

Morphometric Characteristics, Physicochemical Properties and Identified Fatty Acids of Oil Extracted from Roasted *Momordica cabrae* Kernels

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Abstract:

Background: *Momordica cabrae* is an underutilized tropical plant whose seeds may represent a source of vegetable oil. However, limited information is available on its fruit, seed and kernel characteristics and kernel oil composition. This study aimed to characterize mature *M. cabrae* fruits, seeds and kernels and evaluate physicochemical properties, vitamin contents and identified fatty acids of oil extracted from roasted kernels.

Materials and Methods: Thirty mature fruits were collected from four localities in west-central Côte d'Ivoire: Ouragahio, Logobia, Gnagbodougnoa and Zoha. Fruit, seed and kernel masses and lengths were determined in fresh and dry states. Kernels intended for oil extraction were roasted at 55 °C for 15 min, milled and extracted with hexane using a Soxhlet apparatus. The oil was analyzed for acid, saponification, iodine and peroxide values, density, vitamins E and K, and fatty acids by gas chromatography.

Results: Fruits contained 40 seeds each. Fresh masses of fruits, seeds and kernels were 24.13 ± 2.34 , 3.12 ± 0.47 and 2.97 ± 0.19 g, respectively, compared with dry masses of 17.36 ± 2.09 , 2.41 ± 0.28 and 2.25 ± 0.11 g. Drying significantly reduced mass by 28.06%, 22.76% and 24.24%, respectively ($p < 0.05$), whereas length remained unchanged. The oil showed acid, saponification, iodine and peroxide values of 2.97 ± 0.01 mg KOH/g, 168.41 ± 3.98 mg KOH/g, 110.16 ± 3.01 g I₂/100 g and 2.43 ± 0.04 mEq O₂/kg, respectively, with a density of 0.91 ± 0.01 . Vitamin E and K contents were 38.25 ± 2.01 and 2.00 ± 0.02 mg/100 g, respectively. Six fatty acids were identified, with oleic acid ($44.80 \pm 0.01\%$) predominating.

Conclusion: *M. cabrae* kernel oil showed promising preliminary physicochemical characteristics, with oleic acid predominating among the identified fatty acids. Further studies should establish its complete lipid profile and optimize roasting and extraction conditions.

Key Word: *Momordica cabrae*; Kernel Oil; Physicochemical Properties; Fatty Acids

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I. Introduction

Vegetable oils are important food ingredients and sources of dietary lipids, while also providing minor constituents such as tocopherols, phytosterols, pigments and other bioactive compounds (Gharby, 2022). Their physicochemical and nutritional characteristics vary considerably according to botanical origin, cultivar, geographical conditions, maturity and processing conditions. Recent reviews have emphasized that the characterization of vegetable oils requires the combined assessment of physicochemical quality indices, fatty acid composition and minor lipid components (Tian *et al.*, 2023; Xiang *et al.*, 2024).

In tropical Africa, several indigenous and underutilized plant species produce seeds that could constitute alternative sources of vegetable oils (Lykke *et al.*, 2021). However, many of these resources remain poorly characterized, particularly with respect to their technological properties and chemical composition. Studies of indigenous plant oils have demonstrated substantial interspecific variation in density, acid value, saponification value, iodine value, peroxide value and fatty acid composition (Muhammad *et al.*, 2023; Bougma *et al.*, 2025). Such variability highlights the need for species-specific characterization rather than extrapolation from conventional oilseed crops.

Momordica cabrae is a tropical cucurbit occurring in Côte d'Ivoire and other parts of sub-Saharan Africa. Although the fruits and seeds are used locally, the technological potential of its kernels as an oil-bearing material remains insufficiently documented. Characterizing the physical dimensions of the fruits and seeds is relevant for understanding the raw material, while the determination of acid, peroxide, saponification and iodine values provides information about important quality attributes of the extracted oil.

The extraction process can also influence the composition and quality characteristics of vegetable oils. Recent research has shown that extraction technology may affect the concentrations of fatty acids, tocopherols, phytosterols, volatile compounds and other lipid constituents (Zeng *et al.*, 2024). Thermal pretreatments can modify the plant matrix and influence the accessibility of intracellular lipids to the extraction solvent. Consequently, the processing conditions used before extraction should be clearly reported when characterizing an indigenous oil.

In the present study, the seeds intended for oil extraction were therefore subjected to a controlled roasting pretreatment at 55 °C for 15 min before milling and hexane extraction. The objective was to characterize the morphometric properties of mature *M. cabrae* fruits, seeds and kernels and to determine selected physicochemical properties, vitamin contents and the fatty acids effectively identified in the extracted oil.

