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Exploring the potential of *Ricinodendron heudelotii and* anarcadium occidentale (Cashew nut) oil quality and purity from Ivory Coast

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ABSTRACT

This study aimed to characterize and compare oils extracted from the seeds of *Ricinodendron heudelotii* and *Anacardium occidentale*, two underexploited oilseed species from Côte d'Ivoire, to evaluate their potential for local valorization and sustainable use. Seeds were collected from different producing regions, and oil extraction was performed using the Soxhlet method. Lipid yield, oil quality parameters (free acidity, peroxide value, K232, K270), fatty acid composition, minor constituents (sterols, tocopherols), and physical properties (color, viscosity) were assessed. Results showed that the acidity index of both oils complied with Codex Alimentarius standards (≤ 4.0 mg KOH/g oil). *Anacardium occidentale* oil exhibited good oxidative stability, with peroxide values ranging from 1.2 to 8.8 meq O_2/kg, whereas *Ricinodendron heudelotii* oil showed higher values (38–64 meq O_2/kg), reflecting compositional differences. Fatty acid analysis revealed a predominance of oleic acid (65%) in *A. occidentale* oil, known for cardiovascular benefits, while *R. heudelotii* oil was rich in nervonic acid (49–54%), a fatty acid with functional applications. Both oils contained high β-sitosterol (>80%), and *R. heudelotii* oil exhibited notably high tocopherol content (480–1140 mg/kg). Overall, these findings highlight the complementary properties of the two oils. Their valorization could strengthen local oilseed value chains, reduce dependence on imported vegetable oils, and support sustainable development and nutritional security in Côte d'Ivoire. Vegetable oils; Oilseed seeds; Quality parameters; Fatty acid profile; Tocopherols; Sterols; *Ricinodendron heudelotii*; *Anacardium occidentale*; Côte d'Ivoire.

Contribution/Originality: This study contributes to the existing literature by providing the first comprehensive comparison of major and minor oil constituents in *Ricinodendron heudelotii* and *Anacardium occidentale* from Côte d'Ivoire, revealing their nutritional and valorization potential.

1. INTRODUCTION

Vegetable oils, in particular, play a key role not only in human nutrition but also in the cosmetics, pharmaceutical, and energy sectors. However, global production remains dominated by a few intensively cultivated species such as soybean, palm, rapeseed, and sunflower, which limits the diversity of fats available on the market (Food and Agriculture Organization of the United Nations, 2020; Gunstone, 2011). In sub-Saharan Africa, particularly in Ivory Coast, several local or naturalized oilseed species offer significant untapped potential. Their development could not only enhance nutritional security but also promote the structuring of local high-value-added sectors (Kapseu, Kayem,

& Parmentier, 2005; Yapo, Kouadio, Kouamé, & Coulibaly, 2021). Among these resources, the cashew nut (Anacardium occidentale), which is already cultivated for its exported kernels, produces an oil that remains undervalued in commercial channels. Similarly, Ricinodendron heudelotii, a forest species whose seeds are commonly used in traditional sauces under the name "akpi," is a promising source of lipids, especially in rural areas where it is harvested using traditional methods (Coulibaly, N'Dri, Kouassi, Kouamé, & N'Guessan, 2018; Diamond et al., 2019). The characterization of oils derived from these seeds is of particular interest in terms of endogenous local development. From a technological standpoint, knowledge of lipid yields, fatty acid profiles, oxidative stability, and bioactive compound content is essential for determining potential uses such as food, cosmetics, and artisanal processing. Economically, these oils could serve as a source of income for rural communities, especially women, who are often involved in the collection and processing of these seeds. The objective of this study is to evaluate and compare the physicochemical characteristics of oils extracted from R. heudelotii and A. occidentale seeds harvested in various regions of Côte d'Ivoire. The analysis focuses on yield and quality parameters, including acidity, peroxides, and specific extinction, as well as fatty acid profiles and minor compound content such as tocopherols, sterols, and pigments. These data will contribute to a better understanding of the potential of these oils and may serve as a basis for local development initiatives aligned with principles of sustainability, food sovereignty, public health, and the recognition of endogenous African resources.

2. MATERIALS AND METHODS

2.1. Samples

Seeds of Ricinodendron heudelotii and cashew nuts (Anacardium occidentale) were collected during their respective harvest seasons from six distinct localities: Katiola (KTL), Korhogo (KRG), and Sandegue (SDG), located in the northern cashew-producing zone; and Daloa (DLA), Bouaflé (BFL), and Koun-Fao (KNF), situated in the forested region favorable to the growth of R. heudelotii.

