PHYSICOCHEMICAL STUDIES WITH EXPERIMENTALLY PRODUCED GINGER POWDER

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CERTIFICATION

This is to certify that this project work was carried out by NMALAGU CHINYERE RAYNER in the Department of Chemistry, Faculty of Physical Sciences, University of Benin, Benin City, in partial fulfilment for the award of Bachelor of Science (B.Sc) degree in Industrial Chemistry.

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DEDICATION

This project work is dedicated to the Almighty God for the gift of life, wisdom, and his grace upon me, and my lovely parents, Rev. and Dcns. Mrs Solomon Nmalagu as well as my ever-supportive friends, for their huge contribution in all spheres of my life.

ACKNOWLEDGEMENT

I thank God for the knowledge, power, wisdom, protection, guidance and love which he has bestowed on me most especially the gift of life, and the grace to complete my B.Sc program peacefully in this great institution.

I sincerely wish to acknowledge the effort of my lecturers who took out time despite the economic hardship and unpaid salaries to ensure that the knowledge of chemistry was imparted in us.

I want to use this opportunity to acknowledge the Head of department, Prof. J. Iyasele, my course advisor, Dr K.O Ogbeide, and other lecturers in the Department of Chemistry, for their relentless effort and assistance.

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ABSTRACT

The experiment was carried out to produce ginger powder from fresh ginger rhizomes using sun drying technique. The fresh rhizomes were collected from Forestry market, Benin City, Edo State. The ginger was then examined for its proximate, phytochemical and mineral element composition. These tests were carried out on the ginger before and after processing. The phytochemicals examined were alkaloids, glycosides, phenolic compounds, tanins, saponins, terpenoids, flavonoids, quinones and steroids. Specifically, the absence or presence of these phytochemicals were determined. The results from the mineral element test on the fresh ginger showed the following values in mg/L; Magnesium (0.75), Iron (1.0), Calcium (0.50), Zinc (0.80), Potassium (19.70) and Sodium (2.20). The processed ginger powder showed; Iron (1.60), Magnesium (1.08), Calcium (0.30), Zinc (1.20), Potassium (61.10) and Sodium (11.40).

Based on this study, the sun drying technique proved effective in reducing the moisture content of the ginger thereby improving its shelf-life, and its overall consumer desirability. The processed ginger powder is also a good source of the aforementioned minerals.

TABLE OF CONTENTS

CERTIFICATION ……I

DEDICATION …… II

ACKNOWLEDGEMENT ……III

ABSTRACT ……IV

TABLE OF CONTENTS ……V

CHAPTER ONE

1.1 Introduction …… 1

1.2 Background of Study …… 2

1.3 Statement of Problem …… 3

1.4 Justification / Relevance of Study …… 4

1.5 Scope of Study …… 4

1.6 Aim …… 4

1.7 Specific Objectives …… 5

1.8 Literature Review …… 5

1.8.1 Taxonomy / Classification of Zingiber Officinale …… 6

1.8.2 Morphology of Zingiber Officinale …… 6

1.8.3 Ethnomedicinal Uses of Plant …… 8

1.8.4 Mineral Analysis …… 8

1.8.5 Proximate Analysis …… 16

1.8.6 Phytochemical Screening …… 17

1.8.7 Spectrophotometry …… 18

CHAPTER TWO

MATERIALS AMD METHODOLOGY

2.0 Apparatus Used …… 21

2.1 Reagents Used …… 21

2.2 Methodology …… 22

2.2.1 Sample Collection and Preparation …… 22

2.2.2 Proximate Analysis …… 23

2.2.3 Extraction of Ginger …… 27

2.2.4 Mineral Analysis …… 27

2.2.5 Phytochemical Screening …… 28

CHAPTER THREE

RESULTS AND CONCLUSION

3.0 Results …… 30

3.1 Proximate Composition Results for Fresh and Sun – dried Ginger Powder Samples ……. 30

3.1.1 Discussion ……. 30

3.2 Results of Phytochemical Screening ……... 32

3.2.1 Fresh Ginger Sample …… 32

3.2.2 Powdered Ginger Sample ……. 33

3.3 Results on the Mineral Analysis of Ginger ……... 33

3.4 CONCLUSION

3.5 REFERENCES

CHAPTER ONE

1.1 INTRODUCTION

Ginger, a perennial flowering herbaceous plant, is classified as part of the Zingiberaceae family. It originated in South-East Asia and then used in many countries as a spice and condiment to add flavor to food (Park *et al*., 2002). Originating in Maritime Southeast Asia, Austronesian peoples are most likely the ones who originally domesticated ginger. It's native to Southeast Asia but is now cultivated in many tropical and subtropical. India is the largest grower of ginger and also the largest producer of dry ginger in the world (Dhingra *et al*., 2005). India produces about 50% of the world's total production and is the largest exporter (FAO 2009). The earliest known evidence of its domestication dates back to the Austronesian peoples, who have long farmed and used several types of ginger. Other varieties of ginger were grown by them, such as bitter ginger (*Zingiber zerumbet*), white turmeric (*Curcuma zedoaria*), and turmeric (*Curcuma longa*). Ginger has been used over the centuries in various cultures for its culinary, medicinal, and aromatic properties. Ginger is a flavorful culinary spice. Its leaves and rhizomes were either eaten raw or used to flavor dishes. Young ginger rhizomes have a mild flavor and are luscious and meaty. Rhizomes of mature ginger are almost entirely dry and fibrous. The ginger plant has been widely employed as a traditional remedy and is regarded as the oldest spice. On a global scale the ginger plant is used as a spice, both in its fresh and dried state, to boost the flavor, spiciness, and bite of cuisine (Jayashree *et al.*, 2011). For instance, it is packed with ascorbic acid and β-carotene, which are excellent sources of vitamins and minerals. This plant is used for the manufacture of food masala (pickles, cookies, marmalade) for confections, as well as a spice and flavoring ingredient for baked goods, diet drinks, and alcoholic and non-alcoholic beverages

(Plotto, 2002). The fresh ginger rhizome can be used in its fresh state or processed into powder via various methods. The ginger production process basically consists of four major steps: cleaning, quality control and selection, drying and packaging. Processing of the fresh ginger into ginger powder has numerous benefits.

