

Studies in the Evaluation of Unconventional Oils from Burkina Faso Rich in Linoleic Acid, Oleic Acid or Other Unusual Fatty Acids

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Abstract

A study on unconventional seed oils from Burkina Faso was carried out to determine their potential usefulness. The highest oil content was obtained with *Marantes polyandra* (55.0%) and the lowest with *Detarium microcarpum* seed oil (12.0%). Linoleic and oleic acids were the most dominant fatty acids of *Balanites aegyptiaca*, *Combretum aculeatum*, *Detarium microcarpum* and *Lophira lanceolata*. Eleostearic acid and cyclopropenic acids were the major fatty acids in the oils of *Parinari curatelliflora* and *Sterculia setigera*, respectively. *Combretum aculeatum* had the highest tocopherol content (800 ppm). All the results suggest that seed oils may have potential applications in food and cosmetic products.

Keywords: Seed oils; Fatty acids; Tocopherol and stability

Introduction

Fats and oils are the most essential nutrients of both human and animal diets. They provide the most concentrated energy of any foodstuff, supply essential fatty acids (which are precursors for the important hormones prostanoids), serve as carrier for fat soluble vitamins, make food more palatable and contribute towards the feeling and satiety after eating. In human nutrition plant lipids and seed oils are preferable to animal fats due to their low content of cholesterol and their generally high proportions of Polyunsaturated Fatty Acids (PUFA), of which the predominant ones are linoleic acid (C 18:2 n-6) and linolenic acid (C 18:3 n-3). Both of these fatty acids are of vital importance to human metabolism as we cannot form additional double bonds between carbon numbers 12 and 13 and between carbon numbers 15 and 16 of an oleic acid molecule.

Out of the total world production of major oils and fats about 90% is directed towards food uses and 75-80% of the vegetable oil produced belongs to the oleic-linolenic fatty acid group. Several other studies reported various properties of oils and fats [1-4]. So much attention has recently been focused on the seed oil from different vegetable species. Thereby scientists of various specialties invest to highlight their new product and its industrial application as cooking oil or for pharmaceutical and cosmetic purposes.

In West Africa, particularly in Burkina Faso, Oil products from native trees are essential for human dietary requirements as well as for use in medicine and cosmetics, but their potentials are far from fully exploited because of lack of information concerning chemical composition of seed oils and their potential uses. This paper presents the data of n-6 or other unusual fatty acids in the unconventional oils of Burkina Faso.

Materials and Methods

Materials

The ripe fruits and seeds were collected in different locations in Burkina Faso. Some of the samples were extracted in Burkina Faso and transported to IFSC A/S as oil samples. Others were transported as seed samples.

Methods

Oil content: The oils were extracted using a Soxhlet apparatus.

Four to five g of the samples were extracted with boiling petroleum ether p.a. overnight. The solvent was evaporated and residues were dried in a vacuum oven to constant weight [5].

Fatty acid composition analysis: The oils were transesterified with Methanol/Boron trifluoride and the methyl esters were extracted with Hexane (IUPAC 2.301 and 2.302) [6]. Gas Liquid Chromatography (GLC) was performed using a Perkin Elmer Autosystem XL equipped with a Programmable Temperature Injector (PTV) and a Flame Ionization Detector (FID). The column was a capillary CP Sil 88 (Chrompack, Varian Instruments, Walnut Creek, CA. 50.0 m x 0.25 mm with a film thickness at 0.2 μ . Helium was used as the carrier gas. The PTV injector was maintained at 50°C and after injection raised to 270°C. The column temperature was initially 100°C for 2 min, then raised with 5°C/min to 225°C where it was kept for the rest of the run.

Determination of lipid class: High Performance Size Exclusion Chromatography (HPSEC) was performed as reported earlier [7]. The oils were taken up into tetrahydrofuran (THF) to make a 20% solution. This solution was injected directly into the columns. These were three connected polystyrene-divinyl benzene polymer packed columns, in order 500 Å, 100 Å and 100 Å. Each column was 300mm x 7.5 mm stainless steel (PL Laboratories, Shropshire, England) and the packing was 5 μ in diameter. Detector used was the Waters Model 410 differential refractometer. Tetrahydrofuran was used as a mobile phase.