In each locality, samples were collected directly from producers to ensure traceability and authenticity. For each site, approximately 3 to 5 kilograms of seeds were obtained and transported in clean, labeled cloth bags. Upon arrival at the laboratory, all samples were stored in a cold room (4 ± 1 °C) until oil extraction, in order to preserve their physicochemical integrity.

2.2. Quality Criteria

The following quality criteria were determined for each oil sample:

- Acidity Index (AI): Measured by titration according to the standard NF ISO 660. Acidity is expressed as a percentage of free oleic acid (%).
- Peroxide value (PV): Determined according to the standard NF ISO 3960, expressed in milliequivalents of active oxygen per kilogram of oil (meq O_2/kg).
- K232 and K270 values: These indices correspond to the absorbances measured at 232 nm and 270 nm, respectively, by UV spectrophotometry, in accordance with the standard NF EN ISO 3656. The oil, diluted in hexane, was analyzed using a 1 cm thick quartz cuvette to evaluate primary (K232) and secondary (K270) oxidation.

2.3. Analysis of Sterols and Tocopherols

Total tocopherols were determined by high-performance liquid chromatography (HPLC) according to ISO 9936. Free sterols were analyzed by gas chromatography (GC) after saponification of total lipids, following the AOCS Ch 6-91 method. The unsaponifiable extracts were derivatized into trimethylsilyl (TMS) ethers before being injected onto a DB-5 capillary column. The sterols, including campesterol, stigmasterol, and β-sitosterol, were identified by comparison with commercial standards.

2.4. Fatty acid Profile Analysis

The fatty acids were analyzed in the form of methyl esters (FAMEs), obtained after transesterification with methanol in the presence of potassium hydroxide, according to the standard NF ISO 12966-4. The separation and determination of fatty acid methyl esters (ranging from C8 to C24) were performed using gas chromatography (GC) on a capillary column.

2.5. Color Determination

The color of the oils was measured using a Lovibond colorimeter. The measurements were performed according to the CIE Lab colorimetric coordinate system, which is defined as follows: L represents lightness (0 = black, 100 = white); a indicates hue on the green-red axis (negative values = green, positive values = red); and b indicates hue on the blue-yellow axis (negative values = blue, positive values = yellow).

The oils were placed in standard tanks, and measurements were taken at room temperature, with three repetitions for each sample.

2.6. Viscosity Measurement

The dynamic viscosity of the oils was measured at room temperature, specifically at 25°C, using a viscometer. The viscometer was of the brand and model specified by the user, and it was of the type, such as rotary or capillary. Prior to analysis, the oil samples were maintained at a stable temperature to ensure the reproducibility of the measurements. The results were expressed in Pascal-seconds (Pa·s).

2.7. Statistical Analyses

Measurements were carried out in three repetitions, and subsequent statistical analyses were performed using SPSS Statistics 27. Specifically, the analysis of variance (ANOVA) test was employed, followed by Tukey's post hoc test to identify statistically significant differences between mean values.

3. RESULTS

3.1. Oil Yield

The oil yield of the analyzed samples ranges from 40.40% to 46.00% (see Figure 1). Seeds of A. occidentale exhibit the highest extraction rates, with an average yield of 45%, compared to 40% for Ricinodendron heudelotii samples. These yields are comparable to those observed in other tropical oilseeds, such as peanut (45%), sesame (50%), and sunflower (40%), as reported by Gunstone (2011), Shahidi (2005), Bockisch (1998), and Nwokolo and Smartt (1996) (Figure 1).