1.2 BACKGROUND OF STUDY

The current practices in Chemistry, as it relates to food processing and distribution demands that the shelf life of foods be increased. Due to it's high moisture content, fresh ginger rhizome is susceptible to spoilage. As a result, alterations in its chemical reactions during storage and inappropriate postharvest management can occur. To avoid postharvest losses and to maintain the quality of fresh food commodities, different processing and preservation techniques such as drying, salting, canning, freezing, vacuum packaging, are practiced in the food industry (Malik *et al*., 2023). Although ginger postharvest management is not well established (Pruthi, 1993), it is however imperative to investigate substitute methodologies he industrial processing of fresh ginger. An effective method for the processing of fresh ginger is drying. The processing as well as preservation of foods via drying is one of the most effective methods. Drying as a method of food preservation, can be defined as a process of making a product dehydrated or reducing its moisture content by evaporating free water which is the water available to support microbial activities which would in turn cause undesirable characteristics and even spoilage in some cases. In processing via drying, it is of utmost importance that parameters such as temperature, time and controlled climate conditions are optimized to yield products with superior quality (Zargórska *et al*, 2022). Ginger powder is the creamy yellow colored powder extracted and grounded from the dried ginger rhizome. It possesses an intense aroma and a sharp spicy flavor

resembling the natural ginger taste profile. Fresh ginger can be substituted with dried powder, which can be kept fresh for a long time. Compared to raw ginger, dried ginger powder requires less space and weighs less. The dried powder is therefore an effective means for processors to create a commercial product with a longer shelf life and improved functionality (Sarker *et al.*, 2021). Some other advantages associated with processing of ginger include:

1. Convert the ginger to a more stable form that can be stored and transported to distant markets.
2. Convert fresh ginger to a form that is more convenient to use and with better compatibility compared to fresh ginger.
3. Produce dried ginger powder which is less prone to microbial contamination (Prasad *et al*., 2006).

Different drying techniques are employed in processing, some of which include: sun drying, vacuum drying, freeze drying, oven drying, to mention but a few (Jayashree *et al*., 2014). The different drying techniques could affect the nutritional, therapeutic, and possibly the organoleptic properties of processed ginger. Sarker *et al.,* (2021) posited that low temperature drying techniques would be effective in the production of ginger powder with retained colour, flavor, phytochemicals and nutritional content.

1.3 STATEMENT OF PROBLEM

The perishable nature of ginger is of concern both to the producers and end users of this highly nutritional versatile food spice. Hence, the need to process ginger root into its derived powdered form that possesses improved shelf life

1.4 JUSTIFICATION/RELEVANCE OF STUDY

According to NIH, medicinal plants are widely known to be a rich source of biologically active compounds such as phytochemical and anti-oxidative compounds. These compounds are beneficial to the health and also for human consumption. Ginger has long been used in both conventional and complementary medicine. Its anti-inflammatory and anti-nausea qualities have helped with digestion, lessened nausea, and assisted in the fight against the common cold and flu, to name a few benefits. Studies on both humans and animals suggest that ginger may assist to enhance metrics related to weight. They consist of the waist-to-hip ratio and body weight. Significantly decreasing LDL levels is another potential benefit of ginger. Gingerol, a compound with strong anti-inflammatory and anti-oxidant qualities, is abundant in ginger. Pregnant women have also used ginger to relieve morning sickness and other pregnancy-related nausea. The consumption of ginger has been proven to generally reduce intestinal gas and bloating as well as fermentation, constipation, and other related issues.

1.5 SCOPE OF STUDY

The scope of this work covers the proximate analysis (ash, moisture, crude fiber, crude protein, carbohydrate and crude fat content) of both fresh and dried ginger powder, its mineral element composition, the phytochemicals present, and the effect of the sun-drying technique used in the ginger powder processing.

1.6 AIM

This study's primary goal is to determine the nutritional makeup of ginger powder, particularly its mineral concentration, phytochemical content, and proximate composition.

1.7 SPECIFIC OBJECTIVES

To achieve the above aim, the following objectives were set to:

1] Fresh and matured ginger rhizomes were purchased from the local market.

2] Collected ginger rhizomes were peeled to remove the bark.

3] The peeled ginger rhizomes were washed with running water

4] The ginger rhizomes were cut in bits and dehydrated using the sun drying technique.

5] The dehydrated ginger slices were ground into powder using a grinder.

