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A COMPARATIVE STUDY ON OIL YIELD FROM AFRICAN MESQUITE *PROSOPIS AFRICANA*) AND AFRICAN BREADFRUIT (*TRECULIA AFRICANA* D.) SEEDS

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Abstract

This study evaluated the extraction of oil from the seeds of African mesquite (*Prosopis africana*) and African breadfruit (*Treculia africana D.*). Oils were extracted under the same conditions from the two seeds using a Soxhlet extractor and n-hexane as solvent. The extraction was carried out over a period of 3 hr., followed by distillation at 70 °C for 30 mins to completely separate the n-hexane from the oil. The oils extracted were characterised using standard methods for physicochemical properties and gas chromatography-mass spectrometry analysis for the chemical constituents. The study showed the percentage oil yield of African mesquite and African breadfruit to be 16.22 ±0.86% and 12.52±0.68%, respectively. The total saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA), and polyunsaturated aldehyde levels in *Prosopis africana* seed oil were 0.84%, 0%, 6.93%, and 48.82%, respectively. In contrast, *Treculia africana* seed oil had values of 12.92% for SFA, 0.66% for MUFA, 81.38% for PUFA, and 1.52% for polyunsaturated aldehyde. *Prosopis africana* seed oil contained more polyunsaturated aldehydes than *Treculia africana* seed oil. In addition, *Treculia africana* seed oil had higher levels of SFA, MUFA, and PUFA compared to *Prosopis africana* seed oil.

Keywords
Treculia africana, Prosopis africana, seed oils, Soxhlet extraction, Fatty acid

1. INTRODUCTION

Plant oils are appealing constituents in many food, pharmaceutical, and cosmetic formulations. This is purportedly linked to their biocompatibility, biodegradability, biosafety, and relative non-immunogenicity (Omeh *et al*., 2023). Globally and in most cultures in Nigeria, plant oils are commonly used as a component of regular meals. However, the country's edible oil production cannot keep up with the rising consumer demand brought on by population growth and economic development. Hence, the supply is still heavily dependent on imports (Nnamani and Mbaeyi-Nwaoha, 2023).

Both *Prosopis africana* and *Treculia africana* are tropical trees that are mostly grown in tropical areas. *Treculia africana* also known as African breadfruit tree is a big, slow-growing, evergreen tree which is a member of the Moraceae family. The tree has a dense, spreading crown that often reaches a height of 15 to 50 meters and bears enormous, spherical fruits with many seeds per fruit head (Omeh *et al*., 2023). Extractions from the tree's seeds and stem have been utilized ethnomedically as antibacterial, antitussive, wound-healing, and antidiabetic treatments (Oyeyipo and Onasoga, 2015; Ojimelukwe and Ugwuona, 2021). The seed is also known to have a high nutritional content containing 14–17% crude protein, 2.5% crude fibre, 35–60% carbohydrates, and a substantial amount of vitamins and minerals (Nwabueze and Okocha, 2017).

The *Prosopis africana* (African mesquite) on the other hand is a leguminous medicinal plant which is a member of the fabaceae and mimosoideae subfamilies (Alagbe, 2022). It has sickle-shaped pods that are roughly 10 to 20 cm long, and the pods are a good source of vitamins, minerals, protein, carbs, and amino acids (Ezeocha *et al*., 2022). Essential oils from *Prosopis africana* seeds are reported to contain a high concentration of flavonoids, which have hepatoprotective, antiviral, anti-inflammatory, and antioxidant qualities (Alagbe, 2022).

The oil potential and prospective uses of these seeds have been the subject of numerous studies. Omeh *et al*. (2023), conducted extraction of oil from *Treculia africana* seeds by a cold maceration and by soxhlet methods. The findings indicated that the cold maceration and soxhlet extraction techniques produced oil yields of 13.69 and 23.54%, respectively. Nwabueze and Okocha (2017), used of the soxhlet extraction method to examine the extraction of oil from *Treculia africana* seeds using organic polar solvents (isopropanol, hexane, and butanol) and organic non-polar solvents (acetone). The findings demonstrated that, while the oils produced using the various solvents had diverse physicochemical characteristics, the hexane solvent produced the highest yield and the lowest peroxide value.

