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Effect of Baobab (*Adansonia digitata* L.) Seeds Washing and Origin on Their Fatty Acids and Phenolic Compounds Oils Content

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Abstract

The aim of the present study was to evaluate the effects of baobab seed washing and origin on the chemical composition of the oil extracted by pressing. Six (6) oil samples were obtained from seeds of three (3) geographical origins. The identification and quantification of fatty acids and the polyphenolic profile were carried out by GC-MS and HPLC-UV, respectively. Analysis of fatty acid methyl esters allowed the identification and quantification of 18 fatty acids. Oils from unwashed seeds were richer in palmitic (C16:0), stearic (C18:0), oleic (C18:1) and arachidic (C20:0) acids. In addition, HPLC-UV analysis at 279 nm shows that oils from unwashed seeds are richer in tyrosol, hydroxytyrosol and caffeic acid. With regard to the polyphenolic profile, gallic acid and quercetin were not detected in these baobab oils. Principal component analysis of fatty acid and phenolic compound content showed that oils from unwashed seeds would best preserve their chemical and associated potential bioactive characteristics.

Keywords

Adansonia digitata L., Seeds, Extraction, Pressure, Oil, Fatty Acids, Tyrosol, Hydroxytyrosol

1. Introduction

The African baobab (*Adansonia digitata* L.) is an emblematic tree of the African savannah [1]. It plays an important social, economic and environmental role in Africa. *Baobab* belongs to the Bombacaceae family, of the Malvales order [2] [3]. The fruit weighs between 150 and 350g in Senegal, and can reach over 496g in Niger [4] [5]. The total mass of the seeds represents from 43% to 60% of the total mass of the fruit [4]-[6]. The seeds of the baobab (*Adansonia digitata* L.) are not edible as such, even though they contain proteins, lipids, carbohydrates, amino acids, carotenoids, sterols and tocopherols [7]-[11]. They are mainly rich in potassium, calcium and magnesium [12] as well as vitamins B1, B2 and B3 [9]. The oil extracted from the seed is increasingly used and contains vitamins A, D, E and K [13]. This oil is an excellent source of unsaturated fatty acids. It mainly contains palmitic, oleic and linoleic acids [4] [10] [14]. Baobab oil is also known for its high permeability, nourishing properties, emollient properties and ability to soften the skin and scalp [15] [16]. It is used in the treatment of wounds, pain, skin conditions, hair, nails, acne, eczema and psoriasis [16]. Several studies have been devoted to the physicochemical characteristics of oils extracted with organic solvents in Soxhlet [17]-[20]. In processing plants, baobab oil is mainly obtained by pressing [21]. This process requires pre-treatment of the seeds, such as soaking, mixing, washing, drying and grinding. As these operations can have an impact on the oil quality, it is essential to introduce a new process to maintain the quality of the extracted oil. Furthermore, studies on the fatty acid and phenolic compound composition of cold pressed baobab oils are scarce. In this context, the aim of the present study is to evaluate the effects of baobab seed washing and its origin on the chemical composition of the oil extracted by pressing.

2. Material and Methods

2.1. Plant Material and Pre-Treatments

The plant material consisted of baobab (*Adansonia digitata* L.) seeds from fruits collected at three locations: seeds from Kougheul (13˚58'60" N and 14˚48'0" W), Ziguinchor (12˚33'50" N and 16˚15'50" W) and Bignona (12˚48'18" N and 16˚14'4" W), Senegal. Three (3) batches of 50 kg of seeds from each source were used for oil extraction. Each batch was divided into two equal parts: 25 kg unwashed seeds and 25 kg washed seeds (**Figure 1**). Approximately 150 litres of water at room temperature (25˚C) were used to wash the 75 kg of seeds, which were soaked and mixed for a total of two (2) hours. After washing, the seeds were dried in an oven at 65˚C ± 1˚C for 24 hours. Six (6) samples of 25 kg of seed were then taken. The seeds from the different lots were ground separately in a mill and passed through a 1 mm mesh sieve.

2.2. Oil Extraction by Pressing

The baobab oil was extracted using a mechanical press (DD85G, IBG Monforts Oekotec GmbH, Mönchengladbach, Germany). The 10 mm spinner was used

throughout the extraction, and the rotation speed of 25 rpm was maintained. The outlet head temperature was also maintained at 105˚C throughout the procedure. The outlet head was previously heated to this temperature for approximately 25 minutes at the start of the extraction process. At the end of the extraction, the product obtained was a mixture of oil with rubbery impurities. The crude oil was immediately bottled in amber bottles for two days. After decanting, the oil was transferred to new bottles and centrifuged using a centrifuge (Hettich, Zentrifugen, Germany) at 4500 rpm for ten (10) minutes. The baobab oil obtained was stored at 4˚C before analysis.

