Chemical Methodologies 5(2021) 240-249

Chemical Methodologies

Journal homepage: http://chemmethod.com

Original Research Article

Gas Chromatography-Mass spectrum and Infra-Red spectral analysis of Fixed Oil from Sudanese *Adansonia digitata* Seeds

Mohamed Aamer Abubaker[1,2], GuiGuo Huo[1], Jipeng Shi[1], Alsadig.A.M.Farah[2], Ji Zhang [1*]

[1]*College of Life Science, Northwest Normal University, Lanzhou 730070, China*
[2]*Department of Biology, Faculty of Education, University of Khartoum, Khartoum, 11111, Sudan*

ARTICLE INFO

Article history

Submitted: 2021-02-17
Revised: 2021-03-17
Accepted: 2021-03-27
Manuscript ID: CHEMM-2102-1319
Checked for Plagiarism: **Yes**
Language Editor:
Behrouz Jamalvandi
Editor who approved publication:
Dr. Hasan Karimi Maleh

DOI: 10.22034/chemm.2021.128584

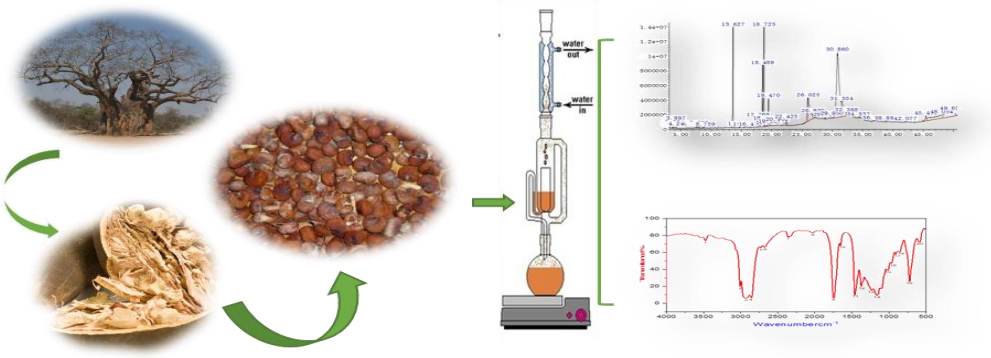
KEYWORDS

Adansonia digitate
Seed oil
Novel drugs
Therapeutic
Nutritional

ABSTRACT

The recent trend of using natural products from the plants, either as pure constituents or as standardised extracts, provides many opportunities for novel drugs, precisely the wild edible plants. The *Adansonia digitata* is considered one of the most important therapeutic and nutritional wild edible plants because of bioactive compounds existing in the seed oil; therefore, this study investigated the petroleum ether and methanol seed oil extracts via using two analytical methods [GC-MS, and FTIR spectrometer]. The seed oil was extracted by using Soxhlet apparatus. The GC-MS analysis of *A. digitata* seed oil showed thirty-five compounds. About twenty-four of them showed peak Area > 1%, The major compounds were eight, they showed peak area% (2.6%-1508%), namely Hexadecanoic acid, methyl ester, 9-Octadecenoic acid, methyl ester, (E), 9, 17-Octadecadienal, (Z), 9, 12-Octadecadienoic acid (Z, Z)-, methyl ester, Diethyl malonic acid, monochloride, hexadecyl ester, Malonic acid, 4-heptyl propyl ester, 9-Octadecenal, and (Z), 13-Tetradecen-1-ol acetate, while the FTIR spectrum showed functional groups for alcohols, phenols, alkanes, alkenes, carbonyls and Carboxylic acids and aromatic compounds in the petroleum ether and methanol extracts with different absorbance bands and their correspondences. The GC-MS and FTIR analysis showed the availability of bioactive compounds in the plant extracts, and these ingredients may be responsible of pharmaceutical value of the *A. digitata* plant.

