International Journal of Advances in Engineering and Management (IJAEM)
Volume 7, Issue 02 Feb. 2025, pp: 632-646 www.ijaem.net ISSN: 2395-5252

Comparative Study of Proximate and Mineral Composition of Cocoyam (Cococasia Esculenta) Grown From Bauchi, Plateau, Gombe and Kaduna States of Northern Nigeria

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Date of Submission: 15-02-2025 Date of Acceptance: 25-02-2025

ABSTRACT: The proximate and mineral composition of cocoyam (colocasiaescienta) grown in Bauchi, Plateau, Gombe and Kaduna States were analyzed using association of official analytical chemistry. The analysis included, ash; 3%, 2.6% and 3.2% crude protein; 2.7%, 3.4%, 2.8% and 2.9% crude fibre; 1.5%, 1.9%, 1.8% and 1.0% crude fat; 0.3%, 0.3%, 0.2% and 0.4%. Moisture; 19%, 21%, 15.3% and 16.5%. Carbohydrate; 73.5%, 70.5%, 77.3% and 75.6% for the results obtained from Bauchi, Plateau, Gombe and Kaduna States. The mineral contents were determined using Atomic Absorption spectrophotometer (ADS), were as follows; P. 51423 PPM, 803.11PPM, 550.71PPM and 445.45PPM. Zn: 7.53PPm, 14.01PPM, 10.25PPM, 7.4PPM. Ca: 896.1PPM, 1110.39PPM, 864.98PPM and 884.87PPM. Fe: 48.91PPM, 3.21PPM, 50.88PPM and 31.67PPM. Cu: 6.58PPM, 11.09PPM, 4.86PPM and 5.9PPM. K: 3478.71PPM, 4630.20PPM, 3617.91PPM and 3236.63PPM. Mg: 334.11PPM, 506.73PPM, 367.73PPM and 324.71PPM. Mn: 5.11PPM, 8.43PPM, 6.30PPM and 4.80PPM. Na: 204.89PPM, 203.59PPM, 159.34PPM and 191.12PPM for the results of samples obtained from Bauchi, Plateau, Gombe and Kaduna States, the high level of carbohydrate observed from all the samples also agrees with the finding reported by FOA (1990), that the main nutrients supplied is dietary energy provided by the carbohydrates. The results from the current study reveal that cocoyam is nutritionally rich in carbohydrate and minerals such as potassium and sodium.

I. INTRODUCTION

The cocoyam (Colocasia esculenta L.) are herbaceous plants belonging to the Aracea family and constitute one of the important roots and tuber crops worldwide (Otekunrin, 2021). About 1.4 million hectares worldwide have been recorded to be cultivated with aroids yielding 8.3 million tonnes per year (FAOSTAT, 2021). China, Ghana, Nigeria, Burundi, Coted'voire, Japan, Madagascar, Papua New Guinea, Philippines and Thailand are cocoyam producers in the world (FAO, 2018).

In most African countries, cocoyam is mainly cultivated by small-scale farmers Offei (2016). Like many plants of the Araceae family, cocoyam grows from the fleshy corm (tubers) that can be boiled, baked or mashed into a meal and used as a staple food or snack (Offei, 2016).

The corms supply easily digestible starch and are known to contain substantial amount of protein, vitamin C, thiamine, riboflavin, niacin and significant amount of dietary fiber (Mortensen, 2016). Leaves of taro (colocasia) are cooked and eaten as vegetable. They contain β-carotene, iron and folic acid which protect against anemia and are important source of protein and vitamins (Opoku, 2015).

The main nutrient supplied by cocoyam as with other roots and tubers is dietary energy provided by the carbohydrate. Cocoyam flour can be used for the preparation of soups, biscuits, bread, beverage and pudding (Jirarat, 2019). However, in spite of its importance as a staple food in many countries, cocoyam has received very little research attention to enhance its production and utilization potentials (Geonagaet al., 2016).

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Research and development of root and tuber crops in general and cocoyam in particular have been neglected because only 10% of the world population mainly leaving in developing tropical countries use root and tuber crops as staple foods. Despite their nutritional composition, the potential for the development of value-added cocoyam products have not been investigated (Palapala et al, 2015).

Opportunities to promote and support the use of cocoyam can make a major contribution to the food security of countries in the cocoyam grown regions (EBSCO, 2016).

Recent studies also shows that cocoyam starch can be incorporated in the development of weaning food which is easily digestible and accessible to low-income earners in developing countries (Ojinnakaet al., 2018).

According to Abdel-Aal, (2015), suggested that starch finds numerous uses in the baking industry. Ashogbon, (2016) gave insight into the physical properties of native starch which limit its usefulness in many commercial applications and defined a modified starch as a production which the chemical and or the physical properties of the native starch may have been altered.

1.1 Justification

Despite the economic importance of cocoyam as a source of nutrient, but it is also found very limited in production in some parts of northern Nigeria. Hence this study shows that cocoyam flour can be incorporated in the development of weaning food which is easily digestible and accessible to supplement the infant especially for low-income earners in developing countries.

1.2 Aim of the Study

This project is aimed at comparing the proximate and mineral compositions of cocoyam (Colocasia esculenta L.) grown in Bauchi, Plateau, Gombe and Kaduna States

1.3 Objectives of the Study

The objectives of this study are:

i. To determine the proximate content of cocoyam (Colocasia esculenta) grown in Bauchi, Plateau, Gombe and Kaduna States
ii. To determine the mineral composition of cocoyam (Colocasia esculenta) grown in Bauchi, Plateau, Gombe and Kaduna States

1.4 Scope of the Study

The study is limited to the proximate determination and some mineral viz calcium, magnesium, copper, iron, sodium, zinc and potassium in cocoyam samples, collected from Bauchi, Plateau, Gombe and Kaduna States.