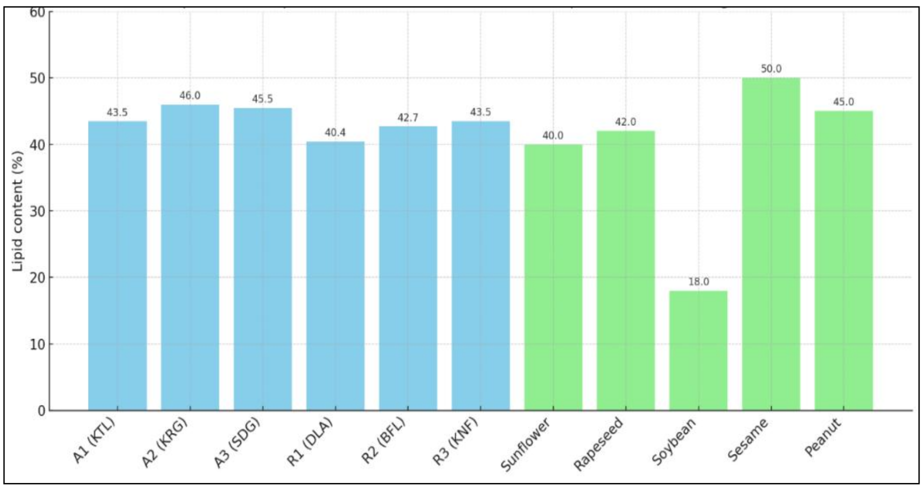

Figure 1. Comparison of lipid content between the studied vegetable oil and other vegetable oils.

3.2. Quality Criteria

The quality parameters of the oil samples are presented in Table 1. The samples from A. occidentale seeds generally meet the Codex Alimentarius standards for unrefined vegetable oils (Table 2). The acidity indices measured for the KTL (2.70 mg KOH/g) and SDG (4.05 mg KOH/g) samples remain below or equal to the recommended limit of 4 mg KOH/g (Codex Alimentarius Commission, 2019). However, the KNF sample shows a high value (5.96 mg KOH/g), indicating increased hydrolysis of triglycerides. The peroxide values, which are indicators of primary fatty acid oxidation, confirm the good stability of cashew nut oils, with values ranging from 1.19 to 8.79 meq O_2/kg, all below the regulatory threshold of 15 meq O_2/kg (Codex Alimentarius Commission, 2019). Conversely, oils from R. heudelotii exhibit highly advanced oxidation, particularly in the KNF (64.2 meq O_2/kg) and BFL (38.3 meq O_2/kg) samples, which are well above the permissible limits. The specific extinction indices K_{232} and K_{270}, which provide information on hydroperoxides and secondary oxidation products (aldehydes, ketones), respectively, reinforce this trend. All samples have K_{232} values below 2.5, except BFL (3.38), suggesting a significant accumulation of peroxides. Similarly, K_{270} values are low overall, with the exception of BFL (1.61) and KNF (1.06), indicating increased formation of secondary oxidation compounds.

Table 1. Quality parameters of oils extracted from cashew seeds of A. occidentale and R. heudelotii.

Samples	A1 (KTL)	A2 (KRG)	A3 (SDG)	R1 (DLA)	R2 (BFL)	R3 (KNF)
Acidity index	2.70 ± 0.00^{c}	1.35 ± 0.00^{b}	4.05 ± 0.23^{d}	3.15 ± 0.00^{c}	1.80 ± 0.00^{a}	5.96 ± 0.00^{a}
Peroxide value	1.19 ± 0.00^{a}	3.19 ± 0.00^{b}	8.79 ± 0.68^{c}	37.90 ± 0.22^{d}	51.30 ± 0.18^{e}	64.20 ± 0.20^{f}
K232	1.19 ± 0.28^{a}	1.95 ± 0.12^{a}	1.96 ± 0.04^{a}	1.67 ± 0.07^{a}	3.38 ± 0.46^{b}	2.18 ± 0.30^{a}
K270	0.32 ± 0.01^{a}	0.38 ± 0.00^{b}	0.45 ± 0.00^{c}	0.94 ± 0.00^{d}	1.61 ± 0.00^{e}	1.06 ± 0.01^{f}

Note: Values are expressed as mean ± standard deviation. Means within the same row followed by different superscript letters (a–f) are significantly different ($p < 0.05$) according to one-way ANOVA followed by Tukey's post hoc test.

Table 2. Quality criteria for edible vegetable oils based on Codex Alimentarius standards.

Analysis	Criteria	Specificity / Reference
Acid value	≤ 4.0 mg KOH/g of oil	Named vegetable oils (Codex Stan 210-1999)
Peroxide value	≤ 15 meq O_2/kg of oil	Named vegetable oils (Codex Stan 210-1999)
Specific extinction at K232	≤ 2.60	Olive oils (Codex Stan 33-1981)
Specific extinction at K270	≤ 0.90	Olive oils (Codex Stan 33-1981)

