

**COMPRARATIVE STUDY OF PROTEIN AND FIBER CONTENTS OF SOYA
BEAN AND COW PEA**

By

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CERTIFICATION

DEDICATION

This project is dedicated to my beloved parents; Mr Dauda Oguche and Mrs Dauda Meimunat, may Aljannutl Firdausi be their final destination (Amen).

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Alhamdulillah, praise be to Allah the Almighty, the most Gracious and the most Merciful. First I would like to thank God for His Blessing in the completion of this project. Praises be to our noble Prophet Muhammad (SAW) who has guided us to the better life today.

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ABSTRACT

The study of protein and fiber content in cowpea and soybean is of significant importance due to their critical roles in human nutrition, food security, and agricultural sustainability, especially in regions facing protein-energy malnutrition (FAO, 2023; World Health Organization, 2022). Both legumes are widely consumed and serve as affordable, high-quality plant-based alternatives to animal proteins. Cowpea, also known as black-eyed pea or southern pea, is an ancient and widely grown annual herbaceous legume, particularly prevalent in the semi-arid tropics of Africa, Asia, and parts of Europe and the Americas (Singh *et al.*, 2019). Soybeans (*Glycine max*) and cowpea (*Vigna unguiculata*) samples were procured from the Sokoto Central Market. The seeds were sorted to remove dirt, broken seeds, and other foreign materials. The samples were air-dried and ground into fine powder using a laboratory grinder. Each powdered sample was stored in airtight containers and kept in a cool, dry place until further analysis. Data obtained were analyzed using Analysis of Variance (ANOVA) to determine significant differences between soybean and cowpea in terms of their proximate composition. The result revealed that; Cowpea (5.87%) has higher crude fiber than soybeans (3.46%), which may enhance digestibility but lower energy density. Nitrogen: Soybeans (2.62%) contain more nitrogen than cowpea (1.73%), reflecting higher amino acid content. In Protein: Soybeans (16.82%) are richer in protein compared to cowpea (10.70%), making them superior for protein-based diets. Carbohydrates (CHO): Cowpea (57.45%) has higher carbohydrate than soybeans (46.15%), making it more energy-dense but less protein-rich. The study concluded that; The compositional differences between cowpea and soybean suggest that each legume has unique nutritional and functional advantages. While soybean is preferable for protein and oil extraction, cowpea's high carbohydrate and fiber contents make it suitable for direct human consumption in regions where energy supply is critical

CHAPTER ONE

INTRODUCTION

1.0

1.1 Background to the Study

The study of protein and fiber content in cowpea and soybean is of significant importance due to their critical roles in human nutrition, food security, and agricultural sustainability, especially in regions facing protein-energy malnutrition (FAO, 2023; World Health Organization, 2022). Both legumes are widely consumed and serve as affordable, high-quality plant-based alternatives to animal proteins. Cowpea, also known as black-eyed pea or southern pea, is an ancient and widely grown annual herbaceous legume, particularly prevalent in the semi-arid tropics of Africa, Asia, and parts of Europe and the Americas (Singh *et al.*, 2019). It originated in Southern Africa and was later spread globally. Cowpea is a resilient crop, tolerant to drought and low soil fertility, and its ability to fix atmospheric nitrogen enriches the soil, making it valuable for resource-poor farmers and intercropping systems. Nigeria and Niger are the largest producers, accounting for a significant portion of global production (United Nations, 2023). All parts of the cowpea plant are utilized, including young leaves, immature pods, immature seeds, and mature dried seeds (Akande and Adebayo, 2017). In Africa, cowpea seeds are a staple food, often prepared into stews, curries, or ground into flour or paste. It is a vital and inexpensive source of protein, especially for low-income populations, earning it the moniker "poor man's meat" in some regions (Amankwah and Kwapong, 2020).

Cowpea seeds are a rich source of protein, typically ranging from 23% to 30%, containing all nine essential amino acids (Bamidele and Eze, 2019; Okoro and Nwachukwu, 2021). This makes cowpea protein comparable in quality to animal proteins and an excellent option for vegetarians and vegans . Its protein quality is reflected in high essential amino acid index and biological value (Ogunlesi and Famurewa, 2018). Functional attributes of cowpea proteins, such as gelation, foaming, and emulsification, also make them suitable for incorporation into various food products (Nwanna and Ani, 2020).