II. LITERATURE REVIEW

Cocoyams(Colocasia esculenta L.) and Xanthosa Sagittifolium contribute a significant portion of carbohydrate content of the diet in many regions in developing countries and provide edible starchy storage corms or cormels. Although they are less important than other tropical root crops such as yam, cassava and sweet potato. They are still a major staple food in some parts of tropics and sub-tropics (Sarma, 2016).

Cocoyam has nutritional advantage over roots crops and other tubers. It has more crude protein than root and other tubers and its starch is highly digestible because of the small size of the starch granules, its content of calcium, phosphorus, vitamin A and B are reasonable. All these are losing to nutrition because of the low production and utilization (Acheampong et al., 2015).

Despite the economic importance of cocoyam as a food in some parts of tropics and sub-tropics, there is a limited information on their post-harvest characteristics which perhaps to the very limited application of improved post-harvest technologies to maintain quality and improve marketing potential (FAOSTAT, 2021).

Flour milled from other crops such as maize, millet, sorghum, cassava, potatoes and rice had been added to wheat flour to extend the use of the local crops and reduce the cost of wheat importation. This practice mostly in tropical countries where the soil and climate are not favorable for commercial large production of wheat. Satisfactory bread has been made from such composite flour through the blend of wheat flour with other cereals and root crops (Karikari, 2017).

Composite flour incorporating cocoyam has been used in extracted products such as needless and macaroni. FAOSTAT, (2021) reported that lack of knowledge of the functional, chemical and nutritional properties of grain-legumes grown in developing countries is responsible for the extensive use of these traditional crops in different food formulations.

Cocoyam consumption has been affected by the presence of acridity factors which cause sharp irritation and burning sensation in the throat mouth on ingestion. (Ashogboret al., 2017). The acridity factor can also be reduced by peeling, grating, soaking and fermentation operation during processing (FAOSTAT, 2021).

Removal of skin and long period of cooking required to remove acridity Xiao et al.,(2017). Other methods of removal of acridity include fermentation, baking or extraction with ethanol. Traditional cooking methods also can neutralize the acridity in cocoyam. There is also the selection and breeding of none or low acrid cultivars of aroids (Falade et al., 2019).

Cocoyam is good base for food preparation for infant because of the high digestibility of its starch, reasonable content of calcium and phosphorus for borne building, B complex vitamins and Pro vitamin A (Acheampong, et al., 2015). Infant in some developing countries are traditionally weaned solely on starch prepared from pre-cooked, wet-milled and wet-sieved corn (Akobundu et al., 2017).

Recent studies also show that cocoyam starch can be incorporated in the developing of wearing food which is easily digestible and accessible to low income earners in developing countries (Ojinnakaet al., 2018).

According to Adane, (2016), starch finds numerous uses in the baking industry. Quaye, (2016) gave an insight into the physical properties of native starch which limit its usefulness in many commercial applications and defined a modified starch as a production which the chemical and or the physical properties of the native starch may have been altered.

Root and tubers belong to the class of foods that basically provide energy in the human diet in the form of carbohydrates and also essential vitamin (Hahn, 1984). The terms rood and tubers refers to any growing plant that stores edible materials in subterranean root, corms or tubers (Ugwu, 2009).

Historically, very little attention has been paid to root crops by policy makers and researchers as most of their effort have been concentrated on cash crops or the more familiar grains. Root crops were regarded as food mainly for poor and have played a very minor role in international trade. This misconception has lingered for so long because of the lack of appreciation of the number of people who depend on these root crops and the number of lives that have been saved during famine or disasters by root crops (FAOSTAT, 2021).

Root and tuber were critical components in the diet during the early evolution of mankind and the most important food crops of very ancient origin in the tropics and sub-tropics, associate with human existence, survival and socio-economic history (Amandikwa, 2015).

Roots and tubers as food include yam, cassava, potatoes and cocoyam. They have high moisture content resulting in short storage life under ambient condition of the solid nutrient content in these crops, carbohydrates predominates (FAOSTAT, 2021).

Cocoyam also known as taro is a tropical plant grown primarily as a vegetable food for its edible corm and secondarily as a leaf vegetable and is believed to be one of the earliest cultivated plant. In its raw form, the plant is toxic due to the presence of calcium oxalate, although the toxin is destroyed by cooking or can be removed by steeping taro roots in cool water overnight (Lebot, 2016).

Cocoyam being among the tuberous roots that are very well adapted to most agro-ecological zones in Nigeria. Proper measures should be taken to utilize the crop to contribute to the enhancement of industrial growth. Yet, despite the wide adaptability as well as nutritional and economic values of the crop, cocoyam have received minimal interest and attention by producers, consumers and even researchers. The potential of cocoyam for food security, income generation and nutritional enhancement in the households are grossly underutilized (Andresen et al., 2019).

Cocoyam (colocasia esculenta) is well known food plant that has along history of cultivation. Its corms are important sources of starch. Cultivators of two species colocasia esculenta (taro) and xanchosomasayiltifolium (tannia) are generally grown food. It is consumed in homes especially during periods preceding the yam harvest which underscores its importance as a possible substitute for the crop. It is used essentially the same way as yam, although it is not as highly valued.

Cocoyam is a perfect complementary element for all sorts of meals, as it offers vitamins and soluble fibers. Cocoyam ranks third in importance after cassava and yam among the rood and tuber crops that are cultivated and consumed in rural areas by the elderly in Nigeria (Karikari et al, 2017).

