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Identification of compounds and functional groups of n-hexane seed extracts of *Citrullus lanatus* and *Elaeis guineensis* using GC-MS and FT-IR

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Abstract

Citrullus lanatus and *Elaeis guineensis* are regarded as two of the most significant edible fruits in terms of nutrition and medicine. Utilizing FTIR and GC-MS spectroscopy, the current work aims at identifying bioactive compounds and functional groups present in n-hexane seed extracts of *Citrullus lanatus* and *Elaeis guineensis*. The GC-MS approach is used to screen and identify phytocompounds. Using a Buck Scientific M530 USA spectrophotometer, the FTIR technique was used to identify the functional groups. Twenty-five (25) and twenty-nine (29) bioactive compounds were identified in *Citrullus lanatus* and *Elaeis guineensis* respectively, by Gas Chromatographic-Mass Spectrometry (GC-MS). Linoelaidic acid (58.79%) was the most prevalent compound identified in *Citrullus lanatus* seed extract. Gamma-tocopherol has the most diverse pharmacological role. n-hexadecanoic acid (16.82%), dodecanoic acid (0.12%), 9, 12-octadecadienoic acid methyl ester (3.45%) and 9, 12-octadecadienoic acid (Z, Z) (0.91%) are some of the other bioactive compounds detected. The most prevalent phytocompound identified in *Elaeis guineensis* seed extract is dodecanoic acid (37.20%), whereas the most diverse pharmacological activity was found in n-hexadecanoic acid. N-decanoic acid (6.32%), 6-octadecenoic acid (11.95%), octanoic acid (5.27%) and tetradecanoic acid (17.59%) are some other bioactive compounds identified. Ether, ethene, primary amine, carboxylic acid, cyclic ester, nitrile, methylene, primary, secondary and tertiary alcohols were detected at various wavelengths in both seed extracts by Fourier transform infrared (FTIR) spectrophotometer. Both extracts contain phytocompounds with antioxidant, anti-inflammatory and antimicrobial properties that are useful in preventing and treating diseases.

Keywords: *Citrullus lanatus; Elaeis guineensis*; FT-IR; GC-MS.

1. Introduction

Citrullus lanatus, a plant belonging to the Cucurbitaceae family, is widely grown because of its tasty fruit, which is composed of approximately 6% sugar and 92% water [1]. Important components such as pulp and seeds are utilized to create a variety of delectable recipes, sweets, oils, cosmetics [2] and supplements for a range of diseases, including microbial infections, diabetes, hypertension, ulcers and others [3-5]. *Citrullus lanatus* fruits, pulp, seeds and peels have a variety of therapeutic properties due to the presence of several phytoconstituents. A monocotyledonous plant, *Elaeis guineensis* is a member of the Arecaceae family of palms. This species is monoecious and is known to alternately produce unisexual male and female inflorescences [6]. Palm oil and palm kernel oil are the two types of oil produced by the African oil palm (*Elaeis guineensis*) [7]. Presently, palm oil is the most widely used edible oil in the world [8] and is Africa's primary source of edible oil [9, 10].

Food and medicine are seen to originate from the same source in many cultures. They are vital for preserving and enhancing health, as well as for preventing and treating diseases. In addition to their normal nutritional value, humans

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have utilized fruits as medicine for hundreds of years. Fruits are beneficial to human health. Fruits are good sources of vitamins A, C, E, thiamine and dietary fiber which are beneficial in the management of several diseases, including cancer, heart disease, stroke and other chronic diseases [11, 12]. The optimal outcome for preventing various diseases and maintaining human health is achieved when the appropriate quantity is met [13]. In addition, various fruit parts including fruit peels, roots, leaves, bark and seeds have therapeutic properties that are good for human health. Many ailments such as fever, cough, asthma, diarrhea, indigestion and skin conditions, have been treated by the locals using these parts as herbs [14]. Due to the presence of phytochemicals, fruits like oranges, mangoes, watermelon, bananas, guava, pear, papaya, pineapple and apples have anti-inflammatory, antibacterial, antioxidant and anticancer properties [15–18].

Fourier transform infrared spectroscopy (FT-IR) and gas chromatography-mass spectrometry (GCMS) are analytical techniques used to identify compounds and functional groups in samples. Using GC-MS and FT-IR spectroscopy, the study aims to identify bioactive compounds and functional groups in n-hexane seed extracts of *Citrullus lanatus* and *Elaeis guineensis*.

2. Materials and Methods

2.1. Collection of Plant Materials

Healthy and mature seeds of *Citrullus lanatus* (CL) and *Elaeis guineensis* (EG) were purchased at the popular Relief market in Owerri Municipal Local Government Area of Imo State. The plants were identified by a plant taxonomist in the Department of Wildlife and Forestry, Federal University of Technology Owerri (FUTO), Imo state.

