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Evaluation of Phytoconstituents of *Solenostemon monostachyus* by FTIR, UV-VIS and GC-MS Spectroscopic Analysis

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Authors' contributions

This work was carried out in collaboration between all authors. Author ABO designed the study, performed the analysis, wrote the protocol and wrote the first draft of the manuscript. Authors OP and IO managed the literature searches. All authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

Spectroscopic techniques can advantageously be employed for qualitative and quantitative analysis of plant isolates. In the present work, we dealt with the nature of visible absorption spectra of hexane and methanolic isolates of a medicinal plant *S. monostachyus*. *S. monostachyus* is a plant known to be rich in phytoconstituents that are regarded as compounds possessing beneficial biological activities and, in view of these phenomena, an attempt at identifying such phytoconstituents present in *S. monostachyus* was undertaken.
Spectroscopic data of methanolic isolate gave UV max at 215 nm (Emax 21000) with an average sharp peak indicating the chromophore –C=C- (K-band, Emax > 10000). There was a major I.R band of 2955.10 cm^{-1} (C-H stretch) of alkyl group among others. The GC-MS detected Octacosane (RT: 27.651, 13.25%), large molecular weight hydrocarbon and hexadecane (RT: 25.557, 13.00%) while the hexane isolate gave UV max at 224 nm (Emax 13000) with an average sharp peak indicating the chromophore –COO^- (K band, Emax > 10000). Major I.R bands

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were 2919.14 cm^{-1} (C-H stretch), 1741.21 cm^{-1} (C=O) among others. The GC-MS detected Hexadecanoic acid (RT: 16.608, 40.16%), a large molecular fatty acid and Oleic acid (RT: 19.017, 21.54%).

Keywords: Phytoconstituents; functional group; S. monostachyus FTIR; UV-VIS and GC-MS.

1. INTRODUCTION

The characterization of plant metabolites is important as it relates to the nature and extent of therapeutic action possible with its use. Therefore, screening of plant extracts for their anti-oxidative and antimicrobial abilities has assumed a great significance [1]. There are varieties of techniques which are used to determine and estimate the presence of bioactive substances in medicinal plants such as alkaloids, terpenoids, flavonoids, steroids, tannins, phenolic compounds and others that provide definite physiological action in the human body [2]. These phytochemicals are planted metabolites often termed 'secondary metabolites', they form the basis of the medicinal importance of plants and have shown to alter biological processes which may reduce the risk of chronic diseases in humans [3].

Solenostemon monostachyus P. Beauv which belongs to the family of *Lamiaceae* is an important herb that is widespread in West and Central Africa. It occurs as an annual weed in anthropogenic habitats and rocky savannahs. It is slightly succulent, aromatic and grows up to 100cm tall [4]. *Solenostemon monostachyus* is commonly called Monkey's potato. It is locally called *ębę kpu ahięmęn* by the Edos, *ariophe* by the Urhobos, *ironopolo* by the Yorubas, *sankwo* by the Hausas and *ntorikwot* by the Efiks [5].

In Southern Nigeria, *S. monostachyus* plant is believed to be of great medicinal value in the treatment of convulsion, tuberculosis, stomach-ache. For convulsion, the leaf juice is put in the eyes and for the treatment of tuberculosis; the crushed leaves are given with honey. The decoction of the leaves with *Piper guineense* is prescribed for the stomach –ache. The dose is a wine glass full thrice daily. Also, the decoction of the leaves with seven-pepper (*Capsicum annuum*) and crayfish is a good remedy for weak bladder [6].

Among the great Akan group, the Ehotile people in Cote d'ivoire use the leaf juice for the treatment of laryngitis (inflammation of the voice cord in the voice box) by swallowing the juice and for a headache a nose drop with leaf juice [7]. The present research work has been taken up to produce the UV-VIS, FTIR and GC-MS spectrum profile of *S. monostachyus.*

2. MATERIALS AND METHODS

2.1 Plant Material and Collection

The materials used in this research include the plant samples, the reagents used were of analytical grades and the instruments used for characterization were IR, UV and GC-MS Spectrophotometer. The fresh plant material *S. monostachyus* (whole plant) were collected from an open field in Ikpoba Okha area in Benin City, Edo State, Nigeria. The plants were identified and authenticated by Dr. Emmanuel Izaka Aigbokhan of the Department of Plant Biology and Biotechnology, University of Benin, Benin City, Edo State, Nigeria and a herbarium voucher specimen with number UBN/ PCG/1659 was deposited in the herbarium of the Department of Pharmacognosy, University of Benin, Benin City, Nigeria.