1.8 LITERATURE REVIEW

During the Austronesian expansion, they carried it with them all the way to Hawaii across the Indo-Pacific. Southeast Asian maritime regions are the source of ginger. It does not exist in the wild; it is a real cultigen. Mats were also woven from the leaves. By the first century CE, traders had brought it from India to the Middle East and the Mediterranean Chinese, Korean, Japanese, Vietnamese, and many other South Asian cuisines frequently employ the juice from ginger roots as a condiment to enhance the flavor of fish, meat, and vegetarian foods. Indian recipes also frequently use this juice. The plant is cultivated by planting root stalk cuttings and does not require seeds for propagation. The rhizome is harvested by simply lifting it from the soil, cleansing it and drying it in the sun., or they're pickled in vinegar or sherry as a snack.

1.8.1 TAXONOMY / CLASSIFICATION OF ZINGIBER OFFICINALE

Kingdom: Plantae

Phylum: Tracheophyta

Class: Liliopsida

Order: Zingiberales

Family: Zingiberaceae

Genus: Zingiber

Species: *officianale*

Scientific Name: Zingiber *officianale* **- Common Name:** Ginger

1.8.2 MORPHOLOGY OF ZINGIBER OFFICINALE

Ginger is a perennial herbaceous plant that can reach a height of one meter. The leaves are lengthy and elongated in nature, and they grow in alternate directions. When it reaches maturity, the clusters of white and pink flower buds turn into yellow flowers. A spike that resembles a cone and is covered in overlapping green bracts holds the blooms. The plant has monocotyledons. Its colour varies from dark yellow to light brown to pale buff. The altered underground stem develops into a widely used spice, rhizome and is the source of the inflorescence. The rhizome produces leafy shoots and is palmately branched. The dried rhizome is irregular, palmate and branched in appearance. With eight to twelve distichous leaves, the leafy hoots are a pseudostem made of leafy sheaths.

Plate 1

Plate 2

The best soil for ginger is loose, loamy, and rich in organic matter. Loamy soils allow water to drain freely, which will help prevent the rhizomes from becoming waterlogged. Thick mulch can also provide nutrients, retain water, and help control weeds. After planting, ginger takes 210–240 days to reach full maturity. Depending on demand, ginger harvesting for vegetable use begins 180 days later. However, the matured rhizomes are taken at full maturity, or when the leaves turn yellow and begin to dry, in order to make dried ginger. The rainy season, which is often between March and May, is when the ginger seeds are sown. It takes 8 to 10 months for the ginger to mature. Ginger needs to be periodically weeded and fertilized in order to promote growth and guarantee abundant harvests. Rich, nutrient-rich soil and hot, humid weather are ideal growing environments for ginger. The plants thrive in full sun in our chilly climate, although they could need some partial shade in more southern regions.

1.8.3 ETHNOMEDICINAL USES OF THE PLANT

For thousands of years, ginger, the "root" or rhizome, of the plant *Zingiber officinale*, has been used as a popular spice and herbal remedy. Herbal cultures of Asia, India, and Arabia have long used it. For instance, ginger has been used for more than 2,000 years in China to aid with digestion and alleviate nausea, diarrhea, and upset stomachs. In addition, ginger has been used to treat heart problems, colic, arthritis, and diarrhea. It has been used to help treat the common cold, flu-like symptoms, headaches, and painful menstrual periods. According to preliminary research, ginger may help prevent blood clotting and reduce cholesterol. This can aid in the treatment of heart disease, a condition in which clogged blood vessels can result in a heart attack o3r stroke. According to additional research, ginger may assist type 2 diabetics better regulate their blood sugar levels. Although care has to be taken in the regulations of the quantities that must be taken.

1.8.4 MINERAL ANALYSIS

The human body requires different types of minerals because each mineral has a different set of function (Sarker *et al*.,2021). Mineral analysis is the examining of a given sample to ascertain its mineral content and structure. Identification of mineral species and comprehension of their traits and attributes are possible through analysis. The mineral elements present in ginger include:

- Iron
- Magnesium
- Calcium
- Zinc
- Potassium
- Sodium

- **IRON**

Iron is an essential mineral found in the body. It is a vital component of many biochemical processes in the body. They provide support for enzyme systems. Iron is used by the body to make myoglobin, a protein that supplies oxygen to muscles, and hemoglobin, a protein found in red blood cells that transports oxygen from the lungs to every part of the body.

Sources

Some sources of iron in our diet include: liver (but avoid this during pregnancy), red meat, beans, such as red kidney beans, edamame beans and chickpeas, nuts, dried fruits such as dried apricots, fortified breakfast cereals and soy bean flour.

Health Benefits:

Iron is an essential mineral, among its many health advantages are the prevention of anaemia, bolstering of the immune system, improvement of sleep quality, and promotion of foetal health. Anaemia, exhaustion, and poor concentration are the results of an iron deficiency.

Iron is vital for the proliferation of all cells including those of the immune system.

Iron supports enzyme systems that are involved in the synthesis of collagen and elastin. In addition to making the hair mvibrant and shiny, it keeps the nails strong and hydrated, preventing them from drying out and breaking.

- **MAGNESIUM**

What is magnesium? Magnesium is a mineral that is essential for healthy muscles, nerves, bones and blood sugar levels. The body uses magnesium for a variety of functions, including as controlling blood pressure, blood sugar, muscle and neuron activity, and the synthesis of DNA, protein, and bone. If you don't get enough magnesium in your diet over a long time, you may be

at a higher risk of health problems such as heart attack, stroke, diabetes or osteoporosis. Symptoms of magnesium deficiency include: low appetite, nausea and vomiting, fatigue and weakness, muscle spasms or tremors and abnormal heart rhythms.

