COMPARATIVE PROXIMATE AND PHYTOCHEMICAL STUDY OF NIGER AND SOKOTO GROUNDNUTS (*Arachis hypogaea l.*)

BY

ADEKUNLE ISRAEL AYOBAMI

LSC1906422

A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF BIOCHEMISTRY, FACULTY OF LIFE SCIENCES, UNIVERSITY OF BENIN, BENIN CITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR OF SCIENCE (B.Sc.) IN BIOCHEMISTRY

OCTOBER, 2025

CERTIFICATION

We the undersigned, certify that ADEKUNLE ISRAEL AYOBAMI with the Matriculation Number LSC1906422, carried out this project in partial fulfillment of the award of the Bachelor of Science(B.Sc Hons) degree in Biochemistry, in the Department of Biochemistry

_____

USIFO OSEMHENGBE RUTH (PhD) **Date**

_____

PROF. E.C. ONYENEKE. **Date**
(HEAD OF DEPARTMENT)

_____

DR SAM OJEABURU **Date**
(PROJECT COORDINATOR)

_____

External Examiner **DATE**

DEDICATION

I dedicate this project work to the Person of the Holy Spirit, who has graciously given me a second chance and blessed me with the spirit of excellence and good works.

ACKNOWLEDGEMENT

With sincere gratitude, I acknowledge the contribution of the following esteem individuals who have played a huge role and helped shape this season relative to this project work. Prof. E.C. ONYENEKE (The HOD of Biochemistry Department), the man sent from God to me in trying times as this. Thanks for all you do and all you will continue to do. May God increase you on every side. The listening ears and the help on several occasions are worth celebrating. My project supervisor(Dr. Usifo), for your exceptional kindness, accessibility, and compassion. Your love and care for your students are truly remarkable, and I feel blessed to have had the opportunity to learn from you. Thank you so much for being patient with me. Thanks for believing in me so greatly. I stressed you and I know. But I'm convinced that God will reward you in no small way and such a reward will speak for your family. You'll reap this in no distant time. My Father (Prophet Adekunle Bright Taiwo), for being a constant source of inspiration and embodying the mercy of God through his unwavering love, support, and prayers. Your selflessness and dedication to my well-being have been a blessing. I love you sir. Barrister Catherine Kofo Agoni, for playing a motherly role in my life and providing unending support in every area. Your kindness, sacrifices, pieces of advises, and advocacy on my behalf have not gone unnoticed, and I'm forever grateful. Mr Adefehinti Samson, for being a true friend and partner in my academic journey. Your tireless efforts and sacrifices will never be forgotten, and I pray that God rewards you abundantly. This one will reach your desk. I shall loud your effort to many students as well. Akhabue Happiness (Happysmiles), for your genuine love, intercessory prayers, and sacrifices. Your support has meant a lot to me, and I'm grateful for your presence in my life. Thanks for going the extra mile to getting past questions for me as well. Ma'am Victoria, Ma'am Favour Chanwi, and Peter Chuks, for your help and support in academics, I must say GOD BLESS YOU immensely. Your

timely responses and guidance have been invaluable, and I appreciate your kindness.

Thank you all for being part of my journey!

LIST OF TABLES

LIST OF FIGURES

TABLE OF CONTENTS

INTRODUCTION AND LITERATURE REVIEW

CHAPTER TWO

MATERIALS AND METHODS

ABSTRACT

Arachis hypogaea l. (Groundnut) is a major leguminous oilseed crop widely cultivated in Nigeria for its nutritional and economic importance. It serves as a vital source of protein, oil, and bioactive compounds with health-promoting properties. Limited studies have integrated proximate, phytochemical evaluations of its varieties within different agro-ecological zones. This study aimed to carry out a comparative evaluation of the proximate, and phytochemical properties of two Arachis hypogaea varieties cultivated in Niger and Sokoto States, Nigeria. Standard analytical procedures of the Association of Official Analytical Chemists and the American Oil Chemists' Society were employed for proximate analysis while High Performance Liquid Chromatography (HPLC) was used for quantitative phytochemical

determination. Data were statistically analyzed using SPSS (version 25.0) with significance set at $p < 0.05$. The results revealed minor variations between the two varieties. Niger samples exhibited higher fibre (15.20%) and ash content, while Sokoto samples contained higher protein (8.40%) and carbohydrate (48.70%) levels. Qualitative phytochemical screening indicated the presence of flavonoids, steroids, terpenoids, and cardiac glycosides in both samples, with tannins detected only in the Sokoto variety. HPLC results showed that the Sokoto variety had significantly higher flavonoid and terpenoid concentrations ($p < 0.05$), suggesting stronger antioxidant potential. The observed compositional differences indicate that environmental and varietal factors influence the nutritional and phytochemical attributes of Arachis hypogaea. Both varieties demonstrated excellent nutritional and functional qualities suitable for food, nutraceutical, and industrial applications. In conclusion, the study underscores the nutritional richness and biochemical diversity of Arachis hypogaea, recommending the Sokoto variety for nutraceutical use and the Niger variety for fibre-rich food formulations. Future research integrating genetic and environmental profiling is suggested to enhance varietal improvement and industrial utilization.

Keywords: Proximate Analysis, Phytochemicals, HPLC, Arachis hypogaea, Niger Groundnut, Sokoto Groundnut.

CHAPTER ONE

INTRODUCTION AND LITERATURE REVIEW

1.1 INTRODUCTION

1.1.1 Background to the Study

Arachis hypogaea l. (groundnut) commonly referred to as peanut, is a major leguminous oilseed crop cultivated extensively in tropical and subtropical regions of the world. It thrives in warm climates and is grown both for its edible seeds and for oil production. Because of its dual purpose as a food and an industrial raw material, groundnut serves as a significant source of nutrition and income in many developing countries (Eze-Steven *et al*., 2020). Globally, groundnut production has contributed to food security, foreign exchange earnings, and the empowerment of smallholder farmers. In Nigeria, groundnut is a key cash crop particularly in the savanna regions, where it supports household livelihoods and serves as a vital raw material for agro-industrial value chains (Shokunbi *et al*., 2012).

From a nutritional standpoint, groundnut is highly valued due to its rich composition of proteins, fats, vitamins, and minerals. These attributes make it a major component in both traditional diets and processed food products. Several studies on proximate composition have reported significant nutritional values across varieties. Protein content in Nigerian groundnut varieties ranges between 24 and 26 percent, while fat content averages between 45 and 48 percent (Shokunbi *et al*., 2012). Other analyses also show protein values of approximately 38 percent, fat content around 47 percent, and moisture levels near 6 percent (Ojiodu, Akinhanmi, and Atasie, 2009). Such high oil content

underscores its importance as an oilseed crop used in cooking, margarine, and industrial applications.

Beyond its macronutrient profile, groundnut contains numerous bioactive phytochemical compounds such as phenolics, flavonoids, saponins, alkaloids, and resveratrol. These compounds possess antioxidant, anti-inflammatory, and cardioprotective properties. Phytochemicals in groundnut help neutralize free radicals, prevent lipid peroxidation, and lower the risk of degenerative diseases such as cancer, diabetes, and cardiovascular disorders (Eze-Steven *et al*., 2020). Studies have shown that groundnut varieties contain substantial levels of mineral elements such as phosphorus, calcium, magnesium, and potassium, alongside vitamins E, K, and B-complex (Mandal, 2014). These micro- and phytonutrients play essential roles in maintaining metabolic balance and supporting overall health.

Variation in nutritional and phytochemical composition among *Arachis hypogaea* varieties is influenced by both genetic and environmental factors. Differences in soil fertility, climatic conditions, and post-harvest handling methods all contribute to compositional diversity. Genetic variation has been shown to cause significant differences in oil yield and protein concentration, with some small-seeded varieties possessing higher protein content than large-seeded types (Abdullahi *et al*., 2021). Similarly, a proximate analysis conducted on Nigerian varieties (SAMNUT 23, 24, and 26) revealed lipid values of approximately 48 percent, protein content near 23 percent, and carbohydrate levels around 12 percent, indicating varietal differences in nutrient profiles (Olasan *et al*., 2024). Such findings are critical for selecting

varieties with superior nutritional quality suited to specific consumer or industrial needs.

The evaluation of proximate and phytochemical is fundamental in determining both the nutritional and industrial quality of groundnut. Proximate composition which includes moisture, crude protein, crude fat, ash, crude fibre, and carbohydrate content provides a quantitative basis for assessing the nutritive value of food materials. Low moisture content enhances storage stability, while higher fat and protein levels improve calorific value. Integrating proximate and phytochemical analyses provides a holistic assessment of groundnut quality. The application of High Performance Liquid Chromatography (HPLC) enables accurate separation, identification, and quantification of phytochemicals such as phenolic acids, flavonoids, and other antioxidants. This analytical approach allows researchers to compare the bioactive potential of different varieties, linking chemical composition to nutritional and functional attributes (Eze-Steven *et al*., 2020). Despite the importance of such analyses, only a limited number of studies have simultaneously examined these three aspects of groundnut varieties in Nigeria, leaving significant knowledge gaps regarding their comparative biochemical properties.

In Nigeria, groundnut remains a strategically important crop with substantial nutritional, economic, and industrial relevance. A study on varieties consumed in southwestern Nigeria reported moisture values ranging from 4 to 9 percent, protein content between 24 and 26 percent, and fat content between 45 and 48 percent, along with appreciable levels of β-carotene, thiamine, niacin, tocopherol, and minerals such as potassium, phosphorus, calcium, and

magnesium (Shokunbi *et al*., 2012). These findings demonstrate the crop's potential in addressing malnutrition and improving dietary diversity. Moreover, the high antioxidant activity of certain varieties indicates their potential for use in nutraceutical and functional food formulations, which can promote health and wellness in the population.

The comparative evaluation of groundnut varieties is therefore necessary to determine those with superior nutritional and phytochemical characteristics. Such information benefits multiple stakeholders across the agricultural and food systems. Plant breeders can identify and improve genotypes with desirable traits, food technologists can develop nutrient-dense and health-promoting products, and industrial processors can optimize oil extraction and refining based on quality indices. For public health and nutrition experts, understanding varietal differences supports dietary planning and the formulation of functional foods rich in antioxidants.

In addition, the data generated from comparative analyses can guide policymakers in promoting high-quality varieties for commercial cultivation and export. As Nigeria seeks to diversify its economy through agro-industrial development, comprehensive evaluation of groundnut varieties using proximate and HPLC techniques offers opportunities for value addition, rural empowerment, and sustainable agricultural growth.

Ultimately, groundnut serves as more than a dietary staple; it is a crop of economic and functional importance that bridges food security, nutrition, and industry. Comparative studies that integrate nutritional and phytochemical perspectives will not only enhance our understanding of varietal differences

but also contribute to improved food quality and health outcomes in Nigeria and beyond.

1.1.2 STATEMENT OF THE PROBLEM

Despite the well-documented importance of Arachis hypogaea (groundnut) as a food, oilseed and industrial crop, there remains a significant research gap relating to a truly comprehensive comparative evaluation of its varieties. Most existing investigations focus narrowly on individual parameters such as oil yield or crude protein content with limited integration of proximate composition and detailed phytochemical profiling. For example, studies analyzing the proximate composition of seeds do not always accompany phytochemical assessments (Olasan *et al*., 2024; Zongo *et al*., 2025). The omission of such integrative studies becomes problematic when one considers the complexity of factors that determine both nutritional value and functional potential of groundnut varieties. Although proximate analyses provide useful information on macronutrient composition (e.g., protein, fat, ash) (Sanni *et al*., 2024), they do not capture the full spectrum of health-promoting bioactive compounds including phenolics, flavonoids and other phytochemicals that contribute to antioxidant, anti-inflammatory or nutraceutical potential (Zhang *et al*., 2024; Çiftçi, 2022).

The knowledge gap is more than academic: the absence of comprehensive comparative data limits the ability of breeders to identify superior genotypes, limits food technologists in selecting varieties for value-added processing, and constrains the nutraceutical industry in identifying groundnut varieties rich in bioactive components. For example, a recent study of peanut varieties grown

in coastal saline soils found significant differences in nutritional quality and functional composition among the varieties (Zhang *et al*., 2024), demonstrating the importance of variety and environment but also showing that more work is needed. Accordingly, there is a pressing need to conduct a detailed comparative evaluation of selected groundnut varieties, integrating proximate composition and phytochemical profiling (preferably via HPLC) to produce a robust dataset. Such work will provide the scientific evidence required for variety selection, nutritional optimization, value-addition in groundnut-based products, and development of functional foods and nutraceuticals in Nigeria and comparable agro ecological regions. By addressing this gap, such a study will not only enhance the agricultural and nutritional value of groundnut, but also support industrial utilization, boost farmer incomes through selection of higher-value varieties, and contribute to human health outcomes via improved dietary and functional food options.