II. Material And Methods

Plant Material and Sampling

Thirty mature fruits of *Momordica cabrae* were collected from four localities in west-central Côte d'Ivoire: Ouragahio, Logobia, Gnagbodougnoa and Zoha. Approximately 5 kg of mature fruits were collected and transported in jute bags to the Laboratory of Food Biochemistry and Tropical Processing (LBATPT), Nangui ABROGUA University, Abidjan, Côte d'Ivoire.

The fruits were manually opened and their seeds were separated. Approximately 40 seeds were obtained per fruit. Fruits, seeds and kernels were characterized according to their mass, length and external colour.

Morphometric Characterization

The fresh masses of the fruits, seeds and kernels were determined immediately after sample preparation. The samples intended for morphometric comparison in the dry state were dried at 45 °C for 4 days in a ventilated MEMMERT laboratory oven. This drying step was used exclusively for morphometric characterization and was not the pretreatment used for oil extraction.

The lengths of fruits, seeds and kernels were measured using a ruler or appropriate laboratory measuring equipment. The colour characteristics were recorded visually.

Roasting Pretreatment for Oil Extraction

The seeds intended specifically for oil extraction were subjected to a roasting pretreatment at 55 °C for 15 min, following the procedure described by Oupoh *et al.* (2023) for *Momordica cabrae* kernels. This treatment was applied to facilitate oil release from the seed matrix and improve the accessibility of lipids during subsequent solvent extraction.

After roasting, the seeds were allowed to cool to room temperature. The kernels were then obtained and milled. This distinction is important because the 55 °C/15 min roasting treatment was used specifically for the oil-extraction material, whereas the 45 °C/4-day treatment described above was used only for morphometric characterization.

Milling and Solvent Extraction of Oil

The roasted kernels were milled using an IKA mill (Germany). A 200-g portion of the resulting roasted kernel flour was placed in a Whatman extraction cartridge and extracted with 250 mL of hexane under reflux for 8 h.

After extraction, the mixture was filtered to separate the solid residue from the solvent containing the extracted oil. Hexane was removed using a rotary evaporator (Heidolph Laborota 4000 Q10). The extracted oil was subsequently placed in an oven at 104 °C for 2 h to facilitate the removal of residual solvent. The drying procedure was repeated until a constant mass was obtained.

The oil was transferred into amber glass bottles and stored under frozen conditions until physicochemical, vitamin and fatty acid analyses.

Determination of Physicochemical Properties

The acid, saponification, iodine and peroxide values were determined using standard analytical procedures. The acid value was determined according to AOAC (2000). Approximately 0.5 g of oil was dissolved in a mixture of ethanol and diethyl ether and titrated with 0.5 N ethanolic potassium hydroxide using phenolphthalein as indicator. The result was expressed as mg KOH/g oil.

The saponification value was determined according to AOAC (2000). Approximately 5 g of oil were treated with 6.3 mL of 0.5 N alcoholic KOH and refluxed for 1 h. The hot solution was titrated with 0.5 N HCl using phenolphthalein. A blank determination was performed under the same conditions.

The iodine value was determined using the Wijs method according to AOAC (2000). Approximately 200 mg of oil were dissolved in chloroform and treated with Wijs reagent. After reaction in the dark, potassium iodide and distilled water were added, and the liberated iodine was titrated with 0.1 N sodium thiosulfate using starch as indicator. The iodine value was expressed as g I₂ /100 g oil.

The peroxide value was determined according to Cocks and van Rede (1966). Approximately 1 g of oil was treated with chloroform and allowed to react before addition of water and starch indicator. The liberated iodine was titrated with 0.01 N sodium thiosulfate. Results were expressed as mEq O₂ /kg oil.

The density was determined at 20 °C using a pycnometer according to Wolf (1968). The pH was measured using a HANNA pH meter according to the procedure described by Dufour *et al.* (1994).

Determination of Fatty Acids

The fatty acid composition of the extracted oil was determined by gas chromatography equipped with a flame ionization detector (GC-FID). An HP 6890 Series gas chromatograph fitted with an HP-5 capillary column was used. The stationary phase consisted of 5% diphenyl and 95% dimethyl polysiloxane.

The chromatographic conditions included an injector temperature of 275 °C and a detector temperature of 325 °C. Nitrogen was used as the carrier gas. Fatty acids were identified by comparing their retention times with those of reference fatty acid methyl ester standards. Quantification was performed from the relative peak areas obtained for the identified compounds in comparison with the standards.

