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Nutritional and Chemical Characterization of Avocado Oil from Three Cultivars in Mambila Plateau, Taraba State, Nigeria

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Abstract: *Avocado oil is valued for its nutritional, cosmetic, and industrial applications due to its rich lipid profile and bioactive compounds. This study compared oil extracted from three avocado cultivars—Hass, Maluma, and* Persea schiedeana*—grown on the Mambila Plateau, Taraba State, Nigeria. Oil was obtained via Soxhlet extraction and analyzed for proximate composition, fatty acid profile, and chemical characteristics using standard AOAC and GC-MS methods. Oil yield ranged from 20.48% in Hass to 28.20% in* P. schiedeana*, with lipid content mirroring these values. Proximate analysis showed protein content of 1.33–1.96%, ash 0.04–0.10%, moisture 1.36–2.71%, and carbohydrates 68.14–76.16%, reflecting cultivar-specific nutritional differences. Fatty acid profiling revealed oleic acid concentrations of 5.8% (Hass), 4.3% (Maluma), and 19.17% (*P. schiedeana*), while palmitic acid ranged from 6.79% to 15.4%. Chemical characterization indicated iodine values of 83.0–94.0 g I_2/100 g, saponification values of 174.4–197.7 mg KOH/g, and unsaponifiable matter of 0.6–2.6%.* P. schiedeana *demonstrated the highest oil yield, oleic acid, and iodine value, suggesting superior nutritional quality and oxidative stability. Maluma's elevated protein and unsaponifiable matter highlight its potential for cosmetic applications. These findings underscore the influence of genotype and agro-ecological conditions on avocado oil quality and support the strategic utilization of indigenous cultivars to enhance Nigeria's agricultural value chain.*

Keywords*: Avocado oil, fatty acid profile, proximate composition, GC-MS, Persea schiedeana, Nigeria*

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1.0 Introduction

Avocado (*Persea americana*) is a tropical fruit widely cultivated for its nutrient-dense pulp and oil-rich composition. Globally, avocado oil has gained prominence due to its favorable lipid profile, antioxidant content, and versatility in culinary, cosmetic, and pharmaceutical applications (Dreher & Davenport, 2013). The oil is particularly valued for its high monounsaturated fatty acid content—especially oleic acid—which contributes to cardiovascular health, anti-inflammatory effects, and improved lipid metabolism (Borges et al., 2017; Wang et al., 2020).

While extensive research has been conducted on avocado oil from cultivars grown in regions such as Mexico, Chile, and South Africa, there remains a significant gap in the literature regarding African-grown varieties, particularly those cultivated in Nigeria. The Mambila Plateau in Taraba State offers a unique agro-ecological zone with high altitude, moderate temperatures, and rich volcanic soils—conditions that may influence the biochemical composition of avocado fruits (Adeyeye, 2019). Despite the potential of these unique conditions, the chemical and nutritional profiles of avocado oil from this region remain largely undocumented.

Previous studies have shown that cultivar type, climate, and soil conditions can significantly affect oil yield, fatty acid distribution, and the presence of bioactive compounds (Nasri et al., 2023; Campos-Hernández et al., 2011). For instance, Hass and Maluma varieties are known for their commercial viability and consistent oil profiles, while Persea schiedeana, a lesser-known species, has been reported to produce oil with unique nutritional attributes (González-Torres et al., 2023). However, information on the comparative performance of these three cultivars under Nigerian agro-ecological conditions is lacking, limiting the strategic utilization of indigenous avocado varieties.

This study aims to characterize the proximate composition, fatty acid profile, and key chemical parameters of avocado oil extracted from three cultivars—Hass, Maluma, and Persea schiedeana—grown on the Mambila Plateau. By comparing these varieties, we seek to identify cultivar-specific advantages and potential applications in food, cosmetic, and nutraceutical industries. The selection of these three cultivars allows for evaluation of both commercially dominant and lesser-known indigenous types, providing insight into their suitability for local and international markets**.** The findings will contribute to the growing body of knowledge on indigenous oil sources and support the development of value-added products from Nigerian-grown avocados. Furthermore, the study highlights the importance of leveraging local agro-ecological conditions to enhance nutritional quality and economic value, thereby promoting sustainable agricultural practices and food security in Nigeria.

