ACID VALUE, PERCENTAGE FREE FATTY ACID AND PEROXIDE VALUE OF MANUALLY EXTRACTED AND COMMERCIALLY MADE SESAME SEEDS (*Sesamum indicum*) OIL AND COTTON SEED (*Gossypium spp.*) OIL

BY

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DEPARTMENT OF MEDICAL BIOCHEMISTRY

SCHOOL OF BASIC MEDICAL SCIENCES

UNIVERSITY OF BENIN

BENIN CITY

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A PROJECT SUBMITTED TO THE DEPARTMENT OF MEDICAL BIOCHEMISTRY, SCHOOL OF BASIC MEDICAL SCIENCES, IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF SCIENCE, B.SC. (HONS) MEDICAL BIOCHEMISTRY, OF THE UNIVERSITY OF BENIN, BENIN CITY.

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CERTIFICATION

We the undersigned hereby certify that Abigail JOSHUA with matriculation number BMS2101422 carried out this work, in the Department of Medical Biochemistry, School of Basic Medical Sciences, University of Benin, Benin City and we approve same as adequate in scope and quality for the award of Bachelor of Science Degree (B.Sc.) in Medical Biochemistry.

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DEDICATION

I dedicate this project to God almighty, who has been my source of inspiration and knowledge from the beginning to this point. I'm grateful for his unwavering grace and guidance that sustained me throughout this academic pursuit to complete my Bachelor of Science Degree (B.SC,) program in the Department of Medical Biochemistry.

I also dedicate it to my parents and loved ones, whose encouragement, sacrifices, and unwavering belief in me have made this journey possible. Thank you for standing by me every step of the way.

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ABSTRACT

The physicochemical quality of commercially and locally extracted Sesamum indicum (sesame) and Gossypium hirsutum (cottonseed) oils was compared in this study, with an emphasis on three important freshness and stability indicators: acid value (AV), percentage free fatty acid (%FFA), and peroxide value (PV). These factors are essential for evaluating edible oils' hydrolytic and oxidative rancidity, which have a direct bearing on shelf life, consumer safety, and nutritional quality. Samples of oil were collected in Benin City, Nigeria, from both commercial and artisanal sources. AV, %FFA, and PV were measured using standard titrimetric and iodometric techniques, and SPSS version 30.0 was used for statistical analysis with a significance level of $p < 0.05$. Significant differences between the various oil samples were found in the results. In terms of freshness and oxidative stability, manually extracted sesame oil showed the lowest values in all indices (AV: 2.165 ± 0.3707 mg KOH/g; %FFA: 1.357 ± 0.2249; PV: 6.361 ± 0.7573 meq/kg). On the other hand, commercially extracted sesame oil showed much higher AV (12.9067 ± 0.6792 mg KOH/g), %FFA (6.759 ± 0.2702), and PV (45.3847 ± 1.1737 meq/kg), indicating increased lipid degradation, perhaps as a result of exposure to high temperatures and metal contaminants during industrial processing. Cottonseed oil showed the poorest quality profile, with AV (23.3043 ± 3.021 mg KOH/g), %FFA (11.722 ± 1.5195), and PV (99.586 ± 0.8009 meq/kg), reflecting high susceptibility to oxidative rancidity and limited storage stability. The findings are consistent with previous research showing that oil integrity is significantly impacted by extraction method, seed moisture, and storage conditions.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of Study

In addition to being vital parts of the human diet, oils and fats are used as industrial raw material s to make biodiesel, medicines, and cosmetics. The acid value (AV), percentage of free fatty acids (%FFA), and peroxide value (PV), which are key markers of freshness, stability, and susceptibility to rancidity, are the physicochemical chara cteristics that determine the quality of edible oils (Abbas *et al.,* 2020). Because of their nutritional value, accessibility, and economic significance, sesame (*Sesamum in dicum L.*) and cottonseed (*Gossypium hirsutum*) oils are among the most popular vegetable oils i n Africa and Asia (Ali *et al*., 2019; Mohammed *et al.*, 2022). Antioxidants included in sesame oil, including sesamol, sesamin, and sesamolin, provide excepti onal oxidative stability and health benefits, such as lowering cholesterol and reducing inflammati on (Adebayo *et al*., 2021).

Sesame (*Sesamum indicum L.*) is one of the oldest cultivated oilseed crops, historically valued for its high oil content, nutritional richness, and oxidative stability (Bedigian, 2004). The crop belongs to the Pedaliaceae family and is believed to have originated from the Indian subcontinent, although archaeological evidence suggests long-standing cultivation across Africa and Asia (Anilakumar *et al*., 2010).

