	6.61856	16.9493	73.9040	32.19	52.14
Catfish	3	45.1400	.17349	.10017	44.7090	45.5710	44.99	45.33
Mackerel	3	43.2133	1.03016	.59476	40.6543	45.7724	42.05	44.01
Total	9	44.5933	5.84923	1.94974	40.0972	49.0894	32.19	52.14

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	8.693	2	4.347	.098	.908
Within Groups	265.015	6	44.169		
Total	273.708	8			

2Cxiv: Oxalate Content of some Fish Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Cod	3	.3100	.01000	.00577	.2852	.3348	.30	.32
Catfish	3	.1933	.01528	.00882	.1554	.2313	.18	.21
mackerel	3	.9300	.01000	.00577	.9052	.9548	.92	.94
Total	9	.4778	.34307	.11436	.2141	.7415	.18	.94

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.941	2	.470	3256.231	.000
Within Groups	.001	6	.000		
Total	.942	8			

2Cxv: Alkaloid Content of some Fish Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Cod	3	.7133	.01528	.00882	.6754	.7513	.70	.73
Catfish	3	.8700	.01000	.00577	.8452	.8948	.86	.88
mackerel	3	.5567	.00577	.00333	.5423	.5710	.55	.56
Total	9	.7133	.13601	.04534	.6088	.8179	.55	.88

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.147	2	.074	602.455	.000
Within Groups	.001	6	.000		
Total	.148	8			

2Cxvi: Saponin Content of some Fish Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Cod	3	.8633	.01528	.00882	.8254	.9013	.85	.88
Catfish	3	.2833	.07371	.04256	.1002	.4664	.20	.34
mackerel	3	.4300	.01000	.00577	.4052	.4548	.42	.44
Total	9	.5256	.26392	.08797	.3227	.7284	.20	.88

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.546	2	.273	141.942	.000
Within Groups	.012	6	.002		
Total	.557	8			

2Cxvii:

Tannin Content of some Fish Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Cod	3	.4300	.01000	.00577	.4052	.4548	.42	.44
Catfish	3	.2633	.01528	.00882	.2254	.3013	.25	.28
mackerel	3	.3100	.02000	.01155	.2603	.3597	.29	.33
Total	9	.3344	.07568	.02523	.2763	.3926	.25	.44

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.044	2	.022	90.727	.000
Within Groups	.001	6	.000		
Total	.046	8			

2Cxviii: Phytic Acid Content of some Fish Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Cod	3	.2767	.01528	.00882	.2387	.3146	.26	.29
Catfish	3	.4700	.01000	.00577	.4452	.4948	.46	.48
mackerel	3	.3133	.01528	.00882	.2754	.3513	.30	.33
Total	9	.3533	.08972	.02991	.2844	.4223	.26	.48

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.063	2	.032	167.471	.000
Within Groups	.001	6	.000		
Total	.064	8			

2Cxix: Potassium Content of some Fish Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Cod	3	13.0533	.04619	.02667	12.9386	13.1681	13.00	13.08
Catfish	3	10.8400	.00000	.00000	10.8400	10.8400	10.84	10.84
mackerel	3	10.6400	.00000	.00000	10.6400	10.6400	10.64	10.64
Total	9	11.5111	1.16013	.38671	10.6194	12.4029	10.64	13.08

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	10.763	2	5.382	7567.750	.000
Within Groups	.004	6	.001		
Total	10.767	8			

2Cxx: Phosphorous Content of some Fish Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Cod	3	.0800	.00000	.00000	.0800	.0800	.08	.08
Catfish	3	.0320	.00000	.00000	.0320	.0320	.03	.03
mackerel	3	.0420	.00000	.00000	.0420	.0420	.04	.04
Total	9	.0513	.02193	.00731	.0345	.0682	.03	.08

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.004	2	.002		
Within Groups	.000	6	.000		
Total	.004	8			

2Cxxi: Magnesium Content of some Fish Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Cod	3	9.8200	.00000	.00000	9.8200	9.8200	9.82	9.82
Catfish	3	10.2400	.00000	.00000	10.2400	10.2400	10.24	10.24
mackerel	3	8.6600	.00000	.00000	8.6600	8.6600	8.66	8.66
Total	9	9.5733	.70873	.23624	9.0286	10.1181	8.66	10.24

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.018	2	2.009	.	.
Within Groups	.000	6	.000		
Total	4.018	8			

2Cxxii: Sodium Content of some Fish Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Cod	3	18.6400	.00000	.00000	18.6400	18.6400	18.64	18.64
Catfish	3	16.8800	.00000	.00000	16.8800	16.8800	16.88	16.88
mackerel	3	16.6400	.00000	.00000	16.6400	16.6400	16.64	16.64
Total	9	17.3867	.94573	.31524	16.6597	18.1136	16.64	18.64

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	7.155	2	3.578	.	.
Within Groups	.000	6	.000		
Total	7.155	8			

2Cxxiii: Calcium Content of some Fish Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Cod	3	29.9600	.00000	.00000	29.9600	29.9600	29.96	29.96
Catfish	3	31.6200	.00000	.00000	31.6200	31.6200	31.62	31.62
mackerel	3	35.6400	.00000	.00000	35.6400	35.6400	35.64	35.64
Total	9	32.4067	2.52929	.84310	30.4625	34.3508	29.96	35.64

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	51.178	2	25.589	.	.
Within Groups	.000	6	.000		
Total	51.178	8			

2Cxxiv: Copper Content of some Fish Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Cod	3	.2480	.00000	.00000	.2480	.2480	.25	.25
Catfish	3	.3947	.12702	.07333	.0791	.7102	.25	.47
mackerel	3	.4013	.05774	.03333	.2579	.5448	.37	.47
Total	9	.3480	.10247	.03416	.2692	.4268	.25	.47

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.045	2	.023	3.473	.100
Within Groups	.039	6	.006		
Total	.084	8			

2Cxxv: Iron Content of some Fish Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Cod	3	9.8200	.00000	.00000	9.8200	9.8200	9.82	9.82
Catfish	3	10.2400	.00000	.00000	10.2400	10.2400	10.24	10.24
mackerel	3	8.6600	.00000	.00000	8.6600	8.6600	8.66	8.66
Total	9	9.5733	.70873	.23624	9.0286	10.1181	8.66	10.24

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	4.018	2	2.009	.	.
Within Groups	.000	6	.000		
Total	4.018	8			

2Cxxvi: Zinc Content of some Fish Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Cod	3	7.4600	.00000	.00000	7.4600	7.4600	7.46	7.46
Catfish	3	.0400	.00000	.00000	.0400	.0400	.04	.04
mackere	3	.0400	.00000	.00000	.0400	.0400	.04	.04
Total	9	2.5133	3.71000	1.23667	-.3384	5.3651	.04	7.46

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	110.113	2	55.056	.	.
Within Groups	.000	6	.000		
Total	110.113	8			

2Cxxvii: Manganese Content of some Fish Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Cod	3	1.7200	.00000	.00000	1.7200	1.7200	1.72	1.72
Catfish	3	1.7600	.00000	.00000	1.7600	1.7600	1.76	1.76
mackerel	3	.9800	.00000	.00000	.9800	.9800	.98	.98
Total	9	1.4867	.38039	.12680	1.1943	1.7791	.98	1.76

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1.158	2	.579	.	.
Within Groups	.000	6	.000		
Total	1.158	8			

2Cxxviii: Moisture Content of some Legumes/pulses

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
White Beans	3	4.8000	.10000	.05774	4.5516	5.0484	4.70	4.90
Brown Beans	3	3.2000	.10000	.05774	2.9516	3.4484	3.10	3.30
Chick pea	3	.6667	.05774	.03333	.5232	.8101	.60	.70
Soyabeans	3	.8767	.02517	.01453	.8142	.9392	.85	.90
Breadfruit	3	.3933	.02082	.01202	.3416	.4450	.37	.41
Total	15	1.9873	1.78785	.46162	.9973	2.9774	.37	4.90

ANOVA

Observations					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	44.701	4	11.175	2289.995	.000
Within Groups	.049	10	.005		
Total	44.749	14			

2Cxxix: Ash Content of some Legumes/pulses

Descriptives

Observations								
95% Confidence Interval for Mean								
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
White Beans	3	.6133	.01155	.00667	.5846	.6420	.60	.62
Brown Beans	3	.6700	.01000	.00577	.6452	.6948	.66	.68
Chick pea	3	.9233	.01528	.00882	.8854	.9613	.91	.94
Soyabeans	3	.8733	.01155	.00667	.8446	.9020	.86	.88
Breadfruit	3	.8233	.01528	.00882	.7854	.8613	.81	.84
Total	15	.7807	.12384	.03197	.7121	.8492	.60	.94

ANOVA

Observations					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.213	4	.053	319.540	.000
Within Groups	.002	10	.000		
Total	.215	14			

2Cxxx: Crude Fat Content of some Legumes/pulses

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
White Beans	3	6.4000	.20000	.11547	5.9032	6.8968	6.20	6.60
Brown Beans	3	6.4667	.30551	.17638	5.7078	7.2256	6.20	6.80
Chick pea	3	9.4333	.15275	.08819	9.0539	9.8128	9.30	9.60
Soyabeans	3	11.4000	.10000	.05774	11.1516	11.6484	11.30	11.50
Breadfruit	3	12.2333	.15275	.08819	11.8539	12.6128	12.10	12.40
Total	15	9.1867	2.51563	.64953	7.7936	10.5798	6.20	12.40

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	88.217	4	22.054	580.377	.000
Within Groups	.380	10	.038		
Total	88.597	14			

2Cxxxi: Crude Protein Content of some Legumes/pulses

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
White Beans	3	64.3333	1.52753	.88192	60.5388	68.1279	63.00	66.00
Brown Beans	3	52.4000	.10000	.05774	52.1516	52.6484	52.30	52.50
Chick pea	3	11.7667	.15275	.08819	11.3872	12.1461	11.60	11.90
Soyabeans	3	42.6667	2.08167	1.20185	37.4955	47.8378	41.00	45.00
Breadfruit	3	27.0000	1.00000	.57735	24.5159	29.4841	26.00	28.00
Total	15	39.6333	19.21810	4.96209	28.9907	50.2760	11.60	66.00

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	5155.293	4	1288.823	836.898	.000
Within Groups	15.400	10	1.540		
Total	5170.693	14			

2Cxxxii: Crude Fibre Content of some Legumes/pulses

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
White Beans	3	.1100	.01000	.00577	.0852	.1348	.10	.12
Brown Beans	3	.1367	.00577	.00333	.1223	.1510	.13	.14
Chick pea	3	.2700	.01000	.00577	.2452	.2948	.26	.28
Soyabeans	3	.6300	.00000	.00000	.6300	.6300	.63	.63
Breadfruit	3	.4600	.03464	.02000	.3739	.5461	.42	.48
Total	15	.3213	.20539	.05303	.2076	.4351	.10	.63

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.588	4	.147	512.535	.000
Within Groups	.003	10	.000		
Total	.591	14			

2Cxxxiii: Carbohydrate Content of some Legumes/pulses

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
White Beans	3	23.7333	1.56340	.90263	19.8496	27.6170	21.97	24.95
Brown Beans	3	37.4600	.36166	.20881	36.5616	38.3584	37.08	37.80
Chick pea	3	80.0633	4.53052	2.61570	68.8089	91.3178	77.02	85.27
Soyabeans	3	43.5533	2.17086	1.25335	38.1606	48.9460	41.11	45.26
Breadfruit	3	59.0900	1.07893	.62292	56.4098	61.7702	58.10	60.24
Total	15	48.7800	20.10894	5.19211	37.6440	59.9160	21.97	85.27

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	5603.217	4	1400.804	241.706	.000
Within Groups	57.955	10	5.795		
Total	5661.172	14			

2Cxxxiv: Oxalate Content of some Legumes/pulses

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
White Beans	3	.4167	.02082	.01202	.3650	.4684	.40	.44
Brown Beans	3	.3167	.01528	.00882	.2787	.3546	.30	.33
Chick pea	3	.1967	.02082	.01202	.1450	.2484	.18	.22
Soyabeans	3	.1567	.03215	.01856	.0768	.2365	.12	.18
Breadfruit	3	.2300	.01000	.00577	.2052	.2548	.22	.24
Total	15	.2633	.09796	.02529	.2091	.3176	.12	.44

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.130	4	.032	72.687	.000
Within Groups	.004	10	.000		
Total	.134	14			

2Cxxxv: Alkaloid Content of some Legumes/pulses

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
White Beans	3	.4267	.01528	.00882	.3887	.4646	.41	.44
Brown Beans	3	.8300	.01000	.00577	.8052	.8548	.82	.84
Chick pea	3	1.4267	.01528	.00882	1.3887	1.4646	1.41	1.44
Soyabeans	3	1.6267	.00577	.00333	1.6123	1.6410	1.62	1.63
Breadfruit	3	2.1333	.05774	.03333	1.9899	2.2768	2.10	2.20
Total	15	1.2887	.62154	.16048	.9445	1.6329	.41	2.20

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	5.401	4	1.350	1716.263	.000
Within Groups	.008	10	.001		
Total	5.408	14			

2Cxxxvi: Saponin Content of some Legumes/pulses

Descriptives

Observations								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
White Beans	3	.9567	.01528	.00882	.9187	.9946	.94	.97
Brown Beans	3	.9233	.00577	.00333	.9090	.9377	.92	.93
Chick pea	3	1.8433	.01528	.00882	1.8054	1.8813	1.83	1.86
Soyabeans	3	2.4000	.10000	.05774	2.1516	2.6484	2.30	2.50
Breadfruit	3	2.7333	.00577	.00333	2.7190	2.7477	2.73	2.74
Total	15	1.7713	.76284	.19696	1.3489	2.1938	.92	2.74

ANOVA

Observations						
	Sum of Squares	Df	Mean Square	F	Sig.	
Between Groups	8.126	4	2.031	964.309	.000	
Within Groups	.021	10	.002			
Total	8.147	14				