Sources

Includes a variety of vegetables; fruits; grains (at least half whole grains); fat-free and low-fat milk, yogurt, and cheese; and oils. Whole grains and dark-green, leafy vegetables are good sources of magnesium. Low-fat milk and yogurt contain magnesium as well.

Health Benefits

Magnesium is involved in hundreds of biochemical reactions in your body. Magnesium is found throughout your body. Every cell in your body contains this mineral and needs it to function. About 60% of the magnesium in your body occurs in bone, while the rest is in muscles, soft tissues, and fluids, including blood. One of its main roles is to act as a cofactor — a helper molecule — in the biochemical reactions continuously performed by enzymes. It's involved in more than 600 reactions in your body including;

- **Energy creation:** converting food into energy
- **Protein formation:** creating new proteins from amino acids
- **Gene maintenance:** helping create and repair DNA and RNA
- **Muscle movements:** aiding in muscle contraction and relaxation
- **Nervous system regulation:** regulating neurotransmitters, which send messages throughout your brain and nervous systems.

- **CALCIUM**

The most prevalent mineral in the body, calcium can be found as a nutritional supplement, added to other foods, and even in some medications (like antacids). Much of the construction of bones and teeth is composed of calcium, which also maintains tissue robust, flexible, and rigid, allowing for appropriate physical movement (Institute of Medicine, 2011). Blood artery contraction and dilatation, muscular activity, blood clotting, neuronal transmission, and hormone production are all mediated by the little ionized pool of calcium present in the circulatory system, extracellular fluid, and different tissues (Institute of Medicine, 2011). The bones contain nearly all of the calcium in the body (98%) and are both a source and a reservoir for calcium, helping the body to maintain calcium homeostasis (Institute of Medicine, 2011).

Sources

The greatest dietary sources of calcium are dairy products like cheese and yogurt as well as milk. Additional calcium-rich foods include: fish (like tuna and salmon), leafy greens (like kale and turnip greens), tofu (which is calcium-set), and small, boneless fish (like canned salmon and sardines).

Health Benefits

Calcium possesses many nutritional and health relevance. For instance; Calcium is important for maintaining bone health in older adults. It may also help lower the risk of cancer, particularly in the colon and rectum (Institute of Medicine, 2011). Because calcium binds fatty acids, it may also lessen the risk of cardiovascular disease (CVD) by reducing lipid absorption.

Insufficient Calcium:

Osteoporosis, which is characterized by brittle bones and an elevated risk of falling, can result from a calcium deficit that weakens bones. (Institute of Medicine, 2011). While vitamin D insufficiency is most frequently the cause of these problems, calcium shortage can also result in rickets in children and other bone disorders in adults. The rickety development cartilage in children might cause irreparable abnormalities to the skeletal structure because it does not mineralize normally (Institute of Medicine, 2011). Osteomalacia, or abnormal bone mineralization and softening, is another consequence of long-term calcium insufficiency that can affect both adults and children (Institute of Medicine, 2011).

- **ZINC**

For all living organisms, zinc is a trace element that is necessary. It was only lately that the importance of zinc for human nutrition and public health was realized. One of the main functions of Zinc is that it acts as a cofactor for numerous enzuymes. Many specialists have acknowledged that inadequate zinc intake is a serious public health concern, particularly in poorer nations. The frequency of zinc deficiency and its clinical effects on growth retardation, diarrhea, pneumonia, altered cognitive function, and anomalies in prenatal development. Because zinc is so important to human health, even a slight deficit can have disastrous consequences. Zinc is an essential trace mineral that is necessary for cell division, DNA and protein synthesis, and the metabolic function of 300 enzymes in the body. Protein, carbohydrate, fat, and alcohol metabolism are all impacted by these enzymes. According to Bhowmik *et al.,* (2010), zinc is also essential for immune system function, prostaglandin synthesis, bone mineralization, thyroid function, blood coagulation, cognitive processes, fetal growth, wound healing, taste acuity, connective tissue growth and maintenance, and immune system function.

Sources:

Shellfish, beef and other red meats are rich sources of zinc. Nuts and legumes are relatively good plant sources.

Health Benefits

The health benefits of Zinc include proper functioning of immune system, digestion, control of diabetes, improves stress level, energy metabolism, acne and wounds healing. Also, pregnancy, hair care, eczema, weight loss, night blindness, cold, eye care, appetite loss and many other factors are included as health benefits of zinc. Zinc, being an important mineral plays a vital role for the protein synthesis and helps in regulation of the cells production in the immune system of the human body (Bhowmik *et al*., 2010).

- **POTASSIUM**

One significant mineral that is thought to be necessary for human survival is potassium. It is among the most crucial minerals required for the heart, kidneys, and other major body organs to operate properly. It is one of the seven major macro minerals that are regularly needed to support vital body processes, along with magnesium, calcium, sodium, phosphorous, and sulfur milligrams of potassium. Excessive potassium consumption can assist lower blood pressure, stroke, muscle loss, kidney stone production, and bone mineral density preservation. In the human body, potassium primarily regulates fluid balance and manages the electrical activity of the heart and other muscles. In essence, potassium is an electrolyte that balances the body's acid-base levels while opposing the effects of sodium.

Sources

Citrus fruits, grains and vegetables are the most important sources of potassium. It is also possible to get potassium in good amounts from chicken, salmon, fresh fruit juices, almonds and

whole milk. Lime beans, nuts, poultry and potatoes also contain potassium. Nevertheless, the most significant dietary sources of potassium include coconut water, avocados and bananas.