2.0 Materials and Methods

2.1 Study Area and Sample Collection

Avocado fruits were harvested from three distinct cultivars—Hass, Maluma, and Persea schiedeana—grown on the Mambila Plateau, Taraba State, Nigeria. This region is characterized by high elevation (~1,600 m), moderate temperatures (15–25°C), and fertile volcanic soils, which contribute to unique phytochemical profiles in crops (Adeyeye, 2019). Mature fruits were randomly handpicked during the peak season (May–June) and transported under cooled conditions to the chemistry laboratory at Modibbo Adama University, Yola, to maintain sample integrity. All harvested fruits were immediately inspected to ensure uniform ripeness and absence of physical damage**.**

2.2 Sample Preparation

Fruits were washed, peeled, and the pulp was manually separated from the seed. The pulp was homogenized using a stainless-steel blender and stored at −20°C prior to oil extraction. All glassware and equipment were sterilized prior to homogenization and extraction to prevent contamination. Homogenization was performed under chilled conditions to minimize enzymatic degradation of bioactive compounds.

2.3 Oil Extraction Procedure

Oil was extracted using the Soxhlet method, following AOAC Official Method 945.16 (AOAC, 2019). Approximately 50 g of homogenized pulp was dried at 60°C for 24 hours to reduce moisture content. The dried sample was then placed in a cellulose thimble and extracted with 300 mL of analytical-grade methanol for 6 hours. Methanol was selected as the extraction solvent to allow co-extraction of polar bioactive compounds, providing a more comprehensive chemical profile of the avocado oil. The solvent was evaporated using a rotary evaporator at 40°C, and the residual oil was weighed to determine yield. Oil yield (%) was calculated using equation 1

$$Oil\ yeild = \frac{Weight\ of\ extracted\ sample}{Weight\ of\ dried\ sample} \times \frac{100}{1} \qquad (1)$$

2.4 Proximate Composition Analysis

Proximate parameters, including moisture, ash, lipid, protein, and carbohydrate, were determined using AOAC methods. Moisture content was measured by oven-drying at 105°C until constant weight (AOAC 925.10), and ash content was determined by muffle furnace incineration at 550°C (AOAC 923.03). Crude lipid was determined via Soxhlet extraction as described above, while crude protein was quantified using the Kjeldahl method with a nitrogen conversion factor of 6.25 (AOAC 984.13). Carbohydrate content was calculated by difference using the corrected formula:

$$Carbohydrate = 100 - (moisture + Ash + Lipid + Protein \qquad (2)$$

These methods are widely accepted for nutritional profiling of plant-based oils and provide reliable data for comparative analysis across cultivars**.**

2.5 Fatty Acid Profiling via GC-MS

Fatty acid methyl esters (FAMEs) were prepared using the transesterification method described by Christie (1993). Briefly, 100 mg of oil was reacted with 2 mL of methanolic KOH and heated at 60°C for 30 minutes. The resulting FAMEs were extracted with hexane and analyzed using a Shimadzu GCMS-QP2010 system equipped with a DB-23 capillary column (60 m × 0.25 mm × 0.25 µm). The injector temperature was set at 250°C, and the oven program started at 50°C for 2 minutes before ramping to 220°C at 10°C/min. Helium was used as the carrier gas at 1.0 mL/min, and detection was performed via electron impact ionization at 70 eV. A 1 µL injection volume was used for all GC-MS analyses to ensure consistency and reproducibility**.** Fatty acids were identified by comparing retention times and mass spectra with NIST library standards, following the approach used by Borges et al. (2017).

2.6 Chemical Properties of Oil

Three key chemical parameters were assessed. Iodine value, determined using the Wijs method (AOCS Cd 1-25), indicates the degree of unsaturation. Saponification value, measured by titration with HCl after KOH hydrolysis (AOCS Cd 3-25), reflects the average molecular weight of the triglycerides, while unsaponifiable matter was extracted with ether after saponification and quantified gravimetrically (ISO 18609:2000). These parameters provide critical information on oil quality, stability, and potential industrial applications in food, cosmetic, and nutraceutical formulations.

2.7 Statistical Analysis

All measurements were performed in triplicate, and results were expressed as mean ± standard deviation. Data were analyzed using SPSS v25.0. One-way ANOVA was used to compare means across cultivars, with significance set at $p < 0.05$. Post-hoc Tukey's test was applied where appropriate. Prior to ANOVA, data were checked for normality and homogeneity of variance to satisfy statistical assumptions.

