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Profiling and comparison of fatty acids in the oils from the fruits of *Dacryodes edulis* and *Canarium schweinfurthii*

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Abstract
The fatty acids and fatty acid methyl esters from the oil extracts of *Dacryodes edulis* (DEO) and *Canarium schweinfurthii* (CSO) were identified and compared. The oil extracts were analyzed using a gas chromatography-mass spectrometer. DEO contained three (3) fatty acids and four (4) fatty acid methyl esters, while CSO contained two (2) fatty acids and four (4) fatty acid methyl esters. Six (6) similar compounds which include pentadecanoic acid (4.55%, 5.21%), 11-octadecenoic acid methyl ester (DEO: 40.47%, CSO: 45.23%), heptacosanoic acid (DEO: 37.81%, CSO: 38.48%), oleic acid (DEO: 7.43%, CSO: 4.36%), eicosanoic acid methyl ester (DEO: 6.65%, CSO: 4.84%) and octadecanoic acid (DEO: 1.90%, CSO: 1.89%) were identified from both fruits. n-hexadecanoic acid (DEO: 1.20%) was the only fatty acid compound detected in DEO that was not found in CSO. This study has revealed the contiguity in the chemical properties of both seed oils.

Keywords: Fatty acids, fatty acid methyl ester, *Dacryodes edulis*, *Canarium schweinfurthii*, gas chromatography

1. Introduction
The use of natural products as sources of medicinal compounds can be dated back to the primitive man. In actuality, the therapeutic ability of plants has long been recognized since the primeval age when plants were eaten by man and animals as a remedy against infections and diseases [1]. The therapeutic properties of plants are believed to come from compounds formed during plant primary and secondary metabolism [2]. Investigations on some plants have shown that these compounds possess different culinary, medicinal, and nutraceutical properties [3]. While the medicinal properties of plants have been highly recognized in literature, the potential use of these substances as drug targets in Nigeria has been underdeveloped and undervalued. Among these undervalued plants are the African bush butter pear and bullet pear, *Dacryodes edulis* (bush butter pear), and *Canarium schweinfurthii* (bullet pear) respectively, two tropical Oleiferous fruit trees from the burseraceae family [4]. These plants are indigenous to the tropical rainforest of Western and Central African countries, including Cameroun, Equatorial Guinea, Congo, Angola, and Nigeria [5].
In Nigeria, *D. edulis* is traditionally known as Ube (Igbos); Eben (Efiks); Elemi (Yoruba), while *C. schweinfurthii* is known traditionally as ube okpoko or ubengba (Igbo); atile (Hausa), and origbo (Yoruba) [6]. Both trees grows to a height of 12–57 m with feathery like shiny leaves, ellipsoidal fruit of about 4 to 9 cm long with a width of 2–5 cm for *D. edulis* [2] and 0.9 to 1.3cm length and 0.7 to 1.2 cm width for *C. schweinfurthii* [7, 8]. Most times, the trees are cultivated and harvested mainly for their oily, nutritious edible fruits and seed kernel. The pulp of these fruits is softened by either warm salt water, hot ash, or grilled in an oven and then often eaten alone or with maize [9].
Investigations on the nutritional potentials of the fruits have revealed wealth in lipids, vitamins, and minerals [10, 11]. However, the fruits and seeds have been noted to contain a high nutritional value that makes it useful as a supplement to both humans and animals. A reasonable amount of oil has been extracted from these plants showing that they can compete with other oil bearing seeds, and therefore adequate development of these oils could contribute to the nation's demand for vegetable oils [12, 13]. Investigations made on the fatty acid composition have revealed the presence of several fatty acids in the pulp oil, which include but are not limited to oleic, linoleic, palmitic, stearic, and linoleic acid [12].

The oil extracted from the fruits has been utilized in treating some health problems such as anemia, eyes diseases, helminths infection, diarrhea, goiter hypertension, gastro-intestinal disorder, toothache, cardiovascular condition, yellow fever, fever, malaria, constipation, post-partum pain, rheumatism, sexually transmitted diseases, dysentery, gonorrhea, coughs, chest pains, pulmonary affections, stomach complaints, food poisoning, roundworm infections and other intestinal parasites, skin affections, eczema, leprosy, ulcers, diabetes mellitus, colic, gale etc. [12].