Health Benefits

Potassium plays an important role in the normal functioning of the human brain, it helps in regulating sugar level in the body, it plays an important factor in muscle contraction, it helps in the prevention of low blood pressure and cardiovascular diseases, it helps promote the alkaline environment within the body, it helps decrease muscle cramps and improve strength of the muscles, it helps to flush out excessive waste from the cells, potassium salts go a long way in improving the health of the bones and in warding off osteoporosis, it is needed by the body for building muscle and protein, it plays an important role in building lean muscle mass and in keeping the muscle healthy for a very long span of time, it also helps in improving the function of the cells and in helping individuals cope up very well with stress.

Side Effects of lack of Potassium

Those who consume excessive amounts of potassium may experience major health problems. Hypokalemia, a condition in which there is an excess of potassium in the blood. Hypokalemia can lead to dangerous or abnormal heart rhythms, elevated blood pressure, and weak muscles.

- **SODIUM**

The mineral Sodium, is present in numerous food materials. Sodium is responsible for regulating body water and electrolyte balance and is also required for the absorption of certain nutrients from the gut. Sodium is essential for the proper functioning of the muscles and nerves. In addition to this, Sodium also maintains the equilibrium of body fluids. Sodium is the main cation of blood plasma and other extracellular bodily fluids because of its enormous importance in maintain the body's acid-base balance and osmotic control. Although the mineral sodium is

required by the body, too much of this could be harmful to your health. Regular consumption of meals high in sodium might make your body retain more water. Additionally, your organs have to work harder as a result of the additional bodily water. This raises your chance of hypertension, which can impair the health of your heart and kidneys.

Sources

Although there are a number of sources of this mineral which is present in our everyday diet, some foods naturally contain sodium. Others have added salt — and foods with added salt usually contain higher amounts of sodium. The top 10 foods high in salt that we eat include breads, pizza, sandwiches, cold cuts and cured meats, soups, burritos, tacos, savory snacks (chips, popcorn, pretzels, crackers), chicken, cheese, eggs, and omelets, according to the Centers for Disease Control and Prevention.

Health Benefits

Sodium is a vital nutrient that is involved in the maintenance of normal cellular homeostasis and in the regulation of fluid and electrolyte balance and blood pressure (BP). In addition to this, the human body requires a small amount of sodium to conduct nerve impulses, contract and relax muscles, and maintain the proper balance of water and minerals. It is estimated that we need about 500 mg of sodium daily for these vital functions. However, excess consumption/intake of sodium can as well increase the blood pressure and the risk for heart disease and stroke. Hyponatremia occurs when the concentration of sodium in your blood is abnormally low. Sodium as an electrolyte, helps to regulate the amount of water that's in and around the body cells. When the concentration of this mineral is low, Hyponatremia occurs. This condition is

usually accompanied with symptoms such as nausea, vomiting, headache, fatigue, restlessness and other related symptoms.

1.8.5 PROXIMATE ANALYSIS

Proximate analysis is a test or a series of tests carried out a sample to calculate the composition of the biomass as regards the moisture content, volatile matters, ash content, and fixed carbon. Conventionally proximate analysis includes determinations of the amount of water, protein, fat (ether extract), ash and fiber, with nitrogen-free extract. The significance of proximate analysis lies in its ability to yield significant details regarding food samples' composition, which includes the protein, carbohydrate, lipid, fat, fiber, moisture and ash concentrations.

TYPES OF PROXIMATE ANALYSIS

1.**Moisture Content Analysis**: Moisture content analysis is the determination of the concentration water in a sample.

2.**Ash Content Analysis:** Ash content represents the total mineral content in a given sample.

3.**Crude Fiber Content:** Crude fiber content is a measure of the plant food left after extraction by dilute acid followed by dilute alkali.

4.**Crude Protein Content:** The term "crude protein content" refers to a chemical analysis of food, wherein the amount of nitrogen in the food sample is estimated to be the amount of protein. Protein nitrogen and non-protein nitrogen (NPN) are included in this crude protein (total protein), which is calculated by determining the feed's total nitrogen content.

5.**Crude Fat Content:** This refers to the measurement of the mixture of the fat-soluble materials present in the food sample

6. **Carbohydrate Content:** Carbohydrate levels are traditionally computed using a method known as "carbohydrate by subtraction." This means that when a food is subjected to a chemical analysis in a lab, the grams of water, ash, fat, protein, and fiber are deducted from the sample's total gram weight, and the quantity that is left over is what is known as the carbohydrate value.

Proximate analysis, which analyzes a food sample's major constituents, is a crucial technique in the food industry since it can yield a thorough understanding of the food's nutritional value and quality. This information is useful in various aspects of the food industry, including product development, quality control, and regulatory purposes.

1.8.6 PHYTOCHEMICAL SCREENING

Phytochemical is a combination of the two words- ‘phyto’ and ‘chemical’. Phyto comes from the Greek word ‘phyton’ meaning plant. Hence, Phytochemical is a broad term that classifies the various chemicals that are naturally occurring in plants. Also called phytonutrients, it is a wide variety of bioactive compounds found in plants. These chemical compounds present in plants generally help them resist fungi, bacteria and plant virus infections, and also consumption by insects and other animals.