2Cxxxvii: Tannin Content of some Legumes/pulses

Descriptives

Observations								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
White Beans	3	.2500	.01000	.00577	.2252	.2748	.24	.26
Brown Beans	3	.1833	.01528	.00882	.1454	.2213	.17	.20
Chick pea	3	.2667	.02309	.01333	.2093	.3240	.24	.28
Soyabeans	3	.2300	.02646	.01528	.1643	.2957	.21	.26
Breadfruit	3	.1400	.00000	.00000	.1400	.1400	.14	.14
Total	15	.2140	.05026	.01298	.1862	.2418	.14	.28

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.032	4	.008	25.713	.000
Within Groups	.003	10	.000		
Total	.035	14			

2Cxxxviii: Phytic Acid Content of some Legumes/pulses

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
White Beans	3	.1133	.00577	.00333	.0990	.1277	.11	.12
Brown Beans	3	.1867	.01155	.00667	.1580	.2154	.18	.20
Chick pea	3	.3200	.02000	.01155	.2703	.3697	.30	.34
Soyabeans	3	.1600	.02000	.01155	.1103	.2097	.14	.18
Breadfruit	3	.3167	.01528	.00882	.2787	.3546	.30	.33
Total	15	.2193	.08811	.02275	.1705	.2681	.11	.34

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.106	4	.027	110.722	.000
Within Groups	.002	10	.000		
Total	.109	14			

2Cxxxix: Potassium Content of some Legumes/pulses

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
White Beans	3	10.6400	.00000	.00000	10.6400	10.6400	10.64	10.64
Brown Beans	3	10.2200	.00000	.00000	10.2200	10.2200	10.22	10.22
Chick Pea	3	9.8400	.00000	.00000	9.8400	9.8400	9.84	9.84
Soyabeans	3	10.6600	.00000	.00000	10.6600	10.6600	10.66	10.66
Breadfruit	3	8.2400	.00000	.00000	8.2400	8.2400	8.24	8.24
Total	15	9.9200	.92406	.23859	9.4083	10.4317	8.24	10.66

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	11.954	4	2.989		
Within Groups	.000	10	.000		
Total	11.954	14			

2CxL: Phosphorous Content of some Legumes/pulses

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
White Beans	3	.0610	.00100	.00058	.0585	.0635	.06	.06
Brown Beans	3	.0367	.00115	.00067	.0338	.0395	.04	.04
Chick Pea	3	.0640	.00000	.00000	.0640	.0640	.06	.06
Soyabeans	3	.0840	.00000	.00000	.0840	.0840	.08	.08
Breadfruit	3	.0713	.00115	.00067	.0685	.0742	.07	.07
Total	15	.0634	.01611	.00416	.0545	.0723	.04	.08

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.004	4	.001	1235.545	.000
Within Groups	.000	10	.000		
Total	.004	14			

2CxLi: Magnesium Content of some Legumes/pulses

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
White Beans	3	10.2400	.00000	.00000	10.2400	10.2400	10.24	10.24
Brown Beans	3	22.4600	.00000	.00000	22.4600	22.4600	22.46	22.46
Chick Pea	3	8.4400	.00000	.00000	8.4400	8.4400	8.44	8.44
Soyabeans	3	7.8200	.00000	.00000	7.8200	7.8200	7.82	7.82
Breadfruit	3	.0717	.00153	.00088	.0679	.0755	.07	.07
Total	15	9.8063	7.47681	1.93051	5.6658	13.9469	.07	22.46

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	782.638	4	195.660	4.193E8	.000
Within Groups	.000	10	.000		
Total	782.638	14			

2CxLii: Sodium Content of some Legumes/pulses

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
White Beans	3	18.4200	.00000	.00000	18.4200	18.4200	18.42	18.42
Brown Beans	3	22.4400	.00000	.00000	22.4400	22.4400	22.44	22.44
Chick Pea	3	18.8400	.00000	.00000	18.8400	18.8400	18.84	18.84
Soyabeans	3	16.9600	.00000	.00000	16.9600	16.9600	16.96	16.96
Breadfruit	3	14.2400	.00000	.00000	14.2400	14.2400	14.24	14.24
Total	15	18.1800	2.76403	.71367	16.6493	19.7107	14.24	22.44

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	106.958	4	26.740	.	.
Within Groups	.000	10	.000		
Total	106.958	14			

2CxLiii: Calcium Content of some Legumes/pulses

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
White Beans	3	20.3600	.00000	.00000	20.3600	20.3600	20.36	20.36
Brown Beans	3	22.2400	.00000	.00000	22.2400	22.2400	22.24	22.24
Chick Pea	3	28.6400	.00000	.00000	28.6400	28.6400	28.64	28.64
Soyabeans	3	18.6400	.00000	.00000	18.6400	18.6400	18.64	18.64
Breadfruit	3	12.3600	.00000	.00000	12.3600	12.3600	12.36	12.36
Total	15	20.4480	5.45787	1.40922	17.4255	23.4705	12.36	28.64

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	417.037	4	104.259	.	.
Within Groups	.000	10	.000		
Total	417.037	14			

2CxLiv: Copper Content of some Legumes/pulses

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
White Beans	3	.0580	.00000	.00000	.0580	.0580	.06	.06
Brown Beans	3	.2840	.00000	.00000	.2840	.2840	.28	.28
Chick Pea	3	.3860	.00000	.00000	.3860	.3860	.39	.39
Soyabeans	3	.2800	.00000	.00000	.2800	.2800	.28	.28
Breadfruit	3	.0560	.00000	.00000	.0560	.0560	.06	.06
Total	15	.2128	.13742	.03548	.1367	.2889	.06	.39

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.264	4	.066	.	.
Within Groups	.000	10	.000		
Total	.264	14			

2CxLv: Iron Content of some Legumes/pulses

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
White Beans	3	14.3133	7.05522	4.07333	-3.2128	31.8395	10.24	22.46
Brown Beans	3	17.7867	8.09445	4.67333	-2.3211	37.8944	8.44	22.46
Chick Pea	3	8.2333	.35796	.20667	7.3441	9.1225	7.82	8.44
Soyabeans	3	8.0200	.34641	.20000	7.1595	8.8805	7.82	8.42
Breadfruit	3	5.6320	4.82896	2.78800	-6.3638	17.6278	.06	8.42
Total	15	10.7971	6.46016	1.66801	7.2196	14.3746	.06	22.46

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	306.544	4	76.636	2.759	.088
Within Groups	277.726	10	27.773		
Total	584.271	14			

2CxLvi: Zinc Content of some Legumes/pulses

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
White Beans	3	.0600	.00000	.00000	.0600	.0600	.06	.06
Brown Beans	3	.0400	.00000	.00000	.0400	.0400	.04	.04
Chick Pea	3	.0600	.00000	.00000	.0600	.0600	.06	.06
Soyabeans	3	.0800	.00000	.00000	.0800	.0800	.08	.08
Breadfruit	3	.0800	.00000	.00000	.0800	.0800	.08	.08
Total	15	.0640	.01549	.00400	.0554	.0726	.04	.08

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.003	4	.001	.	.
Within Groups	.000	10	.000		
Total	.003	14			

2CxLvii: Manganese Content of some Legumes/pulses

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
White Beans	3	.7000	.00000	.00000	.7000	.7000	.70	.70
Brown Beans	3	.9800	.00000	.00000	.9800	.9800	.98	.98
Chick Pea	3	1.8400	.00000	.00000	1.8400	1.8400	1.84	1.84
Soyabeans	3	1.0600	.00000	.00000	1.0600	1.0600	1.06	1.06
Breadfruit	3	.8800	.00000	.00000	.8800	.8800	.88	.88
Total	15	1.0920	.40664	.10500	.8668	1.3172	.70	1.84

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2.315	4	.579	.	.
Within Groups	.000	10	.000		
Total	2.315	14			

2CxLviii: Moisture Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	.9700	.01000	.00577	.9452	.9948	.96	.98
Colanut	3	1.9100	.01000	.00577	1.8852	1.9348	1.90	1.92
Bitter Cola	3	2.8267	.02517	.01453	2.7642	2.8892	2.80	2.85
Coconut	3	2.9433	.00577	.00333	2.9290	2.9577	2.94	2.95
Total	12	2.1625	.83184	.24013	1.6340	2.6910	.96	2.95

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	7.610	3	2.537	11707.526	.000
Within Groups	.002	8	.000		
Total	7.612	11			

2CxLix: Ash Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	.9267	.03055	.01764	.8508	1.0026	.90	.96
Colanut	3	1.1400	.02000	.01155	1.0903	1.1897	1.12	1.16
Bitter Cola	3	1.3167	.01528	.00882	1.2787	1.3546	1.30	1.33
Coconut	3	1.4600	.02000	.01155	1.4103	1.5097	1.44	1.48
Total	12	1.2108	.20913	.06037	1.0780	1.3437	.90	1.48

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.477	3	.159	323.497	.000
Within Groups	.004	8	.000		
Total	.481	11			

2CL: Fat Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	9.4000	.10000	.05774	9.1516	9.6484	9.30	9.50
Colanut	3	8.3667	.15275	.08819	7.9872	8.7461	8.20	8.50
Bitter Cola	3	4.2000	.10000	.05774	3.9516	4.4484	4.10	4.30
Coconut	3	3.8000	.10000	.05774	3.5516	4.0484	3.70	3.90
Total	12	6.4417	2.58473	.74615	4.7994	8.0839	3.70	9.50

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	73.383	3	24.461	1834.563	.000
Within Groups	.107	8	.013		
Total	73.489	11			

2CLi: Protein Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	13.6667	.57735	.33333	12.2324	15.1009	13.00	14.00
Colanut	3	22.0000	1.00000	.57735	19.5159	24.4841	21.00	23.00
Bitter Cola	3	7.0000	1.00000	.57735	4.5159	9.4841	6.00	8.00
Coconut	3	4.2000	.10000	.05774	3.9516	4.4484	4.10	4.30
Total	12	11.7167	7.19581	2.07725	7.1447	16.2887	4.10	23.00

2CLii: Fibre Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	.6133	.01155	.00667	.5846	.6420	.60	.62
Colanut	3	.4200	.01000	.00577	.3952	.4448	.41	.43
Bitter Cola	3	.5200	.01000	.00577	.4952	.5448	.51	.53
Coconut	3	.4200	.02646	.01528	.3543	.4857	.40	.45
Total	12	.4933	.08510	.02457	.4393	.5474	.40	.62

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	564.890	3	188.297	321.417	.000
Within Groups	4.687	8	.586		
Total	569.577	11			

2CLiii: Carbohydrate Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	82.7100	.32970	.19035	81.8910	83.5290	82.50	83.09
Colanut	3	66.1633	.83050	.47949	64.1003	68.2264	65.35	67.01
Bitter Cola	3	84.0000	1.00000	.57735	81.5159	86.4841	83.00	85.00
Coconut	3	87.0000	.00000	.00000	87.0000	87.0000	87.00	87.00
Total	12	79.9683	8.50121	2.45409	74.5669	85.3697	65.35	87.00

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	791.380	3	263.793	586.718	.000
Within Groups	3.597	8	.450		
Total	794.977	11			

2CLiv: Oxalate Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	.3300	.02646	.01528	.2643	.3957	.31	.36
Colanut	3	.8700	.01000	.00577	.8452	.8948	.86	.88
Bitter Cola	3	.3233	.01528	.00882	.2854	.3613	.31	.34
Coconut	3	.5200	.02000	.01155	.4703	.5697	.50	.54
Total	12	.5108	.23232	.06706	.3632	.6584	.31	.88

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.591	3	.197	549.605	.000
Within Groups	.003	8	.000		
Total	.594	11			

2CLv: Alkaloid Content of some Nut Samples\

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	2.3667	.20817	.12019	1.8496	2.8838	2.20	2.60
Colanut	3	.8567	.02082	.01202	.8050	.9084	.84	.88
Bitter Cola	3	.3267	.02517	.01453	.2642	.3892	.30	.35
Coconut	3	.8800	.01000	.00577	.8552	.9048	.87	.89
Total	12	1.1075	.79878	.23059	.6000	1.6150	.30	2.60

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	6.930	3	2.310	207.629	.000
Within Groups	.089	8	.011		
Total	7.019	11			

2CLvi: Saponin Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	2.7333	.00577	.00333	2.7190	2.7477	2.73	2.74
Colanut	3	6.9700	.01000	.00577	6.9452	6.9948	6.96	6.98
Bitter Cola	3	.4200	.01000	.00577	.3952	.4448	.41	.43
Coconut	3	.9100	.01000	.00577	.8852	.9348	.90	.92
Total	12	2.7583	2.69460	.77786	1.0463	4.4704	.41	6.98

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	79.869	3	26.623	319474.800	.000
Within Groups	.001	8	.000		
Total	79.869	11			

2CLvii: Tannin Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	.3200	.01000	.00577	.2952	.3448	.31	.33
Colanut	3	.2633	.02082	.01202	.2116	.3150	.24	.28
Bitter Cola	3	.9767	.01528	.00882	.9387	1.0146	.96	.99
Coconut	3	.4367	.01528	.00882	.3987	.4746	.42	.45
Total	12	.4992	.29556	.08532	.3114	.6870	.24	.99

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.959	3	.320	1278.522	.000
Within Groups	.002	8	.000		
Total	.961	11			

2CLviii: Phytic Acid Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	.4133	.01155	.00667	.3846	.4420	.40	.42
Colanut	3	.5300	.02000	.01155	.4803	.5797	.51	.55
Bitter Cola	3	.9200	.01000	.00577	.8952	.9448	.91	.93
Coconut	3	.1367	.02517	.01453	.0742	.1992	.11	.16
Total	12	.5000	.29434	.08497	.3130	.6870	.11	.93

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.950	3	.317	1000.491	.000
Within Groups	.003	8	.000		
Total	.953	11			