2.2. Preparation and Extraction of Plant Materials

The seeds of *Citrullus lanatus* and *Elaeis guineensis* were spread out and air-dried at room temperature for two weeks after being washed with tap water. A machine of industrial quality was used to grind the seeds into fine particles. The materials were dried and ground into powder, and n-hexane was used as the extraction solvent to perform Soxhlet extraction. To filter and concentrate the extracts, a rotary evaporator (Buchi Rotavapour, Switzerland) was utilized. The dried extracts were stored in an airtight container, corked and refrigerated at 4°C until they were ready for analysis.

2.3. GC-MS ANALYSIS

1ul of the concentrated sample was injected into the GC column for analysis. The GC (Agilent 6890N) and MS (5975B MSD) are equipped with a DB-5ms capillary column (30 m×0.25mm; film thickness 0.25 µm). The initial temperature was set at 40 °C which increased to 150 °C at the rate of 10 °C per minute. The temperature was again increased to 230°C at the rate of 5 °C/min. The process continued till the temperature reached 280 °C at the rate of 20 °C/min which was held for 8 minutes. The injector port temperature remained constant at 280 °C and the detector temperature was 250 °C. Helium was used as the carrier gas with a flow rate of 1 mL/min. The split ratio and ionization voltage were 110:1 and 70 eV respectively. Data were acquired and processed using ChemStation software. To identify and quantify the target active compounds present in the extracted sample, their individual mass spectral peak value was compared with the database of National Institute of Science and Technology 2014; followed by obtaining the percent report from the equipment. The percent report shows the exact amount at which the targeted compounds were present.

2.4. Fourier Transform Infrared Spectroscopic (FT-IR) Analysis

0.5 g of each sample was mixed with 0.5 g of potassium bromide (kbr), after which 1 ml of nujol was introduced into the sample with the aid of a syringe to form a paste before being introduced into the Buck M530 IR-spectrophotometer and allowed to scan at a wavelength of 600-4000 nm to obtain its spectra wavelength.