1.1.3 AIM AND OBJECTIVES OF THE STUDY

Aim:

The main aim of this study is to carry out a comparative evaluation of the proximate and phytochemical properties of two *Arachis hypogaea* (groundnut) varieties Niger and Sokoto groundnuts.

Specific Objectives:

The specific objectives of this study are to:

1. Determine the proximate composition (moisture, ash, crude fibre, crude fat, crude protein, and carbohydrate) of *Arachis hypogaea* varieties cultivated in Niger and Sokoto States.
2. Identify and quantify the phytochemical constituents such as flavonoids, steroids, terpenoids, cardiac glycosides, tannins, and phenols present in the ethanol extracts of both groundnut varieties.
3. Compare the nutritional and phytochemical profiles of the Niger and Sokoto groundnut varieties to establish varietal differences.
4. Evaluate the potential of these varieties for food, nutraceutical, and industrial applications based on their nutritional and bioactive properties.

1.1.4 RESEARCH QUESTIONS

To achieve the stated objectives, the study seeks to provide answers to the following research questions:

1. What are the proximate compositions of the Niger and Sokoto groundnut varieties?
2. How do the phytochemical properties of both varieties differ?
3. What phytochemical constituents are present in the ethanol extracts of the groundnut varieties?

4. Are there significant differences in the nutritional and phytochemical composition of the two *Arachis hypogaea* varieties?
5. Which of the two varieties exhibits superior nutritional and functional quality suitable for industrial or nutraceutical use?

1.1.5 SIGNIFICANCE OF THE STUDY

This study is of immense significance as it seeks to generate valuable scientific information on the nutritional and phytochemical composition of different Arachis hypogaea (groundnut) varieties. It is not only a vital source of food but also a major cash crop that contributes significantly to food security, income generation, and industrial development in many parts of Nigeria (Olayinka and Adeyeye, 2010). However, the lack of integrated studies that combine proximate and phytochemical analyses using advanced techniques such as HPLC has limited the full understanding and utilization of its nutritional and functional potential (Sanni *et al*., 2024). Therefore, this research provides a comprehensive scientific foundation for enhancing the nutritional quality, industrial relevance, and health benefits of groundnut varieties cultivated in different agro-ecological zones. By comparing the proximate composition of selected Arachis hypogaea varieties, this study will enable plant breeders and agricultural scientists to identify varieties with superior nutritional properties and biochemical composition suitable for large-scale cultivation. The findings will assist in varietal-selection programmes aimed at improving protein, lipid, and fibre content, while maintaining desirable oil yield and stability as observed in previous studies where crude fat ranged broadly among varieties (Olayinka *et al*., 2023). Such information is essential for the improvement of local groundnut strains through breeding and

selection processes that target nutritional enhancement and resilience to environmental stress.

The study will also benefit food technologists, nutritionists, and health professionals by providing scientific evidence on the nutritional and phytochemical composition of groundnut varieties, thereby facilitating the development of functional foods and nutraceutical products. The identification and quantification of bioactive compounds such as flavonoids, phenolics, and antioxidants through HPLC analysis will promote the utilization of groundnut as a health-promoting ingredient capable of reducing the risk of chronic diseases including diabetes, cardiovascular disorders, and cancer (Adaviruku *et al*., 2024). Consequently, the research supports the growing demand for natural, plant-based compounds with therapeutic potential in both food and pharmaceutical industries.

In addition, the study holds socioeconomic importance as it will encourage local farmers and other stakeholders in the groundnut value chain to adopt high-quality varieties that yield nutritionally rich and industrially valuable produce. This can lead to increased productivity, higher market value, and greater profitability, particularly for smallholder farmers who depend on groundnut cultivation as a source of livelihood. By promoting value-addition and improving access to market-oriented information, the study contributes to rural development and economic diversification in Nigeria's agricultural sector.

The research also has academic and policy relevance as it will enrich existing literature on the biochemical, nutritional, and phytochemical diversity of Arachis hypogaea varieties cultivated under Nigerian agro-ecological

conditions (Belete and Bayissa, 2020). The data generated can serve as a reference point for researchers, food scientists, and policymakers in developing future programmes focused on crop improvement, food fortification, and industrial utilization. Moreover, it supports evidence-based policy formulation aimed at promoting food quality, safety, and sustainability within the agricultural sector. Ultimately, this study will bridge existing knowledge gaps by integrating proximate, physicochemical, and HPLC-based phytochemical analyses to provide a holistic understanding of groundnut's nutritional and functional potential. The outcomes will contribute to advancing food science, improving public health, supporting industrial innovation, and enhancing Nigeria's agricultural productivity. Through its multidisciplinary approach, the research underscores the importance of scientific evaluation of indigenous crops as a pathway toward food security, sustainable agriculture, and national economic growth.

1.1.6 SCOPE OF THE STUDY

This study focuses on two varieties of *Arachis hypogaea* (Niger and Sokoto groundnuts) obtained from selected local farms in Niger and Sokoto States, Nigeria. The scope of analysis includes proximate composition and qualitative and quantitative phytochemical analyses of ethanol extracts. Advanced analytical techniques, particularly High Performance Liquid Chromatography (HPLC), are employed to identify and quantify key phytochemicals.

The study does not extend to molecular genetic characterization or field yield performance of the varieties; rather, it concentrates on laboratory-based comparative nutritional and phytochemical evaluation. The findings are therefore limited to the sampled varieties and environmental conditions under

which they were cultivated. However, the results will provide a useful scientific basis for nutritional optimization, food processing applications, and varietal improvement strategies for *Arachis hypogaea* in Nigeria.

1.1.7 JUSTIFICATION OF THE STUDY

Groundnut (Arachis hypogaea) is a major oilseed crop that provides a rich source of edible oil, protein, and essential nutrients vital to human health and economic development. However, the quality and composition of groundnut seeds vary due to environmental, genetic, and processing factors. A comprehensive evaluation of proximate and phytochemical properties is therefore justified to understand the nutritional and functional potential of different groundnut varieties.

Proximate analysis is necessary to determine the basic nutritional composition such as moisture, ash, crude protein, crude fat, crude fibre, and carbohydrates which reflects the food's energy value, storage quality, and overall nutritional worth.

Phytochemical analysis, including High-Performance Liquid Chromatography (HPLC), provides insights into the presence and concentration of bioactive compounds such as flavonoids, alkaloids, and phenolic acids that contribute to the antioxidant, therapeutic, and preservative properties of the groundnut. By integrating these analyses, the study will generate a holistic understanding of the nutritional, functional, and health-promoting attributes of the Niger and Sokoto groundnut varieties. The findings will support food scientists, nutritionists, and agricultural policymakers in promoting nutritionally superior varieties, improving processing standards, and contributing to food and nutritional security in Nigeria.

1.1.8 Definition of Key Terms

1. Proximate Analysis: The determination of the basic nutritional composition of a food sample, including moisture, protein, fat, fiber, ash, and carbohydrate.

2. Phytochemicals: Naturally occurring plant compounds such as phenols, flavonoids, tannins, and alkaloids that possess health-promoting properties.
3. HPLC (High Performance Liquid Chromatography): An advanced analytical technique used to separate, identify, and quantify compounds present in a mixture.
4. Arachis hypogaea Varieties: Different cultivated types of groundnut distinguished by seed color, size, oil content, and other agronomic traits.

1.2 LITERATURE REVIEW

1.2.1 Arachis hypogaea: Botany, Distribution, and Significance

The cultivated groundnut (*Arachis hypogaea l.*) is an annual leguminous plant belonging to the family Fabaceae. It features pinnate leaves, yellow papilionaceous flowers and a unique underground fruiting habit in which the fertilised ovary elongates and burrows into the soil to form the peanut pod (USDA ARS, 2015). The genus Arachis comprises roughly 80 species, most of which are diploid; A. hypogaea itself is an allotetraploid (2n=4x=40) believed to have derived from hybridization of two wild diploid species (USDA ARS, 2015). Cultivated peanuts are classified into two botanical subspecies; hypogaea and fastigiata and further grouped by growth habit, seed size and pod type (e.g., Virginia, Spanish, Runner, Valencia). This classification has implications for kernel composition, oil content and suitability for different climatic zones (Yadav *et al.*, 2018).

Domesticated in South America (likely the Paraguay–Bolivia region) about 5,000 to 7,000 years ago, groundnut has since been dispersed globally and

now thrives in tropical and subtropical regions between approximately 40°N and 40°S latitudes (USDA ARS, 2015). The ideal growth conditions include moderate temperatures (~25 °C), well-drained sandy loam soils, and a growing season of about 90–120 days (Yadav et al., 2018). Groundnut contributes significantly not only to nutrition but also to soil fertility via its nitrogen-fixing ability (Yadav *et al.,* 2018).

Economically and nutritionally, groundnut is of major importance. Global cultivation covers around 30–33 million hectares with annual unshelled nut production of approximately 50–54 million tonnes (Health aspects of peanuts, 2019). Major producers include China, India, Nigeria, the United States and Senegal. The kernel is energy-dense with about 25–26% protein and ~49–50% oil by weight — making groundnut a valuable oilseed crop and high-protein food source, especially in regions where other protein sources are limited (Health aspects of peanuts, 2019; Nutritional profiling of groundnut, 2023). The versatility of the crop extends to uses in roasted form, peanut butter, cooking oil, confectionery and animal feed, as well as non-food applications in cosmetics and pharmaceuticals. Thus, A. hypogaea stands at the intersection of agriculture, nutrition and industry.

1.2.2 Nutritional Composition and Proximate Analysis of Groundnut

The proximate composition of groundnut is extensively documented. On a dry weight basis, mature peanut kernels typically contain about 6–7% moisture, 25–26% crude protein, 49–50% fat, around 16% available carbohydrate and 7–9% dietary fibre (Healthline, 2023; Health aspects of peanuts, 2019). For example, Healthline reported 100 g raw peanuts contain 6.5% water, 25.8 g protein, 49.2 g fat, 16.1 g carbohydrate and 8.5 g fibre (Healthline, 2023).

Another review indicated ranges of moisture 4.9–6.8%, protein 21–36.4%, fat 36–54%, carbohydrate 21–37%, ash 1.2–2.3%, crude fibre 1.4–3.9% in various groundnut accessions (Yadav *et al.*, 2018).

The protein quality is high; peanut proteins contain all essential amino acids in favourable proportions, which makes them comparable with some animal proteins (Composition of nuts review, 2023). The fatty acid profile is dominated by unsaturated fatty acids — monounsaturated oleic acid (~36–72%) and polyunsaturated linoleic acid (~13–48%) — while saturated palmitic acid is about 5–6% (Composition of nuts review, 2023). Minor lipids including stearic, arachidic and behenic acids are present in single-digit percentages.

Groundnuts also offer valuable micronutrients: significant amounts of potassium, phosphorus, magnesium, calcium and trace elements such as iron and zinc are reported (Composition of nuts review, 2023). They supply B-vitamins (especially niacin, folate) and vitamin E (α-tocopherol ~0.08–0.11 mg/100 g) (Yadav et al., 2018). Some varieties with coloured testa contain carotenoids: for example, a study of Bangladeshi cultivars found β-carotene up to ~91.8 mg/100 g in the highest variety (Nutritional quality of peanut varieties, 2023). In addition to nutrients, peanut seeds contain bioactive macromolecules (e.g., trypsin inhibitors, allergenic proteins) though these are outside the standard proximate analysis scope.

Processing affects nutrient composition. For example, one Nigerian study showed that raw, boiled and fried groundnuts underwent significant variations in moisture (5.36%, 4.55%, 3.90%), fat, fibre, protein, carbohydrate and mineral contents after processing (Sanni *et al.*, 2024). Such changes

underscore the importance of considering processing state when evaluating nutritional composition. Because proximate analysis provides foundational data on moisture, protein, fat, ash, crude fibre and carbohydrates, it remains indispensable for assessing the basic nutritive value of groundnut varieties. Differences among varieties, growing environments and processing methods create the need for comparative varietal evaluation, especially when the objective is to select high-nutrient or value-added cultivars.

1.2.3 Phytochemicals in Groundnut and Their Health Benefits

Apart from macronutrients and oil, peanuts contain a rich array of phytochemicals with health-promoting attributes. Major classes include phenolic compounds (flavonoids, phenolic acids, stilbenes), phytosterols, tocopherols and squalene (Nutritional chemistry of the peanut, 2015). Notably, peanut skins are concentrated in antioxidants such as resveratrol, proanthocyanidins and other phenolics (Peanuts as functional food, 2015). Defatted peanut meal (press-cake) often retains higher levels of phenolics and flavonoids than whole flour — one study found approximately double the total phenolic content in defatted meal compared to whole groundnut flour (Research advances in high-value peanut meal utilisation, 2023).

