CHAPTER ONE

INTRODUCTION AND LITERATURE REVIEW

1.1 INTRODUCTION

Whole grains were defined by the American Association of Cereal Chemists (AACC) International in 1999 and later adopted by the U.S. Food and Drug Administration (FDA) in 2006 as consisting of the "intact, ground, cracked, or flaked fruit of the grain whose principal components the starchy endosperm, germ, and bran are present in the same relative proportions as they exist in the intact grain" (FDA, 2006). Epidemiological studies have shown that consumption of whole-grain products can lower the risk of chronic diseases such as obesity, type 2 diabetes, cardiovascular diseases (CVDs), and cancer (Benisi-Kohansal *et al*., 2016). The health-promoting effects of whole-grain products, particularly whole wheat, are largely linked to their dietary fiber (DF) and phytochemical content (Karter and Liu, 2010). In response to growing consumer demand for healthier food products, wheat breeders and producers are now considering phytochemicals as additional quality parameters beyond conventional end-use traits (Shery *et al*., 2012).

Over the past two decades, significant advances have been made in wheat phytochemical research, particularly in five main areas: chemistry and distribution; effects of genotype, environment, and management practices changes during grain and food processing; bioavailability; and health benefits. Numerous bioactive compounds such as phenolic acids, flavonoids, transferred, carotenoids, tocopherols, tocotrienols, phytosterols, and benzoxazinoids (BXs) have been identified and characterized (Gupta *et al*., 2021; Liu *et al*., 2020; Luthria *et al*., 2015). The relationships between phytochemical levels and genetic variation, agronomic practices, and environmental conditions are now well documented. Similarly, studies have examined how processing techniques, including milling, fermentation, enzymatic modification, and thermal treatment, alter phytochemical profiles (Karter and Liu, 2010; Shery *et al*., 2012).

Despite this progress, several knowledge gaps remain. For example, the interactions between phytochemicals and key macromolecules such as starch, proteins, and cell-wall polysaccharides remain poorly understood. Similarly, limited work has been carried out on phytochemical

stability during long-term storage. In addition, methodological inconsistencies in extraction protocols and in vitro antioxidant assays often result in conflicting findings, making cross-study comparisons challenging (Gupta *et al*., 2021; Luthria *et al*., 2015). Misinterpretations of total phenolic and flavonoid quantification, as well as antioxidant activity, highlight the need for improved methodological standards (Liu *et al*., 2020).

Screening raw wheat for nutritive and phytochemical indices is a pivotal aspect of assessing the comprehensive quality, nutritional capacity, and potential health benefits of this globally important cereal crop. Wheat (*Triticum aestivum* L.) stands as a staple food for a significant portion of the world's population, supplying essential macronutrients such as carbohydrates, proteins, dietary fibers, and lipids, along with critical micronutrients including minerals like calcium, iron, magnesium, and sodium (Adeyemo *et al*., 2025). These nutrients contribute significantly to the daily nutritional requirements and overall health of consumers, emphasizing the importance of detailed screening to quantify their presence and availability.

Beyond basic nutritional components, wheat also serves as an abundant source of biologically active phytochemicals. These secondary metabolites include flavonoids, tannins, phenolic acids, coumarins, saponins, and alkaloids, all of which exhibit diverse bioactivities such as antioxidant, anti-inflammatory, anti-carcinogenic, and antimicrobial effects (Hamli *et al*., 2017; Shahidi and Ambigaipalan, 2022). Phytochemicals play a vital role in protecting human cells against oxidative stress caused by free radicals, which are implicated in chronic diseases including cancer, cardiovascular diseases, and neurodegenerative disorders (Shahidi and Ambigaipalan, 2022). Therefore, evaluating the abundance and variation of these compounds in raw wheat is essential for understanding its potential as a functional food ingredient.

Phytochemical screening involves using a variety of qualitative and quantitative analytical methods to detect, identify, and measure these bioactive compounds in wheat. Techniques such as solvent extraction, chromatography, spectrophotometry, and mass spectrometry provide detailed profiles of phenolics, flavonoids, and other phytochemicals (Krishna *et al*., 2022). For example, total phenolic content and flavonoid concentration are frequently analyzed due to their strong correlation with antioxidant activity, commonly assessed through methods like the DPPH radical scavenging assay (Hamli *et al*., 2017). These measurements offer insight into the

comparative antioxidant capacities of different wheat varieties, which can be influenced by genetic factors, environmental conditions, and agronomic practices.

In parallel with phytochemical analysis, nutritional screening typically includes proximate composition analysis to determine moisture, crude protein, crude fiber, crude fat, ash, and carbohydrate content. This nutritive profiling is critical for assessing wheat's energy yield and nutrient density, which are directly tied to its value as a food source (Adeyemo *et al*., 2025). Moreover, the evaluation of mineral content, such as levels of iron, calcium, magnesium, zinc, and manganese, supplements the nutritive profile by highlighting essential elements that contribute to physiological functions such as oxygen transport, bone mineralization, and enzymatic reactions (Adeyemo *et al*., 2025). Mineral bioavailability in wheat further enhances its nutritional appeal and justifies the need for comprehensive screening.

Recent technological advances have transformed the screening of raw wheat, offering rapid, non-destructive, and precise measurement techniques. Near-infrared spectroscopy (NIR), hyperspectral imaging, and mass spectrometry have been widely adopted to facilitate simultaneous analysis of both nutritive and phytochemical indices (Krishna *et al*., 2022; Shahidi and Ambigaipalan, 2022). These tools improve efficiency and accuracy in wheat quality control and enable breeders and food scientists to select and develop wheat varieties with optimal nutritional and functional qualities. Such advancements are instrumental in supporting sustainable food systems and enhancing public health outcomes by promoting the consumption of nutrient-rich, phytochemical-abundant wheat products.

The screening of raw wheat for nutritive and phytochemical indices integrates multiple analytical approaches aimed at elucidating wheat's complex biochemical composition. These efforts are not only vital for improving the nutritional and functional quality of wheat products but also for supporting breeding programs, food processing innovations, and dietary health strategies. As global demand for healthier foods increases, such comprehensive screening remains crucial for unlocking wheat's full potential as a nutrient-dense and bioactive food source (Adeyemo *et al*., 2025; Hamli *et al*., 2017; Krishna *et al*., 2022; Shahidi and Ambigaipalan, 2022).

1.1.1 BACKGROUND OF STUDY

Wheat (*Triticum aestivum* L.) is a globally significant cereal crop that constitutes a primary source of food and nutrition for a large proportion of the world's population. It is a staple in many diets, forming the basis of numerous culinary traditions and providing essential macronutrients such as carbohydrates, proteins, fats, and dietary fiber. On average, wheat grain is composed of approximately 70–80% carbohydrates, primarily in the form of starch, 10–15% protein, and a minor but important fraction of lipids, minerals, and vitamins (Adeyemo *et al*., 2025; Ramya *et al*., 2023). These components collectively deliver energy, structural material, and cofactors essential for human health. Moreover, wheat contributes substantially to mineral intake, providing key elements such as iron, calcium, magnesium, zinc, and potassium, which are vital for physiological functions including oxygen transport, bone development, enzymatic reactions, and cellular signaling (Adeyemo *et al*., 2025).

