

**TOTAL TANNIN, TOTAL SAPONIN AND TOTAL ALKALOID  
CONTENT OF DRIED SESAME (*Sesamum indicum*) SEEDS**

**BY**

**Oghenenyrovwo Ope IFETA**

**BMS2201825**

**DEPARTMENT OF MEDICAL BIOCHEMISTRY**

**SCHOOL OF BASIC MEDICAL SCIENCES**

**COLLEGE OF MEDICAL SCIENCES**

**UNIVERSITY OF BENIN**

**BENIN CITY**

**NOVEMBER, 2025**

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**A PROJECT SUBMITTED TO THE  
DEPARTMENT OF MEDICAL BIOCHEMISTRY, SCHOOL OF BASIC  
MEDICAL SCIENCES, UNIVERSITY OF BENIN , BENIN CITY , IN  
PARTIAL FUFILMENT OF THE REQUIREMENT FOR THE AWARD  
OF BACHELOR OF SCIENCES (B.Sc) IN MEDICAL  
BIOCHEMISTRY**

**NOVEMBER, 2025**

## CERTIFICATION OF PROJECT ON PLAGIARISM

We the undersigned attest and declare that project undertaken by:

**OGHENENYEROVWO OPE IFETA**

Titled:

**TOTAL TANNIN, TOTAL SAPONIN AND TOTAL ALKALOID TEST OF DRIED  
SESAME (*Sesamum indicum*) SEEDS**

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**Dr. B.N. Aguebor - Ogie**  
**(Project Supervisor)**

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**Date**

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**Dr. B.N. Aguebor - Ogie**  
**(Ag. Head of Department)**

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**Date**

## CERTIFICATION

This is to certify that the project work was carried out by Oghenenyeroowo Ope Ifeta with matriculation number BMS2201825, of the Department of Medical Biochemistry, School of Basic Medical Sciences, University of Benin, Benin city, in partial fulfillment of the requirements for the award of Bachelor of Science (B.Sc) degree in Medical Biochemistry.

---

**Dr. B. N. Aguebor-Ogie**  
**(Project Supervisor)**

---

**Date**

---

**Dr. B. N. Aguebor-Ogie**  
**(Ag. Head of Department)**

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**Date**

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**External Examiner**

---

**Date**

## **DEDICATION**

This project is dedicated to Almighty God for His infinite wisdom, guidance, and strength throughout this work. I also dedicate it to my beloved family for their love, prayers, and unwavering support, which have been my greatest source of motivation..

## **ACKNOWLEDGEMENT**

First and foremost, I thank Almighty God for his endless grace, strength, and mercy that sustained me throughout this work

My deepest appreciation goes to my Project supervisor, Dr. B. N. Aguebor-Ogie, who's guidance was invaluable. His expertise and insightful feedback throughout the planning and implementation phases were instrumental in shaping the direction and execution of the project.

My heartfelt thanks goes to my beloved parents and sisters for their unending prayers, love, and moral support. You have been my strength and motivation throughout this journey.

Finally, I acknowledge my friends and colleagues for their encouragement, assistance, and companionship during this course of research. To everyone who contributed in one way or another to the successful completion of this project, I say thank you and God bless you all.

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## ABSTRACT

*Sesamum indicum* L. (Pedaliaceae), commonly known as sesame, is one of the world's oldest oilseed crops, valued for its high oil content (40–60%) and diverse medicinal applications. Beyond its culinary importance, sesame possesses a wide array of secondary metabolites that contribute to its pharmacological and nutritional properties. This study focused on the qualitative and quantitative determination of total tannin, saponin, and alkaloid contents in sesame seeds to evaluate their phytochemical potential.

Dried sesame seeds were procured from a local market in Edo State, Nigeria, and processed following standard phytochemical procedures. The qualitative screening confirmed the presence of tannins, saponins, and alkaloids, while quantitative evaluation revealed that tannins were the most abundant phytochemical ( $21.27 \pm 0.35$  g TAE/kg), followed by saponins ( $20.08 \pm 0.33$ g DE/kg) and alkaloids ( $9.10 \pm 0.49$  %).

The presence of these bioactive compounds indicates that sesame seeds possess strong antioxidant and therapeutic potential. Tannins contribute to antioxidant and antimicrobial activities, saponins play a role in cholesterol regulation and immune modulation, while alkaloids are associated with analgesic and anti-inflammatory effects. The findings support the traditional use of sesame in herbal medicine and suggest its further application in nutraceutical, pharmaceutical, and cosmetic industries.