Tocopherols analysis: A Perkin Elmer Fluorescence detector Series 200 and a Rheodyne 7125 Injector equipped with a 20 μ L loop were used. Excitation wavelength was 290 nm and emission wavelength was 330 nm. The solvent system used was water saturated hexane, hexane

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Received July 05, 2013; Accepted March 14, 2014; Published March 20, 2014

Citation: Bazongo P, Bassole IHN, Nielsen S, Dicko MH, Shukla VKS (2014) Studies in the Evaluation of Unconventional Oils from Burkina Faso Rich in Linoleic Acid, Oleic Acid or Other Unusual Fatty Acids. J Food Process Technol 5: 303. doi:10.4172/2157-7110.1000303

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and propan-2-ol (49.55:49.55:0.9). The columns consisted of 2 x 150 mm 4.6 mm I.D. Luna columns packed with 3 μ CN particle [1].

Rancimat test: Rancimat tests [8] were performed using a Metrohm, 743. 3 grams of sample was kept at 120°C, under an air flow rate of 20 mL/min. The change in conductivity of 60 mL of deionized water was recorded versus time. The induction period (time in hours) was measured the inflection point, which was calculated using Metrohm software.

Results and Discussion

Oil contents and fatty acid composition

The oil content and the fatty acid composition of the species studied are presented in Table 1. The highest oil content was obtained with *Marantes polyandra* (55.0%) followed by *Lophira lanceolata* (50.4%), *Balanites aegyptiaca* (41.4%), *Parinari curatelliflora* (38.5%), *Combretum aculeatum* (32.7%), *Sterculia setigera* (30.7%) and *Detarium microcarpum* (12.0%). The oil contents of *Balanites aegyptiaca*, *Detarium microcarpum*, *Lophira lanceolata*, *Parinari curatelliflora* and *Sterculia setigera* seed oils were in the range of those previously reported [9-12]. To the best of our knowledge the oil content of *Combretum aculeatum* and *Marantes polyandra* have not previously reported.

Unsaturated fatty acids (52.6–86.5%) were the most abundant fatty acids detected in the seven species of oils (Table 1). Linoleic and oleic acids were the most dominant fatty acids of *Balanites aegyptiaca*, *Combretum aculeatum*, *Detarium microcarpum* and *Lophira lanceolata*. Unusual fatty acids (Eleostearic acid and cyclopropenic acids) were found in high amount in the oils of *Marantes polyandra*, *Parinari curatelliflora* and *Sterculia setigera*.

A total of eleven fatty acids were identified in the oil of *Balanites aegyptiaca*, representing 99.1% of the total oil. The Linoleic acid (47.1%) followed by oleic acid (28%) and palmitic acid (15.3%) were the predominant fatty acids. This chemical composition is different to

that with oleic, palmitic and behnic acids as major fatty acids previously described by Hanan [9].

Combretum aculeatum seed oil was characterized by the presence of eight components, representing 99.7% of the total oil. Oleic acid (44.5%), myristic acid (25.8%) and palmitic acid (18.8%) were the major fatty acids.

Seven fatty acids accounting for 99.9% of the total oil was identified in the oil of *Detarium microcarpum*. The dominant fatty acids were linolenic acid (39.5%), oleic acid (28%) and arachidic acid (10.1%). Oleic and linoleic acids have been previously reported as major fatty acids of *Detarium microcarpum* seed oil [13].

Eleven fatty acids characterised the oil of *Lophira lanceolata*, representing 99.9% of the total oil. Quantitatively, the most abundant fatty acids were linoleic acid (32.7%), palmitic acid (28.6%) and oleic acid (17.2%).