Beyond its macronutrient and mineral content, wheat is a rich repository of various phytochemicals, bioactive compounds synthesized by plants that exert positive effects on human health. These phytochemicals include phenolic acids (ferulic, caffeic, and sinapic acids), flavonoids (apigenin, luteolin), lignans, alkaloids, saponins, and carotenoids. They are particularly concentrated in the bran and germ fractions of the wheat kernel but also present in the endosperm to lesser extents (Hamli *et al.,* 2017; Shahidi and Ambigaipalan, 2022). The antioxidant properties of these phytochemicals play a crucial role in neutralizing free radicals generated within the human body, thereby mitigating oxidative stress that contributes to aging and various chronic diseases such as cancer, cardiovascular diseases, and neurodegenerative disorders (Shahidi and Ambigaipalan, 2022). Additionally, wheat phytochemicals have been linked to anti-inflammatory, antimicrobial, and anticancer activities, which underline the importance of their quantification and characterization (Hamli *et al*., 2017).

Phytochemical and nutritive screening of raw wheat involves established analytical techniques that quantify these bioactive and nutritive components. Proximate analysis measures fundamental nutritional aspects such as moisture, crude protein, fat, ash, total dietary fiber, and carbohydrate content, offering insights into the energy and nutritional density of wheat grains (Adeyemo *et al*., 2025). Mineral content analysis covers a suite of macro- and microminerals, with particular attention to nutrients that are often deficient in human diets, such as iron and zinc

(Ramya *et al*., 2023). These analyses are essential in assessing wheat's contribution to nutritional security and guiding consumption recommendations.

On the phytochemical front, qualitative screening may use colorimetric tests to detect the presence of broad classes such as alkaloids, tannins, saponins, and flavonoids, while quantitative methods involve high-performance liquid chromatography (HPLC), gas chromatography-mass spectrometry (GC-MS), and spectrophotometric assays to measure specific individual compounds and total phenolic or flavonoid content (Krishna *et al*., 2022; Hamli *et al*., 2017). The antioxidant jcapacities of wheat extracts is frequently evaluated using assays such as DPPH, ABTS, and FRAP, which provide functional measures of radical scavenging ability (Hamli *et al*., 2017). These phytochemical profiles are influenced by numerous factors including wheat genotype, environmental growing conditions, soil fertility, storage, and processing methods, contributing to variability observed in different studies (Shahidi and Ambigaipalan, 2022).

Recent technological advancements have greatly enhanced the scope and precision of screening methods. Spectroscopic techniques, notably near-infrared spectroscopy (NIR) and hyperspectral imaging, enable rapid, non-destructive simultaneous assessment of multiple nutritive and phytochemical traits in wheat grain, facilitating high-throughput screening in breeding programs and quality control in processing industries (Krishna *et al*., 2022). Combining chromatographic methods with mass spectrometry has also expanded the understanding of wheat's complex phytochemical composition at a molecular level, allowing for the discovery of novel bioactive compounds and their metabolites (Shahidi and Ambigaipalan, 2022).

The nutritional and phytochemical screening of raw wheat holds considerable implications beyond academic research. It informs plant breeders aiming to develop wheat cultivars with enhanced nutritional quality and increased bioactive compound contents to meet consumer demand for healthier foods. It guides food scientists and technologists in optimizing processing methods that preserve or even enhance these beneficial compounds. Additionally, it aids nutritionists and public health experts in crafting dietary guidelines that leverage the full potential of wheat as a functional food (Adeyemo *et al*., 2025; Ramya *et al*., 2023; Shahidi and Ambigaipalan, 2022). Moreover, this screening is crucial in addressing malnutrition and micronutrient deficiencies, commonly referred to as "hidden hunger" that affect millions globally. By identifying wheat varieties rich in key minerals and phytochemicals, biofortification

initiatives can be bolstered, thereby improving the dietary quality of populations dependent on wheat as a staple food (Shewry, 2009; Ramya *et al*., 2023).

Wheat's dual role as a vital source of energy and a reservoir of health-promoting phytochemicals underscores the importance of thorough screening of its raw grains for nutritive and phytochemical indices. These comprehensive analyses provide invaluable data that support efforts to enhance wheat quality at multiple levels, from genetic improvement to food formulation, ultimately contributing to better nutrition and health outcomes worldwide.

1.1.2 STATEMENT OF PROBLEM

Wheat is a fundamental staple crop worldwide, providing essential nutrients such as carbohydrates, proteins, dietary fiber, vitamins, and minerals critical for human health and nutrition (Frontiers in Nutrition, 2023 sig). In addition to its nutritive value, wheat contains a range of bioactive phytochemicals including phenolic acids, flavonoids, carotenoids, and saponins that have been linked to antioxidant properties and potential health benefits (Zendehbad *et al*., 2014; Victor-Osanyinlusi & Obajuluwa, 2025).However, the nutritional quality and phytochemical content of wheat can vary significantly due to genetic differences and environmental factors, impacting both its health-promoting potential and suitability for processing (Frontiers in Nutrition, 2023).

A limited understanding of the variation in nutritive and phytochemical indices among raw wheat samples restricts the optimization of wheat quality through selection and breeding. Insufficient screening and characterization methods have impeded the identification of wheat varieties with enhanced nutritional and phytochemical profiles that could improve consumer health and address food industry requirements (GSC Advanced Research and Reviews, 2025). Therefore, systematic screening of raw wheat for key nutritive and phytochemical parameters is essential to address this knowledge gap, enhance wheat quality, promote nutritional security, and facilitate the development of functional food products.

This study aims to provide comprehensive data on the variability of nutritive and phytochemical indices in raw wheat using systematic screening methods. The resulting data will contribute to advancements in wheat research and food science.

1.1.3 JUSTIFICATION OF STUDY

Understanding the nutritive and phytochemical indices of wheat, scientifically known as *Triticum aestivum L.*, is essential for advancing its role in human nutrition and health. *Triticum aestivum L.* is the most widely cultivated species of wheat worldwide and belongs to the family Poaceae (grass family). Its grains form a staple food that supports the diet of a large portion of the global population. Comprehensive evaluation of the nutrient and bioactive compound profiles in raw *Triticum aestivum L.* has profound implications for improving wheat quality, health outcomes, and food security.