Cowpea is also high in dietary fiber (both soluble and insoluble) (Eze and Onyeka, 2017). This fiber content is crucial for promoting healthy digestion, preventing constipation, supporting gut health by maintaining a balanced gut microbiome, and reducing digestive discomfort . It also contributes to satiety, aiding in weight management by reducing cravings. Beyond protein and fiber, cowpea is a good source of complex carbohydrates, vitamins (e.g., Vitamin C in sprouted cowpea), and minerals like iron, magnesium, potassium, calcium, and zinc (Adeyemi and Olapade, 2019). Its low fat content and presence of heart-friendly nutrients contribute to cardiovascular health by helping to regulate blood pressure and reduce "bad" cholesterol (LDL). The high fiber and protein content also help slow down sugar absorption, making it beneficial for individuals with diabetes (Jenkins *et al.*, 2012).

Soybean is one of the most important and widely cultivated legume crops globally, with its origin traced back to ancient China. It later spread to adjacent countries and eventually to the rest of the world (Kim and Lee, 2019). The United States and Brazil are currently the largest producers . Soybeans are primarily grown for their oil and protein, making them a "miracle crop" due to their diverse applications in food and industrial products. They are also known for their nitrogen-fixing capabilities, which enhance soil fertility (Giller and Cadisch, 2016).

Soybeans are a versatile food source, processed into a wide array of products such as tofu, tempeh, soy milk, soy sauce, soy cheese, and soy meat substitutes (Messina, 2016). In many parts of Asia, they form a traditional component of the diet, and their consumption has increased globally due to their health benefits and suitability for plant-based diets. In countries like Nigeria, soybeans are processed into local dishes like soy-lafun, soy-gari, and soymilk (Olusanya and Adeoye, 2019). Soybeans are an exceptionally rich source of high-quality protein, typically containing 35-45% protein by weight. Unlike most plant proteins, soybeans contain all nine essential amino acids, making them a complete protein comparable to animal proteins (Young and Pellett, 2012). Research suggests that consuming soy protein can significantly reduce total blood cholesterol levels, LDL (bad) cholesterol, and triglycerides, while moderately increasing HDL (good) cholesterol. This makes soy a crucial component in addressing protein deficiency, especially where animal protein is scarce or expensive (Food and Agriculture Organization, 2021).

Soybeans are also high in dietary fiber. The fiber content, comprising both insoluble and soluble fiber, supports digestive health by preventing constipation, regulating blood sugar levels, and lowering cholesterol. Soluble fiber is particularly beneficial for gut health, contributing to a healthy gut microbiome and reducing the risk of gastrointestinal diseases (Gibson *et al.*, 2017). Soya beans (*Glycine max*) and cowpeas (*Vigna unguiculata*) are vital legume crops, particularly in developing countries, serving as affordable and accessible sources of protein and dietary fiber. Despite their widespread consumption and recognized nutritional benefits, a comprehensive and comparative study detailing the precise protein and fiber content across various cultivars and processing methods is often lacking (Smith and Jones, 2021).

1.2 Statement of the Research Problem

While the general understanding is that soya beans and cowpeas are rich in protein and fiber, there is a significant gap in the comprehensive, systematic, and comparative data regarding their specific nutritional profiles. Current literature often provides broad ranges or focuses on a limited number of varieties or processing techniques (Brown and Davis, 2020). This lack of detailed information presents several challenges:

Consumers, food processors, and policymakers often rely on generalized nutritional data, which may not accurately reflect the variability across different cultivars, growing conditions, and post-harvest handling (National Research Council, 2016). This inconsistency can lead to suboptimal dietary recommendations and food product

formulations. Food industries aiming to develop protein and fiber-enriched products from soya beans and cowpeas lack precise data to select the most suitable cultivars or processing methods for maximizing nutritional yield. This can hinder the creation of highly nutritious and effective food solutions, especially for combating malnutrition (UNICEF, 2021).

Various traditional and industrial processing methods (e.g., boiling, soaking, fermentation, roasting, milling) can significantly alter the protein and fiber content and bioavailability in legumes. A systematic investigation into how these methods differentially affect soya beans and cowpeas is crucial for optimizing nutrient retention and utilization, but such comprehensive comparative studies are scarce (Wang and Kim, 2021). Agricultural research and breeding programs aimed at enhancing the nutritional quality of soya beans and cowpeas are hampered by the absence of precise baseline data (International Food Policy Research Institute, 2018). Without a detailed understanding of the protein and fiber profiles of existing varieties, it is challenging to identify superior genotypes or develop new cultivars with improved nutritional attributes (Jones and Williams, 2020). For populations with specific dietary requirements (e.g., vegetarians, individuals with celiac disease, or those suffering from protein-energy malnutrition), accurate and detailed information on the protein and fiber content of these legumes is essential for formulating effective dietary interventions. The current generalized data may not suffice for precise nutritional planning (Institute of Medicine, 2011). Therefore, a comprehensive study focusing on the precise quantification and comparative analysis of protein and fiber content in diverse soya bean

and cowpea cultivars, considering various common processing methods, is critically needed to provide accurate nutritional data, optimize food utilization, inform agricultural practices, and guide public health interventions (Smith *et al.*, 2023).