The eleostearic acid was the most dominant fatty acid of *Marantes polyandra* (31.9%) and *Parinari curatelliflora* (38.2%) seed oil followed by palmitic (20.6%) and oleic (19.2%) acids for *M. polyandra* and oleic (36.2%) and linoleic acids (10.2%) for *P. curatellifolia*. Considering the major constituent, the literature reveals that *P. curatellifolia* exhibited intraspecific variation in its oil composition [12]. The variations in fatty acids composition may be as a result of climatic conditions, rainfall and temperature effects on the biosynthesis of fatty acid in the seed bearing plant [14].

In *Sterculia setigera* oil, the most dominant fatty acids were palmitic acid (25.8%), sterculic acid (20.0%) and linoleic acid (19.8%). Linoleic acid (30%), oleic acid (21%) and palmitic (20%) acid have been reported as the dominant fatty acid of the specie of Senegal [15]. Both cyclopropenic acids (sterculic acid (20.0%) and malvalic (11.6%) have been found in higher content that of 17.1% reported for the specie of Senegal.

	<i>Balanites aegyptiaca</i>	<i>Combretum aculeatum</i>	<i>Detarium microcarpum</i>	<i>Lophira lanceolata</i>	<i>Marantes polyandra</i>	<i>Parinari curatelliflora</i>	<i>Sterculia setigera</i>
Oil %	41.3 ± 1	32.7 ± 0.2	12 ± 0.3	50.4 ± 0.1	55.0 ± 0.6	38.5 ± 1.8	30.7 ± 0.6
Fatty acids							
Myristic acid 14:0		25.8					
Palmitic acid 16:0	15.4	18.8	9.6	28.6	20.6	6.7	25.8
Palmitoleic acid 16:1 n-7	0.1	0.3		0.1			0.3
Margaric acid 17:0	0.2						
Stearic acid 18:0	11.9	1.4	2.0	1.8	10.1	6.3	4.3
Oleic acid 18:1 n-9	22.9	44.5	28.0	17.2	19.2	36.2	16.4
Oleic acid 18:1 Trans							
Linoleic acid 18:2 n-6	47.1	8.1	39.5	32.7	14.7	10.2	19.8
Linolenic acid 18:3	0.1		3.0	0.2			0.3
Arachidic acid 20:0	0.4	0.2	0.9	1.9	1.5	0.5	0.4
Gondoic acid 20:1 n-9	0.1	0.6		1.9	1.0	1.2	
Behenic acid 22:0	0.3		10.1	14.4	0.3		
Erucic acid 22:1 n-9			0.8	0.5			
Lignoceric acid 24:0	0.7		6.0	0.6			
others	0.8	C12:0: 0.3			*total: 32.6	**total: 38.9	***total: 32.7
USFA	70.3	53.5	71.3	52.6	67.5	86.5	69.5
SFA	28.9	46.2	28.6	47.3	32.5	13.5	30.5

*α-Eleostearic acid = 30.5. β-Eleostearic acid = 1.4 others = 0.7

**α-Eleostearic acid = 36.5. β-Eleostearic acid = 1.7 others = 0.7

***Malvalic acid = 11.6. Sterculic acid = 20.0. others: 1.1

Table 1: Fatty Acid Composition (FAC) (wt%) of unconventional seed oils from Burkina Faso.

Lipid class

The total amount of oil was separated into polymer, free fatty acid, mono-, di-, and triacylglycerol fractions by means of High Performance Size Exclusion Chromatography (HPSEC) and the results are shown in Table 2. The triacylglycerols varied from 84.5.11 to 99.0% while

iacylglycerols from 1.0 to 9.6% and free fatty acids from 0.4 to 5.9%. Monoacylglycerols were not detected in the oils. The oils, except that of *Parinari curatelliflora*, were characterized by high amount of triglycerides and low amount diacylglycerol and free fatty acids. Diacylglycerol and free fatty acids are products of hydrolytic degradation of triglycerides, their presence in high amount in the fresh oil of *Parinari curatelliflora* are indicative of its low stability.