(a) (b)

Figure 1. Unwashed seeds (a) and washed seeds (b).

2.3. Physicochemical Analysis

2.3.1. Chemicals and Reagents

In this section, all the reagents used were of analytical quality. These reagents were methanol, water and acetonitrile of HPLC quality, ammonium formate, formic acid, cyclohexane, hexane and potassium hydroxide. These reagents were also purchased from Sigma (St. Louis, MO, USA).

2.3.2. Fatty Acids Composition

1) ***Methyl esters preparation***

To convert the oils to fatty acid methyl esters, 2 mL of hexane was added to a 20 µL volume of baobab oil. To this solution 100 µL of a 3 M methanolic solution of potassium hydroxide (KOH) was added and stirred at 40 rpm for five (5) minutes. After this stirring period the mixture was allowed to stand until a clear hexane phase was obtained. Gas chromatography was used to identify and quantify the fatty acids.

2) ***Analysis by gas chromatography-mass spectroscopy (GC-MS)***

Fatty acids were analysed using a gas chromatograph (Trace GC electron) coupled to a mass spectrometer (ISQ, Thermo Finnigan, Thermo Scientific, USA). The stationary phase is a capillary silica column SGE-BPX5 (30 m × 0.25 mm i.d., 0.25 µm thick). The mobile phase (carrier gas), consisting of helium (He), was injected at a flow rate of 1 $mL \cdot min^{-1}$ in split 1/20 mode. For GC-MS detection, the ionisation energy was 70 eV in electron impact (EI) mode. The transfer and ion source temperatures were 200˚C and 300˚C, respectively. The oven temperature was set at 120˚C for 20 minutes and then increased to 275˚C at a rate of 5˚C per

minute. After dilution of the prepared methyl esters (1/20, v/v, in $CHCl_3$), a volume of 1 µL was injected into the GC-MS chromatograph in split mode. The m/z mass spectra were determined with ratios between 45 and 600. The total retention time was 60 min. Peak integration and chromatographic data processing were performed using Thermo Xcalibur software. Computer superposition of the mass spectra obtained with those of the standards and the NIST MS Search 2.0 spectral library allowed the identification of the compounds in baobab oil.

2.3.3. Polyphenol Composition

1) *LC-UV analysis*

LC-UV analyses were performed on a Shimadzu LC 20AD instrument consisting of a quaternary pump, a solvent degasser, a thermostated column with a ZORBAX® SB-Phenyl column (250 mm × 4.6 mm, 5 µm) and an autosampler connected to an SPD-M20A DAD detector. LabSolutions LCMS software (Shimadzu) was used to evaluate the chromatograms. The chromatographic and UV conditions were optimised to obtain the appropriate sensitivity for the analysis of polyphenols as tyrosol (λmax = 279 nm) or caffeic acid (λmax = 325 nm). The mobile phase, consisting of a mixture of acetonitrile (solvent A) and 3 mM formate buffer, pH 3 (solvent B), was injected at a flow rate of 1 mL·min^{-1}. Chromatographic analysis was performed at 30˚C and the volume injected into the chromatographic system was 20 µL. Table 1 shows the variation in the proportions of solvents A and B.

Table 1. Elution gradient (%) for HPLC-UV analysis.

Time (min)	Solvent A (%)	Solvent B (%)
0	0	100
4	0	100
12	60	40
15	60	40
16	100	0
18	100	0
19	0	100
20	0	100

2) *Sample preparation*

The phenolic fraction of baobab oils was obtained by liquid-liquid extraction. A mass of 2.0 g of baobab oil was weighed to the nearest 0.0001 g in a test tube. A volume of 1 mL of cyclohexane was added to the tube and vortexed for 10 seconds. Three (3) mL of methanol was then added and the mixture was mechanically stirred (Stuart SB3 rotator) for 5 minutes. The tube containing the mixture was immediately uncapped and centrifuged (P. Slecta centro 8-BL) at 1000 rpm for

ten (10) minutes. The methanolic phase was then collected with a glass pasteur pipette and dried under a gentle nitrogen stream at 50˚C and 50 kPa pressure. The final dry residue was taken up with 0.5 mL of mobile phase (acetonitrile/formate buffer). With gentle vortexing, the new mixture was withdrawn with a syringe and then filtered. This filtration was performed on Acrodisc (Pall GHP, Membrane Acrodisc 13 mm, Syringe Filter) 0.45 µm. To analyse the phenolic fraction, a volume of 200 µL was added to a vial with an insert.