The crops are no longer favoured in urban areas due to poor information about its nutritive values. The widespread ignorance of the nutritive value and diversities of foods from cocoyam constitutes a major impediment to its general acceptability and wider cultivation. Therefore, further efforts are needed to popularize its production among farmers and enhance its food use among consumers (Aniekwe, 2015).

The main nutrient supplied by cocoyam as with other root and tubers is dietary energy provided by its carbohydrate content. Its protein content is low (1-2%) and as in almost all root crops, proteins sulfur containing amino acids are limiting. By contrast, cowpea protein is of higher value and can complement the deficiencies of cocoyam. Cowpea is popularly referred to as "beans" in Nigeria and it belongs to the group known as legumes. It is nutritious and provides protein, vitamins and minerals (Karikari, 2019).

Cocoyam, a member of the Araceae family is a subsistence and emergency food source in many parts of the world. Taro or cocoyam (colocasia esculenta L.) is a tropical food from with high potential because of the high yield of the roots (or corms) and foliage (Awrzbury, 2016).

The soil's condition and its health status are vital for the agricultural production. This need for long term studies at fixed sites for monitoring changes in fertility status of soil. Long term experiment in India suggested that under continuous cropping, changes in soil fertility due to imbalanced fertilization may be recognized as one of the important factors that limit crops yields. Application of synthetic fertilizers towards an increase in agricultural production of farming system is well known, but injudicious use exhibit a detrimental effect on soil health. Bush fallow which had been an efficient, balanced and sustainable system for soil productivity and fertility restoration in the past is presently unsustainable due to high population pressing and other human activities which have resulted in reduced fallow period (Steiner, 2019).

Cocoyam contributes significantly to the human diet in parts of the specific region, Latin America, Africa and Asia (Bermejo et al., 2019). It is ranked as the fifth most consumed root and tuber crop in the world, after potato, cassava, sweet potato and yam (FAOSTAT, 2015). Its starchy corms and comers are used as a subsistence staple as they provide a cheap source of carbohydrates.

Cocoyam serves as a source of income for many families in the tropics and sub-tropics Boakye et al, (2015). The main nutrient provided by cocoyam, as with many other root and tuber crops is the dietary energy supplied by carbohydrates (Boakye, 2017).

The protein fraction of cocoyam tubers is low (1-3%) and like most root and tuber crop proteins, sulphur containing amino acid are limiting cocoyam corms and comers are good source of essential mineral nutrients that contribute to the growth as well as health maintenance and general well-being (Karikari, 2019).

The major mineral nutrient in cocoyam is K (Food and Agricultural Organization of the United Nation, 2018) and it is also rich in Fe, Zn and Ca (karikari, 2019).

2.1 Significance of some mineral elements

2.1.1 Phosphorus

Phosphorus is the second most plentiful mineral in your body. The first is calcium. Your body needs phosphorus for many functions, such as filtering waste and repairing tissue and cells. Most people get the amount of phosphorus that they need through their daily diets. In fact, it's more common to have too much phosphorus in your body than too little. Kidney disease or eating too much phosphorus and not enough calcium can lead to an excess of phosphorous. However, certain health conditions (such as diabetes and alcoholism) or medications (such as some antacids) can cause phosphorus levels in your body to drop too low. Phosphorus levels that are too high or too low can cause medical complications, such as heart disease, joint pain, or fatigue (Chukwu, 2018).

2.1.2 Zinc

Zinc is an important trace mineral that people need to Stay healthy. Of the trace minerals, this element is second only to iron in its concentration in the body. Zinc is found in cells throughout the body. It is needed for the body's defensive (immune) system to properly work. It plays a role in cell division, cell growth, wound healing, and the breakdown of carbohydrates (Lide et al., 2015).

Zinc is also needed for the senses of smell and taste. During pregnancy, infancy, and childhood the body needs zinc to grow and develop properly. Zinc also enhances the action of insulin. (Lide et al., 2015). Information from an expert review on zinc supplements showed that:

When taken for at least 5 months, zinc may reduce your risk of becoming sick with the common cold.

Starting to take zinc supplements within 24 hours after cold symptoms begin may reduce how long the Symptoms last and make the symptoms less severe. However, supplementation beyond the RDA is not recommended at this time.

2.1.3 Calcium

Calcium is a mineral found in many foods. The body needs calcium to maintain strong bones and to carry out many important functions. Almost all calcium is stored in bones and teeth, where it supports their structure and hardness (Dissing et al., 2015).

The body also needs calcium for muscles to move and for nerves to carry messages between the brain and every body part. In addition, calcium is used to help blood vessels move blood throughout the body and to help release hormones and enzymes that affect almost every function in the human body.

Calcium is found in many foods. You can get recommended amounts of calcium by eating a variety of foods, including the following:

- Milk, yogurt, and cheese are the main food sources of calcium for the majority of people in the United States.
- Kale, broccoli, and Chinese cabbage are fine vegetable sources of calcium.
- Fish with soft bones that you eat, such as canned sardines and salmon, are fine animal sources of calcium.
- Most (such as breads, pastas, and unfortified cereals), while not rich in calcium, add significant amounts of calcium to the diet because people eat them often or in large amounts.
- Calcium is added to some breakfast cereals, fruit juices, soy and rice beverages, and tofu. To find out whether these foods have calcium, check the product labels.

Calcium is found in many multivitamin-mineral supplements, though the amount varies by product. Dietary supplements that contain only calcium or calcium with other nutrients such as vitamin D are also available. Check the Supplement Facts label to determine the amount of calcium provided.