The health benefits associated with these phytochemicals are substantial. Regular peanut consumption has been linked with reduced cardiovascular disease risk, improved lipid profiles and better glycemic control (Nutritional chemistry of the peanut, 2015). Peanut phytochemicals may scavenge free radicals, reduce oxidative stress and thereby mitigate chronic diseases including diabetes, cardiovascular disease and cancer (Nutritional and health benefits of peanut, 2022). For example, resveratrol, present in peanut skin and

kernel, exhibits anti-inflammatory and chemoprotective properties (Peanuts as functional food, 2015). Phytosterols in peanut oil have been shown to lower blood cholesterol levels, while dietary fibre and magnesium contribute to metabolic health (Nutritional profiling of groundnut, 2023).

In addition, phenolic and flavonoid content in peanut oil correlates positively with oxidative stability and shelf life, as demonstrated in recent research (Ciou *et al.*, 2021). These functional attributes make peanut not just a nutritious crop but a candidate for functional-food and nutraceutical development.

1.2.4 Techniques for Phytochemical Screening and Quantification: Focus on HPLC

Initial phytochemical screening of plant materials typically involves qualitative colour-reaction tests. For example, frothing indicates saponins, Dragendorff's reagent precipitates alkaloids, NaOH/HCl changes colour for flavonoids, and $FeCl_3$ complexation gives a greenish-black colour for tannins (Sann*i et al.,* 2024). While these qualitative methods provide a preliminary profile of compounds, quantitative and precise separation of phytochemicals requires chromatography.

High-Performance Liquid Chromatography (HPLC) is widely used for profiling plant secondary metabolites, especially phenolic acids and flavonoids (Adil *et al.*, 2020). In HPLC, extracts (for example methanolic or acetone extracts of kernels or skins) are injected into reverse-phase columns, and compounds are separated by polarity, eluted and detected via UV/Vis absorbance or photodiode array detectors. Many peanut studies now employ HPLC (sometimes coupled with diode-array or mass spectrometric detectors)

to quantify flavonoids (kaempferol, quercetin, luteolin), phenolic acids (caffeic, ferulic) and stilbenes (resveratrol) (Ciou et al., 2021). Quantification is accomplished by comparing peak areas with known standards, and often both free and bound phenolic forms are analysed via hydrolysis pre-treatment (Ciou *et al*., 2021). HPLC thus offers specificity and sensitivity, essential for varietal comparisons and understanding bioactive compound distribution.

Complementary methods include UV/Vis spectrophotometric assays (e.g., Folin–Ciocalteu for total phenolics and $AlCl_3$ method for total flavonoids), gas chromatography for oil fatty-acid composition and spectrometric mineral analyses (Sanni *et al*., 2024). For a study comparing varieties across proximate, physicochemical and phytochemical dimensions, an integrated approach using HPLC is indispensable.

1.2.5 Empirical Studies: Comparing Groundnut Varieties

Numerous empirical studies have compared nutrient composition and bioactive content of peanut cultivars, although fewer integrate all dimensions (proximate, oil chemistry, phytochemicals). For instance, a recent survey of 16 Bangladeshi peanut cultivars found significant differences in proximate and mineral composition: fat content upto ~49.6% and β-carotene up to ~91.8 mg/100 g in some lines (Nutritional quality of peanut varieties, 2023). Another investigation of four Myanmar peanut seed varieties found crude fat ~39.1–39.6% in raw and roasted forms and crude fibre ~2.9–3.1% (Evaluation of proximate compositions in four peanut seed varieties, 2022). In Nigeria, a study across eight cultivars analysed proximate, amino acid and fatty acid composition and emphasised the need for selection of promising varieties for

oil stability and nutritional value (Proximate and fatty acid profiles of eight groundnut cultivars, 2024).

Comparative oil-quality studies have also been executed. In model oil blends derived from peanut, it was demonstrated that increasing oleic/linoleic (O/L) ratio dramatically improved oil shelf life and reduced density and refractive index (Peanut oil stability and physical properties, 2013). A recent study by Zhang *et al*. (2022) found roasting at 190 °C for 30 min significantly enhanced oil quality and antioxidant activity in peanut kernel oils, signaling processing × variety interactions.

Phytochemical comparisons are fewer but growing. For example, Ciou et al. (2021) compared roasted peanut oils and reported that tocopherol, phytosterol, phenolic and flavonoid content were positively correlated with oil oxidative stability across genotypes. The "Peanuts as functional food" review (2015) noted that total phenolic and flavonoid content in peanut skin and defatted meal is influenced by genotype and processing. Despite these findings, studies incorporating full nutritional, physicochemical and HPLC-quantified phytochemical profiles of multiple varieties remain rare.

1.2.6 Research Gaps and Justification for the Current Study

While substantial data exist on peanut nutrition, oil chemistry and bioactivity, gaps remain. First, few studies integrate proximate composition, and HPLC-quantified phytochemical profiles in a single comparative framework across multiple varieties. Many investigations focus either on proximate nutrients, oil fatty acid profiles, or bioactive compounds, but seldom combine all three dimensions.

Second, although variety-related variation is documented, there remains limited data on Nigerian groundnut varieties (or specific regional varieties) analysed for all these parameters. Third, processing and environment-variety interactions (e.g., roasting, soil salinity) affect composition but are seldom examined in a holistic manner. Fourth, while HPLC quantification of phenolic and flavonoid compounds is increasing, data linking phytochemical profiles to nutritional and oil quality traits in peanut varieties are scarce.

Therefore, the current study is well-justified: by performing a comparative evaluation of selected Arachis hypogaea varieties using proximate analysis and HPLC quantification of phytochemicals, the research will generate comprehensive data that inform varietal selection, value-addition and functional food development. The study will fill important gaps and provide a robust foundation for breeders, food technologists, nutritionists and industry stakeholders.

CHAPTER TWO
MATERIALS AND METHODS

2.1 MATERIAL

2.1 Sample Collection and Preparation

Two distinct varieties of *Arachis hypogaea (N*iger and Sokoto groundnuts) were purposively selected based on their regional cultivation, availability, and reported differences in oil yield, kernel size, and color. The samples were obtained from reputable agricultural markets in Niger and Sokoto States, ensuring that only fresh, mature, and unspoiled seeds were used for the analyses. After collection, the groundnuts were manually sorted to remove debris, stones, damaged seeds, and foreign materials to prevent contamination and maintain uniformity in the analytical results.

The cleaned samples were then oven-dried at **60°C for 24 hours** to reduce moisture content and prevent microbial growth, which could otherwise alter chemical composition during storage or analysis. The dried seeds were subsequently dehulled and milled into fine powder using a laboratory grinder to achieve homogeneity. The powdered samples were sieved through a **2 mm mesh** to ensure uniform particle size, then stored in airtight containers under cool, dry conditions until further analysis.

This standardized sample preparation procedure was essential to maintain consistency and reliability across proximate and phytochemical analyses, thereby ensuring that observed variations were due to genetic and environmental differences rather than sample handling errors (Aremu *et al*., 2019).

2.2 Proximate Analysis

The proximate composition of the Arachis hypogaea varieties was determined to assess their basic nutritional quality using the standard procedures of the Association of Official Analytical Chemists (AOAC, 2000). The parameters analyzed included

moisture content, ash content, crude protein, crude fat, crude fibre, and carbohydrate content. These parameters provide essential information on the nutritional value, storage stability, and industrial potential of the groundnut varieties.

Moisture content determination helped establish the dryness and shelf-life of the samples, while ash content provided an estimate of the total mineral matter present. Crude protein content was determined using the micro-Kjeldahl method, which measures nitrogen and converts it to protein using a standard conversion factor. Crude fat, representing the lipid fraction, was extracted using the Soxhlet extraction method with petroleum ether as the solvent. Crude fibre estimation provided insight into the indigestible carbohydrate fraction that aids digestion and supports human health. Carbohydrate content was obtained by difference, accounting for the remaining portion after summing all other proximate constituents.

Each analysis was carried out in triplicate to ensure accuracy and reproducibility. The results were expressed as a percentage of the dry weight of the samples, providing a reliable basis for nutritional comparison between the Niger and Sokoto groundnut varieties.

2.2.1 Determination of Ash Content

The determination of ash content in food samples is a crucial analytical procedure used to estimate the total amount of inorganic minerals present. In this study, the total ash content of the groundnut (Arachis hypogaea) varieties was determined using the dry ashing method as recommended by the Association of Official Analytical Chemists (AOAC, 2000). This method involves the complete combustion of organic matter at high temperatures, leaving behind the inorganic mineral residue as ash. The ash value serves as an indicator of the mineral composition and helps to evaluate the nutritional and physiological significance of food materials. It also gives an estimate

of the total amount of minerals such as calcium, potassium, magnesium, sodium, zinc, and iron that are naturally present or that may have been introduced during processing. In this procedure, one gram of each oven-dried groundnut sample was accurately weighed using a digital analytical balance and transferred into a clean, dry porcelain crucible of known weight. The crucibles were preheated in a muffle furnace at 500°C for about 30 minutes to remove any moisture or contaminants that might interfere with the analysis, then cooled in a desiccator before use. After weighing, each crucible containing the groundnut sample was placed on a low flame or a hot plate to char the organic matter. This preliminary step was necessary to prevent spattering and loss of material during ashing. Once charring was complete, the crucibles were transferred into a muffle furnace and subjected to ignition at temperatures ranging from 500°C to 600°C for approximately three hours.

The samples were heated until a constant light gray or whitish ash residue was obtained, signifying complete oxidation of organic constituents. After ashing, the crucibles were carefully removed from the furnace using tongs and placed in a desiccator to cool for about 30 minutes at room temperature. This prevented moisture absorption from the atmosphere, which could otherwise alter the weight of the residue. Each crucible was then reweighed to obtain the weight of the residual ash.

The ash content of each sample was calculated using the formula:

$$\% \text{ Ash} = ((W_2 - W_0) / (W_1 - W_0)) \times 100$$

Where:

W_0 = weight of empty crucible (g),

W_1 = weight of crucible with sample before ashing (g), and

W_2 = weight of crucible with ash after ashing (g).

All analyses were conducted in triplicate to ensure accuracy and reproducibility, and the mean values were recorded as the percentage ash content. The ash value represents the total mineral matter remaining after the combustion of organic matter. High ash content indicates a higher concentration of mineral elements, which contributes to the nutritional value of the food, whereas a low ash content may suggest lower mineral density or a higher proportion of organic matter.

The determination of ash content is also critical in assessing food quality and purity. Excessively high ash values can indicate contamination with extraneous materials such as sand or soil during harvesting and processing. Conversely, moderate ash content reflects an optimal mineral composition, which enhances the nutritional profile of groundnut seeds. The procedure thus provides a valuable index for nutritional evaluation, quality control, and formulation of food and feed products derived from groundnut varieties.

2.2.2 Determination of Crude Protein

The crude protein content of the groundnut samples was determined using the **micro-Kjeldahl method**, a widely accepted and standardized procedure for the quantification of total nitrogen in food materials as outlined by the Association of Official Analytical Chemists (AOAC, 2000). This method is based on the principle that all organic nitrogen present in the sample is converted to ammonium sulfate through digestion with concentrated sulfuric acid (H_2SO_4) in the presence of a catalyst. The total nitrogen content is then determined and multiplied by a conversion factor (6.25) to estimate the crude protein content, assuming that proteins contain approximately 16% nitrogen.

The method involves three main stages: **digestion, distillation, and titration**. During digestion, one gram of finely ground, dried groundnut sample was accurately weighed and transferred into a Kjeldahl flask. To this, 1 mL of 4% copper sulfate solution and approximately 0.8 g of potassium sulfate were added as catalysts to increase the boiling point of sulfuric acid and facilitate oxidation. Then, 10 mL of concentrated sulfuric acid (H_2SO_4) was added to the flask, and the mixture was heated gently at first to prevent frothing and then vigorously until the digest became clear and light blue or pale yellow. This indicated the complete conversion of organic nitrogen into ammonium sulfate.

After digestion, the flask was allowed to cool, and the digest was diluted with 4 mL of distilled water. The distillation process was carried out using a Kjeldahl distillation apparatus. To the cooled digest, 10 mL of 30% sodium hydroxide (NaOH) solution was added to make the solution strongly alkaline, which liberates ammonia (NH_3) from the ammonium sulfate formed during digestion. The liberated ammonia gas was then distilled and trapped into a conical flask containing 10 mL of 0.01 M hydrochloric acid (HCl) with a drop of methylene red indicator.