2.4. Statistical Analysis

Principal component analysis (PCA) and hierarchical classification were performed on the data for acids and phenolic compounds in oils to find the best correlations between the random variables. Analyses of variance using Fisher's LSD test at 5% significance level were also performed to compare means. All analyses were performed using R software (version 4.3.2, 2023).

3. Results and Discussion

3.1. Chemical Composition of Baobab Oils

3.1.1. Fatty Acid Composition

Analysis of fatty acid methyl esters by GC-MS allowed the identification and quantification of eighteen (18) fatty acids in the different baobab oils. The results obtained are presented in **Table 2**. They show a variation in the fatty acid composition of baobab oils depending on the origin and/or the type of pre-treatment applied to the seeds. The results show that the main saturated fatty acids in these oils are palmitic acid (14.01% to 24.63%), stearic acid (2.32% to 3.75%) and arachidic acid (2.03% to 4.45%). The most abundant monounsaturated fatty acid in these baobab oils is oleic acid (29.98% to 40.66%), followed by cis-10-nonadecenoic acid (3.18% to 8.08%). Palmitoleic acid (0.21% to 1.17%) and margaric acid (0.21% to 0.62%) are the two least abundant monounsaturated fatty acids. The main polyunsaturated fatty acid was linoleic acid (21.59% to 26.57%). The two (2) cyclopropenoic fatty acids found in the oils are malvalic acid and sterculic acid in proportions ranging from 0.72% to 1.57% and from 0.56% to 2.65% respectively. Dihydrosterculic acid, a cyclopropanic acid, was found in proportions ranging from 0.20% to 1.01%. Comparison of our results with those reported in the literature highlights the variation in composition depending on the country in which the baobab fruit was collected. Palmitic and stearic acids are also the main saturated fatty acids in these oils. Baobab seed oil collected in Pakistan had the highest stearic acid content [7]. Its high content suggests that it should be used for dietary purposes as it is converted to oleic acid by the liver [22]. The main unsaturated fatty acids in these oils are oleic and linoleic acids. The presence of palargonic acid (0.05% ± 0.07%), myristic acid (between 0.1% and 1.01%), anisostearic acid (between 0.11% and 0.15%), linolenic acid (between 2.06% and 8.84%), linolelaidic acid (between 0.18% and 0.03%), vaccenic acid (between 0.81% and 1.36%) and elaidic acid (2.8% ± 0.00%) were found in baobab oils [7] [14] [23]-[25] (**Table 3**).

Table 2. Quantification of fatty acids (%) identified by GC-MS in baobab (*Adansonia digitata* L.) oils at the beginning of storage.

R.T.	Chemical name	M.F.	Match	WZS	UZS	WBS	UBS	WKS	UKS
34.22	**Palmitoleic acid**	C16:1n-7	908	0.78	0.21	0.49	0.21	1.17	0.39
34.47	**Palmitic acid**	C16:0	949	20.13	21.59	23.78	24.63	22.34	14.01
36.32	***cis*-10-Heptadecenoic acid**	C17:1n-7	852	2.21	1.11	1.40	1.10	2.17	1.39
36.82	**Margaric acid**	C17:0	849	0.62	0.21	0.36	0.24	0.39	0.35
37.48	**Malvalic acid**	C18:CE	907	1.57	1.47	1.37	1.47	1.05	0.72
38.01	**Linoleic acid**	C18:2n-6	938	21.59	26.57	22.91	24.01	23.32	24.02
38.13	**Oleic acid**	C18:1n-9	940	29.98	36.55	34.92	35.39	36.34	40.66
38.65	**Stearic acid**	C18:0	925	2.32	3.75	3.22	3.47	2.40	2.85
39.39	**Sterculic acid**	C19:CE	853	2.65	0.56	1.50	0.64	1.89	1.24
39.94	**Dihydrosterculic acid**	C19:CA	883	1.01	0.55	0.20	0.56	1.01	0.90
40.18	***cis*-10-Nonadécénoic acid**	C19:1n-9	916	8.08	3.18	4.71	4.15	3.28	6.38
41.84	**Gondoic acid**	C20:1n-9	909	1.33	0.48	0.64	0.50	0.39	1.05
42.30	**Arachidic acid**	C20:0	935	4.45	2.34	2.77	2.34	2.03	3.56
45.48	**Behenic acid**	C22:0	916	1.90	0.88	0.91	0.82	0.62	1.37
47.08	**Tricosylic acid**	C23:0	804	0.20	0.10	0.12	0.00	0.25	0.16
48.47	**Lignoceric acid**	C24:0	874	0.95	0.44	0.53	0.45	1.06	0.76
49.94	**Hyenic acid**	C25:0	692	0.09	0.00	0.08	0.00	0.14	0.07
51.30	**Cerotic acid**	C26:0	679	0.12	0.00	0.06	0.00	0.12	0.11