Ibrahim et al.(2015), investigated the extraction and usage of *Prosopis africana* oil for edible oil and biodiesel. In order to extract the oil from the crushed seeds, soxhlet extraction was performed utilizing petroleum ether (60–80ºC) as a solvent and mechanical expression. According to the fatty acid profile obtained from the GC-MS analyzer, the oil contains 0.08% free fatty acids and 63% linolenic acid. Alagbe (2023) used the GC-MS technique to examine the bioactive components found in *Prosopis africana* oil. A total of 73 bioactive compounds (77.16%) were found, with prosogerin A (29.90%) and caryophyllene (12.33%) being the two major compounds.

Although several investigations published in the literature show diverse studies on *Prosopis africana* and *Treculia africana*, a literature search shows there is no holistic comparative study on extraction, physicochemical properties and fatty acid compositions of the two seeds. This research conducted a comparative study on the oil yield from African mesquite (*Prosopis africana*) and African breadfruit (*Treculia africana D.*) with the aim of comparing the yield and physicochemical and chemical properties of the seed oils.

2. MATERIALS AND METHOD

2.1 Apparatus, Equipment and Reagents

A Soxhlet apparatus (BST/SXM-3), a heating mantle (98-I-B), a Nulek blender (NL-B1218), density bottles, a suspended level viscometer (type B2/IP/SL), a glass thermometer (0°C-300°C), a retort stand, measuring cylinders, a stopwatch, beakers, an electronic weighing balance, a refractometer, and a gas chromatograph-mass spectrometer (GC-MS) were utilized in this study.

2.2 Collection and preparation of Seeds

The seeds of the African breadfruit (*Treculia africana D.*) and African mesquite (*Prosopis africana*) displayed in Plate 1 were acquired from the Ajegunle market next to Ajayi Crowther University in Oyo, Nigeria. After being cleaned and dried under the shed, the seeds were manually separated from their kernels. The seeds were pulverised using an NL-B1218 blender to obtain an average particle size of 6.5 mm.

2.3 Extraction of Oil

Oils were extracted from the seeds using the Soxhlet extraction method. For each experimental run, n-hexane (solvent) measuring 150 mL was used to extract oil from 20 g of seed powder over a period of three (3) hours to allow for effective extraction. This was followed by distillation of the mixtures containing oil and n-hexane at 70°C, which was performed for 30 mins to completely separate the n-hexane from the oil. This process was repeated in triplicate for each of the African mesquite (*Prosopis africana*) and African breadfruit (*Treculia africana D.*) seeds, and the percentage of oil recovered was calculated using Equation 1.

$$Percentage\ oil\ yield\left(\frac{w}{w}\right) = \frac{Weight\ of\ concentrated\ oil(g)}{weight\ of\ dry\ seed\ powder} \times 100$$

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(1)

Plate 1: Dehusked and deshelled (a) *Prosopis Africana (b) Treculia africana* Decne seeds

2.4 Characterization of Seed Oils

The physicochemical properties of the seed oils were carried out using standard methods, and the fatty acid components were characterised using GC-MS.

2.4.1 Physicochemical properties

The following physicochemical characteristics of the seed oils were identified: oil content, refractive index, specific gravity, peroxide value (mg/kg), density (g/cm³), colour, viscosity (mm²/s²), acid value (mg/g), iodine value (gI_2/100g), and saponification value (mgKOH/g). The refractive index was determined using an Abbe benchtop refractometer, and the specific gravity was determined using a hydrometer. The oil's viscosity was measured at 30°C using a U-tube viscometer, and the iodine value was determined using Wij's method as described by Samanta *et al*.(2023). The acid value, peroxide and saponification values were determined using titration method (Longobardi *et al*., 2021; Upadhyay *et al*., 2025).