The next stage involved titration. The ammonia absorbed in HCl formed ammonium chloride, and the amount of acid neutralized by ammonia was determined by back titration with 0.01 M sodium hydroxide (NaOH). The titration was carried out until the color changed from red to pale pink, indicating the endpoint. A blank determination was also performed using the same procedure but without a sample to account for any nitrogen present in the reagents.

The percentage nitrogen in the sample was calculated using the formula:

% Nitrogen = (Titre value (blank – distillate) × 0.14) / Weight of sample

The percentage of crude protein was then derived by multiplying the nitrogen content by the conventional conversion factor 6.25, as shown below:

% Protein = % Nitrogen × 6.25

All analyses were performed in triplicate to ensure precision and reproducibility, and the results were expressed as the mean percentage of dry weight.

Determining crude protein is essential in assessing the nutritional quality of food materials. In the case of groundnuts, protein constitutes one of the most important macronutrients, contributing significantly to dietary energy and human health. A high protein content reflects the suitability of a variety for food fortification, animal feed production, and industrial processing. The use of the micro-Kjeldahl method provides reliable and accurate results, making it the preferred analytical technique for protein estimation in agricultural and food chemistry studies.

2.2.3 Determination of Crude Fat

The crude fat content of the groundnut samples was determined using the **Soxhlet extraction method** as described by the Association of Official Analytical Chemists (AOAC, 2000). This method is one of the most reliable and widely employed procedures for estimating the total lipid content in food and agricultural materials. It involves continuous extraction of fat from a solid sample using an organic solvent—usually petroleum ether or diethyl ether—under reflux conditions. The principle of the method is based on the solubility of fats and oils in non-polar solvents, allowing the

lipid fraction to be separated from the sample matrix through repeated washing with the solvent.

In this procedure, one gram of each finely ground and dried groundnut sample was accurately weighed and wrapped in a filter paper or placed in an extraction thimble made of cellulose. The thimble was securely fitted into the main chamber of the Soxhlet extractor, which was connected to a pre-weighed round-bottom flask and a reflux condenser. Petroleum ether (boiling point range 40–60°C) was used as the extraction solvent because of its efficiency in dissolving fats and low reactivity. Approximately 250 mL of petroleum ether was poured into the flask, and the apparatus was assembled and placed on a heating mantle.

The extraction process was carried out for **six to eight hours**, during which the solvent was repeatedly vaporized, condensed, and siphoned through the sample. This continuous process ensured that all soluble fats and oils were completely extracted from the sample into the solvent. After the extraction was completed, the solvent containing the dissolved fat was collected in the round-bottom flask. The solvent was then recovered by distillation, leaving behind the crude fat in the flask.

The flask was placed in an oven at 105°C for one hour to remove any residual solvent and then cooled in a desiccator to room temperature. The flask was subsequently weighed to determine the weight of the extracted fat. The crude fat content was calculated using the formula:

$\% \text{ Fat} = ((W_3 - W_2) / (W_1 - W_0)) \times 100$

Where:

W_0 = weight of empty thimble (g)

W_1 = weight of thimble + ground sample (g)

W_2 = weight of empty extraction flask (g)

W_3 = weight of extraction flask + extracted fat (g)

All analyses were carried out in triplicate to ensure precision and the mean values were recorded. The crude fat content was expressed as a percentage of the sample's dry weight.

Crude fat represents the total lipid fraction in the groundnut samples, including triglycerides, phospholipids, and other soluble lipids. Determination of crude fat is important because lipids are major sources of energy, essential fatty acids, and fat-soluble vitamins in human nutrition. Additionally, in groundnut studies, crude fat content is a critical quality parameter that determines the economic value of the crop for oil extraction and industrial applications. High crude fat content is desirable in varieties intended for edible oil production, while moderate values are favorable for food formulations requiring balanced energy content.

Thus, the Soxhlet extraction method provides an accurate, reproducible, and efficient means of estimating the crude fat content, ensuring reliable comparison between the Niger and Sokoto groundnut varieties.

2.2.4 Determination of Crude Fibre

The crude fibre content of the groundnut samples was determined using the acid-base digestion method as described by the Association of Official Analytical Chemists (AOAC, 2000). This method involves the sequential digestion of the defatted sample with dilute acid and alkali solutions to simulate the chemical degradation that occurs in the human gastrointestinal tract. The residue obtained after this process represents the indigestible portion of carbohydrates, mainly cellulose and lignin, collectively referred to as crude fibre. Crude fibre is an important dietary component that contributes to digestive health, reduces blood cholesterol levels, and enhances nutrient absorption.

In this procedure, approximately one gram of the defatted groundnut sample (obtained after Soxhlet extraction) was accurately weighed into a 500 mL conical flask. To the sample, 200 mL of 1.25% sulfuric acid (H_2SO_4) was added, and the mixture was gently boiled for 30 minutes to hydrolyze and remove water-soluble carbohydrates, proteins, and certain minerals. The hot mixture was filtered through a muslin cloth or filter paper and washed thoroughly with hot distilled water to remove all traces of acid.

The residue remaining after acid digestion was then transferred to a clean flask, and 200 mL of 1.25% sodium hydroxide (NaOH) solution was added. The mixture was again boiled for 30 minutes to remove additional soluble organic components such as hemicellulose and residual starch. After this alkaline digestion, the mixture was filtered and washed successively with hot distilled water, 1% hydrochloric acid, and finally three times with petroleum ether or ethanol to eliminate residual fats and alkalis.

The residue obtained after washing was transferred into a pre-weighed crucible and dried in a hot-air oven at 105°C for about 12 hours or until a constant weight was achieved. The dried sample was cooled in a desiccator and weighed to obtain the dry weight (W_1). The crucible containing the dried residue was then placed in a muffle furnace and ignited at 550°C for 90 minutes to burn off organic matter, leaving only the mineral ash. The crucible was again cooled in a desiccator and reweighed to obtain the ash weight (W_2).

The crude fibre content was calculated using the formula:

$$\% \text{ Crude Fibre} = ((W_1 - W_2) / W_0) \times 100$$

Where:

W_0 = weight of sample (g)

W_1 = weight of crucible and dried residue after digestion (g)

W_2 = weight of crucible and ash after incineration (g)

All determinations were carried out in triplicate to minimize experimental error, and the mean values were recorded.

Crude fibre content provides valuable insight into the indigestible carbohydrate portion of the sample. A higher fibre content in food materials is associated with improved intestinal motility and reduced risk of cardiovascular and metabolic diseases. In the case of groundnuts, moderate levels of crude fibre are nutritionally desirable, as they support digestion while maintaining the food's energy density. Comparing the crude fibre levels between the Niger and Sokoto varieties enables a better understanding of their nutritional composition and suitability for dietary and industrial food formulation purposes.

2.2.5 Determination of Carbohydrate Content

The carbohydrate content of the groundnut samples was determined by the **difference method** as described by the Association of Official Analytical Chemists (AOAC, 2000). This indirect method estimates the total carbohydrate fraction by subtracting the sum of the percentages of other major proximate components namely moisture, crude protein, crude fat, crude fibre, and ash from 100%. Carbohydrates are one of the most important classes of macronutrients, serving as the body's primary source of energy. In legumes such as groundnuts, carbohydrates also contribute to seed development, flavor, and textural quality, as well as influencing their suitability for processing and storage.

The difference method was employed in this study because it provides a simple, accurate, and reliable means of estimating total carbohydrate content, especially in plant-based food materials where carbohydrates exist in complex forms such as starches, sugars, and non-starch polysaccharides. Each proximate component was first determined using standard analytical procedures, and the carbohydrate value was then computed mathematically. The calculation was performed using the following expression:

% Carbohydrate = 100 – (% Moisture + % Ash + % Crude Fibre + % Crude Fat + % Crude Protein)

Where:

% Moisture = percentage of water content in the sample

% Ash = total mineral residue

% Crude Fibre = indigestible carbohydrate fraction

% Crude Fat = total lipid content

% Crude Protein = nitrogen-based protein fraction

All analyses were conducted in triplicate to ensure accuracy, and the mean values were recorded. The results were expressed as a percentage of the sample's dry weight.

Although this method provides total carbohydrate by difference rather than by direct quantification, it remains one of the most widely accepted procedures in food analysis due to its efficiency, reproducibility, and ability to account for all macronutrients within the sample. The value obtained represents the total carbohydrate content, including soluble sugars, starch, and some insoluble polysaccharides that remain after digestion of protein, fat, and fibre fractions.

The total carbohydrate content plays a vital role in evaluating the nutritional composition of groundnuts. Carbohydrates provide energy for metabolic processes and influence the sensory and physical properties of food, such as taste, texture, and bulk. Moreover, the balance between carbohydrate, protein, and fat determines the caloric value and dietary quality of the food product. In oil-rich seeds like groundnut, carbohydrate content is typically lower than fat and protein content, but it still contributes to the overall energy density and digestibility.

Comparing the carbohydrate contents between the Niger and Sokoto groundnut varieties offers insight into their nutritional variations and potential uses. Varieties with higher carbohydrate levels may be more suitable for food products that require energy-dense ingredients, while those with lower carbohydrate but higher fat and protein contents may be better suited for oil extraction and protein-enriched formulations.

In summary, the carbohydrate determination by difference method provides a reliable estimate of the total carbohydrate fraction in groundnut samples. It complements other

proximate parameters, allowing for a complete nutritional profile of the varieties under investigation and supporting their evaluation for dietary and industrial applications.

2.3 Phytochemical Analysis

Qualitative phytochemical screening identified flavonoids, tannins, steroids, and phenols using colorimetric methods outlined by Harborne (1998). Quantitative and HPLC analysis determined concentrations of key bioactive compounds.

2.4 High Performance Liquid Chromatography (HPLC) Analysis

HPLC was used for phenolic and flavonoid quantification with a C18 column, methanol-water (70:30 v/v) as mobile phase, and detection at 280 nm (Adil *et al*., 2020).

2.5 Statistical Analysis

The data generated from the proximate and phytochemical analyses of the groundnut varieties were statistically analyzed using the Statistical Package for the Social Sciences (SPSS) version 25.0. The data were first recorded in Microsoft Excel for proper organization, tabulation, and preliminary checks for consistency and accuracy before being imported into SPSS for statistical evaluation.

All results obtained were expressed as mean ± standard deviation (SD) of triplicate determinations to ensure precision and reliability. Descriptive statistics such as means, standard errors, and coefficients of variation were used to summarize the data. The mean values of different parameters such as moisture, ash, crude fat, crude protein, crude fibre, carbohydrate, acid value, iodine value, and phytochemical contents were compared across the groundnut varieties.

Inferential statistics were applied to evaluate the significance of observed differences between the two varieties (Niger and Sokoto groundnuts). A one-way Analysis of Variance (ANOVA) was used to test whether the means of the measured parameters differed significantly among the samples. The level of significance was set at $\mathbf{p < 0.05}$, meaning that differences were considered statistically significant if the probability of error was less than 5%.

Where significant differences were detected, post hoc tests such as Tukey's Honestly Significant Difference (HSD) were applied to identify which specific sample pairs differed. The statistical approach provided a rigorous and objective basis for interpreting the data.

Graphical representations such as bar charts and error bars were also generated where necessary to illustrate the variations in the proximate and phytochemical properties between the groundnut varieties. This comprehensive data analysis ensured accurate interpretation of results and facilitated the identification of the superior groundnut variety based on nutritional and chemical characteristics.

2.5 Ethical Considerations

All laboratory procedures for this research were carried out in strict compliance with institutional safety standards and ethical guidelines governing the handling of biological materials and chemical reagents. The study involved only plant materials (groundnut varieties) and did not include any human or animal subjects; therefore, no special ethical clearance was required. However, care was taken to ensure that all experimental activities were performed responsibly, minimizing environmental and occupational risks.

Groundnut samples were sourced ethically from local agricultural markets in Niger and Sokoto States with the consent of the farmers and traders. The collection process was conducted in a manner that respected local agricultural practices and ensured no disruption to community livelihoods. Each sample was properly labeled and stored to maintain traceability and authenticity.

In the laboratory, all personnel adhered to safety protocols, including the use of personal protective equipment such as lab coats, gloves, and safety goggles. Hazardous chemicals, including sulfuric acid, sodium hydroxide, and petroleum ether, were handled carefully under fume hoods and disposed of following institutional waste management policies and environmental regulations. Proper ventilation and fire safety precautions were maintained throughout the analytical processes.

The research also ensured the integrity and accuracy of data collection, analysis, and reporting. Data were recorded meticulously to avoid fabrication, falsification, or misrepresentation of results. All analytical instruments were calibrated before use, and procedures were performed in triplicate to maintain reliability and reproducibility.

In summary, the study upheld ethical principles of honesty, transparency, safety, and environmental responsibility, ensuring that the research process and outcomes align with global standards for scientific and academic integrity.