R.T.: Retention Time; M.F.: Molecular Formula; WZS: Washed Ziguinchor Seeds; UZS: Unwashed Ziguinchor Seeds; WBS: Washed Bignona Seeds; UBS: Unwashed Bignona Seeds; WKS: Washed Koungheul Seeds; UKS: Unwashed Koungheul Seeds.

Table 3. Fatty acid composition (%) of baobab (*Adansonia digitata* L.) oils from different localities.

Chemical name	M.F.	Baobab (*Adansonia digitata* L.)					
Palargonic acid	C9:0	–	–	–	–	–	0.05 ± 0.07
Myristic acid	C14:0	0.13 - 0.20	0.168 ± 0.01	–	1.01 ± 0.07	–	0.1 ± 0.14
Palmitoleic acid	C16:1n-7	0.13 - 0.32	–	–	0.27 ± 0.06	–	0.25 ± 0.07
Palmitic acid	C16:0	23.16 - 26.52	21.76 ± 1.45	14.95 – 21.82	29.57 ± 1.03	20.96 ± 1.2	28.5 ± 0.42
***cis*-10-Heptadecenoic acid**	C17:1n-7	0.14 - 0.38	0.29 ± 0.02	–	–	–	0.58 ± 0.02
Margaric acid	C17:0	0.13 - 0.28	–	–	–	–	0.17 ± 0.04
Malvalic acid	C18:CE	1.77 - 3.87	–	–	–	–	–
Anteiso-stearic acid	ai-18	0.11 - 0.15	–	–	–	–	–
Linolenic acid	C18:3n-6	–	2.06 ± 0.13	–	–	–	–
Linolenic acid	C18:3n-3	–	2.60 ± 0.22	0.75 – 1.33	–	8.84 ± 2.2	0.5 ± 0.00
Linolelaidic acid	C18:2n-6*t*	–	–	–	–	–	0.18 ± 0.03
Linoleic acid	C18:2n-6	22.19 - 26.25	25.50 ± 1.68	19.62 – 28.08	27.31 ± 0.16	27.47 ± 1.4	35.75 ± 0.35
Vaccenic acid	C18:1n-7	0.81 - 1.36	–	–	–	–	–
Elaidic acid	C18:1n-9*t*	–	–	–	–	–	2.8 ± 0.00
Oleic acid	C18:1n-9	32.52 - 38.90	36.40 ± 2.41	32.09 – 39.06	31.41 ± 0.53	22.14 ± 0.7	25.66 ± 0.95
Stearic acid	C18:0	3.09 - 5.42	8.85 ± 0.53	1.19 – 1.59	36.28 ± 0.81	20.29 ± 0.2	5.85 ± 2.05
Sterculic acid	C19:CE	0.42 - 1.68	–	–	–	–	–

Continued

Dihydrosterculic acid	C19:CA	1.74 - 3.86	–	–	–	–	–
Gondoic acid	C20:1n-9	0.15 - 0.29	0.30 ± 0.02	–	0.20 ± 0.02	–	–
Arachidic acid	C20:0	0.56 - 1.18	0.17 ± 0.00	–	0.14 ± 0.04	0.29 ± 0.9	0.7 ± 0.28
Behenic acid	C22:0	–	0.33 ± 0.02	–	–	–	–
Lignoceric acid	C24:0	–	0.21 ± 0.01	–	–	–	–
Not identified	–	–	–	–	6.67 ± 0.37	–	–
References	–	[26]	[24]	[25]	[7]	[23]	[14]