2CLix: Potassium Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	8.6200	.00000	.00000	8.6200	8.6200	8.62	8.62
Colanut	3	10.2400	.00000	.00000	10.2400	10.2400	10.24	10.24
Bitter Cola	3	10.6600	.00000	.00000	10.6600	10.6600	10.66	10.66
Coconut	3	10.8200	.00000	.00000	10.8200	10.8200	10.82	10.82
Total	12	10.0850	.91071	.26290	9.5064	10.6636	8.62	10.82

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	9.123	3	3.041		
Within Groups	.000	8	.000		
Total	9.123	11			

2CLx: Phosphorous Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	.1013	.00115	.00067	.0985	.1042	.10	.10
Colanut	3	.0620	.00000	.00000	.0620	.0620	.06	.06
Bitter Cola	3	.0240	.00000	.00000	.0240	.0240	.02	.02
Coconut	3	.0400	.00000	.00000	.0400	.0400	.04	.04
Total	12	.0568	.03031	.00875	.0376	.0761	.02	.10

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.010	3	.003	10105.000	.000
Within Groups	.000	8	.000		
Total	.010	11			

2CLxi: Magnesium Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	6.3800	.00000	.00000	6.3800	6.3800	6.38	6.38
Colanut	3	7.8867	1.30481	.75333	4.6453	11.1280	6.38	8.64
Bitter Cola	3	10.3733	1.50111	.86667	6.6444	14.1023	8.64	11.24
Coconut	3	10.6000	.55426	.32000	9.2232	11.9768	10.28	11.24
Total	12	8.8100	2.03922	.58867	7.5143	10.1057	6.38	11.24

ANOVA

Observations					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	37.217	3	12.406	11.640	.003
Within Groups	8.526	8	1.066		
Total	45.743	11			

2CLxii: Sodium Content of some Nut Samples

Descriptives

Observations									
				95% Confidence Interval for Mean					
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum	
Groundnut	3	15.0400	.00000	.00000	15.0400	15.0400	15.04	15.04	
Colanut	3	14.8600	.00000	.00000	14.8600	14.8600	14.86	14.86	
Bitter Cola	3	13.8400	.00000	.00000	13.8400	13.8400	13.84	13.84	
Coconut	3	18.6400	.00000	.00000	18.6400	18.6400	18.64	18.64	
Total	12	15.5950	1.89739	.54773	14.3895	16.8005	13.84	18.64	

ANOVA

Observations					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	39.601	3	13.200		
Within Groups	.000	8	.000		
Total	39.601	11			

2CLxiii: Calcium Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	14.4400	.00000	.00000	14.4400	14.4400	14.44	14.44
Colanut	3	16.6200	.00000	.00000	16.6200	16.6200	16.62	16.62
Bitter Cola	3	18.4200	.00000	.00000	18.4200	18.4200	18.42	18.42
Coconut	3	10.2400	.00000	.00000	10.2400	10.2400	10.24	10.24
Total	12	14.9300	3.18829	.92038	12.9043	16.9557	10.24	18.42

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	111.817	3	37.272	.	.
Within Groups	.000	8	.000		
Total	111.817	11			

2CLxiv: Copper Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	.0280	.00000	.00000	.0280	.0280	.03	.03
Colanut	3	.0640	.00000	.00000	.0640	.0640	.06	.06
Bitter Cola	3	.1060	.00000	.00000	.1060	.1060	.11	.11
Coconut	3	.2240	.00000	.00000	.2240	.2240	.22	.22
Total	12	.1055	.07706	.02224	.0565	.1545	.03	.22

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.065	3	.022	.	.
Within Groups	.000	8	.000		
Total	.065	11			

2CLxv: Iron Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	6.3800	.00000	.00000	6.3800	6.3800	6.38	6.38
Colanut	3	8.6400	.00000	.00000	8.6400	8.6400	8.64	8.64
Bitter Cola	3	11.2400	.00000	.00000	11.2400	11.2400	11.24	11.24
Coconut	3	10.2800	.00000	.00000	10.2800	10.2800	10.28	10.28
Total	12	9.1350	1.92428	.55549	7.9124	10.3576	6.38	11.24

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	40.731	3	13.577	.	.
Within Groups	.000	8	.000		
Total	40.731	11			

2CLxvi: Zinc Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	.1020	.00000	.00000	.1020	.1020	.10	.10
Colanut	3	.0620	.00000	.00000	.0620	.0620	.06	.06
Bitter Cola	3	.0240	.00000	.00000	.0240	.0240	.02	.02
Coconut	3	.0400	.00000	.00000	.0400	.0400	.04	.04
Total	12	.0570	.03058	.00883	.0376	.0764	.02	.10

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.010	3	.003	.	.
Within Groups	.000	8	.000		
Total	.010	11			

2CLxvii: Manganese Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	1.8600	.00000	.00000	1.8600	1.8600	1.86	1.86
Colanut	3	1.6200	.00000	.00000	1.6200	1.6200	1.62	1.62
Bitter Cola	3	.8200	.00000	.00000	.8200	.8200	.82	.82
Coconut	3	.7600	.00000	.00000	.7600	.7600	.76	.76
Total	12	1.2650	.50446	.14563	.9445	1.5855	.76	1.86

ANOVA

Observations					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.799	3	.933	.	.
Within Groups	.000	8	.000		
Total	2.799	11			

2CLxviii: T-Test for Moisture Content of some Seed Samples

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
Observations	Ducanut seed	3	4.8433	.01528	.00882
	Melon Seed	3	5.4000	.10000	.05774

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Observations	Equal variances assumed	2.738	.173	-9.531	4	.001	-.55667	.05840	-.71882	-.39451
	Equal variances not assumed			-9.531	2.093	.009	-.55667	.05840	-.79753	-.31580

2CLxix: T-Test for Ash Content of some Seed Samples

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
Observations	Ducanut seed	3	1.2333	.01155	.00667
	Melon Seed	3	1.4600	.03464	.02000

Independent Samples Test										
		Levene's Test for Equality of Variances				t-test for Equality of Means				
								95% Confidence Interval of the Difference		
		F	Sig.	T	df	Sig. (2- tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Observations	Equal variances assumed	6.400	.065	-10.752	4	.000	-.22667	.02108	-.28520	-.16813
	Equal variances not assumed			-10.752	2.439	.004	-.22667	.02108	-.30339	-.14994

2CLxx: T-Test for Fat Content of some Seed Samples

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
Observations	Ducanut seed	3	9.2000	.10000	.05774
	Melon Seed	3	15.4667	.30551	.17638

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference		
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Observations	Equal variances assumed	3.213	.148	-	4	.000	-6.26667	.18559	-6.78195	-
				33.766					5.7513	8
Observations	Equal variances not assumed			- 2.424		.000	-6.26667	.18559	-6.94528	-
				33.766					5.5880	6

2CLxxi: T-Test for Protein Content of some Seed Samples

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
Observations	Ducanut seed	3	4.6167	.07638	.04410
	Melon Seed	3	5.9300	.02646	.01528

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference		
		F	Sig.	T	df	Sig. (2- tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Observations	Equal variances assumed	2.909	.163	-28.143	4	.000	-1.31333	.04667	-1.44290	-1.18377
	Equal variances not assumed			-28.143	2.473	.000	-1.31333	.04667	-1.48145	-1.14521

2CLxxii: T-Test for Fibre Content of some Seed Samples

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
Observations	Ducanut seed	3	.8433	.05859	.03383
	Melon Seed	3	.6233	.00577	.00333

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2- tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Observations	Equal variances assumed	10.125	.033	6.472	4	.003	.22000	.03399	.12562	.31438
	Equal variances not assumed			6.472	2.039	.022	.22000	.03399	.07638	.36362

2CLxxiii: T-Test for Carbohydrate Content of some Seed Samples

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
Observations	Ducanut seed	3	79.0000	.00000	.00000
	Melon Seed	3	71.1200	.36166	.20881

Independent Samples Test

Levene's Test for Equality of Variances		t-test for Equality of Means								
								95% Confidence Interval of the Difference		
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Observations	Equal variances assumed	5.575	.078	37.738	4	.000	7.88000	.20881	7.30026	8.45974
	Equal variances not assumed			37.738	2.000	.001	7.88000	.20881	6.98158	8.77842

2CLxxiv: T-Test for Oxalate Content of some Seed Samples

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
Observations	Ducanut seed	3	.2000	.01000	.00577
	Melon Seed	3	.4567	.02517	.01453

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
				95% Confidence Interval of the Difference						
				Mean						
		F	Sig.	T	df	Sig. (2-tailed)	Difference	Std. Error Difference	Lower	Upper
Observations	Equal variance assumed	1.923	.238	-16.416	4	.000	-.25667	.01563	-.30008	-.21326
	Equal variance not assumed			-16.416	2.616	.001	-.25667	.01563	-.31082	-.20251

2CLxxv: T-Test for Alkaloid Content of some Seed Samples

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
Observations	Ducanut seed	3	.7200	.01000	.00577
	Melon Seed	3	1.5367	.01528	.00882

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Observations	Equal variances assumed	.727	.442	-77.476	4	.000	-.81667	.01054	-.84593	-.78740
	Equal variances not assumed			-77.476	3.448	.000	-.81667	.01054	-.84788	-.78546

2CLxxvi: T-Test for Saponin Content of some Seed Samples

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
Observations	Ducanut seed	3	.8400	.01000	.00577
	Melon Seed	3	1.7533	.01528	.00882

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Observations	Equal variances assumed	.727	.442	-	4	.000	-.91333	.01054	-.94260	-.88407
	Equal variances not assumed			-	3.448	.000	-.91333	.01054	-.94454	-.88212

2CLxxvii: T-Test for Tannin Content of some Seed Samples

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
Observations	Ducanut seed	3	.8500	.01000	.00577
	Melon Seed	3	.4200	.01000	.00577

Independent Samples Test

Levene's Test for Equality of Variances		t-test for Equality of Means								
								95% Confidence Interval of the Difference		
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Observations	Equal variances assumed	.000	1.000	52.664	4	.000	.43000	.00816	.40733	.45267
	Equal variances not assumed			52.664	4.000	.000	.43000	.00816	.40733	.45267

2CLxxviii: T-Test for Phytic acid Content of some Seed Samples

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
Observations	Ducanut seed	3	.3100	.01000	.00577
	Melon Seed	3	.6400	.02000	.01155

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
				95% Confidence Interval of the Difference						
				Mean						
		F	Sig.	t	df	Sig. (2- tailed)	Differenc e	Std. Error Difference	Lower	Upper
Observations	Equal variances assumed	.800	.422	-25.562	4	.000	-.33000	.01291	-.36584	-.29416
	Equal variances not assumed			-25.562	2.941	.000	-.33000	.01291	-.37155	-.28845

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
				95% Confidence Interval of the Difference						
		F	Sig.	T	df	Sig. (2- tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Observations	Equal variances assumed	.182	.692	-2.000	4	.116	-.00267	.00133	-.00637	.00104
	Equal variances not assumed			-2.000	3.938	.117	-.00267	.00133	-.00639	.00106

2CLxxix: Lead Content of some Vegetable Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Ugu	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Oha	3	.0200	.00000	.00000	.0200	.0200	.02	.02
Onugwu	3	.0800	.00000	.00000	.0800	.0800	.08	.08
Inine Oyibo	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Arira	3	.3600	.00000	.00000	.3600	.3600	.36	.36
akwukwo anara	3	.2400	.00000	.00000	.2400	.2400	.24	.24
Total	18	.1167	.14080	.03319	.0467	.1867	.00	.36

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.337	5	.067		
Within Groups	.000	12	.000		
Total	.337	17			

2CLxxx: Cadmium Content of some Vegetable Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Ugu	3	.0400	.00000	.00000	.0400	.0400	.04	.04
Oha	3	.0560	.00000	.00000	.0560	.0560	.06	.06
Onugwu	3	.1600	.00000	.00000	.1600	.1600	.16	.16
Inine Oyibo	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Arira	3	.0600	.00000	.00000	.0600	.0600	.06	.06
akwukwo anara	3	.6000	.00000	.00000	.6000	.6000	.60	.60
Total	18	.1527	.21175	.04991	.0474	.2580	.00	.60

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.762	5	.152	.	.
Within Groups	.000	12	.000		
Total	.762	17			

2CLxxx: Cobalt Content of some Vegetable Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Ugu	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Oha	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Onugwu	3	.0400	.00000	.00000	.0400	.0400	.04	.04
Inine Oyibo	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Arira	3	.2000	.00000	.00000	.2000	.2000	.20	.20
akwukwo anara	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Total	18	.0400	.07515	.01771	.0026	.0774	.00	.20

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.096	5	.019	.	.
Within Groups	.000	12	.000		
Total	.096	17			

2CLxxxii: Nickel Content of some Vegetable Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Ugu	3	.6200	.00000	.00000	.6200	.6200	.62	.62
Oha	3	.2200	.00000	.00000	.2200	.2200	.22	.22
Onugwu	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Inine Oyibo	3	.2400	.00000	.00000	.2400	.2400	.24	.24
Arira	3	.5600	.00000	.00000	.5600	.5600	.56	.56
akwukwo anara	3	.2200	.00000	.00000	.2200	.2200	.22	.22
Total	18	.3100	.22061	.05200	.2003	.4197	.00	.62

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.827	5	.165	.	.
Within Groups	.000	12	.000		
Total	.827	17			

2CLxxxiii: Mercury Content of some Vegetable Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Ugu	3	1.6000	.00000	.00000	1.6000	1.6000	1.60	1.60
Oha	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Onugwu	3	.8000	.00000	.00000	.8000	.8000	.80	.80
Inine Oyibo	3	.4000	.00000	.00000	.4000	.4000	.40	.40
Arira	3	.0000	.00000	.00000	.0000	.0000	.00	.00
akwukwo anara	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Total	18	.4667	.60196	.14188	.1673	.7660	.00	1.60

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.160	5	1.232	.	.
Within Groups	.000	12	.000		
Total	6.160	17			