Importantly, only fatty acids for which analytical peaks could be reliably identified were reported. No extrapolation was made to estimate unidentified fatty acids, and no total saturated or total unsaturated fatty acid content was calculated from the six identified compounds.

Determination of Vitamins E and K

Vitamins E and K were determined by high-performance liquid chromatography following the procedure described by Deguine and Hau (2001), with appropriate sample preparation and filtration. The oil samples were treated with an alcoholic solvent, clarified, filtered and analysed by HPLC.

The chromatographic analysis was conducted at 30 °C using an acetonitrile/water mobile phase (80:20, v/v), UV detection and the reported analytical conditions. The concentrations of vitamins E and K were expressed as mg/100 g oil.

Statistical Analysis

The results were expressed as mean ± standard deviation. Differences between fresh and dried samples were assessed at the 5% significance level using the statistical procedure applied in the original experimental design. Different superscript letters indicate statistically significant differences at $p < 0.05$.

III. Result and Discussion

Morphometric Characteristics of Fruits, Seeds and Kernels

The morphometric characteristics of mature *Momordica cabrae* fruits, seeds and kernels are presented in Table 1. The fresh fruit mass averaged 24.13 ± 2.34 g, whereas the corresponding dry mass was 17.36 ± 2.09 g, representing a reduction of approximately 28.06%. Similarly, seed mass decreased from 3.12 ± 0.47 to 2.41 ± 0.28 g, while kernel mass decreased from 2.97 ± 0.19 to 2.25 ± 0.11 g, corresponding to reductions of 22.76 and 24.24%, respectively. These differences were statistically significant ($p < 0.05$). The observed reduction in mass is consistent with the expected loss of moisture during drying, since drying is commonly associated with substantial mass transfer from seeds and other biological materials while preserving much of their initial structural dimensions (Barrozo *et al.*, 2014).

In contrast, the reduction in mass was not accompanied by significant changes in length. Fruit length decreased only slightly from 7.91 ± 0.10 to 7.88 ± 0.10 cm, while seed length decreased from 2.28 ± 0.26 to 2.26 ± 0.24 cm. Kernel length remained unchanged at 1.88 ± 0.10 cm. The significant decrease in mass without a corresponding significant reduction in length suggests that drying primarily involved the removal of water rather than pronounced longitudinal shrinkage. Similar observations have been reported in studies of fruit and seed characteristics in *Momordica*, where mass, length and other morphological traits may vary independently according to genotype, maturity stage and growing conditions. For example, morphological characterization of *M. cochinchinensis* demonstrated significant differences among accessions for fruit weight, fruit length and seed weight, highlighting the contribution of genetic variability to morphometric characteristics (Othman & Khairi, 2023).

The relatively limited change in seed and kernel length observed in the present study may also be related to the structural organization of these tissues. Seeds possess protective coats and relatively rigid structural components that can constrain dimensional deformation during moisture removal. In *M. charantia*, detailed anatomical investigations have shown that the seed coat comprises several distinct tissue layers,

supporting the presence of a structurally organized protective barrier around the seed (Giuliani *et al.*, 2016). Thus, the preservation of seed and kernel length despite mass loss in the present study may reflect the resistance of these structures to substantial dimensional contraction during drying.

Comparative morphometric information on *M. cabrae* remains limited relative to better-characterized species of the genus. However, considerable morphological variability has been documented within *Momordica*. In *M. cochinchinensis*, for example, fruit weight and length differed significantly among accessions, with fruit weights ranging from 193.72 to 334.70 g and fruit lengths from 9.42 to 12.13 cm (Othman & Mohd Khairi, 2023). Similarly, studies conducted at different maturity stages of *M. cochinchinensis* have shown progressive increases in fruit weight and length during fruit development, demonstrating the importance of maturity stage when comparing morphometric characteristics among samples (Tran *et al.*, 2016). These findings indicate that differences among *Momordica* species, accessions or populations may be influenced by genetic background, developmental stage and environmental conditions. Consequently, direct comparisons of absolute morphometric values should be made cautiously when the plant material originates from different species or geographical environments.

The colour characteristics provided additional qualitative differentiation among the plant tissues. Mature fresh fruits were yellow, whereas the dried fruits became black. The seeds were black with a whitish covering in the fresh state and remained predominantly black after drying. The kernels were yellow and covered by a greenish layer. Such qualitative characteristics can contribute to the morphological description and identification of plant material, particularly when quantitative measurements alone are insufficient to distinguish anatomical fractions. Variation in fruit and seed colour has also been documented within *Momordica*. For instance, morphological studies of *M. cochinchinensis* have reported differences in mature seed colour, including black, dark brown and light brown seeds, among different morphological groups (Wimalasiri *et al.*, 2016). Therefore, the colour characteristics recorded for *M. cabrae* in the present study provide useful complementary descriptors for the identification and characterization of its fruits, seeds and kernels. Because colour in the present study was assessed visually rather than using instrumental colour measurements, these observations should be considered descriptive rather than quantitative. Future studies could complement these observations with CIE L*, a* and b* measurements to objectively characterize colour variation during drying and subsequent processing.