3. Results and Discussion

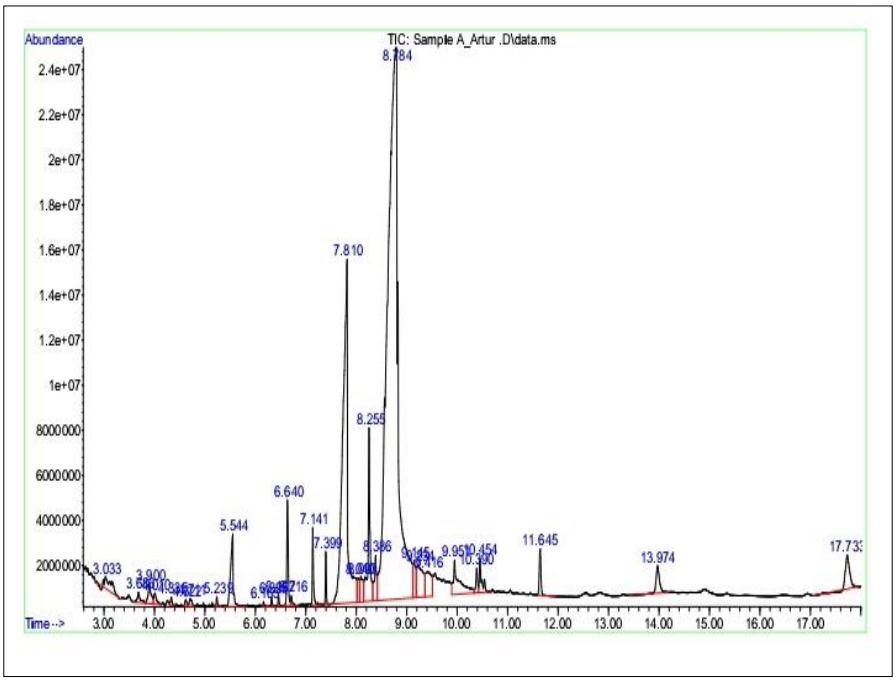

Figure 1 GC-MS chromatogram of n-hexane extract of *Citrullus lanatus* seed

Legend: Sample A- *Citrullus lanatus*

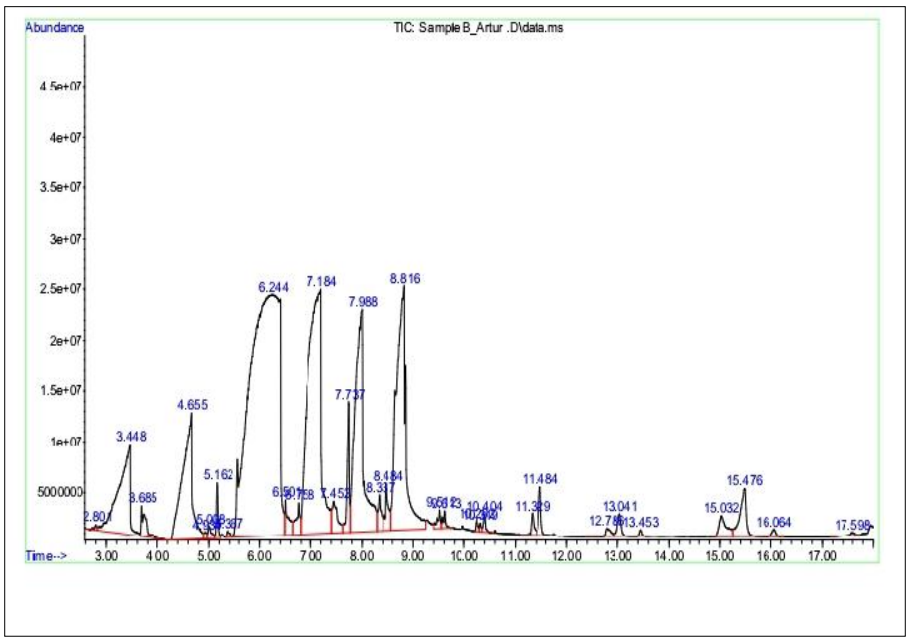

Figure 2 GC-MS chromatogram of n-hexane extract of *Elaeis guineensis* seed

Legend: Sample B- *Elaeis guineensis*

Table 1 Gas Chromatography-Mass Spectrophotometry (GCMS) result of n-hexane seed extract of *Citrullus lanatus*

S/N	Retention time	Area %	Name of Compound	Molecular Formula	Molecular Weight
1	3.033	0.81	Dodecane	$C_{12}H_{26}$	170
2	3.685	0.31	tridecane	$C_{13}H_{28}$	184
3	3.902	0.59	Naphthalene, 2, -methyl	$C_{11}H_{10}$	142
4	4.336	0.14	tetradecane	$C_{14}H_{30}$	198
5	4.622	0.12	Naphthalene, 1,6-dimethyl	$C_{12}H_{12}$	156
6	5.239	0.12	2-butenedioic acid, dibutyl ester	$C_{12}H_{20}O_4$	228
7	5.242	0.12	Dodecanoic acid	$C_{12}H_{24}O_2$	200
8	6.165	0.07	Pentadecane, 2,6,10,14-tetramethyl	$C_{19}H_{40}$	268
9	6.325	0.11	Cyclobutane, 1,2-diphenyl	$C_{16}H_{16}$	208
10	6.463	0.14	1,3-dithiol-2-one, 4-(phenylmethyl)	$C_{10}H_8OS_2$	208
11	6.640	1.52	Benzene, 1,1'-(1,2-cyclobutanediyl)bis-, trans	$C_{16}H_{16}$	208
12	6.714	0.15	Octadecane	$C_{18}H_{38}$	254
13	7.143	0.85	Phthalic acid, isobutyl trans-hex-3-enyl ester	$C_{18}H_{24}O_4$	304
14	7.400	0.46	Hexadecanoic acid, methyl ester	$C_{17}H_{34}O_2$	270
15	7.811	16.82	n-hexadecanoic acid	$C_{16}H_{32}O_2$	256
16	8.257	3.45	9,12-octadecadienoic acid, methyl ester	$C_{19}H_{24}O_2$	294
17	8.389	1.00	Methyl stearate	$C_{19}H_{38}O_2$	298
18	8.783	58.79	Linoelaidic acid	$C_{18}H_{32}O_2$	280
19	9.143	0.91	9,12-Octadecadienoic acid (Z,Z)	$C_{18}H_{32}O_2$	280
20	9.949	2.01	(2,3-Diphenylcyclopropyl)methyl phenyl sulfoxide, trans	$C_{22}H_{20}OS$	332
21	10.389	0.41	7-methyl-2-phenyl-1H-indole	$C_{15}H_{13}N$	207
22	10.452	0.80	1-propene, 3-(2-cyclopentenyl)-2-methyl-1, 1-diphenyl	$C_{21}H_{22}$	274
23	11.646	0.75	Squalene	$C_{30}H_{50}$	410
24	13.972	0.91	Gamma-tocopherol	$C_{28}H_{48}O_2$	416
25	17.733	1.33	Stigmasta-7, 16, 25-trien-3-ol, (3 beta, 5 alpha)	$C_{29}H_{46}O$	410

Table 2 Gas Chromatography-Mass Spectrophotometry (GCMS) result of n-hexane seed extract of *Elaeis guineensis*