Key points of relevance include:

1. *Triticum aestivum L.* supplies essential macronutrients such as carbohydrates, proteins, and dietary fiber, alongside vital micronutrients including vitamins and minerals, all of which are foundational to human health. Accurate assessment of these nutritive components informs wheat quality evaluation and dietary recommendations (GSC Advanced Research and Reviews, 2025).
2. Besides basic nutrients, *T. aestivum L.* contains diverse bioactive phytochemicals phenolic acids, flavonoids, carotenoids, phytosterols known for their antioxidant, anti-inflammatory, and disease-preventive properties. These phytochemicals elevate wheat's potential as a functional food source (Comprehensive Reviews in Food Science and Food Safety, 2022).
3. The nutritive and phytochemical profiles vary widely among *Triticum aestivum L.* genotypes and due to environmental factors affecting cultivation and post-harvest handling. Systematic screening helps identify superior wheat varieties with enhanced nutritional and health-promoting qualities (Frontiers in Nutrition, 2023).
4. Establishing reliable screening and characterization methods is essential to support breeding programs, quality control, and the development of wheat-based functional foods, ultimately maximizing the crop's health benefits (ScienceDirect, 2015).
5. Addressing micronutrient deficiencies and chronic diseases globally requires improved staple crops like *T. aestivum L.* with enriched nutritive and phytochemical content, contributing to nutritional security and public health (PMC, 2025).

6. Knowledge of these indices also guides agricultural practices and processing techniques to preserve the beneficial properties of *Triticum aestivum L.* throughout the food supply chain (Journal of Pharmaceutical and Scientific Innovation, 2014).

   In essence, this research fills critical gaps by systematically profiling the nutritive and phytochemical components of *Triticum aestivum L.*, providing valuable insights for agriculture, nutrition, and food sciences to enhance health outcomes globally.

1.1.4 SCOPE OF WORK

The scope of this research encompasses a comprehensive evaluation of the nutritive, mineral, and phytochemical indices present in raw *Triticum aestivum L.* (wheat) grains. The study specifically focused on analyzing the nutritional profile and bioactive compound composition of wheat to provide insights into its dietary significance and potential health benefits.

The scope of this study covered the following areas:

1. Proximate Analysis: Determination of the major nutritive components including moisture content, ash content, crude fat, crude protein, crude fiber, carbohydrates, and dry matter. These analyses were conducted to establish the nutritional quality and energy value of raw *Triticum aestivum L.*
2. Mineral Analysis: Evaluation of essential macro- and micro-minerals such as sodium, potassium, magnesium, calcium, zinc, and iron using Atomic Absorption Spectrophotometry (AAS), with the aim of quantifying mineral density and comparing obtained values with established reference ranges.
3. Vitamin C Analysis: Assessment of the Vitamin C content of *Triticum aestivum L.* grains using UV–Vis spectrophotometry, in order to determine the antioxidant potential and contribution of the grain to dietary vitamin intake.
4. Phytochemical Screening: Qualitative and quantitative analysis of selected phytochemicals, including alkaloids, tannins, saponins, flavonoids, and phenolic compounds, to evaluate the bioactive constituents that contribute to the medicinal and functional properties of *Triticum aestivum L.*.

5. Methodological Boundaries: The analyses were restricted to raw *Triticum aestivum L.* grains, excluding processed wheat products. Standardized laboratory techniques and protocols were employed to ensure reproducibility and reliability of results, though variations due to environmental factors, handling, and procedural limitations were acknowledged.
6. Interpretation of Findings: The results obtained were interpreted in relation to human nutrition and potential health benefits, thereby highlighting the role of *Triticum aestivum L.* as a functional food with both nutritive and phytochemical importance.

This scope thus clearly defines the scientific evaluation undertaken in this research, emphasizing the nutritional, mineral, and phytochemical composition of *Triticum aestivum L.,* and supports its relevance in agricultural, nutritional, and food science advancements.

1.1.5 LIMITATIONS

Every research study encounters various factors that may hinder or compromise the smooth execution and reliability of its findings. These factors, recognized as limitations, provide essential context for interpreting results and highlight areas for enhancement in future studies. In the context of this research on screening raw Triticum aestivum for nutritive and phytochemical indices, several practical and methodological challenges can significantly impact research outcomes.

Key factors that may impede or influence this study include:

1. Sample Variability: Variations in wheat varieties, geographical locations, and environmental conditions can lead to inconsistent nutrient and phytochemical profiles, making it difficult to draw generalized conclusions.

2. Extraction Challenges: The methods employed to extract phytochemicals may not capture all compounds, particularly those present in trace amounts or bound forms, potentially resulting in an underestimation of their levels.

3. Analytical Sensitivity: The instruments and assays utilized may have inherent detection limits and variability, which can affect the accurate quantification of specific nutrients or bioactive substances.

4. In Vitro vs. In Vivo: Laboratory tests assessing antioxidant activity or phytochemical presence may not fully reflect the bioavailability or biological effects in living organisms.

5. Resource Constraints: Limited access to advanced laboratory equipment, reagents, and skilled personnel can restrict the extent and depth of analysis.

6. Sample Handling: Improper storage or delays between sample collection and analysis can lead to the degradation of sensitive nutrients and phytochemicals, thereby influencing the results.

7. Environmental and Agronomic Influences: Factors such as pest infestations, diseases, soil quality, and farming practices introduce variability that is challenging to control but significantly affects wheat composition.

8. Standardization Issues: The absence of universally accepted protocols for sample preparation, extraction, and analysis complicates the ability to compare results across different studies.

Acknowledging these factors as limitations fosters a realistic evaluation of the study and guides future research efforts to address and overcome these challenges.

1.1.6 AIM AND OBJECTIVES

Aim:

The aim of this work is to investigate whole wheat *Triticum aestivum L*. purchased from Makogi market, Owode local government area, Ogun state, for selected phytochemical and physiological properties.

Objectives:

1. To determine the proximate nutrient composition of raw wheat samples, including protein, carbohydrate, moisture, fiber, fat, and ash contents.
2. To determine some essential minerals and vitamin c content of samples.
3. To screen and analyze the presence and concentrations of key phytochemicals, such as phenolic acids, flavonoids, tannins, and alkaloids in the wheat samples.
4. To compare the obtained values of proximate, mineral, and phytochemical compositions of wheat with established standard ranges in literature, in order to evaluate the quality and deviations.
5. To provide baseline data that may serve as a reference for future research and for stakeholders in nutrition, agriculture, and food science.

1.2 LITERATURE REVIEW

Wheat *Triticum aestivum L.* is a vital cereal crop that contributes significantly to the global food supply, offering a broad range of nutrients and bioactive compounds essential for human health (Bhat *et al*., 2023). The comprehensive profiling of its nutritive and phytochemical constituents is critical for understanding its nutritional value, promoting functional food development, and guiding crop improvement programs.

1.2.1 DESCRIPTION OF WHEAT PLANT

Wheat (*Triticum* spp.) is an annual cereal grass belonging to the family Poaceae. It has hollow stems with nodes, long linear leaves, and a terminal inflorescence in the form of spikes containing spikelets, which enclose the grains. Depending on the species and environmental conditions, wheat plants can grow between 0.6 and 1.5 meters in height (Hamilton College, 1996). Wheat possesses a fibrous root system that enhances water and nutrient absorption, contributing to its adaptability to diverse agro-climatic regions, which explains its success as a globally cultivated crop.