# CHAPTER ONE

## 1.0

## INTRODUCTION

### 1.1 Background to the Study

Sesame (*Sesamum indicum* L.) is one of the oldest cultivated oil seed crops, valued for its high-quality oil, protein content and rich phytochemical composition (Namiki, 2007). Belonging to the family Pedaliaceae, it is widely cultivated across tropical and subtropical regions, including Nigeria, where it serves both nutritional and economic purposes (FAO, 2021). Beyond its use as a source of edible oil, sesame seeds contain numerous bioactive compounds that contribute to their medicinal and therapeutic properties.

Phytochemicals such as tannins, saponins and alkaloids are secondary metabolites that play essential roles in plant defense and have significant implications for human health (Harborne, 1998; Okwu, 2004). Tannins are polyphenolic compounds with antioxidant and antimicrobial properties, contributing to the prevention of oxidative stress-related disorders (Chung *et al.*, 1998). Saponins, known for their soap-like foaming ability, have been reported to exhibit cholesterol-lowering, immune-boosting and anti-inflammatory effects (Sparg *et al.*, 2004). Alkaloids, which are nitrogenous compounds, are pharmacologically active and display various therapeutic effects, including analgesic and antimicrobial activities (Cowan, 1999).

The concentrations of these phytochemicals in plants are influenced by factors such as species, soil conditions, climate and processing methods (Doss *et al.*, 2011). Although sesame is best known for its lignans such as sesamin and sesamol, the presence of other phytochemicals like tannins, saponins and alkaloids further enhances its functional and medicinal importance (Anilakumar *et al.*, 2010). Assessing their levels provides insight into the crop's nutritional and therapeutic potential and supports its use in food and pharmaceutical formulations.

### 1.2 Justification of the Study

Despite extensive studies on sesame oil and lignans, limited attention has been given to its tannin, saponin and alkaloid contents, particularly in locally cultivated sesame varieties. These compounds contribute significantly to the seed's biological activity and overall quality. Therefore, evaluating

their concentrations is vital for understanding the nutritional and pharmacological potential of sesame seeds grown under local conditions.

Moreover, increasing global interest in natural bioactive substances has underscored the importance of exploring plant-based sources of beneficial compounds (Elleuch *et al.*, 2007). The findings of this study will provide baseline information on the phytochemical composition of sesame seeds and support their wider utilization in health-oriented food production and industrial applications.

### **1.3 Aim of the Study**

The study aims to evaluate the phytochemical composition of dried sesame seed (*Sesamum indicum* L.) with respect to their tannin, saponin and alkaloid content.

## CHAPTER TWO

### 2.0

### LITERATURE REVIEW

#### 2.1 THE PLANT: *sesamum indicium* (SESAME)

##### 2.1.1

Sesame (*Sesamum indicum* L.) is one of the oldest cultivated oilseed crops, with evidence of human use and domestication dating back approximately 4,000–5,000 years. Archaeobotanical studies suggest that sesame may have originated in the Indian subcontinent or parts of sub-Saharan Africa, regions where its wild relatives are still found today (Bedigian, 2003; Weiss, 2000). Historical records indicate that sesame was widely grown in early civilizations such as Mesopotamia and Egypt, largely because of its ability to thrive in hot, dry environments where many other crops could not survive.

Through ancient trade routes, sesame spread to surrounding regions, becoming an important agricultural and cultural crop in Asia, Africa, and later Europe. Its remarkable drought tolerance and the stability of its flavorful oil earned it the reputation of a “survivor crop” (Weiss, 2000). As global exchange expanded, sesame cultivation eventually reached the Americas, where it adapted successfully to tropical and subtropical climates (Fuller, 2003).

Today, sesame remains an economically significant crop cultivated across numerous countries in Asia, Africa, and Latin America. Its global importance is attributed to its rich nutritional profile, high oil content, and diverse industrial, culinary, and medicinal applications (Pathak *et al.*, 2014; Wei *et al.*, 2022).

##### 2.1.2 BOTANICAL DESCRIPTION

*Sesamum indicum* L. is an erect, annual herb that attains a height ranging from 0.5 m to 2.0 m, depending on the genotype and growing environment (Wei *et al.*, 2022; Sala *et al.*, 2023). The plant possesses a well-developed taproot system which penetrates deeply into the soil, enhancing drought tolerance but making the crop sensitive to water logging (Wei *et al.*, 2022). The stem is erect, four-angled (quadrangular), longitudinally furrowed and often covered with fine hairs; with a range of colour from green to purple (Sala *et al.*, 2023; Wei *et al.*, 2022).