S/N	Retention time	Area %	Name of Compound	Molecular Formula	Molecular Weight
1	2.799	0.06	Diglycerol	$C_6H_{14}O_5$	166
2	3.450	5.27	Octanoic acid	$C_8H_{16}O_2$	144
3	3.685	0.70	2-Undecanone	$C_{13}H_{26}O$	198
4	4.656	6.32	n-decanoic acid	$C_{10}H_{20}O_2$	172

5	5.011	0.22	3-Furanacetic acid, 4-hexyl-2,5-dihydro-2,5-dioxo-	$C_{12}H_{16}O_5$	240
6	5.165	0.48	Dodecanoic acid, methyl ester	$C_{13}H_{26}O_2$	214
7	5.365	0.12	n-Octanoic acid isopropyl ester	$C_{11}H_{22}O_2$	186
8	6.245	37.20	Dodecanoic acid	$C_{12}H_{24}O_2$	200
9	6.502	0.63	Tridecanoic acid	$C_{13}H_{26}O_2$	214
10	6.760	0.63	n-hexadecanoic acid	$C_{16}H_{32}O_2$	256
11	7.182	17.59	Tetradecanoic acid	$C_{14}H_{28}O_2$	228
12	7.737	1.35	Hexadecanoic acid	$C_{16}H_{30}O_4$	286
13	7.988	9.93	n-hexadecanoic acid	$C_{16}H_{32}O_2$	256
14	8.337	0.64	9-Octadecenoic acid (Z)-, methyl ester	$C_{19}H_{36}O_2$	296
15	8.486	0.79	Dodecanoic acid, 2-hydroxy-1-(hydroxymethyl) ethyl ester	$C_{15}H_{30}O_4$	274
16	8.817	11.95	6-Octadecenoic acid	$C_{18}H_{34}O_2$	282
17	9.514	0.27	Cis-13-Octadecenoic acid	$C_{18}H_{34}O_2$	282
18	9.611	0.22	6H-1, 3,4-thiadiazine-6-carboxylic acid, 2-amino-5-methyl-, ethyl ester	$C_7H_{11}N_3O_2S$	201
19	10.252	0.10	9-Octadecenoic acid (Z)-, 2,3-dihydroxypropyl ester	$C_{21}H_{40}O_4$	356
20	10.320	0.08	Fumaric acid, cyclobutyl hexyl ester	$C_{14}H_{22}O_4$	254
21	10.406	0.21	Fumaric acid, 2-ethylbutyl 2-chloro-6-fluorophenyl ester	$C_{16}H_{18}CIFO_4$	328
22	11.332	0.31	Pyridazine, 3-phenyl-5-nitro-2-Dibenzofuranamine	$C_{10}H_7N_3O_2$	201
23	11.486	0.59	Aluminum, bis(2-methylpropyl) (2,4-pentanedionato-O,O')-, (T-4)-	$C_{13}H_{25}ALO_2$	240
24	12.783	0.21	Carbamic acid, N-(3-chloro-4-methoxyphenyl)-, glycidyl ester	$C_{11}H_{12}CINO_4$	257
25	13.041	0.45	1,2-cyclohexanedicarboxylic acid, di (2-methylbutyl) ester	$C_{18}H_{32}O_4$	312
26	13.452	0.09	Dodecanoic acid 3-dodecanoyloxy-propyl ester	$C_{27}H_{52}O_4$	440
27	15.030	0.80	Dodecanoic acid, 1-(hydroxymethyl)-1,2-ethanediyl ester	$C_{27}H_{52}O_5$	456
28	16.064	0.17	2,7-Diphenylindole	$C_{20}H_{15}N$	269
29	17.596	0.06	Glycerol tricaprylate	$C_{27}H_{50}O_6$	470

Table 3 Gas Chromatography-Mass Spectrophotometry (GCMS) result of n-hexane seed extract of *Citrullus lanatus* with biological activity

S/N	Area %	Name of Compound	Class of Compound	Biological Activity
1	0.31	Dodecane	Alkane	Antibacterial property [19], Antifungal property [20]
2	0.12	2-butenedioc acid, dibutyl ester	Fatty acid esters	Psoriasis treatment [21]
3	2.00	Dodecanoic acid (lauric acid)	Saturated fatty acid	Antibacterial property [22-24]
4	0.46	Hexadecanoic acid methyl ester	Fatty acid methyl ester	Antioxidant, anti-inflammatory, antimicrobial, nematicides, pesticides, insecticides, hypocholesterolemic, anti-androgenic effects [25]
5	16.82	n-hexadecanoic acid	Long-chain fatty acid	Antiandrogenic, antioxidant, hemolytic 5-alpha-reductase inhibitory, hypocholesterolemic, nematicides, pesticides activities and flavoring agent [26-28]
6	3.45	9,12-Octadecadienoic acid methyl ester	Fatty acid methyl ester	Antioxidant and antimicrobial properties [29]
7	1.00	Methyl stearate	Fatty acid methyl ester	Antioxidant activity [30]
8	58.79	Linoelaidic acid	Fatty acid (linoleic acids and derivatives)	Heart disease research [31]
9	0.91	9, 12, Octadecadienoic acid (Z,Z)	Fatty acyl (linoleic acids and derivatives)	Antibacterial property [32, 33]
10	2.01	2,3-diphenylcycloproyl methyl phenyl sulfoxide, trans-	Stibenes	Antimicrobial property [34]
11	0.75	Squalene	Triterpenoids	Chemopreventive substance for cancer [35]. Used in cosmetics as an emollient, skin toner and elasticity maintainer [36]
12	0.91	Gamma-tocopherol (Vit. E)	Fat-soluble compound	Antioxidant [37], Anti-inflammatory activity [38, 39]