Table 1: Morphometric Characteristics of Mature *Momordica cabrae* Fruits, Seeds and Kernels

Parameters	Products	Fresh	Dry
Mass (g)	Ripe fruit	24.13 ± 2.34 ^a	17.36 ± 2.09 ^b
	Seed	3.12 ± 0.47 ^a	2.41 ± 0.28 ^b
	Kernel	2.97 ± 0.19 ^a	2.25 ± 0.11 ^b
Length (cm)	Ripe fruit	7.91 ± 0.10 ^a	7.88 ± 0.10 ^a
	Seed	2.28 ± 0.26 ^a	2.26 ± 0.24 ^a
	Kernel	1.88 ± 0.10 ^a	1.88 ± 0.10 ^a
Colour	Ripe fruit	Yellow	Black
	Seed	Black with a white coating	Black
	Kernel	Yellow with a greenish coating	Yellow with a greenish coating

Different superscript letters within a row indicate significant differences at $p < 0.05$.

Physicochemical Characteristics of *M. cabrae* Kernel Oil

The physicochemical characteristics of oil extracted from roasted *M. cabrae* kernels are shown in Table 2. The acid value of the oil was 2.97 ± 0.01 mg KOH/g. Acid value is commonly used as an indicator of the extent of hydrolytic deterioration of fats and oils. The relatively low value observed in the present study indicates a limited concentration of free fatty acids at the time of analysis. However, it should not be interpreted alone as evidence of long-term storage stability.

The saponification value was 168.41 ± 3.98 mg KOH/g oil. This parameter reflects the amount of alkali required to saponify the glyceride fraction and is influenced by the average molecular mass of the fatty acids present in the oil. Values reported for indigenous plant oils vary substantially according to species and fatty acid composition (Muhammad *et al.*, 2023).

The iodine value was 110.16 ± 3.01 g I₂ /100 g oil, indicating a substantial degree of unsaturation in the lipid fraction detected by this global physicochemical assay. The iodine value should nevertheless be interpreted together with the chromatographic fatty acid results because it reflects the overall capacity of the oil to react with iodine and does not identify individual fatty acids.

The peroxide value was 2.43 ± 0.04 mEq O₂ /kg oil. Peroxide value measures primary oxidation products and is therefore useful for assessing the oxidation state of an oil at the time of analysis. The low value

observed indicates a low level of detectable primary lipid oxidation products under the conditions used. Nevertheless, peroxide value alone does not establish the long-term oxidative stability of the oil.

The density was 0.91 ± 0.01 , while the measured pH was 6.75 ± 0.10 . Because vegetable oils are essentially non-aqueous systems, pH should be interpreted cautiously and should not replace more established oil-quality indices such as acid value and peroxide value.

Vitamin E was detected at 38.25 ± 2.01 mg/100 g oil, whereas vitamin K was 2.00 ± 0.02 mg/100 g. Tocopherols and other minor lipid constituents are important components of vegetable oils and may contribute to their compositional characteristics and technological properties (Tian *et al.*, 2023; Xiang *et al.*, 2024).

The physicochemical characteristics obtained in this study are within ranges reported for several indigenous plant oils, although direct comparisons should be made cautiously because botanical origin, extraction method, pretreatment and analytical procedures can substantially affect oil characteristics. For example, Muhammad *et al.* (2023) reported substantial variation in acid, peroxide, saponification and iodine values among indigenous plant oils.

Table 2 : Physicochemical Characteristics and Vitamin Contents of *Momordica cabrae* Kernel Oil

Parameter	Value
Acid value (mg KOH/g oil)	2.97 ± 0.01
Saponification value (mg KOH/g oil)	168.41 ± 3.98
Iodine value (g I ₂ /100 g oil)	110.16 ± 3.01
Peroxide value (mEq O ₂ /kg oil)	2.43 ± 0.04
Density	0.91 ± 0.01
pH	6.75 ± 0.10
Vitamin E (mg/100 g oil)	38.25 ± 2.01
Vitamin K (mg/100 g oil)	2.00 ± 0.02

Identified fatty acids

Six fatty acids were effectively identified by gas chromatography (Table 3). These included four saturated fatty acids, myristic, palmitic, stearic and arachidic acids and two unsaturated fatty acids, oleic and linoleic acids.