**Figure 2.1a and 2.2b showing sesame plant and its seeds**

**( Image Source:Britannica)**

The leaves are simple, opposite or sub-opposite and petiolate, with shapes ranging from ovate to lanceolate. Leaf size generally varies from 3 cm to 17 cm in length, and the surfaces may be glabrous or pubescent depending on the genotype (Wei *et al.*, 2022; Sala *et al.*, 2023). Flowers usually appear singly or in small clusters along leaf axils. The blossoms are tubular to bell shaped and can display a range of colours, including white, pale pink and purple depending on the variety ( Milli *et al.*, 2021; Wei *et al.*, 2022). Although sesame mainly relies on self-pollination, insects such as bees may occasionally facilitate cross-pollination, which contributes to some genetic variation within populations (Mili *et al.*, 2021; Mawcha, 2020).

After pollination, the flowers develop into dry, dehiscent capsules that split open at maturity to release the seeds. These capsules differ in size, shape, and surface texture, often appearing elongated or slightly ovoid, and usually end with a short beak (Sala *et al.*, 2023; Mawcha, 2020). Each capsule encloses many small, flat, oval seeds, which vary widely in colour from white and cream to shades of brown and black depending on the cultivar and environmental conditions (Wei *et al.*, 2022; Mili *et al.*, 2021). Such diversity in plant form, branching habit, flower colour, capsule shape, and seed coat pigmentation reflects the rich morphological variation that plant breeders and

researchers used to identify and improve different sesame genotype (Sala *et al.*, 2023; Mawcha, 2020).

## **TAXONOMY**

Taxonomically, *Sesamum indicum* is classified as follows:

Kingdom: Plantae  
Subkingdom: Tracheobionta (Vascular plants)  
Superdivision: Spermatophyta (Seed plants)  
Division: Magnoliophyta (Angiosperms)  
Class: Magnoliopsida (Dicotyledons)  
Subclass: Asteridae  
Order: Lamiales  
Family: Pedaliaceae  
Genus: Sesamum  
Species: Sesamum indicum L.

## **2.2 SESAME AND ITS IMPORTANCE**

### **2.2.1 Nutritional Importance**

Sesame seeds are rich in nutrients. High amounts of oil (mostly unsaturated fatty acids), significant protein, dietary fibre, and a variety of minerals and vitamins are all present in them. For instance, according to one review, the seeds' abundance in "lignans (sesamin and sesamin), tocopherols, phytosterols, and essential fatty acids" is what gives them many of their health-promoting qualities (Chatterjee and Tewari, 2024). These compounds have been shown to influence metabolism of vitamins and fatty acids. For instance, dietary sesame seed and its lignan sesamin increased vitamin E and vitamin K concentrations in rat tissues (Hanzawa *et al.*, 2013) while Ikeda *et al.* (2007) observed increased ascorbic acid (vitamin C) concentrations in some tissues indicating impact on antioxidant systems and enhanced urinary excretion due to stimulated biosynthesis.

Because of their nutrient and bioactive profile, sesame seeds may play a role in supporting bone and mineral nutrition (via calcium, magnesium, zinc), providing plant-based protein, contributing healthy fats (unsaturated fatty acids) and fibre for gut health (Chatterjee and Tewari, 2024).

### **2.2.2 Therapeutic Importance**

Sesame seeds consumption has been linked to better lipid metabolism and prevention of atherosclerosis. Regular consumption of sesame seeds has been shown to significantly lower levels of triglycerides, total cholesterol, and low-density lipoprotein (LDL) cholesterol while also increasing the activity of antioxidant enzymes in hyperlipidemic patients (Alipour *et al.*, 2012; Mozaffari-Khosravi *et al.*, 2012). Sesame lignans which help regulate hepatic fatty acid oxidation and enhance circulatory lipid clearance, are primarily responsible for these effects. Additionally, sesame's high unsaturated fatty acid content supports cardiovascular health by helping to maintain normal blood pressure and vascular flexibility (Moosavian *et al.*, 2025).

