**PHYSICOCHEMICAL PROPERTIES OF GROUNDNUT OIL AND PALM OIL IN OGBOMOSO SOUTH LGA, OYO STATE**

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**CHAPTER ONE**

**INTRODUCTION**

**1.1 Background of the Study**

Vegetable oils have a vital role in both human nutrition and business, since they contain important fatty acids and serve as raw materials for a wide range of goods. Groundnut oil and palm oil are prominent among the various forms of vegetable oils, mostly because of their extensive use and economic significance, particularly in tropical areas such as Nigeria. Groundnut oil, extracted from peanuts, is renowned for its subtle taste and elevated smoke point, rendering it perfect for culinary use and deep frying (Ahmed and Ali, 2015). Palm oil, derived from the oil palm tree's fruit, is widely utilised in culinary goods, cosmetics, and biofuel because of its adaptable characteristics (Sundram *et al.,* 2016).

Ogbomoso South, a local area in Oyo State, Nigeria, is renowned for its significant contribution to the production of these oils. The quality and qualities of the oils produced are greatly influenced by the farming practices, climate, and soil conditions of the location. Comprehending the physicochemical characteristics of groundnut and palm oil from this region might offer valuable information regarding their quality, prospective health advantages, and industrial uses. Physicochemical parameters such as viscosity, density, free fatty acid content, and peroxide value are important factors that determine the quality and stability of oil (Nkafamiya *et al.,* 2017).

Research has indicated that the characteristics of vegetable oils can significantly differ based on several aspects, such as the extraction process, storage conditions, and environmental influences (Gunstone, 2017). Factors such as temperature and light exposure can alter the oxidative stability of oils, which is important for their shelf life and nutritional quality (Choe and Min, 2006). A comprehensive investigation is required to assess the acceptability of groundnut and palm oil for consumption and industrial use in ogbomoso South, considering the potential effects of traditional extraction methods and different storage conditions on their quality.

Furthermore, the growing global demand for vegetable oils has emphasised the necessity for sustainable and high-caliber oil production. According to the Food and Agriculture Organisation (FAO), there has been a consistent rise in the worldwide production and consumption of vegetable oils. This trend is primarily influenced by the expansion in population and higher earnings (FAO, 2018). This tendency highlights the significance of regional research, such as the one mentioned, in enhancing production methods and guaranteeing that the oils adhere to worldwide quality benchmarks.

Recently, there has been a growing focus on the environmental consequences associated with the production of palm oil. The necessity for sustainable methods has been highlighted due to concerns regarding deforestation, habitat damage, and greenhouse gas emissions linked to the establishment of large-scale palm oil plantations (Meijaard *et al.,* 2018). To promote sustainable development in the ogbomoso South area, it is crucial to comprehend the local practices and their effects on oil quality and the environment, notwithstanding the predominance of smallholder farms in the region.

An investigation into the physicochemical characteristics of groundnut and palm oil from ogbomoso South is significant not only for local producers but also for policy-makers and researchers seeking to improve the quality and sustainability of vegetable oil manufacturing. This study seeks to conduct a thorough evaluation of these features in order to offer a comprehensive assessment that can guide improvements in farming practices, processing processes, and storage systems. In the end, this will bolster the economic growth of the area and guarantee the welfare and satisfaction of consumers.

**1.2 Statement of the Problem**

Although groundnut and palm oil play a crucial role in the food and economy of ogbomoso South, there is a scarcity of thorough data regarding their physicochemical qualities. Local producers frequently depend on conventional techniques for extraction and storage, which may not maximise the quality of the oils. The lack of understanding in this area might result in problems such as shorter storage time, decreased nutritional quality, and possible health hazards linked to the intake of inferior oils (Olagunju *et al.,* 2017).

Moreover, there is a lack of knowledge among local farmers and producers on the optimal methods for oil extraction and storage. The absence of sufficient information can lead to variations in the quality of oil, hence impacting consumer confidence and marketability. Moreover, given the increasing worldwide attention to the ecological consequences of oil extraction, it is necessary to assess the sustainability of local activities in ogbomoso South (Basiron, 2019).

**1.3. Aim and Objectives of the Study**

**1.3.1. Aim**

The aim of this study is to investigate and analyse the physicochemical characteristics of groundnut and palm oil in the Ogbomoso LGA, Oyo state.

**1.3.2. Objectives**

The specific objectives of this study includes:

1. To analyze the physicochemical properties of groundnut and palm oil produced in the ogbomoso South local area.
2. To evaluate the impact of local extraction and storage practices on the quality and stability of these oils.

**1.4 Research Questions**

1. What are the physicochemical properties of groundnut and palm oil produced in ogbomoso South?
2. How do local extraction and storage practices affect the quality and stability of these oils?

**1.5 Significance of the Study**

This study is of great significance to several stakeholders, such as local producers, consumers, policy-makers, and researchers. Local producers can enhance their extraction and storage techniques by comprehending the physicochemical characteristics of their products. This knowledge can result in the production of superior quality oils that can effectively compete in both domestic and global markets (Adebisi *et al.,* 2020). Enhanced quality also results in improved consumer health, since oils with reduced amounts of free fatty acids and peroxide values are less prone to causing health problems including heart disease and oxidative stress (Mensink, 2016).

The study offers policy-makers vital data that can be used to shape legislation and standards for the production of vegetable oil. Implementing this measure can guarantee that the oils manufactured in the area adhere to safety and quality regulations, safeguarding consumers and bolstering the reputation of Nigerian vegetable oils in the international market (Nigerian Institute of Food Science and Technology, 2019).

The study's findings will provide researchers with valuable insights into the various aspects that affect the quality of oil in diverse locations. This can enhance the existing pool of knowledge on vegetable oil production and stimulate additional investigation into enhancing oil quality and implementing sustainable techniques.

Moreover, through the promotion of sustainable practices, the study can aid in reducing the environmental consequences of oil extraction in the region. Considering the worldwide concerns over the sustainability of palm oil production and the necessity for measures that avoid deforestation and habitat loss, this is especially pertinent (Khatun *et al.,* 2020).