Of the different baobab oils obtained by cold pressing, those from the Bignona seeds are the richest in saturated fatty acids (SFA). The percentage SFA in WBS and UBS oils is 31.96% and 31.83% respectively (**Figure 2**). The lowest values were found in Koungheul oils with 29.37% and 23.24% respectively. This difference in SFA between the Koungheul oils and those from Bignona and Ziguinchor could logically be linked to the soil and climatic conditions, phenological variability, duration and/or storage conditions of the baobab seeds, as stated by Ranalli *et al.* [27] and Diop *et al.* [4]. Nevertheless, the Koungheul oils showed the highest percentages of monounsaturated fatty acids (MUFA) and cyclic fatty acids (CFA). The percentages of MUFA and CFA were 43.35% and 49.87% for Koungheul oil and 3.95% and 2.86% respectively. The polyunsaturated fatty acids (PUFAs) found in baobab oil are linoleic acid and cis-10-nonadecenoic acid. These two (2) acids were higher in the Ziguinchor oils. Ziguinchor oil from unwashed seeds contained more linoleic acid (26.57%) while Ziguinchor oil from washed seeds contained more cis-10-nonadecenoic acid (8.08%). Razafimamonjison *et al.* [26] indicate that baobab oil contains malvalic acid (1.77% to 3.87%), sterculic acid (0.42 to 1.68%) and dihydrosterculic acid (1.74% to 3.86%). However, the malvalic acid content obtained is lower than the 5.52% reported by Abeer *et al.* [28]. These cyclic fatty acids make this crude oil unsuitable for human consumption. Andrianaivo-Rafehivola *et al.* [29] suggest refining the oil before consumption in order to significantly reduce the cyclic fatty acids.

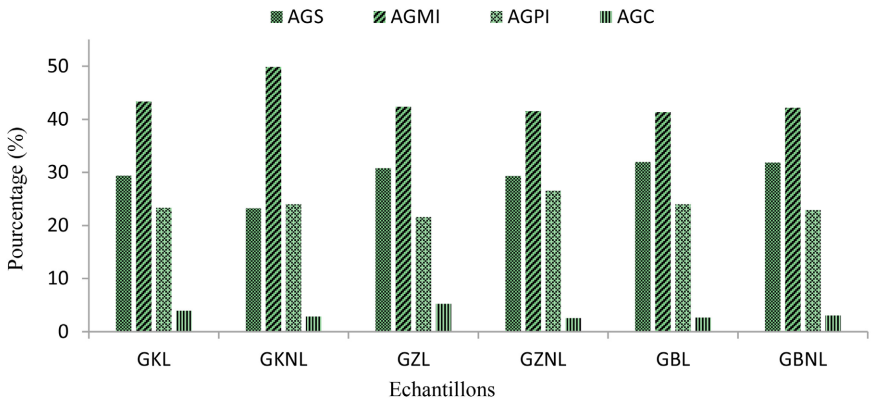

Figure 2. Percentages (%) of saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA) and cyclic fatty acids (CFA).

3.1.2. Polyphenol Composition

Figure 3(a) and Figure 3(b) show examples of chromatograms of the phenolic fractions of some baobab oils obtained by HPLC-UV analysis.