The two main forms of calcium dietary supplements are carbonate and citrate. Calcium carbonate is inexpensive, but is absorbed best when taken with food. Some over-the-counter antacid products, such as Tums and Rolaids, contain calcium carbonate. Each pill or chew provide 200-400 mg of calcium. Calcium citrate, a more expensive form of the supplement, is absorbed well on an empty or a full stomach. In addition, people with low levels of stomach acid (a condition more common in people older than 50) absorb calcium citrate more easily than calcium carbonate. Other forms of calcium in supplements and fortified foods include gluconate, lactate, and phosphate.

Calcium absorption is best when a person consumes no more than 500 mg at one time. So a person who takes 1,000 mg/day of calcium from supplements. for example, should split the dose rather than take it all at once. Calcium supplements may cause gas. bloating. and constipation in some people. If any of these symptoms occur, try spreading out the calcium dose throughout the day, taking the supplement with meals, or changing the supplement brand or calcium form you take.

2.1.4 Iron

Iron is an essential element for blood production. About 70 percent of your body's iron is found in the red blood cells of your blood called hemoglobin and in muscle cells called myoglobin. Hemoglobin is essential for transferring oxygen in your blood from the lungs to the tissues. Myoglobin, in muscle cells, accepts, Stores, transports and releases oxygen. (Ekwe, 2019).

About 6 percent of body iron is a component of certain proteins, essential for respiration and energy metabolism, and as a component of enzymes involved in the synthesis Of collagen and some neurotransmitters. Iron also is needed for proper immune function.

About 25 percent of the iron in the body is stored as ferritin, found in cells and circulates in the blood. The average adult male has about 1,000 mg of stored iron (enough for about three years), whereas women on average have only about 300 mg (enough for about six months). When iron intake is chronically low, Stores can become depleted, decreasing hemoglobin levels.When iron stores are exhausted, the condition is called iron depletion. Further decreases may be called iron-deficient erythropoiesis and still further decreases produce iron deficiency anemia.

Blood loss is the most common cause of iron deficiency. In men and postmenopausal women, iron deficiency is almost always the result of gastrointestinal blood loss. In menstruating women, genitourinary blood loss Often accounts for increased iron requirements. Oral contraceptives tend to decrease menstrual blood loss, whereas intrauterine devices tend to increase menstrual bleeding. Other causes of genitourinary bleeding and respiratory tract bleeding also increase iron requirements.

For blood donors, each donation results in the loss of 200 to 250 mg of iron. During periods of growth in infancy, childhood and adolescence, iron requirements may outstrip the supply of iron from diet and store. Iron loss from tissue growth during pregnancy and from bleeding during delivery and post-partum averages 740 mg. Breastfeeding increases iron requirements by about 0.5 to I mg a day.

Iron Requirements

Your "iron level" is checked before each blood donation to determine if it is safe for you to give blood. Iron is not made in the body and must be absorbed from what you eat. The adult minimum daily requirement of iron is 1.8 mg. Only about 10 to 30 percent of the iron you consume is absorbed and used by the body.

The daily requirement of iron can be achieved by taking iron supplements. Ferrous sulfate 325 mg, taken orally once a day, and by eating foods high in iron. Foods high in vitamin C also are recommended because vitamin C helps your body absorb iron. Cooking in iron pots can add up to 80 percent more iron to your foods. Consult with your primary care provider before taking iron supplements.

Some foods rich in iron include: Meat and Poultry, Seafood, Vegetables.

2.1.5 Copper

Copper of all the metals, copper is the one most likely to be found in its native state, often released by the chemical reaction of its ores. (Rayner, 2017)

Although only small amounts of native copper can be found, there was enough of it for our ancestors to discover the metal and begin using it.

Copper has been used by humans for as many as ten thousand years. Beads made from native copper dating from the eighth millennium BC have been found in Turkey.

Crucibles and slags found in Europe suggest that smelting of copper (producing the metal from its ores) took place in the fifth millennium BC.

Copper mining and smelting were commonplace by 4500 BC in the Balkans — Bulgaria, Greece, Serbia and Turkey.

The Copper Age sits between the Neolithic (Stone) and Bronze Ages. It took place at different times in different cultures, when people began using copper tools alongside stone tools.

The Copper Age was followed by the Bronze Age, when people learned that by adding tin to copper, a harder metal that is also more easily cast was formed. Again, this happened at different times in different locations in the world.

The word copper is derived from the Latin word 'cuprum' meaning 'metal of Cyprus' because the Mediterranean island Of Cyprus was an ancient source of mined copper.

The element symbol Cu also comes from 'cuprum. '

Appearance and Characteristics
Harmful Effects:

Copper is essential in all plants and animals. Excess copper is, however, toxic.

Cooking acidic food in copper pots can cause toxicity. Copper cookware should be lined to prevent ingestion of toxic verdigris (compounds formed when copper corrodes).

Characteristics:

Copper is a reddish orange, soft metal that takes on a bright metallic luster.

It is malleable, ductile, and an excellent conductor of heat and electricity only silver has higher electrical conductivity than copper.

Copper surfaces exposed to air gradually tarnish to a dull, brownish color.

If water and air are present, copper will slowly corrode to form the carbonate verdigris often seen on roofs and statues.

Uses of Copper

As a result of its excellent electrical conductivity, copper's most common use is in electrical equipment such as wiring and motors.

Because it corrodes slowly, copper is used in roofing, guttering, and as rainspouts on buildings.

It is also used in plumbing and in cookware and cooking utensils.

Commercially important alloys such as brass and bronze are made with copper and other metals.

Gun metals and American coins are copper alloys.

Copper sulfate is used as a fungicide and as an algicide in rivers. lakes and ponds.

Copper oxide in Fehling's solution is widely used in tests for the presence of monosaccharides (simple sugars).

2.1.6 Potassium

Potassium is a mineral that your body needs to work properly. It is a type of electrolyte. It helps your nerves to function and muscles to contract. It helps your heartbeat Stay regular. It also helps move nutrients into cells and waste products out of cells. A diet rich in potassium helps to offset some of sodium's harmful effects on blood pressure. (Schmidt, 2018).