GRAPHICAL ABSTRACT



* Corresponding author: Ji Zhang
✉ E-mail: zhangj@nwnu.edu.cn

Introduction

Wild edible plants are considered one of the most important natural products source in recent decades, representing the main source of natural medicine[1]. They are responsible for building the basis of traditional medicine systems [2]. The contribution of plants in the traditional medicine has an ancient history documented as old as 2600 B.C. [3]. Recently, there is a return to the use of natural products derived from the medicine plants, because of an unprecedented increase in the occurrence of multidrug-resistant (MDR) infections worldwide, according to the World Health Organisation (WHO) report [4]. Besides comparing natural products derived from wild plants with synthetic drugs, the natural products show less mischievousness, with continuous cytotoxicity assessment [5]. The Sudanese flora is wealthy with the variety of medicine plants [6]. Wherein 1996 the United Nations Industrial Development Organization (UNIDO) reported that about 90% of Sudanese people using medicine plants [7]. One of the most important Sudanese nutritional and therapeutic plants is called *Adansonia digitata*, known as baobab belonging to the malvaceae family plant. Morphologically it is a tree with a big trunk, and length of about 25m, classified as a perennial plant [8]. Different *Adansonia digitata* plant parts are vastly used as medicine and food sources [9]; the stem bark extract is used to treat human and animal diseases such as malaria fever and poultry diarrhoea, and the root bark showing antiviral and anti-bacterial impacts [10]. The leaves are essential food for many populations in Africa [11], which are used fresh or dried for making food [12]. The *A. digitata* fruits powder is rich in carbohydrate, and protein [13]. Besides possessing vitamin (C), the fruit pulp shows antioxidant activity[14]. There were total soluble solids (79.3%), and Total sugars (23.2%) [15]. The *A. digitata* seed is edible and possesses oil used in producing biofuel, and in the cosmetic industries [16], where the oil content in seed is about 33% [17]. Therefore, the seeds are considered an important part of the plant that can play an important role in the increasing food demands for the growing world population [18], due to high protein content in the seed oil, and its use in animal feeding [19]. Despite several studies on the seed oil, the knowledge of the nutrition and curative value of the ingredients is weak, so it is necessary to encourage the increased cultivation and consumption of this plant. The screening of chemical constituents also known as phytoconstituents is conducted with high cost and Gas Chromatography (GC) and liquid Chromatography (LC) techniques as well as specific detection schemes are applied, so recently phytochemical screening has become plain more than before by using GC-MS, FTIR, and other efficient techniques [20]. The aim of this study was to investigate the active chemical compounds of the Fixed Oil from Sudanese *Adansonia digitata* via using the GC-MS, and two types of FTIR Spectra (first–second derivative) analysis. This study was carried out to show that that seed oil is rich with many phytoconstituents which could be a novel drugs in future.

Material and methods

Chemicals and reagents

Methanol, Petroleum Ether, KBr, and all the chemicals and solvents were commercially graded and used after further purification.

Plant material

We purchased seeds of *Adansonia digitata* from the market in Khartoum, Om-Dorman, Sudan. The plant materials were washed thoroughly with distilled water to remove the dirt and other contaminations. After drying under ambient temperature, the pulp was removed carefully from seeds, and dried by using the technique of freezing and drying (Lyophilization).

Experiments

Oil extraction

The dried seeds of *A. digitata* were ground into powder. 100g of the powder was extracted with solvent by using Soxhlet extractor for (6 h). The

extracted oil was concentrated under pressure and stored in 4 ºC for further analysis.

Figure 1: Extraction *Adansonia digitata* seed oil

Oil preparation for GC test

The methods and conditions of preparation were set up according to the literature [21] with slight modification. 500 µL of *Adansonia digitata* seed oil was added into 10 mL centrifugal tubes, then 3 mL of H2SO4–MeOH solution (1 %) was added. The mixture was heated on water bath at 70 °C for 20 minutes. After cooling, 3 mL of n-hexane and 2 mL of distilled water were added and mixed completely. The extracts were prepared for GC analysis.

Preparation of FTIR Liquid sample (Seed Oil)

To prepare the liquid sample of *A. digitata* oil for FTIR analysis, a good thin layer of pellet dried KBr (Potassium bromide), and a small drop of the oil dropped via micropipette were used, then subjected to IR spectra.

GC-MS analysis

We exposed the sample of oil extracted to GC-MS HP6890/5973, Hewlett-Packard Company, USA for analysis. Injector temperature was 300 °C, and column description was Rtx 5MS-Length 30 meter-Diameter 0.25 mm- thickness 0.25 ml. Temperature programming maintained from 60 °C to 300 °C, pressure 100 Kpa, Total flow 50 ml/min, Column Flow 1.61 ml/min, Linear Velocity 46.3 cm/sec. The ion source ionizing energy was 70 eV; Scan range: 50-650 amu; and MS transfer line temperatures were 2500 °C, interface Temp. 250 °C, acetone solvent time 2.50 min. We injected the seeds fruits oil with a split less mode. We accomplished the ultimate confirmation of constituents via comparing their retention times and mass fragmentation patent with those available in the library of the National Institute of Standards and Technology (NIST). We recorded the results.

Result and Dissection

GC-MS result discussion

Petroleum ether *A. digitata* seed oil extract was investigated via using Gas Chromatography Mass Spectrum (GC-MS); the corresponding chromatogram is present in Figure 3. Identification of components for the sample was achieved by comparing their retention time (RT) and mass fragmentation patent (Table 1) with those available in the Wiley 9.0, NIST libraries, and with those published in the literature. The GC-chromatogram showed (thirty-five) components (twenty-four) of them as peak area %> 1% in Figure 2.