Table 4 Gas Chromatography-Mass Spectrophotometry (GCMS) result of n-hexane seeds extract of *Elaeis guineensis* with biological activity

S/N	Area %	Name of Compound	Class of Compound	Biological Activity
1	0.06	Diglycerol	Glycerolipids	Inhibition of CD31-positive tumor blood vessel growth [40]
2	6.32	n-decanoic acid	Medium-chain fatty acid	Seizure control [41, 42]

3	0.22	3-furanacetic acid, 4-hexyl-2, 5-dihydro-2, 5-dioxo-	Acid	Antibacterial and antifungal potential [43]
4	0.48	Dodecanoic acid, methyl ester	Fatty acid methyl ester	Antibacterial, antiviral, and antifungal properties [44]
5	37.20	Dodecanoic acid (lauric acid)	Saturated fatty acid	Antibacterial property [22]
6	0.63	n- hexadecanoic acid	Long-chain fatty acid	Antiandrogenic, antioxidant, hemolytic 5-alpha-reductase inhibitory, hypocholesterolemic, nematicides, pesticides activities and flavoring agent [26-28]
7	17.59	Tetradecanoic acid (Myristic acid)	Long-chain saturated fatty acid (fatty acyl)	Antibacterial, antifungal, Impact positively on cardiovascular health, immunomodulatory functions and cosmetics [45, 46]
8	0.64	9-Octadecenoic acid (Z)- methyl ester	Fatty acid methyl ester	Antioxidant activity [47]