1.2.2 THE WHEAT GRAIN AND ITS COMPONENTS

The wheat grain (caryopsis) has three principal parts:

- Bran (14–16%) – outer covering rich in dietary fibre, phenolic compounds, B vitamins, and minerals.
- Endosperm (80–85%) – the starchy middle layer composed mainly of carbohydrates and storage proteins (gliadins and glutenins).
- Germ (2–3%) – the reproductive embryo rich in proteins, lipids, vitamin E, and minerals (Khalid *et al*., 2023).

The nutritional quality of wheat depends on the integrity of these components, many of which are lost during refining.

plate 1.1.Wheat plants

plate 1.2.Wheat grains

1.2.3 CLASSIFICATION AND TAXONOMY OF WHEAT

Taxonomically, wheat is classified as follows:

Kingdom: *Plantae*

Division: *Magnoliophyta*

Class: *Liliopsida*

Order: *Poales*

Family: *Poaceae*

Genus: *Triticum*

Species: *Triticum aestivum* (bread wheat), *Triticum durum* (durum wheat), *Triticum monococcum* (einkorn wheat), among others.

Cytogenetically, wheat exists in diploid (2n = 14), tetraploid (2n = 28), and hexaploid (2n = 42) forms. These ploidy levels influence yield, grain quality, and nutritional composition (Zhou *et al*., 2018).

1.2.4 HISTORY OF WHEAT GRAIN

The domestication of wheat dates back about 10,000 years in the Fertile Crescent, making it one of the earliest domesticated crops (de Sousa *et al*., 2021). Wheat's domestication marked a turning point in human civilization during the Neolithic Agricultural Revolution, providing a stable food source that supported population growth and urbanization. Through trade and migration, wheat spread to Europe, Asia, and Africa, becoming a cornerstone of many diets.

In the 20th century, the Green Revolution introduced high-yielding, disease-resistant wheat varieties that improved global food security. However, selective breeding reduced genetic diversity, raising concerns about sustainability and nutritional variability (Sustainable Food Trust, 2021).

1.2.5 CHEMICAL COMPOSITION OF WHEAT GRAIN

Wheat is a nutritionally diverse grain with the following components:

- Carbohydrates (65–70%) – primarily starch (amylose and amylopectin).
- Proteins (12–14%) – albumins, globulins, gliadins, and glutenins. Gluten (gliadins + glutenins) provides dough elasticity and extensibility (Wani *et al*., 2022).
- Lipids (1.5–2%) – mainly unsaturated fatty acids, glycolipids, and phospholipids.
- Dietary fibre (2–3%) – arabinoxylans, β-glucans, cellulose, and hemicellulose, which regulate digestion and improve glycaemic control (Liu *et al*., 2020).

- Vitamins – B-complex vitamins, vitamin E, and small amounts of vitamin C.
- Minerals – Fe, Zn, Mg, Ca, P, and K (Morton *et al*., 2023).
- Phytochemicals – phenolic acids, flavonoids, carotenoids, alkylresorcinols, and lignans, with antioxidant and anti-inflammatory properties (Ammar *et al*., 2023).

1.2.6 REPORTED USES OF WHEAT

CULINARY USES

Wheat is the most widely consumed cereal grain, forming the basis of foods such as bread, cakes, pastries, biscuits, pasta, noodles, bulgur, couscous, and breakfast cereals (FAO, 2021). Whole wheat products are nutritionally superior to refined flour. Wheat is also used in brewing and traditional beverages (Wikipedia, 2025).

PHARMACOLOGICAL AND FUNCTIONAL USES

Wheat bioactive compounds provide multiple pharmacological benefits:

- Antioxidant activity (phenolic compounds).
- Anti-inflammatory effects (flavonoids, phenolics).
- Glycaemic control (dietary fibre) (Liu *et al*., 2020).
- Cardiovascular protection (WHO, 2020).
- Cancer prevention (lignans, alkylresorcinols) (Khalid *et al*., 2023).

INDUSTRIAL APPLICATIONS

Wheat has applications in the food, feed, pharmaceutical, cosmetic, and biofuel industries. Wheat gluten is used as a dough improver, starch as a thickener, bran as animal feed, starch as a pharmaceutical excipient, germ oil in nutraceuticals, and wheat residues in bioethanol production (Saini *et al*., 2020; Xu *et al*., 2022).

1.2.7 PHYTOCHEMICALS IN WHEAT

Wheat phytochemicals include:

- Phenolic acids (ferulic, caffeic, p-coumaric acids) – antioxidants.
- Flavonoids (quercetin, apigenin) – anti-inflammatory and vascular protective.
- Carotenoids (lutein, zeaxanthin) – protect eye health.
- Alkylresorcinols – biomarkers of whole grain intake, with antimicrobial and anti-cancer potential.
- Lignans and saponins – linked to hormone regulation and cancer protection.
- Tocopherols and phytosterols – antioxidants and cholesterol-lowering agents (Khalid *et al*., 2023; Ammar *et al*., 2023).

1.2.8 PROXIMATE COMPOSITION OF WHEAT

Proximate analysis provides key nutritional data:

- Moisture – 10–14% (storage stability).
- Protein – 12–14% (gluten-forming proteins critical for baking).
- Carbohydrates – 65–70% (energy source).
- Fat – 1.5–2% (essential fatty acids).
- Fiber – 2–3% (digestion, cholesterol regulation).
- Ash – 1.5–2% (reflects mineral content).

Abuengmoh *et al*. (2022) reported proximate values in wheat flour blends: protein (10.53–13.01%), fat (1.01–2.50%), fiber (0.30–1.05%), and carbohydrate (43.12–48.86%).

1.2.9 MINERAL COMPOSITION OF WHEAT AND THEIR FUNCTIONS

Wheat contains several essential minerals:

- Iron (Fe) – haemoglobin synthesis, oxygen transport.
- Zinc (Zn) – immunity, growth, DNA synthesis (Morton *et al*., 2023).
- Magnesium (Mg) – enzymatic reactions, muscle and nerve function.
- Phosphorus (P) – ATP production, bone mineralisation.
- Potassium (K) – regulates blood pressure and nerve transmission.

- Calcium (Ca) – bone health and clotting.
- Selenium (Se) – antioxidant enzyme function (Wani *et al*., 2022; Zulfiqar, 2024).

Bioavailability of Fe and Zn is reduced by phytates, making biofortification and processing methods important.

1.3 VITAMIN C CONTENT IN WHEAT

Vitamin C is present in small amounts in wheat, ranging from 0.06–3.20 mg/100 g, with higher values in whole wheat (Abuengmoh *et al*., 2022). Although cereals are not major sources of vitamin C, its presence adds antioxidant potential.

Functions of vitamin C include:

- Collagen synthesis.
- Iron absorption.
- Antioxidant protection.
- Immune system regulation (Carr & Maggini, 2017; Rathore *et al*., 2020).