Tocopherol contents

Tocopherol contents of the studied oil samples are summarized in Table 2. The highest tocopherol content was obtained with *Combretum aculeatum* seed oil (800 ppm) followed by *Parinari curatelliflora* (275 ppm), *Balanites aegyptiaca* (214 ppm) and *Sterculia setigera* (45 ppm). The total content of tocopherols in *Combretum aculeatum* seed oil was higher than that recorded in *Sclerocarya birrea* seed oil (137 ppm) and olive oil (100-300 ppm) [16,17]. The α Tocopherol and δ tocopherol were the major forms of tocopherol in *Parinari curatelliflora* and *Combretum aculeatum*, respectively. The γ Tocopherol was the dominant form of tocopherol in *Balanites aegyptiaca* and *Sterculia setigera*. β -tocopherol was not detected (Table 3).

Oil stability

The Rancimat test was used to establish the relative oxidative stability of oils, as measured by the induction time (called the oxidative stability index, OSI) for an oil to begin oxidizing under controlled temperature and air flow conditions. OSI is a measurement of resistance of lipids to oxidation [18]. The longer the OSI duration, the more stable the oil. The result of the Rancimat test is shown in Table 4. The OSI of the *Sterculia setigera* seed oil was lowest (0.6 h) while *Combretum aculeatum* seed oil had the highest stability (5.1 h). The oxidative stability of oils are affected by many factors, including fatty acid composition, concentration and stability of antioxidants in the oil, and the presence of prooxidant compounds, such as free fatty acids, lipid peroxides, or prooxidant metals [18]. The relative high oxidative of *Combretum aculeatum* and *Balanites aegyptiaca* could be due to the combination of these factors.

Conclusions

In conclusion it is evident from these studies that the plant kingdom globally provides us with a large variety of unexploited oils/fats which could be developed commercially in order to balance the deficit emerging out of developing countries. These countries have not given serious considerations to the development for their existing or potential agriculture resources.

	<i>Balanites aegyptiaca</i>	<i>Combretum aculeatum</i>	<i>Lophira lanceolata</i>	<i>Parinari curatelliflora</i>	<i>Sterculia cetigens</i>
Glyceride					
Polymer	-	-	-	-	-
Triglycerides	98.6	99	97.5	84.5	97.3
Diglycerides	1	-	1.3	9.6	1.8
Monoglycerides	-	-	-	-	-
FFA	0.4	1	1.2	5.9	0.9

Table 2: HPSEC Composition (Weight %) of unconventional seed oils from Burkina Faso.

Species	α Tocopherol	β Tocopherol	γ Tocopherol	δ Tocopherol	Total Tocopherol
<i>Balanites aegyptiaca</i> (Zygophylloceae)	97	-	110	7	214
<i>Combretum aculeatum</i> (Combretaceae)	5	3	360	432	800
<i>Parinari curatelliflora</i> (Chrysobalanaceae)	221	-	54	-	275
<i>Sterculia setigera</i> (Malvaceae)	4	-	36	5	45

Table 3: Tocopherol Composition of unconventional seed oils from Burkina Faso.

Species	Hours at 120°C
<i>Balanites aegyptiaca</i>	3.6
<i>Combretum aculeatum</i>	5.1
<i>Lophira lanceolata</i>	1.9
<i>Sterculia setigera</i>	0.6

Table 4: Rancimat Hours of unconventional seed oils from Burkina Faso.

The failure rate and financial uncertainties facing even traditionally successful enterprises are formidable. Nevertheless, the diversity, potential quality, and abundance of tropical crops ideal seasonal match with temperate zones (developed country) demands, labour advantages and critical need for generation of hard currency are factors meriting careful development efforts.

Acknowledgement

We thank the Danish International Development Agency, DANIDA, for financially supporting these studies and Dr. Anne Mette Lykke for her untiring efforts in coordinating the whole project (Qualitree.neri.dk).

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