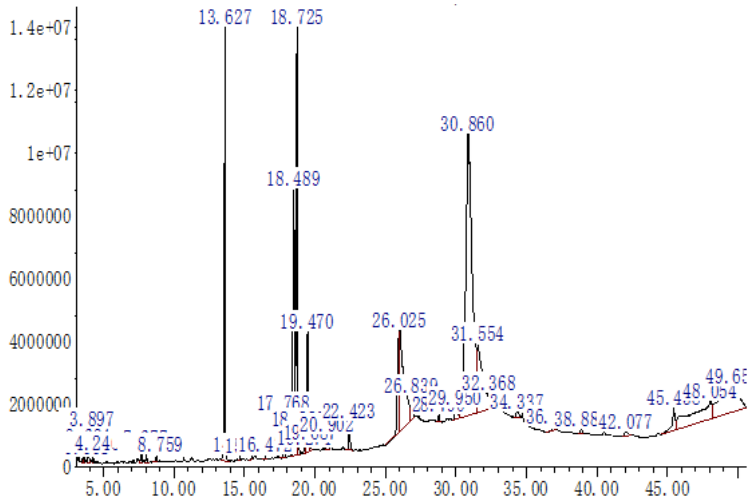


Figure 2: The GC Chromatogram of petroleum ether extract of *A. digitata* seed oil

Table 1: The chemical constituents of petroleum ether extract of *A. digitata* seed oil

Peak No	RT/min	Area	Area%	M.W	Identified Compounds
1	3.528	294148	0.30	240	Heptadecane
2	3.637	626219	0.64	226	Hexadecane
3	3.895	1191478	1.23	206	Phenol, 2,4-bis(1,1-dimethylethyl)-
4	4.248	399680	0.41	352	Pentacosane
5	7.676	610097	0.63	338	Tetracosane
6	8.036	383167	0.39	242	Tridecanoic acid, 12-methyl-, methyl ester
7	8.762	364865	0.37	282	Eicosane
8	13.63	14601612	15.08	270	Hexadecanoic acid, methyl ester
9	14.668	396569	0.40	266	2H-Pyran, 2-(7-dodecynyloxy)tetrahydro-
10	15.524	350041	0.36	280	9,12-Octadecadienoic acid (Z,Z)-
11	16.474	367316	0.37	284	Heptadecanoic acid, methyl ester
12	17.771	1695660	1.75	110	Bicyclo[4.1.0]heptane, 3-methyl-
13	18.49	8576963	8.86	294	9,12-Octadecadienoic acid (Z,Z)-, methyl ester
14	18.728	14599065	15.08	296	9-Octadecenoic acid, methyl ester, (E)-
15	18.823	1203975	1.24	296	cis-13-Octadecenoic acid, methyl ester
16	19.271	594956	0.61	324	*n*-Propyl 9-octadecenoate
17	19.468	4289703	4.43	298	Methyl stearate
18	19.685	773459	0.79	380	2-Methylhexacosane
19	20.90	1007965	1.04	308	Methyl 2-octylcyclopropene-1-octanoate
20	22.421	1424883	1.47	310	Cyclopropaneoctanoic acid, 2-octyl-, methyl ester
21	25.985	4338811	4.48	403	Diethylmalonic acid, monochloride, hexadecyl ester
22	26.026	4330568	4.47	244	Malonic acid, 4-heptyl propyl ester
23	26.84	2217464	2.29	326	Eicosanoic acid, methyl ester
24	28.789	1657828	1.71	282	Octadec-9-enoic acid
25	29.949	1839398	1.90	280	9,12-Octadecadienoic acid (Z,Z)-
26	30.859	10592170	10.94	264	9,17-Octadecadienal, (Z)-
27	31.552	3894977	4.02	266	9-Octadecenal, (Z)-
28	32.366	2350632	2.42	266	13-Octadecenal, (Z)-
29	34.335	1758547	1.81	280	Cyclopropaneoctanal, 2-octyl-
30	36.894	1259715	1.30	280	Cyclopropaneoctanal, 2-octyl-
31	38.883	1198491	1.23	264	1,2-Benzisothiazole, 3-(hexahydro-1H-azepin-1-yl)-, 1,1-dioxide
32	42.074	1122064	1.15	282	Oleic Acid
33	45.455	1877380	1.93	410	Squalene
34	48.055	2082036	2.15	264	1,2-Benzisothiazole, 3-(hexahydro-1H-azepin-1-yl)-, 1,1-dioxide
35	49.65	2528695	2.61	254	13-Tetradecen-1-ol acetate