2.8 Reagents and Standards

All chemicals used were of analytical grade. Calibration standards for GC-MS were prepared from certified FAME mixtures. Care was taken to store all reagents under recommended conditions to maintain stability and accuracy during analyses.

3.0 Results and Discussion

This section presents a comparative analysis of avocado oil extracted from three cultivars—Hass, Maluma, and Persea schiedeana—grown on the Mambila Plateau. The results include oil yield, proximate composition, fatty acid profile, and key chemical characteristics. Each parameter is interpreted with technical insights and discussed in relation to existing literature to highlight implications for nutritional and industrial applications.

3.1 Oil Yield and Lipid Content

Table 1 summarizes the oil yield and lipid content of the three avocado cultivars. The results show significant variation in oil yield among the cultivars ($p < 0.05$). Persea schiedeana produced the highest yield (28.20%), followed by Maluma (25.36%), with Hass yielding the least (20.48%). This superior oil yield in P. schiedeana can be attributed to its dense mesocarp and elevated lipid biosynthesis, which aligns with findings reported by González-Torres et al. (2023). The lipid content mirrored the oil yield, confirming the efficiency of Soxhlet extraction and the inherently lipid-rich nature of these cultivars. These results indicate that P. schiedeana may be the most suitable cultivar for industrial-scale oil production in Nigeria, while Hass remains a commercially viable option for moderate-scale processing.

Table 1. Oil Yield and Lipid Content of *Hass, Maluma,* and *Persea schiedeana Cultivars*

Variety	Oil Yield (%)	Lipid Content (%)
Hass	20.48	20.48
Maluma	25.36	25.36
Persea schiedeana	28.20	28.20

3.2 Proximate Composition

Table 2 presents the proximate composition of the three cultivars, including protein, ash, moisture, lipid, and carbohydrate contents.

Table 2. Proximate Composition of Avocado Pulp from Hass, *Maluma*, and *Persea schiedeana*

Parameter	Hass (%)	Maluma (%)	Persea schiedeana (%)
Protein	1.960	1.330	1.580
Ash	0.040	0.100	0.070
Moisture	1.360	2.710	2.010
Lipid Content	20.48	25.36	28.20
Carbohydrates	76.16	71.83	68.14

Maluma exhibited the highest protein and ash content, suggesting a richer mineral and amino acid profile beneficial for nutritional and therapeutic applications. Hass had the highest carbohydrate content, which may influence glycemic responses when consumed. The moisture content ranged from 1.36% to 2.71%, consistent with typical values for ripe avocado pulp. Lower moisture in Maluma may partly explain its higher oil yield, as reduced water content facilitates more efficient solvent extraction (Nasri et al., 2023). These observations align with prior proximate analyses of avocado pulp and demonstrate how cultivar and regional factors influence nutritional composition (Adeyeye, 2019).

3.3 Fatty Acid Profile

The fatty acid composition of the avocado oils is presented in Table 3, highlighting differences in major fatty acids.

Persea schiedeana demonstrated exceptionally high oleic acid content (19.17%), nearly four times that of Hass. Oleic acid is a monounsaturated fatty acid with recognized cardioprotective properties and contributes to oxidative stability, making P. schiedeana oil nutritionally superior (Borges et al., 2017; Wang et al., 2020).

Table 3. Fatty Acid Composition of Hass, Maluma, and Persea schiedeana Oils (%)

Fatty Acid	Hass (%)	Maluma (%)	Persea schiedeana (%)
Oleic Acid (C18:1)	5.8	4.3	19.17
Palmitic Acid (C16:0)	14.0	15.4	6.79
Linoleic Acid (C18:2)	0.6	Trace	0.75
Stearic Acid (C18:0)	0.3	0.2	0.4
Myristic Acid (C14:0)	Trace	Trace	Trace

In contrast, Hass and Maluma exhibited higher palmitic acid concentrations, which enhance oil firmness and shelf life but may elevate LDL cholesterol when consumed excessively. Linoleic acid, an essential polyunsaturated fatty acid, was present in small amounts, with P. schiedeana again showing the highest concentration. The variation in fatty acid profiles reflects cultivar genetics and local agro-ecological conditions, underscoring the importance of selecting cultivars for targeted dietary or cosmetic applications.

3.4 Chemical Characteristics of Avocado Oil

Table 4 summarizes key chemical properties, including iodine value, saponification value, and unsaponifiable matter, which are critical indicators of oil quality.