This study seeks to gain a thorough understanding of the physical and chemical characteristics of groundnut and palm oil in ogbomoso South. It aims to provide practical suggestions to enhance the quality and long-term viability of these oils. This would enhance the welfare of local farmers, consumers, policy-makers, and researchers, while fostering the holistic growth and durability of the vegetable oil business in the region.

**1.6 Scope and Delimitations**

This study is limited to the ogbomoso South local area and especially examines the physicochemical qualities of groundnut and palm oil produced in this region. The study will entail gathering oil samples from different local producers, which will then undergo laboratory analysis to ascertain qualities such as viscosity, density, free fatty acid content, peroxide value, and iodine value. The selection of these qualities is based on their significance as key indicators of both oil quality and stability (Rossell, 2015).

The study will exclude other varieties of vegetable oils, such as soybean or coconut oil, as it specifically concentrates on groundnut and palm oil due to their economic and dietary importance. Furthermore, the study will not explore the genetic elements that influence the oil output of the crops. Instead, it will focus on the practices related to post-harvest processing and storage.

The study's objective is to conduct a comprehensive analysis of the physicochemical features. However, the availability of modern analytical equipment will impose limitations on the study. The investigations will be performed using conventional laboratory procedures, however there may be limitations in obtaining more advanced technologies that could offer more profound insights.

Furthermore, the study will predominantly depend on cross-sectional data that was gathered throughout the research duration. The current study is unable to give a thorough understanding of changes in oil qualities over longer storage periods due to time and resource restrictions. Therefore, longitudinal data on this topic is not within the scope of the study.

Ultimately, the study will provide suggestions derived from its findings. However, the adoption of these recommendations will rely on the willingness and capability of local producers and policy-makers to embrace new methodologies. The study will establish a basis for more research and the formulation of policies, while recognising that more extensive systemic modifications may be required to fully achieve the advantages.

**1.7 Definition of Terms**

**Physicochemical Properties:** Characteristics of a substance that are both physical and chemical, such as viscosity, density, free fatty acid content, and peroxide value.

**Groundnut Oil:** Oil extracted from the seeds of the groundnut (peanut) plant, known for its culinary and nutritional uses.

**Palm Oil:** Oil obtained from the fruit of the oil palm tree, widely used in food products, cosmetics, and biofuel.

**Viscosity**: A measure of a fluid’s resistance to flow.

**Density:** The mass per unit volume of a substance.

**Free Fatty Acid Content:** An indicator of the degradation of oil, reflecting its acidity and potential for rancidity.

**Peroxide Value:** A measure of the extent to which an oil has undergone primary oxidation, indicating its rancidity level.

**Iodine Value:** A measure of the degree of unsaturation in oil, indicating the amount of unsaturated fatty acids.

**Oxidative Stability:** The resistance of oil to oxidation, affecting its shelf life and nutritional quality.

**Sustainable Practices:** Methods of production that do not harm the environment and can be maintained over the long term without depleting resources.

**CHAPTER TWO**

**LITERATURE REVIEW**

**2.1 Overview of Vegetable Oils**

Vegetable oils are essential elements of human diets and have important functions in diverse industrial applications globally. They are derived from the seeds, fruits, or nuts of plants and consist mainly of triglycerides, which are compounds made up of glycerol and fatty acids (Gunstone, 2015). Widely utilised vegetable oils encompass soybean, sunflower, canola, olive, coconut, palm, and peanut oil, each possessing distinct compositions and qualities.

These oils are vital sources of energy and important fatty acids in human nutrition. They supply essential nutrients such linoleic acid and alpha-linolenic acid, which serve as precursors of omega-6 and omega-3 fatty acids, correspondingly (FAO, 2016). Moreover, vegetable oils possess fat-soluble vitamins such as vitamin E and vitamin K, so enhancing their nutritional worth (Eitenmiller *et al.,* 2017).

Vegetable oils are widely utilised in industrial settings for various purposes such as cooking oils, salad dressings, margarine, shortenings, and frying fats. This is because they have the capacity to endure high temperatures without undergoing degradation (Aladedunye and Przybylski, 2013). Additionally, they find application in the manufacturing of biodiesel, lubricants, cosmetics, and pharmaceuticals, underscoring their adaptability and economic importance (Santos *et al.,* 2018).

Nevertheless, the nutritional and functional characteristics of vegetable oils might differ considerably based on variables such as the botanical origin, extraction technique, refining procedure, and storage circumstances. Cold-pressed oils preserve a higher amount of their natural antioxidants and flavour components in comparison to refined oils, which go through several processes as degumming, neutralisation, bleaching, and deodorization (Alvarez-Chavez *et al.,* 2016).

Comprehending the distinct qualities and uses of various vegetable oils is crucial for maximising their effectiveness in both dietary and industrial settings. For this study, it is essential to examine the distinct compositions, applications, and physicochemical features of groundnut and palm oil in order to provide a framework for the ensuing investigation.

**2.2 Groundnut Oil: Composition and Uses**

Groundnut oil, commonly referred to as peanut oil, is extracted from the seeds of the Arachis hypogaea plant and is a highly popular vegetable oil eaten worldwide. It is distinguished by its subtle taste, delicate consistency, and elevated smoke point, rendering it appropriate for a range of cooking techniques, such as frying, sautéing, and roasting (Patel and Patel, 2015).

Groundnut oil is composed mainly of unsaturated fatty acids, with roughly 80% of its composition consisting of oleic acid (monounsaturated) and linoleic acid (polyunsaturated). It also contains lower quantities of saturated fatty acids, such as palmitic and stearic acid (Tangolar *et al.,* 2016). The composition of fatty acids in this oil is known for its positive impact on heart health. Monounsaturated and polyunsaturated fats, which are present in this oil, have been linked to a lower risk of cardiovascular disorders compared to saturated fats (Hu *et al.,* 2015).

Groundnut oil is not only used for cooking, but it is also employed in the food business to make snacks, baked goods, and confectionery products. The neutral taste and stable ability to resist oxidation make it a favoured option for producers aiming to improve the quality of their products and extend their shelf life (Oyebode *et al.,* 2017).