Phytochemical investigations have revealed some secondary metabolites such as tannin, resin, saponins, flavonoids, terpenoids, steroids, alkaloids, protein, glycosides in the oils of these plants [2, 14]. Further studies have shown that these secondary metabolites are responsible for interesting activities such as antimicrobial, antioxidant anti-sickle-cell, insecticidal and larvicidal actions [15]. Adesina and his colleagues [16] have documented the potential use of these plants against respiratory disorders. *D. edulis* and *C. schweinfurthii* have undergone different levels of study as possible prostate cancer chemopreventive agents, with promising results, including potential antimutagenesis, antitumour and antimetastasis properties. A report made by Atawodi [17] also suggests them as a replacement or substitute for imported bakery fat. The effects of *C. schweinfurthii* and *D.edulis* oils on blood lipids, lipid peroxidation and oxidative stress in rats has been reported [4]. The researchers concluded that oils of both pear decrease the risk factor of cardiovascular disease. Duru and coworkers [6], designed a study on the oxidative/hydrolytic stabilities of *D. edulis* and *C. schweinfurthii* oils, which showed that the *D. edulis* oil undergoes oxidative damage faster than the *C. schweinfurthii* oil. Furthermore, the D. eludis seed oil has also been tipped to be a major raw material for biodiesel production as investigations show that biodiesel produced from its oil meets acceptable standards of ASTM (American Society for Testing and Materials) and European Norm (EN) limits [18]. Meanwhile, the resin produced by bullet pear has been reported to be a good source of economical oleoresin, which has served as bush candle and is burned for fumigating dwellings in some parts of West Africa [19]. The Anti-termitic activity of the essential oil of *C. schweinfurthii* has also been reported [8]. Both plants have served as flavor in snacks and non-alcoholic beverages. The use of their oil as a possible precursor for the synthesis of surface coating driers has been documented [20]. The species has presented potentialities in the manufacture of cosmetics as well as in pharmaceuticals [2]. Furthermore, other parts of these plants have found uses in traditional medicine where the bark, leaves, and resin have been used to treat parasitic skin diseases, jigger, cough, mouthwash, tonsillitis, drepanocytosis fever, pain, malaria, and some skin diseases [16, 19].

Information from literature has shown that there are many similarities between the oils of *D. edulis* and *C. schweinfurthii*. There is however, very scarce or no reports on the empirical comparison of the components of the oils from the fruits of these plants. In this investigation, the fatty acid composition of the oil extracts from the fruit pulps of *D. edulis* and *C. schweinfurthii* were profiled, and their quantities were compared.

2. Materials and Methods

2.1. Collection and preparation of sample

The fruits of C. *schweinfurthii* (CSO) and *D. edulis* (DEO) were bought from an open market in Owerri, Imo State. The pulp of each fruit was separated from the seeds and pounded to a paste using a ceramic mortar and pestle.

2.2. Oil Extraction

500 g of the pulverized sample (in portions of 100 g) was weighed and extracted exhaustively for 3 h in a Soxhlet extraction apparatus, with heater (Merck Chemicals GmbH, Darmstadt, Germany) using hexane at a regulated temperature (60-65 ºC about the boiling point of hexane). The solvent was evaporated in vacuo using a rotary vacuum evaporator (Rotavapor R210, BÜCHI, Flawil, Switzerland). The oil extract was stored in a refrigerator before use [1].

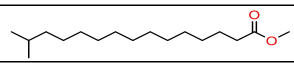
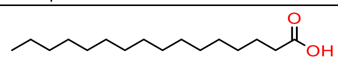
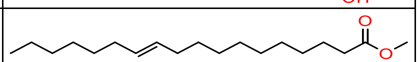
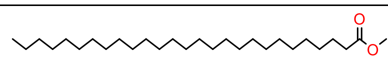
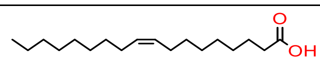
2.3. GC-MS analysis

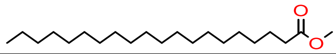
The Gas chromatography–mass spectrometric (GC-MS) investigation of the presence and quantity of the fatty acids in the oil extracts was done using GCMS-QP2010 PLUS (SHIMADZU, Japan). The machine comprises of the injector, and GC interfaced to the mass spectrophotometer. The condition for the analysis is described as follows: Column oven temperature was at 70.0 °C, while the injection temperature was set at 250 °C, injection mode split ratio was at 20.0 °C, carrier gas (Helium) flow rate was 1.80 mL/min, the system temperature was programmed from 60 °C (at 10 °C/min) to 160 °C (held for 2 min) then (10 °C/min) to 250 °C and the injection volume was 0.5 µL. Mass spectrophotometer condition: Ion source temperature 200 °C and interface temperature 250 °C, solvent cut time 2.5 min, and the acquisition was in the scan mode. The GC-MS chromatographic peaks were critically studied, and a list of candidate compounds was generated for each peak using the NIST MS extended library (NIST 11, Version 2.0g). The retention indices and mass spectra of the candidates were compared to the stored information in the library, and the best hit was assigned as the most probable compound [21].