CHAPTER 2

MATERIALS AND METHODS

This chapter is divided into sections viz materials, which deals with all the reagents and apparatus used in the study, methods which deals with the scientific techniques employed in the study, sample collection and preparation, experimental procedures, instrumentations and quality-control measures used to evaluate the properties of wheat. All procedures were carried out between July to September at the annex in chemistry department.

2.1.0 MATERIALS

- Whole wheat flour
- Distilled water
- Filter papers (Whatman filter paper)
- Standard ascorbic acid solution

2.1.1 REAGENTS AND CHEMICALS USED

- Hager's reagent (saturated picric acid solution)
- Ferric chloride solution
- Lead acetate solution
- Frothing test solution
- Conc. Sulphuric acid
- Acetic anhydride
- KOH solution and dilute HCl
- Chloroform
- Glacial acetic acid
- Molisch's reagent
- Fhelings solution A & B
- Ethanol
- Standard solutions of know mineral elements
- Hydrochloric acid
- Sodium hydroxide
- Boric acid solution

- Petroleum ether
- oxalic acid
- potassium permanganate
- Ascorbic acid

2.1.2 INSTRUMENTS / APPARATUS

- Beakers (250ml)
- Conical flasks (100ml)
- Measuring cylinders (100ml & 250ml)
- Test tubes (20ml)
- Funnels
- Glass rods
- Dropper
- Crucible (porcelain)
- Muffle furnace (BIOBASE; Model MX6-10TP)
- Desiccator
- Digital weighing balance
- Volumetric flasks
- Hot plate (EUROSONIC; 1500W; Model ES-3825)
- Atomic Absorption Spectrophotometer (AAS) (Model-AA-6800)
- Fume hood (JINAN BIOBASE; Model FH18Z1407015)
- Mortar and pestle
- Hot air oven (Model serial No 980704)
- Heating mantle (Techmel & Techmel USA)
- Kjeldahl digestion and distillation apparatus
- Soxhlet extractor
- Pipette
- UV-Vis spectrophotometer (SHIMADZU UV-1900 i-plus)
- Clamp and retort stand

2.2 METHODOLOGY

2.2.1 SAMPLE COLLECTION, IDENTIFICATION AND PREPARATION

Raw wheat sample (*Triticum aestivum L.*) were obtained from Makogi market, Owode local government area, Lagos state. Before analysis, the wheat grains were manually cleaned to remove dirt, chaff, and foreign materials, then air-dried under ambient laboratory conditions. The cleaned grains were milled into fine powder for uniformity in subsequent analyses.

2.2.2 PREPARATION OF THE EXTRACTS

Sample preparation: 10g of the sample (whole wheat flour) was weighed and transferred into a sample bottle.

Extraction process: 50ml of distilled water was added into the sample bottle, and shaken vigorously after which it was left to stand for 24 hours in order to enhance extraction. The mixture was then filtered using a filter paper into a clean beaker.

2.2.3 SCREENING OF PHYTOCHEMICALS

1. **Screening of Alkaloids**: Picric acid was used to test for alkaloids. 2ml of the extract was added to 2ml of picric acid, a yellow precipitate was formed which indicates the presence of alkaloids.
2. **screening of Saponins (frothing test):** about 0.5g of the sample extract was shaken with water in a test tube and a persistent frothing being observed for about 10 mins indicates the Prescence of saponins.
3. **screening of Flavonoids**: about 2ml of the extract was boiled in 10 ml of distilled water and filtered. Few drops of lead acetate were added to the extract, a yellow precipitate formed indicates a positive result.
4. **screening of Tannins:** 10ml of distilled water was added to about 2ml of the extract and boiled for about 3 mins then filtered into a test tube. 2 drops of 1% ferric chloride ($FeCl_3$) solution were added. The formation of a blue-black coloration indicates the presence of phenols

5. **screening of phenols:** 2ml of 90% ethanol and 1 drop of 10% ferric chloride was added to 2ml of the extract. The formation of a pale-yellow coloration indicates the presence of phenols
6. **screening of terpenoids (salkowski test):** 2ml of the extract was mixed with 2ml of chloroform and 3ml of concentrated sulphuric acid (H_2SO_4) was carefully added and a layer formation was observed. A reddish-brown coloration at the interface confirms terpenoids.
7. **screening of glycosides:** 1ml of the extract was dissolved in 1ml of glacial acetic acid containing 1 drop of ferric chloride solution. This was under-layered with 1ml of conc. H_2SO_4. A brown ring at the interface indicates the presence of glycosides.
8. **screening of reducing sugar (Fheling's test):** equal volume of fheling's solution A & B was boiled for one minute and a volume of the extract added and boiled for 5 minutes. A brick-red precipitate is required for a positive test.
9. **screening of steroids:** about 2mls of acetic anhydride was added to 0.5g of the extract in 2ml of dilute sulphuric acid. A color change from violet to blue or green indicates the presence of steroids.

2.2.4 PROXIMATE ANALYSIS

1. **Moisture content determination:** 5g of the sample was weighed and dried in an oven to dry for 3-4 hours. The crucibles were taken out, placed in a desiccator and reweighed. Heating, cooling and weighing were repeated until a constant weight was achieved.

   CALCULATION:

   Moisture (%) = initial weight – final weight (%) ÷ initial weight

2. **Ash content determination:** two gramme of the dried sample from the moisture test were placed in a pre-weighed porcelain crucible and then transferred into a pre-heated muffle furnace set at a temperature of 900˚C, the sample was heated at this temperature for one hour after which the crucible and its content were transferred to a desiccator and allowed to cool. Thereafter the crucible and its content were re-weighed and the weight

noted. The process of heating, cooling and weighing were repeated, until constant weight was obtained. Thereafter, the percentage ash content was calculated from the relationship.

CALCULATION:

Ash (%) = weight of ash (%) ÷ weight of sample

3. **Crude protein determination:** A modified method of micro-Kjeldahl as described by AOAC (1990) was used for crude protein determination.

   Procedure for digestion: one gram of each of the defatted samples were separately weighed into a micro-Kjeldahl digestion flask together with a few anti-bumping granules. Two grams of catalyst mixture ($CuSO_4$: Na_2SO_4: SeO_2, 5:1:02 w/w) was added to each flask and then 10 ml nitrogen-free concentrated H_2SO_4 was also added to each flask. The flasks were placed at an inclined position on a heating mantle in a fume cupboard. Digestion was commenced at a temperature of 30°C until frothing ceased and then heating was increased to 50°C for another 30 min and finally at full heating (100°C) until a clear solution was obtained. Simmering was continued below boiling point for another 30 min to ensure complete digestion and conversion of nitrogen to ammonium sulphate. After digestion was completed, samples were allowed to cool and then transferred quantitatively to 100 mL volumetric flasks with washing and cooling to room temperature. Volumes were made up to mark with distilled water.