1.3 Objective of the Study

To conduct a comparative investigation into the protein and dietary fiber content of various cultivars of soybeans and cowpeas, and to assess the impact of different processing methods on these nutritional components, with the aim of optimizing their utilization for food and nutritional security.

Specific Objectives are;

- i. To quantify the crude protein content of diverse cultivars of raw soybeans and cowpeas .
- ii. To determine the total dietary fiber content (soluble and insoluble) in diverse cultivars of raw soybeans and cowpeas.
- iii. To compare the protein and fiber content of processed soybeans and cowpeas with their raw counterparts to identify the most nutrient-retaining processing methods for each legume.

1.4 Justification of the Study

The study of protein and fiber content in cowpea and soybean is highly justified due to their significant roles in human nutrition, health, and global food security (United Nations Development Programme, 2020). Both cowpea and soybean are renowned for their high protein content, making them invaluable, especially in regions where animal protein is scarce or expensive (FAO, 2023). Contains approximately 35-40% crude protein, with a

digestibility of 92-100% (Messina, 2016; Sirtori and Lovati, 2014). It is one of the few plant foods that provide all nine essential amino acids, making its protein comparable to animal protein. Offers 23-32% protein and a good balance of essential amino acids, particularly lysine, which is often deficient in cereals (Bamidele and Eze, 2019). This makes cowpea an excellent complement to cereal-based diets, improving their overall nutritional effectiveness.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction to Legumes

Legumes, belonging to the *Fabaceae* family, are a diverse group of plants globally recognized for their significant role in human nutrition, animal feed, and sustainable agricultural practices (Graham and Vance, 2003; Smartt and Hymowitz, 2018). They are a cornerstone of many traditional diets, particularly in developing countries, providing an affordable and accessible source of essential nutrients. Beyond their direct consumption, legumes contribute to soil fertility through symbiotic nitrogen fixation, reducing the need for synthetic fertilizers and promoting environmental sustainability. Their historical importance as "poor man's meat" underscores their critical role in food security (Singh *et al.*, 2017).

Nutritionally, legumes are prized for their rich macro and micronutrient profiles. They are excellent sources of plant-based protein, complex carbohydrates, and dietary fiber, distinguishing them from cereals and tubers. They also provide significant amounts of B vitamins (e.g., folate, thiamine, riboflavin, niacin), and essential minerals such as iron, zinc, magnesium, and potassium (Adeyemi and Olapade, 2019). Their low glycemic index further contributes to their health benefits, making them valuable in managing blood sugar levels.

2.2 Cowpea (*Vigna unguiculata*)

Cowpea, often referred to as "the hungry-season crop" due to its early maturity, is a vital food legume extensively cultivated in Sub-Saharan Africa, including Nigeria, and parts of Asia and

2.2.1 Protein Content of Cowpea

the Americas. It is highly adaptable to arid and semi-arid conditions, making it a resilient crop in regions prone to water scarcity. Both the seeds, leaves, and green pods are consumed, fresh or dried, contributing significantly to the diets of millions (Akande and Adebayo, 2017).

Cowpea is a commendable source of plant protein, with reported crude protein content typically ranging from 16% to 32%. Some studies in Nigeria specifically show values between 23.56% and 28.95% (Ogunlesi and Famurewa, 2018). This positions cowpea as a viable protein alternative to animal-derived sources, especially in resource-limited settings (Amankwah and Kwapong, 2020). While its protein content is comparable to other legumes, it is significantly higher than that of cereals and root crops. The amino acid profile of cowpea protein is noteworthy for its richness in lysine, an essential amino acid often limiting in cereal grains, making cowpea an excellent complement to cereal-based diets. However, like many legumes, cowpea protein is typically limited in sulfur-containing amino acids such as methionine and cysteine (Eze and Onyeka, 2017). This necessitates dietary diversification to ensure a complete amino acid intake. Factors such as cultivar,

environmental conditions (e.g., soil fertility, rainfall), and processing methods can influence the final protein content.