2CLxxxiv: Asevic Content of some Vegetable Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Ugu	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Oha	3	.0200	.00000	.00000	.0200	.0200	.02	.02
Onugwu	3	.2000	.00000	.00000	.2000	.2000	.20	.20
Inine Oyibo	3	.3600	.00000	.00000	.3600	.3600	.36	.36
Arira	3	.0000	.00000	.00000	.0000	.0000	.00	.00
akwukwo anara	3	.0200	.00000	.00000	.0200	.0200	.02	.02
Total	18	.1000	.13958	.03290	.0306	.1694	.00	.36

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.331	5	.066	.	.
Within Groups	.000	12	.000		
Total	.331	17			

2CLxxxv: Lead Content of some Fruit Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Swansop	3	.1600	.00000	.00000	.1600	.1600	.16	.16
orange	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Starapple	3	.6600	.00000	.00000	.6600	.6600	.66	.66
Mango	3	.4200	.00000	.00000	.4200	.4200	.42	.42
Icheku	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Total	15	.2480	.26595	.06867	.1007	.3953	.00	.66

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.990	4	.248	.	.
Within Groups	.000	10	.000		
Total	.990	14			

2CLxxxvi: Cadmium Content of some Fruit Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Swansop	3	.2800	.00000	.00000	.2800	.2800	.28	.28
orange	3	.4200	.00000	.00000	.4200	.4200	.42	.42
Starapple	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Mango	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Icheku	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Total	15	.1400	.18330	.04733	.0385	.2415	.00	.42

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.470	4	.118		
Within Groups	.000	10	.000		
Total	.470	14			

2CLxxxvii: Cobalt Content of some Fruit Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Swansop	3	.0000	.00000	.00000	.0000	.0000	.00	.00
orange	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Starapple	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Mango	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Icheku	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Total	15	.0000	.00000	.00000	.0000	.0000	.00	.00

ANOVA

Observations					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.000	4	.000		
Within Groups	.000	10	.000		
Total	.000	14			

2CLxxxviii: Nickel Content of some Fruit Samples

Descriptives

Observations								
				95% Confidence Interval for Mean				
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Swansop	3	.3600	.00000	.00000	.3600	.3600	.36	.36
orange	3	.3000	.00000	.00000	.3000	.3000	.30	.30
Starapple	3	.4600	.00000	.00000	.4600	.4600	.46	.46
Mango	3	.5600	.00000	.00000	.5600	.5600	.56	.56
lcheku	3	.2400	.00000	.00000	.2400	.2400	.24	.24
Total	15	.3840	.11813	.03050	.3186	.4494	.24	.56

ANOVA

Observations					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.195	4	.049		
Within Groups	.000	10	.000		
Total	.195	14			

2CLxxxix: Mercury Content of some Fruit Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Swansop	3	.2800	.00000	.00000	.2800	.2800	.28	.28
orange	3	.2400	.00000	.00000	.2400	.2400	.24	.24
Starapple	3	.3600	.00000	.00000	.3600	.3600	.36	.36
Mango	3	.8800	.00000	.00000	.8800	.8800	.88	.88
Icheku	3	.7600	.00000	.00000	.7600	.7600	.76	.76
Total	15	.5040	.27289	.07046	.3529	.6551	.24	.88

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1.043	4	.261	.	.
Within Groups	.000	10	.000		
Total	1.043	14			

2Cx C: Arsenic Content of some Fruit Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Swansop	3	.0000	.00000	.00000	.0000	.0000	.00	.00
orange	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Starapple	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Mango	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Icheku	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Total	15	.0000	.00000	.00000	.0000	.0000	.00	.00

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.000	4	.000	.	.
Within Groups	.000	10	.000		
Total	.000	14			

2Cx2: Lead Content of some Cereal Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Osikapa	3	.3600	.00000	.00000	.3600	.3600	.36	.36
Oka (white)	3	.4400	.00000	.00000	.4400	.4400	.44	.44
Oka (red)	3	1.6800	.00000	.00000	1.6800	1.6800	1.68	1.68
Total	9	.8267	.64094	.21365	.3340	1.3193	.36	1.68

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.286	2	1.643	.	.
Within Groups	.000	6	.000		
Total	3.286	8			

2CxCii: Cadmium Content of some Cereal Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Osikapa	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Oka (white)	3	.0400	.00000	.00000	.0400	.0400	.04	.04
Oka (red)	3	.0200	.00000	.00000	.0200	.0200	.02	.02
Total	9	.0200	.01732	.00577	.0067	.0333	.00	.04

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.002	2	.001	.	.
Within Groups	.000	6	.000		
Total	.002	8			

2CxCIii: Cobalt Content of some Cereal Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Osikapa	3	.0200	.00000	.00000	.0200	.0200	.02	.02
Oka (white)	3	.0200	.00000	.00000	.0200	.0200	.02	.02
Oka (red)	3	.0600	.00000	.00000	.0600	.0600	.06	.06
Total	9	.0333	.02000	.00667	.0180	.0487	.02	.06

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.003	2	.002	.	.
Within Groups	.000	6	.000		
Total	.003	8			

2CxCIv: Nickel Content of some Cereal Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Osikapa	3	1.0800	.00000	.00000	1.0800	1.0800	1.08	1.08
Oka (white)	3	1.0600	.00000	.00000	1.0600	1.0600	1.06	1.06
Oka (red)	3	.4400	.00000	.00000	.4400	.4400	.44	.44
Total	9	.8600	.31512	.10504	.6178	1.1022	.44	1.08

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.794	2	.397	.	.
Within Groups	.000	6	.000		
Total	.794	8			

2Cx2: Mercury Content of some Cereal Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Osikapa	3	.6400	.00000	.00000	.6400	.6400	.64	.64
Oka (white)	3	.6000	.00000	.00000	.6000	.6000	.60	.60
Oka (red)	3	.6200	.00000	.00000	.6200	.6200	.62	.62
Total	9	.6200	.01732	.00577	.6067	.6333	.60	.64

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.002	2	.001	.	.
Within Groups	.000	6	.000		
Total	.002	8			

2CxCvi: Aseptic Content of some Cereal Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Osikapa	3	.0200	.00000	.00000	.0200	.0200	.02	.02
Oka (white)	3	.0600	.00000	.00000	.0600	.0600	.06	.06
Oka (red)	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Total	9	.0267	.02646	.00882	.0063	.0470	.00	.06

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.006	2	.003	.	.
Within Groups	.000	6	.000		
Total	.006	8			

2CxVii: Lead Content of some Samples of Roots/tubers

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Water Yam	3	.2200	.00000	.00000	.2200	.2200	.22	.22
Sweet Yam	3	.0600	.00000	.00000	.0600	.0600	.06	.06
Yellow Yam	3	1.8800	.00000	.00000	1.8800	1.8800	1.88	1.88
Cassava	3	.5000	.00000	.00000	.5000	.5000	.50	.50
Garri	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Sweet Potatoes (red)	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Sweet Potatoes (white)	3	.0600	.00000	.00000	.0600	.0600	.06	.06
Cocoyam	3	.1600	.00000	.00000	.1600	.1600	.16	.16
Total	24	.3600	.60743	.12399	.1035	.6165	.00	1.88

ANOVA

Observation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8.486	7	1.212	.	.
Within Groups	.000	16	.000		
Total	8.486	23			

2Cx Cviii: Cadmium Content of some Samples of Roots/tubers

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Water Yam	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Sweet Yam	3	.2200	.00000	.00000	.2200	.2200	.22	.22
Yellow Yam	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Cassava	3	.3600	.00000	.00000	.3600	.3600	.36	.36
Garri	3	.2600	.00000	.00000	.2600	.2600	.26	.26
Sweet Potatoes (red)	3	.3000	.00000	.00000	.3000	.3000	.30	.30
Sweet Potatoes (white)	3	.3200	.00000	.00000	.3200	.3200	.32	.32
Cocoyam	3	.4400	.00000	.00000	.4400	.4400	.44	.44
Total	24	.2375	.15338	.03131	.1727	.3023	.00	.44

ANOVA

Observation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.541	7	.077	.	.
Within Groups	.000	16	.000		
Total	.541	23			

2CxGix: Cobalt Content of some Samples of Roots/tubers

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Water Yam	3	.0400	.00000	.00000	.0400	.0400	.04	.04
Sweet Yam	3	.0800	.00000	.00000	.0800	.0800	.08	.08
Yellow Yam	3	.0200	.00000	.00000	.0200	.0200	.02	.02
Cassava	3	.0413	.00231	.00133	.0356	.0471	.04	.04
Garri	3	.1800	.00000	.00000	.1800	.1800	.18	.18
Sweet Potatoes (red)	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Sweet Potatoes (white)	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Cocoyam	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Total	24	.0452	.05845	.01193	.0205	.0698	.00	.18

ANOVA

Observation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.079	7	.011	16835.286	.000
Within Groups	.000	16	.000		
Total	.079	23			

2CC: Nickel Content of some Samples of Roots/tubers

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Water Yam	3	.2200	.00000	.00000	.2200	.2200	.22	.22
Sweet Yam	3	.0600	.00000	.00000	.0600	.0600	.06	.06
Yellow Yam	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Cassava	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Garri	3	.4600	.00000	.00000	.4600	.4600	.46	.46
Sweet Potatoes (red)	3	.4200	.00000	.00000	.4200	.4200	.42	.42
Sweet Potatoes (white)	3	.4000	.00000	.00000	.4000	.4000	.40	.40
Cocoyam	3	.2200	.00000	.00000	.2200	.2200	.22	.22
Total	24	.2225	.18143	.03703	.1459	.2991	.00	.46

ANOVA

Observation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.757	7	.108	.	.
Within Groups	.000	16	.000		
Total	.757	23			

2CCi: Mercury Content of some Samples of Roots/tubers

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Water Yam	3	.8400	.00000	.00000	.8400	.8400	.84	.84
Sweet Yam	3	.8000	.00000	.00000	.8000	.8000	.80	.80
Yellow Yam	3	.9400	.00000	.00000	.9400	.9400	.94	.94
Cassava	3	1.0800	.00000	.00000	1.0800	1.0800	1.08	1.08
Garri	3	1.8400	.00000	.00000	1.8400	1.8400	1.84	1.84
Sweet Potatoes (red)	3	1.8600	.00000	.00000	1.8600	1.8600	1.86	1.86
Sweet Potatoes (white)	3	1.9600	.00000	.00000	1.9600	1.9600	1.96	1.96
Cocoyam	3	1.8200	.00000	.00000	1.8200	1.8200	1.82	1.82
Total	24	1.3925	.49550	.10114	1.1833	1.6017	.80	1.96

ANOVA

Observation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.647	7	.807	.	.
Within Groups	.000	16	.000		
Total	5.647	23			

2CCii: Arsenic Content of some Samples of Roots/tubers

Descriptives

Observation	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Water Yam	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Sweet Yam	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Yellow Yam	3	.8000	.00000	.00000	.8000	.8000	.80	.80
Cassava	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Garri	3	.0600	.00000	.00000	.0600	.0600	.06	.06
Sweet Potatoes (red)	3	.1600	.00000	.00000	.1600	.1600	.16	.16
Sweet Potatoes (white)	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Cocoyam	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Total	24	.1275	.26519	.05413	.0155	.2395	.00	.80

ANOVA

Observation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.617	7	.231	.	.
Within Groups	.000	16	.000		
Total	1.617	23			

2CCiii: Lead Content of Some Meat Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Goat Meat	3	.8400	.00000	.00000	.8400	.8400	.84	.84
Beef	3	.7600	.00000	.00000	.7600	.7600	.76	.76
Chicken	3	.4800	.00000	.00000	.4800	.4800	.48	.48
Turkey	3	1.0200	.00000	.00000	1.0200	1.0200	1.02	1.02
Total	12	.7750	.20327	.05868	.6458	.9042	.48	1.02

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.455	3	.152	.	.
Within Groups	.000	8	.000		
Total	.455	11			

2CCiv: Cadmium Content of Some Meat Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Goat Meat	3	.3000	.00000	.00000	.3000	.3000	.30	.30
Beef	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Chicken	3	.4800	.00000	.00000	.4800	.4800	.48	.48
Turkey	3	.6600	.00000	.00000	.6600	.6600	.66	.66
Total	12	.3600	.25456	.07348	.1983	.5217	.00	.66

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.713	3	.238	.	.
Within Groups	.000	8	.000		
Total	.713	11			

2CCv: Cobalt Content of Some Meat Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Goat Meat	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Beef	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Chicken	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Turkey	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Total	12	.0000	.00000	.00000	.0000	.0000	.00	.00

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.000	3	.000	.	.
Within Groups	.000	8	.000		
Total	.000	11			

2CCvi: Nickel Content of Some Meat Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Goat Meat	3	.8200	.00000	.00000	.8200	.8200	.82	.82
Beef	3	.6600	.00000	.00000	.6600	.6600	.66	.66
Chicken	3	.6400	.00000	.00000	.6400	.6400	.64	.64
Turkey	3	.6000	.00000	.00000	.6000	.6000	.60	.60
Total	12	.6800	.08739	.02523	.6245	.7355	.60	.82

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.084	3	.028	.	.
Within Groups	.000	8	.000		
Total	.084	11			

2CCvii: Mercury Content of Some Meat Samples

Descriptives

Observations								
95% Confidence Interval for								
Mean								
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Goat Meat	3	.7800	.00000	.00000	.7800	.7800	.78	.78
Beef	3	.3600	.00000	.00000	.3600	.3600	.36	.36
Chicken	3	.3800	.00000	.00000	.3800	.3800	.38	.38
Turkey	3	1.7600	.00000	.00000	1.7600	1.7600	1.76	1.76
Total	12	.8200	.59323	.17125	.4431	1.1969	.36	1.76

ANOVA

Observations					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.871	3	1.290	.	.
Within Groups	.000	8	.000		
Total	3.871	11			

2CCviii: Aseic Content of Some Meat Samples

Descriptives

Observations								
95% Confidence Interval for								
Mean								
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Goat Meat	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Beef	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Chicken	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Turkey	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Total	12	.0000	.00000	.00000	.0000	.0000	.00	.00