   4ml of the filtrate from the digest was transferred with the aid of a 10 ml pipette into a 25 ml standard flask. 2.5ml of the Alkaline Phenate was added and the solution was shaken to mix properly. Then 1ml of Sodium Potassium tartarate was added and shaken properly followed by the addition of 1ml of sodium hypochlorite. The solution was made up to the 25ml mark with distilled water and the absorbance of the resultant solution was measured with the aid of a UV/visible spectrophotometer, at 630nm. The Nitrogen standards were treated the same way with the sample.

CALCULATION:

Nitrogen (%) = $\frac{\text{Instrument Reading} \times \text{Slope Reciprocal} \times \text{Color Vol.} \times \text{Digest Vol.}}{}$

Weight of Sample × Aliquot Taken × 10000

Crude Protein determination (%) = Nitrogen (%) × 6.25 (AOAC, 1975)

4. **Crude fat determination:** The method of Pearson (1973) was employed; this method was based on the principle that non-polar components of samples are easily extracted into organic solvents.

   Procedure: Three grams, (Moist-free) of each sample, was placed into fat-free thimbles. These were then weighed plugged with glass wool and introduced into Soxhlet extractors containing 160 mL petroleum ether (B.P 60-80°C). Clean dry receiver flask weighed and fitted to the extractors. The extraction unit was then assembled and cold water was allowed to circulate, while the temperature of the water bath was maintained at 60°C. Extraction was carried out for 8 hours. At the end of this time, the thimble containing the sample was removed and placed in an oven at 70°C for 3hrs and dried to constant weight. The weight of the Thimble and the content were then obtained using a standard analytical balance.

   CALCULATION: The crude fat was obtained as the difference in weight before and after the exhaustive extraction. Hence the percentage of fat was calculated as:

$$\text{Fat (\%)} = \frac{X - Y}{Z} \times 100$$

   Where;

   x = Weight of sample and thimble (g)

   Y = Weight of empty thimble (g)

   Z = Weight of sample (g)

   (X-Y) = Weight of extracted fat

5. **Crude fiber determination**: This was carried out according to the procedure of AOAC (1980). Briefly, 4 g of each moisture-free sample was weighed into a 250 mL beaker, and 50 mL of 4% H_2SO_4 was added followed by distilled water to a volume of 200 ml. This was then heated to boiling and kept boiling for exactly 30 min on a Bunsen flame, with constant stirring using a rubber-tipped glass rod to remove all particles from the sides of the beaker. The volume was kept constant by the addition of hot distilled water. After 30 min of boiling, the content was poured into a butchner funnel fitted with an ash less Whatman no. forty filter paper and connected to a vacuum pump. The beaker was washed several times with hot distilled water and then transferred quantitatively with a jet of hot water. Washing continued on the funnel until the filtrate was acid-free as indicated by litmus paper. The acid-free residue was transferred quantitatively from the filter paper into the same beaker removing the last traces with 5% NaOH solution and hot water to a volume of 200 ml. The mixture was boiled for 30 min with constant stirring as earlier described, keeping the volume constant with hot water. The mixture was then filtered and washed as earlier described until it was alkaline-free. Finally, the resultant residue was washed with two portions of 2 mL 95% alcohol. Residues on filter paper were transferred to a pre-weighed porcelain crucible. The content of the crucible was then dried in an oven maintained at 110°C to a constant weight after cooling in a desiccator. Crucible content was then ignited in a muffle furnace at 550°C for 8hrs, cooled, and weighed. A triplicate determination was carried out on each sample. The percentage of crude fiber was therefore calculated as:

CALCULATION:

$$\text{Crude Fiber (\%)} = \frac{(Y-A)}{X} \times 100$$

X = Weight of sample (g)

Y = Weight of insoluble matter (g)

A = Weight of Ash (g)

6. **Carbohydrate determination**: The total carbohydrate content of the diet samples was obtained by subtracting the sum of percentage crude protein, crude fat, Moisture, Fiber and ash from 100.

   CALCULATION:

   Carbohydrate (%) = 100 – (%moisture + %ash + %protein + %fat)

7. **Nitrogen free extract (NFS):** this represents the digestible carbohydrate portion of the sample. It is not measured directly but calculated by the difference after analyzing other proximate components.

CALCULATION:

NFE (%) = 100 – (%moisture + %protein + %fat + %fiber + %ash)

8. **Dry matter:** this represents the portion of the sample that remains after all the moisture is removed.

CALCULATION:

Dry matter (%) = 100 – moisture content (%)

2.2.5 DETERMINATION OF VITAMIN C CONTENT:

5g of the ground sample was weighed and about 50ml of oxalic acid solution (0.5% w/v) was added in order to prevent the oxidation of ascorbic acid (vitamin C). The mixture was filtered through a precleaned cloth and the filtrate was in a 250 ml Erlenmeyer flask. The aliquot of each sample was transferred to a 100 ml volumetric flask and then completed to the mark with 0.5% oxalic acid solution.

1. **Preparation Of Stock and Standard Solutions of Ascorbic Acid:** A standard solution of ascorbic acid was prepared by dissolving 0.01g of ascorbic acid in a small amount of oxalic acid solution (0.5%.) and then made up to 100 ml with the same solution to obtain a concentration of 100 µg/ml. A series of dilutions 10, 8.0, 6.0, 4.0, and 2.0 µg/mL were prepared from the stock ascorbic acid solution.
2. **Preparation Of Potassium Permanganate ($KMnO_4$) Solution**: A solution of KMnO4 of concentration of 100 µg/mL was prepared by dissolving 0.01 g of KMnO4 in 5.0M

H_2SO_4 solution, then transferred into a 100 mL volumetric flask and made to the 100mL mark with distilled water and thoroughly mixed.

3. **Determination Of Vitamin C Composition**: 10ml of the sample extract was measured and transferred into a test tube. Thereafter, 1.0ml of the prepared $KMnO_4$ (100 µg/ml) was added and content mixed thoroughly. It was then allowed to stand for 5 minutes. The standard solutions and blank were treated in the same manner. The resultant solutions were read at 530nm, using a UV/Visible Spectrophotometer against the reagent blank.

CALCULATION:

$$\text{Vitamin c (mg/100g)} = \frac{IR \times SR \times CV \times EV}{AT \times W(g)}$$

Where;

IR = Instrument reading

SR = Slope reciprocal (from y = mx + c; m = slope)

CV = Color volume

EV = Equivalent volume

AT = Aliquot taken (ml)

W = weight of sample (g)

2.2.6 MINERAL ELEMENT ANALYSIS:

Determination of minerals was done by applying the AOAC method. 2g of the sample was ashed in a furnace with temperature of about 550°C and the ash of the sample was dissolved in 10ml of 0.1M HCl, filtered and made up to the mark in a 100ml volumetric flask using distilled water. This was used to determine the minerals; Potassium (K), Magnesium (Mg), Sodium (Na), Calcium (Ca), Iron (Fe) and Zinc (Zn) using an atomic absorption spectrophotometer (AAS).

