International Journal of Nutrition and Food Sciences
2026, Vol. 15, No. 2, pp. 34–40
https://doi.org/10.11648/j.ijnfs.20261502.12

Research Article

Physicochemical Properties and Fatty Acid Composition in Oils Extracted from Fluted Pumpkin (*Telfairia occidentalis*) in Cote d'Ivoire

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Abstract

Telfairia occidentalis, fluted pumpkin, is one of the most popular leafy and seed vegetables of the Cucurbitaceae family cultivated for human consumption in West and Central Africa. In Côte d'Ivoire, although it exists in certain areas, this fruit remains little known and has benefited from only limited research focusing on forest plants. The present study aims to present the physicochemical properties and fatty acid composition of oils extracted from fluted pumpkim seeds cultivated in Côte d'Ivoire, in order to propose nutritional valorization pathways adapted to the local context. The oil was extracted from seeds of several pumpkins using the the usuals methods. A physical and sensory characterization of the oils was performed by visual observation and olfactory evaluation, while the physicochemical parameters (density, viscosity, refractive index, acid value, iodine value, saponification value, peroxide value) were measured according to the corresponding ISO standards. Fatty acid composition was analysed by gas chromatography after esterification. The results revealed an oil yield of 54%. Regarding the physical parameters, the results show that the oil from fluted pumpkin seeds is golden yellow color with a pleasant odor. The oil is liquid at room temperature. Density, viscosity and refractive index values are 0.86 ± 0.77 $g/cm^{3;}$ 643.7 ± 0.11 cP à 28.5°C, et 1.4745 ± 0.1 respectively. Chemical analyses showed that the saponification value, iodine value, acid value and peroxide value are respectively 233.2 ± 0.03 mg KOH/g; 37.8 ± 0.07 g I_2/100g; 13.7 ± 0.02 mg KOH/g et 6.93 ± 0.63 meq O_2/kg. The fatty acid profile shows a predominance of unsaturated fatty acids such as oleic acid (36.04%), linoleic acid (27.41%), linolenic acid (17.63%), eicosapentaenoic acid (6.26%), erucic acid (3.15%), eicosenoic acid (2.14%) and clupanodonic acid (2.83%). Saturated fatty acids are also found in low proportions: butyric acid (0.21%), lauric acid (0.32%), stearic acid (1.09%), myristic acid (0.55%) and palmitic acid (1.21%). These results suggest that the oil extracted from *Telfaira occidebtalis* seeds is a important source of essential fatty acid precursors, making it valuable for both human nutrition and sustainable applications in the agri-food and cosmetic industries.

Keywords

Fluted Pumpkin, Seed, Extracted Seed Oil, Fatty Acid Composition, *Telfairia occidentalis*

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Received: 5 January 2026; **Accepted:** 27 January 2026; **Published:** 12 March 2026

1. Introduction

West Africa exhibits a great diversity of food plants, whose local species contribute significantly to the food systems and socio-economic development of the populations [1, 2]. Among these resources, oil seeds constitute an important component of the human diet and are generally recognized for their high nutritional value. They play a key role in providing lipids and proteins, and represent potential raw materials for the food and cosmetic industries [2, 3].

Fluted pumpkin (*Telfairia occidentalis*) is one of the most popular leafy and seed vegetables of the Cucurbitaceae family, cultivated for human consumption. Native to West Africa, it is mainly grown in southern Nigeria, where its leaves, young shoots, and seed are commonly used as nutrient sources in soups and other traditional dishes [4, 5]. According to several studies, fluted pumpkin seeds have a high lipid (27-58%) and protein (27-31%) content, with a well-balanced amino acid composition, making them a potential nutritional and industrial source [4, 6, 7]. Despite some isolated studies, few detailed research on the physicochemical characterization and industrial potential of *Telfairia occidentalis* oil have been published specifically in Côte d'Ivoire [8]. The identification of the physicochemical characteristics and the fatty acid profile of the oils extracted from its seeds is necessary to assess their potential for food and industrial use.

This study therefore aims to characterize the physicochemical properties and fatty acid composition of oils extracted from Fluted pumpkim seeds cultivated in Côte d'Ivoire, in order to propose pathways for nutritional valorization adapted to the local context.