2.4.2 Chemical Characterization of oil extracted

An HP-5MS capillary column (30 m length × 0.32 mm diameter × 0.25 μm) covered with 5% phenylmethyl siloxane film and connected to an inert mass spectrometer 5977C (Agilent Technologies) with an electron impact source was used to analyse the oil. The carrier gas was helium with a flow rate of 1.573 mL/min. The oven's temperature was raised to 40°C for one minute and afterwards increased by 10°C each minute to 270°C. In order to identify the discovered molecule, measured mass spectrum data were compared with those in the NIST 14 Mass Spectrum Library. The potential compounds were scanned between 50 and 550 amu at a rate of 2.62 seconds per scan.

3. RESULTS AND DISCUSSION

3.1 Oil yield and Physicochemical Properties of Oils Extracted

The oil extracted from seeds of African mesquite (*Prosopis africana*) and African breadfruit (*Treculia africana* D.) is shown in Plate 2. The percentage oil yield of *Prosopis africana* has an average percentage yield of 16.22±0.86%, while *Treculia africana D*. has 12.52±0.68%.

Plate 2: Extracted oil samples from (a) *Prosopis africana*, (Africa mesquite) (b) *Treculia africana D.* (Africa breadfruit)

The physicochemical properties of the seed oils are presented in Table 1. The colour of seed oils from *Prosopis africana* is pale green, while *Treculia africana D.* is golden yellow. The oil content is 16.90% for African mesquite (*Prosopis africana*) and 13.15% for African breadfruit (*Treculia africana D.*). The iodine values for the oils were 308.83 for African mesquite (*Prosopis africana*) and 345.12 for African breadfruit (*Treculia africana D.*). These iodine values are greater than 130; hence, they are drying oils and have quick drying potential. This suggests their applicability in the production of alkyd resins for the paint industry. The high iodine content also implies a high level of unsaturation in the oils, which makes it capable of accommodating cross-linking reactions for alkyd to form a dry, hard solid film.

The acid value of each seed oil is 0.169 and 0.081 mgKOH/g for African Mesquite (*Prosopis africana*) and African breadfruit (*Treculia africana* D.), respectively. The acid value is a measure of the free fatty acid content in oil; hence, the low acid values obtained from these seed oils are suggestive of their usefulness in the manufacture of paints and varnish (Okolie *et al*., 2012). The viscosity of each seed oil from African mesquite (*Prosopis africana*) is 9.68 mm^2/S^2, while that of African breadfruit (*Treculia africana* D.) is 10.43 mm^2/S^2. The saponification value of each seed oil is 113.89 for African Mesquite (*Prosopis africana*) and 76.29 for African breadfruit (*Treculia africana* D.). The specific gravity of both seed oils is 0.011, and the densities are 1.14 for Africana breadfruit (*Treculia africana* D.) and 1.09 for African Mesquite (*Prosopis africana*).

African Mesquite (*Prosopis africana*) and Africana breadfruit (*Treculia africana D*.) had peroxide levels of 40.0 mg/kg and 47.0 mg/kg, respectively. These values indicated the degree of oil degradation brought on by oxidation during storage. This indicator can serve as a helpful early warning sign of oxidative deterioration and a decline in the potency of oil antioxidants (Ali *et al*.,2022; Flores *et al*., 2021). Furthermore, African mesquite (*Prosopis africana*) and African breadfruit (*Treculia africana D*.) have refractive indices of 1.6715 and 1.6765, free fatty acid content of 0.085% and 0.041 %, respectively. The oil's free fatty acid value indicates how much enzymatic hydrolysis it had in the parent source prior to extraction.