Oleic acid was the predominant identified fatty acid, with a concentration of $44.80 \pm 0.01\%$, followed by palmitic acid at $9.52 \pm 0.01\%$. Stearic acid accounted for $2.23 \pm 0.01\%$, arachidic acid for $1.40 \pm 0.01\%$, linoleic acid for $0.93 \pm 0.01\%$, and myristic acid for $0.12 \pm 0.01\%$.

The dominance of oleic acid among the compounds identified is consistent with the frequent occurrence of oleic acid as an important fatty acid in several plant oils. Recent studies have reported oleic acid as a major component of different indigenous and conventional plant oils, although the relative proportions vary substantially among species and extraction procedures (Muhammad *et al.*, 2023; Zeng *et al.*, 2024).

However, the six identified fatty acids accounted collectively for 59.00% of the chromatographically identified values reported in this study. Therefore, this sum must not be presented as the total fatty acid content of the oil. In particular, the present data do not support a calculation of total saturated fatty acids, total unsaturated fatty acids or an unsaturated-to-saturated fatty acid ratio. The absence of such calculations avoids overinterpretation of a partial chromatographic profile.

This limitation is particularly important when comparing indigenous oils because the number and identity of detected fatty acids depend on analytical conditions, standards used for identification and chromatographic resolution. Recent reviews have emphasized the importance of comprehensive analytical characterization for the reliable classification and quality assessment of vegetable oils (Xiang *et al.*, 2024). More comprehensive GC-FID and/or GC-MS analyses using an extended fatty acid methyl ester standard set would therefore be required to establish the complete fatty acid profile of *M. cabrae* oil.

Table 3. Fatty Acids Identified in *Momordica cabrae* Kernel Oil.

Fatty acid	Content (%)
Myristic acid (C14:0)	0.12 ± 0.01
Palmitic acid (C16:0)	9.52 ± 0.01
Oleic acid (C18:1)	44.80 ± 0.01
Stearic acid (C18:0)	2.23 ± 0.01
Linoleic acid (C18:2)	0.93 ± 0.01
Arachidic acid (C20:0)	1.40 ± 0.01

Relevance of the roasting pretreatment

In the present work, roasting at 55 °C for 15 min was deliberately introduced before solvent extraction to facilitate oil release from the seed matrix. Thermal pretreatment can modify the physical structure of plant tissues and consequently influence the accessibility of lipids during extraction. Recent studies have demonstrated that extraction methods can influence both the major and minor constituents of vegetable oils (Zeng *et al.*, 2024).

The relatively mild temperature used in the present study should nevertheless be distinguished from high-temperature cooking or frying. Severe thermal treatment can promote lipid oxidation and, under appropriate conditions, other chemical transformations such as isomerization and polymerization (Abrante-Pascual *et al.*, 2024; Mavlanov *et al.*, 2025). The present roasting conditions were considerably milder and were applied for a short duration.

Because the experimental design did not include a non-roasted control, the present study cannot quantitatively establish the specific improvement in extraction yield attributable to roasting. The treatment should therefore be described as an extraction pretreatment rather than as a demonstrated optimization. Future experiments should compare several roasting temperatures and durations with an untreated control and determine oil yield, extraction efficiency, oxidation indices and fatty acid composition.

IV. Conclusion

This study provides preliminary information on the morphometric characteristics of *Momordica cabrae* fruits, seeds and kernels and on selected properties of oil extracted from roasted kernels. Roasting at 55 °C for 15 min followed by hexane extraction produced oil with an acid value of 2.97 ± 0.01 mg KOH/g, saponification value of 168.41 ± 3.98 mg KOH/g, iodine value of 110.16 ± 3.01 g I₂ /100 g and peroxide value of 2.43 ± 0.04 mEq O₂ /kg. Vitamin E and K contents were 38.25 ± 2.01 and 2.00 ± 0.02 mg/100 g, respectively.

Six fatty acids were identified, with oleic acid predominating ($44.80 \pm 0.01\%$), followed by palmitic acid ($9.52 \pm 0.01\%$). Since the identified compounds do not represent a complete fatty acid profile, total saturated or unsaturated fatty acid contents should not be inferred. Further studies should determine oil yield, compare roasted and non-roasted kernels, optimize processing conditions and establish a comprehensive fatty acid profile. Characterization of tocopherols, phytosterols and phenolic compounds would further clarify the technological potential of *M. cabrae* kernel oil.

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