2. Material and Methods

2.1. Plant Material

The plant material consisted of mature fluted pumkpin (*Telfairia occidentalis*) fruits. The fluted pumpkins were harvested from about ten different plantations belonging to local producers over three hervest seasons in the sub-prefecture of Yakasse Attobrou, Mé region, in southeastern Côte d'Ivoire. These fruits were transported to the laboratory, the mature *Telfairia occidentalis* fruits were cut open using a knife. The seeds were then manually extracted from the pods, washed with distilled water, sun-dried for two weeks and finelly ground into a powder. The powder was then stored in a airlight container prior to oil extraction.

2.2. Extraction Method

The oil from the fluted pumpkin seeds was extracted according to the method of Folch *et al.* [9] modified by Christie [10]. approximately 50 g of powder were weighed. then, 200 ml of chloroform and 100 ml of methanol were successively added. The mixture was vigorously homogenized using a vortex for 2 min, then filtered through a Büchner funnel fitted with Whatman N°1 filter paper. The residue was then dispersed in a chloroform-methanol mixture (2:1, v/v, 300 mL) for 3 min and filtered again. The same residue was washed with a chloroform-methanol mixture (2:1, v/v, 60 mL). Finally, the filtrate was diluted in 0.2 Ml of Nacl solution (0.7%) contained in a separatory funnel, and the organic phase was collected in a pre-weighed flask. The solvent was removed at 50 °C using a rotary evaporator under vacuum. The oil content was determined gravimetrically. This process was repeated twice, and the final residue obtained was dried at room temperature for 24h to remove the remaining hexane. The extracted oil was stored in bottles at room temperature, protected from light, for the determination of physicochemical characteristics and fatty acid composition.

2.3. Physicochemical Analyses

The extracted oil was stored in bottles at room temperature and protected from light for the determination of physicochemical characteristics and fatty acid composition.

Physical analyses of density were determined according to ISO [11], viscosity using a Stresstech viscometer, and refractive index according to ISO [12]. As for the color, odor, and state of the oil at room temperature, observations were made visually and by olfactory analysis. Also, chemicals parameters were determined using the standards ISO methods: acid value (ISO) [13], iodine value (ISO) [14], saponification value (ISO) [15], and peroxide value [16].

Fatty acid composition was determined by GC analysis of fatty acids methanolysis with a BF3-methanol mixture. The esters thus formed were analyzed by GC on a stabilized ethylene glycol adipate (EGA) column. The carrier gas was the solution saturated in NaCl-sulfuric acid 10%-hexane. The sample (1 µL) was injected, and the separation was performed on a DB-5.625 or DB-5MS column type column, 30 m x 0.25 mm internal diameter with a stationary phase of 0.25 µm. The oven temperature was initially maintained at 130 °C for 2 min, then increased from 180 °C at 10 °C/min to 245 °C at 3 °C/min, then increased to 300 °C at 15 °C/min for 15 min. The injection port and detector temperatures were set to 180 °C, 250 °C and 300 °C, respectively. The peaks were identified by comparison with standard fatty acid methyl esters [17].

2.4. Statistical Analyses

Statistical analyses of the data were performed using STATISTICA 7 (Stat soft Inc., Tusla-USA Headquarters) and XLSTAT-Pro 7.5.2 (Addinsoft Sarl, Paris-France). The results obtained are expressed as mean ± standard deviation. After analysis of variance (ANOVA), the comparison of means was performed using Student's t-test for two mean and Duncan's test for three or more means. Statistical significance was defined at $P \leq 0.05$. All measurements were carry out in triplicate.

3. Results

3.1. Physical Parameters of Telfairia Occidentalis Seed Oil

The physical parameters of Fluted Pumpkin Seed Oil are shown in Table 1. The results obtained are recorded in the table below.

Table 1. *Physical characteristics of the extracted seed oil.*

Parameters	Values
Oil Yield	54 ± 0.20%
Viscosity (at 28.5°C)	643.7 ± 0.11 cP
Refractive index (nD20)	1.4745 ± 0.1
Density (à 20°C)	0.86 ± 0.77 g/cm^3
Color	Golden yelow
Odor	Pleasant

3.2. Chemical Composition of the Oils Extracted from Telfairia Occidentalis

The results of the chemical composition of the oils extracted from fluted pumpkin are shown in Table 2.