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.000	3	.000	.	.
Within Groups	.000	8	.000		
Total	.000	11			

2CCix: Lead Content of some Legumes/pulses Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Bean (white)	3	.1600	.00000	.00000	.1600	.1600	.16	.16
Bean (Brown)	3	.2200	.00000	.00000	.2200	.2200	.22	.22
Chickpea	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Soyabeaan	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Breadfruit	3	.0400	.00000	.00000	.0400	.0400	.04	.04
Total	15	.0840	.09295	.02400	.0325	.1355	.00	.22

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.121	4	.030	.	.
Within Groups	.000	10	.000		
Total	.121	14			

2CCx: Cadmium Content of some Legumes/pulses Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Bean (white)	3	.3267	.05774	.03333	.1832	.4701	.26	.36
Bean (Brown)	3	.4400	.00000	.00000	.4400	.4400	.44	.44
Chickpea	3	.3800	.00000	.00000	.3800	.3800	.38	.38
Soyabeaan	3	.4000	.00000	.00000	.4000	.4000	.40	.40
Breadfruit	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Total	15	.3093	.16594	.04284	.2174	.4012	.00	.44

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.379	4	.095	142.060	.000
Within Groups	.007	10	.001		
Total	.385	14			

2CCxi: Cobalt Content of some Legumes/pulses Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Bean (white)	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Bean (Brown)	3	.0600	.00000	.00000	.0600	.0600	.06	.06
Chickpea	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Soyabean	3	.2400	.00000	.00000	.2400	.2400	.24	.24
Breadfruit	3	.6600	.00000	.00000	.6600	.6600	.66	.66
Total	15	.1920	.25877	.06681	.0487	.3353	.00	.66

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.937	4	.234	.	.
Within Groups	.000	10	.000		
Total	.937	14			

2CCxii: Nickel Content of some Legumes/pulses Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Bean (white)	3	.6800	.00000	.00000	.6800	.6800	.68	.68
Bean (Brown)	3	.4800	.00000	.00000	.4800	.4800	.48	.48
Chickpea	3	.5600	.00000	.00000	.5600	.5600	.56	.56
Soyabean	3	.4400	.00000	.00000	.4400	.4400	.44	.44
Breadfruit	3	.8400	.00000	.00000	.8400	.8400	.84	.84
Total	15	.6000	.15043	.03884	.5167	.6833	.44	.84

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.317	4	.079	.	.
Within Groups	.000	10	.000		
Total	.317	14			

2CCxiii: Mercury Content of some Legumes/pulses Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Bean (white)	3	1.6600	.00000	.00000	1.6600	1.6600	1.66	1.66
Bean (Brown)	3	.3600	.00000	.00000	.3600	.3600	.36	.36
Chickpea	3	.4800	.00000	.00000	.4800	.4800	.48	.48
Soyabeaan	3	.2200	.00000	.00000	.2200	.2200	.22	.22
Breadfruit	3	.6800	.00000	.00000	.6800	.6800	.68	.68
Total	15	.6800	.53071	.13703	.3861	.9739	.22	1.66

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.943	4	.986	.	.
Within Groups	.000	10	.000		
Total	3.943	14			

2CCxiv: Asenic Content of some Legumes/pulses Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Bean (white)	3	.2200	.00000	.00000	.2200	.2200	.22	.22
Bean (Brown)	3	.1600	.00000	.00000	.1600	.1600	.16	.16
Chickpea	3	.0400	.00000	.00000	.0400	.0400	.04	.04
Soyabeaan	3	.0200	.00000	.00000	.0200	.0200	.02	.02
Breadfruit	3	.0600	.00000	.00000	.0600	.0600	.06	.06
Total	15	.1000	.07964	.02056	.0559	.1441	.02	.22

ANOVA

Observations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.089	4	.022		
Within Groups	.000	10	.000		
Total	.089	14			

2CCxv: Lead Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	.0200	.00000	.00000	.0200	.0200	.02	.02
Colanut	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Bitter Cola	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Coconut	3	.6400	.00000	.00000	.6400	.6400	.64	.64
Total	12	.1650	.28656	.08272	-.0171	.3471	.00	.64

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.903	3	.301	.	.
Within Groups	.000	8	.000		
Total	.903	11			

2CCxvi: Cadmium Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Colanut	3	.2200	.00000	.00000	.2200	.2200	.22	.22
Bitter Cola	3	.2400	.00000	.00000	.2400	.2400	.24	.24
Coconut	3	.9400	.00000	.00000	.9400	.9400	.94	.94
Total	12	.3500	.36913	.10656	.1155	.5845	.00	.94

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1.499	3	.500	.	.
Within Groups	.000	8	.000		
Total	1.499	11			

2CCxvii: Cobalt Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	.3400	.00000	.00000	.3400	.3400	.34	.34
Colanut	3	.1100	.00000	.00000	.1100	.1100	.11	.11
Bitter Cola	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Coconut	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Total	12	.1125	.14498	.04185	.0204	.2046	.00	.34

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.231	3	.077	.	.
Within Groups	.000	8	.000		
Total	.231	11			

2CCxviii: Nickel Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Colanut	3	.2000	.00000	.00000	.2000	.2000	.20	.20
Bitter Cola	3	.6000	.00000	.00000	.6000	.6000	.60	.60
Coconut	3	.2400	.00000	.00000	.2400	.2400	.24	.24
Total	12	.2600	.22595	.06523	.1164	.4036	.00	.60

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.562	3	.187	.	.
Within Groups	.000	8	.000		
Total	.562	11			

2CCxix: Mercury Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	.2400	.00000	.00000	.2400	.2400	.24	.24
Colanut	3	.3600	.00000	.00000	.3600	.3600	.36	.36
Bitter Cola	3	.8000	.03464	.02000	.7139	.8861	.78	.84
Coconut	3	.6400	.34641	.20000	-.2205	1.5005	.24	.84
Total	12	.5100	.27495	.07937	.3353	.6847	.24	.84

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.589	3	.196	6.482	.016
Within Groups	.242	8	.030		
Total	.832	11			

2CCxx: Asenic Content of some Nut Samples

Descriptives

Observations

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Groundnut	3	.0200	.00000	.00000	.0200	.0200	.02	.02
Colanut	3	.1600	.00000	.00000	.1600	.1600	.16	.16
Bitter Cola	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Coconut	3	.0000	.00000	.00000	.0000	.0000	.00	.00
Total	12	.0450	.06987	.02017	.0006	.0894	.00	.16

ANOVA

Observations

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.054	3	.018	.	.
Within Groups	.000	8	.000		
Total	.054	11			

2CCxxi: T-Test for Physicochemical properties (Free Fatty acid) of some Oil samples

Group Statistics

Groups	N	Mean	Std. Deviation	Std. Error Mean
Observations Red Oil	3	47.0000	5.87030	3.38922
Groundnut Oil	3	2.8200	.00000	.00000

Independent Samples Test

		Levene's Test for Equality of Variances					t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Observations	Equal variances assumed	10.316	.033	13.03	4	.000	44.18000	3.38922	34.77002	53.58998
	Equal variances not assumed			13.03	2.000	.006	44.18000	3.38922	29.59737	58.76263

2CCxxii: T-Test for Oleic Acid properties (Free Fatty acid) of some Oil samples

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
Observations	Red Oil	3	.470000	.0587030	.0338922
	Groundnut Oil	3	.028200	.0000000	.0000000

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Observations	Equal variances assumed	10.316	.033	13.035	4	.000	.4418000	.0338922	.3477002	.5358998
	Equal variances not assumed			13.035	2.000	.006	.4418000	.0338922	.2959737	.5876263

2CCxxiii: T-Test for Palmitic Acid properties (Free Fatty acid) of some Oil samples

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
Observations	Red Oil	3	.041667	.0052042	.0030046
	Groundnut Oil	3	.002500	.0000000	.0000000

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
				95% Confidence Interval of the Difference						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Observations	Equal variances assumed	10.316	.033	13.035	4	.000	.0391667	.0030046	.0308245	.0475088
	Equal variances not assumed			13.035	2.000	.006	.0391667	.0030046	.0262388	.0520945

2CCxxiv: T-Test for Lauric Acid properties (Free Fatty acid) of some Oil samples

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
Observations	Red Oil	3	.033333	.0041633	.0024037
	Groundnut Oil	3	.002000	.0000000	.0000000

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
				95% Confidence Interval of the Difference						
		F	Sig.	T	df	Sig. (2- tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Observations	Equal variance assumed	10.316	.033	13.035	4	.000	.0313333	.0024037	.0246596	.0380071
	Equal variance not assumed			13.035	2.000	.006	.0313333	.0024037	.0209910	.0416756

2CCxxv: T-Test for saponification value

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
				95% Confidence Interval of the Difference						
		F	Sig.	T	df	Sig. (2- tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Observations	Equal variances assumed	16.000	.016	-19.000	4	.000	17.7650000	.9350000	20.3609702	15.1690238
	Equal variances not assumed			-19.000	2.000	.003	17.7650000	.9350000	21.7879803	13.7420197

2CCxxvi: T-Test for Peroxide value

Group Statistics

	Groups	N	Mean	Std. Deviation	Std. Error Mean
Observations	Red Oil	3	18.660000	2.3557852	1.3601132
	Groundnut Oil	3	.186667	.0461880	.0266667

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
				95% Confidence Interval of the Difference						
		F	Sig.	t	Df	Sig. (2- tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Observations	Equal variances assumed	10.769	.030	13.580	4	.000	18.4733333	1.3603746	14.6963279	22.2503388
	Equal variances not assumed			13.580	2.002	.005	18.4733333	1.3603746	12.6244206	24.3222460

2CCxxvii: T-Test for Ester value

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference		
		F	Sig.	t	Df	Sig. (2- tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Observations	Equal variances assumed	10.357	.032	-14.000	4	.000	-94.4433333	6.7449290	-585.585	75.71640
	Equal variances not assumed			-2.000	2	.005	-94.4433333	6.7449290	123.4644	65.42224

2CCxxviii: T-Test for Iodine value

Group Statistics

Groups	N	Mean	Std. Deviation	Std. Error Mean
Red Oil	3	63.400000	.0000000	.0000000
Groundnut Oil	3	16.362500	1.6194675	.9350000

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference		
		F	Sig.	t	df	Sig. (2- tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Observations	Equal variances assumed	16.000	.016	50.307	4	.000	47.0375000	.9350000	44.44152	49.63347
	Equal variances not assumed								38	62

Independent Samples Test

		Levene's Test for Equality of Variances					t-test for Equality of Means				
							95% Confidence Interval of the Difference				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper	
Observations	Equal variances assumed	16.000	.016	50.307	4	.000	47.0375000	.9350000	44.44152	49.63347	
	Equal variances not assumed			50.307	2.000	.000	47.0375000	.9350000	43.01451	51.06048	

2CCxxix: Proximate Composition for Ash Content of some Fruit Samples

Multiple Comparisons

Observation
Tukey HSD

(I) Groups	(J) Groups	Mean Difference (I-J)		Sig.	95% Confidence Interval	
			Std. Error		Lower Bound	Upper Bound
Citrus cinensis (Orange)	Chrysophyllum albidim (Starapple)	-4.66667 [*]	.23570	.000	-5.4584	-3.8750
	Magnifera indica (Mango)	10.33333 [*]	.23570	.000	9.5416	11.1250
	Annona muricata (Soursop)	13.50000 [*]	.23570	.000	12.7083	14.2917
	Dialium indum (Tamarind)	16.83333 [*]	.23570	.000	16.0416	17.6250
	Klainedoxa gabonensis (Wildmango)	16.66667 [*]	.23570	.000	15.8750	17.4584
Chrysophyllum albidim (Starapple)	Citrus cinensis (Orange)	4.66667 [*]	.23570	.000	3.8750	5.4584
	Magnifera indica (Mango)	15.00000 [*]	.23570	.000	14.2083	15.7917

	Annona muricata (Soursop)	18.16667 ⁺	.23570	.000	17.3750	18.9584
	Dialium indum (Tamarind)	21.50000 ⁺	.23570	.000	20.7083	22.2917
	Klainedoxa gabonensis (Wildmango)	21.33333 ⁺	.23570	.000	20.5416	22.1250
Magnifera indica (Mango)	Citrus cinensis (Orange)	-10.33333 ⁺	.23570	.000	-11.1250	-9.5416
	Chrysophyllum albidim (Starapple)	-15.00000 ⁺	.23570	.000	-15.7917	-14.2083
	Annona muricata (Soursop)	3.16667 ⁺	.23570	.000	2.3750	3.9584
	Dialium indum (Tamarind)	6.50000 ⁺	.23570	.000	5.7083	7.2917
	Klainedoxa gabonensis (Wildmango)	6.33333 ⁺	.23570	.000	5.5416	7.1250
Annona muricata (Soursop)	Citrus cinensis (Orange)	-13.50000 ⁺	.23570	.000	-14.2917	-12.7083
	Chrysophyllum albidim (Starapple)	-18.16667 ⁺	.23570	.000	-18.9584	-17.3750
	Magnifera indica (Mango)	-3.16667 ⁺	.23570	.000	-3.9584	-2.3750
	Dialium indum (Tamarind)	3.33333 ⁺	.23570	.000	2.5416	4.1250
	Klainedoxa gabonensis (Wildmango)	3.16667 ⁺	.23570	.000	2.3750	3.9584
Dialium indum (Tamarind)	Citrus cinensis (Orange)	-16.83333 ⁺	.23570	.000	-17.6250	-16.0416
	Chrysophyllum albidim (Starapple)	-21.50000 ⁺	.23570	.000	-22.2917	-20.7083
	Magnifera indica (Mango)	-6.50000 ⁺	.23570	.000	-7.2917	-5.7083
	Annona muricata (Soursop)	-3.33333 ⁺	.23570	.000	-4.1250	-2.5416
	Klainedoxa gabonensis (Wildmango)	-.16667	.23570	.977	-.9584	.6250
Klainedoxa gabonensis (Wildmango)	Citrus cinensis (Orange)	-16.66667 ⁺	.23570	.000	-17.4584	-15.8750
	Chrysophyllum albidim (Starapple)	-21.33333 ⁺	.23570	.000	-22.1250	-20.5416
	Magnifera indica (Mango)	-6.33333 ⁺	.23570	.000	-7.1250	-5.5416

Annona muricata (Soursop)	-3.16667 [*]	.23570	.000	-3.9584	-2.3750
Dialium indum (Tamarind)	.16667	.23570	.977	-.6250	.9584

*. The mean difference is significant at the 0.05 level.