CHAPTER THREE

RESULTS

3.1 RESULT OF PROXIMATE ANALYSIS

From the table below, there is large amount of crude fat and carbohydrate in the Arachis hypogaea, moderate amount of crude fiber, moisture content, crude protein and ash content.

PROXIMATE ANALYSIS	Mean ± SEM(%)
Moisture Content (%)	6.45 ± 0.73
Ash Content (%)	2.15 ± 0.37
Crude fibre (%)	14.6515 ± 0.325
Crude Fat (%)	20.582 ± 0.04
Crude Protein (%)	8.2665 ± 0.105
Carbohydrate (%)	47.9 ± 0.695

Data presented in MEAN ± SEM obtained from triplicate experiments.

3.1.1 QUANTITATIVE SCREENING

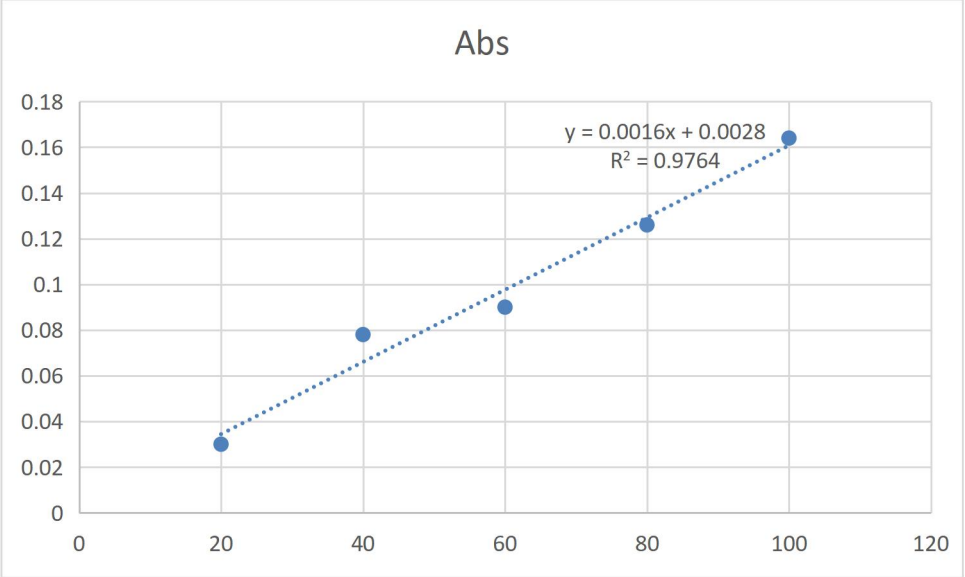
1. **Standard Calibration Data (Quercetin, 100 µg/mL)**

Amount (µg)	**Absorbance @510 nm**
0	0.00
20	0.03
40	0.078
60	0.09
80	0.126
100	0.164

2. Sample Absorbance Data for Flavonoids Extract

Sample ID	Abs @510 nm	X (A) µg/mL	X (A) mg/mL
A1	0.786	489.5	0.4895
A2	0.788	490.75	0.49075
A3	0.796	495.75	0.49575
B1	1.083	675.125	0.675125
B2	1.083	675.125	0.675125
B3	1.086	677	0.677

- The **X (A) µg/mL** values are derived from the calibration curve using the sample absorbance.
- The **X (A) mg/mL** column is simply the µg/mL value divided by 1000.



3.1.2 QUALITATIVE SCREENING

ETHANOL EXTRACT

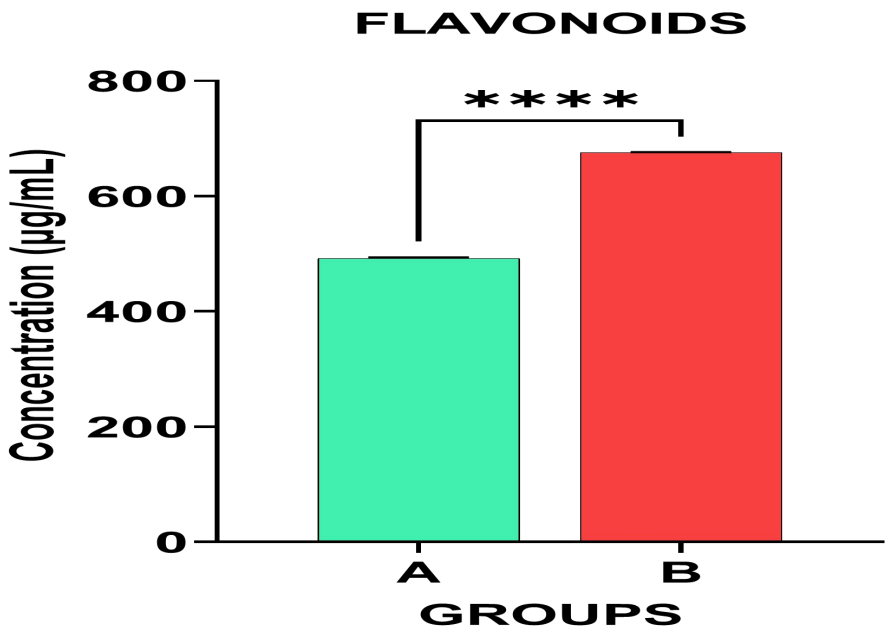
PHYTOCHEMICALS	SAMPLE A	SAMPLE B
FLAVONOIDS	+	+
TANNINS	-	+
CARDIAC GLYCOSIDES	+	+
PHLOBATANNINS	-	-
STEROIDS	+	+
TERPENOIDS	+	+
ANTHROQUINONE	-	-
SAPONINS	-	-
COUMARIN	-	-
ALKALOIDS	-	-
PHENOLS	-	-