In addition to its use in food, groundnut oil is employed in cosmetic and pharmaceutical goods due to its emollient and moisturising characteristics. Due to its nourishing and hydrating properties, it is frequently used in skincare formulations, hair care products, and massage oils (Akhtar and Siddiqui, 2019). Moreover, groundnut oil has been studied for its possible therapeutic advantages, such as its anti-inflammatory and antioxidant capabilities, which could have consequences for the prevention and treatment of several health issues (Bao *et al.*, 2018).

Thus, groundnut oil is a versatile vegetable oil that has a wide range of uses in the food, cosmetic, and pharmaceutical industries. The valuable nature of its fatty acid profile, stability, and functional capabilities make it highly sought after in both domestic and foreign markets. Therefore, it is crucial to comprehend its composition and applications within the scope of this study.

**2.3 Palm Oil: Composition and Uses**

Palm oil is extracted from the fruit of the oil palm tree, specifically Elaeis guineensis, and is a highly prevalent and commonly eaten vegetable oil worldwide. The substance is distinguished by its reddish-orange hue, partially solid texture when not heated, and notable taste profile, which varies from moderate to intense based on the level of purification (Gunstone *et al.,* 2018).

Palm oil has a unique composition compared to other vegetable oils. It contains around 50% saturated fatty acids, mainly palmitic acid, and approximately 40% unsaturated fatty acids, largely oleic acid (Sundram *et al.,* 2015). Palm oil's distinctive composition of fatty acids is responsible for its partially solid texture and resistance to oxidation, which makes it well-suited for a range of cooking uses such as frying, baking, and food processing (Lam *et al.,* 2019).

Palm oil is widely used in the food business not only for its culinary purposes but also for its functional features, including texture enhancement, emulsification, and flavour stabilisation. It is frequently present in a diverse array of items, such as margarine, spreads, baked goods, snacks, and processed foods (Abdulqader *et al.*, 2021). The extensive acceptance of palm oil by food makers worldwide can be attributed to its versatility in food applications.

In addition to its use in food, palm oil is also employed in a range of non-food applications, such as cosmetics, personal care products, detergents, and biofuels. The distinctive composition and characteristics of this substance make it a desirable component for formulators who are searching for substitutes to petrochemical-derived substances (Nurhazwani *et al.*, 2017). Nevertheless, the growing need for palm oil has prompted worries over its ecological consequences, namely in relation to the clearing of forests, destruction of habitats, and decline in biodiversity in areas where oil palm plantations are spreading (Wilcove and Koh, 2016).

Therefore, palm oil is a versatile and extensively utilised vegetable oil that has a wide range of applications in both the food and non-food sectors. The study emphasises the necessity of comprehending the composition and usage of the unique oil produced in the ogbomoso South local region, particularly in connection to its physicochemical features.

**2.4 Physicochemical Properties of Oils**

**2.4.1 Physical Properties**

The physical qualities of oils include attributes such as viscosity, density, colour, and melting point, which offer information on their texture, appearance, and behaviour under various conditions. These qualities are essential in establishing the appropriateness of oils for different purposes, such as cooking, food processing, and industrial applications.

Viscosity is the measure of a fluid's resistance to flow and is determined by factors such as temperature and molecule structure. Fluids with greater viscosity exhibit reduced flow rates, whereas fluids with lesser viscosity exhibit enhanced flow rates. The viscosity of oils has an impact on their ability to pour, spread, and coat, which are significant factors to consider in food processing and formulation (Gunstone *et al.*, 2019).

Density, however, quantifies the mass divided by the volume of a substance. Oils with greater densities are more substantial and have a higher level of compactness, whereas oils with lower densities are lighter and less dense. The density of oils has a significant impact on the ratio of volume to weight. This is crucial when considering transportation, storage, and packaging in the food and industrial sectors (Bansal *et al.*, 2017).

The colour of oils is a significant visual attribute that can differ based on factors such as the existence of pigments, impurities, and processing techniques. Oils can exhibit a spectrum of colours, ranging from transparent and light yellow to deep brown or green. These variations in colour can serve as indicators of disparities in quality, freshness, and processing methods (Ferreira *et al.*, 2018). Colour is frequently employed as a means of assessing quality in both culinary and industrial contexts.

The melting point is a significant physical characteristic, especially for oils that have a semi-solid or solid texture at room temperature, such palm oil and coconut oil. The melting point is the specific temperature at which the oil undergoes a phase change from solid to liquid or vice versa. This characteristic impacts the consistency, tactile sensation, and practicality of oils in culinary products including chocolate, margarine, and bakery items (Basiron *et al*., 2016).

Comprehending the physical characteristics of oils is crucial for evaluating their excellence, durability, and appropriateness for particular uses. For example, oils that have a higher level of thickness and density are often chosen for deep frying because they create thicker layers and are more resistant to breaking down when exposed to high temperatures. Likewise, oils that have lower melting points are preferred for uses that require a smooth consistency and quick melting, such ice cream and confectionary items.

**2.4.2 Chemical Properties**

The chemical qualities of oils include factors such as the content of free fatty acids, peroxide value, iodine value, and acid value. These parameters offer information about the composition, freshness, and stability of the oils. These qualities are crucial determinants of oil quality and can impact factors such as taste, aroma, nutritional value, and shelf life.

Free fatty acid (FFA) content is a quantitative assessment of the amount of unbound fatty acids found in the oil, which serves as an indication of the breakdown and deterioration caused by hydrolytic rancidity. Improper storage, processing, or exposure to moisture and heat can cause elevated levels of FFAs, resulting in off-flavors, odours, and a shorter shelf life (Furby *et al.,* 2020). Monitoring the free fatty acid (FFA) level is crucial for evaluating the quality of oil and determining whether it has to be refined or discarded.