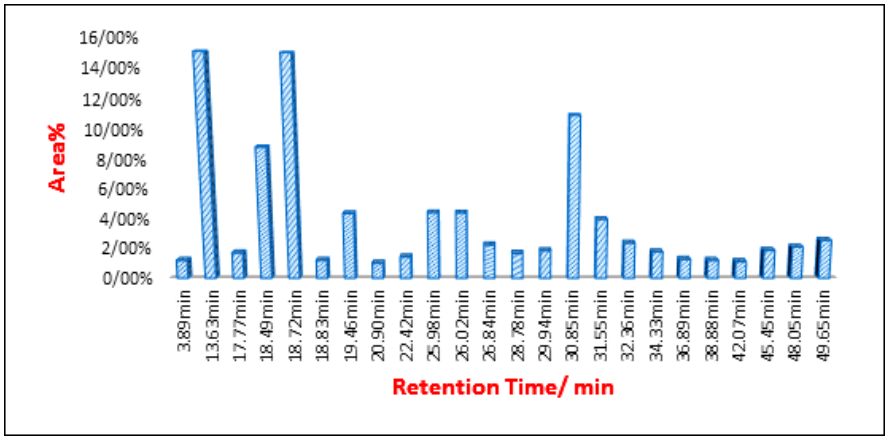
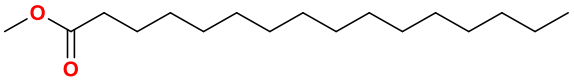
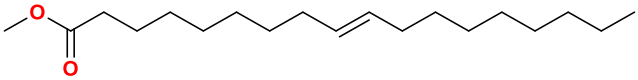
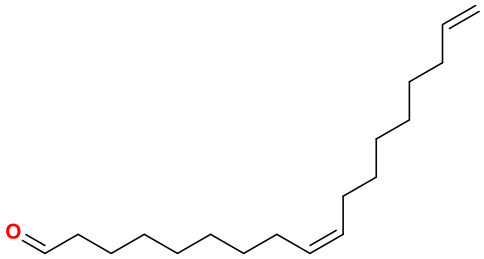
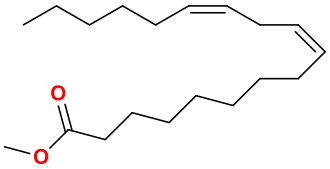
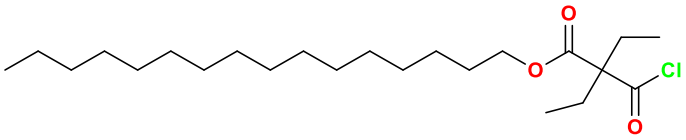
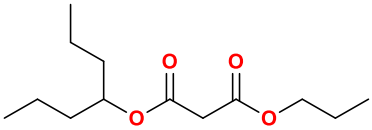
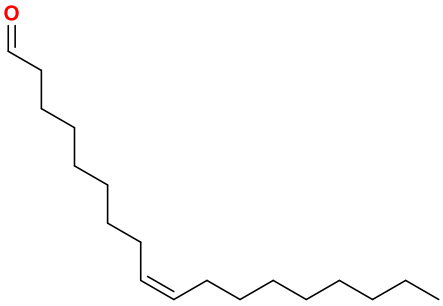
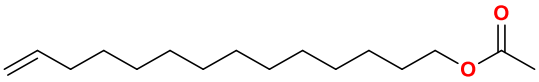


Figure 3: show the (24) compounds of *A. digitata* seed oil in the GC using Area > 1% and Retention time

The major compounds are eight , showing area% range (2.6-15.08)% in Table 2, are namely two compounds (8) and (14) which are presence in the GC at (13.6, and 18.7) minutes, with similar peak area (15.08%), their molecular formula ($C_{17}H_{34}O_2$, $C_{19}H_{36}O_2$), which corresponded to molecular weight m/z 270[M]$^+$, and m/z 296[M]$^+$, The two compounds are identified as Hexadecanoic acid, methyl ester, and 9-Octadecenoic acid, methyl ester, (E)-, which agree to [22], respectively. The Hexadecanoic acid, methyl ester as Fatty acid methyl ester showed Anti-oxidant, decrease the cholesterol in blood, and anti-inflammatory effect [23]. The compound (26) 9,17-Octadecadienal, which (Z)- appeared at (30.8) minute on the GC Chromatogram, with peak area% (10.9%), and molecular formula ($C_{18}H_{32}O$) is shown in Table 2, which produced molecular ion m/z 264[M]$^+$, identified as unsaturated aldehyde, and reported as anti-bacterial, matched with[24].Compound (13) show peak area% (8.86%), generated m/z 294 [M$^+$ at retention time (18.49) minute, showed molecular formula $C_{19}H_{34}O_2$, corresponded to 9,12-Octadecadienoic acid (Z,Z)- , methyl ester, showed Analgesic, anti-inflammatory and ulcerogenic activity[25]. The GC chromatogram at (25.98, 26.02, and 31.55) minutes showed three compounds with peaks Area% (4.48, 4.47, and 4.02) %, By formula ($C_{23}H_{43}ClO_3$, $C_{13}H_{24}O_4$, and $C_{18}H_{34}O$), produced molecular ion m/z 403[M]+, m/z 244[M]$^+$, and m/z 266[M]$^+$, respectively, corresponded to Diethylmalonic acid, monochloride, hexadecyl ester, Malonic acid, 4-heptyl propyl ester, and 9-Octadecenal, (Z), the last one presence anti-microbial and anti-inflammatory. They were identified in [26], [27]. The peak Area (2.6%) appeared in the GC at (49.65) min, with formula $C_{16}H_{30}O_2$, and MS m/z 254 [M]$^+$; the compound showed antibacterial activity, reported in [28]. The compound (29) appeared at two different RT in the GC at 34.3 and 36.8 minutes with different peaks area% (1.8 and 1.3), respectively.