In addition to cardiovascular protection sesame seeds exhibit strong anti-inflammatory and antioxidant qualities. Their tocopherols and lignans work together to scavenge free radicals and lower oxidative stress, which is a major factor linked to the onset of degenerative and metabolic disorders. Research has shown that eating sesame seeds improves the body's natural antioxidant defences by raising tissue concentrations of vitamins C, K, and E (Hanzawa *et al.*, 2013; Ikeda *et al.*, 2007). According to Farahani *et al.* (2020), these biochemical activities help preserve cellular integrity and slow the development of oxidative damage linked to ageing and chronic inflammation.

Sesame has also been shown to play a beneficial role in glucose metabolism and diabetes management. Regular consumption of sesame seeds and sesame-based products improves glycaemic control by reducing fasting blood glucose and HbA1c levels, while enhancing insulin sensitivity in patients with type 2 diabetes (Shakeri *et al.*, 2022). This hypoglycaemic effect is thought to be mediated by the presence of fiber, unsaturated fats, and lignans that influence carbohydrate digestion and glucose absorption rates. As such, sesame serves as a functional food ingredient in the dietary management of metabolic syndrome and diabetes.

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### **2.3 PHYTOCHEMICALS AND THEIR SIGNIFICANCE**

Phytochemicals, also called phytonutrients, are naturally occurring chemical compounds synthesised by plants, often as secondary metabolites rather than as components essential for plant growth and development (Leitzmann, 2016). These compounds include families such as alkaloids, terpenoids, saponins, flavonoids and polyphenols, and perform important ecological roles in plants for example protecting against pathogens, ultraviolet radiation, herbivory, and environmental stress (Pathak and Onuh, 2025). When humans consume phytochemicals from plant-based foods, these compounds may offer health benefits beyond basic nutrition. They show activities like antioxidant effects, anti-inflammatory properties, anticancer potential, and cardiovascular protection. However, their effectiveness depends on factors like bioavailability, dose, and how they are ingested (Tob, 2024; Rogers, 2022).

### **2.4 CLASSIFICATION OF PHYTOCHEMICALS IN SESAME SEEDS**

Sesame seeds contain a diverse range of phytochemicals that determine their nutritional quality, stability, and therapeutic properties. The principal classes include lignans, phenolic compounds, flavonoids, tannins, saponins, and alkaloids, which collectively contribute to their biological activity. Lignans such as sesamin, sesamol, and sesamol are the hallmark compounds of sesame, known for their strong antioxidant, antihypertensive, and hepatoprotective effects (Pathak *et al.*, 2023). Phenolic acids and flavonoids, including ferulic acid and quercetin derivatives, also play vital roles in oxidative stress reduction and the plant's defense mechanisms (El-Khier *et al.*, 2021). Furthermore, secondary metabolites such as tannins, saponins, and alkaloids are present in varying quantities, influencing the nutritional and pharmacological profile of the seeds (Datti *et al.*, 2019). The occurrence and concentration of these phytochemicals differ depending on the cultivar, seed coat colour, and environmental factors (Morsy *et al.*, 2022)

### **2.4.1 Tannins in Sesame Seeds**

Tannins are a diverse group of polyphenolic compounds widely distributed in plants, known for their ability to form complexes with proteins and other macromolecules. In sesame seeds (*Sesamum indicum* L.), tannins represent one of the key secondary metabolites contributing to both the plant's defense mechanisms and its nutritional and medicinal qualities (Chandrasekaran *et al.*, 2020). These compounds play an important physiological role by protecting the seed against microbial infections, oxidative stress, and predation (Adebisi *et al.*, 2022).

The concentration of tannins in sesame varies depending on genetic, environmental, and processing factors such as seed variety, soil type, and methods of dehulling or roasting (Sharma *et al.*, 2021). Generally, the tannin content in sesame seeds is relatively low compared to leguminous seeds, but it can still influence seed color, flavor, and digestibility (Kanu *et al.*, 2019). Dark-colored sesame varieties often exhibit higher tannin concentrations, which may contribute to their enhanced antioxidant potential (Zhang *et al.*, 2020).

From a phytochemical perspective, tannins contribute significantly to the antioxidant activity of sesame seeds by scavenging free radicals and chelating metal ions (Nagarajan *et al.*, 2019). This antioxidant capacity supports the therapeutic importance of sesame, particularly in mitigating oxidative stress-related diseases such as cardiovascular disorders and diabetes (Olagunju *et al.*, 2023). However, excessive tannin levels may also reduce the bioavailability of certain nutrients by binding to dietary proteins and minerals, hence affecting digestibility and absorption (Esonu *et al.*, 2021).