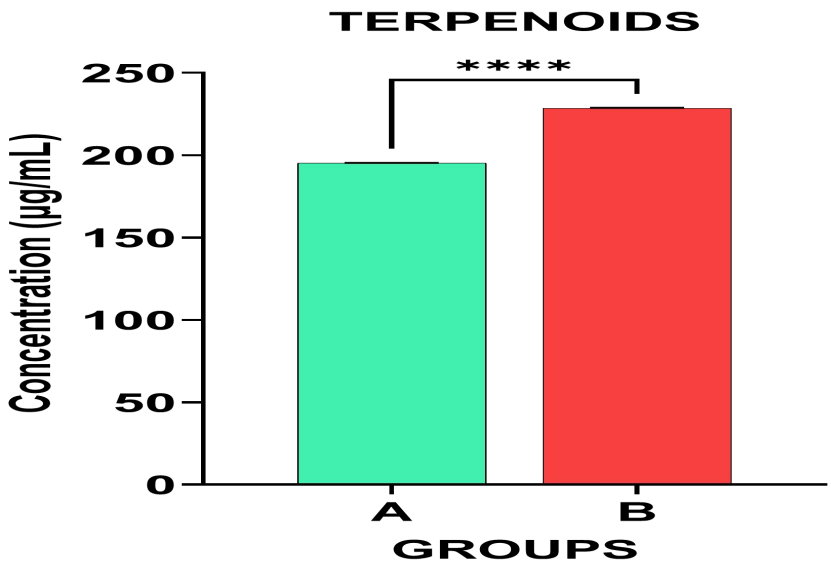
KEY

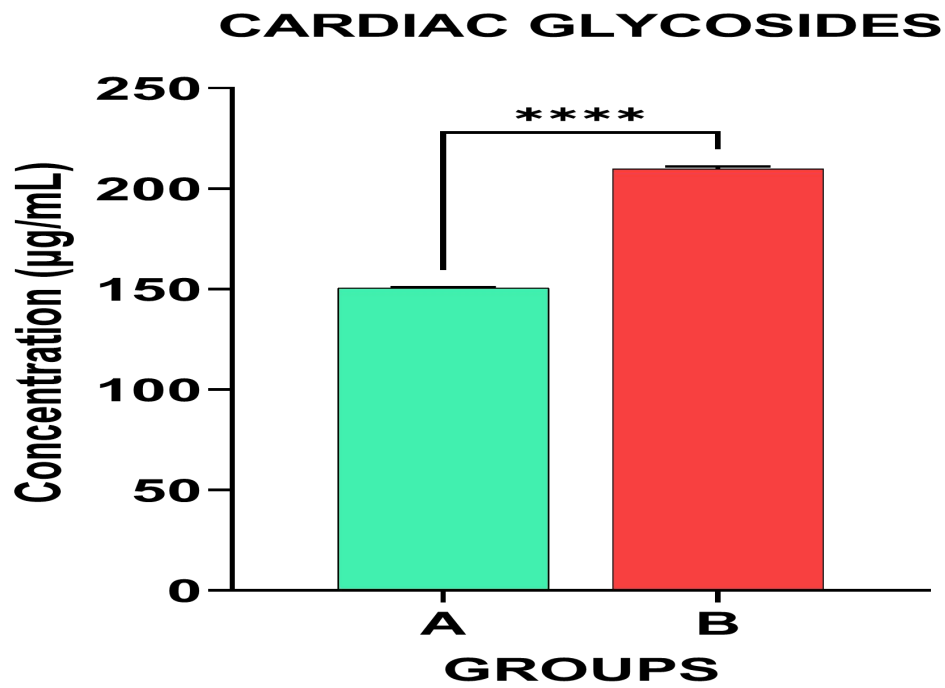
SAMPLE A = NIGER GROUNDNUT

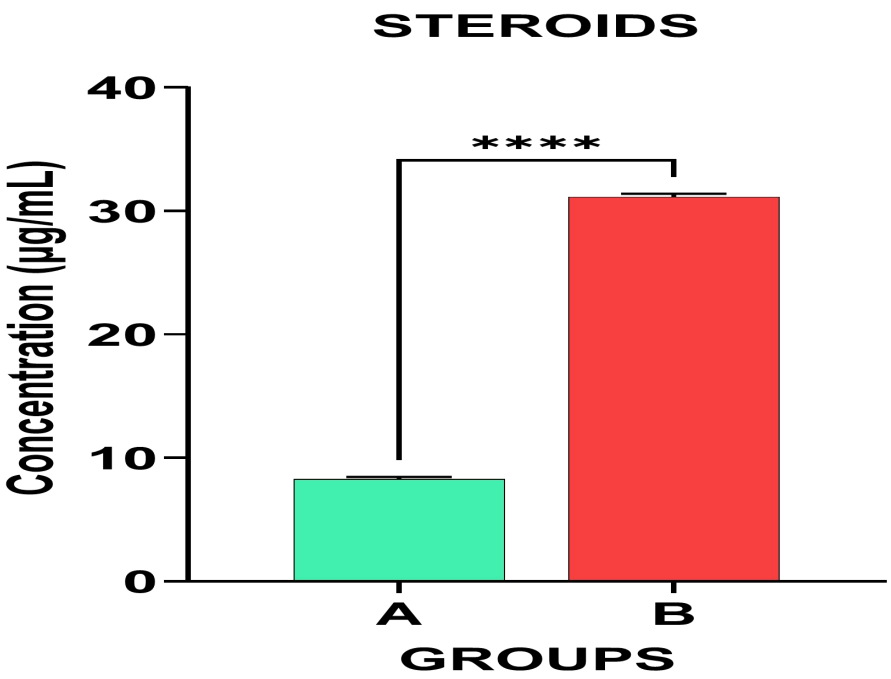
SAMPLE B = SOKOTO GROUNDNUT

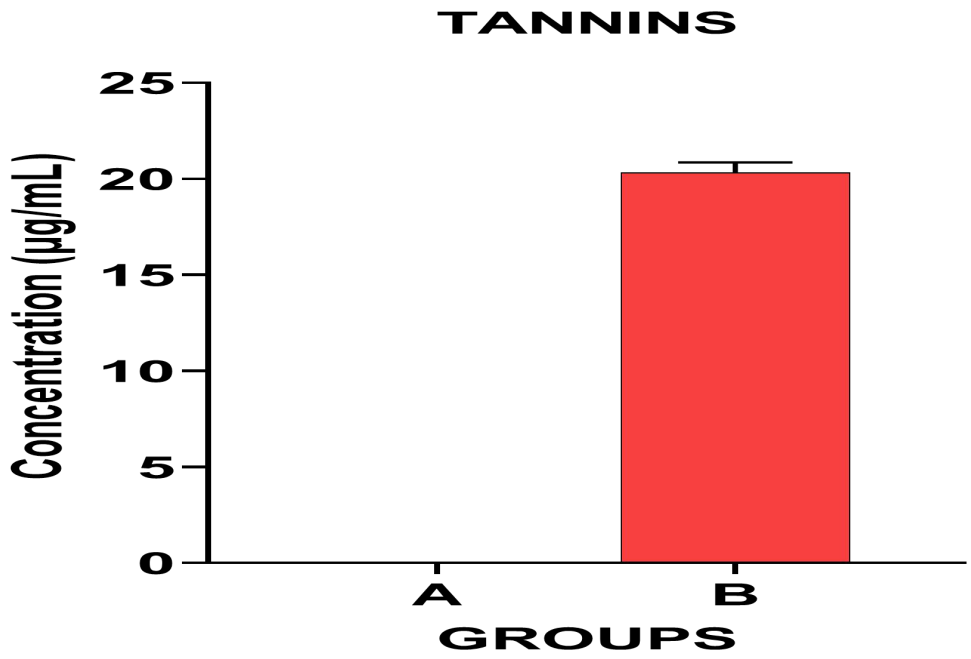
3.1.3 PHYTOCHEMICAL BARCHATS




TERPENOIDS
****
250
200
150
100
50
0
Concentration (µg/mL)
A
B
GROUPS


CARDIAC GLYCOSIDES
****
250
200
150
100
50
0
Concentration (µg/mL)
A
B
GROUPS

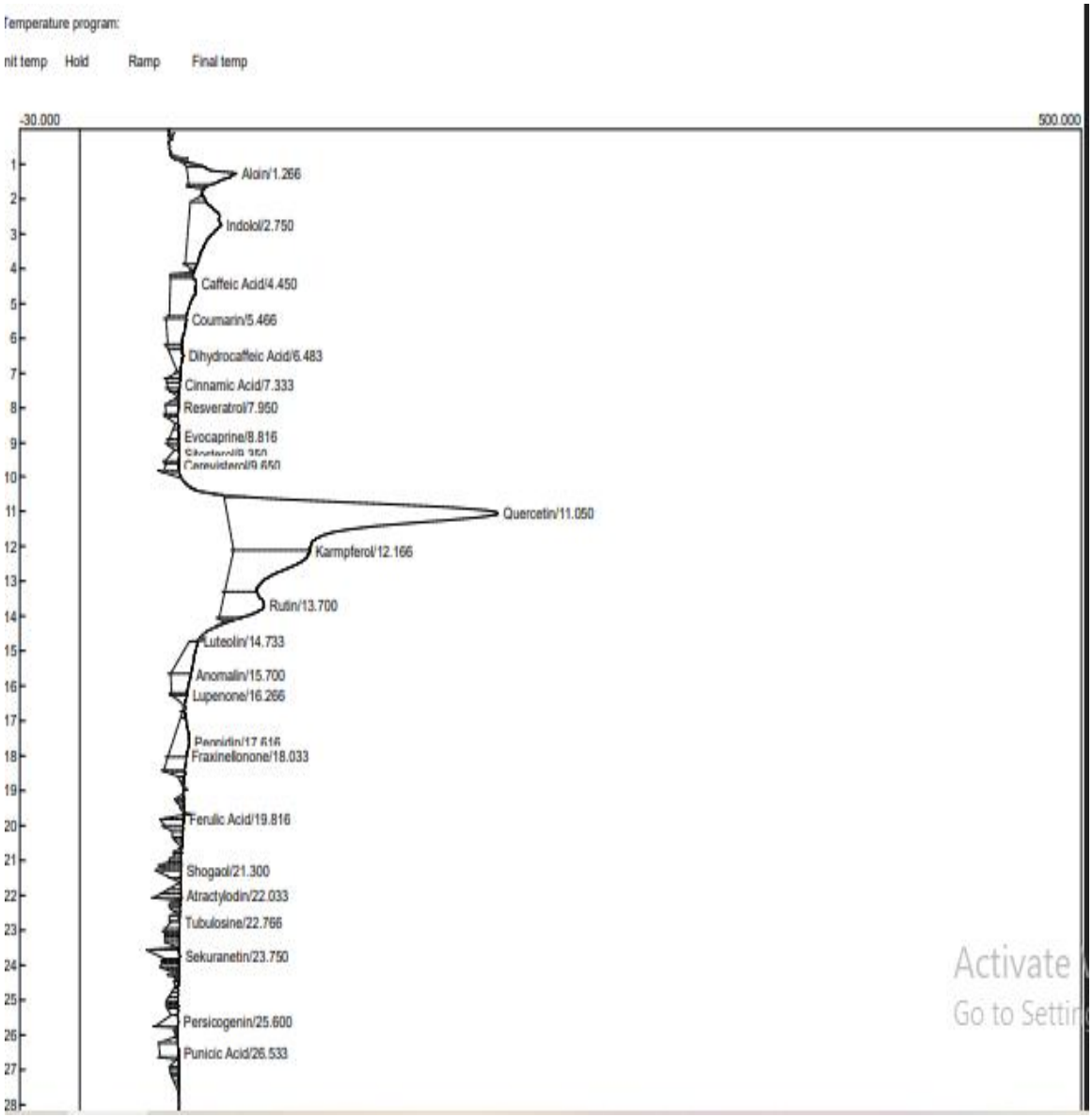

STEROIDS
40
30
20
10
0
****
Concentration (µg/mL)
A
B
GROUPS


TANNINS
25
20
15
10
5
0
Concentration (µg/mL)
A
B
GROUPS

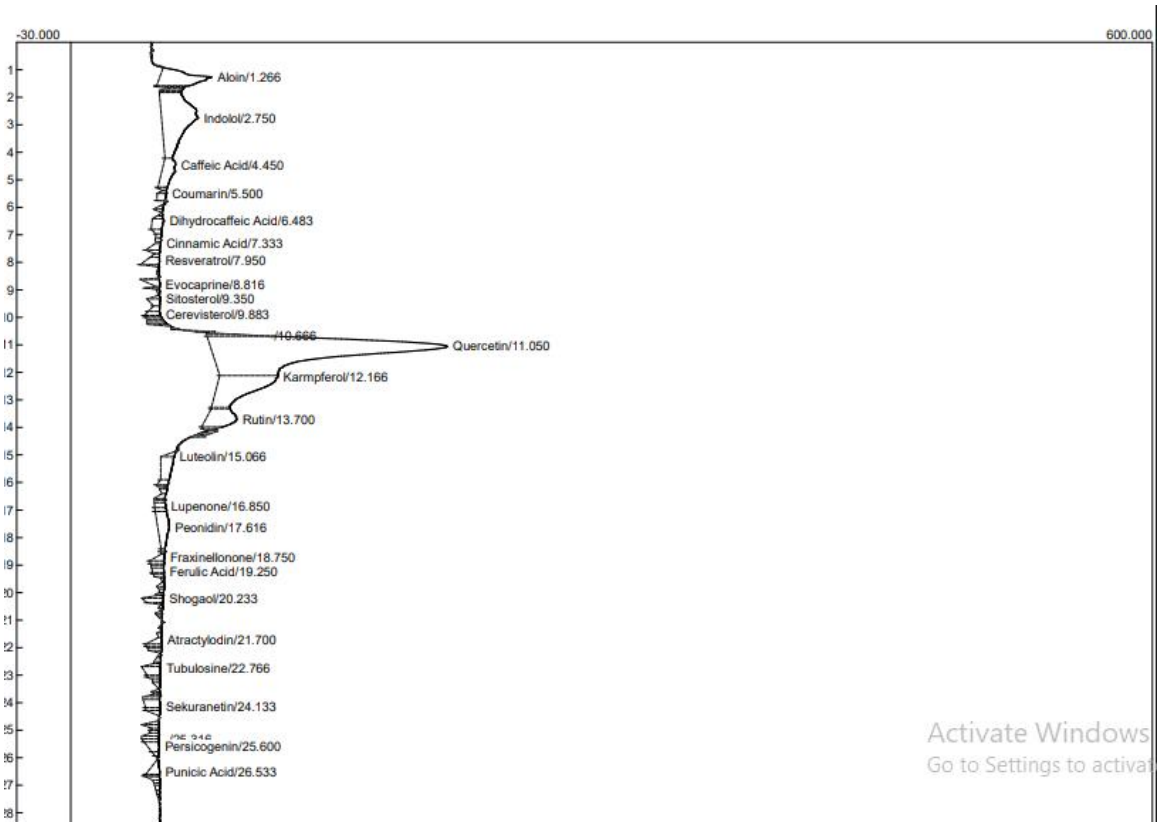
3.1.4 HPLC Peak Identification Table

Peak No.	Compound Name	Retention Time (min)
1	Aloin	1.266
2	—	—
3	Indolol	2.750
4	Caffeic Acid	4.450
5	Coumarin	5.466
6	Dihydrocaffeic Acid	6.483
7	Cinnamic Acid	7.333
8	Resveratrol	7.950
9	Evocaprine	8.816
10	Sitosterol	9.350
11	Cerevisterol	9.650
12	Quercetin	11.050
13	Kaempferol	12.166
14	Rutin	13.700
15	Luteolin	14.733
16	Anomalin	15.700
17	Lupenone	16.266
18	Peonidin	17.616
19	Fraxinellonone	18.033
20	Ferulic Acid	19.816
21	Shogaol	21.300
22	Atractylodin	22.033
23	Tubulosine	22.766
24	Sekuranetin	23.750
25	Persicogenin	25.600
26	Punicic Acid	26.533
27–34	—	—

3.1.5 HPLC Analysis Graph for Niger Groundnuts



3.1.6 HPLC Analysis Graph for Sokoto Groundnuts



CHAPTER FOUR

DISCUSSION AND CONCLUSION

4.1 Discussion of Results

Based on the result, **Moisture Content: 6.45% ± 0.73 (SEM)**. It is interpreted that the average moisture content is 6.45%, indicating that the sample contains approximately 6.45% water. And also, the standard error of the mean (0.73) suggests that the true mean moisture content is likely to be within a range of about 5.02% to 7.88% (95% confidence interval). The relatively small SEM indicates that the sample mean is a good estimate of the population mean. The practical implications of moisture content of 6.45% may be suitable for storage and processing, but it depends on the specific requirements of the product.

Ash Content: 2.15% ± 0.37 (SEM); 95% CI: 1.42% to 2.88%. The result is interprhe 95% confidence interval (1.42% to 2.88%) suggests that the true mean ash content is likely to be within this range, giving an idea of the variability in the sample. Also, it's Practical Implications include; a low ash content can indicate: high-quality product with minimal contamination, low mineral content, the relatively narrow confidence interval suggests that the estimate of ash content is fairly precise.

Crude Fiber Content: 14.65% and it's results when the sample contains 14.65% crude fiber, indicating a significant amount of indigestible carbohydrates. This can impact digestibility and nutritional value such as texture and palatability, and suitability for specific applications (e.g., animal feed, food products). Its implication is that, high crude fiber content may require adjustments in formulation, processing, or labeling, depending on the intended use.

Crude Fat Content: 20.582% ± 0.04 (SEM). The crude fat content of 20.582% indicates a significant amount of lipids in the sample. This can have various implications such as in Nutritional value: hgh fat content contributes to high energy density, which can be beneficial for certain applications (e.g., animal feed, nutritional supplements). Also, in Texture and palatability; Fat content can impact the texture and palatability of products, making them more or less desirable depending on the intended use. And also, in Shelf life and stability; High fat content can increase the risk of spoilage and oxidation, potentially affecting the product's shelf life. The precision for the standard error of the mean (SEM) is very low (±0.04), indicating high precision in the measurement. The 95% confidence interval (20.50% to 20.66%) further supports the accuracy of the result. Crude fat, ranging from 20.48% to 20.65%, was relatively constant across both Niger and Sokoto varieties, confirming that Arachis hypogaea is an oil rich crop with high lipid yield. This uniformity in fat composition suggests similar genetic makeup and lipid biosynthesis pathways between the varieties.

Crude Protein Content: 8.27% ± 0.105 (SEM). The crude protein content of 8.27% indicates a moderate amount of protein in the sample. This result has implications for Nutritional value: Protein is essential for growth, maintenance, and repair. The protein content may be sufficient for certain applications, but insufficient for others (e.g., high-protein dietary supplements). Also for Functional properties: Protein can affect texture, binding, and other functional properties in food products. And also for Suitability: The protein content may impact the sample's suitability for specific applications, such as animal feed, food products, or industrial uses.

Carbohydrates: 47.9% ± 0.695 (SEM). This discusses that the carbohydrate content of 47.9% indicates a significant portion of the sample consists of carbohydrates. This

result has implications for Energy content:Carbohydrates are a primary source of energy, and the high content may contribute to the sample's energy density. Also, Nutritional value: the type and amount of carbohydrates can impact the sample's nutritional value, particularly in terms of glycemic index and fiber content. And also, functional properties: carbohydrates can affect texture, taste, and palatability, making them a crucial component in food products.