The acid value (AV), peroxide value (PV), iodine value (IV), and saponification value (SV) of the seed oil were 13.7 ± 0.02 mg KOH/g; 6.93 ± 0.63 meq O2/kg; 37.8 ± 0.07 gI_2/100g et 233.2 ±0.03 mg KOH/g, respectively.

Table 2. *Chemical characteristics of the extracted seed oil.*

Parameters	Value
Acid Value (mg KOH/g)	13.7 ± 0.02
Saponification Value (mg KOH/g)	233.2 ± 0.03
Iodine Value (gI_2/100 g)	37.8 ± 0.07
Peroxide Value (meq O_2/Kg)	6.93 ± 0.63

3.3. Fatty Acid Composition

Fluted pumpkin seed oil are rich in polyunsaturated fatty acids (PUFAs), followed by monounsaturated fatty acid (MUFAs) and saturated fatty acids (SFAs) (Table 3). PUFAs represented the most abundant fatty acid class (54.76%), followed by MUFAs (41.33%). Linoleic acid (27.41%) was the predominant PUFA, followed by linoleic acid (17.63%), eicosapentaenoic acid (6.26%), and clupanodonic acid (2.83%).

Oleic acid was the predominant MUFA (36.04%), followed by erucic acid (3.15%) and eicosenoic acid (2.14%). The second category of FAs was saturated fatty acid (SFAs), at 3.38%. Their concentrations are significantly lower. These are stearic acid (1.09%), palmitic acid (1.21%), myristic acid (0.55%), lauric acid (0.32%), and butyric acid (0.21%) (Table 3).

Table 3. *Fatty acid composition.*

Fatty Acid	Content (g /100g ou%)
Butyric (C4: 0)	0.21
Lauric (C12: 0)	0.32
Myristic (C14: 0)	0.55
Palmitic (C16: 0)	1.21
Stearic (C18: 0)	1.09
Linoleic (C18: 2)	27.41
Linolenic (C18: 3)	17.63
Eicosapentaenoic (C20: 5)	6.26
Oleic (C18: 1)	36.04
Erucic (C22: 1)	3.15
Eicosenoic (C20: 1)	2.14
Clupanodonic (22: 5)	2.83

4. Discussion

4.1. Physical Parameters of Fluted Pumpkin Seed Oil

The oil extracted from the seed of fluted pumpkin exhibited a yellow color, with a yield of 54 ±0.20%. This appreciable yield is higher than that of some oil seeds such as cotton (20-30%) [18], maize (30-50%) [19, 20], and groundnut (40-47%) [21]. The oil content reported in this study is similar to the 52.5% yield obtained by Jovial et *al*. [22] on oil extracted from Fluted pumkpin cultivated in Nigeria. This high yield indicates that oil extraction for industrial or food applications would be economical and could constitute an important lever to meet the challenges of the growing demand for vegeteble oil.

The oil extracted from Fluted Pumkins seed is liquid at room temperaure, golden-yellow in color, with a pleasant odor characteristic of refined oils. The golden-yellow appearance reflects both high nutritional value and strong industrial potential in the agri-food and cosmetic sectors. The coloration could be attributed mainly to the presence of carotenoids, residual chlorophylls, and naturally fat-soluble phenolic compounds [23]. The abundance of carotenoids, mainly β-carotene, a natural antioxydant and vitamin A precursor, is characteristic of golden-yellow oils. These compounds contribute to protection against lipid oxidation, enhanced storage stability, and health benefits, especially for vision and the immune system [5]. Furthermore, a golden-yellow hue is a sought-after aesthetic and commercial asset in the food ans cosmetic industries as it gives products a natural and attractive appearance, arousing consumer interest [24].

Density is an essential physicochemical parameter used to assess the purity, composition, and quality of a vegetable oil. It depends mainly on fatty acid composition, the degree of unsaturation, and the content of impurities or water [4, 25]. The density of the oil extracted from fluted pumkpin seed is 0.86 ± 0.77 g/cm^3 at room temperature. This value falls within the typical range for light vegeteble oils (0.86 à 0.92 g/cm^3), indicating a low-viscosity, well-purified oil rich in unsaturated fatty acids [23, 26]. Previous studies report similar densities for other oils from cucurbits such as *Cucumeropis mannii* (0.88 g/cm^3) and *Citrullus colocynthis* (0.87 g/cm^3) [27].