3.3. Fatty Acid Composition

Chromatographic analysis of oils extracted from samples of R. heudelotii (R1, R2, R3) and A. occidentale (A1, A2, A3) reveals a contrast between the lipid profiles, demonstrating metabolic and taxonomic differences between the two species (Table 3). Cashew nut oils were predominantly rich in oleic acid (C18:1), with an average value of 65%. Following oleic acid, linoleic acid was the second most abundant, with a mean content of 17.63%, followed by palmitic acid (C16:0), approximately 8%. Other fatty acids, notably palmitoleic acid (C16:1) and stearic acid (C18:0), are present in trace amounts (<0.5%). Despite Ricinodendron heudelotii oil sharing limited similarity with cashew nut oil; namely, the presence of linoleic acid as the second most abundant fatty acid (25.43% on average, slightly higher than in cashew oil), the two oils differ significantly. R. heudelotii oil was distinguished by its atypical fatty acid profile, particularly its remarkably high average content of nervonic acid (C24:1), which accounts for approximately 50.6% of the total fatty acids (Table 3). The latter is a very long-chain monounsaturated fatty acid (VLCFA), which is rare in vegetable oils. Oleic acid content is modest (9.8–12.7%), while eicosenoic acid (C20:1) is detected in low proportions. Saturated fatty acids (C16:0 and C18:0) are generally less abundant than in cashew nut oils.

The histogram in Figure 2 provides a detailed comparative overview of the main fatty acids in both oils, facilitating a clearer visualization of the differences between A. occidentale and R. heudelotii.

Table 3. Fatty acid composition (%) and unsaturation indices of oils extracted from cashew seeds of A. occidentale and R. heudelotii.

Samples	C16 :0	C16 :1	C18 :0	C18 :1	C18 :2	C20 :0	C18 :3	C20 :1	C24 :1
A1	8.1±0.05	0.40±0.02^{b}	7.3±0.04^{d}	64.8±0.12^{d}	18.1±0.03^{b}	0.2±0.03^{a}	0.5±0.03^{b}	0.1±0.06^{a}	
A2	8.5±0.01	0.40±0.02^{b}	8±0.1^{e}	65.3±0.02^{e}	16.6±0.01^{a}	0.5±0.11^{b}	0.2±0.06^{a}	0.2±0.07^{ab}	
A3	8.2±0.01	0.40±0.02^{b}	7.2±0.02^{d}	64.7±0.02^{d}	18.2±0.15^{b}	0.5±0.07^{b}	0.5±0.06^{b}	0.3±0.02^{bc}	
R1	4.7±0.01	0.10±0.03^{a}	6.4±0.01^{a}	9.8±0.03^{a}	24.4±0.12^{c}	0.2±0.12^{a}	0.2±0.07^{a}	0.3±0.02^{bc}	53.6±0.04
R2	5.2±0.04	0.10±0.00^{a}	6.6±0.1^{b}	12.7±0.15^{c}	25.3±0.10^{d}	0.1±0.0^{a}	0.2±0.05^{a}	0.4±0.02^{c}	49.2±0.07
R3	4.6±0.04	0.10±0.00^{a}	6.8±0.1^{c}	11.9±0.07^{b}	26.6±0.03^{e}	0.2±0.10^{a}	0.1±0.05^{a}	0.5±0.33^{bc}	49±0.02

Note: Values are expressed as mean ± standard deviation. Means within the same row followed by different superscript letters (a–e) are significantly different ($p < 0.05$) according to one-way ANOVA followed by Tukey's post hoc test. ND: not detected. Values are expressed as percentage of total fatty acids.