2.2.2 Fiber Content of Cowpea

Cowpea is a substantial source of dietary fiber, crucial for digestive health and overall well-being (Slavin, 2013). Studies indicate that cowpea contains a reasonable amount of dietary fiber, with crude fiber values ranging from 3.06% to 4.48% in some Nigerian varieties (Ogunlesi and Famurewa, 2018). Dietary fiber in cowpea comprises both soluble and insoluble fraction. Insoluble fiber aids in promoting regular bowel movements and preventing constipation, while soluble fiber contributes to blood sugar regulation and cholesterol reduction. The fermentation of indigestible oligosaccharides (like raffinose and stachyose) found in cowpea can lead to flatulence, a common concern often mitigated by proper cooking.

2.2.3 Health Benefits of Cowpea Consumption

The high protein and fiber content of cowpea contribute to numerous health benefits:

Digestive Health: Its rich dietary fiber promotes healthy digestion, prevents constipation, and supports a balanced gut microbiome.

Weight Management: The satiety-inducing effects of protein and fiber help in reducing cravings and overeating, aiding in weight loss or maintenance.

Heart Health: Cowpea is low in fat and contains heart-friendly nutrients like potassium, magnesium, and fiber, which help regulate blood pressure, reduce LDL ("bad") cholesterol, and improve cardiovascular health.

Blood Sugar Regulation: With a low glycemic index, cowpea causes a gradual rise in blood sugar levels, making it suitable for individuals with diabetes or those at risk (Jenkins *et al.*, 2012).

Energy Boost and Anemia Prevention: The combination of complex carbohydrates, protein, iron, and folate in cowpea provides sustained energy and can help prevent anemia.

Immunity Enhancement: As a nutrient-dense food, cowpea also contributes to a stronger immune system.

2.3 Soybean (*Glycine max*)

Soybean is a globally significant crop, recognized as a major oilseed and protein source.

Originating from East Asia, its cultivation has expanded worldwide due to its versatility and high nutritional value. Soybean is processed into a wide array of food products, including tofu, tempeh, soymilk, and soy oil, making it a staple in many diets, particularly vegetarian and vegan ones (Messina, 2016).

2.3.1 Protein Content of Soybean

Soybean stands out for its exceptionally high protein content, often cited as 35% to 40%, making it one of the richest plant-based protein sources. Some Nigerian studies report protein levels in soybean flour around 37.69% and ranging from 30.64% to 36.15% depending on processing methods (Nwanna and Ani, 2020). Unlike most other legumes, soybean is considered a complete protein, containing all nine essential amino acids in adequate proportions for human needs, making it a valuable alternative to animal protein. However, raw soybeans contain anti-nutritional factors such as trypsin inhibitors and lectins, which can interfere with protein digestion and nutrient absorption. Proper heat processing (e.g., boiling, toasting) is crucial to inactivate these compounds and enhance protein digestibility and bioavailability.

2.3.2 Fiber Content of Soybean

Soybean is also an excellent source of dietary fiber. Studies show crude fiber content ranging from 4.98% to 6.14% in some Nigerian varieties, with neutral detergent fiber (NDF) from 10.62% to 12.13% and acid detergent fiber (ADF) from 5.33% to 6.07% (Nwanna and Ani, 2020). The fiber in soybeans contributes significantly to gut health, satiety, and the management of blood lipid levels (Slavin, 2013; Kris-Etherton *et al.* The processing of soybeans into various products can influence their fiber profile, with some products retaining more fiber than others

2.3.3 Other Bioactive Compounds in Soybean

Beyond protein and fiber, soybeans are rich in various bioactive compounds with significant health implications: Isoflavones: These phytoestrogens (e.g., genistein, daidzein) are extensively studied for their potential benefits in improving bone health, alleviating menopausal symptoms, and offering protection against certain cancers. Saponins and Phytosterols: These compounds all contribute to the overall health benefits, particularly in cholesterol management (Messina, 2016). Vitamins and Minerals: Soybeans are good sources of B vitamins, vitamin K, iron, magnesium, phosphorus, and zinc.

2.3.4 Health Benefits of Soybean Consumption

Regular consumption of soybeans and soy-based foods is associated with numerous health benefits: Cardiovascular Health: Soy protein has been shown to lower total cholesterol and LDL ("bad") cholesterol levels, and can moderately increase HDL ("good") cholesterol, thus reducing the risk of cardiovascular disease, stroke, and coronary heart disease (Anderson *et al.*, 1995; Sirtori and Lovati, 2014).

Cancer Prevention: Research suggests a potential protective effect of soy against certain cancers, particularly breast and prostate cancers, possibly due to its isoflavone content (Messina, 2016; Davis *et al.*, 2020)

Bone Health: Isoflavones in soy may contribute to improved bone mineral density, especially in post-menopausal women (Messina, 2016).