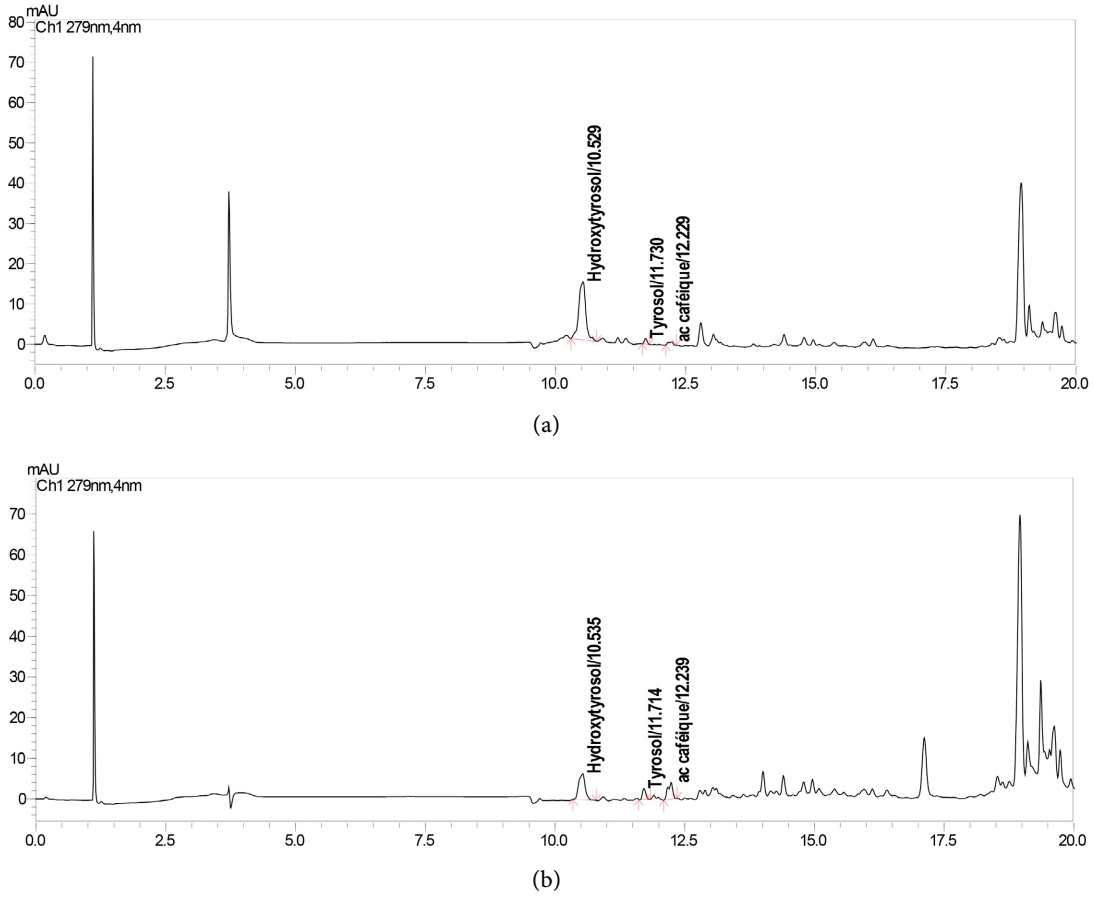

Figure 3. HPLC-UV chromatograms at 279 nm of the phenolic fractions of baobab oils obtained from unwashed Kaolack seeds (UAS) (a) and washed Kaolack seeds (WAS) (b).

HPLC-UV chromatograms at 279 nm show variations in the phenolic compound content of different baobab (*Adansonia digitata* L.) oils extracted by cold pressing. Controls and literature data were used to identify and quantify the peaks. However, the other peaks detected at the end of the chromatogram between 12.5 and 20 min could not be identified due to the absence of specific controls. Phenolic compounds ($mg \cdot L^{-1}$) were analysed by HPLC-UV. The levels of tyrosol, hydroxytyrosol, quercetin, caffeic acid and gallic acid are shown in Table 4. Analysis of the phenolic fractions of the different oils extracted by pressing did not reveal the presence of gallic acid or quercetin. Salih and Yahia [30] found quercetin in the seeds (27.82 ± 0.74 mg·100 g DM, Dry Matter). However, simple phenolic compounds such as tyrosol and hydroxytyrosol are present in these oils. These two molecules are known in the pharmaceutical field for their antioxidant, anticarcinogenic, neuroprotective, antibacterial and anti-inflammatory properties [31]-[35]. The results show significant variations in tyrosol, hydroxytyrosol and caffeic acid content for the six (6) baobab oil samples. The determined tyrosol

contents ranged from 0.397 ± 0.243 to 2.416 ± 2.408 mg·L^{-1}.

Table 4. Levels of phenolic compounds (mg·L^{-1}) in different baobab oils at the start of storage.

Oils	Tyrosol	Hydroxytyrosol	Caffeic acid	Gallic acid	Quercetin
	mg·L^{-1}				
WZS	0.992 ± 0.879^{a}	N.D.	<LOQ	N.D.	N.D.
UZS	2.416 ± 2.408^{a}	0.730 ± 0.229^{a}	<LOQ	N.D.	N.D.
WBS	<LOQ	0.660 ± 0.640^{a}	<LOQ	N.D.	N.D.
UBS	0.397 ± 0.243^{a}	0.585 ± 0.281^{a}	<LOQ	N.D.	N.D.
WKS	0.584 ± 0.306^{a}	5.257 ± 0.511^{b}	0.251 ± 0.031^{a}	N.D.	N.D.
UKS	0.725 ± 0.388^{a}	3.595 ± 1.874^{b}	0.639 ± 0.228^{b}	N.D.	N.D.