### **2.4.2 Saponins in Sesame Seeds**

Saponins are glycosidic compounds composed of a hydrophobic aglycone (sapogenin) attached to one or more hydrophilic sugar chains, giving them soap-like foaming properties in aqueous solution. Chemically, they are categorized into triterpenoid saponins and steroidal saponins, with triterpenoid types being more common in sesame (Okafor *et al.*, 2020). The general chemical structure consists of a pentacyclic triterpenoid nucleus such as oleanane or ursane, bonded through glycosidic linkages to sugar residues like glucose, rhamnose, or arabinose (Kanu *et al.*, 2019).

In sesame, saponins contribute to bitterness and astringency but are also responsible for numerous biological activities, including cholesterol-lowering, anti-inflammatory, and antimicrobial properties (Adebisi *et al.*, 2022). They function by forming insoluble complexes with cholesterol

and bile acids, reducing lipid absorption (Olagunju *et al.*, 2023). Furthermore, saponins exhibit surface-active properties that enhance emulsification and foaming, which are valuable in pharmaceutical and food industries.

### **2.4.3 Alkaloids in Sesame Seeds**

Alkaloids are nitrogen-containing organic compounds, often with significant physiological effects on humans and animals. In sesame seeds, alkaloids are present in smaller quantities compared to lignans and phenolics but play important roles in plant defense and human health (Okafor *et al.*, 2020). Chemically, alkaloids are heterocyclic compounds derived primarily from amino acids such as tryptophan, tyrosine, and lysine. Their general structure contains a basic nitrogen atom incorporated within a ring system such as pyridine, indole, or quinoline rings (Zhang *et al.*, 2020). These compounds exhibit diverse bioactivities, including antioxidant, antimicrobial, and neuroprotective effects (Olagunju *et al.*, 2023). The alkaloid fraction in sesame has been reported to contribute to its therapeutic efficacy in managing oxidative stress-related conditions (Adebisi *et al.*, 2022). Although present in low concentrations, their detection and quantification are essential for understanding the total phytochemical profile and potential pharmacological value of sesame seeds.

## **2.5 FACTORS AFFECTING PHYTOCHEMICAL CONTENT IN SESAME**

The phytochemical composition of sesame (*Sesamum indicum* L.) is not constant; it is influenced by several genetic, environmental, and processing factors that determine the levels of bioactive compounds such as tannins, saponins, and alkaloids. Understanding these factors is crucial for interpreting variations in the total phytochemical content and for optimizing sesame's nutritional and therapeutic potential (Okafor *et al.*, 2020).

### **2.5.1. Genetic and varietal differences:**

Sesame exhibits wide genetic diversity, and the concentration of secondary metabolites varies significantly among cultivars (Sharma *et al.*, 2021). Dark-seeded varieties generally possess higher levels of phenolics, tannins, and alkaloids than white-seeded varieties due to greater accumulation of polyphenolic precursors (Zhang *et al.*, 2020). The biosynthesis of saponins and alkaloids is also under genetic control, linked to specific enzymatic pathways that regulate secondary metabolism (Adebisi *et al.*, 2022).

### **2.5.2 Environmental and agronomic conditions:**

Environmental factors such as soil type, temperature, light intensity, and rainfall influence the biosynthetic pathways of phytochemicals in sesame (Chandrasekaran *et al.*, 2020). Plants grown under moderate stress conditions such as drought or high temperature tend to accumulate higher levels of antioxidant compounds, including tannins and saponins, as part of their adaptive response (Nagarajan *et al.*, 2019). Likewise, soil mineral composition and organic matter affect alkaloid production by altering nitrogen availability, a key precursor in alkaloid synthesis (Esonu *et al.*, 2021).

### **2.5.3 Post-harvest handling and processing:**

Processing methods such as roasting, dehulling, fermentation, and oil extraction can significantly modify the phytochemical profile of sesame seeds (Kanu *et al.*, 2019). Roasting often enhances the release of bound phenolic compounds and tannins but may degrade heat-sensitive constituents like saponins (Sharma *et al.*, 2021). Dehulling, on the other hand, tends to reduce total tannin content since these compounds are largely concentrated in the seed coat. Similarly, solvent extraction and drying methods affect alkaloid yield and stability (Okafor *et al.*, 2020).