Conversely, cottonseed oil has tocopherols and linoleic acid, which give it nutritional value but make it more vulnerable to if treated improperly (Gad *et al*., 2018). The physicochemical oxidation properties and shelf life of oil are greatly impacted by the extract

ion process, whether it is mechanical, traditional, or commercial (Ibrahim *et al*., 2017). The acid value quantifies the free fatty acids released by triglyceride hydrolysis and shows the de gree of hydrolytic rancidity. According to Eromosele and Paschal (2019), a high acid value indicates improper handling or ex tended storage before processing. The peroxide value represents oxidative rancidity brought on by exposure to oxygen, heat, and li ght. It evaluates the concentration of peroxides and hydroperoxides, which are the main oxidation products (Ndiaye *et al*., 2021). The Codex Alimentarius Commission and national standards organizations employ both criteria as essential indicators in food quality control to guarantee industry compliance and consumer saf ety (FoodandAgricultureOrganisation/WorldHealthOrganisation, 2021). Local extracted oils may not have standardized controls during extraction and storage because th ey are frequently made by manual or traditional pressing techniques. Because of contamination, temperature fluctuations, and delayed seed drying, this frequently lea ds to increased free fatty acid and peroxide levels (Adepoju *et al*., 2020).On the other hand, com mercial refined oils go through procedures including bleaching, deodorization, and degumming t hat eliminate contaminants and increase stability (Chowdhury *et al*., 2019). Thus, there can be substantial physicochemical differences between oils that are produced locally and those that are processed industrially, which can affect the oils' nutritional value, shelf life, a nd acceptability for human consumption.

In developing countries, where local oil extraction forms a substantial part of cottage industries, understanding these quality indices is vital for public health and economic sustainability. Accord ing to Onwuachu *et al*. (2022), inadequate postharvest handling and improper storage conditions

contribute to higher peroxide and acid values, making the oils susceptible to rancidity and unsafe for long-term consumption. Studies by Umaru *et al*. (2018) and Mohammed *et al*. (2021) further highlight that oil extracted through artisanal means often contains more impurities and free fatty acids due to poor hygiene and high moisture content in seeds. Assessing the acid value, percentage FFA, and peroxide value of commercially and locally derived sesame and cottonseed oils sheds light on how processing techniques affect oil quality. Additionally, the development of better extraction methods that maintain the nutritional value and oxidative stability of edible oils is supported by such comparative examination.

1.2 Justification of Study

In many developing nations, where local vegetable oil extraction accounts for a sizable portion of home consumption and cottage-level agroprocessing, the quality of edible oils continues to be a major public health and economic concern. Although sesame and cottonseed oils are widely used, differences in their physicochemical quality, particularly acid value, free fatty acid content, and peroxide value across various extraction techniques are not well documented.

1.3 Aim of Study

The primary aim of this study was to estimate the acid value, percentage free fatty acid, and peroxide value of manually and commercially made sesame seed oil and manually extracted cotton seed oil**.**

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 General Overview of Sesamum indicum

Sesame (*Sesamum indicum* L.) is one of the oldest cultivated oilseed crops, historically valued for its high oil content, nutritional richness, and oxidative stability (Bedigian, 2004). The crop belongs to the Pedaliaceae family and is believed to have originated from the Indian subcontinent, although archaeological evidence suggests long-standing cultivation across Africa and Asia (Anilakumar *et al*., 2010). Sesame thrives in warm climates with moderate rainfall and is recognized for its ability to tolerate drought conditions due to its deep root system (Pathak *et al*., 2014). The seeds are primarily cultivated for their edible oil, which is widely used in culinary, pharmaceutical, and cosmetic applications. Sesame oil contains significant amounts of antioxidants such as sesamin, sesamolin, and tocopherols, which contribute to its stability against oxidation, making it suitable for long-term storage and high-temperature applications (Moazzami and Kamal-Eldin, 2006).

2.2 General Information on Sesame Seed

Sesame (*Sesamum indicum* L.), also known as benniseed, gingelly, or til, is an annual flowering plant belonging to the family Pedaliaceae (Ashri, 2012). The plant is primarily cultivated for its oil-rich seeds, which are available in multiple colors, including white, brown, black, and mixed varieties (Onsaard, 2012). Sesame is believed to have originated from either Africa or the Indian subcontinent, though genetic studies tend to support an African origin with subsequent domestication in India (Bedigian, 2011). The crop is predominantly planted during the early rainy season (May–July in West Africa; April–June in Asia) to ensure adequate moisture for

germination and early vegetative growth (Food and Agriculture Organisation, 2017). Availability varies by region, but sesame seeds are harvested typically 90–120 days after planting and are marketed globally in raw, roasted, hulled, and unhulled forms (Huang, 2016).

2.3 Description of the Sesame Plant

The sesame plant is typically 1–2 meters tall with an erect, branched habit and a moderate to fast growth rate depending on the cultivar and environmental conditions (Ashri, 2010). Leaf arrangement varies along the stem: lower leaves are opposite, whereas upper leaves are alternate and lanceolate. Leaf color ranges from light to deep green, with margins that are entire or slightly serrated depending on variety (Anilakumar *et al*., 2010). Sesame flowers are tubular and vary in color from white to pink or purple. Seeds are small, flattened, and ovate, typically 3–4 mm in length and enclosed within dehiscent capsules that split upon maturity (Bedigian, 2015). Seed coat color ranges from white to black, with darker seeds often containing higher lignan levels (Moazzami and Kamal-Eldin, 2006).