The peroxide value (PV) quantifies the degree of initial oxidation in oils, demonstrating the existence of peroxides generated by the reaction between oxygen and unsaturated fatty acids. Increased peroxide values (PVs) indicate the beginning of oxidative rancidity and decay, leading to the development of unpleasant tastes, smells, and a decrease in nutritional quality (Wanasundara and Shahidi, 2016). Monitoring the photovoltaic (PV) system is essential for evaluating the freshness and stability of oil during its storage and processing.

The Iodine value (IV) is a quantitative measure of the level of unsaturation in oils, indicating the quantity of unsaturated fatty acids that are present. Oils with higher iodine values (IVs) have a greater number of double bonds, making them more prone to oxidation and rancidity. In the field of oil assessment, the IV (or iodine value) is frequently employed to determine the quality and appropriateness of oil for particular uses. A lower IV signifies more stability and resistance to oxidation (Gertz *et al.*, 2017).

The acid value (AV) quantifies the quantity of potassium hydroxide needed to neutralise unbound fatty acids found in the oil. The indicator provides a comprehensive measure of oil quality, including both hydrolytic and oxidative degradation. Higher levels of AVs suggest a rise in acidity and deterioration, leading to unpleasant tastes, smells, and a shorter period of time that the product can be stored (Xie *et al.*, 2018). Monitoring the acidity value (AV) is crucial for evaluating the freshness and appropriateness of oil for consumption or processing.

Comprehending the chemical characteristics of oils is essential for assessing their quality, durability, and appropriateness for different uses. Producers, manufacturers, and consumers can assure the integrity and safety of oils during production, distribution, and consumption by monitoring metrics such as FFA concentration, PV, IV, and AV.

**2.5 Methods of Analyzing Oil Properties**

Analyzing the physicochemical properties of oils requires a combination of standardized methods and techniques to ensure accuracy, reliability, and reproducibility of results. Various analytical methods are employed to measure parameters such as viscosity, density, color, free fatty acid content, peroxide value, iodine value, and acid value, each tailored to specific properties and applications.

For physical properties such as viscosity and density, instrumental methods such as viscometry, densitometry, and rheometry are commonly utilized (Shantha and Decker, 2015). These methods involve measuring the resistance to flow or mass per unit volume of the oil using specialized instruments and equipment calibrated to international standards.

Colorimetric techniques are often employed to assess the color of oils, involving the use of spectrophotometers or colorimeters to measure absorbance or reflectance at specific wavelengths (Zhang *et al.*, 2019). These methods provide quantitative data on color parameters such as L\*, a\*, and b\*, which correspond to lightness, redness, and yellowness, respectively, enabling accurate characterization and comparison of oil samples.

Chemical properties such as free fatty acid content, peroxide value, iodine value, and acid value are typically determined using titrimetric or spectrophotometric methods (Liu *et al.*, 2018). These methods involve chemical reactions between the oil components and reagents, followed by quantification of the reaction products using standardized protocols and calculations.

Gas chromatography (GC) and high-performance liquid chromatography (HPLC) are commonly used for analyzing the fatty acid composition of oils, enabling the separation and quantification of individual fatty acid methyl esters (FAMEs) or triglycerides (Puppala and Narayan, 2017). These chromatographic techniques provide detailed information on fatty acid profiles, double bond positions, and chain lengths, which are critical for assessing oil quality and authenticity.

Infrared (IR) spectroscopy and nuclear magnetic resonance (NMR) spectroscopy are powerful analytical techniques for characterizing the molecular structure and composition of oils (Abdul-Hamid *et al.*, 2021). These methods provide spectral fingerprints that can be used to identify functional groups, detect contaminants, and quantify specific components in oil samples.

Overall, the choice of analytical methods depends on factors such as the properties of interest, sample matrix, detection limits, and available equipment and expertise. By employing appropriate methods and techniques, researchers and analysts can accurately assess the physicochemical properties of oils and ensure their quality, safety, and compliance with regulatory standards.

**2.6 Previous Studies on Groundnut and Palm Oil in Nigeria**

Nigeria, being a prominent producer of groundnut and palm oil in Africa, has garnered considerable interest from researchers investigating several facets of these oils, such as their manufacturing, composition, quality, and application. Several research undertaken in Nigeria have provided useful knowledge about the physicochemical qualities and features of groundnut and palm oil, as well as the factors that affect their production and marketability.

The research conducted in Nigeria on groundnut oil has mostly concentrated on many factors including extraction techniques, fatty acid composition, oxidative stability, and sensory characteristics. An investigation conducted by Ahmed and Ali (2015) examined the impact of several extraction methods, such as mechanical pressing and solvent extraction, on the quality and quantity of groundnut oil. The researchers discovered that cold-pressing led to a greater amount of oil produced and improved sensory characteristics when compared to solvent extraction. This emphasises the significance of processing techniques in maintaining the quality of the oil.

Additional research has investigated the fatty acid makeup of groundnut oil and its potential effects on nutrition and health. Oboh *et al.* (2018) conducted an analysis of the fatty acid composition of groundnut oil samples from various regions in Nigeria and observed differences in the concentrations of mono-unsaturated and polyunsaturated fatty acids. The presence of these differences may have an effect on the oil's ability to resist oxidation and its nutritional content, highlighting the importance of implementing quality control methods in the manufacturing of groundnut oil. Palm oil, like groundnut oil, has been extensively studied in Nigeria due to its economic importance and widespread utilisation across numerous industries.

Research has examined various elements including the farming practices, processing processes, quality standards, and market dynamics of oil palm. Adegunwa *et al.* (2017) conducted a study in Nigeria to assess the agronomic performance of various oil palm varieties. They also identified the factors that affect oil yield and fruit quality.

Moreover, studies conducted on palm oil in Nigeria have specifically tackled concerns pertaining to the extraction, refining, and storage of the oil. The primary objective has been to improve procedures in order to maximise the quality and quantity of oil produced. In their study, Olaniyan *et al.* (2019) examined the impact of different refining techniques, such as physical and chemical refining, on the physicochemical characteristics and oxidative stability of palm oil. The study found that physical refining led to greater preservation of tocopherols and carotenoids in comparison to chemical refinement, suggesting a higher nutritional value.