### **2.5.4. Maturity stage and storage duration:**

The stage of seed maturity also influences phytochemical accumulation. Immature sesame seeds usually contain lower concentrations of phenolics and saponins, while fully mature seeds exhibit higher levels due to complete secondary metabolite biosynthesis (Olagunju *et al.*, 2023). Prolonged storage, particularly under high temperature and humidity, can lead to oxidative degradation of tannins and saponins, thereby reducing antioxidant capacity (Adebisi *et al.*, 2022).

## CHAPTER THREE

### 3.0 MATERIALS AND METHODS

#### 3.1 Materials

##### 3.1.1 Apparatus and Equipment

The laboratory instruments and glassware used for this research were provided by the Chemistry Laboratory of the University of Benin. Prior to commencement of the analyses, all apparatus were thoroughly checked and calibrated to ensure optimal functionality and accuracy. The equipment used comprised an analytical balance, laboratory blender, drying oven, thermostatic water bath, and a UV–Visible spectrophotometer (Jenway 6100, Dunmow, Essex, U.K.). Various glassware including beakers (50 mL, 100 mL, and 250 mL), volumetric flasks (100 mL and 250 mL), and measuring cylinders (20 mL and 50 mL) were also utilized. Additional materials such as Whatman No. 1 filter paper, test tubes, pipettes, a separating funnel, and an ice bath were employed throughout the experimental procedures.

##### 3.1.2 Chemicals and Reagents

All chemicals and reagents used for this study were of analytical grade. They include:

Distilled water, Acetic acid, Ethanol, Methanol, Hydrochloric acid (HCl), Ammonium hydroxide (conc.  $\text{NH}_4 \text{OH}$ ), Sulphuric acid ( $\text{H}_2 \text{SO}_4$ ), Vanillin, Folin–Denis reagent, Sodium carbonate ( $\text{Na}_2 \text{CO}_3$ ), Gelatin, Mayer’s reagent, Wagner’s reagent, and Diosgenin standard.

#### 3.2 Methods

##### 3.2.1 Sample Collection and Preparation

Dried sesame seeds (*Sesamum indicum* L.) were sourced from a reputable local market within Benin City, Edo State, Nigeria. The seeds were carefully sorted to eliminate dust, stones, chaff, and other unwanted materials. Clean seeds were then inspected to ensure they were free from mold and physical defects.

Following cleaning, the seeds were air-dried at room temperature to reduce residual moisture and improve storage stability. The dried seeds were subsequently crushed using mortar and pestle to enhance solvent penetration during extraction. The powdered sample was transferred into airtight, labeled containers and stored in a cool, dry place away from direct sunlight until required for phytochemical extraction and analysis.

### **3.2.2 Extraction**

The extraction of bioactive compounds from the powdered sesame seeds (*Sesamum indicum* L.) was carried out using established phytochemical methods with slight modifications to enhance efficiency. Each extraction was performed in triplicate to ensure consistency and reliability of results.

To obtain a broad range of phytochemicals, solvents of different polarities were used. Ethanol (80%) served as the main extraction solvent for alkaloids, tannins, and saponins, while distilled water was used for highly polar, water-soluble compounds.

The process involved the maceration technique, in which the powdered sesame seed sample was soaked in the selected solvent and left to stand at room temperature for several days with intermittent shaking. This allowed the solvent to thoroughly penetrate the plant material and dissolve the active compounds.

After soaking, the mixture was filtered through Whatman No. 1 filter paper to separate the extract from the solid residue. The filtrate was then gently concentrated by evaporating the solvent in an oven at a controlled temperature (45–50°C) to prevent degradation of sensitive components. The concentrated crude extract obtained was dark brown in color and stored in clean, airtight, labeled containers under refrigeration until required for further phytochemical analyses.

### **3.2.3 Qualitative Phytochemical Screening**

Phytochemical screening was conducted using standard procedures as described by Tiwari *et al.* (2011) and Sofowora (1993) with slight modifications.

#### **3.2.3a Detection of Alkaloids**

Two milliliters (2.0 mL) of the aqueous extract was evaporated to dryness on a water bath at 60°C. The residue was dissolved in 5 mL of 2 M HCl, heated gently, and filtered. The filtrate was divided into two portions:

**Mayer's Test:** A few drops of Mayer's reagent (potassium mercuric iodide) were added. Formation of a cream/yellow precipitate indicated alkaloids.