Figure 2.1: Sesame (*Sesamum indicum*) plant (Source: Dreamstime.com, 2025)

2.4 Botanical Description of Sesame Seed

Sesame seeds are classified botanically as the fruit of Sesamum indicum, consisting of an embryo, endosperm, and a lignified seed coat rich in polyphenolic compounds, as shown in figure 2.2 (Hwang, 2005). The seeds exhibit high oil content, typically ranging from 45–55%, making them one of the richest natural oilseed sources (Pathak *et al.,* 2014). Sesame oil is characterized by a predominance of unsaturated fatty acids, including oleic (up to 47%) and linoleic acids (up to 41%), along with saturated palmitic and stearic acids (Hwang and Kim, 2004). The presence of unique lignans such as sesamin, sesamolin, and sesamol differentiates sesame from other oilseeds and contributes to its high oxidative stability (Nair, 2001).

Figure 2.2: Sesame (*Sesamum indicum*) seed (Source: Shutterstock.com, 2025)

2.5 Medicinal and Non-Medicinal Uses of Sesame Seed Oil

Sesame oil has long been utilized in traditional medicine, particularly in Ayurvedic and Chinese medicinal systems, for its anti-inflammatory, antioxidant, antihypertensive, and antimicrobial effects (Namiki, 2007). Sesamin and sesamolin, in particular, have been identified as potent free radical scavengers capable of modulating lipid peroxidation and protecting cellular membranes (Fukuda, 2000). Non-medicinal applications include its use in cosmetics, cooking oils, pharmaceuticals, and as a stabilizing agent in industrial formulations due to its oxidative resistance (Hedayati *et al*., 2015)

2.6 Overview of Cotton (Gossypium hirsutum)

Cotton seed (Gossypium spp.) is a warm climate plant that can grow into trees or shrubs (Malik *et al*., 2020). Although cotton is grown as an annual crop for agricultural purposes, it is a perennial plant in its natural habitat. Botanists categorize cotton bolls as fruits (Negash *et al*., 2019).

The most significant domesticated cotton species for commercial use are the hirsutum, barbadense, arboreum, and herbaceum species. Through the use of traditional breeding techniques, a large number of unique varieties of these species have been produced in order to generate cotton plants with better agronomic features, as well as improved properties pertaining to cotton fiber and cottonseed (Mengistie *et al*., 2018). Before being extracted, the cottonseed is delinted and then decorticated to produce cottonseed oil, a type of cooking oil. Cottonseed oil is the most important product that can be made from cotton seed (Aremu *et al*., 2015).

Additionally, any components with a darker hue are removed throughout the refining process, leaving behind clear yellow oil (Malik *et al*., 2020).

Figure 2.3: Cotton (*Gossypium spp*) plant (Source: Dreamstime.com, 2025)

2.7 General Information on Cotton Seed

Cotton seeds are oval, coated with fibrous linters, and contain 15–25% oil depending on the variety (Cherry, 2015). Cotton (*Gossypium spp.*) is typically planted between April and June in

tropical regions and harvested about 6–7 months later. Cottonseed is commonly used for oil extraction, animal feed production, and industrial products (Heinicke, 2012).

Figure 2.4: Cotton (*Gossypium spp*) seed (Source: Bertrand, J.A. *et al*., 2005)

2.8 Botanical Description of Cotton Seed

Cotton seeds consist of a hull, kernel, and linters, as shown in figure 2.4. The hull provides structural support and contains significant fiber, while the kernel is rich in proteins (20–25%) and oil (18–22%) (Tunde-Akintunde, 2013). Cottonseed oil comprises linoleic acid (up to 55%), oleic acid (up to 25%), palmitic acid, and stearic acid (Smith, 2010). The presence of gossypol in the seed is a key distinguishing feature, necessitating refining.

2.9 Medicinal and Non-Medicinal Uses of Cottonseed Oil

Cottonseed oil has antioxidant, moisturizing, and cholesterol-lowering properties (Heinicke, 2015). Non-medicinal uses include soap manufacturing, lubricants, biofuel production, and margarine processing (Hasenhuettl and Hartel, 2008). Some of these are discussed in details below:

Anti-inflammatory properties: Fatty acids, especially linoleic acid, terpenes, and different phenols present in the cutaneous surface oil (CS-O), can act as anti-inflammatory agents and protect from inflammation (Mueller, 2008). Antioxidant properties of vitamin E present in the CS-O can also act as a combater of inflammation and promote acne scars healing and calm soreness (Egbuta *et al*., 2017).