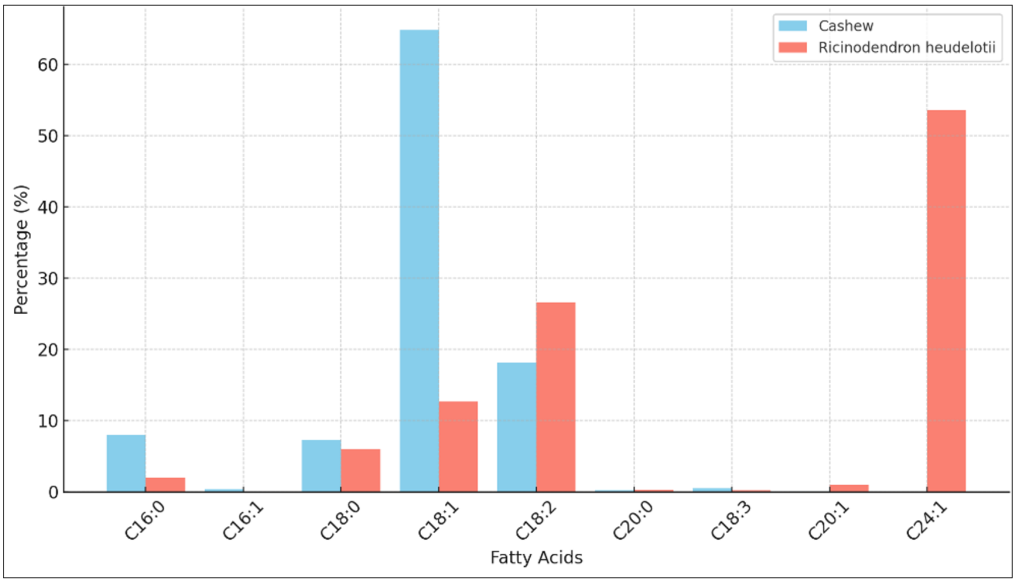

Figure 2. Comparison of main fatty acid profiles between A. occidentale and R. heudelotii oils.

3.4. Sterols and Tocopherols

The results of the analyses reveal that β-sitosterol was the dominant sterol in all samples, representing 81 to 83% of total sterols, with no significant difference between species (R. heudelotii and A. occidentale) (Table 4). Campesterol followed, with a slightly higher content in R. heudelotii oils (≈7.7%) compared to cashew (≈6.7%). Stigmasterol was detected at notable concentrations, respectively 1.80% for cashew oil and 2.87%. A remarkable concentration of Δ5-avenasterol was observed in cashew samples (8.7%), while R. heudelotii oils contain less (3.75%).

With regard to tocopherols, a clear difference was observed between the two species. R. heudelotii oils have high total tocopherol contents (880.97 mg/kg), compared to lower contents for A. occidentale (150.87 mg/kg). Also, we noted a marked variation between localities, particularly for the species R. heudelotii.

Table 4. Sterol composition (%) and total tocopherol content (mg/kg) in oils from cashew of A. occidentale and R. heudelotii seeds.

Minors' Compounds	Cashew nut			*Ricinodendron heudelotii*		
	A1 (KTL)	**A2 (KRG)**	**A3 (SDG)**	**R1 (DLA)**	**R2 (BFL)**	**R3 (KNF)**
Cholesterol (%)		0.3±0.5c	0.3±0.02b	0.2±0.12a	0.2±0.12f	0.2±0.07d
Campesterol (%)	7.8±0.09^{e}	6.4±0.01^{c}	6.1±0.05^{b}	1.5±0.05^{a}	8.1±0.03^{f}	7.5±0.02^{d}
Stigmasterol (%)	3.1±0.02^{d}	0.5±0.05^{a}	0.6±0.04^{a}	2.9±0.07^{c}	2.7±0 .02^{b}	3±0.0.3^{cd}
β sitosterol (%)	82±0.04^{b}	81.4±0.07^{a}	82.7±0.08^{c}	83.2±0.01^{d}	82.9±0.02^{c}	81.3±0.13^{a}
Δ5Avenasterol (%)	4.3±0.07^{d}	10.8±0.06^{f}	9.2±0.07^{e}	3.9±0.04^{c}	3.6±0.00^{b}	
Δ7stigmasterol (%)	1.1±0.06^{d}	0.5±0.06^{b}	0±0.00^{a}	0.9±0.17^{c}	1.1±0.08^{d}	4.7±0.02^{e}
Δ7Avenosterol (%)	1.2±0.03^{c}	0.1±0.07^{a}	0.1±0.05^{a}	1±0.02^{b}	1.1±0.02^{bc}	1.7±0.04^{d}
Totals tocopherols (mg/kg)	173±2.19^{c}	155.5±1.6^{b}	124.1±1.93^{a}	1020.9±2.07^{e}	480.2±1.75^{d}	1141.8±3.24^{f}

Note: Values are expressed as mean ± standard deviation. Means within the same row followed by different superscript letters (a–f) are significantly different ($p < 0.05$) according to one-way ANOVA followed by Tukey's post hoc test. ND: not detected. Values are expressed as percentage of total sterol.

3.5. Color

Table 5 shows the CIE Lab colorimetric parameters (L, a, b) of oils extracted from cashew (Anacardium occidentale) and R. heudelotii seeds. Although the color parameters recorded for the samples of both species revealed significant differences, they generally followed similar trends. All samples showed L values above 50, indicating an overall light appearance. The component was negative, reflecting a tendency toward green rather than red hues, while the b component exceeded 50, indicating a predominant yellow tint. However, Ricinodendron heudelotii oils consistently exhibited higher values across all three parameters, which is further confirmed by the overall color index, averaging 45.23 compared to 34.64 for cashew nut oils.