CHAPTER 3

3.1 RESULT AND DISCUSSION

3.1.1PHYTOCHEMICAL SCREENING:

S/N	PHYTOCHEMICALS	METHOD	INFERENCE
1.	ALKALOIDS	HAGER'S TEST	+
2.	GLYCOSIDES	GENERAL TEST	+
3.	SAPONINS	FROTHING TEST	+
4.	PHENOLICS	FERRIC CHLORIDE TEST	+
5.	TANNINS	FERRIC CHLORIDE TEST	-
6.	FLAVONOIDS	LEAD ACETATE TEST	+
7.	STEROIDS	ACETIC ANHYDRIDE/ H_2SO_4	-
8.	TERPENOIDS	SALKOWSKI TEST	+
9.	REDUCING SUGAR	FHELING'S TEST	+

KEYS : +:present, -:absent

Table 3.1.1: phytochemical constituents of *Triticum aestivum L.* extract

Phytochemical screening is a qualitative method used to detect bioactive compounds such as alkaloids, glycosides, saponins, phenolics, flavonoids, terpenoids, steroids, tannins, etc. These secondary metabolites, although not directly involved in plant growth, contribute to defense mechanisms, nutritional quality, and potential therapeutic properties (Tian *et al*., 2022). Reducing sugars, such as glucose and fructose, are also important in nutritional assessment and

processing quality of cereals.

The presence of **phenolic compounds** and f**lavonoids** confirms wheat's antioxidant potential, which has been widely reported (Yadav & Singh, 2024). **Terpenoids** and **glycosides**, though less studied in wheat, have also been identified in colored and conventional wheat varieties (PubMed, 2021). Detection of **alkaloids** suggests the presence of nitrogenous bioactive compounds. **Saponins** were also observed, which aligns with previous studies showing that wheat grains contain measurable amounts of these compounds (Victor-Osanyinlusi & Obajuluwa, 2025). While saponins can impart bitterness, they also have bioactive roles such as cholesterol-lowering effects.

Tannins (-) were not detected in this water extract this suggests that the absence may be advantageous nutritionally, since tannins can reduce protein digestibility. Similarly, **steroids (-)** were not detected likely due to their poor solubility in water; organic solvent extracts are usually better for detecting phytosterols (Tian et al., 2022).

The positive test for **reducing sugar (-)** suggests that simple carbohydrates such as glucose and maltose are present. Reducing sugars in wheat have been shown to increase during germination and in stress conditions (Yadav & Singh, 2024).

The results show that wheat *Triticum aestivum* contains alkaloids, glycosides, saponins, phenolics, flavonoids, terpenoids, eugenol, and reducing sugars, while tannins and steroids were not detected in the distilled water extract. These findings are consistent with recent studies and reinforce wheat's value as both a staple food and a source of beneficial phytochemicals.

3.1.2 MINERAL ELEMENT ANALYSIS OF WHEAT GRAINS (*Triticum aestivum L.*)

PARAMETERS	WHEAT GRAINS (Mg/kg)
Sodium (Na)	70.0
Potassium (K)	2500.0
Magnesium (Mg)	300.0
Iron (Fe)	30.0
Zinc (Zn)	25.0
Calcium (ca)	1.9

Table 3.1.2: Mineral analysis of *Triticum aestivum L.* extract.

The mineral composition of the wheat sample was analysed and expressed in **mg/kg** as follows: sodium (**70.0 mg/kg**), potassium (**2500.0 mg/kg**), magnesium (**300.0 mg/kg**), iron (**30.0 mg/kg**), zinc (**25.0 mg/kg**), and calcium (**1.9 mg/kg**).

When compared with standard reference ranges (Na: 20–70 mg/kg; K: 3000–4000 mg/kg; Mg: 250–450 mg/kg; Fe: 25–45 mg/kg; Zn: 20–50 mg/kg; Ca: 300–500 mg/kg), the sodium, magnesium, iron, and zinc values were within the expected ranges. However, potassium (**2500.0 mg/kg**) was below the standard, while calcium (**1.9 mg/kg**) was markedly lower than expected.

The deviations observed could be attributed to analytical errors such as improper calibration of the Atomic Absorption Spectrophotometer (AAS), the use of substandard reagents, or procedural errors during bench work. In addition, inappropriate storage conditions of the sample prior to analysis could have led to mineral losses. Furthermore, environmental factors such as nutrient-poor soils, variation in wheat genotype, and differences in agronomic practices have also been reported as possible reasons for reduced mineral content in cereals (Sigalas et al., 2024; Wysocka et al., 2025).

3.1.3 PROXIMATE ANALYSIS OF WHEAT GRAINS (*Triticum aestivum L.*):

NUTRIENT	COMPOSITION (%)
MOISTURE	12.60
ASH	1.80
CRUDE FAT	21.74
CRUDE FIBRE	2.50
CRUDE PROTEIN	6.59
TOTAL CARBOHYDRATE	57.28
NFS	54.78
DRY MATTER	87.40

Table 3.1.3: proximate analysis of *Triticum aestivum L.* extract.

The results of the proximate analysis of the wheat sample were compared with standard ranges reported in the literature. The moisture content obtained **(12.60%)** was within the acceptable range of **10–14%** for wheat, which indicated that the sample was adequately dried and suitable

for storage (Okon *et al*., 2023). The ash content **(1.80%)** also fell within the expected range of **1.0–2.5%**, showing that the mineral residue was consistent with normal values for wheat (Alajaji and El-Adawy, 2006). The crude fibre value **(2.50%)** agreed with the typical range of **2.0–3.0%** reported for whole wheat grains (Rani et al., 2022), while the dry matter (87.40%) corresponded with the complementary range of **86–90%** (Okon et al., 2023). The nitrogen-free extract **(54.78%)** was also found to be within plausible limits when considered against the other proximate fractions.