Phytochemical screening on the other hand is the scientific process of analyzing, examining, extracting, experimenting and thus identifying the different classes of phytoconstituents present in plant parts. Phytochemical screening reveals the presence of phytoconstituents such as; flavonoids, saponins, tanins, carotenoids, alkaloids, terpenoids, lignans, polyphenols, phytosterols, isoflavones, anthocyanins.

IMPORTANCE OF PHYTOCHEMICAL SCREENING

1. **Pharmacological Potential:** While various chemicals may have varying impacts on biological systems, phytochemical screening aids in determination of the pharmacological potential of plants. This may result in the discovery of novel medications or herbal cures.
2. **Identification of bioactive Compounds:** The identification of bioactive chemicals, such as phenolic compounds, flavonoids, terpenoids, alkaloids, and others, is a fundamental goal because these compounds have the potential to have pharmacological effects.
3. **Medical Uses:** Through the detection of particular chemicals, phytochemical screening can provide insight on the traditional applications of plants for medical purposes and substantiate the effectiveness of those applications through empirical research.
4. **Safety Assessment:** Phytochemical screening also helps in the safety evaluation of plants by detecting harmful substances that may be present or possible adverse effects of overdosage, thereby protecting the health and safety of end users.
5. **Biological Activities:** The objective of this study is to ascertain the biological activities of plant extracts. These activities may include anti-inflammatory, anticancer, antioxidant, antibacterial, or antidiabetic qualities, which may have a substantial impact on human health and disease management.

1.8.7 SPECTROPHOTOMETRY

Spectrophotometry is a spectroscopic technique used to determine the concentration of a chemical specie in a given sample. This technique measures how much a substance absorbs light by measuring the light intensity as light beam travels through the sample solution. The foundation of spectrophotometry is the idea that various materials absorb light at various

wavelengths. The amount of light absorbed can be calculated by passing light of a certain wavelength through a sample and measuring the light's intensity before and after the light passes through the sample. Numerous disciplines, including chemistry, biochemistry, pharmacology, environmental science, and clinical analysis, heavily rely on spectrophotometry. It is employed in the quantitative examination of materials, ascertaining analyte concentrations, researching reaction kinetics, and evaluating compound purity.

The instrument used in spectrophotometry is a spectrophotometer. Spectrophotometry operates based on Beer-Lambert's law which states that "the absorbance of light by a sample is directly proportional to the concentration and the path length through the sample.

TYPES OF SPECTROPHOTOMETRY

Atomic Absorption Spectrometry: Absorption Spectrometry (AAS) is an analytical method that measures the absorption of particular electromagnetic radiation wavelengths in order to determine the concentration of specific elements in a sample. In AAS, a sample containing the element of interest is exposed to a beam of light with a specified wavelength, usually in the UV or visible range. The frequencies at which the target element of the atom absorb light corresponds to their electronic transitions from the ground state to the excited state.

Flame Emission Spectrometry: is a technique used to analyze metal ions in solution. It is majorly used for analyzing Group I and Group II elements.

When substances are heated, they often emit energy in the form of light. This is due to electrons falling back to their original energy level after becoming excited which causes them to jump up one or more energy levels.

Flame emission spectrometry works by exposing the sample to a very hot flame and then measuring the intensity and wavelength of the light emitted.

FIG 1. A SPECTROPHOTOMETER

CHAPTER TWO

MATERIALS AND METHODOLOGY

2.0 APPARATUS USED

- Beakers
- Conical flask
- Test tubes
- Volumetric flask
- Crucibles
- Foil paper
- Retort stand
- Burette
- Clamps
- Spatula and thong
- Weighing balance
- Soxhlet apparatus
- Desiccators
- Flame photometer
- Muffle furnace
- Hot air oven
- UV/VIS Spectrophotometer
- Atomic Absorption Spectrophotometer

2.1 REAGENTS USED

- Ferric chloride
- Dragendroff’s reagent
- Wagner's reagent
- Fehling's reagent
- Ammonia solution
- Sodium hypochlorite
- Sodium potassium titrate
- Potassium dichromate
- Alkaline sodium phenate solution
- Kjehdhal catalyst
- Hydrochloric acid
- Sulfuric acid
- Chloroform
- Sodium hydroxide
- Hexane
- Methanol
- Distilled water
- Potassium sulphate
- Sodium sulphate
- Selenium
- Boric acid/methyl red indicator

2.2 METHODOLOGY

2.2.1 SAMPLE COLLECTION AND PREPARATION

Fresh ginger rhizomes were purchased from Forestry Market, Benin City, Edo State. The fresh rhizomes purchased were peeled using a clean knife, to remove the outer skin and other field-damaged portion. The rhizomes were then rinsed thoroughly in clean water to remove any dirt present after which the gingers were sliced into small sizes of 5mm-6mm. The ginger slices were spread out on a clean tray and exposed to direct sunlight for about 3-5 days to reduce the moisture content present in the ginger. After cooling at room temperature, the dried sample was cooled at room temperature and ground into powder using a blender and sieved to achieve uniformity.

2.2.2 PROXIMATE ANALYSIS

A. DETERMINATION OF MOISTURE CONTENT

The moisture content determination was carried out in accordance with the method described by the Association of Official Analytical Chemists (AOAC), in year

A clean and dry crucible was weighed using a weighing balance and the result recorded as W1. After this, 2g of the sample was placed into a second crucible and weighed; the result was recorded as W2. The temperature of the oven (Model no: DHG 9101. 18A, 750W SANJA) was adjusted to 105^0C. The sample containing the crucible was then placed in the oven. The sample was allowed to stay in the oven for about three hours to dry until a constant weight was obtained

which was recorded as W3. This procedure was carried out for both fresh and dried ginger samples.