Table 5. Colorimetric parameters (CIE Lab) of oils extracted from cashew of A. occidentale and R. heudelotii seeds.

Samples	L	a	b	CI
A1 (KTL)	78.43 ± 0.45^{c}	−6.62 ± 0.02^{d}	35.52 ± 0.11^{b}	33.05 ± 0.10^{b}
A2 (KRG)	76.44 ± 0.01^{a}	−5.34 ± 0.07^{f}	33.80 ± 0.49^{a}	29.92 ± 0.36^{a}
A3 (SDG)	84.30 ± 0.06^{d}	−6.99 ± 0.00^{c}	41.59 ± 0.03^{d}	40.95 ± 0.05^{c}
R1 (DLA)	77.73 ± 0.05^{b}	−6.11 ± 0.03^{e}	56.60 ± 0.02^{e}	48.75 ± 0.06^{f}
R2 (BFL)	85.39 ± 0.23^{e}	−8.73 ± 0.03^{a}	41.72 ± 0.15^{d}	43.08 ± 0.22^{d}
R3 (KNF)	91.17 ± 0.03^{f}	−8.36 ± 0.04^{b}	39.78 ± 0.00^{c}	43.89 ± 0.02^{e}

Note: Values are expressed as mean ± standard deviation. Means within the same row followed by different superscript letters (a–f) are significantly different ($p < 0.05$) according to one-way ANOVA followed by Tukey's post hoc test.

3.6. Viscosity

Table 6 presents the viscosity values of the studied oils, showing that cashew nut oil samples exhibited consistent and relatively low values, with an average of 20 mPa·s. In contrast, Ricinodendron heudelotii (Akpi) oils were characterized by higher viscosity values, which varied significantly according to geographic origin, with an average of 46.67 mPa·s.

Table 6. Viscosity (mPa·s) of oils extracted from cashew of A. occidentale and R. heudelotii seeds.

Samples	A1 (KTL)	A2 (KRG)	A3 (SDG)	R1 (DLA)	R2 (BFL)	R3 (KNF)
Mpas	20	20	20	90	30	20

4. DISCUSSION

4.1. Lipid Yield

Oil yield is a key indicator of the economic and technological potential of oilseeds. According to our results, the oil contents obtained for cashew nut and Ricinodendron heudelotii oils classify them as high-yielding oilseeds, since both exceed the 40% threshold commonly used to define high lipid-producing species (Barthet, 2015; Gunstone, 2011). This places cashew (45 %) and R. heudelotii (43.5 %) in a favorable category. In comparison, more widespread crops such as soybeans offer significantly lower yields (17–20%) (Manzi & Houssou, 2020).

Technological factors also influence lipid yield. While the Soxhlet method with hexane is highly efficient, its effectiveness depends on the seed's matrix structure (Tiwari, Brunton, & Brennan, 2013). Cashew nuts (Anacardium occidentale) have a more homogeneous and less fibrous structure. They are mainly composed of lipid-rich parenchymatous tissue, rarely containing more than 3% fiber (FAO, 1989), which promotes better solvent diffusion and more complete lipid release during extraction (Nawade, Srivastava, & Thirumdas, 2021). In contrast, R. heudelotii kernels have a more complex structure, containing significant lignocellulosic fractions (crude fiber: 8.9–9.4%; cellulose: 2.4%) (Kouadio, Konan, Kouamé, & Durand, 2009; Manga, Tadjou, Nya, & Nkouambou, 2000). These anatomical differences may explain the lower lipid yields observed in R. heudelotii, despite the use of an identical extraction protocol (Nde & Foncha, 2020). The values observed are consistent with those in the literature: Yeboah, Mante, Asare, and Agyare (2019) found 43.3%, and Nikiema, Compaoré, Bassolé, and Dicko (2018) reported 47.4% for R. heudelotii, while cashews are known to reach 45% according to Oluwaniyi and Ibiyemi (2007). Finally, these results highlight the potential for local valorization of both species. While cashews are already well integrated into agricultural supply chains, R. heudelotii, although less well known, offers interesting prospects in the agri-food and cosmetics industries, particularly in approaches to diversifying sustainable endogenous resources (Kapseu & Tchiegang, 1995).