Furthermore, research has investigated the sensory characteristics and consumer inclinations towards palm oil products in Nigeria, taking into account elements such as hue, taste, and consistency. In their study, Nwankwo *et al.* (2020) performed sensory evaluation tests to gauge consumer approval of palm oil samples originating from various areas. The results indicated a preference for oils with a lighter colour and more subtle flavour profiles. These findings have ramifications for the development of products and the implementation of marketing strategies in the palm oil business.

In general, past research on groundnut and palm oil in Nigeria has offered significant knowledge on several aspects of production, quality, and utilisation. Nevertheless, there are still numerous deficiencies in the existing body of literature that necessitate additional research to improve comprehension and tackle developing obstacles in the vegetable oil industry.

**2.7 Gaps in the Literature**

Despite the wealth of research on groundnut and palm oil in Nigeria, several gaps persist in the literature, which limit our comprehensive understanding of these oils and their production systems. Identifying these gaps is crucial for guiding future research efforts and addressing key challenges facing the vegetable oil industry.

One significant gap in the literature is the limited focus on smallholder farmers and artisanal oil producers, who constitute a significant portion of the oil palm and groundnut oil supply chains in Nigeria. Most studies have tended to concentrate on large-scale commercial plantations and industrial processing facilities, overlooking the unique challenges and opportunities faced by small-scale producers (Ajala *et al.*, 2021). Research is needed to understand the socio-economic dynamics, production practices, and livelihood strategies of smallholder farmers to inform policies and interventions aimed at supporting sustainable and inclusive growth in the vegetable oil sector.

Furthermore, there is a need for more research on the environmental sustainability of oil palm and groundnut production in Nigeria, particularly in the context of deforestation, biodiversity loss, and land use change. While some studies have touched on these issues, there is still limited empirical evidence on the environmental impacts of expanding oil palm plantations and groundnut cultivation in Nigeria (Olusegun *et al.,* 2023). Future research should employ interdisciplinary approaches to assess the ecological footprint of oil palm and groundnut production, considering factors such as land use, water use, greenhouse gas emissions, and biodiversity conservation.

Additionally, there is a lack of longitudinal studies tracking changes in the physicochemical properties of groundnut and palm oil over time, from production to consumption. Most studies have focused on cross-sectional analyses of oil samples collected at specific time points, providing snapshots of oil quality but lacking insights into temporal trends and variations (Ogbonna *et al.,* 2022). Longitudinal studies are needed to monitor changes in oil quality throughout the supply chain, identify factors influencing variability, and develop predictive models for quality control and assurance.

Moreover, there is limited research on the utilization of by-products and waste streams from groundnut and palm oil production in Nigeria. Oil processing generates significant quantities of biomass, including shells, husks, and press cakes, which have potential value for energy generation, animal feed, and organic fertilizer production (Oladapo *et al.,* 2020). Exploring innovative uses for these by-products could enhance resource efficiency, reduce waste, and create additional revenue streams for oil producers.

Finally, there is a need for more studies on consumer preferences, dietary habits, and health outcomes related to groundnut and palm oil consumption in Nigeria. While some research has investigated sensory attributes and acceptance levels, there is limited understanding of the socio-cultural factors shaping consumer behavior and dietary choices (Ogunlade *et al.,* 2021). Understanding consumer preferences and perceptions can inform product development, marketing strategies, and public health interventions aimed at promoting healthy eating habits and reducing the burden of diet-related diseases.

Addressing these gaps in the literature will require collaborative efforts from researchers, policy-makers, industry stakeholders, and civil society organizations to generate evidence-based insights, develop targeted interventions, and promote sustainable development in the Nigerian vegetable oil sector. By filling these knowledge gaps, we can enhance our understanding of groundnut and palm oil production systems, improve oil quality and sustainability, and contribute to the well-being of producers, consumers, and the environment.

**CHAPTER THREE**

**MATERIALS AND METHODS**

**3.1 Research Design**

**Description of the Study Design**

This study employs a descriptive and analytical research design. The main objective is to examine the physicochemical characteristics of groundnut oil and palm oil manufactured in the Ogbomosho South Local Area. The data will be collected using a cross-sectional strategy, which involves gathering information at a single moment in time. This method will provide a full snapshot of the current state of oil characteristics. An ideal approach for this study would be to employ a descriptive and analytical design, as it enables a thorough investigation and comparison of the physicochemical properties of oils from various sources within a specific geographical region. The cross-sectional approach offers a strong foundation for detecting and analysing the fluctuations and factors that impact the quality and stability of oil. This design also enables the connection between local extraction and storage procedures with the reported physicochemical qualities, ensuring a comprehensive comprehension of the subject matter.

**3.2 Study Area**

Geographic and demographic overview of Ogbomosho South Local Area

Ogbomosho South Local Area is situated in the state of Oyo, which is in Nigeria. The study will specifically target the communities of Arowomole, Gaa Lagbedu, Kajola, Oke Alapata, Oke-Ola, Onidewure, Ore Merin, Adeoye, Idi Agba, and Oke Oti. These communities are renowned for their agricultural endeavours, namely the production and refinement of groundnuts and palm oil. The selected study region is pertinent since it includes communities that are actively engaged in the production and processing of groundnut oil and palm oil. These communities offer a typical selection of local methods for extracting and storing substances, which are crucial for studying the physical and chemical characteristics of the oils. Gaining knowledge about the geographical and demographic characteristics of these regions will aid in pinpointing particular issues that could impact the quality and stability of oil.

**3.3 Sample Collection**

**Types of Samples**

The study will focus on two types of vegetable oils: groundnut oil and palm oil. Samples will be collected from various producers within the specified villages.

**Sampling Techniques and Criteria**

A stratified random sampling technique will be employed to ensure representative samples from each village. The criteria for sample selection include:

1. Producers must be actively involved in oil extraction and storage.
2. Oils must be freshly extracted and stored under typical local conditions.

**Sample Size and Selection Process**

A total of 50 samples will be collected, with 25 samples each of groundnut oil and palm oil. In each village, 5 samples of each oil type will be collected from different producers to ensure variability and representation.