3. Results and Discussion

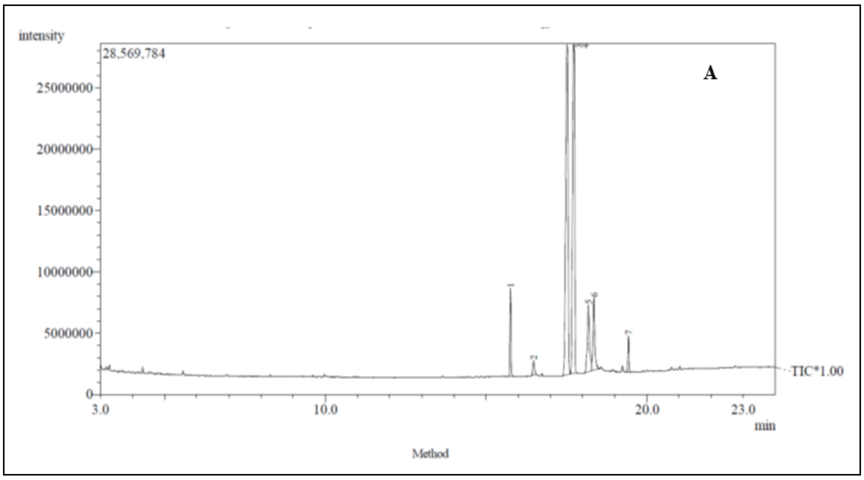
The gas chromatogram of the oils from the fruits of C. *schweinfurthii* and *D. edulis* are shown in Figure 1.

Table 1: Results from the GCMS analysis of *D. edulis* and *C. Schiweinfurthii*

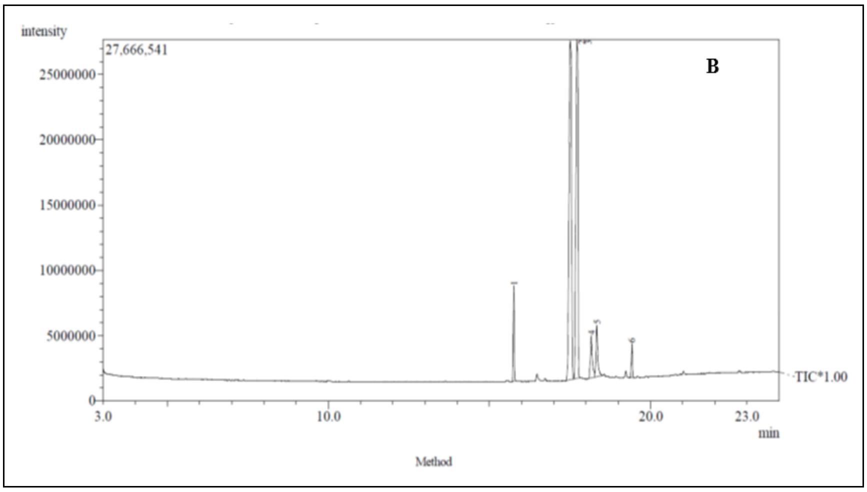
S/N	Name	Molecular formula	Molecular weight	Concentration (%)		Structure
				DEO	*CSO*	
1.	Pentadecanoic acid, 14-methyl-, methyl ester	$C_{17}H_{34}O_2$	270	4.55	5.21	
2.	n-Hexadecanoic acid or Palmitic acid	$C_{16}H_{32}O_2$	250	1.20	–	
3.	11-Octadecenoic acid, methyl ester	$C_{19}H_{36}O_2$	296	40.47	45.23	
4.	Heptacosanoic acid, methyl ester	$C_{28}H_{56}O_2$	424	37.81	38.48	
5.	Oleic Acid or 9-Octadecenoic acid	$C_{18}H_{34}O_2$	282	7.43	4.36	

6.	Octadecanoic acid or Stearic acid	$C_{18}H_{36}O_2$	284	6.65	4.84	
7.	Eicosanoic acid, methyl ester	$C_{21}H_{42}O_2$	326	1.90	1.89	

The fatty acids and fatty acid esters detected in the GC-MS scans of the oils are summarized in Table 1.