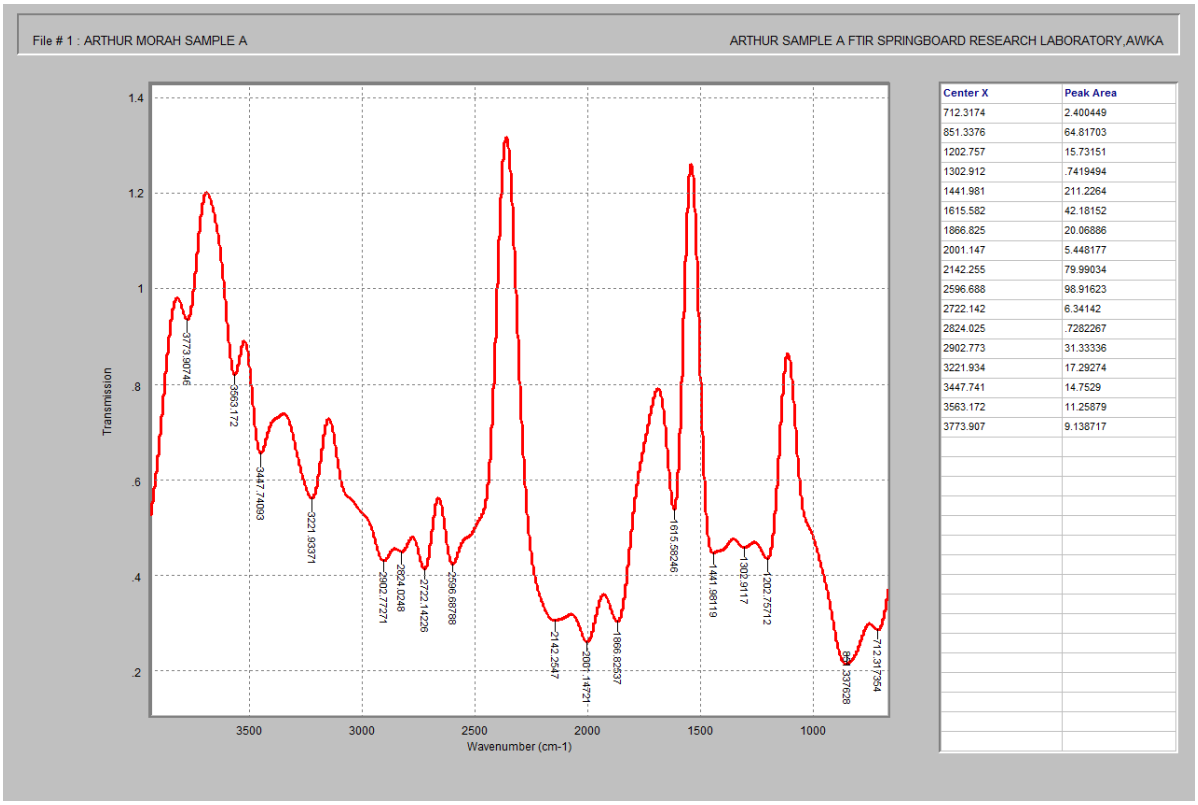

Figure 3 FTIR spectra of n-hexane extract of *Citrullus lanatus* seed

Legend: Sample A- *Citrullus lanatus*

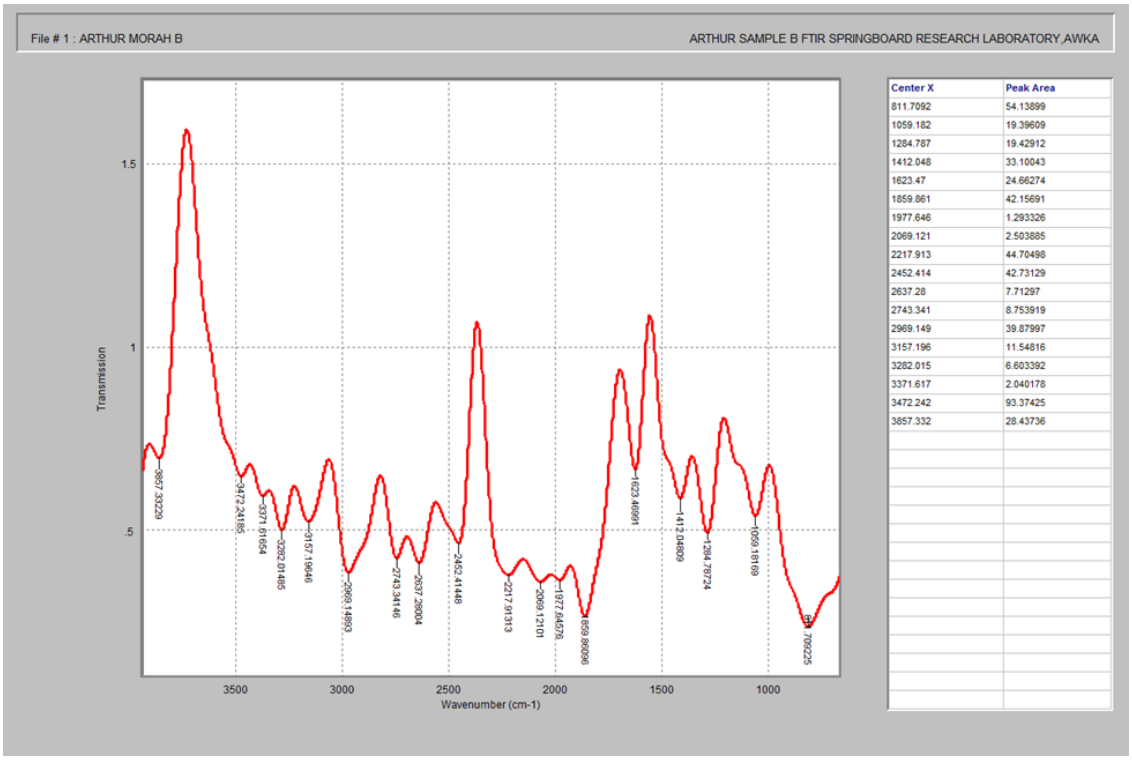

Figure 4 FTIR spectra of n-hexane extract of *Elaeis guineensis* seed

Legend: Sample B- *Elaeis guineensis*

Table 5 Fourier Transform Infra-Red (FT-IR) result of n-hexane seed extract of *Citrullus lanatus*

S/N	Wavelength (cm^{-1})	Functional group	Inference
1	1202.757	R-O-R	Ether CO symmetric stretch
2	1302.912	H_2C=CH	Ethene C=C anti-symmetric stretch
3	1441.981	H_2C=CH	Ethene C=C anti-symmetric stretch
4	1615.582	RNH_3	1° amine N-H symmetric stretch
5	1866.825	R-O-R	Cyclic ester CO symmetric stretching vibration
6	2001.147	RCOOH	Carboxylic acid COO^- stretch
7	2142.255	RCOOH	Carboxylic acid COO^- stretch
8	2596.688	R-C≡N	Nitriles CN antisymmetric stretch
9	2722.142	CH_2	Methylene C-H symmetric stretching vibration
10	2824.025	CH_2	Methylene C-H symmetric stretching vibration
11	2902.773	CH_2	Methylene C-H symmetric stretching vibration
12	3221.934	RCHOH	1° alcohol OH symmetric stretch
13	3447.741	R_2NH	2° amine N-H symmetric stretch
14	3563.172	R_3CHOH	3° alcohol OH symmetric stretch
15	3773.907	R_3CHOH	3° alcohol OH symmetric stretch