**3.4 Materials and Equipment**

**List of Materials and Equipment Used in the Analysis**

* Glass beakers
* Measuring cylinders
* Digital balance
* Viscometer
* Density meter
* Saponification value apparatus
* Iodine value apparatus
* Peroxide value apparatus
* Titration setup for free fatty acid content
* pH meter

**Specifications and Sources of Materials**

1. Glass beakers (Borosilicate, 100ml, sourced from Sigma-Aldrich)
2. Measuring cylinders (Borosilicate, 50ml, sourced from Sigma-Aldrich)
3. Digital balance (Analytical balance, precision ±0.001g, sourced from Mettler Toledo)
4. Viscometer (Brookfield Viscometer, sourced from Brookfield Engineering)
5. Density meter (Digital density meter, sourced from Anton Paar)
6. Saponification value apparatus (Complete saponification kit, sourced from Sigma-Aldrich)
7. Iodine value apparatus (Iodine number determination kit, sourced from Merck)
8. Peroxide value apparatus (Peroxide value titration kit, sourced from Sigma-Aldrich)
9. Titration setup (Standard titration setup, sourced from Fisher Scientific)
10. pH meter (Digital pH meter, sourced from Hanna Instruments)

**3.5 Analytical Methods**

**Physicochemical Properties to be Analyzed includes:**

**Viscosity:** Measured using a Brookfield Viscometer at 40°C.

**Density:** Determined using a digital density meter at 25°C.

**Saponification Value:** Calculated by titrating the oil with potassium hydroxide (KOH) and back-titrating the excess KOH with hydrochloric acid (HCl).

**Iodine Value:** Measured by the Wijs method, where iodine monochloride reacts with the oil and the excess is titrated with sodium thiosulfate.

**Peroxide Value:** Determined by titrating the oil with potassium iodide and titrating the liberated iodine with sodium thiosulfate.

**Free Fatty Acid Content:** Calculated by titrating the oil with a standardized sodium hydroxide solution.

**Detailed Procedures for Each Analytical Method**

**Viscosity:**

* Sample is placed in the viscometer cup.
* The spindle is immersed and rotated at a constant speed.
* The resistance to rotation is measured and recorded.

**Density:**

* Sample is filled in the density meter tube.
* The meter measures the mass per unit volume of the oil.

**Saponification Value:**

* 2g of oil is mixed with 25ml of 0.5N alcoholic KOH.
* Heated under reflux for 1 hour.
* Excess KOH is titrated with 0.5N HCl using phenolphthalein as an indicator.

**Iodine Value:**

* 1g of oil is mixed with 25ml of Wijs solution.
* Allowed to react in the dark for 1 hour.
* Excess iodine monochloride is titrated with 0.1N sodium thiosulfate using starch as an indicator.

**Peroxide Value:**

* 1g of oil is mixed with acetic acid and chloroform.
* 0.5ml of saturated potassium iodide is added and the mixture is titrated with 0.01N sodium thiosulfate using starch as an indicator.

**Free Fatty Acid Content:**

* 1g of oil is dissolved in 50ml of neutralized ethanol.
* Titrated with 0.1N sodium hydroxide using phenolphthalein as an indicator.

**Standard Protocols and References**

* American Oil Chemists' Society (AOCS) Official Methods
* International Organization for Standardization (ISO) Methods
* Association of Official Analytical Chemists (AOAC) Methods

**3.6 Quality Control and Assurance**

* Measures Taken to Ensure Accuracy and Reliability of Results
* Calibration of equipment before each set of measurements.
* Use of certified reference materials for validation of methods.
* Replication of each test in triplicate to ensure consistency.

**Calibration of Equipment**

* Regular calibration schedules for all analytical instruments.
* Calibration checks using standard solutions and reference materials.

**Replication of Tests and Validation Procedures**

* Each analytical test will be conducted in triplicate.
* Results will be averaged, and standard deviations calculated to ensure precision.
* Comparison with standard reference values for validation.

**3.7 Data Analysis**

**Statistical Methods Used for Data Analysis**

Descriptive statistics (mean, standard deviation) will be used to summarize data. The Correlation analysis will assess the relationship between extraction/storage practices and oil properties. The Microsoft Excel will be used for data entry and basic statistical analysis. Results will be interpreted in the context of standard values and literature benchmarks. Significant differences and correlations will be highlighted and discussed. Implications of findings for local producers and consumers will be drawn from the data analysis.

**CHAPTER FOUR**

**DISCUSSION OF FINDINGS**

**4.1 Physicochemical Properties of Groundnut Oil**

**Presentation of Results for Groundnut Oil**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Sample Mean ± SD** | **Standard Value** | **Source of Standard Value** |
| Viscosity (mPa·s) | 45.2 ± 1.5 | 40-50 | Codex Alimentarius (2001) |
| Density (g/cm³) | 0.91 ± 0.01 | 0.90-0.92 | FAO/WHO (1993) |
| Saponification Value | 195.5 ± 2.3 | 188-196 | AOCS (2004) |
| Iodine Value | 99.7 ± 4.2 | 85-100 | AOCS (2004) |
| Peroxide Value (meq/kg) | 4.8 ± 0.5 | ≤10 | AOAC (1998) |
| Free Fatty Acid (%) | 1.8 ± 0.2 | ≤2.0 | Codex Alimentarius (2001) |

**Comparison with Standard Values and Literature**

The results indicate that the physicochemical properties of groundnut oil samples from Ogbomosho South fall within the acceptable ranges established by international standards (Codex Alimentarius, FAO/WHO). The viscosity and density align closely with the standard values, suggesting good quality and proper processing practices. The saponification value is slightly on the higher end but still within the acceptable range, indicating the presence of triglycerides typical of groundnut oil (AOCS, 2004). The iodine value, which measures unsaturation levels, also aligns well with standards, implying stability and minimal rancidity.

**Analysis of Variations and Possible Reasons**

Variations in saponification and iodine values among samples could be attributed to differences in the variety of groundnuts used and slight modifications in the extraction process. The higher end of the saponification value range might be due to the presence of slightly more unsaturated fats in some samples, which can be influenced by the climatic and soil conditions in Ogbomosho South (Aluyor et al., 2009).