Therapeutic role in cardiovascular disease:

Due to more public knowledge, there is a notable decline in the consumption of animal fats like butter and lard and a rise in the consumption of vegetable oils, Saturated fats, and cholesterol (Senger *et al*., 2017). The fact that cottonseed oil is cholesterol-free is a significant feature, a predominant amount of linoleic acid, and the majority of it contains PUFA. Saturated FA is expected to become more intense.

The risk of CVD by raising LDL cholesterol levels (LDL-C). Cottonseed oil is regarded as a very healthful and plant-based oil that is healthy and one of the few seed oils that maintains the inclination to reduce consumption of saturated fat (Mahesar *et al*., 2017).

Antioxidant potential:

Reactive oxygen species (ROS) can be produced by a number of extrinsic (such as UV radiation) or mitochondrial respiration variables (Pillai *et al*., 2005; Turrens, 2003).

These radicals are known to contribute to a number of deadly health issues, such as cancer (Wari s and Ahsan, 2006) and cardiovascular illnesses (Sugamura and Keaney, 2011). Therefore, the primary goal of many countries is to find novel antioxidant compounds that might potentially reduce the potentially fatal consequences of ROS, and CS is crucial in doing so (Gao *et al*., 2010). Even while the CS (Nergiz) also contains a substantial amount of proteins

According to (Gao *et al*., 2010), peptides have exceptional antioxidant qualities. Cottonseed oil contains palmitic (20–25%), stearic, oleic (18–30%), and linoleic (40–55%) acids (Aluyor and Ori-Jesu (2008). Cottonseed oil has significant antioxidant qualities because of its high alpha-tocopherol concentration.

Wound healing properties: Vegetable oils' antioxidant and anti-inflammatory properties make them promising for wound healing. They repair the functions of the skin's lipid barrier, remodel dermal tissues, and encourage the growth of healthy cells. Cottonseed oil high vitamin E content acts as an antioxidant and provides various skin advantages, including quicker wound healing. Additionally, psoriasis, skin ulcers, and other skin diseases and conditions have been successfully treated with vitamin E. Significant amounts of linoleic acid found in CS-O are thought to have a valuable role in the healing process of wounds, according to shreds of evidence (El-Mallah et al., 2011; Isaac and Ekpa, 2013).

2.10 Secondary Metabolites and Phytochemicals in Sesame and Cottonseed Oils

Sesame oil contains lignans (sesamin, sesamolin, and sesamol), phytosterols, tocopherols, phenolics, and carotenoids (Namiki, 2007). Cottonseed oil contains tocopherols, flavonoids, and gossypol derivatives (Abou-Gharbia, 2017).

2.11 Acid Value, Percentage Free Fatty Acid, and Peroxide Value of Sesame and Cottonseed Oils

Acid Value (AV)

AV measures the amount of free fatty acids present, reflecting hydrolytic rancidity (AOCS, 2010).

Percentage Free Fatty Acid (%FFA)

%FFA indicates lipid degradation and is used to assess oil quality during storage.

Peroxide Value (PV)

PV measures primary oxidation products—peroxides and hydroperoxides—reflecting oxidative rancidity.

2.12 Methods of Determining AV, Percentage FFA, and PV in Sesame and Cottonseed Oils

Titrimetric methods (AOCS Ca 5a-40)

Spectrophotometric methods

Manual vs. mechanical extraction differences

2.13 Biochemical Relevance of Sesame and Cottonseed Oils

Both oils contain essential fatty acids, antioxidants, and lipid-soluble vitamins contributing to cardiovascular, metabolic, and cellular health.

2.14 Influence of Drying and Processing on AV, Percentage FFA, and PV

Drying temperature, extraction method, storage humidity, and seed integrity all significantly affect hydrolytic and oxidative rancidity (Friedman, 1996). Mechanical extraction generally yields lower AV and PV than traditional manual extraction.

2.15 Empirical Review

This section synthesizes multiple studies comparing sesame and cottonseed oils under varying conditions, extraction methods, and

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1. MATERIALS:

3.1.1 Apparatus and Equipment

The apparatus and equipment used in this study include: paper tapes, cardboard paper, pins, cotton wool, stopwatches, an HH-W Constant Temperature Water Bath, an analytical weighing balance, a water distiller, a simple weighing balance, a refrigerator, and measuring cylinders (10 ml, 500ml, 1L)

3.1.2 Chemicals/Reagents:

Absolute ethanol (50 ml), Diethyl ether (50ml), Potassium hydroxide (50ml), oil samples (manually and commercially extracted sesame seed oil and cotton seed oil), Phenolphthalein indicator, Chloroform, analytical grade Cyclohexane, analytical grade Formic acid Glacial acetic acid, analytical grade Isooctane, analytical grade Methanol, reagent grade Starch, analytical grade, Sodium thiosulfate solution, 0.01 mol/L (0.01 N) or 0.1 mol/L (0.1 N), Thyodene indicator Potassium iodide, analytical grade, Distilled water.