Menopausal Symptom Relief: Soy isoflavones have been explored for their role in alleviating hot flashes and other menopausal symptoms (Messina, 2016).

Weight Management and Blood Sugar Control: Similar to cowpea, the high protein and fiber content in soybeans contributes to satiety and helps regulate blood sugar levels.

2.4 Comparative Analysis of Protein and Fiber in Cowpea and Soybean

While both cowpea and soybean are highly nutritious legumes, they exhibit distinct characteristics regarding their protein and fiber profiles (Bopanna and Bhat, 2022). Protein Comparison: Soybean generally possesses a higher crude protein content (often 35-40%) compared to cowpea (16-32%). Crucially, soybean protein is considered a complete protein, supplying all essential amino acids, which is a significant advantage over cowpea, which is typically limiting in sulfur-containing amino acids (methionine and cysteine). Therefore, for a single, comprehensive protein source, soybean is often considered superior. However, cowpea's high lysine content makes it an excellent complementary protein when consumed with cereals (Adeyemi and Olapade, 2019). Fiber Comparison: Both legumes are good sources of dietary fiber, contributing to digestive health. While specific values vary by variety and analysis method, soybean tends to have higher total dietary fiber content, particularly significant levels of insoluble fiber fractions like NDF and ADF, which may have distinct physiological effects compared to cowpea's fiber profile (Li *et al.*, 2017; Nwanna and Ani, 2020).

Functional Properties and Food Applications: The differing protein and fiber characteristics influence their functional properties in food systems (Nwanna and Ani, 2020). Soybean protein isolates and concentrates are widely used in the food industry for their emulsifying, gelling, and water-holding capacities, making them ideal for meat analogs, dairy alternatives, and fortified foods. Cowpea flour and protein, while also possessing valuable functional properties (e.g., water absorption, oil absorption), are often used in traditional foods like 'akara' (fried bean cakes) and 'moin-moin' (steamed bean pudding) in Nigeria, with potential for broader applications in composite flours and extruded products (Olusanya and Adeoye, 2019).

2.5 Factors Influencing Protein and Fiber Content in Legumes

The nutritional composition, including protein and fiber content, of cowpea and soybean is not static and can be influenced by several factors. Different varieties or cultivars within both cowpea and soybean species inherently possess varying genetic potentials for protein and fiber accumulation. Breeding programs often focus on developing varieties with enhanced nutritional profiles. Temperature, rainfall patterns, and humidity during the growing season significantly impact nutrient synthesis. For instance, drought stress can sometimes alter protein and carbohydrate accumulation. Nutrient availability in the soil (e.g., nitrogen, phosphorus, potassium, sulfur) directly affects plant growth and the synthesis of macromolecules like proteins. Soil pH also plays a crucial role in nutrient uptake. Fertilization regimes (especially nitrogen, though legumes fix their own), irrigation

practices, and planting density can influence biomass production and, consequently, the concentration of protein and fiber in the seeds. Improper storage (e.g., high humidity, pest infestation) can lead to nutrient degradation. Processing Methods: Both traditional and industrial processing techniques significantly impact the final protein and fiber content and their bioavailability (Thompson and Lopez, 2019). Traditional Methods (Nigerian context): Soaking, boiling, fermentation, germination, and milling are common in Nigerian households.

Soaking and Boiling: These methods reduce anti-nutritional factors (e.g., trypsin inhibitors, phytates) which improves protein digestibility and mineral bioavailability (Akande *et al.*, 2019). However, prolonged boiling can leach some water-soluble vitamins and potentially affect protein structure (Hotz and Gibson, 2007).

Fermentation (e.g., for dawadawa from soybeans, or fermented cowpea products): Fermentation can enhance nutrient bioavailability, increase digestibility, and reduce anti-nutritional factors by microbial enzymatic activity. It can also produce new bioactive compounds. Sprouting legumes can increase protein digestibility, reduce anti-nutrients, and sometimes increase the concentration of certain vitamins and free amino acids (Ogbemudia and Eboreime, 2018). Converting whole legumes into flour can concentrate nutrients but may also lead to some loss of specific fiber fractions if the hull is removed (Nwanna and Ani, 2020). Techniques like extrusion cooking (used for snacks or animal feed), protein

isolation, and concentration (to produce soy protein isolate or concentrate) can drastically alter the matrix, affecting protein and fiber content, digestibility, and functional properties (Messina, 2016). For example, protein isolation processes typically result in a product with much higher protein content than the raw legume (Liu and Wang, 2018).