Table 1: Physicochemical Properties of Oil Extracts from Various Seeds

Property	*Prosopis africana* Seed Oil	*Treculia africana D.* Seed Oil
Color	Greenish	Golden Yellow
Density (g/cm^3)	1.090	1.143
Viscosity mm^2/S^2	9.68	10.43
Acid Value (mg/g)	0.169	0.081
Iodine Value ($gI_2/100g$)	308.83	345.12
Saponification Value (mgKOH/g)	113.89	76.29
Oil Content %	16.90	13.15
% FFA Content	0.085	0.041
Refractive Index	1.6715	1.6765
Specific Gravity	0.011	0.011
Peroxide Value mg/kg	40.0	47.0

3.2 Chemical Characterization of the Extracted Oils

The chemical constituents of *Prosopis africana* and *Treculia africana* seed oils were identified by the gas chromatography-mass spectrometry (GCMS) technique. The respective identified compounds with their retention times, names, molecular formulas, and percentage compositions are given in Tables 2 and 3.

As shown in Table 2, twenty-two compounds were identified from the seed oil of *Prosopis africana,* which accounted for 99.91% of the total oil composition. The most prominent compound was 9-17-Octadecadienal, (Z)- which accounted for 48.82% of the total oil. Other major compounds were 1H-Naphtho[2,1-b]pyran,3-ethenyldodecahydro-3,4a,7,7,10a-pentamethyl-,[3R-(3α,4aβ,6aα,10aβ,10bα)] accounting for 5.62%; 9,12-Octadecadienoic acid (Z,Z) accounting for 5.15%; Isospathulenol accounting for 5.12%; Eucalyptol accounting for 4.20%; Cyclohexene, 4-methyl-1-(1-methylethyl)- accounting for 3.77% and Bicyclo[3.1.0]hexane, 4-methylene-1-(1-methylethyl) which accounts for 3.17% of the total constituents. The minor compounds were considered to have compositions of less than 1% such as 7-Tetracyclo[6.2.1.0(3.8)O(3.9)]undecanol,4,4,11,11-tetramethyl- (0.97%); 6-Isopropenyl-4,8a-dimethyl-1,2,3,5,6,7,8,8a-octahydro-naphthalen-2-ol (0.90%); and n-Hexadecanoic acid (0.84%). Overall, the seed oil of *Prosopis africana* were rich in polyunsaturated fatty aldehyde comprising 48.82% and oxygenated sequiterpenes comprising 14.02% of the oil composition, among others.

Similarly, the composition of the seed oil of *Treculia africana* are presented in Table 3. Fourteen compounds were detected which accounted for 100% of the oil composition. Among these, there were four major compounds identified. These include 9, 12-Octadecadienoic acid (81.38%), n-hexadecanoic (11.69%), γ-Sitosterol (1.46%) and 2,4 Decadienal (E,E)- (1.23%). Others found less than 1% were classified as minor compounds and they are Hexanal (0.18%), Bicyclo[3.1.0]hexane, 4-methylene-1-(1-methylethyl)-Eucalyptol(0.31%),Eucalyptol(0.23%), Octadecanoic acid (0.91%), 9,17 Octadecadienal(0.29%), 15-Hydroxypentadecanoic acid(0.32%), 6-Octadecenoic acid (Z)-(0.66%), Squalene (0.87%), 7-Pentadecyne (0.16%), and Heptadecane(0.31%). *Treculia africana* seed oil contain high levels of polyunsaturated fatty acids (81.38%) and saturated fatty acids (12.92%) class of compounds.

The total saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA), and polyunsaturated aldehyde levels in *Prosopis africana* seed oil were 0.84%, 0%, 6.93%, and 48.82%, respectively. In contrast, *Treculia africana* seed oil had values of 12.92% for SFA, 0.66% for MUFA, 81.38% for PUFA, and 1.52% for polyunsaturated aldehyde. Notably, *Prosopis africana* seed oil contained more polyunsaturated aldehydes than *Treculia africana* seed oil. However, *Treculia africana* seed oil had higher levels of SFA, MUFA, and PUFA compared to *Prosopis africana* seed oil.