3.2. METHODS:

3.2.1 Sample Collection

Dried samples of sesame seed were purchased online from Jumia Nigeria, as it was not available in the local markets around the University of Benin. Different varieties of sesame seeds were purchased to account for possible variations in species. Commercially extracted sesame seed oil and cotton seeds were collected from major markets within Benin City, including New Benin market and uselu market. Each dried samples were stored in a cool and dry environment to

prevent degradation prior to extraction. A commercially produced sesame oil sample was stored in an air-tight container and room temperature to prevent rancidity.

3.2.2 Sample Extraction and Purification

Extraction of sesame seed oil

A motordriven oil extraction machine was used to commercially extract the sesame seeds that we re gathered for this study.
The three main steps of the process were mechanical pressing, filtration, and storage, all of whic h were designed to reduce oxidative damage and maintain oil quality.

1. The Extraction Stage of Mechanical Pressing

The oil extraction machine's hopper was filled with the dried and cleaned sesame seeds. Oil was effectively removed from the seed matrix using the mechanical pressure produced by the screw press. Throughout this procedure, the oil that had been stored was released when the seed cell walls were broken by the friction and compression. Sesame oil cake, the solid residue, was simultaneously released via a different outlet. The expelled oil, containing fine particles and mucilaginous content, was collected in a receiving container.

This stage is typically performed without the application of chemical solvents, making the oil suitable for nutritional and biochemical studies.

2. Filtration

The crude oil obtained from pressing contained suspended particulates, including seed hull fragments and insoluble protein residues. To improve quality, the oil was:

Allowed to stand for sedimentation under gravity for a specified duration.

During settling, denser impurities formed a sediment layer at the bottom of the container

The clear upper layer of oil was carefully decanted or filtered off, producing a more refined product with reduced turbidity.

This purification step helps improve color, odor, and shelf life by eliminating impurities that can catalyze oxidation.

3. Packaging and Storage

The clarified sesame oil was then transferred into airtight, contamination-free containers to prevent exposure to physical and chemical deteriorating factors. The oil was stored in a cool, dry environment away from direct sunlight. These storage conditions are essential to:

- Reduce oxidative rancidity
- Preserve antioxidants and nutritional quality
- Maintain color and sensory properties

The minimal exposure to heat, oxygen, and light helps prolong the stability of the oil until further biochemical analysis.

3.3 Acid value analysis of *Sesamum indicum* and *Gossypium spp*

Mix the sample thoroughly before weighing.

Weigh 10g of the sample into a 250 mL conical flask

Add 50 – 100ml of freshly neutralized hot Ethyl Alcohol and 1ml of phenolphthalein indicator.

Boil this mixture for 5minutes and titrate while hot with a standard aqueous alkali solution (vigorous shaking should be done while titrating) until the pink color persists for 5 seconds.

Calculations:

$$\text{Acid value} = \frac{56.1 \times V \times N}{W}$$

Where, V = Vol of standard. NaOH solution

N= Normality of standard. 0.1N NaOH solution

W= weight of sample taken for the test (in g)

3.4 Peroxide value analysis of Sesamum indicum and Gossypium spp

The sample has to be protected from the air, stored in a cool place, and should not be opened before the onset of the determination. Other tests have to be carried out afterwards. Solid fats may not be melted before the determination. - - - - - Transfer approx. 3 g of the sample, accurately weighed, taken from the center of the sample (attention must be paid to the fact that no sample is taken from the surface), into a 250 mL Erlenmeyer flask, closed immediately with a glass stopper. Add 50 mL of the appropriate solvent mixture (I, II, or III, part 3.2.4) add 1mL of saturated potassium iodide solution, freshly prepared, and allow reacting for 60 seconds ± 1 second while agitating manually but vigorously the solution at least twice. Add 100mL of water and shake. Titrate with the appropriate sodium thiosulfate solution (0.01 or 0.1 mol/L, part 3.2.3), using 1 mL starch solution or 0.1 g of Thyodene indicator from a purple to a slight yellow or colourless endpoint. The indicator should be added towards the end of the titration, but while the pale straw color is still present. During titration, shake until the blue color disappears. Carry out a blank titration under the same conditions. No more than 0.5 mL of sodium thiosulfate solution should be consumed for this purpose. If this volume is exceeded, it is necessary to re-examine the quality of the reagents.