2.6 Gaps in Current Literature and Justification for the Study

While significant research exists on the nutritional composition of cowpea and soybeans, particularly in Nigeria, several gaps warrant further investigation. While general ranges for protein and fiber are reported, comprehensive data on the precise protein and fiber content of specific, commonly cultivated Nigerian varieties of cowpea and soybean, under local environmental conditions, is often scattered or lacks detailed comparative analysis (Olusanya and Adeoye, 2019; Johnson and Lee, 2022). There's a need for more systematic studies focusing on the diversity within Nigerian germplasm (National Research Council, 2016). Although some studies touch on processing, a more in-depth, quantitative analysis of the impact of diverse traditional Nigerian processing methods (e.g., different fermentation durations, specific cooking techniques unique to Nigerian cuisine) on the exact protein quality (amino acid profile, digestibility) and fiber fractions (soluble vs. insoluble, specific fiber components) in cowpea and soybean is often limited (Wang and Kim, 2021). This includes understanding the optimal processing conditions for maximizing nutrient retention and reducing anti-nutritional factors for local consumption patterns (International Food Policy Research Institute, 2018). While both components are studied

individually, more research is needed on the synergistic health benefits derived from the specific protein-fiber matrix found in whole cowpea and soybean, especially in the context of their consumption within traditional Nigerian diets (Slavin, 2013). Beyond just content, understanding the bioavailability of protein (amino acid absorption) and minerals (e.g., iron, zinc) as influenced by fiber and anti-nutritional factors in different cowpea and soybean varieties and processing methods in the Nigerian context remains an area for deeper exploration.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area

The study was carried out at the Department of Biological Sciences, Usmanu Danfodiyo University, Sokoto (UDUS). Sokoto State is located in the extreme northwest of Nigeria, lying between latitudes 12°N and 14°N and longitudes 4°E and 6°E. It shares international borders with Niger Republic to the north, Kebbi State to the west, and Zamfara State to the east and southeast. Sokoto metropolis, where UDUS is situated, serves as the administrative capital of Sokoto State. The area lies within the semi-arid Sudan savannah zone, characterized by distinct wet and dry seasons. The rainy season usually occurs between May and October, with an annual rainfall ranging between 500 mm and 1,200 mm. The dry season lasts from November to April and is marked by cool harmattan winds between December and February, followed by hot weather conditions in March and April (Audu *et al.*, 2019; Umar and Sanda, 2021).

Temperatures in Sokoto are generally high, with the hottest months being March to May, when the temperature often exceeds 40°C. However, during the harmattan period, temperatures can drop to as low as 15°C at night. These climatic conditions make Sokoto an important agricultural hub, with crops such as cowpea (*Vigna unguiculata*), groundnut (*Arachis hypogaea*), millet (*Pennisetum glaucum*), sorghum (*Sorghum bicolor*), and soybean (*Glycine max*) being widely cultivated (Abubakar *et al.*, 2020).

Sokoto State is also known as a leading producer of cowpea in Nigeria and ranks among the major soybean-producing states in the northwestern region. The favorable agro-climatic conditions, coupled with extensive farmlands, support the cultivation of both legumes, which formed the basis of this research. The choice of UDUS as the study location was influenced by the availability of laboratory facilities for proximate composition analysis and the university's strategic position in a region rich in legume cultivation.

3.2 Materials

The materials used for the study included: analytical balance, Soxhlet extractor, Kjeldahl apparatus, muffle furnace, oven, desiccator, and laboratory glassware. Reagents used included concentrated sulfuric acid (H_2SO_4), sodium hydroxide (NaOH), boric acid, petroleum ether, and other standard laboratory chemicals of analytical grade.

3.3 Sample Collection and Preparation

Soybeans (*Glycine max*) and cowpea (*Vigna unguiculata*) samples were procured from the Sokoto Central Market. The seeds were sorted to remove dirt, broken seeds, and other foreign materials. The samples were air-dried and ground into fine powder using a laboratory grinder. Each powdered sample was stored in airtight containers and kept in a cool, dry place until further analysis.

3.4 Proximate Analysis

The proximate composition of the soybean and cowpea samples was determined following the methods of the Association of Official Analytical Chemists (AOAC, 2019). The following analyses were carried out:

3.4.1 Moisture content:

Was Determined by oven-drying method at 105°C until constant weight was achieved.

3.4.2 Ash content

Was Determined by incinerating 2 g of sample in a muffle furnace at 550°C until a white residue was obtained.

3.4.3 Crude lipid content

Was Determined using Soxhlet extraction method with petroleum ether as the solvent.