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Volume 7, Issue 02 Feb. 2025, pp: 632-646 www.ijaem.net ISSN: 2395-5252

Many people get all the potassium they need from what they eat and drink. Sources Of potassium in the diet include:

- Leafy greens, such as spinach and collards
- Fruit from vines, such as grapes and blackberries
- Root vegetables, such as carrots and potatoes
- Citrus fruits, such as oranges and grapefruit

Your kidneys help to keep the right amount of potassium in your body. If you have chronic kidney disease, your kidneys may not remove extra potassium from the blood. Some medicines also can raise your potassium level. You may need a special diet to lower the amount of potassium that you eat.

Potassium is necessary for the normal functioning of all cells. It the heartbeat, ensures proper function of the muscles and nerves, and is vital for synthesizing protein and metabolizing carbohydrates.

Thousands of years ago, when humans roamed the earth gathering and hunting, potassium was abundant in the diet, while sodium was scarce. The so-called Paleolithic diet delivered about 16 times more potassium than sodium. Today, most Americans get barely half of the recommended amount of potassium in their diets. The average American diet contains about twice as much sodium as potassium, because of the preponderance of salt hidden in processed or prepared foods, not to mention the dearth of potassium in those foods. This imbalance, which is at odds with how humans evolved, is thought to be a major contributor to high blood pressure, which affects one in three American adults.

The adequate intake recommendation for potassium is 4,700 mg. Bananas are often touted as a good source of potassium, but other fruits (such as apricots, prunes, and orange juice) and vegetables (such as squash and potatoes) also contain this often-neglected nutrient.

Potassium and Stroke Risk

High blood pressure is a leading risk factor for strokes, so it's no surprise that higher potassium is also associated with a lower stroke incidence. One prospective study that followed more than 43,000 men for eight years found that men who consumed the highest amounts of dietary potassium (a median of 4,300 mg per day) were 38% less likely 10 have a stroke as those whose median intake was just 2,400 mg per day. However, a similar prospective study that followed more than 85,000 women for 14 years found a more modest association between potassium intake and the risk of strokes. Additional research has mostly upheld these findings, with the strongest evidence to support high dietary potassium seen in people with high blood pressure and in blacks, who are more prone to high blood pressure than whites.

2.1.7 Magnesium

Magnesium is needed for more than 300 biochemical reactions in the body. It helps to maintain normal nerve and muscle function, supports a healthy immune system, keeps the heartbeat steady, and helps bones remain strong. It also helps adjust blood glucose levels. It aids in the production of energy and protein (Manner, 2016).

There is ongoing research into the role of magnesium in preventing and managing disorders such as high blood pressure, heart disease, and diabetes. However, taking magnesium supplements is not currently advised. Diets high in protein, calcium, or vitamin D will increase the need for magnesium.

Magnesium is an important mineral, playing a role in over 300 enzyme reactions in the human body. Its many functions include helping with muscle and nerve function, regulating blood pressure, and supporting the immune system.

An adult body contains around 25 gram (g) of magnesium Trusted Source, of which the skeletal system stores. The rest is present in muscle, soft tissues. and bodily fluids.

Many people in the United States do not Trusted Source get enough magnesium in their diet, though deficiency symptoms are uncommon in otherwise healthy people.

Doctors link magnesium deficiency with a range of health complications, so people should aim to meet their daily recommended levels of magnesium.

Almonds, spinach, and cashew nuts are some of the foods highest in magnesium. If a person cannot get enough magnesium through their diet, their doctor may recommend taking supplements.

Magnesium is one of seven essential macrominerals. These macrominerals are minerals that people need to consume in relatively large amounts — at least 100 milligrams (mg) per day. Microminerals, such as iron and zinc, are just as important, though people need them in smaller amounts.

Magnesium is vital for many bodily functions. Getting enough of this mineral can help prevent or treat chronic diseases, including Trusted

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Source Alzheimer's disease, type 2 diabetes, cardiovascular disease, and migraine.
The following sections discuss the function of magnesium in the body and its effects on a person's health.

1. Bone health

While most research has focused on the role of calcium in bone health, magnesium is also essential for healthy bone formation.

Research from 2013 Trusted Source has linked adequate magnesium intake with higher bone density, improved bone crystal formation, and a lower risk of osteoporosis in females after menopause (Jehle, 2015).

Magnesium may improve bone health both directly and indirectly, as it helps to regulate calcium and vitamin D levels, which are two other nutrients vital for bone health.

2. Diabetes

Reseal Th has linked high magnesium diets with a lower risk of type 2 diabetes. This may be because magnesium plays an important role Trusted Source in glucose control and insulin metabolism.

A 2015 review Trusted Source in the World Journal of Diabetes reports that most, but not all, people with diabetes have low magnesium and that magnesium may play a role in diabetes management (Hansen, 2010).

A magnesium deficiency may worsen insulin resistance, which is a condition that often develops before type 2 diabetes. On the other hand, insulin resistance may cause low magnesium levels.

In many studies, researchers have linked high magnesium diets with diabetes. In addition, a systematic review from 2016 by Lim, T. K. suggests that taking magnesium supplements can also improve insulin sensitivity in people with low magnesium levels.

However, researchers need to gather more evidence before doctors can routinely use magnesium for glycemic control in people with diabetes.

3. Cardiovascular health

The body needs magnesium to maintain the health of muscles, including the heart. Research has found that magnesium plays an important role in heart health.