Table 6 Fourier Transform Infra-Red (FT-IR) result of n-hexane seed extract of *Elaeis guineensis*

S/N	Wavelength (cm^{-1})	Functional Group	Inferences
1	1284.787	R-O-R	Ether CO symmetric stretch
2	1412.046	H_2C=CH	Ethene C=C anti-symmetric stretch
3	1623.470	RNH_3	1^o amine N-H symmetric stretch
4	1859.861	R-O-R	Cyclic ester CO symmetric stretching vibration
5	1977.646	R-O-R	Cyclic ester CO symmetric stretching vibration
6	2069.121	RCOOH	Carboxylic acid COO^- stretch
7	2217.913	RCOOH	Carboxylic acid COO^- stretch
8	2452.414	R-C≡N	Nitriles CN antisymmetric stretch
9	2637.280	CH_2	Methylene C-H symmetric stretching vibration
10	2743.341	CH_2	Methylene C-H symmetric stretching vibration
11	2969.149	CH_2	Methylene C-H symmetric stretching vibration
12	3157.196	RCHOH	1^o alcohol OH symmetric stretch
13	3282.015	RCHOH	1^o alcohol OH symmetric stretch
14	3371.617	R_2CHOH	2^o alcohol OH symmetric stretch
15	3472.242	R_2NH	2^o amine N-H symmetric stretch
16	3857.332	R_3CHOH	3^o alcohol OH symmetric stretch

Figure 1, Table 1 and Table 3 present the results of gas chromatography-mass spectrometric screening. Table 1 showed that twenty-five phytocompounds were identified in the n-hexane seed extract of *Citrullus lanatus* by GC-MS. Table 3 shows that twelve compounds of *Citrullus lanatus* have biological activity. The identification of the phytocompounds was confirmed based on the area percentage, retention time, molecular formula and molecular weight. The most abundant phytocompound identified was linoelaidic acid (58.79%), while other phytocompounds detected in significant amounts were n-hexadecanoic acid (16.82%), 9,12-octadecadienoic acid methyl ester (3.45%), 9,12-octadecadienoic acid (Z, Z) (0.91%), dodecanoic acid (0.12%), gamma-tocopherol (0.91%), squalene (0.75%) and other low-percentage compounds found were pentadecane, 2,6,10,14-tetramethyl (0.07%), cyclobutane 1,2-diphenyl (0.11%). Ashfaq and his team from Dehradun, India, conducted research on phytoactive compounds of *C.lanatus* methanol extract. 15.78 area percentage of n-hexadecanoic acid was found by them. This finding is similar to mine, which shows that the second most abundant bioactive compound is n-hexadecanoic acid (16.82%); however, their investigation also showed the presence of other bioactive compounds that we did not identify, and vice versa. Furthermore, the bioactive compounds identified in my GC-MS result includes 9, 12- octadecadienoic acid (Z, Z) methyl ester, n-hexadecanoic acid, hexadecanoic acid, gamma tocopherol (Vitamin E) and 9, 12-octadecadienoic acid (Z, Z), are consistent with the research conducted by [48]. For the study of heart disease, linoelaidic acid may be utilized [31]. Hemolytic 5-alpha-reductase inhibitory, hypocholesterolemic, nematicides, pesticide activities, antioxidant, antiandrogenic and flavoring agents are all positively impacted by N-hexadecanoic acid [26–28]. According to Smith [35], squalene has anti-cancer properties. Strong antioxidant and anti-inflammatory properties are present in gamma-tocopherol [37–39]. Abdel Hadj *et al.* [30] found out methyl stearate has potent antioxidant activity. Dodecane exhibited antibacterial properties [19], while 9, 12, Octadecadienoic acid (Z, Z) demonstrated antibacterial property [32, 33], 9, 12-Octadecadienoic acid methyl ester has antioxidant and antimicrobial property [29] and (2, 3-diphenylcycloproyl) methyl phenyl sulfoxide trans-1 also exhibited antimicrobial property [34].