(A)



(B)

Fig 1: GC chromatogram of (A) *Dacryodes edulis* and (B) *Canarium schweinfurthii*

A total of seven (7) compounds were found in DEO, and six (6) in CSO. Out of the seven (7) compounds in DEO, six (6) were present in both fruits. They included pentadecanoic acid, 11-Octadecenoic acid methyl ester, heptacosanoic acid, oleic acid, eicosanoic acid methyl ester, and octadecanoic acid, while n-hexadecanoic acid was the only fatty acid not detected in CSO but was present in DEO. Pentadecanoic acid, n-hexadecanoic acid, heptacosanoic acid, octadecanoic acid, and eicosanoic acid are saturated fatty acids, while 11-octadecenoic acid and oleic acid are unsaturated fatty acids.

The fatty acid and fatty acid methyl ester components in the extracted oils are compared in Figure 2. 11-octadecenoic acid methyl ester was the most abundant compound in the two fruits (DEO: 40.47%; CSO: 45.23%), followed by heptacosanoic acid, methyl ester (DEO: 37.81%; CSO: 38.48%). Fatty acid methyl esters have exhibited antimicrobial and antibacterial activities in humans and animals [22, 23, 24]. Palmitic acid (n-hexadecanoic acid) was found only in DEO oil (1.20%). Palmitic acid is a saturated fatty acid with antimicrobial, nematicidal and larvicidal, anti-inflammatory, anti-cancerous antioxidant, hypo-cholesterolemic, and anti-androgenic activities [25, 26]. Oleic acid, a monounsaturated omega-9 fatty acid that occurs naturally in oils was found in both fruits. It is the most common fatty acid found in human cells and is considered an essential fatty acid like omega-3 and omega-6 oils. It greatly benefits the heart, brain, skin cells, and waistline [3]. Oleic acid also has antioxidant activities that give health benefits like anti-cancer and anti-ulcer effects. Small amounts of oleic acid are used as an excipient in pharmaceuticals, and it is used as an emulsifying or solubilizing agent in aerosol products [3]. Another saturated fatty acids detected in a significant amount in both fruits was stearic acid (DEO = 6.65% and CSO = 4.84%), which has also been reported to exhibit antimicrobial activities [26].

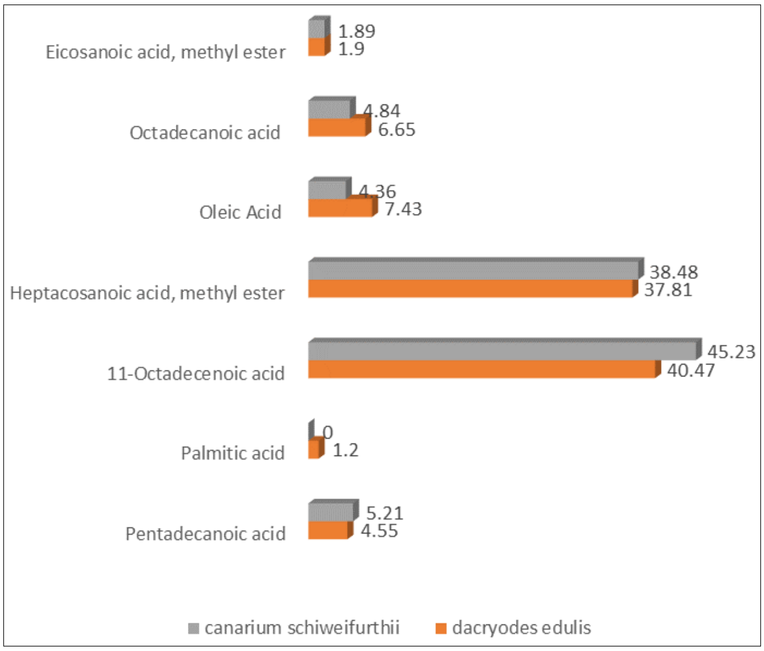


Fig 2: Comparison of extracted compounds from *Dacryodes edulis* and *Canarium schiweinfurthii*

4. Conclusion

The oils from the fruits of *D. edulis* and *C. schweinfurthii* were extracted, and the various compounds present in them identified, and their composition compared. The results showed that oils of *D. edulis* and *C. schweinfurthii* fruits contained (six) 6 similar fatty acid compounds with therapeutic properties. 11-Octadecenoic acid methyl ester and heptacosanoic acid were the most abundant compounds in both fruits. The present findings revealed that the oils from these two fruits could substitute each other due to their striking similarities.

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