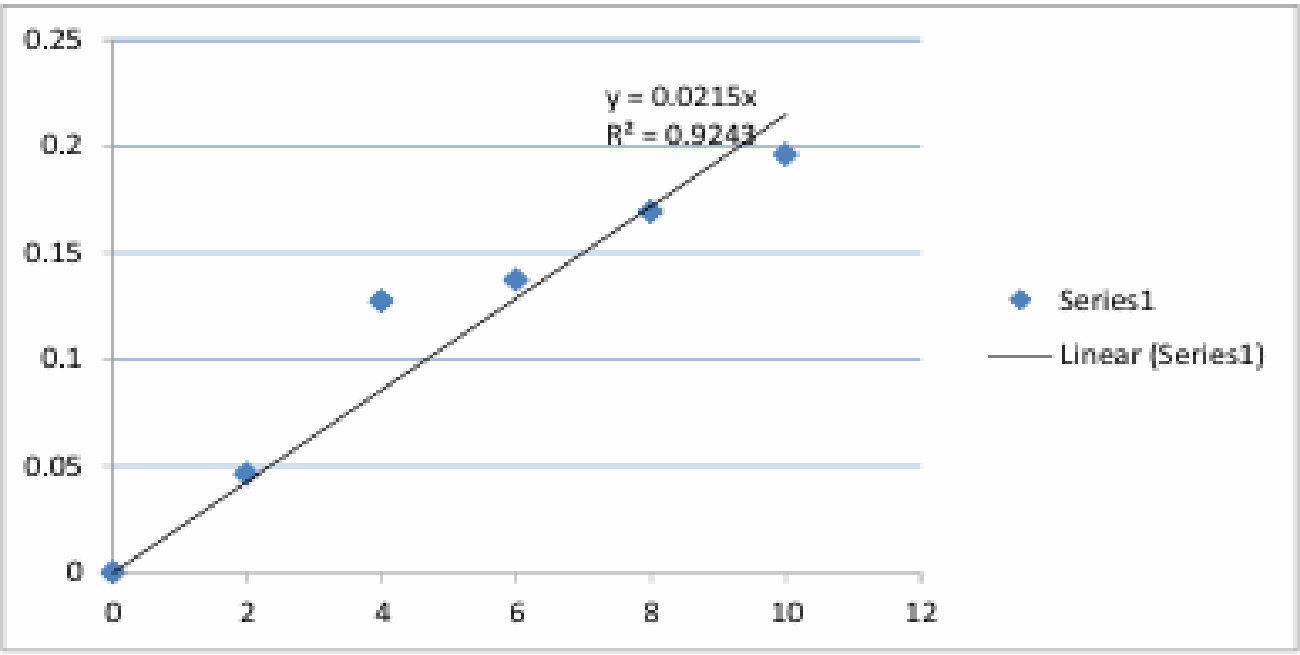
However, two parameters did not conform to the expected ranges. The crude fat content **(21.74%)** was much higher than the typical range of 1.5–3.0% reported for wheat (Okon *et al*., 2023; Sharma et al., 2017). This unusually high value was likely due to methodological issues during Soxhlet extraction, such as incomplete removal of the extraction solvent, co-extraction of non-lipid compounds like pigments and waxes, or contamination of the sample during handling. In addition, inaccurate drying of the extracted fat could have led to residual solvent weight being recorded as fat, artificially inflating the result. Sample heterogeneity, where bran or germ fractions (naturally higher in lipids) were unevenly represented, may also have contributed to this deviation.

The crude protein content **(6.59%)** was below the standard range of **9–15%** generally reported for wheat (Shewry and Hey, 2015). This lower value could have been influenced by several factors. Genotypic variation between wheat cultivars has been shown to strongly affect protein levels, with some varieties bred for high starch content containing less protein. Soil fertility and nitrogen availability at the site of cultivation may also have been limiting, resulting in reduced protein accumulation in the grain. Furthermore, errors during Kjeldahl digestion and titration, such as incomplete digestion of nitrogen-containing compounds or loss of ammonia, could have reduced the measured nitrogen value. Reporting on a wet weight basis instead of dry weight could also explain the depressed protein percentage.

In summary, while most proximate values were found to be within the ranges reported in literature, the deviations observed in crude fat and crude protein highlighted the potential impact of methodological errors, sample composition, and environmental conditions on proximate

analysis outcomes. These findings emphasised the importance of strict adherence to standardised procedures and careful sample preparation to ensure accuracy and reliability of results.

3.1.4 VITAMIN C CONTENT IN WHEAT GRAINS (*Triticum aestivum L.*)



PARAMETER	1 (mg/100g)	2 (mg/100g)	3 (mg/100g)	MEAN (mg/100g)
Vitamin c	0.28	0.31	0.29	0.29

Table 3.1.4: vitamin c content analysis of *Triticum aestivum L.* extract.

The Vitamin C content of the wheat sample was analysed using a UV–Vis spectrophotometer, with triplicate values obtained as **0.28, 0.31, and 0.29 mg/100 g**, giving a mean of **0.29 mg/100g**. This result falls within the expected range of **0.2 – 6 mg/100 g** previously reported for wheat (FAO, 2021; USDA, 2022; Kumar et al., 2022).

The relatively low Vitamin C content obtained is consistent with earlier reports that cereals, including wheat, contain only trace amounts of ascorbic acid compared with fruits and

vegetables. Consequently, wheat is considered a negligible contributor to dietary Vitamin C intake (Sigalas et al., 2024; Wysocka et al., 2025).

3.1.5 DISCUSSION:

The overall findings of this study revealed notable variations between the experimental results and reported literature values across different parameters of wheat analysis. While proximate composition (moisture, ash, crude fat, and crude protein) provided useful insights into the nutritional profile, some of the obtained values deviated from established ranges, likely due to sample handling, procedural inconsistencies, and instrumental limitations. Mineral analysis also showed fluctuations, which may have arisen from methodological or conversion errors. Similarly, the phytochemical and Vitamin C results indicated the presence of bioactive compounds, but in certain cases, values were unusually high, suggesting interference from other compounds, poor calibration, or bench work inaccuracies.

In general, although the data generated were informative, the discrepancies highlighted the importance of strict adherence to standard protocols, proper calibration of instruments, and careful sample preparation to ensure reliability. These observations further emphasize the need for replication, method validation, and cross-checking with alternative analytical techniques to improve accuracy and reproducibility in future studies.

3.1.6 CONCLUSION:

The conclusion drawn from this study is that the proximate, mineral, and phytochemical composition of wheat was generally consistent with established literature values, thereby providing reliable and useful data on its nutritional profile. Although most results fell within standard ranges, a few minor deviations were observed, which may be attributed to methodological limitations, instrumental calibration issues, or procedural inconsistencies during bench work.

Despite these challenges, the research highlighted the potential of wheat as an important source of nutrients and bioactive compounds. The findings also underscored the need for accuracy and precision in analytical procedures to avoid variations that could affect data interpretation.

Therefore, it is recommended that future studies place greater emphasis on method validation, strict quality control, and replication of analyses. Incorporating complementary analytical techniques would also enhance reliability and ensure that results are more representative of the true nutritional and phytochemical profile of wheat.

RECOMMENDATONS FOR FUTURE STUDIES:

For future studies on the nutritional, mineral, and phytochemical composition of wheat, it is recommended that more rigorous analytical protocols be adopted to minimize errors and ensure accuracy. Researchers should emphasize strict adherence to standard methods, proper calibration and maintenance of instruments, and the use of high-grade reagents to reduce variability in results. Improved sample handling and storage practices are also essential to prevent nutrient degradation, particularly for sensitive compounds such as Vitamin C.

Furthermore, replication of analyses and the inclusion of multiple analytical techniques are encouraged to validate findings and enhance reproducibility. Expanding the scope of research to include different wheat varieties and environmental growth conditions would also provide more representative data and deepen understanding of the nutritional and functional potential of wheat.

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Plant Name: *Triticum aestivum* Linn.

Family: Poaceae

Common Name: Common Wheat, Bread Wheat

Voucher Number: UBH-T555

Students Names: Eunice Chinweotuto Emeruwa *et al.*

Plant Identification and Voucher Number Issued by:

28/10/2025

Prof. Akinnibosun Henry Adewale (FLS, MRSB; London, LMBOSON, MNES; Nigeria)