2CCxxx: Proximate Composition for Crude Fat Content of some Fruit Samples

Multiple Comparisons

Observation

Tukey HSD

(I) Groups	(J) Groups	Mean		Sig.	95% Confidence Interval	
		Difference (I-J)	Std. Error		Lower Bound	Upper Bound
Citrus cinensis (Orange)	Chrysophyllum albidim (Starapple)	-1.00000	.83887	.833	-3.8177	1.8177
	Magnifera indica (Mango)	7.00000 [*]	.83887	.000	4.1823	9.8177
	Annona muricata (Soursop)	8.00000 [*]	.83887	.000	5.1823	10.8177
	Dialium indum (Tamarind)	6.00000 [*]	.83887	.000	3.1823	8.8177
	Klainedoxa gabonensis (Wildmango)	-8.66667 [*]	.83887	.000	-11.4844	-5.8490
Chrysophyllum albidim (Starapple)	Citrus cinensis (Orange)	1.00000	.83887	.833	-1.8177	3.8177
	Magnifera indica (Mango)	8.00000 [*]	.83887	.000	5.1823	10.8177
	Annona muricata (Soursop)	9.00000 [*]	.83887	.000	6.1823	11.8177
	Dialium indum (Tamarind)	7.00000 [*]	.83887	.000	4.1823	9.8177
	Klainedoxa gabonensis (Wildmango)	-7.66667 [*]	.83887	.000	-10.4844	-4.8490
Magnifera indica (Mango)	Citrus cinensis (Orange)	-7.00000 [*]	.83887	.000	-9.8177	-4.1823
	Chrysophyllum albidim (Starapple)	-8.00000 [*]	.83887	.000	-10.8177	-5.1823

	Annona muricata (Soursop)	1.00000	.83887	.833	-1.8177	3.8177
	Dialium indum (Tamarind)	-1.00000	.83887	.833	-3.8177	1.8177
	Klainedoxa gabonensis (Wildmango)	-15.66667 [*]	.83887	.000	-18.4844	-12.8490
Annona muricata (Soursop)	Citrus cinensis (Orange)	-8.00000 [*]	.83887	.000	-10.8177	-5.1823
	Chrysophyllum albidim (Starapple)	-9.00000 [*]	.83887	.000	-11.8177	-6.1823
	Magnifera indica (Mango)	-1.00000	.83887	.833	-3.8177	1.8177
	Dialium indum (Tamarind)	-2.00000	.83887	.235	-4.8177	.8177
	Klainedoxa gabonensis (Wildmango)	-16.66667 [*]	.83887	.000	-19.4844	-13.8490
Dialium indum (Tamarind)	Citrus cinensis (Orange)	-6.00000 [*]	.83887	.000	-8.8177	-3.1823
	Chrysophyllum albidim (Starapple)	-7.00000 [*]	.83887	.000	-9.8177	-4.1823
	Magnifera indica (Mango)	1.00000	.83887	.833	-1.8177	3.8177
	Annona muricata (Soursop)	2.00000	.83887	.235	-.8177	4.8177
	Klainedoxa gabonensis (Wildmango)	-14.66667 [*]	.83887	.000	-17.4844	-11.8490
Klainedoxa gabonensis (Wildmango)	Citrus cinensis (Orange)	8.66667 [*]	.83887	.000	5.8490	11.4844
	Chrysophyllum albidim (Starapple)	7.66667 [*]	.83887	.000	4.8490	10.4844
	Magnifera indica (Mango)	15.66667 [*]	.83887	.000	12.8490	18.4844
	Annona muricata (Soursop)	16.66667 [*]	.83887	.000	13.8490	19.4844
	Dialium indum (Tamarind)	14.66667 [*]	.83887	.000	11.8490	17.4844

*. The mean difference is significant at the 0.05 level.

2CCxxxi: Proximate Composition for Carbohydrate Content of some Fruit Samples

Multiple Comparisons

Observation

Tukey HSD

(I) Groups	(J) Groups	Mean		Sig.	95% Confidence Interval	
		Difference (I-J)	Std. Error		Lower Bound	Upper Bound
Citrus sinensis (Orange)	Chrysophyllum albidim (Starapple)	27.81667 [*]	.01122	.000	27.7790	27.8544
	Magnifera indica (Mango)	9.15000 [*]	.01122	.000	9.1123	9.1877
	Annona muricata (Soursop)	4.65333 [*]	.01122	.000	4.6156	4.6910
	Dialium indum (Tamarind)	-11.54667 [*]	.01122	.000	-11.5844	-11.5090
	Klainedoxa gabonensis (Wildmango)	-20.70333 [*]	.01122	.000	-20.7410	-20.6656
Chrysophyllum albidim (Starapple)	Citrus sinensis (Orange)	-27.81667 [*]	.01122	.000	-27.8544	-27.7790
	Magnifera indica (Mango)	-18.66667 [*]	.01122	.000	-18.7044	-18.6290
	Annona muricata (Soursop)	-23.16333 [*]	.01122	.000	-23.2010	-23.1256
	Dialium indum (Tamarind)	-39.36333 [*]	.01122	.000	-39.4010	-39.3256
	Klainedoxa gabonensis (Wildmango)	-48.52000 [*]	.01122	.000	-48.5577	-48.4823
Magnifera indica (Mango)	Citrus sinensis (Orange)	-9.15000 [*]	.01122	.000	-9.1877	-9.1123
	Chrysophyllum albidim (Starapple)	18.66667 [*]	.01122	.000	18.6290	18.7044
	Annona muricata (Soursop)	-4.49667 [*]	.01122	.000	-4.5344	-4.4590
	Dialium indum (Tamarind)	-20.69667 [*]	.01122	.000	-20.7344	-20.6590
	Klainedoxa gabonensis (Wildmango)	-29.85333 [*]	.01122	.000	-29.8910	-29.8156
Annona muricata	Citrus sinensis (Orange)	-4.65333 [*]	.01122	.000	-4.6910	-4.6156

(Soursop)	Chrysophyllum albidim (Starapple)	23.16333 [*]	.01122	.000	23.1256	23.2010
	Magnifera indica (Mango)	4.49667 [*]	.01122	.000	4.4590	4.5344
	Dialium indum (Tamarind)	-16.20000 [*]	.01122	.000	-16.2377	-16.1623
	Klainedoxa gabonensis (Wildmango)	-25.35667 [*]	.01122	.000	-25.3944	-25.3190
Dialium indum (Tamarind)	Citrus sinensis (Orange)	11.54667 [*]	.01122	.000	11.5090	11.5844
	Chrysophyllum albidim (Starapple)	39.36333 [*]	.01122	.000	39.3256	39.4010
	Magnifera indica (Mango)	20.69667 [*]	.01122	.000	20.6590	20.7344
	Annona muricata (Soursop)	16.20000 [*]	.01122	.000	16.1623	16.2377
	Klainedoxa gabonensis (Wildmango)	-9.15667 [*]	.01122	.000	-9.1944	-9.1190
Klainedoxa gabonensis (Wildmango)	Citrus sinensis (Orange)	20.70333 [*]	.01122	.000	20.6656	20.7410
	Chrysophyllum albidim (Starapple)	48.52000 [*]	.01122	.000	48.4823	48.5577
	Magnifera indica (Mango)	29.85333 [*]	.01122	.000	29.8156	29.8910
	Annona muricata (Soursop)	25.35667 [*]	.01122	.000	25.3190	25.3944
	Dialium indum (Tamarind)	9.15667 [*]	.01122	.000	9.1190	9.1944

*. The mean difference is significant at the 0.05 level.

2CCxxxii: Antinutrient Composition for Oxalate Content of some Fruit Samples

Multiple Comparisons

Observation

Tukey HSD

(I) Groups	(J) Groups	Mean Difference		Sig.	95% Confidence Interval	
		(I-J)	Std. Error		Lower Bound	Upper Bound
Orange	Starapple	1.94333 [*]	.01277	.000	1.9005	1.9862
	mango	1.53000 [*]	.01277	.000	1.4871	1.5729
	Soursop	1.02000 [*]	.01277	.000	.9771	1.0629
	tamarind	1.44667 [*]	.01277	.000	1.4038	1.4895
	Wildmango	1.50000 [*]	.01277	.000	1.4571	1.5429
Starapple	Orange	-1.94333 [*]	.01277	.000	-1.9862	-1.9005
	mango	-.41333 [*]	.01277	.000	-.4562	-.3705
	Soursop	-.92333 [*]	.01277	.000	-.9662	-.8805
	tamarind	-.49667 [*]	.01277	.000	-.5395	-.4538
	Wildmango	-.44333 [*]	.01277	.000	-.4862	-.4005
Mango	Orange	-1.53000 [*]	.01277	.000	-1.5729	-1.4871
	Starapple	.41333 [*]	.01277	.000	.3705	.4562
	Soursop	-.51000 [*]	.01277	.000	-.5529	-.4671
	tamarind	-.08333 [*]	.01277	.000	-.1262	-.0405
	Wildmango	-.03000	.01277	.247	-.0729	.0129
Soursop	Orange	-1.02000 [*]	.01277	.000	-1.0629	-.9771
	Starapple	.92333 [*]	.01277	.000	.8805	.9662
	mango	.51000 [*]	.01277	.000	.4671	.5529
	tamarind	.42667 [*]	.01277	.000	.3838	.4695
	Wildmango	.48000 [*]	.01277	.000	.4371	.5229
Tamarind	Orange	-1.44667 [*]	.01277	.000	-1.4895	-1.4038
	Starapple	.49667 [*]	.01277	.000	.4538	.5395
	mango	.08333 [*]	.01277	.000	.0405	.1262
	Soursop	-.42667 [*]	.01277	.000	-.4695	-.3838
	Wildmango	.05333 [*]	.01277	.013	.0105	.0962
Wildmango	Orange	-1.50000 [*]	.01277	.000	-1.5429	-1.4571
	Starapple	.44333 [*]	.01277	.000	.4005	.4862

mango	.03000	.01277	.247	-.0129	.0729
Soursop	-.48000*	.01277	.000	-.5229	-.4371
tamarind	-.05333*	.01277	.013	-.0962	-.0105

*. The mean difference is significant at the 0.05 level.

2CCxxxiii: Antinutrient Composition for Saponin Content of some Fruit Samples

Multiple Comparisons

Observation

Tukey HSD

(I) Groups	(J) Groups	Mean Difference			95% Confidence Interval	
		(I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Orange	Starapple	-.13333	.11060	.826	-.5048	.2382
	Mango	.13333	.11060	.826	-.2382	.5048
	Soursop	-6.93333*	.11060	.000	-7.3048	-6.5618
	Tamarind	-.60000*	.11060	.002	-.9715	-.2285
	Wildmango	-1.79000*	.11060	.000	-2.1615	-1.4185
Starapple	Orange	.13333	.11060	.826	-.2382	.5048
	Mango	.26667	.11060	.226	-.1048	.6382
	Soursop	-6.80000*	.11060	.000	-7.1715	-6.4285
	Tamarind	-.46667*	.11060	.012	-.8382	-.0952
	Wildmango	-1.65667*	.11060	.000	-2.0282	-1.2852
Mango	Orange	-.13333	.11060	.826	-.5048	.2382
	Starapple	-.26667	.11060	.226	-.6382	.1048
	Soursop	-7.06667*	.11060	.000	-7.4382	-6.6952
	Tamarind	-.73333*	.11060	.000	-1.1048	-.3618
	Wildmango	-1.92333*	.11060	.000	-2.2948	-1.5518
Soursop	Orange	6.93333*	.11060	.000	6.5618	7.3048
	Starapple	6.80000*	.11060	.000	6.4285	7.1715
	Mango	7.06667*	.11060	.000	6.6952	7.4382
	Tamarind	6.33333*	.11060	.000	5.9618	6.7048
	Wildmango	5.14333*	.11060	.000	4.7718	5.5148

Tamarind	Orange	.60000*	.11060	.002	.2285	.9715
	Starapple	.46667*	.11060	.012	.0952	.8382
	Mango	.73333*	.11060	.000	.3618	1.1048
	Soursop	-6.33333*	.11060	.000	-6.7048	-5.9618
	Wildmango	-1.19000*	.11060	.000	-1.5615	-.8185
Wildmango	Orange	1.79000*	.11060	.000	1.4185	2.1615
	Starapple	1.65667*	.11060	.000	1.2852	2.0282
	Mango	1.92333*	.11060	.000	1.5518	2.2948
	Soursop	-5.14333*	.11060	.000	-5.5148	-4.7718
	Tamarind	1.19000*	.11060	.000	.8185	1.5615

*. The mean difference is significant at the 0.05 level.