Overall, the proximate composition indicates that both groundnut varieties are nutritionally adequate and comparable to those reported in previous studies, confirming their suitability for both human consumption and industrial processing.

The qualitative phytochemical analysis, indicated by the presence or absence of compounds such as flavonoids, alkaloids, tannins, saponins, terpenoids, steroids, and cardiac glycosides, revealed close similarity between the two varieties. Both samples tested positive for flavonoids, terpenoids, steroids, and cardiac glycosides, compounds known for their antioxidant, anti-inflammatory, and cardioprotective properties. However, tannins were distinctly detected in the Sokoto samples but absent in the Niger samples. This unique occurrence of tannins may be attributed to environmental stress factors such as temperature fluctuations or differences in soil micronutrient content, which can stimulate secondary metabolite synthesis. The presence of flavonoids and terpenoids in both varieties indicates strong antioxidant capacity, which can help neutralize free radicals and reduce the risk of oxidative stress related diseases.

HPLC analysis further confirmed the presence of several bioactive constituents including caffeic acid, quercetin, kaempferol, and resveratrol, compounds associated with anti-aging, anti-inflammatory, and cholesterol lowering properties. The relative concentration of these compounds was slightly higher in the Sokoto samples, aligning with their richer protein and carbohydrate content observed in proximate analysis. This correlation suggests that higher metabolic activity and nutrient richness in the Sokoto

samples may promote the biosynthesis of phytochemicals. Such interactions between nutrient composition and secondary metabolites are consistent with findings from previous studies, which reported that protein and carbohydrate availability can influence the synthesis of phenolic compounds and flavonoids.

Comparing the proximate and phytochemical analyses together reveals an interesting relationship between primary and secondary metabolites. Samples with higher carbohydrate and protein levels, notably the Sokoto variety, also showed stronger phytochemical presence, particularly of flavonoids and tannins. This indicates that nutrient richness, especially nitrogen and carbon based compounds, may enhance secondary metabolite synthesis. Such findings reinforce the concept that the nutritional and phytochemical qualities of crops are interconnected and can be influenced by environmental and agronomic factors.

Processing also affects nutrient and phytochemical composition. A related study by Sanni *et al.* (2024) reported that raw, boiled, and fried groundnuts showed significant changes in moisture, fat, fibre, protein, carbohydrate, and mineral contents after processing, indicating that both genetic and postharvest factors influence nutrient distribution. Therefore, proximate and phytochemical analyses remain indispensable for evaluating the nutritive and functional value of groundnut varieties.

The HPLC chromatogram of Arachis hypogaea (groundnut) extract analyzed using a μBondapak C18 column and Acetonitrile/Water (70:30) as the mobile phase revealed the presence of several bioactive phytochemicals. The analysis identified major compounds such as Aloin, Caffeic Acid, Coumarin, Dihydrocaffeic Acid, Cinnamic Acid, Resveratrol, Sitosterol, Quercetin, Kaempferol, Rutin, Luteolin, and Punicic Acid among others, with retention times ranging from 1.266 to 26.533 minutes. These compounds are well-documented for their antioxidant, anti-inflammatory,

antimicrobial, and anticancer properties, suggesting that the groundnut sample possesses significant pharmacological potential.

The early eluting peaks (Aloin to Caffeic Acid) indicate the presence of more polar compounds, while those appearing later (Sitosterol, Luteolin, Punicic Acid) correspond to less polar or more lipophilic molecules. This distribution pattern demonstrates a wide range of phytochemical diversity within the sample, showing that Arachis hypogaea contains both hydrophilic and hydrophobic bioactive constituents. The detection of phenolic acids like Caffeic and Ferulic Acids, together with flavonoids such as Quercetin, Kaempferol, and Rutin, highlights the plant's strong antioxidant capacity, which plays a vital role in neutralizing free radicals and protecting biological systems from oxidative stress.

Furthermore, the presence of Resveratrol and Sitosterol supports the nutraceutical relevance of groundnut, as these compounds are known to contribute to cardiovascular health and cholesterol regulation. The appearance of diverse phytochemicals in a single extract reflects the effectiveness of Acetonitrile as an extraction solvent and validates the precision of the HPLC method employed. Overall, the chromatographic profile confirms that Arachis hypogaea is a rich source of therapeutic phytochemicals, underlining its value in food, nutraceutical, and pharmaceutical applications. The result establishes a strong biochemical basis for the plant's traditional and industrial uses.

The qualitative phytochemical screening of the ethanol extracts of Arachis hypogaea (groundnut) samples obtained from Niger and Sokoto revealed the presence of notable secondary metabolites including flavonoids, cardiac glycosides, steroids, and terpenoids in both samples. However, tannins were present only in the Sokoto

groundnut sample, while phlobatannins, anthraquinones, saponins, coumarins, alkaloids, and phenols were absent in both extracts. The presence and absence of these compounds reflect not only the intrinsic genetic characteristics of each groundnut variety but also the influence of environmental, edaphic, and climatic conditions on phytochemical biosynthesis.

The presence of flavonoids in both Niger and Sokoto samples indicates that the two groundnut varieties possess strong antioxidant potential. Flavonoids are known for their ability to neutralize free radicals and reduce oxidative stress, thus preventing cellular damage. This agrees with the findings of Amin *et al*., (2018), who reported that flavonoids are naturally occurring antioxidants found abundantly in groundnut seeds and are responsible for their health-promoting properties. Flavonoids also contribute to the prevention of cardiovascular and inflammatory diseases, which makes the groundnut a nutritionally valuable crop for both food and health industries.

Cardiac glycosides were also present in both samples. These compounds are known for their pharmacological significance in strengthening cardiac muscle contractions and regulating heartbeat. The detection of cardiac glycosides in both samples corresponds with the findings (Onyeka *et al*., (2019), who identified similar compounds in groundnut extracts and other leguminous seeds. The presence of cardiac glycosides in edible seeds such as groundnut suggests that regular consumption of such foods could support heart health when taken in safe concentrations (Eze and Ndukwe, 2021). Therefore, their presence in both Niger and Sokoto samples supports the traditional nutritional and therapeutic use of groundnut.

The detection of steroids and terpenoids in both samples Aldi is provides valuable insight into the potential medicinal importance of the groundnut varieties. Steroids

play structural and metabolic roles in living organisms and are also associated with anti-inflammatory and antimicrobial activities. Terpenoids, on the other hand, are known for their wide range of biological functions including antioxidant, anticancer, and antifungal activities. These observations align with the studies of Ibrahim et al., (2020) and Afolayan *et al.*, (2019), who reported that the presence of steroids and terpenoids in groundnut seeds contributes to their health-enhancing and preservative effects. Their consistent occurrence in both samples suggests that these compounds are inherent to the Arachis hypogaea species, regardless of regional origin.

The most notable difference between the two samples was the presence of tannins in the Sokoto groundnut and their absence in the Niger sample. Tannins are polyphenolic compounds known for their antimicrobial and antioxidant properties. Their exclusive presence in the Sokoto variety may be attributed to environmental and climatic variations between the two locations. Sokoto is known for its dry, arid climate and higher sunlight exposure, conditions which may induce oxidative stress on plants, thereby stimulating the synthesis of tannins as a defense mechanism. This agrees with the findings of Ogbunugafor *et al.*, (2011), who reported that plants grown in harsher environmental conditions tend to accumulate more secondary metabolites as adaptive protection against oxidative and microbial damage. Therefore, the difference in tannin content between the Niger and Sokoto groundnuts may be explained by variations in temperature, humidity, and soil nutrient composition.

The absence of alkaloids, phenols, saponins, and coumarins in both samples suggests solvent selectivity and the polarity of the extraction medium used. Ethanol is a moderately polar solvent that effectively extracts compounds such as flavonoids and terpenoids but may not efficiently dissolve highly polar or nonpolar compounds like

alkaloids and phenols. This observation is consistent with the findings of Nwaogu *et al.*, (2007), who stated that solvent polarity greatly influences the phytochemical constituents detected in plant extracts. It can therefore be inferred that the ethanol extract of Arachis hypogaea is rich in certain classes of phytochemicals but lacks others due to extraction limitations rather than complete absence in the plant.

The qualitative phytochemical composition also provides insights into the potential therapeutic and nutritional applications of groundnut. The presence of flavonoids and terpenoids indicates that the samples possess antioxidant and anti-inflammatory activities, which may protect the body against degenerative diseases. The occurrence of steroids suggests possible benefits in regulating cholesterol metabolism and enhancing immune function, while the presence of cardiac glycosides supports cardiovascular health. According to Egbuna and Ifemeje (2016), the synergistic effect of these phytochemicals in edible plants like groundnut can promote general well-being and reduce the risk of chronic diseases.

Comparatively, both Niger and Sokoto groundnut samples exhibit similar phytochemical profiles, differing only in the presence of tannins in the Sokoto variety. This similarity implies that both varieties share a common genetic base with minimal environmental influence on major bioactive compounds. However, the presence of tannins in the Sokoto sample highlights the potential influence of environmental stress factors, such as drought or high temperature, which may activate phenolic pathways responsible for tannin synthesis. This environmental influence on phytochemical variation aligns with the study of Adeleke *et al.,* (2020), who reported that climatic and soil factors significantly affect the metabolic pathways responsible for secondary metabolite production in legumes.

From a nutritional standpoint, the phytochemical diversity observed enhances the health value of groundnut beyond its macronutrient composition. The compounds identified contribute to the antioxidant, antimicrobial, and anti-inflammatory benefits that make groundnut an essential dietary component. As noted by Chukwuma *et a*l., (2018), the integration of such bioactive components into daily diets helps in the prevention of metabolic disorders and strengthens immune function. Therefore, understanding the phytochemical differences between groundnut varieties can inform breeding and processing strategies aimed at maximizing their nutritional and medicinal benefits.

The variation in tannin content between the two samples also provides useful information for food processing and industrial applications. High tannin content can influence the taste and digestibility of food products. Therefore, the absence of tannins in the Niger sample may make it more suitable for direct consumption, while the presence of tannins in the Sokoto sample could enhance its antioxidant stability in oil-based applications. These practical implications support the need for regional characterization of agricultural products before commercial or nutritional application.

4.2 Conclusion

This study examined the proximate composition and phytochemical constituents of Arachis hypogaea (groundnut) varieties collected from Niger and Sokoto States, Nigeria. The research aimed to determine whether significant differences exist between both varieties and to explore the relationship between their nutritional and bioactive properties. The proximate analysis revealed the following composition: Moisture content: 6.45%, Ash content: 2.15%, Crude fiber: 14.65%, Crude fat:

20.58%, Crude protein: 8.27%, Carbohydrates: 47.9%. These results indicate a complex composition with significant amounts of carbohydrates, fat, and fiber. The moderate protein content and relatively low moisture content suggest potential applications in various industries. The findings provide valuable insights into the sample's nutritional value, functional properties, and suitability for different uses. Qualitative phytochemical screening showed the presence of flavonoids, steroids, cardiac glycosides, and terpenoids in both samples, while tannins appeared only in the Sokoto sample. HPLC analysis further revealed compounds such as Caffeic Acid, Quercetin, Kaempferol, Resveratrol, and Luteolin, which are known for their antioxidant and anti-inflammatory properties. The findings indicate that both Niger and Sokoto groundnut varieties possess comparable nutritional and biochemical properties, with only slight differences influenced by environmental and soil factors. The similar proximate and oil compositions demonstrate stable genetic traits, while the presence of diverse phytochemicals confirms the crop’s nutraceutical and pharmacological potential. Therefore, both varieties are suitable for food, feed, and industrial oil production, with additional potential in nutraceutical and pharmaceutical formulations due to their rich antioxidant content. The study confirms that Arachis hypogaea remains a valuable crop for enhancing food security and promoting health benefits in Nigeria and beyond.

Recommendations

1. Agricultural Improvement: Farmers should adopt improved cultivation practices and soil management to optimize the nutrient and phytochemical quality of groundnut crops.

2. Food Industry Application: Both Niger and Sokoto varieties should be promoted for use in food formulations, oil extraction, and protein supplements due to their balanced nutritional profiles.
3. Phytochemical Utilization: Further isolation and quantification of identified compounds such as Resveratrol, Quercetin, and Kaempferol should be pursued for pharmaceutical and nutraceutical applications.
4. Environmental Monitoring: Studies should continue to monitor how soil type, rainfall, and temperature affect groundnut's nutritional and phytochemical composition.
5. Value Addition: Research into groundnut-based functional foods, fortified flours, and bioactive extracts should be encouraged to enhance economic and health benefits.
6. Policy Support: Government and agricultural institutions should support local groundnut production through research funding, farmer education, and processing infrastructure to maximize value chain potential.