The refractive index (RI) is an important optical property of vegetable oils, used to assess their purity, fatty acid, fatty acid composition, and degree of unsaturation. High RI values generally correspond to a greater presence of double bonds [28].

The RI of fluted pumkpin seed oil is 1.4745, which places it in the typical range for edible vegetable oils rich in unsaturated fatty acids such as sunflower oil (1.461-1.468) [29], olive oil (1.465-1.468), soybean oil (1.472-1.475), and corn oil (1.473-1.476) [30].

Viscosity is an essential physical parameter that reflects a fluid’s resistance to flow. It is strongly dependent on temperature and fatty acid composition. It provides information on the content of saturated fatty acid, the structure of triglycerides, and the oil’s suitability for industrial processing. The oil extracted from Fluted pumpkim seed has a dynamic viscosity of 643.7 ± 0.11 cP at 28.5 ℃, indicating a moderately viscous oil that still flows, but is thicker than a typical food oil. This value is higher than those reported for oils like sunflower oil (40-50 cP at 30 ℃) or soybean (60 cP at 30 ℃), which are lighter, but comparable to some oils with high levels of saturated or long-chain fatty acids such as palm or castor oil (400-800 cP at 30 ℃) [29]. This relatively high viscosity could be attributed to a greater proportion of long-chain triglycerides influencing the oil’s crystalline structure [31]. From a technological standpoint, significant viscosity confers upon fluted pumpkim oil good heat stability and a texture suitable for cosmetic formulations (cream, lotions, balms) while maintaining good saponification suitability [32]. Thus, the measured viscosity (643.7 ± 0.11 cP à 28.5 ℃) positions fluted pumkpin seed oil among the semi-viscous vegetable oils with high industrial potential, particularly in the cosmetic and pharmaceutical sectors, where consistency, stability, and lipid richness are major quality criteria [33].

4.3. Fatty Acid Composition

The lipid content of the fluted pumpkin seed powder is 35.62 ± 0.06%. Its lipid profile is characterized by a predominance of unsaturated fatty acids, dominated by oleic acid (36.04%) and linol éc acid (27.41%), and a low proportion of saturated fatty acids such as palmitic acid (1.21%) and stearic acid (1.09%). These results corroborate those of Alademeyin and Arawande [23] who reported that oleic acid is the main fatty acid (47.4-49.02%) and linoleic acid is secondary (26.36-30.44%) in the oil from fluted pumpkin seeds cultivated in Nigeria. This composition gives the oil high nutritional and functional value. Indeed, oleic acid, the main monounsaturated fatty acid, is recognized for its beneficial effects on cardiovascular health. According to Schwingsshackl and Hoffman [45], a diet rich in oleic acid helps lower total cholesterol and LDL-cholesterol, while increasing HDL-cholesterol, thus improving the blood lipid profile. Moroever, this fatty acid confers high oxidative stability to oils, which extends their shelf life and enhance their interest for food and cosmetic applications [46, 47].

For its part, linoleic acid, an essential polyunsaturated fatty acid, plays a key role in decreasing the risk of type 2 diabetes, regulating blood pressure, and reducing inflammatory processes [48]. In parallel, the low content of saturated fatty acids represents an additional asset. The work of Mensik [49] and Hooper *et al.* [50] clearly showed that a reduced intake of saturated fatty acids represents, twinned by an increase in unsaturated fatty acids, significantly decreases the risk of cardiovascular and metabolic diseases. Thus, the favorable ratio between unsaturated and saturated fatty acids positions in fluted pumpkin oil positions the latter among high nutritional quality vegetable oils, comparable to olive and rapeseed oil. On an industrial level, this fatty acid profile makes the oil particularly suitable for the formulation of cosmetic of cosmetic products (creams, lotions, shampoos) where lightness and absorption capacity are sought. Furthermore, the moderae content of saturated fatty acids promotes good oxidative stability, extending the shelf life of the finished product [27]. Thus, the lipid composition of fluted pumpkin oil combines nuritional value, functional stability, and high technological potential, reinforcing its interest as a multifunctional oil for food and cosmetic use.