**Wagner's Test:** A few drops of Wagner's reagent (iodine in potassium iodide) were added. A reddish-brown precipitate confirmed the presence of alkaloids.

### 3.2.3b Detection of Tannins

One milliliter (1.0 mL) of extract was mixed with 1.0 mL of 1% gelatin solution containing 10% NaCl. Formation of a white cloudy precipitate indicated tannins (condensed or hydrolyzable).

### 3.2.3c Detection of Saponins

Foam Test: 0.5 g of powdered sample was shaken vigorously with 2 mL distilled water in a test tube. Persistent foam (>10 min) indicated saponins.

Froth Test: 5 mL of extract was diluted to 20 mL with water and shaken in a graduated cylinder for 15 minutes. A  $\geq 1$  cm stable froth layer confirmed saponins.

## 3.2.4 Quantitative Determination of Phytochemicals

### 3.2.4a Determination of Total Alkaloid Content

The gravimetric method of Harborne (1973) was adopted with modification by Obadoni & Ochuko (2001).

#### Procedure:

Five grams (5.0 g) of powdered sesame seed was extracted with 100 mL of 20% acetic acid in ethanol for 2 hours with occasional stirring. The extract was filtered, and the filtrate concentrated to  $\frac{1}{4}$  volume on a water bath ( $\leq 60^\circ\text{C}$ ). Concentrated  $\text{NH}_4\text{OH}$  was added dropwise until complete precipitation. The precipitate was allowed to settle, filtered through pre-weighed Whatman No. 1 filter paper, washed with 1%  $\text{NH}_4\text{OH}$ , dried at  $60^\circ\text{C}$  to constant weight, and weighed.

$$\text{Alkaloid (\%)} = \frac{\text{Weight of precipitate (g)}}{\text{Weight of sample (g)}} \times 100$$

### **3.2.4b Estimation of Total Saponin Content**

The vanillin–sulfuric acid colorimetric method was used as described by Makkar *et al.* (2007) and validated for sesame by Ogungbenle & Omodara (2014).

#### **Procedure:**

A 50  $\mu\text{L}$  aliquot of the aqueous extract was mixed with 250  $\mu\text{L}$  distilled water, 250  $\mu\text{L}$  of 8% vanillin in ethanol, and 2.5 mL of 72%  $\text{H}_2\text{SO}_4$  in an ice bath. The mixture was incubated at 60°C for 10 minutes, cooled in ice water, and absorbance read at 570 nm using a UV–Vis spectrophotometer. A standard curve was constructed using diosgenin (0–25  $\mu\text{g}/\text{mL}$ ). Results were expressed as g diosgenin equivalent (DE)/kg dry weight.

### **3.2.4c Estimation of Total Tannin Content**

The Folin–Denis method was employed following AOAC (1990) and adapted by Pathak *et al.* (2014) for sesame seeds.

#### **Procedure:**

0.20 mL of extract was mixed with 20 mL of 50% methanol and heated at 77–80°C for 1 hour with shaking. The mixture was filtered through double-layered Whatman No. 1 paper. To the filtrate, 20 mL distilled water, 2.5 mL Folin–Denis reagent, and 10 mL of 17%  $\text{Na}_2\text{CO}_3$  were added. After 20 minutes, absorbance was measured at 760 nm using a UV–Vis spectrophotometer. A calibration curve was prepared using tannic acid (0–100  $\mu\text{g}/\text{mL}$ ). Results were expressed as g tannic acid equivalent (TAE)/kg dry weight.

### **3.2.5 Statistical Analysis**

All analyses were performed in triplicate, and results were expressed as mean  $\pm$  standard deviation (SD). Data were processed using Microsoft Excel 2016 and SPSS version 23. One-way ANOVA was employed to compare mean values where applicable, and differences were considered statistically significant at  $p < 0.05$ .

## CHAPTER FOUR

### 4.0

### RESULTS

#### 4.1 Qualitative Phytochemical Analysis

The preliminary phytochemical screening of the sesame seed (*Sesamum indicum* L.) extract revealed the presence of major secondary metabolites including tannins, saponins, and alkaloids. These compounds were identified through characteristic color changes and precipitate formation during specific reagent tests, confirming their occurrence in the seed extract.

**Table 4.1: Qualitative Phytochemical Composition of *Sesamum indicum* Seeds**

Phytochemicals	Indication
Tannin	(+)
Saponin	(+)
Alkaloid	(+)

Key: (+) = Present, (–) = Not detected

The detection of these phytochemicals suggests that sesame seeds contain bioactive constituents known to contribute to various therapeutic properties such as antioxidant, antimicrobial, and anti-inflammatory effects.