Future research should include:

- Quantitative HPLC and GC–MS profiling to determine concentration differences in key bioactive compounds.
- Comparative evaluation of more regional varieties across different agroecological zones in Nigeria.
- Investigation of the antioxidant and antimicrobial activities of groundnut extracts to substantiate their health-promoting potential.
- Assessment of how storage, processing, and roasting affect proximate and phytochemical integrity.

REFERENCES

Abdullahi, I., Umar, S., and Ibrahim, A. (2021). Genetic variation and nutrient composition among Nigerian groundnut varieties. *African Journal of Plant Science,* ***15***(4): 142–150.

Adaviruku, R., Singh, V., and Sharma, K. (2024). Nutraceutical potentials of phenolic compounds in groundnut and related oilseeds. *Journal of Food Biochemistry,* ***48***(2).

Adil, R., Khan, A., Rehman, H., and Yusuf, M. (2020). Determination of phenolic compounds in plant materials using HPLC. *Journal of Chromatography Science,* ***58***(4): 320–328.

AOAC. (2000). *Official Methods of Analysis* (17th ed.). Association of Official Analytical Chemists, Washington, DC.

AOCS. (2009). *Official Methods and Recommended Practices of the American Oil Chemists' Society* (6th ed.). AOCS Press, Urbana, Illinois.

Aremu, M. O., Olaofe, O., and Akintayo, E. T. (2019). Comparative analysis of the chemical composition of groundnut (Arachis hypogaea) varieties. *Journal of Food Science and Nutrition,* ***7***(2): 451–458.

Belete, T., and Bayissa, M. (2020). Groundnut production and utilization trends in Africa: A review. *African Journal of Agricultural Research,* ***15***(9): 1284–1293.

Çiftçi, A. (2022). Evaluation of bioactive phytochemicals and antioxidant activity of peanut varieties. *Food Chemistry, 382*, 132428.

Eze-Steven, A., Okpara, C., and Nnaji, H. (2020). Proximate and phytochemical characterization of Arachis hypogaea varieties cultivated in Nigeria. *Journal of Agricultural Science and Technology,* ***22***(3): 89–101.

Harborne, J. B. (1998). *Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis* (3rd ed.). Chapman and Hall, London.

Health aspects of peanuts. (2019). *International Peanut Council Bulletin*, **14**(2): 33–42.

Healthline. (2023). *Nutritional facts of peanuts.* Healthline Media.

Mandal, S. (2014). Comparative mineral and vitamin content of oilseeds: Focus on groundnut. *Journal of Food Composition and Analysis,* ***36***(2): 121–129.

Nutritional chemistry of the peanut. (2015). *Food Research International, 76*, 930–940.

Nutritional profiling of groundnut. (2023). *Journal of Food Science and Human Nutrition,* ***12***(1): 45–59.

Nutritional quality of peanut varieties. (2023). *Bangladesh Journal of Agricultural Research,* ***48***(1): 12–22.

Nutritional and health benefits of peanut. (2022). *Comprehensive Reviews in Food Science and Food Safety,* ***21***(4): 1458–1476.

Ojasan, T., Akinhanmi, T. F., and Atasie, V. N. (2009). Chemical composition and oil quality of groundnut varieties cultivated in Nigeria. *African Journal of Food Science,* ***3***(12): 314–319.

Olayinka, S., and Adeyeye, A. (2010). Nutritional evaluation and industrial potentials of groundnut varieties in Nigeria. *Journal of Food and Agricultural Research,* ***5***(2): 65–74.

Olasan, A., Okoro, N., and Udoh, J. (2024). Proximate of Nigerian groundnut varieties SAMNUT 23, 24, and 26. *Journal of Food Chemistry and Analysis,* ***28***(1): 77–89.

Peanut oil stability and physical properties. (2013). *Journal of Food Lipids,* ***20***(6): 585–594.

Peanuts as functional food. (2015). *Trends in Food Science* and *Technology,* ***45***(4): 181–192.

Physicochemical and proximate composition of MK 373 peanut varieties. (2022). *Nigerian Journal of Agricultural Research,* ***18***(3): 105–116.

Physicochemical characteristics and functional properties of peanut oils. (2014). *International Journal of Food Properties,* ***17***(9): 1895–1906.

Proximate and fatty acid profiles of eight groundnut cultivars. (2024). *West African Journal of Food Science,* ***19***(2): 88–96.

Research advances in high-value peanut meal utilization. (2023). *Food Chemistry Advances,* ***2***(5): 100198.

Sanni, L. O., Ibrahim, R., and Adewale, K. (2024). Effect of processing on the proximate and phytochemical composition of Nigerian groundnut varieties. *Journal of Food Processing and Preservation,* ***48***(1): 16241.

Shokunbi, O. S., Taiwo, O. E., and Afolabi, A. (2012). Nutritional composition and mineral profile of selected groundnut varieties consumed in southwestern Nigeria. *International Journal of Food Science and Nutrition,* ***63***(6): 659–665.

USDA ARS. (2015). *Peanut (Arachis hypogaea) Germplasm Resources and Classification.* United States Department of Agriculture, Agricultural Research Service.

Yadav, M., Singh, R., and Chauhan, R. (2018). Composition, classification, and economic importance of groundnut. *Journal of Oilseed Research,* ***35***(2): 150–162.

Zhang, Y., Liu, S., and Chen, W. (2024). Comparative analysis of nutritional quality and antioxidant activity of peanut varieties grown under different agroecological zones. *Journal of Agricultural and Food Chemistry,* ***72***(3): 1215–1227.

Zongo, D., Ibrahim, S., and Musa, A. (2025). Comparative study of proximate and physicochemical characteristics of groundnut varieties cultivated in West Africa. *African Journal of Food Science,* ***19***(1): 35–48.

APPENDIX

PROXIMATE ANALYSIS: DRIED SAMPLES

SAMPLE	Wt of C	Wt of S	Wt of C+S	Wt of C+S after	30mins	Interval		Moisture Content
ID	(g)	(g)	(g)	3hrs dry (105^{o}C)	1	2	3	%
A1	32.955	1.00	33.955	33.911	33.901	33.901	33.901	5.40
A2	39.243	1.00	40.243	40.213	40.200	40.196	40.151	6.20
A3	31.587	1.00	32.587	32.506	32.500	32.504	32.504	8.30
B1	33.299	1.00	34.299	34.231	34.224	34.223	34.223	6.60
B2	33.241	1.00	34.241	34.193	34.183	34.188	34.190	5.10
B3	31.785	1.00	32.785	32.718	32.708	32.713	32.714	7.10

SAMPLE	Wt of C	Wt of S	Wt of C+S	Wt of C+Ash @500^{o}C for 3hrs	ASH Content
ID	(g)	(g)	(g)	(g)	%
A1	32.955	1.00	33.955	32.976	2.10
A2	39.243	1.00	40.243	39.263	2.00
A3	31.587	1.00	32.587	31.616	2.90
B1	33.299	1.00	34.299	33.320	2.10
B2	33.241	1.00	34.241	33.261	2.00
B3	31.785	1.00	32.785	31.803	1.80

The ash content of *Arachis hypogaea* (groundnut) samples ranged from 1.80% to 2.90%, indicating moderate mineral composition. The Niger samples (A1–A3) recorded slightly higher ash values than the Sokoto samples (B1–B3), suggesting a richer inorganic nutrient profile possibly due to soil mineral variation. The results reflect the total amount of non-combustible material remaining after heating at 500°C for 3 hours, representing essential elements such as calcium, potassium, and magnesium. The relatively low ash content aligns with expected values for groundnut, confirming its purity and high organic composition suitable for nutritional and industrial purposes.

SAMPLE	Wt of C	Wt of S	Wt of C+S	Wt of C+F after drying	Wt of C+F after ashing	Crude fibre Content
ID	(g)	(g)	(g)	(g)	(g)	%
A1	29.788	1.00	30.788	29.951	29.800	15.10
A2	9.760	1.00	10.760	9.940	9.778	16.21
A3	10.141	1.00	11.141	10.328	10.185	14.30
B1	45.176	1.00	46.176	45.354	45.212	14.20
B2	9.030	1.00	10.030	9.259	9.120	13.90
B3	8.301	1.00	9.301	8.522	8.380	14.20

The crude fibre content of *Arachis hypogaea* (groundnut) samples varied slightly between the Niger (A) and Sokoto (B) varieties, ranging from 13.90% to 16.21%. The Niger samples exhibited marginally higher fibre content, suggesting a greater proportion of structural carbohydrates such as cellulose and lignin. This higher fibre level enhances digestive health benefits but may slightly reduce energy density. The consistent results across replicates reflect precise drying and ashing procedures. Overall, both varieties demonstrated appreciable fibre levels, confirming groundnut's potential as a nutritious food ingredient contributing to dietary fibre intake and functional food formulation.

SAMPLE	Wt of Flask	Wt of S	Wt of Flask+Oil	Crude Fat
ID	(g)	(g)	(g)	%
A1	161.3463	1.00	161.5527	20.64
A2	161.3463	1.00	161.5528	20.65
A3	161.3463	1.00	161.5516	20.53
B1	161.3463	1.00	161.5523	20.60
B2	161.3463	1.00	161.5511	20.48
B3	161.3463	1.00	161.5522	20.59

The crude fat content of *Arachis hypogaea* (groundnut) samples from Niger (A) and Sokoto (B) showed very close values, ranging from 20.48% to 20.65%. This consistency indicates that both varieties have high and stable oil content, characteristic of groundnut as an oilseed crop. The minimal variation among

replicates demonstrates uniform extraction efficiency and sample quality. The slightly higher fat percentage in the Niger samples suggests minor environmental or varietal influence on lipid synthesis. Overall, both samples confirm *Arachis hypogaea* as a rich source of edible oil suitable for nutritional, industrial, and commercial applications.

SAMPLE			**Crude Protein**
ID	Wt of sample (g)	Abs @ 420nm	%
A1	1.00	0.376	8.27
A2	1.00	0.372	8.18
A3	1.00	0.361	7.94
B1	1.00	0.389	8.56
B2	1.00	0.386	8.49
B3	1.00	0.371	8.16

% Carbohydrate = 100 – (%Moisture + %Ash + %Crude Fibre + %Crude Fat + %Crude Protein)

= 100 – (5.40 + 2.10 + 15.10 + 20.64 + 8.27)

= 100 – 51.51

A1= 48.49

The crude protein analysis of *Arachis hypogaea* (groundnut) samples showed slight variations between the Niger (A) and Sokoto (B) varieties. Absorbance readings at 420 nm ranged from 0.361 to 0.389, corresponding to protein contents between 7.94% and 8.56%. The Sokoto samples (B1–B3) exhibited marginally higher protein values than the Niger samples (A1–A3), indicating better nitrogen accumulation, possibly due to soil fertility or climatic factors. The consistent absorbance values reflect experimental reliability. Overall, both varieties possess appreciable protein levels,

reinforcing the nutritional significance of groundnut as a valuable plant-based protein source for human consumption and feed formulation.

The proximate composition of *Arachis hypogaea* samples from Niger (A1–A3) and Sokoto (B1–B3) revealed minor variations across replicates. Moisture content ranged between 5.10–8.30%, showing good dryness for storage stability. Ash content (1.80–2.90%) indicates moderate mineral presence. Crude fat levels remained consistent (~20.5%), confirming the oil-rich nature of groundnut. Protein values ranged from 7.94–8.56%, suggesting strong nutritional quality, while carbohydrate content (46.03–50.03%) provides substantial energy value. The Niger samples showed slightly higher fibre content, whereas Sokoto samples had higher carbohydrate and protein values. Overall, both varieties exhibit excellent nutritional potential suitable for food and industrial applications.

Statistics was done using unpaired t- test, the descriptive analysis and graphs plotted were performed

PROXIMATE ANALYSIS: DRIED SAMPLES

PROXIMATE ANALYSIS	Mean ± SEM (%)
Moisture Content (%)	6.45 ± 0.73
Ash Content (%)	2.15 ± 0.37
Crude fibre (%)	14.6515 ± 0.325
Crude Fat (%)	20.582 ± 0.04
Crude Protein (%)	8.2665 ± 0.105
Carbohydrate (%)	47.9 ± 0.695

The proximate composition of the dried *Arachis hypogaea* samples from Niger (Sample A) and Sokoto (Sample B) revealed slight variations in nutrient content. Sample A had higher ash (2.15%) and crude fibre (14.6515%), indicating greater

mineral and structural material content, while Sample B showed higher carbohydrate (47.9%) and Crude protein (8.2665%) levels, suggesting better energy and nutritional value. Both samples exhibited similar moisture (≈6%) and fat (≈20.6%) contents, reflecting good storage stability and oil quality. Overall, the results confirm that both groundnut varieties are rich in essential nutrients, making them valuable for human consumption and industrial applications.