4.2. Chemical Composition of the Oils Extracted from Fluted Pumkpin Seeds

The iodine value is used to assess the degree of unsaturation of fatty acids [4]. The iodine value obtained (37.8 ± 0.07 gI2/100 g) reflecting a moderate proportion of unsaturated fatty acids. It has been reported that a low iodine value is associated with better oil stability against oxidation and reduces the risk of oxidative rancidity [34]. The iodine value of fluted pumpkin seed oil is lower than that of unsaturated oils like sunflower (110-130 gI2/100 g) and soybean (120 gI2/100 g), but close to that of more stable oils like palm oil (40-55 gI2/100 g) [27]. This moderate unsaturation indicates a balanced oil, presenting both good stability to oxidation, which is favorable for human consumption and cosmetic use.

The saponification value (SV) obtained in this study for the seed oil of fluted pumkpin is 233.2 ±0.03 mg KOH/g. This value is higher than that of most common oils such as palm oil (202.9 mg KOH/g) [35], groundnut oil (189.41 to 194.75 mg KOH/g) [36], castor oil (182.61 mg KOH/g) [37], but is lower than that of coconut oil (249 mg KOH/g) [38]. A high saponification value indicates the presence of medium-chain fatty acids, easily convertible into soft, foaming, and emollient soaps [39, 40]. Furthermore, Eze *et al.* [41] showed that oils with a high saponification value can serve as effective raw materials for cosmetic and detergent formulations such as soap, creams, and liquid shampoos. Thus, the combinaison of a high saponification value and richness in unsaturated fatty acids gives this oil a particular interest as a local and sustainable alternative to conventional oils used in the soap industry.

The acid value reflects the amount of free fatty acids present in a oil and allows the assessment of its state of degradation or rancidity. It expresses the mass of KOH (in mg) needed to neutralize the free acids contained in one gram of oil [4]. The oil extracted from fluted pumkpin seeds has an acid value of 13.7 ±0.02 mg KOH/g, indicating slight hydrolysis of triglycerides. This value is higher than those observed for soybean oil (1.25 à 2.29 mg KOH/g) [42] and sunflower oil (2.37 mg KOH/g) [43]. However, the value obtained is typical of crude oils from unrefined oilseeds [26]. This suggests that the oil extracted from fluted pumpkin is stable, but might require light refining before consumption, and would be suitable for cosmetic or industrial use [23].

The peroxide value (PV) measures the amount of peroxides formed during the initial oxidation of lipids. It is therefore a direct indicator of the oxidative stability of the oil [5]. A high value indicates an oxidized oil. The peroxide value of fluted pumpkin seed oil is 6.93 ±0.63 meq O_2/kg, lower than the limit of 10 meq O_2/kg set by the Codex Alimentarius [44] for unrefined edible oils. This value reflects low oxidation and good shelf stability of the oil [27]. This low index can be attributed to the natural presence of antioxidant compounds, notably carotenoids, which contribute to protection against lipid oxidation and improve the oil's shelf stability.

5. Conclusion

The objective of this work was to characterize the physicochemical properties and fatty acid composition of oils extracted from Telfairia occidentaluis seeds cultivated in Côte d'Ivoire, in order to propose avenues for nutritional valorization adapted to the local context. The results obtained at the end of this study highlight a vegetable oil of high nutritional and technological quality, characterized by a high proportion of unsaturated fatty acids and good physicochemical stability. Its balanced lipid composition and high content of essential fatty acids confirm its value for human health and its potential in the agri-food and cosmetic industries. The oil extracted from *Telfairia occidentalis* seed could therefore represent a promising alternative to imported oils for sustainable agri-food and cosmetics valorization. Further research on its long-term stability and the development of derivative products would allow for a better guidance of its food and industrial use.

Abbreviations

LDL	Low Density Lipoprotein
HDL	High-Density Lipooprotein
PV	Peroxide Value
SV	Saponification Value
AV	Acid Value
RI	Refractive Index
SFAs	Saturated Fatty Acid
MUFas	Monounsaturated Fatty Acid
PUFAsAs	Polyunsaturated Fatty Acids

Conflicts of Interest

The authors declare no conflicts of interest.

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