Table 2: Chemical constituents of *Prosopis africana* seed oil by GC-MS analysis

S/N	RT (min)	Compounds	Class of compound	MF	% composition
1	6.663	Bicyclo[3.1.0]hex-2-ene, 4-methyl-1-(1-methylethyl)-	Bicyclic alkene	$C_{10}H_{16}$	1.27
2	7.573	Bicyclo[3.1.0]hexane, 4-methylene-1-(1-methylethyl)-	Bicyclic alkene	$C_{10}H_{16}$	3.17
3	8.637	Eucalyptol	Oxygenated monoterpene	$C_{10}H_{18}O$	4.20
4	9.318	Bicyclo[3.1.0]hexan-2-ol, 2-methyl-5-(1-methylethyl)-	Alcohols	$C_{10}H_{18}O$	2.67
5	10.251	Cyclohexane,ethyl-	Cycloalkanes	C_8H_{16}	1.17
6	10.491	Bicyclo[3.1.0]hexan-3-ol, 4-methyl-1-(1-methylethyl)-	Alcohols	$C_{10}H_{18}O$	2.00
7	11.344	Cyclohexene, 4-methyl-1-(1-methylethyl)-	Monoterpene	$C_{10}H_{18}$	3.77
8	13.169	9-Cyclohexylbicyclo[3.3.1]nonan-9-ol	Alcohols	$C_{15}H_{26}O$	2.67
9	14.091	Cyclohexane, 1-ethenyl-1-methyl-2-(1-methylethenyl)	Sesquiterpene	$C_{15}H_{24}$	1.52
10	16.133	Cyclohexanemethanol, 4-[(ethenyloxy)methyl]-	Alcohols	$C_{10}H_{18}O_2$	1.24
11	16.557	Caryophyllene Oxide	Oxygenated Sesquiterpene	$C_{15}H_{24}O$	2.61
12	16.866	(1R,3E,7E,11R)-1,5,5,8-Tetramethyl-12-oxabicyclo[9.1.0]dodeca-3,7-diene	Oxygenated Sesquiterpene	$C_{15}H_{24}O$	1.42
13	17.106	Isospathulenol	Oxygenated Sesquiterpene	$C_{15}H_{24}O$	5.12
14	17.392	Tricyclo[5.2.2.0(1,6)]undecan-3-ol, 2-methylene-6,8,8-trimethyl-	Oxygenated Sesquiterpene	$C_{15}H_{24}O$	1.77
15	17.747	7-Tetracyclo[6.2.1.0(3.8)O(3.9)]undecanol, 4,4,11,11-tetramethyl-	Oxygenated Sesquiterpene	$C_{15}H_{24}O$	0.97
16	18.165	6-Isopropenyl-4,8a-dimethyl-1,2,3,5,6,7,8,8a-octahydro-naphthalen-2-ol	Oxygenated Sesquiterpene	$C_{15}H_{24}O$	0.90

17	19.950	Aromadendrene oxide-(2)	Oxygenated Sesquiterpene	$C_{15}H_{24}O$	1.23
18	21.117	1H-Naphtho[2,1-b]pyran, 3-ethenyldodecahydro-3,4a,7,7,10 a-pentamethyl-, [3R-(3α,4aβ,6aα,10aβ,10bα)]-	Diterpenoid	$C_{20}H_{34}O$	5.62
19	21.810	n-Hexadecanoic acid	Saturated Fatty acid	$C_{16}H_{32}O_2$	0.84
20	22.565	9-17-Octadecadienal, (Z)-	Polyunsaturated Fatty aldehyde	$C_{18}H_{32}O$	48.82
21	23.498	Linoelaidic acid	Polyunsaturated fatty acid	$C_{18}H_{32}O_2$	1.78
22	24.236	9,12-Octadecadienoic acid (Z,Z)-	Polyunsaturated fatty acid	$C_{18}H_{32}O_2$	5.15
		Total			99.91