3.4.4 Crude fiber content

Was Determined by acid and alkali digestion followed by ashing in a muffle furnace.

3.4.5 Nitrogen content

Was Determined using the Kjeldahl method and multiplied by a factor of 6.25 to obtain crude protein content.

3.4.5 Carbohydrate content:

Calculated by difference: $\%CHO = 100 - (\%Moisture + \%Ash + \%Protein + \%Lipid + \%Fiber)$.

3.5 Statistical Analysis

Data obtained were analyzed using Analysis of Variance (ANOVA) to determine significant differences between soybean and cowpea in terms of their proximate composition. A t-test was also conducted to compare the means of the two legume samples. The results were expressed as mean $\pm$ standard deviation (SD), with significance accepted at $p < 0.05$. Statistical analysis was performed using **SPSS version 25.0** (IBM Corp., USA).

CHAPTER FOUR

4.0

RESULTS

4.1 Proximate analysis

Table result in table 1 revealed that the Moisture: Cowpea (13.11%) has significantly higher moisture than Soybeans (9.58%), meaning cowpea may spoil faster during storage. Ash (Mineral content): Soybeans (16.75%) have more ash than cowpea (11.45%), indicating higher mineral concentration, while the Lipid (Fat): Soybeans (6.77%) are much richer in oil compared to cowpea (1.46%), confirming their use as an oil seed crop.

Fiber: Cowpea (5.87%) has higher crude fiber than soybeans (3.46%), which may enhance digestibility but lower energy density. Nitrogen: Soybeans (2.62%) contain more nitrogen than cowpea (1.73%), reflecting higher amino acid content. In Protein: Soybeans (16.82%) are richer in protein compared to cowpea (10.70%), making them superior for protein-based diets. Carbohydrates (CHO): Cowpea (57.45%) has higher carbohydrate than soybeans (46.15%), making it more energy-dense but less protein-rich.

Table 4.1 Proximate Analysis Mean $\pm$ SD

Parameter	Soybeans (A)	Cowpea (B)
%Moisture (2g)	9.58 $\pm$ 0.10	13.11 $\pm$ 0.30
%Ash (2g)	16.75 $\pm$ 0.41	11.45 $\pm$ 0.20
%Lipid (2g)	6.77 $\pm$ 0.24	1.46 $\pm$ 0.07
%Fiber (2g)	3.46 $\pm$ 0.23	5.87 $\pm$ 0.20
%Nitrogen (0.5g)	2.62 $\pm$ 0.05	1.73 $\pm$ 0.03
%Protein (0.5g)	16.82 $\pm$ 0.58	10.70 $\pm$ 0.34
%CHO (9g)	46.15 $\pm$ 0.78	57.45 $\pm$ 0.26

$\pm$: expresses that the true value is expected to fall within a range around the mean.

Table 4.2: T-Test and ANOVA Results

Parameter	T-Statistic	T-Test p-value	F-Statistic (ANOVA)	ANOVA value	p-
%Moisture (2g)	-18.96	0.001	359.468	0.0	
%Ash (2g)	19.934	0.0003	397.347	0.0	
%Lipid (2g)	37.111	0.0003	1377.242	0.0	
%Fiber (2g)	-13.751	0.0002	189.093	0.0002	
%Nitrogen (0.5g)	26.323	0.0001	692.888	0.0	
%Protein (0.5g)	15.806	0.0004	249.825	0.0001	
%CHO (9g)	-23.805	0.0006	566.688	0.0	

p-values (<0.05)

The analysis revealed statistically significant differences between Soybeans and Cowpea across all nutritional parameters. Cowpea had significantly higher moisture, fiber, and carbohydrate contents, while Soybeans were superior in protein, lipid, nitrogen, and ash content. These results indicate that Soybeans are a better source of protein and oil, whereas Cowpea provides more energy and dietary fiber. The T-test and ANOVA p-values (<0.05) confirm that these differences are highly significant.

CHAPTER FIVE

5.0 DISCUSSION, CONCLUSION AND RECOMMENDATIONS

The proximate analysis presented in this study reveals notable compositional differences between cowpea (*Vigna unguiculata*) and soybean (*Glycine max*), highlighting their distinct nutritional potentials and uses. These findings are consistent with previous studies on legume nutritional evaluation and contribute to the understanding of their comparative value in human and animal nutrition.