4.2. Quality Criteria

The differences in quality between the oils of the two species can be explained by intrinsic biochemical factors related to their lipid profile and the presence of antioxidant compounds. Cashew oil, rich in oleic acid (65%) and tocopherols (section 2.4), has better oxidative stability. The results observed for the peroxide and K270 indices bear witness to this, particularly for the KTL and KRG samples. This stability is reinforced by the presence of sterols, mainly β-sitosterol, which has been shown to reduce lipid peroxidation and enhance oxidative stability through antioxidant mechanisms in lipid systems (Yoshida & Niki, 2003). On the other hand, R.heudelotii oils, characterized by a high content of linoleic acid (25.43%) and especially nervonic acid (50.6%), are more sensitive to oxidation. This profile, rich in very long-chain unsaturated fatty acids (VLCFA), increases reactivity to oxygen in the absence of sufficient natural antioxidants. This hypothesis is consistent with the very high peroxide values observed, despite storage conditions identical to those of cashew nut oil controlled storage at 4 °C, under nitrogen, and in amber bottles. These observations align with those of Diamond et al. (2019), who reported a peroxide value of 37.98 meq O_2/kg, and Olasehinde, Oboh, Akindahunsi, and Ademosun (2016), who recorded a value as high as 45.95 meq O_2/kg. In contrast, other studies (Bamba et al., 2024; Coulibaly et al., 2018) have reported more moderate values, respectively 12.83 and 23.74 meq O_2/kg, suggesting that interregional variability, seed maturity, or extraction parameters (duration, temperature) may significantly influence peroxide levels. Finally, it is important to note that the oxidative stability of an oil depends on its overall composition, particularly the fatty acid profile, as well as the content of natural antioxidants such as tocopherols and sterols (Choe & Min, 2006; Shahidi, & Zhong, Y., 2010).

4.3. Functional Interpretation and Nutritional Value

The contrasting fatty acid profiles of these two oils reflect major biochemical differences between them. Cashew oil, rich in oleic acid and monounsaturated fatty acids, exhibited a lipid profile typical of stable, nutritionally beneficial vegetable oils. Oils rich in oleic acid such as olive oil, high-oleic sunflower oil, and cashew oil are characterized by enhancing oxidative stability and are associated with cardiovascular health benefits, particularly through LDL cholesterol reduction. This is supported by Sales-Campos, Reis de Souza, Crema Peghini, Santana da Silva, and Ribeiro Cardoso (2013), who showed that oleic acid modulates key biological mechanisms involved in blood lipid regulation, including lowering LDL cholesterol production and reducing inflammation-related pathways linked to cardiovascular risk. Moreover, its low polyunsaturated fatty acids content ensures greater resistance to oxidation. On the other hand, R. heudelotii oil was distinguished by its exceptionally high content of nervonic acid (C24:1). Nervonic acid, a very-long-chain monounsaturated fatty acid, constitutes a key component of the myelin sheath and plays a significant role in neuroprotection and remyelination (Phung et al., 2024; Saito, Sekine, Nagatsu, & Hashimoto, 1991). Both in vitro and in vivo studies have demonstrated its ability to enhance oligodendrocyte function, stimulate myelin synthesis, and protect neurons from oxidative stress (Saito et al., 1991; Wang et al., 2023). Our results confirm those of Diamond et al. (2019), who found a similar proportion of C24 (45.24%). The nervonic acid content (50.3%) found in this study reaches levels comparable to those of the most nervonic-rich plant oils, including Malania oleifera and Licania rigida (Silva, Chaves, & Lima, 2018; Wang, Wang, & Wu, 2015), reinforcing its nutraceutical and pharmaceutical relevance, this richness in polyunsaturated and very long-chain fatty acids may contribute to lower oxidative stability. This hypothesis is corroborated by the high peroxide indices measured in the samples, indicating advanced oxidation. The increased susceptibility to oxidation could therefore limit certain industrial applications without an adequate antioxidant process. Ultimately, these fatty acid profiles reveal a complementarity: cashew oil is well suited to common nutritional uses and cooking, while R. heudelotii oil, although less stable, represents a unique source of nervonic acid with high potential for specialized uses, particularly in neurology, cellular cosmetics, or in the formulation of functional supplements.

4.4. Sterols and Tocopherols

The results indicated a notable richness in antioxidant compounds in both oils, although their composition differs. In all samples, β-sitosterol represented the major sterol component, aligning with the sterol composition commonly reported in conventional vegetable oils (Dachtler, Glaser, Kohler, & Albert, 2003). The variations in content observed between samples can be attributed to environmental and agroecological factors.