Table 2: Structurer of the *A. digitata* seed oil's major compounds appearing on the GC-MS

No	Compound structure	Molecular Formula
1	 Hexadecanoic acid, methyl ester	$C_{17}H_{34}O_2$
2	 9-Octadecenoic acid, methyl ester, (E)	$C_{19}H_{36}O_2$

3	 9,17-Octadecadienal, (Z)-	$C_{18}H_{32}O$
4	 9,12-Octadecadienoic acid (Z,Z)-, methyl ester	$C_{19}H_{34}O_2$
5	 Diethylmalonic acid, monochloride, hexadecyl ester	$C_{23}H_{43}ClO_3$
6	 Malonic acid, 4-heptyl propyl ester	$C_{13}H_{24}O_4$
7	 9-Octadecenal, (Z)-	$C_{18}H_{34}O$
8	 13-Tetradecen-1-ol acetate	$C_{16}H_{30}O_2$

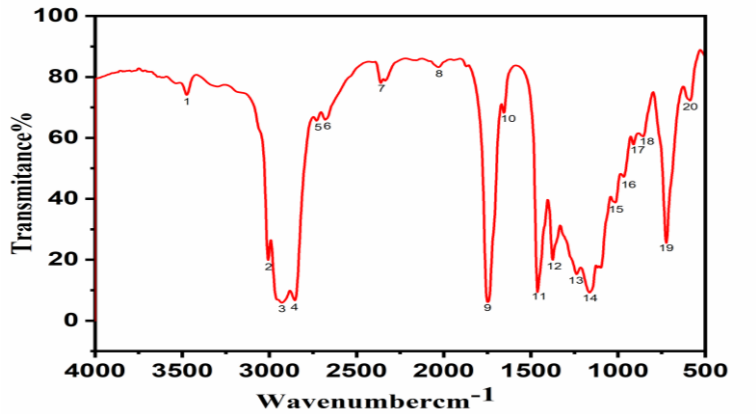


Figure 4: The FTIR spectra of Petroleum ether seed oil extract

Table 3: the functional groups in petroleum ether extract seed oil extract

No	Wavenumber cm^{-1}	Functional groups	Identification
1	3473.84 cm^{-1}	OH	Alcohol (w)
2	3007.09 cm^{-1}	C-H	aliph (w)
3	2929.44 cm^{-1}	C-H	aliph (b)
4	2853.83 cm^{-1}	C-H	aliph (s)
5	2729.41 cm^{-1}	C-H	Aldehyde (v.w)
6	2679.31 cm^{-1}	C-H	aliph (v.w)
7	2360.67 cm^{-1}	C≡C	aliphatic (m)
8	2335.37 cm^{-1}	C≡C	Alkyne (w)
9	1746.97 cm^{-1}	C=O	carbonyl (s)
10	1654.37 cm^{-1}	C=O	carbonyl (v.w)
11	1461.70 cm^{-1}	C=C	aromatic(s)
12	1375.09 cm^{-1}	C-O	alcohol (m)
13	1237.41 cm^{-1}	C-O	alcohol (w)
14	1163.12 cm^{-1}	C-O	ether (m)
15	1015.28 cm^{-1}	C-N	amine (w)
16	967 cm^{-1}	C-H	aromatic (w)
17	911.32 cm^{-1}	C=C	bending (w)
18	855.68 cm^{-1}	C-Cl	halo compound(w)
19	723.11 cm^{-1}	C-H	aromatic (s)
20	586.78 cm^{-1}	C-H	aromatic (w)