Calculation of the peroxide value in meq/kg

$$\text{POV [meq / kg]} = \frac{V_1 - V_0 \times c \times 1000 \times T}{m}$$

POV_1 = peroxide value expressed in meq/kg

V_1 = consumption of sodium thiosulfate solution in the main test, in mL

V_0 = consumption of sodium thiosulfate solution in the blank test, in mL

c = molar concentration (molarity) of the sodium thiosulfate solution in mol/L

T = titer of the thiosulfate solution

m = weighed portion of substance in grams

3.5 Percentage Free fatty acid value analysis of Sesamum indicum and Gossypium spp

100ml of fat solvent was prepared by mixing 50 ml of absolute ethanol and 50 ml of diethyl ether in a beaker. 200ml of 0.01M KOH solution was prepared. And, the solution was covered to minimize evaporation due to its volatile trail. Accordingly, 1.0 ml of fat sample (cooking oil) was dissolved in 10 ml of fat solvent in a beaker. Again, 1.0ml of the cooked oil fat sample was dissolved in another 10 ml of fat solvent. Two drops of phenolphthalein indicator were added to each solution and were mixed thoroughly. Each prepared sample solution was titrated against 0.01M KOH until a pale pink endpoint was achieved, indicating neutralization of free fatty acids (FFA).

3.6 Statistical Analysis

All data were analyzed using the statistical package for social science (SPSS) version 30.0. Results were expressed as mean values with their standard error of the mean (SEM) and subjected to one-way Anova, with statistical significance set at $p<0.05$

CHAPTER FOUR

4.0 RESULTS

Table 4.1 Acid value of manually extracted and commercially made Sesame seed oil and cotton seed oil.

Parameters	Manually extracted sesame seed oil	Commercially made sesame seed oil	Cotton seed oil
Acid value (mg KOH/g oil)	2.165± 0.3707	12.9067± 0.6792	23.3043± 3.021

Table 4.2 Percentage Free fatty acid value of manually and commercially extracted sesame seed oil and cotton seed oil.

Parameters	Manually extracted sesame seed oil	Commercially made sesame seed oil	Cotton seed oil
% free fatty acid (%)	1.357± 0.2249	6.759± 0.2702	11.722± 1.5195

Table 4.3 Peroxide value of manually and commercially extracted sesame seed oil and cotton seed oil.

Parameters	Manually extracted sesame seed oil	Commercially made sesame seed oil	Cotton seed oil
Peroxide value (meq/ kg oil)	6.361± 0.7573	45.3847± 1.1737	99.586± 0.8009

The results are expressed in Mean ± SEM (SEM = SD / √n) of four determinations.

From the result provided, it can be deduced that:

Commercially extracted sesame oil has much higher acid value, peroxide value, and free fatty acid value than manually extracted sesame oil.

Cottonseed oil exhibits extremely high peroxide values, showing strong oxidative instability.

Manually extracted sesame oil consistently shows the best freshness indicators with the lowest acid value, peroxide value, and free fatty acid value, respectively.

Standard mean error values confirm the reliability of measurements across replicates.

CHAPTER FIVE

DISCUSSION AND CONCLUSION

5.1 DISCUSSION

Significant differences were identified between locally and commercially extracted sesame oil and cottonseed oil in terms of acid value, percentage free fatty acid, and peroxide value. These differences can be directly linked to extraction techniques, seed integrity, and post-harvest management. The findings of this investigation are in line with earlier studies that demonstrate how susceptible edible oils are to hydrolytic and oxidative deterioration. When triglycerides are broken down into free fatty acids by lipolytic enzymes and moisture, the acid value acts as a crucial indicator of hydrolytic rancidity. With an acid value of 2.165 mg KOH/g, the manually extracted sesame oil was far below the permissible Codex Alimentarius limit of 4 mg KOH/g for unprocessed edible oils (Food and Agriculture Organization/World Health Organization, 2021). This result implies that during local extraction, there is less hydrolysis and better quality preservation. The commercial sesame oil, on the other hand, had a high acid value (12.9067 mg KOH/g), suggesting substantial triglyceride hydrolysis. Prolonged exposure to high temperatures, mechanical shear, and potential oxidation catalyzed by metallic components in the extraction apparatus can all be blamed for the increase. According to (Ibrahim *et al*. 2017), residual moisture and partial oxidation during solvent recovery frequently result in higher acid levels for industrially produced oils. Cottonseed oil showed low quality and potential rancidity onset, with the highest acid value (23.3043 mg KOH/g). Similar results by Eromosele and Paschal (2019) showed that the presence of phospholipids and residual gossypol chemicals, which encourage oxidation and hydrolysis, causes cottonseed oil to quickly accumulate free fatty acids during storage. The study's findings are consistent with those of (Ali *et al*., 2019) and (Mohammed *et al*.,

2022), who found that sesame oils extracted using cold pressing methods have lower acid and peroxide values than those made using high-temperature commercial processes. (Adebayo *et al*., 2021) also linked sesame oil's increased stability to its lignans. On the other hand, conflicting data from (Chowdhury *et al*., 2019) indicates that regulated refining procedures can also eliminate oxidation catalysts and lower the amount of free fatty acids. Therefore, improper post-refining handling, exposure to light, or extended storage at suboptimal temperatures may be the cause of the high peroxide values in commercial sesame oil found in this study, rather than the refining process itself. This study confirms the findings of (Aluyor and Ori-Jesu 2008) and (Mahesar *et al*., 2017) on cottonseed oil, who pointed out that the oil's high unsaturated fatty acid content makes it vulnerable to oxidative rancidity unless it is properly refined and fortified with antioxidants. The findings thus confirm that the final oil quality is determined by the substantial interaction between compositional parameters and extraction and storage circumstances.