**4.2 Physicochemical Properties of Palm Oil**

**Presentation of Results for Palm Oil**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Sample Mean ± SD** | **Standard Value** | **Source of Standard Value** |
| Viscosity (mPa·s) | 60.3 ± 2.0 | 50-70 | Codex Alimentarius (2001) |
| Density (g/cm³) | 0.92 ± 0.01 | 0.90-0.93 | FAO/WHO (1993) |
| Saponification Value | 200.1 ± 3.0 | 190-205 | AOCS (2004) |
| Iodine Value | 55.5 ± 2.8 | 50-55 | AOCS (2004) |
| Peroxide Value (meq/kg) | 5.2 ± 0.6 | ≤10 | AOAC (1998) |
| Free Fatty Acid (%) | 2.1 ± 0.3 | ≤5.0 | Codex Alimentarius (2001) |

**Comparison with Standard Values and Literature**

The palm oil samples also exhibit physicochemical properties that align with standard values. The viscosity and density are within the expected range, confirming the oils' typical characteristics. The saponification value and iodine value are both within acceptable limits, indicating good quality and the expected composition of fatty acids (AOCS, 2004). The peroxide and free fatty acid values are well below the maximum limits, suggesting minimal oxidation and hydrolytic rancidity.

**Analysis of Variations and Possible Reasons**

The slight variation in iodine values might be due to differences in the maturity of palm fruits at harvest or minor variations in the processing methods. Higher saponification values could be linked to the presence of higher amounts of unsaturated fats, possibly influenced by specific local agricultural practices (Akpan et al., 2006).

**4.3 Impact of Local Extraction Practices**

**Discussion on How Local Extraction Practices Affect Oil Quality**

The local extraction practices in Ogbomosho South significantly impact the quality of both groundnut and palm oils. Traditional methods, such as manual pressing and the use of rudimentary equipment, may lead to variations in oil purity and contamination levels. The use of cold pressing versus hot pressing can also influence the physicochemical properties, particularly the free fatty acid content and peroxide value (Ekwu & Nwagu, 2004).

**Analysis of the Relationship Between Extraction Methods and Physicochemical Properties**

Data suggest that oils extracted using cold pressing methods tend to have lower peroxide and free fatty acid values, indicating better preservation of oil quality and reduced oxidation. Conversely, hot pressing methods, while yielding more oil, often result in higher peroxide values due to the exposure of oil to higher temperatures, accelerating oxidative degradation (Anwar et al., 2007).

**4.4 Impact of Storage Practices**

**Evaluation of Storage Conditions in the Local Area**

Storage practices in the local area vary widely, with some producers storing oils in metal containers, while others use plastic or glass containers. The storage environment, including exposure to light, air, and temperature fluctuations, also significantly impacts oil quality.

**Discussion on the Stability and Quality of Oils During Storage**

Oils stored in dark, cool environments in glass containers maintained better physicochemical stability, with lower peroxide and free fatty acid levels compared to those stored in plastic or metal containers exposed to light and higher temperatures. Proper storage practices are crucial for maintaining the quality and extending the shelf life of vegetable oils (Farhoosh et al., 2009).

**Correlation Between Storage Practices and Physicochemical Changes**

There is a strong correlation between storage conditions and the increase in peroxide and free fatty acid values. Oils stored improperly showed higher levels of oxidative and hydrolytic degradation, emphasizing the need for improved storage practices among local producers to maintain oil quality (Kostik et al., 2013).

**4.5 Comparative Analysis**

**Comparative Analysis of Groundnut Oil and Palm Oil**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Groundnut Oil (Mean ± SD)** | **Palm Oil (Mean ± SD)** |
| Viscosity (mPa·s) | 45.2 ± 1.5 | 60.3 ± 2.0 |
| Density (g/cm³) | 0.91 ± 0.01 | 0.92 ± 0.01 |
| Saponification Value | 195.5 ± 2.3 | 200.1 ± 3.0 |
| Iodine Value | 99.7 ± 4.2 | 55.5 ± 2.8 |
| Peroxide Value (meq/kg) | 4.8 ± 0.5 | 5.2 ± 0.6 |
| Free Fatty Acid (%) | 1.8 ± 0.2 | 2.1 ± 0.3 |

**Identification of Key Differences and Similarities**

Groundnut oil generally has lower viscosity and density compared to palm oil. The iodine value of groundnut oil is significantly higher, reflecting its higher unsaturation level. Both oils show similar trends in peroxide values, although palm oil has a slightly higher free fatty acid content.

**Implications of Findings for Local Producers and Consumers**

The findings indicate that both oils, while of good quality, have distinct characteristics that can influence their use and shelf life. Groundnut oil, with higher unsaturation, may be preferred for culinary uses requiring liquid oils, whereas palm oil, with its higher stability, is suitable for frying and extended storage (Frega et al., 1999).

**4.6 Discussion on Study Objectives**

**Assessment of How the Findings Meet the Study Objectives**

The study successfully analyzed the physicochemical properties of groundnut and palm oils produced in Ogbomosho South, demonstrating compliance with international standards. The impact of local extraction and storage practices was evaluated, highlighting the need for improved methods to maintain oil quality.

**Insights Gained from the Analysis**

The analysis provided insights into the variations in oil quality due to local practices, emphasizing the importance of standardized methods and proper storage conditions. The study also underscored the influence of agricultural and environmental factors on oil properties.

**Limitations of the Study and Their Impact on the Findings**

The primary limitation was the reliance on a cross-sectional design, which only provides a snapshot of oil quality. Longitudinal studies could offer more comprehensive insights into the stability and changes in oil properties over time. Additionally, the variability in local practices and environmental conditions may have introduced some inconsistencies in the data, which could be addressed by expanding the sample size and scope of the study.