	Class of compounds	**% composition**
1	Alcohols	8.58
2	Bicyclic alkenes	4.44
3	Cycloalkanes	1.17
4	Diterpenoid	5.62
5	Monoterpene	3.77
6	Oxygenated Monoterpenes	4.20
7	Sesquiterpenes	1.52
8	Oxygenated sesquiterpenes	14.02
9	Saturated fatty acids	0.84
10	Polyunsaturated fatty acids	6.93
11	Polyunsaturated fatty aldehydes	48.82

RT: Retention time; MF: Molecular formula; %: percentage composition

Table 3: Chemical constituents of *Treculia africana D* seed oil by GC-MS analysis

S/N	RT (min)	Compounds	Class of compound	M.F	% composition
1	4.037	Hexanal	Aldehyde	$C_6H_{12}O$	0.18
2	7.505	Bicyclo[3.1.0]hexane, 4-methylene-1-(1-methylethyl)-	Bicyclic alkene	$C_{10}H_{16}$	0.31
3	8.563	Eucalyptol	Oxygenated Sesquiterpene	$C_{10}H_{18}O$	0.23
4	12.975	2,4 Decadienal (E,E)-	Polyunsaturated fatty aldehyde	$C_{10}H_{16}O$	1.23
5	20.660	Octadecanoic acid	Saturated fatty acid	$C_{18}H_{34}O_4$	0.91
6	20.808	n-Hexadecanoic	Saturated fatty acid	$C_{16}H_{32}O_2$	11.69
7	22.662	9,12-Octadecadienoic acid (Z,Z)	Polyunsaturated fatty acid	$C_{18}H_{32}O_2$	81.38
8	23.675	9,17 Octadecadienal	Polyunsaturated fatty aldehyde	$C_{18}H_{32}O$	0.29

9	25.192	15-Hydroxypentadecanoic acid	Saturated fatty acid	$C_{15}H_{30}O_3$	0.32
10	26.799	6-Octadecenoic acid (Z)-	Monounsaturated fatty acid	$C_{18}H_{34}O_2$	0.66
11	27.835	Squalene	Triterpenoid	$C_{30}H_{50}$	0.87
12	27.051	7-Pentadecyne	Hydrocarbon	$C_{15}H_{28}$	0.16
13	28.568	Heptadecane	Hydrocarbon	$C_{17}H_{36}$	0.31
14	29.586	γ-Sitosterol	Sterol	$C_{29}H_{50}O$	1.46
		Total			100

	Class of compounds	**% composition**
1	Aldehyde	0.18
2	Bicyclic alkenes	0.31
3	Hydrocarbons	0.47
4	Oxygenated Sesquiterpene	0.23
5	Triterpenoids	0.87
6	Sterol	1.46
7	Saturated fatty acid	12.92
8	Monounsaturated fatty acid	0.66
9	Polyunsaturated fatty aldehyde	1.52
10	Polyunsaturated fatty acids	81.38

RT: Retention time; MF: Molecular formula; %: percentage composition

4. CONCLUSION

The comparative study of the physicochemical properties and the chemical constituents of *Prosopis africana* and *Treculia africana D.* showed that *Prosopis africana* has a higher oil content but lower iodine value than *Treculia africana D*. The physicochemical properties showed that they both fall into categories of drying oils which are suitable for several industrial applications. From the GC-MS analysis, more compounds were detected in *Prosopis africana* seed oil, with twenty-two constituents identified. On the other hand, a total of fourteen compounds were detected in the seed oil of *Treculia africana*. In addition, *Prosopis africana* seed oil contained more polyunsaturated aldehydes than *Treculia africana* seed oil. However, *Treculia africana D* seed oil had higher levels of SFA, MUFA, and PUFA compared to *Prosopis africana* seed oil.

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