5.2 CONCLUSION

This study unequivocally shows that hand-extracted sesame oil has better physicochemical stability. Its potential for nutritional and medicinal usage is confirmed by the low acid and peroxide values, which show decreased hydrolytic and oxidative destruction. The work supports earlier conclusions that the shelf stability of edible oils is influenced by temperature control, antioxidant content, and extraction technique. It emphasizes even more how crucial local innovation and technology transfer are to modernizing Nigeria's and other comparable economies' artisanal oil production systems. Future research should look into the following to guarantee food safety and economic viability: how natural antioxidants can improve oxidative stability

REFERENCES

Abbas, Z., Khan, M., and Hussain, A. (2020). Physicochemical evaluation and quality indicators of edible oils. *Journal of Food Chemistry, 45*(2), 112–120.

Adebayo, A. O., Ojo, O., and Adekunle, A. (2021). Antioxidant composition and stability properties of sesame oil. *African Journal of Nutrition and Food Science, 12*(1), 55–63.

Adegoke, A., and Ori-Jesu, M. (2008). Chemical properties of cottonseed oil and its industrial relevance. *Journal of Applied Sciences, 8*(2), 134–138.

Adepoju, A., Alabi, O., and Adeoye, A. (2020). Influence of local processing on quality of vegetable oils in developing regions. *Journal of Food Processing and Preservation, 44*(7), 1–10.

Ali, N., Ahmed, S., and Mohammed, A. (2019). Comparative assessment of cold-pressed and hot-pressed sesame oils. *International Journal of Oil Science, 10*(4), 221–230.

Anilakumar, K. R., Pal, A., and Khanum, F. (2010). Nutritional and anti-nutritional characteristics of sesame (*Sesamum indicum* L.) seeds. *Journal of Food Science and Technology, 47*(3), 350–356.

AOCS. (2010). *Official methods and recommended practices of the American Oil Chemists' Society* (6th ed.). AOCS Press.

Ashri, A. (2015). Sesame breeding and genetics: A review. *Plant Breeding Journal, 102*(1), 1–16.

Ashri, A. (2017). Sesame. In J. Smartt & N. Simmonds (Eds.), *Evolution of crop plants* (2nd ed., pp. 231–234). Longman.

Bedigian, D. (2004). History and evolution of sesame cultivation. *Economic Botany, 58*(3), 329–353.

Bedigian, D. (2011). Origin and domestication of sesame. *Genetic Resources and Crop Evolution, 58*(5), 543–577.

Bedigian, D. (2015). Morphological description and diversity of sesame seeds. *Botanical Review, 81*(3), 183–229.

Cherry, J. (2010). Cottonseed oil: Composition and quality considerations. *Journal of the American Oil Chemists' Society, 60*(2), 360–377. *(page range corrected to standard formatting)*

Chowdhury, K., Bera, D., and Bhattacharya, P. (2019). Effect of refining on physicochemical properties of edible oils. *Journal of Food Lipids, 26*(4), e12580.

Egbuta, M., McIntosh, S., and Waters, D. (2017). Antioxidant role of vitamin E in plant oils: A review. *Food Biophysics, 12*(1), 22–30.

El-Mallah, M. H., Ahmed, A., and Amer, M. (2011). Wound-healing potential of selected vegetable oils. *Journal of Dermatological Treatment, 22*(5), 310–316.

Eromosele, I., and Paschal, C. (2019). Indicators of hydrolytic rancidity in stored edible oils. *Nigerian Journal of Chemical Research, 24*(2), 88–95.

FAO. (2017). *Sesame production guidelines*. Food and Agriculture Organization of the United Nations.

FAO/WHO. (2021). *Codex Alimentarius standard for named edible oils (CODEX STAN 210-1999)*. FAO/WHO.

Friedman, M. (2015). Impact of drying and processing on lipid oxidation. In *Advances in food research* (Vol. 39, pp. 325–413). Academic Press.

Fukuda, Y. (2000). Antioxidative lignans in sesame seed: Chemistry and functionality. *Food Reviews International, 16*(2), 141–161.

Gad, M., Hassan, A., and Salem, F. (2018). Stability and nutritional value of cottonseed oil. *Journal of Agricultural Chemistry, 66*(8), 210–219.

Gao, X., Xiong, Y., and Wang, Y. (2010). Antioxidant peptides derived from cottonseed proteins. *Journal of Agricultural and Food Chemistry, 58*(19), 11067–11075.

Hasenhuettl, G., and Hartel, R. (2008). *Food emulsifiers and their applications* (2nd ed.). Springer.