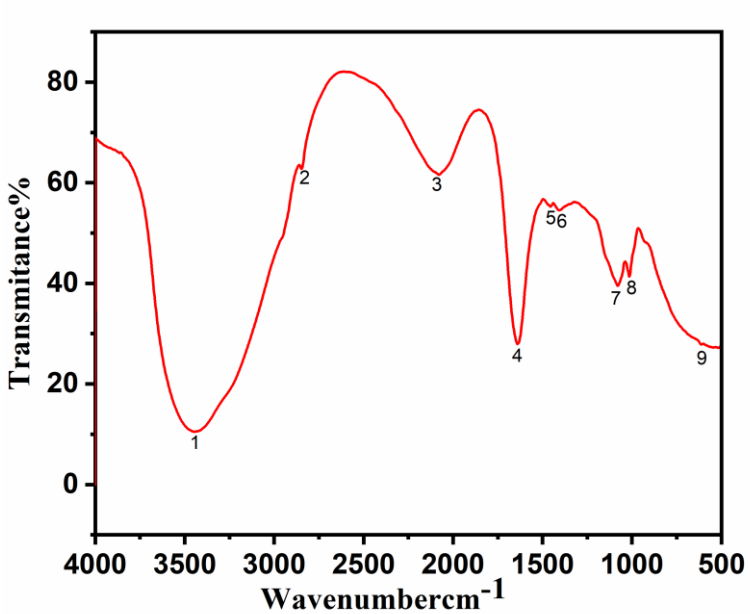


Figure 5: the FTIR spectra of Methanolic A. digitata seed oil extract

Table 4: the functional groups in Methanolic extract seed oil extract

No	Wavenumber cm^{-1}	Functional groups	Identification
1	3441.11 cm^{-1}	OH	Alcohol (v.br.)
2	2844.49 cm^{-1}	C-H	aliphatic (w)
3	2076.99 cm^{-1}	C≡C	aliphatic (br.)
4	1634.57 cm^{-1}	C=O	amides, Aromatic (s)
5	1453.77 cm^{-1}	C=C	cis (w)
6	1404.43 cm^{-1}	C=C	trans(w)
7	1079.40 cm^{-1}	C-O	alcohol (m)
8	1014.99 cm^{-1}	C-N	amine (w)
9	614.05 cm^{-1}	C-H	aromatic (br.)

Key: m = medium, v = very, s = strong, w = weak, br = broad

FTIR result discussion

The FTIR analysis was carried out for petroleum ether and methanolic extract, by using Mid-IR in the region (4000-500 cm^{-1}), after preparing the oil sample and was subjected to the IR. The result is shown in Figures 3 and 4. The IR spectra of the petroleum ether showed about twenty absorbance bands in different regions, showing the existence of several compounds. By dividing the IR result over regions similar to those in Figure 5, the Petroleum ether *A. digitata* seed oil in the region (3500-3000 cm^{-1}), the two bands at 3473.84 cm^{-1} and 3007.09 cm^{-1} were identified as OH, alcohol, C-H , aliph with weak stretch, in agreement with[29]. The four bands 2929.44 cm^{-1}, 2853.83 cm^{-1}, 2729.41 cm^{-1}, and 2679.31 cm^{-1} appear in region (3000-2500 cm^{-1}) corresponded to C-H, aliph.(b), C-H, aliph.(s), C-H, aldehyde (v.w), C-H , aliph (v.w), respectively, match with[30].

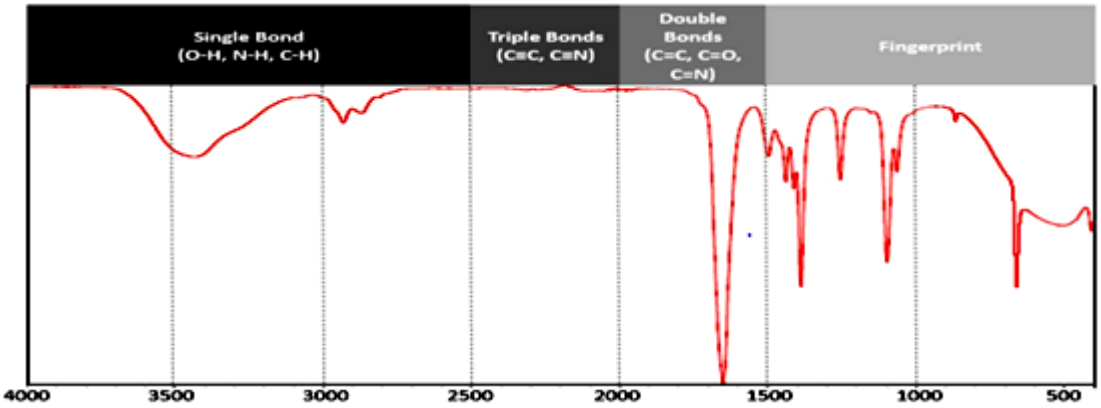


Figure 6: Mid-IR spectrum regions

The absorbance band at (2335.37 cm^{-1}) is shown in the region (2500-2000 cm^{-1}), showing weak C≡C, (Alkynes) [31]. The 1746.97 cm^{-1}, and 1654. 37 cm^{-1} are shown in the region (2000-1500cm^{-1}), because of strong band of C=O, carbonyl, and very weak band of C=O, carbonyl [32]. In the fingerprint region (1500-500 cm^{-1}) ten bands (1461.70 cm^{-1}, 1375.09 cm^{-1}, 1237.41 cm^{-1}, 1163.12 cm^{-1}, 1015.28 cm^{-1}, 967 cm^{-1}, 911.32 cm^{-1}, 855.68 cm^{-1}, 723.11 cm^{-1}, 586.78 cm^{-1}) are shown, which are identified as strong band of C=C , aromatic, medium band of C-O, alcohol, weak band of C-O, alcohol, medium band of C-O, ether, weak band of C-N, amine, weak band of C-H, aromatic, weak C=C bending, weak C-Cl, halo compound, strong C-H , aromatic, and C-H , aromatic. Methanolic *A. digitata* seed oil FTIR results showed nine absorbance bands in variety regions on IR, at the region (3500-3000 cm^{-1}), showing one very broad band at 3441.11 cm^{-1}, and the existence of OH, alcohol[33], the weak band at 2844. 49 cm^{-1}, because of C-H , aliphatic