A 2015 review by Huang reports that magnesium deficiency can increase a person's risk of cardiovascular problems. This is partly due to its roles on a cellular level. The authors observe that magnesium deficiency is common in people with congestive heart failure and can worsen their clinical outcomes.

People who receive magnesium soon after a heart attack have a lower risk of mortality. Doctors sometimes use magnesium during treatment for congestive heart failure (CHF) to reduce the risk of arrhythmia, or abnormal heart rhythm.

According to Long, et al., (2019) meta-analysis Trusted Source. increasing magnesium intake may lower a person's risk of stroke. They report that for each 100 mg per day increase in magnesium, the risk of stroke reduced by 2%. Some also suggests that magnesium plays a role in hypertension. However, according to the office of Dietary Supplements Trusted Source (ODS), based on current research, taking magnesium supplements lowers blood pressure "to only a small extent. "The ODS call for a "large, well-designed" investigation to understand the role of magnesium in heart health and the prevention of cardiovascular disease.

4. Migraine headaches

Magnesium therapy may help Trusted Source prevent or relieve headaches. This is because a magnesium deficiency can affect neurotransmitters and restrict blood vessel constriction, which are factors doctors link to migraine (Ndabikunze, 2015).

People who experience migraines may have lower levels of magnesium in their blood and body tissues compared with others. Magnesium levels in a person's brain may be low during a migraine.

A systematic review by Odebunmi (2017) states that magnesium therapy may be useful for preventing migraine. The authors suggest that taking 600 mg of magnesium citrate appears to be a safe and effective prevention Strategy.

The American Migraine Foundation report that people frequently use doses of 400—500 mg per day for migraine prevention. The amounts that may have an affect ale likely to be high. and people should only use this therapy under the guidance of their doctor.

5. Premenstrual syndrome

Magnesium may also play a role in premenstrual syndrome (PMS).

Small-scale studies, including a 2012 article Trusted Source, suggest that taking magnesium supplements along with vitamin 136 can improve PMS symptoms. However, a more recent 2019 review Trusted Source by Bashiru reports that the research is mixed, and further studies are needed.

The American College of Obstetricians and Gynecologists suggest that taking magnesium supplements could help to reduce bloating, mood symptoms, and breast tenderness in PMS.

6. Anxiety

Magnesium levels may play a role in mood disorders, including depression and anxiety. According to a systematic review from 2017 Trusted Source, low magnesium levels may have links with higher levels of anxiety. This is partly due to activity in the hypothalamic-pituitary-adrenal (HPA) axis, which is a set of three glands that control a person's reaction to Stress.

However, the review points out that the quality of evidence is poor, and that researchers need to do high quality studies to find out how well magnesium supplements might work for reducing anxiety.

2.1.8 Manganese

Manganese is a trace mineral, which your body needs in small amounts. It's required for the normal functioning of your brain, nervous system and many of your body's enzyme Systems.

Manganese is considered an essential nutrient and can be found especially in seeds and whole grains, as well as in smaller amounts in legumes, beans, nuts, leafy green vegetables and tea.

Manganese is a chemical element with the symbol Mn and atomic number 25. It is not found as a free element in nature; it is Often found in minerals in combination with iron. Manganese is a transition metal with a multifaceted array of industrial alloy uses, particularly in stainless steels. (Osuji, 2015).

First isolated in 1774, manganese is mainly used in the production of steel. It is familiar in the laboratory in the form of the deep violet salt potassium permanganate. It occurs at the active sites in some enzymes. Of particular interest is the use of a Mn-O cluster, the oxygen-evolving complex, in the production of Oxygen by plants.

2.1.9 Sodium

A sodium test checks how much sodium is in the blood. Sodium is both an electrolyte and mineral. It helps keep the water (the amount of fluid inside and outside the body's cells) and electrolyte balance of the body. Sodium is also important in how nerves and muscles work. Most of the sodium in the body (about 85%) is found in blood and lymph fluid. Sodium levels in the body are partly controlled by a hormone called aldosterone, which is made by the adrenal glands. Aldosterone levels tell the kidneys when to hold sodium in the body instead of passing it in the urine. Small amounts of sodium are also lost through the skin when you sweat. Most foods have sodium naturally in them or as an ingredient in cooking. Sodium is found in table salt as sodium chloride and in baking soda as sodium bicarbonate. Many medicines and other products also have sodium in them, including laxatives, aspirin, mouthwash, and toothpaste (Luft, 2016).

Low sodium levels have many causes, such as heart failure, malnutrition, and diarrhea. Other electrolytes, such as potassium, calcium, chloride, magnesium, and phosphate, may be checked in a blood sample at the same time as a blood test for sodium.

III. MATERIALS AND METHOD

3.1Materials

3.1.1 Reagents

The following reagents were used for experimental investigation. The reagents are of analytical grade. (AnaLar).

Con. Sulphuric acid (H_2SO_4) Dil. Hydrochloric acid (Hcl) Methanol Potassium disulphate (K_2SO_4) Copper sulphate ($CUSO_4$) Methyl red indicator Boric acid Sodium hydroxide (NaOH) Pellet Distilled water (H_2O) Acetone

3.1.2 Apparatus

The following equipment and glassware were used for the experimental investigation; Atomic absorption spectrophotometer (AAS) Analytical weighing balance Muffle furnace Heating mantle Distillation apparatus Soxhlet extractor Porcelain crucible Kjedahl flask Volumetric flask Measuring cylinder Pyrex beaker Pyrex conical flask Burette Pipette Retort stand Sterile spatula Whatman filter paper Hot dry air oven (prolabo) Watch glass Motar and pestle(wooden).