Table 4. Chemical Characteristics of *Hass, Maluma*, and *Persea schiedeana* Oils

Parameter	*Hass*	*Maluma*	*Persea schiedeana*
Iodine Value (g I2/100g)	91.7	83.0	94.0
Saponification Value (mg KOH/g)	196.2	174.4	197.7
Unsaponifiable Matter (%)	0.7	2.6	0.6

The iodine value, which indicates the degree of unsaturation, was highest in *P. schiedeana* (94.0 g I_2/100g), supporting its superior monounsaturated fatty acid content and suitability for applications requiring oxidative stability, such as salad oils and skincare formulations (Campos-Hernández et al., 2011). Saponification value reflects the average molecular weight of triglycerides and potential for emulsification; *P. schiedeana* again exhibited the highest value (197.7 mg KOH/g), suggesting shorter-chain fatty acids favorable for soap and emulsion production. Interestingly, *Maluma* exhibited the highest unsaponifiable matter (2.6%), comprising bioactive compounds such as sterols, tocopherols, and pigments, which enhance antioxidant activity and cosmetic utility (Borges et al., 2017). These chemical parameters confirm that cultivar selection directly influences both nutritional quality and industrial applicability of avocado oil.

3.5 Comparative Insights and Technical Interpretation

The results highlight cultivar-specific strengths. Persea schiedeana is superior in oil yield, oleic acid content, and iodine value, making it ideal for nutritional, culinary, and functional food applications. Maluma, with elevated protein and unsaponifiable matter, is better suited for cosmetic and therapeutic formulations, while Hass presents a balanced profile suitable for general consumption and industrial blending. The observed differences can be attributed to genetic variation and the unique environmental conditions of the Mambila Plateau, which affect lipid biosynthesis, fatty acid desaturation, and accumulation of minor bioactive components**.**

These findings are consistent with global avocado oil research while demonstrating the untapped potential of Nigerian-grown cultivars for value-added products and localized agro-industrial development.

4.0 Conclusion

The study demonstrated significant cultivar-specific variations in avocado oil yield, proximate composition, fatty acid profile, and chemical characteristics. Persea schiedeana produced the highest oil yield and lipid content, accompanied by a remarkably high oleic acid concentration and iodine value, indicating superior nutritional quality and oxidative stability. Maluma exhibited the highest protein content and unsaponifiable matter, highlighting its potential for cosmetic and therapeutic applications. Hass showed a balanced profile with moderate oil yield, lipid content, and fatty acid composition, making it suitable for general consumption and industrial blending. The moisture and carbohydrate content varied across cultivars, reflecting differences in pulp composition and their influence on oil extraction efficiency.

In conclusion, the findings reveal that avocado cultivar and agro-ecological conditions of the Mambila Plateau significantly influence the quality, nutritional composition, and industrial applicability of avocado oil. Persea schiedeana emerges as the most promising cultivar for functional food, nutraceutical, and culinary applications due to its high oleic acid content and favorable chemical properties, while Maluma offers advantages for cosmetic and therapeutic uses. Hass remains a versatile option for general consumption and blended oil products.

It is recommended that Persea schiedeana be prioritized for industrial-scale oil production and nutritional applications in Nigeria. Maluma should be considered for the development of cosmetic formulations and value-added products exploiting its high unsaponifiable matter and protein content. Further studies should investigate seasonal, post-harvest, and processing factors affecting oil quality, as well as the exploration of additional indigenous avocado cultivars to expand Nigeria's capacity for high-quality avocado oil production and local agro-industrial development.

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Declaration

Consent for publication

Not applicable.

Availability of data and materials

The publisher has the right to make the data publicly available.

Ethical Statement

All procedures in this study, including sample collection and laboratory analyses, were conducted following the highest standards of scientific integrity and safety. The research did not involve human or animal subjects, and all authors contributed voluntarily and have been appropriately acknowledged.

Competing interests

The authors declare no conflicts of interest. This work was a collaborative effort among all authors.

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Authors' Contributions

UUM conceptualized the study and supervised the research. JS performed sample collection, laboratory experiments, and data analysis. MM assisted with oil extraction, proximate analysis, and GC-MS profiling. VJD contributed to data interpretation, literature review, and manuscript drafting. All authors reviewed and approved the final manuscript.