[33]. The absorbance of broad band at 2076.99 cm^{-1} indicated C≡C, aliphatic [34]. The 1634.57 cm^{-1} was because of strong stretch of C=O, amides, Aromatic[35]. The fingerprint region (1500-500cm^{-1}) of methanolic oil extract shows five absorbance bands (1634.57 cm-1, 1453.77 cm-1, 1404.43 cm-1, 1079.40 cm-1, 1014.99 cm-1, and 614.05 cm-1), proved presence of weak band of C=C , cis, weak band of C=C, trans , medium band of C-O, weak band of alcohol C-N , amine, and broad band of C-H , aromatic.

FTIR second derivative for A. digitata seed oil fingerprint region

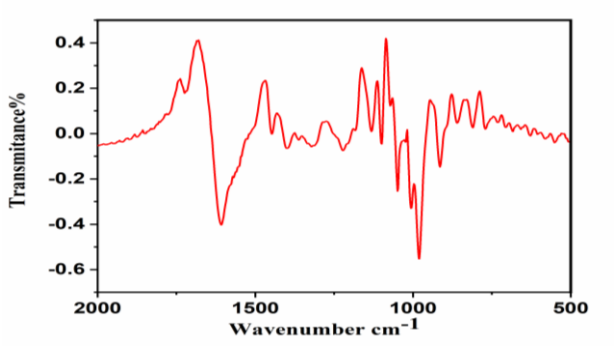


Figure 7: FTIR second derivative of *A. digitata* seed oil

The FTIR second derivative was conducted for *Adansonia digitata* seed oil for figure print region (1500-600 cm^{-1}). The result showed about twenty absorbance bands more than those appearing at first FTIR in Figures 3 and 4. We can confirm the origin of different extracts accurately and effectively, identify the medicinally important plant, and even assess the qualities of medicinal materials by investigating the finger print region [36].

Conclusion

We carried out this study to screen the phytochemical compounds that might be presented in the *Adansonia digitata* seed oil grown in Sudan, via using two advance analytical methods (GC-MS and FTIR). *Adansonia digitata* has been considered as one of the most important plants growing in Sudan, because of multiple nutritional and therapeutic lineaments, antioxidants, and antimicrobial activities behaviors, where fruit and seed have a potent source of numerous phytochemical compounds precisely polyphenol, flavonoids, Tannin, Alkaloids, Terpenoids, and saponins. The phytochemical screening by using GC-MS shown in the fixed petroleum ether oil extract of *A. digitata* seed possesses about thirty-five compounds, most of which possess bioactivity such as anti-bacterial, anti-fungi, and anti-oxidants agents. Besides, the technique of Mid-FTIR spectrum shows the presence functional groups of alcohols, phenols, alkanes, alkenes, carbonyls and Carboxylic acids and aromatic in the extracts with different absorbance bands and correspondences. This work has provided many ingredients that could be responsible for pharmaceutical value of this plant.

Acknowledgment

The authors would like to acknowledge Prof. Ji Zhang and the University of North West Normal - College of Life Science staff for support.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Authors' contributions

All authors contributed toward data analysis, drafting and revising the paper and agreed to be responsible for all the aspects of this work.

Conflict of Interest

We have no conflicts of interest to disclose.

References

[1]. Zhang Q.W., Lin L.G., Ye W. C., *Chinese Med.* 2018**, 13**:1

[2]. Cragg G.M., Newman D.J., *Biochim. Biophys. Acta - Gen. Subj.,* 2013**, 1830:**3670

[3]. Adhikari P.P., Paul S.B., *Asian J. Pharm. Clin. Res.,* 2018, **11**:421

[4]. Thomford N. E., Dimakatso Alice Senthebane, Arielle Rowe , Daniella Munro, Palesa Seele, Alfred Maroyi, and Kevin Dzobo, *Int. J. Mol. Sci.,* 2018,**19**:1578