3.2 Methods

3.2.1 Sample Collection

Fresh samples of cocoyam (colocasia esculenta L.) were obtained from selected areas of Bauchi, Plateau, Gombe and Kaduna states of Nigeria.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 7, Issue 02 Feb. 2025, pp: 632-646 www.ijaem.net ISSN: 2395-5252

Reagents, chemicals and equipment were obtained from departmental of Science Laboratory Technology, the Federal Polytechnic, Bauchi.

3.2.2 Sample Preparation and Treatment

Fresh cocoyam samples were collected from four (4) various places in respect of their state of origin; such as Bauchi, Plateau, Gombe and Kaduna respectively. These samples were kept and left open to the atmosphere in an empty, cleaned carton before transported into the department of Science Laboratory Technology, Federal Polytechnic, Bauchi. The samples were peeled prior to drying in a conventional oven at 105^oC for 24 hours for further analysis.

3.2.2.1Nutritional Value Analysis

The analysis carried out for the nutritional value include moisture, ash, crude protein, crude fibre, crude fat and carbohydrate determinations. The methods adopted in the analysis were those of Association of Official Analytical Chemists (AOAC; 2017). Moisture content of the dried samples was determined by weighing 2g of a sample and drying in an oven at 105^oC to constant weight. The lost in weight of the sample was calculated as moisture content. Ash content was determined by incineration 2g of the freeze-dried sample in a muffle furnace at 525^oC and the weight of ash was calculated by difference from the sample taken and calculated on dry weight bases. Crude protein was determined by kjeldahl method. The crude fibre was determined by fibretec system. Crude fat was quantified from dried samples by soxhlet method using n-hexane as the solvent and percentage fat was calculated on dry weight bases (Subbalakshim and Chitra, 1996). Carbohydrate was estimated by difference (AOAC, 1990).

3.2.2.2 Determination of Moisture Content

The initial weight of four labeled porcelain crucible were determined and noted as (W1). 2g of each sample in the four labeled porcelain crucible were weighted and noted as (W2). The samples were dried in the oven at 105^oC for 6 hours. After drying, they were removed from the oven, cooled in the desiccator and were weighted as (W3). The procedure was repeated by replacing the sample back into the oven for sometimes, cooled in the desiccator and weighted for several times until a constant weight was obtained for each sample.

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

Where W_1=weight of each crucible
W_2 = weight of each crucible + sample before heating.
W_3 = weight of each crucible + sample after heating

3.2.2.3 Determination of Ash Content

Four (4) porcelain crucibles were pre-heated in muffle furnace at a temperature of 500^oC, cooled in a desiccator and weighed as (W_1). 2g of each sample powdered in the crucible were weighed as (W_2) and then burnt on a Bunsen burner to remove smoke before transferred into the muffle furnace. The temperature was raised to 555^oC for 6 hours until residue was completely chaired. The heating was discontinued allowing the furnace to cool and the samples were removed, cooled in a desiccator and weighed as (W_3).

$$\% \text{ Ash Content} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where W_1 = weight of each crucible
W_2 = weight of each crucible + sample before heating.
W_3 = weight of each crucible + sample after heating

3.2.2.4 Determination of Crude Fat

The soxhlet extractor was fixed to a reflux condenser ad a small round bottom flask (500ml). An extracting thimble was dried in the oven and cooled in the desiccator. It was then plugged with a cotton wool and weighed as (W_1). The 2g of the sample powdered in the thimble plugged with a cotton wool was weighed as (W_2). This was placed in the extractor and 300ml of ethanol was added until it siphoned over half filled the extractor. The condenser was replaced and the round bottom flask placed on a heating mantle and heated gently. The solvent gradually boils and siphoned over and over for 6 hours. The heating was discontinued and the thimble removed from the extractor, dried in the oven at (50^oC) and cooled in a desiccator. The weight was taken as (W_3). It was returned back to the oven for sometimes, cooled and weighed until a constant weight was obtained. These steps were respectively carried out for each sample.

$$\% \text{ Fat Content} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where W_1 = weight of thimble and Cotton wool
W_2 = weight of thimble and cotton wool + sample before extraction.
W_3 = weight of thimble and cotton wool + sample after extraction.

3.2.2.5 Determination of Crude Protein Content.
Digestion

3g of the sample was weight in macro kjedahl flask. 20ml of concentrated H_2SO_4, 1g of K_2SO_4 and 1g of $CUSO_4$ was added into the macro kjedahl flask. The flask was heated in an inclined position on a heating mantle. It was heated gradually at the initial and later increased until the sample was completely digested. The digestion lasted for 3 hours in a fume cupboard. These steps were respectively carried out for each sample.

Distillation

The digested sample was allowed to cool and transferred into a distillation apparatus. 100ml of distilled water, 20ml of 40% Na0H was added into the distillation flask where the digested sample was poured. While 30ml of 2% boric acid and 2 drops of methyl red was added as an indicator into the receiving flask and distillation process commenced. These steps were carried out for each sample.

Titration

The distillate obtained during distillation was allowed to cool and then titrate with 0.1ml Hcl until end point was reached as indicated by a colour change. The blank determination was carried out using the entire reagent in the sample quantities but without the sample to be tested present. These steps also carried out for each sample.

$$\% \text{ Nitrogen} = \frac{(V_2 - V_1 \ \text{x Conc. Hcl x } 100}{\text{Wet of sample}}$$

Where V_1 = The value of blank
V_2 = Titre value of sample
W = weight of sample
Conc. Hcl = Molar concentration of Hcl used

$$\% \text{ Crude Protein content} = \frac{\% N_2 \ \text{x factor}}{\% N_2 \ \text{x } 6.25}$$