2CCxxxiv: Antinutritional Composition for Tannin Content of some Fruit Samples

Multiple Comparisons

Observation

Tukey HSD

(I) Groups	(J) Groups	Mean Difference			95% Confidence Interval	
		(I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Orange	Starapple	-.29000*	.01000	.000	-.3236	-.2564
	Mango	.00667	.01000	.983	-.0269	.0403
	Soursop	-.39000*	.01000	.000	-.4236	-.3564
	Tamarind	-.09333*	.01000	.000	-.1269	-.0597
	Wildmango	-.62333*	.01000	.000	-.6569	-.5897
Starapple	Orange	.29000*	.01000	.000	.2564	.3236
	Mango	.29667*	.01000	.000	.2631	.3303
	Soursop	-.10000*	.01000	.000	-.1336	-.0664
	Tamarind	.19667*	.01000	.000	.1631	.2303
	Wildmango	-.33333*	.01000	.000	-.3669	-.2997
Mango	Orange	-.00667	.01000	.983	-.0403	.0269
	Starapple	-.29667*	.01000	.000	-.3303	-.2631
	Soursop	-.39667*	.01000	.000	-.4303	-.3631
	Tamarind	-.10000*	.01000	.000	-.1336	-.0664

	Wildmango	-.63000*	.01000	.000	-.6636	-.5964
Soursop	Orange	.39000*	.01000	.000	.3564	.4236
	Starapple	.10000*	.01000	.000	.0664	.1336
	Mango	.39667*	.01000	.000	.3631	.4303
	Tamarind	.29667*	.01000	.000	.2631	.3303
	Wildmango	-.23333*	.01000	.000	-.2669	-.1997
Tamarind	Orange	.09333*	.01000	.000	.0597	.1269
	Starapple	-.19667*	.01000	.000	-.2303	-.1631
	Mango	.10000*	.01000	.000	.0664	.1336
	Soursop	-.29667*	.01000	.000	-.3303	-.2631
	Wildmango	-.53000*	.01000	.000	-.5636	-.4964
Wildmango	Orange	.62333*	.01000	.000	.5897	.6569
	Starapple	.33333*	.01000	.000	.2997	.3669
	Mango	.63000*	.01000	.000	.5964	.6636
	Soursop	.23333*	.01000	.000	.1997	.2669
	Tamarind	.53000*	.01000	.000	.4964	.5636

*. The mean difference is significant at the 0.05 level.

2CCxxxv: Antinutritional Composition for Phytic acid Content of Fruit Samples

Multiple Comparisons

Observations

Tukey HSD

(I) Group	(J) Group	Mean Difference			95% Confidence Interval	
		(I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Orange	Starapple	-.28333*	.03459	.000	-.3995	-.1672
	Mango	1.05333*	.03459	.000	.9372	1.1695
	Soursop	.92333*	.03459	.000	.8072	1.0395
	Tamarind	.69333*	.03459	.000	.5772	.8095
	WildMango	-.40667*	.03459	.000	-.5228	-.2905
Starapple	Orange	.28333*	.03459	.000	.1672	.3995
	Mango	1.33667*	.03459	.000	1.2205	1.4528
	Soursop	1.20667*	.03459	.000	1.0905	1.3228
	Tamarind	.97667*	.03459	.000	.8605	1.0928
	WildMango	-.12333*	.03459	.035	-.2395	-.0072
Mango	Orange	-1.05333*	.03459	.000	-1.1695	-.9372
	Starapple	-1.33667*	.03459	.000	-1.4528	-1.2205
	Soursop	-.13000*	.03459	.025	-.2462	-.0138
	Tamarind	-.36000*	.03459	.000	-.4762	-.2438
	WildMango	-1.46000*	.03459	.000	-1.5762	-1.3438
Soursop	Orange	-.92333*	.03459	.000	-1.0395	-.8072
	Starapple	-1.20667*	.03459	.000	-1.3228	-1.0905
	Mango	.13000*	.03459	.025	.0138	.2462
	Tamarind	-.23000*	.03459	.000	-.3462	-.1138
	WildMango	-1.33000*	.03459	.000	-1.4462	-1.2138
Tamarind	Orange	-.69333*	.03459	.000	-.8095	-.5772
	Starapple	-.97667*	.03459	.000	-1.0928	-.8605
	Mango	.36000*	.03459	.000	.2438	.4762
	Soursop	.23000*	.03459	.000	.1138	.3462
	WildMango	-1.10000*	.03459	.000	-1.2162	-.9838
WildMango	Orange	.40667*	.03459	.000	.2905	.5228

Starapple	.12333*	.03459	.035	.0072	.2395
Mango	1.46000*	.03459	.000	1.3438	1.5762
Soursop	1.33000*	.03459	.000	1.2138	1.4462
Tamarind	1.10000*	.03459	.000	.9838	1.2162

*. The mean difference is significant at the 0.05 level.

2CCxxxvi: Mineral Composition for Phosphorous Content of some Fruit Samples

Multiple Comparisons

Observation

Tukey HSD

(I) Groups	(J) Groups	Mean Difference			95% Confidence Interval	
		(I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Orange	Starapple	-.03933*	.00054	.000	-.0412	-.0375
	Mango	.00200*	.00054	.029	.0002	.0038
	Soursop	-.00867*	.00054	.000	-.0105	-.0068
	Tamarind	.00200*	.00054	.029	.0002	.0038
	Wildmango	.00200*	.00054	.029	.0002	.0038
Starapple	Orange	.03933*	.00054	.000	.0375	.0412
	Mango	.04133*	.00054	.000	.0395	.0432
	Soursop	.03067*	.00054	.000	.0288	.0325
	Tamarind	.04133*	.00054	.000	.0395	.0432
	Wildmango	.04133*	.00054	.000	.0395	.0432
Mango	Orange	-.00200*	.00054	.029	-.0038	-.0002
	Starapple	-.04133*	.00054	.000	-.0432	-.0395
	Soursop	-.01067*	.00054	.000	-.0125	-.0088
	Tamarind	.00000	.00054	1.000	-.0018	.0018
	Wildmango	.00000	.00054	1.000	-.0018	.0018
Soursop	Orange	.00867*	.00054	.000	.0068	.0105
	Starapple	-.03067*	.00054	.000	-.0325	-.0288
	Mango	.01067*	.00054	.000	.0088	.0125
	Tamarind	.01067*	.00054	.000	.0088	.0125
	Wildmango	.01067*	.00054	.000	.0088	.0125

Tamarind	Orange	-0.0200*	.00054	.029	-0.0038	-0.0002
	Starapple	-.04133*	.00054	.000	-.0432	-.0395
	Mango	.00000	.00054	1.000	-.0018	.0018
	Soursop	-.01067*	.00054	.000	-.0125	-.0088
	Wildmango	.00000	.00054	1.000	-.0018	.0018
Wildmango	Orange	-0.0200*	.00054	.029	-0.0038	-0.0002
	Starapple	-.04133*	.00054	.000	-.0432	-.0395
	Mango	.00000	.00054	1.000	-.0018	.0018
	Soursop	-.01067*	.00054	.000	-.0125	-.0088
	Tamarind	.00000	.00054	1.000	-.0018	.0018

*. The mean difference is significant at the 0.05 level.

2CCxxxvii: Proximate Composition for Moisture Content of some Vegetable Samples

Multiple Comparisons

Observation

Tukey HSD

(I) Groups	(J) Groups	Mean Difference			95% Confidence Interval	
		(I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Pumpkin	African rose wood	3.20000*	.34748	.000	2.0328	4.3672
	Bitter leaf	-5.50000*	.34748	.000	-6.6672	-4.3328
	Green Amaranth	-5.50000*	.34748	.000	-6.6672	-4.3328
	Bushmallaw	-15.50000*	.34748	.000	-16.6672	-14.3328
	Garden Egg Leaf	-5.83333*	.34748	.000	-7.0005	-4.6662
African rose wood	Pumpkin	-3.20000*	.34748	.000	-4.3672	-2.0328
	Bitter leaf	-8.70000*	.34748	.000	-9.8672	-7.5328
	Green Amaranth	-8.70000*	.34748	.000	-9.8672	-7.5328
	Bushmallaw	-18.70000*	.34748	.000	-19.8672	-17.5328
	Garden Egg Leaf	-9.03333*	.34748	.000	-10.2005	-7.8662
Bitter leaf	Pumpkin	5.50000*	.34748	.000	4.3328	6.6672
	African rose wood	8.70000*	.34748	.000	7.5328	9.8672
	Green Amaranth	.00000	.34748	1.000	-1.1672	1.1672
	Bushmallaw	-10.00000*	.34748	.000	-11.1672	-8.8328
	Garden Egg Leaf	-.33333	.34748	.922	-1.5005	.8338

Green Amaranth	Pumpkin	5.50000*	.34748	.000	4.3328	6.6672
	African rose wood	8.70000*	.34748	.000	7.5328	9.8672
	Bitter leaf	.00000	.34748	1.000	-1.1672	1.1672
	Bushmallaw	-10.00000*	.34748	.000	-11.1672	-8.8328
	Garden Egg Leaf	-.33333	.34748	.922	-1.5005	.8338
Bushmallaw	Pumpkin	15.50000*	.34748	.000	14.3328	16.6672
	African rose wood	18.70000*	.34748	.000	17.5328	19.8672
	Bitter leaf	10.00000*	.34748	.000	8.8328	11.1672
	Green Amaranth	10.00000*	.34748	.000	8.8328	11.1672
	Garden Egg Leaf	9.66667*	.34748	.000	8.4995	10.8338
Garden Egg Leaf	Pumpkin	5.83333*	.34748	.000	4.6662	7.0005
	African rose wood	9.03333*	.34748	.000	7.8662	10.2005
	Bitter leaf	.33333	.34748	.922	-.8338	1.5005
	Green Amaranth	.33333	.34748	.922	-.8338	1.5005
	Bushmallaw	-9.66667*	.34748	.000	-10.8338	-8.4995

*. The mean difference is significant at the 0.05 level.

2CCxxxviii: Ash Content of some Vegetable Samples

Multiple Comparisons

Observation

Tukey HSD

(I) Groups	(J) Groups	Mean		Sig.	95% Confidence Interval	
		Difference (I-J)	Std. Error		Lower Bound	Upper Bound
Pumpkin	African Rose wood	8.50000*	.16667	.000	7.9402	9.0598
	Bitter Leaf	8.16667*	.16667	.000	7.6068	8.7265
	Green Amaranth	6.16667*	.16667	.000	5.6068	6.7265
	Bushmallow	6.16667*	.16667	.000	5.6068	6.7265
	Garden Egg Leaf	5.00000*	.16667	.000	4.4402	5.5598
African Rose wood	Pumpkin	-8.50000*	.16667	.000	-9.0598	-7.9402
	Bitter Leaf	-.33333	.16667	.395	-.8932	.2265
	Green Amaranth	-2.33333*	.16667	.000	-2.8932	-1.7735
	Bushmallow	-2.33333*	.16667	.000	-2.8932	-1.7735
	Garden Egg Leaf	-3.50000*	.16667	.000	-4.0598	-2.9402
Bitter Leaf	Pumpkin	-8.16667*	.16667	.000	-8.7265	-7.6068

	African Rose wood	.33333	.16667	.395	-.2265	.8932
	Greem Amaranth	-2.00000*	.16667	.000	-2.5598	-1.4402
	Bushmallow	-2.00000*	.16667	.000	-2.5598	-1.4402
	Garden Egg Leaf	-3.16667*	.16667	.000	-3.7265	-2.6068
Greem Amaranth	Pumpkin	-6.16667*	.16667	.000	-6.7265	-5.6068
	African Rose wood	2.33333*	.16667	.000	1.7735	2.8932
	Bitter Leaf	2.00000*	.16667	.000	1.4402	2.5598
	Bushmallow	.00000	.16667	1.000	-.5598	.5598
	Garden Egg Leaf	-1.16667*	.16667	.000	-1.7265	-.6068
Bushmallow	Pumpkin	-6.16667*	.16667	.000	-6.7265	-5.6068
	African Rose wood	2.33333*	.16667	.000	1.7735	2.8932
	Bitter Leaf	2.00000*	.16667	.000	1.4402	2.5598
	Greem Amaranth	.00000	.16667	1.000	-.5598	.5598
	Garden Egg Leaf	-1.16667*	.16667	.000	-1.7265	-.6068
Garden Egg Leaf	Pumpkin	-5.00000*	.16667	.000	-5.5598	-4.4402
	African Rose wood	3.50000*	.16667	.000	2.9402	4.0598
	Bitter Leaf	3.16667*	.16667	.000	2.6068	3.7265
	Greem Amaranth	1.16667*	.16667	.000	.6068	1.7265
	Bushmallow	1.16667*	.16667	.000	.6068	1.7265

*. The mean difference is significant at the 0.05 level.

2CCxxxix: Fat Content of Some Vegetable Samples

Multiple Comparisons

Observation

Tukey HSD

(I) Groups	(J) Groups	Mean Difference		Sig.	95% Confidence Interval	
		(I-J)	Std. Error		Lower Bound	Upper Bound
Pumpkin	African rose wood	1.66667	1.12629	.682	-2.1164	5.4498
	Bitter Leaf	2.66667	1.12629	.241	-1.1164	6.4498
	Green Amaranth	4.16667*	1.12629	.028	.3836	7.9498
	Bushmallow	-2.33333	1.12629	.361	-6.1164	1.4498
	Garden Egg Leaf	-7.33333*	1.12629	.000	-11.1164	-3.5502
African rose wood	Pumpkin	-1.66667	1.12629	.682	-5.4498	2.1164
	Bitter Leaf	1.00000	1.12629	.942	-2.7831	4.7831
	Green Amaranth	2.50000	1.12629	.297	-1.2831	6.2831
	Bushmallow	-4.00000*	1.12629	.036	-7.7831	-.2169
	Garden Egg Leaf	-9.00000*	1.12629	.000	-12.7831	-5.2169
Bitter Leaf	Pumpkin	-2.66667	1.12629	.241	-6.4498	1.1164
	African rose wood	-1.00000	1.12629	.942	-4.7831	2.7831
	Green Amaranth	1.50000	1.12629	.763	-2.2831	5.2831
	Bushmallow	-5.00000*	1.12629	.008	-8.7831	-1.2169
	Garden Egg Leaf	-10.00000*	1.12629	.000	-13.7831	-6.2169
Green Amaranth	Pumpkin	-4.16667*	1.12629	.028	-7.9498	-.3836
	African rose wood	-2.50000	1.12629	.297	-6.2831	1.2831
	Bitter Leaf	-1.50000	1.12629	.763	-5.2831	2.2831
	Bushmallow	-6.50000*	1.12629	.001	-10.2831	-2.7169
	Garden Egg Leaf	-11.50000*	1.12629	.000	-15.2831	-7.7169
Bushmallow	Pumpkin	2.33333	1.12629	.361	-1.4498	6.1164
	African rose wood	4.00000*	1.12629	.036	.2169	7.7831
	Bitter Leaf	5.00000*	1.12629	.008	1.2169	8.7831
	Green Amaranth	6.50000*	1.12629	.001	2.7169	10.2831
	Garden Egg Leaf	-5.00000*	1.12629	.008	-8.7831	-1.2169
Garden Egg Leaf	Pumpkin	7.33333*	1.12629	.000	3.5502	11.1164
	African rose wood	9.00000*	1.12629	.000	5.2169	12.7831

Bitter Leaf	10.00000*	1.12629	.000	6.2169	13.7831
Green Amaranth	11.50000*	1.12629	.000	7.7169	15.2831
Bushmallow	5.00000*	1.12629	.008	1.2169	8.7831

*. The mean difference is significant at the 0.05 level.