[5]. Owolarafe T.A., Salau A.K., Salawu K., *Comp. Clin. Path.,* 2020, **29**:267
[6]. Hilmi Y., Abushama M.F., Abdalgadir H., Khalid A., Khalid H., B*MC Complement. Altern. Med.,* 2014, **14**:1
[7]. El-Kamali H.H., El-amir M.Y., *Curr. Res. J. Biol. Sci.,* 2010, **2:**143
[8]. Ibrahim A.Y., Mahmoud G., Asker M.M.S., *Int. J. Pharm. Sci. Rev. Res.,* 2014, **25:**174
[9]. De Caluwé E., Halamová K., Van Damme P., *ACS Symp. Ser.,* 2009, **1021:**51
[10]. Masola S.N., Mosha R.D., Wambura P.N., *African J. Biotechnol.,* 2009, **8:**5076
[11]. Shahzad A., E-*Jurnal Manaj. Univ. Udayana.*, 2019, **4:**1
[12]. Ogbaga C.C., Nuruddeen F.A., Alonge O.O., Nwagbara O.F., 2017, *13th Int. Conf. Electron. Comput. Comput. ICECCO.,* 2018, **2018:**1
[13]. Braca A., Sinisgalli C., De Leo M., Muscatello B., Cioni P.L., Milella L., Ostuni A., Giani S., Sanogo R., *Molecules*., 2018, **23:**3104
[14]. Kaboré D., *African J. Food Sci*., 2011, **5:**833
[15]. Gebauer J., El-Siddig K., Ebert G., *Gartenbauwissenschaft*., 2002, **67**:155
[16]. Warra A.A., Sheshi F., *Am. J. Chem. Appl*., 2015, **2:**110
[17]. Komane B.M., Vermaak I., Kamatou G.P.P., Summers B., Viljoen A.M., *Rev. Bras. Farmacogn.,* 2017, **27:**1
[18]. Asemave K., Anure T.T., *Prog. Chem. Biochem. Res.,* 2019, **2:**92
[19]. Babiker S., Mirghani M.E.S., Matar S.M., Kabbashi N.A., Alam M.Z., Marikkar J.M.N., *Int. Food Res. J.,* 2017, **24:**441
[20]. Visveshwari M., Subbaiyan B., Thangapandian V., *Int. J. Pharmacogn. Phytochem. Res*.., 2017, **9:**914
[21]. Wang J.U.N., Wu W., Wang X., Wang M.I.N., Wu F., *J. Serbian Chem. Soc.,* 2015, **80:**9
[22]. Shaheed K.A., Algaraawi N.I., Alsultany A.K., Abbas Z H., Khshayyish I.K., Al Khazali M.T., *IOP Conf. Ser. Earth Environ. Sci*.,2019, **388**:012064
[23]. Belakhdar G., Benjouad A., Abdennebi E.H., *J. Mater. Environ. Sci.,* 2015, **6**: 2778
[24]. Krishnamoorthy K., Subramaniam P*., Int. Sch. Res. Not.,* 2014, **2014**:1
[25]. Hadi M.Y., Mohammed G.J., Hameed I.H*., J. Pharmacogn. Phyther.,* 2016, **8:**8
[26]. Talha N.S., Sulaiman S., Azmi A.S., *J. Teknol*., 2017, **79:**67
[27]. Extract M., Cypraea O.F., *J. Pharm. Res.,* 2015, **5:**800
[28]. Tayade A.B., Dhar P., Kumar J., Sharma M., Chauhan R.S., Chaurasia O.P., Srivastava R.B., *PLoS One*., 2013, **8:**e52797
[29]. Dos Santos M.A.Z., Alicieo T.V.R., Pereira C.M.P., Ramis-Ramos G., Mendonça C.R.B., *JAOCS, J. Am. Oil Chem. Soc.,* 2014, **91:**19
[30]. Painter P.C., Snyder R.W., Starsinic M., Coleman M.M., Kuehn D.W., Davis A., *Appl. Spectrosc.*, 1981, **35:**475
[31]. Nikalje G.C., Kumar J., Nikam T.D., Suprasanna P., *Biotechnol. Reports. Elsevier B.V.,* 2019, **23:**e00352
[32]. Endrawati Y.C., Solihin D.D., Suryani A., Subyakto A., *J. Sci. Ind. Res. Ser. A: phys. sci.,* 2019, **62:**38
[33]. Pandya K.Y., *Res. J. Appl. Sci.,*2017, **6:**1
[34]. Susumu K., Therien M.J., *J. Porphyr. Phthalocyanines,* 2015, **19:**205
[35]. Durgawale T., Durgawale P., Khanwelkar C., *Int. J. Pharm. Sci.,* 2019, **10:**2250
[36]. Vijayalakshmi R., Ravindhran R., *Asian Pac. J. Trop. Biomed*., 2012, **2:**S1367

HOW TO CITE THIS ARTICLE
Mohamed Aamer Abubaker, Gui Guo Huo, Jipeng Shi, Alsadig.A.M.Farah, Ji Zhang. Gas Chromatography-Mass spectrum and Infra-Red spectral analysis of Fixed Oil from Sudanese *Adansonia digitata* Seeds, Chem. Methodol., 2021, 5(3) 240-249
DOI: 10.22034/chemm.2021.128584
URL: http://www.chemmethod.com/article_128584.html