3.2.2.6 Determination of Crude Fibre Content

3g of each sample was weighed and transferred into four separate conical flasks. 50ml of 0.3m H_2SO_4 was added to each and then poured into a filter paper for filtration. Each was later re-washed for ten (10) minutes with hot distilled H_2O before washing with 50ml acetone to dry the residue. The samples in the crucible were dried in the oven at 100°C for an hour. They were cooled in the desiccator and weighed. They were later transferred to the muffle furnace at 700°C for an hour. They were cooled and weighed.

$$\text{Crude fibre} = \frac{a - b}{c} \text{ x } 100$$

where a = weight of sample + crucible before ashing
b =weight of sample + crucible after ashing
c = weight of sample

3.2.2.7 Determination of Mineral Content

The mineral contents of dried cocoyam samples were determined at Faculty of Agriculture and Technology Bayero University Kano, Nigeria using standard AOAC (1990) method. Ash was dissolved in 20ml at NHcl and heated for 5 minutes at 90°C. the solute was transferred quantitatively to a 100ml volumetric flask and made to level with distilled water Ca, Mg, Cu, Fe, Na and K were determined using Atomic Spectrophotometer (ASS) with air acetylene flame at 9.22nm.

IV. RESULTS

Table 1, present the proximate composition of cocoyam collected from Bauchi, Plateau, Gombe and Kaduna States. From the table, the ash content ranges from 2.6-3.2%, protein content, 2.7-3.4%, fibre 1.5-1.9%, fat 0.2-0.4%, moisture, 15.3-1.9% and carbohydrate 70.5-77.3.

The mineral composition of cocoyam samples grown in Bauchi, Plateau, Gombe and Kaduna States are presented in table 2. From the table, the phosphorus content ranges from 44.5-805.11ppm; Zinc 7.4-14.01ppm; Calcium 864.98-1110.39ppm; Iron 3.21-50.88ppm; Copper 5.9-11.09ppm; Potassium 367.91-4630-02ppm; Magnesium 324.71-506.73ppm; Manganese 4.80-8.43ppm; Sodium 191.12-204.89ppm.

Table 1: Shows the proximate composition results of the cocoyam sample (colocasiaesculenta) grown at Bauchi, Plateau, Gombe and Kaduna States Northern Nigeria.

Samples	Ash (%)	Protein (%)	Fibre (%)	Fat (%)	Moisture (%)	Carbohydrate (%)
Bauchi	3.0	2.7	1.5	0.3	19.0	73.5
Plateau	2.9	3.4	1.9	0.3	21.2	70.5
Gombe	2.6	2.8	1.8	0.2	15.3	77.3
Kaduna	3.2	2.9	1.9	0.4	16.5	75.6

Table 2: Shows the minerals composition of cocoyam sample (colocasiaesculenta) grown at Bauchi, Plateau, Gombe and Kaduna States Northern Nigeria.

Samples	P (PPM)	Zn (PPM)	Ca (PPM)	Fe (PPM)	Cu (PPM)	K (PPM)	K (PPM)	Mg (PPM)	Na (PPM)
Bauchi	514.23	7.53	896.10	48.91	6.58	3478.71	334.67	5.11	204.89
Plateau	803.11	14.01	1110.39	3.21	11.09	4630.20	506.73	8.43	203.59
Gombe	550.71	10.25	864.98	50.88	4.86	367.91	367.73	6.30	159.34
Kaduna	445.45	7.4	884.87	31.67	5.9	3236.63	324.71	4.80	191.12

V. DISCUSSION

The results obtained from this analysis for the comparison of proximate and mineral composition from four different northern states in Nigeria are presented in Tables 1 and 2. Table 1 shows the proximate composition of cocoyam (Colocasia esculenta) grown in Bauchi, Plateau, Gombe, and Kaduna States. The samples from Bauchi and Kaduna had higher ash and carbohydrate contents compared to those from Plateau and Gombe, with values of 3.0% and 3.2% for ash and 73.5% and 75.6% for carbohydrates, respectively. The protein content was highest in Plateau (3.4%), while the moisture content varied across the samples, with Plateau having the highest (21.2%) and Gombe the lowest (15.3%). These variations could be due to differences in soil composition, climatic conditions, and agronomic practices, as noted by Offei (2017).

The mineral composition of the cocoyam samples, as presented in Table 2, shows that potassium was the most abundant mineral, with the highest concentration recorded in Plateau (4630.20 PPM). Calcium was also highest in Plateau (1110.39 PPM), while iron content was highest in Gombe (50.88 PPM). Zinc and copper levels were generally low, with the least values observed in Kaduna (7.4 PPM for Zn) and Gombe (4.86 PPM for Cu). These variations in mineral content could be attributed to genetic factors, environmental conditions, and soil nutrient availability (FAO, 2018). The high potassium content supports the role of cocoyam as an important dietary source of essential minerals, aligning with previous research that highlights its nutritional benefits in food applications (Onyeka, 2016). Additionally, cocoyam starch granules, which range from 3 to 20 nm in size, make it easily digestible and suitable for baby foods and composite bread production (Offei, 2016). However, due to its low protein content, cocoyam's utilization in protein-rich foods may require supplementation with other protein sources (Onokpiese, 2019).

VI. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The results from current study revealed that cocoyam is nutritionally rich in carbohydrates and minerals such as magnesium and sodium. However, its composition varies according to their variety, country and location. The sources of these variations can be attributed to genetic variation, seasons of harvest and the agronomic factors of the sampled varieties as it was observed by (Offei, 2016).

6.2 Recommendations

This works is limited to on variety of cocoyam sample (colocasiaesculenta L.). However, low levels of protein in cocoyam limits its utilization in preparation of protein rich foods. This can be improved by combining cocoyam with other high protein sources. Further work can be carried out using two varieties of cocoyam (colocasiaescyulenta l.And XanthsomaSagitifoliumI.).

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