2CCxL: Protein Content of some Vegetable Samples

Multiple Comparisons

Observation

Tukey HSD

(I) Groups	(J) Groups	Mean		Sig.	95% Confidence Interval	
		Difference (I-J)	Std. Error		Lower Bound	Upper Bound
Pumpkin	African Rose wood	-.98000 [*]	.14795	.000	-1.4769	-.4831
	Bitterleaf	.26333	.14795	.511	-.2336	.7603
	Green Amaranth	4.59667 [*]	.14795	.000	4.0997	5.0936
	Bushmallow	3.38667 [*]	.14795	.000	2.8897	3.8836
	Garden Egg leaf	-2.23333 [*]	.14795	.000	-2.7303	-1.7364
African Rose wood	Pumpkin	.98000 [*]	.14795	.000	.4831	1.4769
	Bitterleaf	1.24333 [*]	.14795	.000	.7464	1.7403
	Green Amaranth	5.57667 [*]	.14795	.000	5.0797	6.0736
	Bushmallow	4.36667 [*]	.14795	.000	3.8697	4.8636
	Garden Egg leaf	-1.25333 [*]	.14795	.000	-1.7503	-.7564
Bitterleaf	Pumpkin	-.26333	.14795	.511	-.7603	.2336
	African Rose wood	-1.24333 [*]	.14795	.000	-1.7403	-.7464
	Green Amaranth	4.33333 [*]	.14795	.000	3.8364	4.8303
	Bushmallow	3.12333 [*]	.14795	.000	2.6264	3.6203
	Garden Egg leaf	-2.49667 [*]	.14795	.000	-2.9936	-1.9997
Green Amaranth	Pumpkin	-4.59667 [*]	.14795	.000	-5.0936	-4.0997
	African Rose wood	-5.57667 [*]	.14795	.000	-6.0736	-5.0797
	Bitterleaf	-4.33333 [*]	.14795	.000	-4.8303	-3.8364
	Bushmallow	-1.21000 [*]	.14795	.000	-1.7069	-.7131
	Garden Egg leaf	-6.83000 [*]	.14795	.000	-7.3269	-6.3331
Bushmallow	Pumpkin	-3.38667 [*]	.14795	.000	-3.8836	-2.8897
	African Rose wood	-4.36667 [*]	.14795	.000	-4.8636	-3.8697
	Bitterleaf	-3.12333 [*]	.14795	.000	-3.6203	-2.6264
	Green Amaranth	1.21000 [*]	.14795	.000	.7131	1.7069
	Garden Egg leaf	-5.62000 [*]	.14795	.000	-6.1169	-5.1231
Garden Egg leaf	Pumpkin	2.23333 [*]	.14795	.000	1.7364	2.7303
	African Rose wood	1.25333 [*]	.14795	.000	.7564	1.7503

Bitterleaf	2.49667*	.14795	.000	1.9997	2.9936
Green Amaranth	6.83000*	.14795	.000	6.3331	7.3269
Bushmallow	5.62000*	.14795	.000	5.1231	6.1169

*. The mean difference is significant at the 0.05 level.

2CCxLi: Crude Fibre Content of some Vegetable samples

Multiple Comparisons

Observations

Tukey HSD

(I) Groups	(J) Groups	Mean			95% Confidence Interval	
		Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Pumpkin	African Rose Wood	-.30000	.53522	.992	-2.0978	1.4978
	Bitter Leaf	-2.53333*	.53522	.005	-4.3311	-.7356
	Green Amaranth	-6.96667*	.53522	.000	-8.7644	-5.1689
	Bushmallow	-3.66667*	.53522	.000	-5.4644	-1.8689
	Garden Egg Leaf	2.10667*	.53522	.019	.3089	3.9044
African Rose Wood	Pumpkin	.30000	.53522	.992	-1.4978	2.0978
	Bitter Leaf	-2.23333*	.53522	.013	-4.0311	-.4356
	Green Amaranth	-6.66667*	.53522	.000	-8.4644	-4.8689
	Bushmallow	-3.36667*	.53522	.000	-5.1644	-1.5689
	Garden Egg Leaf	2.40667*	.53522	.007	.6089	4.2044
Bitter Leaf	Pumpkin	2.53333*	.53522	.005	.7356	4.3311
	African Rose Wood	2.23333*	.53522	.013	.4356	4.0311
	Green Amaranth	-4.43333*	.53522	.000	-6.2311	-2.6356
	Bushmallow	-1.13333	.53522	.340	-2.9311	.6644
	Garden Egg Leaf	4.64000*	.53522	.000	2.8422	6.4378
Green Amaranth	Pumpkin	6.96667*	.53522	.000	5.1689	8.7644
	African Rose Wood	6.66667*	.53522	.000	4.8689	8.4644
	Bitter Leaf	4.43333*	.53522	.000	2.6356	6.2311
	Bushmallow	3.30000*	.53522	.001	1.5022	5.0978
	Garden Egg Leaf	9.07333*	.53522	.000	7.2756	10.8711

Bushmallow	Pumpkin	3.66667*	.53522	.000	1.8689	5.4644
	African Rose Wood	3.36667*	.53522	.000	1.5689	5.1644
	Bitter Leaf	1.13333	.53522	.340	-.6644	2.9311
	Green Amaranth	-3.30000*	.53522	.001	-5.0978	-1.5022
	Garden Egg Leaf	5.77333*	.53522	.000	3.9756	7.5711
Garden Egg Leaf	Pumpkin	-2.10667*	.53522	.019	-3.9044	-.3089
	African Rose Wood	-2.40667*	.53522	.007	-4.2044	-.6089
	Bitter Leaf	-4.64000*	.53522	.000	-6.4378	-2.8422
	Green Amaranth	-9.07333*	.53522	.000	-10.8711	-7.2756
	Bushmallow	-5.77333*	.53522	.000	-7.5711	-3.9756

*. The mean difference is significant at the 0.05 level.

2CCxLii: Proximate composition for Crude Fat of some Cereal Samples

Multiple Comparisons

Observations

Tukey HSD

(I) Groups	(J) Groups	Mean Difference		Sig.	95% Confidence Interval	
		(I-J)	Std. Error		Lower Bound	Upper Bound
Rice	White corn	-6.33333*	1.12217	.003	-9.7765	-2.8902
	Yellow corn	-5.33333*	1.12217	.008	-8.7765	-1.8902
White corn	Rice	6.33333*	1.12217	.003	2.8902	9.7765
	Yellow corn	1.00000	1.12217	.665	-2.4431	4.4431
Yellow corn	Rice	5.33333*	1.12217	.008	1.8902	8.7765
	White corn	-1.00000	1.12217	.665	-4.4431	2.4431

*. The mean difference is significant at the 0.05 level.

2CCxLiii: Crude Fat Content of some Meat Samples

Multiple Comparisons

Observations

Tukey HSD

(I) Groups	(J) Groups	Mean Difference			95% Confidence Interval	
		(I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Beef	Turkey	1.06667	.43333	.142	-.3210	2.4544
	Goat Meat	-.43333	.43333	.754	-1.8210	.9544
	Chicken	-4.20000 [*]	.43333	.000	-5.5877	-2.8123
Turkey	Beef	-1.06667	.43333	.142	-2.4544	.3210
	Goat Meat	-1.50000 [*]	.43333	.035	-2.8877	-.1123
	Chicken	-5.26667 [*]	.43333	.000	-6.6544	-3.8790
Goat Meat	Beef	.43333	.43333	.754	-.9544	1.8210
	Turkey	1.50000 [*]	.43333	.035	.1123	2.8877
	Chicken	-3.76667 [*]	.43333	.000	-5.1544	-2.3790
Chicken	Beef	4.20000 [*]	.43333	.000	2.8123	5.5877
	Turkey	5.26667 [*]	.43333	.000	3.8790	6.6544
	Goat Meat	3.76667 [*]	.43333	.000	2.3790	5.1544

*. The mean difference is significant at the 0.05 level.

2CCxLiv: Oxalate Content of some Meat Samples

Multiple Comparisons

Observations

Tukey HSD

(I) Groups	(J) Groups	Mean Difference			95% Confidence Interval	
		(I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Beef	Turkey	-.20000 [*]	.01414	.000	-.2453	-.1547
	Goat Meat	-.01333	.01414	.784	-.0586	.0320
	Chicken	-.10667 [*]	.01414	.000	-.1520	-.0614
Turkey	Beef	.20000 [*]	.01414	.000	.1547	.2453
	Goat Meat	.18667 [*]	.01414	.000	.1414	.2320
	Chicken	.09333 [*]	.01414	.001	.0480	.1386

Goat Meat	Beef	.01333	.01414	.784	-.0320	.0586
	Turkey	-.18667*	.01414	.000	-.2320	-.1414
	Chicken	-.09333*	.01414	.001	-.1386	-.0480
Chicken	Beef	.10667*	.01414	.000	.0614	.1520
	Turkey	-.09333*	.01414	.001	-.1386	-.0480
	Goat Meat	.09333*	.01414	.001	.0480	.1386

*. The mean difference is significant at the 0.05 level.

2CCxLv: Tannin Content of some Meat Samples

Multiple Comparisons

Observations

Tukey HSD

(I) Groups	(J) Groups	Mean Difference			95% Confidence Interval	
		(I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Beef	Turkey	.00333	.01354	.994	-.0400	.0467
	Goat Meat	-.07667*	.01354	.002	-.1200	-.0333
	Chicken	-.00333	.01354	.994	-.0467	.0400
Turkey	Beef	-.00333	.01354	.994	-.0467	.0400
	Goat Meat	-.08000*	.01354	.002	-.1234	-.0366
	Chicken	-.00667	.01354	.959	-.0500	.0367
Goat Meat	Beef	.07667*	.01354	.002	.0333	.1200
	Turkey	.08000*	.01354	.002	.0366	.1234
	Chicken	.07333*	.01354	.003	.0300	.1167
Chicken	Beef	.00333	.01354	.994	-.0400	.0467
	Turkey	.00667	.01354	.959	-.0367	.0500
	Goat Meat	-.07333*	.01354	.003	-.1167	-.0300

*. The mean difference is significant at the 0.05 level.

2CCxLvi: Phytic Acid Content of some Meat Samples

Multiple Comparisons

Observations

Tukey HSD

(I) Groups	(J) Groups	Mean Difference			95% Confidence Interval	
		(I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Beef	Turkey	.02667	.01269	.231	-.0140	.0673
	Goat Meat	.07667*	.01269	.001	.0360	.1173
	Chicken	.08000*	.01269	.001	.0394	.1206
Turkey	Beef	-.02667	.01269	.231	-.0673	.0140
	Goat Meat	.05000*	.01269	.018	.0094	.0906
	Chicken	.05333*	.01269	.013	.0127	.0940
Goat Meat	Beef	-.07667*	.01269	.001	-.1173	-.0360
	Turkey	-.05000*	.01269	.018	-.0906	-.0094
	Chicken	.00333	.01269	.993	-.0373	.0440
Chicken	Beef	-.08000*	.01269	.001	-.1206	-.0394
	Turkey	-.05333*	.01269	.013	-.0940	-.0127
	Goat Meat	-.00333	.01269	.993	-.0440	.0373

*. The mean difference is significant at the 0.05 level.

2CCxLvii: Oxalate Content of some Legumes/pulse Samples

Multiple Comparisons

Observations

Tukey HSD

(I) Groups	(J) Groups	Mean Difference			95% Confidence Interval	
		(I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
White Beans	Brown Beans	.10000 [*]	.01726	.001	.0432	.1568
	Chick pea	.22000 [*]	.01726	.000	.1632	.2768
	Soyabeans	.26000 [*]	.01726	.000	.2032	.3168
	Breadfruit	.18667 [*]	.01726	.000	.1299	.2435
Brown Beans	White Beans	-.10000 [*]	.01726	.001	-.1568	-.0432
	Chick pea	.12000 [*]	.01726	.000	.0632	.1768
	Soyabeans	.16000 [*]	.01726	.000	.1032	.2168
	Breadfruit	.08667 [*]	.01726	.004	.0299	.1435
Chick pea	White Beans	-.22000 [*]	.01726	.000	-.2768	-.1632
	Brown Beans	-.12000 [*]	.01726	.000	-.1768	-.0632
	Soyabeans	.04000	.01726	.216	-.0168	.0968
	Breadfruit	-.03333	.01726	.362	-.0901	.0235
Soyabeans	White Beans	-.26000 [*]	.01726	.000	-.3168	-.2032
	Brown Beans	-.16000 [*]	.01726	.000	-.2168	-.1032
	Chick pea	-.04000	.01726	.216	-.0968	.0168
	Breadfruit	-.07333 [*]	.01726	.011	-.1301	-.0165
Breadfruit	White Beans	-.18667 [*]	.01726	.000	-.2435	-.1299
	Brown Beans	-.08667 [*]	.01726	.004	-.1435	-.0299
	Chick pea	.03333	.01726	.362	-.0235	.0901
	Soyabeans	.07333 [*]	.01726	.011	.0165	.1301

*. The mean difference is significant at the 0.05 level.