The percentage moisture content was calculated thus;

% Moisture content = (W2 – W3) / W1 X 100%

W1 = Initial weight of crucible

W2 = Weight of crucible + sample before drying

W3 = Weight of crucible + sample after drying

% Dry matter = 100% - moisture content

B. DETERMINATION OF ASH CONTENT

Ash content determination was carried out in accordance with the method described by the Association of Official Analytical Chemists (AOAC) in the year

A clean empty crucible was weighed and recorded as **W1**. 2g of the sample was placed into the crucible and weighed as **W2**. The crucible containing the sample was then placed in a muffle furnace set to a temperature of 500^0C and maintained for about three hours. After this period of time, the muffle furnace was allowed to cool and the crucible containing the ash was removed from the furnace using a pair of thongs. The crucible was then weighed and recorded as **W3**. This procedure was carried out for both fresh and dry ginger samples.

The percentage ash content was calculated thus;

% Ash content = (W3 – W1) / (W2 – W1) x 100%

Where;

W1 = Weight of crucible

W2 = Weight of crucible + sample

W3 = Weight of crucible + ash

C. DETERMINATION OF CRUDE FIBRE CONTENT

2g of the sample was placed in a weighed conical flask and then filled with 1.25% Sulfuric acid and allowed to boil for 30minutes. The solution was then filtered and washed to reduce its acidity. After this, the residue was transferred into a second conical, heated to boil and filled with 1.25% Sodium hydroxide. The resulting solution was then filtered and placed in a muffle furnace for about an hour with a temperature of 300^0C for drying to occur. After drying, the conical flask containing the residue was cooled and measured.

The percentage crude fibre content was calculated using the formula:

% Crude fibre = (W2 – W3) / W1 x 100

Where:

W1 = Weight of sample used (calculated by subtracting the weight of the empty crucible from the total weight of the crucible + sample)

W2 = Weight of crucible + dried residue

W3 = Weight of crucible + ash

D. DETERMINATION OF CRUDE FAT CONTENT

The AOAC standard method was used.

2g of the sample was put in a thimble and placed into a Soxhlet apparatus setup. A flask containing methanol was placed on a heating temperature of about 60^0C. As the solvent was heated up, the hot methanol solvent rose and dripped through the sample in the thimble, thereby allowing the fat extraction to occur. This process was left to continue for about five hours until all the fat was extracted from the sample. After this process, the fat was dried in an oven for an hour at a temperature of 60^0C.

The percentage crude fat was then calculated as follows;

% Crude fat = (weight of fat) / weight of sample x 100

E. DETERMINATION OF CRUDE PROTEIN CONTENT

The method used to determine the crude protein content was the Kjedahl's method. The method involved 3 stages and these were; digestion, distillation and titration stages.

I. <u>The Digestion Stage</u>

1g of the sample and 15ml of Sulfuric acid were placed into a clean Kjedahl flask. Mixed catalyst (copper sulphate and selenium) was also added to the flask. The mixture was then placed in a heating mantle set to a temperature of 75^0C for digestion to occur. This process was allowed to occur until the mixture turned clear and a colour change from dark brown to golden colour was observed.

II. <u>The Distillation Stage</u>

After cooling, water of about five times the amount of digest available for distillation, was added to the mixture alongside an excess 40% sodium hydroxide. The flask was then placed on the heating mantle and distilled off in a flat bottom flask containing methyl red indicator solution. The solution was allowed to distil until about 100 ml of distillate was collected. The distillate obtained was observed to be a golden colour.

III. <u>The Titration Stage</u>

The distillate obtained was then titrated against 0.01N hydrochloric acid. A colour change from yellow to pink marks the end point of the titration.

The nitrogen content was calculated using the formula;

% Nitrogen Content = $\frac{Na*Va*14*100}{wt\ of\ sample}$ Na = Normality of acid

Va = Volume of acid

14 = Atomic weight of Nitrogen

The crude protein was then obtained by multiplying the nitrogen content by a factor of 6.25.

% crude protein = % nitrogen content * 6.25

F. DETERMINATION OF CARBOHYDRATE CONTENT

The carbohydrate content was calculated by subtracting the protein, fat, ash, crude fibre and moisture from 100.

% carbohydrate = 100- (protein+ fat + ash+ fibre + moisture) % content

G. DETERMINATION OF NITROGEN FREE EXTRACT

It was calculated using the formula for food analysis:

% N.F.E = % total carbohydrate - % crude fibre

2.2.3 EXTRACTION OF GINGER

A) <u>Preparation Of Fresh Ginger Extract</u>

An aqueous extract solution was prepared by measuring sufficient amounts of freshly peeled ginger rhizomes, pounding it with the use of mortar and pestle. The ground ginger is then transferred into a thimble and placed in a Soxhlet extractor using methanol as solvent under heat.

B) <u>Preparation of Dry Ginger Powder Extract</u>

An aqueous extract solution was prepared by measuring sufficient amounts of dry ginger powder. The ginger powder is transferred into a thimble and placed in a Soxhlet extractor using methanol as solvent under heat.

2.2.4 MINERAL ANALYSIS

The determination of the minerals present in both the fresh and dried ginger samples was achieved using the AOAC standard method.