In the same column, means with the same letter are not significantly different at the 5% threshold. WZS: Washed Ziguinchor Seeds; UZS: Unwashed Ziguinchor Seeds; WBS: Washed Bignona Seeds; UBS: Unwashed Bignona Seeds; WKS: Washed Koungheul Seeds; UKS: Unwashed Koungheul Seeds; LOQ: Limit of quantification; N.D.: Not Detected.

Oils from seeds collected in Ziguinchor had the highest tyrosol content. These were 0.992 ± 0.879 mg·L^{-1} for WZS oil and 2.416 ± 2.408 mg·L^{-1} for UZS oil. The highest levels were also obtained in oils extracted from unwashed seeds. This difference between the two categories of oil is probably due to the contribution of tyrosol molecules from the pulp. In fact, the unwashed seeds still contained a small quantity of pulp despite the pulping operation. Studies by Vertuani *et al.* [36] detected the presence of tyrosol, hydroxytyrosol, caffeic acid and gallic acid in baobab pulp.

The hydroxytyrosol content was also higher in oils extracted from unwashed seeds. These hydroxytyrosol contents were 0.730, 0.585 and 3.595 mg·L^{-1} respectively for oils from UZS, UBS and UKS. For WBS and WKS oils, these contents were 0.660 and 5.257 mg·L^{-1}, respectively. The hydroxytyrosol content of oil extracted from UKS is close to that of olive oil (1.4 - 5.6 mg·L^{-1}) reported by Montedoro *et al.* [37]. However, hydroxytyrosol was not detected in WZS oils. Like tyrosol and hydroxytyrosol content, caffeic acid content varies according to the origin of the seeds and the type of pre-treatment applied. In the case of seeds collected in Koungheul, the caffeic acid content of the extracted oils was 0.251 and 0.690 mg·L^{-1} for washed and unwashed seeds respectively. In addition, the caffeic acid content of oils extracted from seeds collected in Bignona and Ziguinchor was very close to the limit of quantification (LOQ). Gallic acid was not detected in any of the oils. These results are consistent with those of Salih and Yahia [30] who did not detect the presence of gallic acid in baobab seeds. It should be noted that Vertuani *et al.* [36] found very low levels of gallic acid in the pulp. Therefore, the absence of gallic acid and quercetin could be explained by their absence or very low content in baobab seed shells. In short, the seeds from Koungheul provided the richest oils in tyrosol, hydroxytyrosol and caffeic acid. This richness in phenolic compounds could be explained by the greater quantity of pulp in these seeds. As a result, this UKS oil is thought to have more therapeutic properties than the other baobab oils extracted.

3.2. Statistical Analysis

Principal component analysis (PCA) was used to assess the impact of baobab seed pre-treatment and fruit origin on the fatty acid and polyphenol content of cold-pressed oils. The first dimension (Dim 1) contributed 51.23% and the second (Dim 2) 22.21%. In addition, these first two dimensions (Dim 1 and Dim 2) had the highest eigenvalues (10.76 and 4.66). On the other hand, the third dimension (Dim 3), the fourth dimension (Dim 4) and the fifth dimension (Dim 5) had contributions of 17.01%, 6.97% and 2.58% respectively, and eigenvalues of 3.57%, 1.46% and 0.54%. Consequently, the first two dimensions (Dim 1 and Dim 2) selected express 73.44% of the total variance. The variables cerotic acid (0.959), sterculic acid (0.940), margaric acid (0.922), lignoceric acid (0.919), heptadecenoic acid (0.909), tricosylic acid (0.833) and hyenic acid (0.828) are positively well correlated with the first dimension, while stearic acid (−0.976) is negatively correlated with it. The variables hydroxytyrosol (0.931) and oleic acid (0.817) are positively correlated with the second dimension (Dim 2), while malvalic acid (−0.845) is negatively correlated with it. Baobab oils extracted by cold pressing were classified into three classes (Figure 4 and Figure 5). Class 1, represented by Washed Bignona Seeds, Unwashed Bignona Seeds and Unwashed Ziguinchor Seed (WBS, UBS, UZS) oils, is characterised by a high content of stearic acid (V.test = 2.023; p = 0.043) and low levels of dihydrosterculic acid (V.test = -2.030; p = 0.0423), cerotic acid (V.test = −2.062; p = 0.0392) and lignoceric acid (V.test = −2.069; p = 0.0385). Class 2 is represented by Washed Ziguinchor Seed oils (WZS). Class 3, represented by Washed Koungheul Seeds and Unwashed Koungheul Seeds (WKS, UKS) oils, has a high content of hydroxytyrosol (V.test = 2.148; p = 0.0317) and a