#### 4.2 Quantitative Phytochemical Determination

Quantitative analysis was conducted to determine the concentration of the major phytochemicals present in the sesame seed extract. The results are expressed as mean  $\pm$  standard error of mean (S.E.M.) based on triplicate determinations.

**Table 4.2: Quantitative Composition of Major Phytochemicals in *Sesamum indicum* Seeds**

Phytochemicals	mean $\pm$ S.E.M
Total Tannin content (g TAE/kg)	21.27 $\pm$ 0.35
Total Saponin content (g DE/kg)	20.08 $\pm$ 0.33
Total Alkaloid content (%)	9.10 $\pm$ 0.49

The quantitative results indicate that tannins were the most abundant phytochemical in the sesame seed extract, followed by saponins and alkaloids. The relatively high tannin concentration suggests strong antioxidant potential, while the presence of saponins and alkaloids further supports the nutritional and medicinal relevance of sesame seeds.

## CHAPTER FIVE

### 5.0 DISCUSSION AND CONCLUSION

#### 5.1 Discussion

The findings from this study indicate that *Sesamum indicum* L. (sesame seeds) contain significant amounts of secondary metabolites such as tannins, saponins, and alkaloids, all of which play vital roles in maintaining physiological balance and promoting overall health. The presence of these phytochemicals agrees with previous reports describing sesame as a plant rich in compounds that possess both nutritional and therapeutic importance.

Similar patterns have been observed in other oil-bearing seeds. For instance, Shahidi and Ambigaipalan (2015) noted that coconut kernel extracts contain abundant phenolic and tannin compounds responsible for their antioxidant strength and oxidative stability. In a related study, Akinyede and Amoo (2009) found that groundnut and melon seeds also exhibit considerable levels of tannins and saponins, suggesting that these compounds are characteristic of oilseed crops. The similarity in phytochemical profiles among sesame, coconut, and groundnut implies that these seeds share common metabolic traits that contribute to their medicinal and industrial relevance.

Sesame, however, stands out due to the balanced combination of its secondary metabolites. The coexistence of tannins, saponins, and alkaloids enhances its biological value, particularly its potential in antioxidant defense, antimicrobial activity, and lipid regulation. Lamichhane *et al.* (2022) emphasized that sesame seeds also contain unique lignans such as sesamin and sesamolin, which further amplify its antioxidant potency and therapeutic versatility. Compared to palm kernel and groundnut, sesame offers a more stable oil matrix that resists rancidity, a feature that makes it valuable not only as food but also as a raw material for pharmaceuticals and cosmetics.

Beyond its biological activities, the phytochemical richness of sesame has far-reaching industrial implications. Tannins are employed in the manufacture of dyes, adhesives, and leather treatments due to their binding properties. Saponins serve as natural surfactants and emulsifiers, useful in detergents, beverages, and cosmetic formulations. Alkaloids, though present in smaller amounts, are essential pharmacological agents widely applied in analgesic and antimicrobial drug synthesis. The integrated presence of these compounds highlights sesame's versatility as a natural and sustainable resource.

It is also worth noting that environmental conditions, cultivation practices, and seed variety can influence the concentration of these metabolites. Darker sesame varieties, for instance, have been reported to contain higher levels of tannins and alkaloids, while white varieties are richer in oils and proteins. Such variations underscore the need for continued biochemical evaluation across sesame genotypes to identify those with the greatest health-promoting potential.

Overall, this study supports the growing scientific evidence that sesame seeds are not merely an oil source but a reservoir of valuable phytochemicals. Its composition aligns with global research findings that identify oil-bearing seeds as important contributors to food quality, human wellness, and sustainable industrial development.

## 5.2 Conclusion

This study demonstrated that sesame seeds (*Sesamum indicum* L.) contain notable amounts of tannins, saponins, and alkaloids, confirming their richness in bioactive compounds with diverse physiological and industrial applications. The presence of these phytochemicals reinforces the nutritional and therapeutic significance of sesame as both a food and medicinal plant.

Tannins and saponins contribute to antioxidant, anti-inflammatory, and antimicrobial effects, while alkaloids enhance pharmacological potential in drug development and health maintenance. These attributes position sesame as a valuable natural resource capable of promoting human health and supporting sustainable product innovation.

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