GC-MS analysis revealed the presence of twenty-nine phytocompounds in the n-hexane seed extract of *Elaeis guineensis*, as indicated in Figure 2, Table 2 and Table 4. Dodecanoic acid (37.20%) is the most prevalent compound, followed by tetradecanoic acid (17.59%) and 6-octadecenoic acid (11.95%). N-hexadecanoic acid (9.93%), n-decanoic acid (6.32%) and octanoic acid (5.27%) are three more significant compounds that were identified in the *Elaeis guineensis* seed extract based on peak area percentage. Dodecanoic acid 3-dodecanoyloxy-propyl ester (0.09%) and glycerol tricaprylate (0.06%) were found, albeit in trace amounts. Phytocompounds detected by GC-MS from the n-hexane seed

extract of *Elaeis guineensis* fruit were studied by [49]. The results showed that the percentage concentration of tetradecanoic acid was 1.23%, the percentage concentration of n-hexadecanoic acid was 31.41%, and the percentage concentration of 9-Octadecenoic acid (Z) methyl ester was 3.91%. These compounds are similar to mine, which has an abundance of 17.59% for tetradecanoic acid, 9.93% for n-hexadecanoic acid and 0.64% for 9-octadecenoic acid (Z) methyl ester. They did, however, find other phytocompounds in their investigation that we did not identify and vice versa. *Elaeis guineensis* n-hexane extract contains a variety of bioactive compounds with a wide range of biological activities. Diglycerol has been shown by [40] to inhibit the growth of CD31-positive tumor blood vessels. N-decanoic acid is used to control seizures [41, 42]. Dodecanoic acid methyl ester, 3-furanacetic acid 4-hexyl-2, 5-dihydro-2, 5-dioxo- and Dodecanoic acid (lauric acid) have been demonstrated to have antibacterial and antifungal potential [22] [43], [44].

Citrullus lanatus n-hexane seed extract FT-IR results are presented in Figure 3 and Table 5. Plant extracts, biological compounds and synthetic compounds possess significant functional groups that can be identified using the spectroscopy method known as FTIR [50]. This study attributed the peak at 1202.757cm^{-1} to the ether compound CO stretching vibration. The ethenes compound C=C anti-symmetric vibration was identified as the source of the absorbance around 1302.912 cm^{-1} and 1441.981 cm^{-1}, respectively. The medium band in the vicinity of 1615.582 cm^{-1} and 3447.741 cm^{-1} was identified as the N-H stretching vibration of the 1^{o} and 2^{o} amine compounds respectively. The CO stretching vibration of the cyclic ester compound was detected at a spectrum height of about 1866.825 cm^{-1}. The carboxylic acid compound COO^{-} stretching vibration was identified at wavelengths around 2001.147cm^{-1} and 2142.255cm^{-1}, respectively. The peak was attributed to the nitrile compound CN anti-symmetric stretching vibration. The C-H stretching vibration of the methylene molecule is shown by the weak bands at 2722.142 cm^{-1}, 2824.025 cm^{-1}, and 2902.773 cm^{-1}, respectively. Strong bands were identified as the OH stretching vibration of the 1^{o} and 3^{o} alcohols at 3221.934 cm^{-1}, 3563.172 cm^{-1} and 3773.907 cm^{-1} respectively.

The FT-IR result for the n-hexane seed extract of *Elaeis guineensis* is shown in Figure 4 and Table 6. The CO stretching vibration of the ether compound was attributed to the peak of approximately 1284.787 cm^{-1}. The absorbance at approximately 1412.046 cm^{-1} was attributed to the alkene compound C=C anti-symmetric vibration. The N-H stretching vibration of the 1^{o} and 2^{o} amine compounds was allocated to the medium band at about 1623.470cm^{-1} and 3472.242 cm^{-1}, respectively. Around 1859.861 cm^{-1} and 1977.646 cm^{-1} in the spectrum, there is a CO stretching vibration associated with the cyclic ester compound. Peaks associated with carboxylic acid compound COO^{-} stretching vibration were identified at around 2069.121 cm^{-1} and 2217.913cm^{-1}. The CN anti-symmetric stretching vibration of the nitrile compound was attributed to the peak at around 2452.414 cm^{-1}. The C-H stretching vibration of the methylene molecule is shown by weak bands at approximately 2637.280 cm^{-1}, 2743.341 cm^{-1} and 2969.149 cm^{-1} respectively. The OH stretching vibration of the 1^{o} and 3^{o} alcohols was identified as the source of strong bands at 3157.196 cm^{-1}, 3282.015 cm^{-1}, 3371.617 cm^{-1} and 3857.332 cm^{-1} respectively.

4. Conclusion

GC-MS and FT-IR analysis of the n-hexane seed extracts from *Citrullus lanatus* and *Elaeis guineensis* revealed a variety of bioactive compounds and functional groups, many of which are responsible for biological activities. The results of the study showed that gamma-tocopherol identified in n-hexane seed extract of *Citrullus lanatus*, has antioxidant and anti-inflammatory activities that help prevent oxidative stress and degenerative diseases. N-hexadecanoic acid and dodecanoic acid methyl ester are identified in n-hexane seed extract of *Elaeis guineensis* to have antimicrobial property for disease prevention and treatment.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare no conflict of interest.

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