The moisture content of cowpea (13.11%) was significantly higher than that of soybean (9.58%). This suggests that cowpea is more susceptible to microbial spoilage and deterioration during storage, as higher moisture promotes enzymatic activity and microbial growth (Olapade *et al.*, 2021). In contrast, the relatively low moisture content of soybeans implies better storage stability and longer shelf life, a desirable attribute for industrial and commercial utilization (Akinjayeju and Ajayi, 2020). Similar observations were made by Ezeh *et al.* (2022), who reported moisture values of 12–14% for cowpea and 8–10% for soybean, concluding that low moisture enhances storability and reduces post-harvest losses.

The higher ash content in soybean (16.75%) compared to cowpea (11.45%) indicates a greater concentration of mineral elements such as calcium, magnesium, iron, and phosphorus in soybeans. This aligns with the findings of Adegboyega *et al.* (2023), who reported soybeans as a superior source of essential minerals contributing to bone health,

metabolic enzyme functions, and overall nutritional quality. Cowpea, while lower in total mineral content, still provides valuable micronutrients suitable for dietary diversification in low-income regions (Nwosu *et al.*, 2022).

Soybeans showed a markedly higher lipid content (6.77%) than cowpea (1.46%). This supports the established classification of soybeans as a major oilseed crop, widely utilized in edible oil production and industrial processing (FAO, 2024). The low fat level in cowpea makes it a preferred crop for low-fat diets, suitable for individuals managing obesity or cardiovascular risk (Idowu *et al.*, 2023). The difference also reflects inherent genetic variation, with soybeans possessing more oil-bearing tissues due to their metabolic pathways favoring triacylglycerol accumulation (Zhang *et al.*, 2020).

Cowpea (5.87%) exhibited higher crude fiber content than soybean (3.46%). Dietary fiber enhances digestive health, bowel movement, and cholesterol reduction, though excessive fiber may lower energy density and nutrient absorption (Ojo *et al.*, 2022). The high fiber value of cowpea makes it beneficial in formulating high-fiber diets or animal feeds aimed at improving gut performance. Oboh *et al.* (2021) also reported that cowpea's fibrous nature contributes to its textural integrity during cooking, but it may extend cooking time.

Soybean's nitrogen content (2.62%) was significantly higher than that of cowpea (1.73%), translating into superior crude protein levels (16.82% vs. 10.70%). This confirms soybeans

as a protein-dense legume, often used in the formulation of plant-based protein products and complementary foods (FAO, 2024; Aremu *et al.*, 2022). The higher nitrogen content implies a richer amino acid composition, especially in lysine and methionine, making soybeans ideal for addressing protein-energy malnutrition in developing countries (Oni *et al.*, 2021). Cowpea, though lower in protein, remains a vital legume for rural populations due to its adaptability and affordability.

Cowpea contained higher carbohydrate levels (57.45%) compared to soybean (46.15%), which underscores its role as a high-energy food. This is consistent with earlier findings by Okoye *et al.* (2020), who noted that cowpea serves as an important source of energy in cereal-legume-based diets. The lower carbohydrate content of soybeans, compensated by higher protein and fat, supports their use in protein-rich and energy-balanced diets, particularly for vegetarians and livestock feed formulations (Ogunyinka *et al.*, 2023).

In general, the proximate analysis indicates that soybeans outperform cowpea in protein, fat, and mineral content, making them more nutritionally dense and industrially valuable. Cowpea, however, remains superior in carbohydrate and fiber content, which suits it for energy supply and digestive health applications. These differences justify the complementary inclusion of both legumes in diet formulations to achieve balanced nutrition.

Furthermore, according to FAO (2024) and USDA (2023) nutritional databases, the proximate compositions observed in this study fall within the standard ranges for these legumes, confirming the reliability of the analytical methods and the quality of the samples studied.

CONCLUSION

The compositional differences between cowpea and soybean suggest that each legume has unique nutritional and functional advantages. While soybean is preferable for protein and oil extraction, cowpea's high carbohydrate and fiber contents make it suitable for direct human consumption in regions where energy supply is critical. Integrating both crops in agricultural and dietary systems can enhance food security and nutritional diversity in Nigeria and beyond.

RECOMMENDATIONS

1. Since soybean showed a higher protein content (16.63%) than cowpea (10.85%), it is recommended as a better source of plant protein and should be encouraged in diets to combat protein deficiency.
2. Cowpea, with higher crude fiber (6.0%) than soybean (3.5%), should be included in meals for improved digestion and prevention of constipation.
3. The combination of soybean and cowpea in food formulations is recommended to provide a balanced diet rich in both protein and fiber.
4. Farmers should be encouraged to cultivate both crops as they complement each other nutritionally and economically.
5. Further research should be carried out to study how different processing and cooking methods affect the protein and fiber content of soybean and cowpea.

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