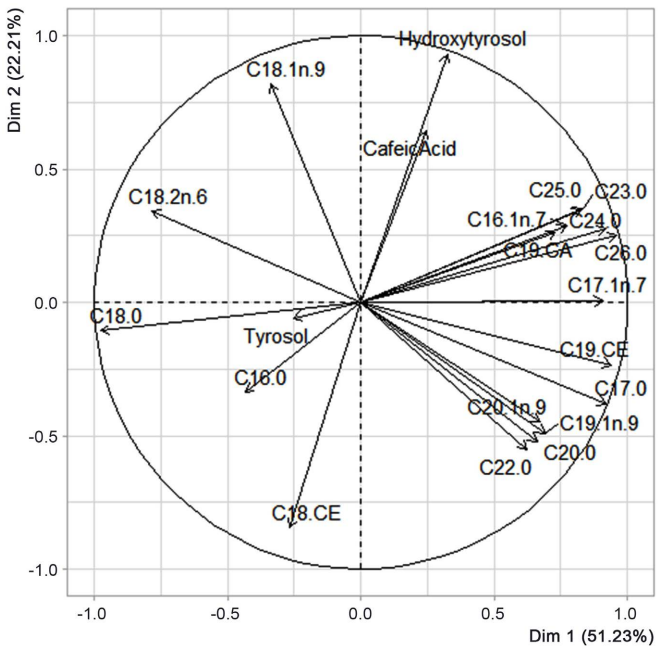

Figure 4. Projection of different baobab oils according to fatty acids in the factorial plane of the PCA.

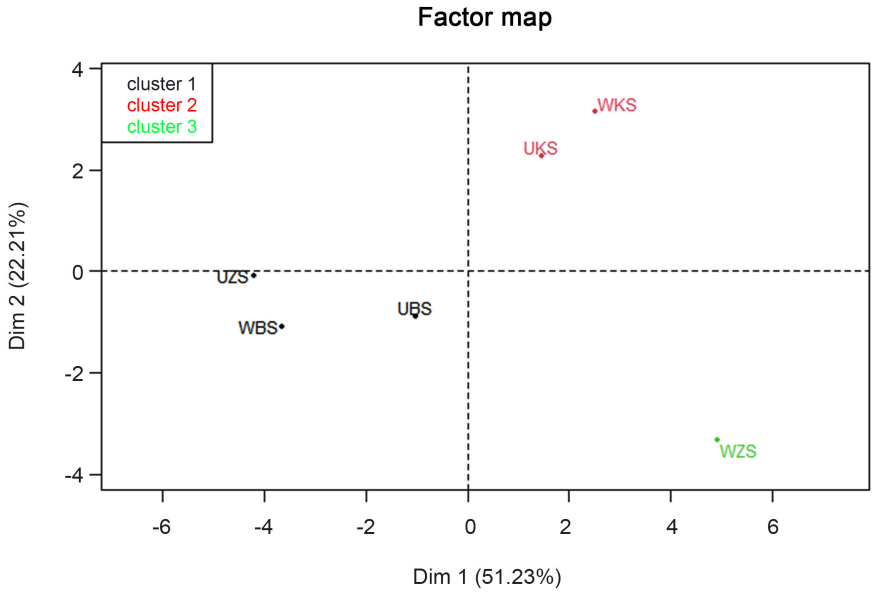

Figure 5. Correlation between baobab oil fatty acids and the first two PCA dimensions.

low content of malvalic acid (V.test = −2.073; p = 0.0381). These results suggest that baobab oil extracted from Koungheul seeds would bear more biological effects as it contains less cyclic fatty acids. The presence of significant content in hydroxytyrosol molecules may offer prospects in the treatment of diseases associated with full or low-grade inflammation status.

4. Conclusion

In this study, the effect of washing and the origin of the baobab seeds on the fatty acid and phenolic compound composition of the extracted oils were evaluated. Our results indicate that the pressed oils from Bignona and Koungheul seeds are respectively, the richest in saturated fatty acids and monounsaturated and cyclic fatty acids. The main saturated fatty acids in these oils are palmitic, stearic and arachidic acids. Washing the seeds also reduces their composition in linoleic acid, tyrosol, hydroxytyrosol and caffeic acid potentially impacting their bioactive interest in nutrition-health applications. Therefore, the study of the stability of these oils during storage would be interesting. Also, the identification of phenolic compounds would make it possible to evaluate the therapeutic virtues of baobab oil.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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