2g of the ginger sample was ashed in a muffle furnace at a temperature of 550^0C and the ash obtained from the sample was dissolved in 10 ml of 0.1M HCl, filtered and then filled with distilled water to reach the 100ml mark. This was done to ascertain the presence of the minerals Mg, Ca, P, Fe, Mn by employing the use of an Atomic Absorption Spectrophotometer (AAS). This procedure was carried out on both fresh and dried ginger samples.

2.2.5 PHYTOCHEMICAL SCREENING

Several tests were carried out on both fresh and ground ginger powder samples to assess the presence of some phytochemicals.

The extracts of both the fresh and dried ginger samples were used to conduct the phytochemical screening. The phytochemical screening was carried out on both the using standard procedures to test for the phytochemicals present. The following tests were carried out:

- **Test for Alkaloids:** 2ml of 10% picric acid (Hager's reagent) was added to 1ml of the ginger extract.
- **Test for Flavonoids:** 10% of lead acetate was added to 1ml of the ginger extract.
- **Tests for Tanins:** 1ml of the ginger extract was dissolved in 2.5ml of distilled water. 1% gelatin solution and 10% NaCl were then added to the solution.
- **Test for Steroids:** 2ml of Chloroform and 2ml of concentrated sulfuric acid were added to 2ml of the ginger extract.
- **Tests for Glycosides:** 1ml of glacial acid, a drop of ferric chloride and 1ml of concentrated sulfuric acid were added to the ginger extract.

- **Test for coumarin:** 10% NaOH was added in drops alongside chloroform to 1ml of the ginger extract.
- **Test for quinines:** To 1ml of ginger extract, few drops of 10% NaOH were added.
- **Test for terpenoids:** 2ml of the extract was measured and 1ml of chloroform and 1.5ml of concentrated sulfuric acid are added carefully along the sides of the tube.
- **Test for saponin:** 2ml of distilled water was added to 1ml of ginger extract and was shaken vigorously.
- **Test for phenolic compound**: Few drops of 10% ferric chloride were added to 1ml of the ginger extract.

CHAPTER THREE

RESULTS AND CONCLUSION

3.0 RESULTS

3.1 PROXIMATE COMPOSITION RESULTS FOR FRESH AND SUN-DRIED GINGER POWDER SAMPLES.

Sample	% Moisture Content	% Ash Content	% Ether Extract	% Crude Protein	% Crude Fibre	% Nitrogen Free Extract	% Carbohydrate Content	% Dry matter
Fresh Ginger	72.0	2.35	7.80	7.75	5.90	4.20	4.20	28.0
Ginger Powder	16.0	3.20	11.0	10.8	6.50	52.5	52.5	84.0

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3.1.1 <u>DISCUSSION</u>

The proximate composition of both fresh and sun-dried ginger samples is shown in fig. 1 above.

- The moisture content is the major concern for the shelf life of processed ginger because a higher moisture content decreases the shelf life of the ginger. In this study, the highest moisture content is evident in the fresh ginger, which has a moisture content of 72.0% significantly different from the sundried ginger sample with a moisture content of 16%.
- Ash content was also determined in this study as it represents the presence of minerals in food samples. The highest amount of ash content was found in the sundried ginger powder (3.20%).

- Protein content was determined as it is related to the water absorption capacity, texture and volume of the samples. The highest protein content was observed in the sundried ginger powder. Similar findings related to protein content have been reported in other studies (Sangwan et al., 2014).
- Fat content was measured as it is responsible for holding the flavor of ginger sample and a low-fat content is closely related to its shelf life (Rahman et al., 2013). The higher fat content was observed in the fresh ginger sample. This indicates that the sundried ginger sample with lower fat content would be less prone to microbial activity since there is reduced lipid oxidation.
- The crude fibre content was also determined as it indicates the presence of organic content and a good amount of fibre content benefits in reducing indigestion problem. The higher crude fibre content was found in the dried ginger sample.
- From the results, it was also observed that the dried ginger powder contained an increased amount of carbohydrates, which in turn is a good source of energy.

3.2 RESULTS ON PHYTOCHEMICAL SCREENING

3.2.1 FRESH GINGER SAMPLE

Test	Fresh ginger (methanolic extract)	Observation
Alkaloids	+	Yellow precipitate
Glycosides	+	Brown ring observed at the interface
Phenolic compounds	++	White precipitate
Tannins	-	No colour observed
Saponins	+	Foamy at upper layer
Terpenoids	+	Reddish brown colour
Flavonoids	+	Cloudiness observed
Quinones	-	No colour
Steroids	+	Red colour at lower layer

+ = present, ++ = present in higher concentration, - =absent

3.2.2 POWDERED GINGER SAMPLE

Test	Ginger powder (methanolic extract)	Appearance
Alkaloids	+	Yellow precipitate
Glycosides	+	Brown ring observed at the interface
Phenolic compounds	+	White precipitate
Tannins	-	No colour change
Saponins	+	Foamy at upper layer
Terpenoids	+	Reddish brown colour
Flavonoids	+	Cloudiness
Quinones	-	No color
Steroids	+	Red colour at yellow layer

+ = present, ++ = present in higher concentration, - =absent

3.3 RESULTS ON THE MINERAL ANALYSIS OF GINGER

Elements (mg/L)	Iron (Fe)	Magnesium (Mg)	Calcium (Ca)	Zinc (Zn)	Potassium (K)	Sodium (Na)
Fresh Ginger	1.00	0.75	0.50	0.80	19.70	2.20
Ginger powder	1.60	1.08	0.30	1.20	61.10	11.40

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