Cashew oil is distinguished by its high content of Δ5-avenasterol (8.10%), a sterol known for its stabilizing role in oxidative contexts, particularly in oils rich in PUFAs (Normand, Viau, & Sébédio, 1983). This compound could explain, in part, the better oxidative stability observed in these oils despite their low tocopherol content.

Alternatively, R. heudelotii oils, although highly concentrated in tocopherols, have lower oxidative stability, as indicated by their peroxide indices and K232/K270 values. This observation is consistent with the work of Kamal-Eldin and Appelqvist (1996), which shows that excess tocopherols in the absence of other antioxidants can lead to pro-oxidative instability, especially in the presence of highly unsaturated PUFAs. This paradox highlights the importance of a synergistic antioxidant balance. Psomiadou and Tsimidou (2002) demonstrated that the stability of oils depends on an interaction between tocopherols, sterols, and polyphenols, rather than on a single isolated factor. Our results support this hypothesis: cashew nut oils, although less rich in tocopherols, benefit from a better stabilizing sterol profile, which could explain their superior oxidative performance.

4.5. Color

The differences observed between the samples can be attributed to the pigment composition of the oils, particularly the carotenoid and chlorophyll content, which strongly influence color and oxidative stability (Kiralan, Özcan, & Arslan, 2009). The more intense and luminous color of R. heudelotii oils could therefore constitute a sensory advantage, particularly in food or cosmetic applications where color is an important quality criterion. Compared to previous studies, the Ricinodendron heudelotii oils analyzed here were significantly lighter (L was 84.76 vs. 24.61 in Coulibaly et al. (2018) and 70.73 in Adomè, Honfo, Chadare, and Hounhouigan (2023)). Unlike Adomè et al. (2023), who reported reddish tones ($a > 0$), our samples showed greenish hues ($a < 0$). The yellow component (b) was also much higher in our samples, suggesting differences in raw materials, pigments, or processing methods.

4.6. Viscosity

Viscosity is a crucial physicochemical parameter reflecting the flow behavior and technological properties of vegetable oils. It is influenced by factors such as fatty acid composition, minor compounds (e.g., phospholipids, pigments), and storage conditions (Calliauw, 2018). The results indicate that cashew oils (A1 and A3) exhibit relatively low and similar viscosities (20 mPa·s), typical of oils rich in unsaturated fatty acids. These values suggest good fluidity, which is advantageous for food processing and edible oil applications. In contrast, the significantly higher viscosity of the R2 (BFL) sample (90 mPa·s) from R. heudelotii may also offer advantages for industrial uses requiring thicker oils (e.g., cosmetics, lubricants). This variability in viscosity among samples is consistent with previous studies on Ricinodendron heudelotii oil, which report values around 60 mPa·s, specifically 60.32 mPa·s according to Yirankiyuki, Tchatchueng, Kapseu, and Njintang (2018) and 65.4 mPa·s according to Ketaona, Clerge, and Noumi (2013). The intermediate values for R1 and R3 (20 and 30 mPa·s) reflect heterogeneity among R. heudelotii samples, possibly due to ecological factors or differences in post-harvest handling.

5. CONCLUSION

This study highlighted the nutritional, physicochemical, and functional potential of oils extracted from Ricinodendron heudelotii and Anacardium occidentale. Both oils exhibited significant yields, confirming their relevance as alternative vegetable oil sources in the Ivory Coast. Cashew oil, characterized by its high oleic acid and sterol content, demonstrated superior oxidative stability and is well-suited for culinary and nutritional applications. In contrast, R. heudelotii oil presented a unique fatty acid profile, notably its exceptionally high concentration of nervonic acid, which positions it as a promising candidate for use in the pharmaceutical, neurological, and cosmetic industries. Despite its high tocopherol content, the oxidative sensitivity of R. heudelotii oil underscores the need for stabilization strategies, whether through blending with more stable oils or enrichment with natural antioxidants. The variability observed across samples also underscores the influence of ecological and post-harvest factors on oil quality. Beyond their biochemical value, these two indigenous species represent an opportunity for the local valorization of underexploited natural resources. Their integration into agro-industrial chains could support sustainable development, rural entrepreneurship, and innovation in functional food and cosmetic formulations. Further research on refining processes, storage conditions, and health impacts would help enhance the industrial applicability and consumer acceptability of these oils.

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