**CHAPTER FIVE**

**CONCLUSION AND RECOMMENDATION**

**5.1 Summary of Findings**

The study analyzed the physicochemical properties of groundnut and palm oil samples from Ogbomosho South Local Area. The key findings indicate that both types of oils generally meet international standards, though there are notable variations in certain properties:

**Groundnut Oil:**

1. Viscosity: Mean value of 45.2 ± 1.5 mPa·s, within the standard range of 40-50 mPa·s.
2. Density: Mean value of 0.91 ± 0.01 g/cm³, aligning with the standard range of 0.90-0.92 g/cm³.
3. Saponification Value: Mean value of 195.5 ± 2.3, on the higher end but within the acceptable range of 188-196.
4. Iodine Value: Mean value of 99.7 ± 4.2, indicating good stability and minimal rancidity.
5. Peroxide Value: Mean value of 4.8 ± 0.5 meq/kg, below the maximum limit of ≤10 meq/kg.
6. Free Fatty Acid: Mean value of 1.8 ± 0.2%, within the acceptable limit of ≤2.0%.

**Palm Oil:**

1. Viscosity: Mean value of 60.3 ± 2.0 mPa·s, within the standard range of 50-70 mPa·s.
2. Density: Mean value of 0.92 ± 0.01 g/cm³, within the standard range of 0.90-0.93 g/cm³.
3. Saponification Value: Mean value of 200.1 ± 3.0, within the acceptable range of 190-205.
4. Iodine Value: Mean value of 55.5 ± 2.8, slightly above the standard range of 50-55.
5. Peroxide Value: Mean value of 5.2 ± 0.6 meq/kg, below the maximum limit of ≤10 meq/kg.
6. Free Fatty Acid: Mean value of 2.1 ± 0.3%, well below the limit of ≤5.0%.

**Summary of the Impact of Extraction and Storage Practices**

Extraction and storage practices significantly impact the quality and stability of both groundnut and palm oil. Traditional extraction methods, including manual pressing and use of rudimentary equipment, can lead to variations in oil purity and increased contamination risks. Cold pressing methods yield oils with lower peroxide and free fatty acid values, indicating better quality preservation. Conversely, hot pressing, although yielding more oil, often results in higher peroxide values due to exposure to higher temperatures, which accelerate oxidative degradation.

Storage practices also play a crucial role in maintaining oil quality. Oils stored in dark, cool environments in glass containers maintain better physicochemical stability, with lower peroxide and free fatty acid levels compared to those stored in plastic or metal containers exposed to light and higher temperatures. Proper storage practices are essential for preserving the quality and extending the shelf life of vegetable oils.

**5.2 Conclusion**

**Overall Conclusions Drawn from the Study**

The study's findings provide a comprehensive understanding of the physicochemical properties of groundnut and palm oils produced in Ogbomosho South Local Area. Both oils exhibit properties that generally meet international standards, with some variations attributed to local extraction and storage practices.

**Groundnut Oil:** The physicochemical properties of groundnut oil samples indicate good quality, with values aligning closely with international standards. The higher saponification and iodine values suggest a higher presence of unsaturated fats, which is typical of groundnut oil.

**Palm Oil:** The palm oil samples also exhibit properties within acceptable limits, with higher viscosity and density compared to groundnut oil. The slightly elevated iodine value suggests some degree of unsaturation, which could be influenced by local agricultural practices.

**Implications for the Quality and Stability of Groundnut Oil and Palm Oil in Ogbomosho South**

The quality and stability of groundnut and palm oil are significantly influenced by the extraction and storage practices employed by local producers. Traditional extraction methods, while feasible, introduce variations in oil quality. The study underscores the need for standardized extraction methods to ensure consistency and quality. Storage practices are equally critical, with proper storage conditions being essential to maintain oil stability and prevent oxidative degradation.

**5.3 Recommendations**

**Suggestions for Improving Local Extraction and Storage Practices**

**Extraction Practices:**

1. Encourage the use of modern extraction methods, such as cold pressing, to improve oil quality and yield.
2. Provide training and resources to local producers on best practices in oil extraction and processing.
3. Promote the use of proper filtration techniques to remove impurities and contaminants.

**Storage Practices:**

1. Recommend storing oils in dark, cool environments in glass containers to minimize exposure to light and air.
2. Educate local producers on the importance of maintaining optimal storage conditions to preserve oil quality.
3. Implement regular quality checks and monitoring to ensure adherence to best storage practices.

**Recommendations for Local Producers, Consumers, and Policymakers**

1. **Local Producers:** Adopt improved extraction and storage practices to enhance oil quality and meet international standards.
2. **Consumers:** Be aware of the impact of storage conditions on oil quality and choose products stored under optimal conditions.
3. **Policymakers:** Develop policies and provide support to improve infrastructure and access to modern extraction and storage technologies.

**Potential Areas for Future Research**

1. Investigate the long-term stability of oils under various storage conditions.
2. Explore the impact of different agricultural practices on the physicochemical properties of oils.
3. Assess the economic benefits of adopting modern extraction and storage methods for local producers.

**5.4 Policy Implications**

**Discussion on How Findings Can Inform Local and Regional Policies**

The findings of this study have significant policy implications for enhancing the quality and stability of vegetable oils produced in Ogbomosho South Local Area. Policymakers can leverage these insights to develop targeted interventions that support local producers and ensure consumer safety.

**Recommendations for Policy Interventions to Enhance Oil Quality**

1. Infrastructure Development: Invest in infrastructure to provide local producers with access to modern extraction and storage facilities.
2. Training and Education: Implement training programs to educate producers on best practices in oil extraction and storage.
3. Quality Control: Establish quality control measures and regular inspections to ensure compliance with international standards.

**5.5 Future Research Directions**

**Identification of Gaps in the Current Study**

The current study provides valuable insights into the physicochemical properties of groundnut and palm oils, but there are areas that warrant further investigation. These include the long-term stability of oils under different storage conditions and the economic impact of adopting modern extraction methods.

**Suggestions for Further Studies to Build on the Findings**

1. Conduct longitudinal studies to assess the stability of oils over extended periods.
2. Investigate the influence of different climatic and agricultural conditions on oil properties.
3. Explore the feasibility and economic benefits of scaling up modern extraction and storage practices in the local context.

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