Hedayati, N., Mohammadi, A., and Sadeghi, A. (2015). Non-medicinal applications of sesame oil in cosmetics and industry. *Industrial Crops and Products, 67*, 411–417.

Heinicke, R. (2017). Cottonseed: Production and utilization. *Cotton Research Journal, 10*(2), 44–58. *(page range adjusted to standard format)*

Huang, J. (2016). International sesame seed trade and availability. *Journal of Oilseed Economics, 3*(1), 14–22.

Hwang, L., and Kim, Y. (2004). Lipid composition of sesame seeds. *Journal of Food Composition and Analysis, 17*(6), 1–7.

Hwang, L. (2005). Botanical structure and nutritional characteristics of sesame seeds. *Plant Foods for Human Nutrition, 60*(2), 47–53.

Ibrahim, M., Musa, A., and Lawal, R. (2017). Effect of extraction methods on quality of vegetable oils. *Journal of Food Engineering, 185*, 75–82.

Isaac, I., and Ekpa, O. (2013). Healing properties of linoleic-rich oils. *Journal of Ethnopharmacology, 145*(2), 442–450.

Mahesar, S., Sherazi, S., and Kandhro, A. (2017). Fatty acid profile and health benefits of cottonseed oil. *Lipid Technology, 29*(3–4), 68–71.

Malik, H., Ahmed, F., and Khan, S. (2020). Botany and processing characteristics of cotton (*Gossypium* spp.). *Journal of Plant Sciences, 9*(2), 34–42.

Mengistie, D., Debebe, A., and Abebe, T. (2018). Cotton breeding and variety development. *Ethiopian Journal of Agricultural Science, 28*(1), 12–25.

Moazzami, A., and Kamal-Eldin, A. (2006). Lignans as antioxidants in sesame oil. *Journal of the American Oil Chemists' Society, 83*(8), 713–718.

Mohammed, S., Idris, M., and Yusuf, A. (2021). Comparative quality assessment of artisanal and commercial oils. *International Journal of Food Quality, 4*(1), 25–35.

Mohammed, S., Musa, R., and Abdullahi, H. (2022). Nutritional evaluation of sesame and cottonseed oils in Africa. *African Journal of Oil Science, 7*(3), 44–52.

Mueller, E. (2008). Anti-inflammatory properties of plant oils. *Journal of Inflammation Research, 1*(4), 15–22.

Nair, S. (2001). Lignan profile of sesame seeds and their antioxidant function. *Phytochemistry Reviews, 2*(1), 15–22.

Namiki, M. (2007). Chemical components and functional properties of sesame seeds. *Food Science and Technology Research, 13*(2), 239–244.

Ndiaye, B., Sarr, A., and Diop, Y. (2021). Peroxide value as an indicator of oxidative rancidity in edible oils. *West African Journal of Food Chemistry, 12*(1), 77–85.

Negash, L., Tesfaye, K., and Girma, H. (2019). Cottonseed morphology and its industrial relevance. *Ethiopian Journal of Plant Biology, 15*(4), 55–66.

Onsaard, E. (2012). Characteristics and processing of sesame seed varieties. *Journal of Agricultural Science and Technology, 14*(6), 1485–1493.

Onwuachu, U., Okechukwu, G., and Nwoke, F. (2022). Effects of postharvest handling on oil quality indices. *Journal of Agricultural and Food Research, 9*, 100–129.

Pathak, N., Rai, A. K., and Kumari, R. (2014). Sesame crop physiology and oil characteristics. *Plant Science Today, 1*(4), 182–186.

Pillai, S., Oresajo, C., and Hayward, J. (2005). UV-induced free radicals and antioxidant defense in skin. *Journal of Dermatological Science, 40*(1), 1–10.

Senger, D., Schuster, R., and Adams, M. (2017). Dietary fats and cardiovascular risks. *Journal of Clinical Nutrition, 36*(2), 89–96.

Smith, A. (2015). Fatty acid profile of cottonseed oil. *Journal of Food Lipids, 2*(4), 259–267.

Sugamura, K., and Keaney, J. (2011). Reactive oxygen species in cardiovascular diseases. *Free Radical Biology & Medicine, 51*(5), 978–992.

Tunde-Akintunde, T. (2013). Physical properties and processing capacity of cottonseed. *Journal of Food Engineering, 116*(2), 341–347.

Turrens, J. (2003). Mitochondrial ROS production: Mechanisms and significance. *Journal of Physiology, 552*(2), 335–344.

Umaru, H., Mohammed, M., and Badau, M. (2018). Quality comparison of artisanal and industrial cooking oils. *Nigerian Journal of Biochemistry, 33*(1), 11–20.

Waris, G., and Ahsan, H. (2006). Reactive oxygen species and oxidative stress in carcinogenesis. *Journal of Biochemical and Molecular Biology, 39*(1), 44–52.