2.2 Preparation of Extracts

The whole plant of *S. monostachyus* was rinsed under running tap water and air dried at room temperature. The dried material was reduced to powdered form using wooden mortar and pestle. The pulverized plants were extracted with hexane, chloroform, ethyl acetate, butanol and methanol solvent successively on the same plant sample for isolation of possible phyto-constituents using soxhlet extractor. The extracts were concentrated and stored in the refrigerator until further use.

2.3 Isolation of the Hexane and Methanol Fractions

The hexane and methanol crude extract was purified using chromatographic tools such as TLC, VLC, Prep TLC and Column Chromatography. The column gave a pure fraction after carrying out TLC which gave a spot with a Rf value of 0.88cm for the hexane isolate and 0.90cm for the methanol isolate.

2.4 FTIR Analysis

The isolated samples were analyzed for functional and fingerprint regions using Bruker Alpha FTIR Spectrometer.

2.5 UV-VIS Analysis

The sample was analyzed for wavelength and absorbance using UV-2600 UV-Vis Spectrophotometer Shimadzu.

2.6 Gas Chromatography-Mass Spectrometer (GC-MS) Analysis

The gas chromatography was carried out using Agilent technologies 7890A couple with Agilent technologies 5975C VL MSD. The mobile phase is helium gas while the stationary phase was the column agilent technology HP5 MS with length 30 m, internal diameter 0.320 mm and the thickness 0.25 microns. The volume injected was 1 microlitre, oven initial temperature was 80°C to hold for 2 minutes. The mode was splitless and scan range was 35-55.

3. RESULTS

3.1 Functional Groups Identification

The FTIR spectrum was used to identify functional groups of the active components present in plant samples based on the peaks values in the region of IR radiation.

SMM1 (*S. monostachyus* methanol Isolate 1)

This was a colourless oily liquid obtained from the methanol fraction *S. monostachyus*.

3.2 UV-Vis Spectrophotometric Analysis

The UV-VIS profile of methanol plant extract was studied over the 200 to 900nm wavelength due to the sharpness of the peaks and proper baseline.

Table 1. IR Bands for SMM1(*S. monostachyus* methanol extract Isolate 1)

S/N	Peak frequency(cm^{-1})	Bond	Functional group Suspected
1	2955.10	C-H stretch	Alkyl (CH_3, CH_2,CH)
2	2849.26	C-H stretch	Alkyl (CH_3, CH_2,CH)
3	1462.84	C-H bend	Alkyl
4	1365.64	C-H stretch	Methyl
5	719.76	C-H bend	Mono substituted benzene

Table 2. UV Absorption maximum of SMM1

Maximum wavelength(nm)	Emax	Absorbance	Peak	Chromophore suspected
215	21000	3.80	Sharp	$-(C=C)_2-$

Table 3. GC –MS Spectra analysis of SMM1

Peak no	Retention time (mins)	Compound	Molecular weight(g/mol)	Molecular formular	Area percent (%)	Quality index
1	16.934	Eicosane	282.6	$C_{20}H_{42}$	1.55	95
2	19.749	Hexadecane	226.5	$C_{16}H_{34}$	4.84	95
3	21.243	Eicosane	282.6	$C_{20}H_{42}$	3.26	95
4	22.748	Hexacosane	366.7	$C_{26}H_{54}$	8.09	94
5	24.252	Tridecane, 7-hexyl-	268.5	$C_{19}H_{40}$	7.09	93
6	25.557	Hexadecane	226.5	$C_{16}H_{34}$	13.00	95
7	26.667	Eicosane	282.6	$C_{20}H_{42}$	10.59	97
8	27.651	Octacosane	394.8	$C_{28}H_{58}$	13.25	98
9	27.926	1-Hexacosene	364.7	$C_{26}H_{52}$	2.80	93
10	28.532	Eicosane	282.6	$C_{20}H_{42}$	9.90	97
11	29.345	Eicosane	282.6	$C_{20}H_{42}$	9.69	95
12	30.112	Heptadecane	240.5	$C_{17}H_{36}$	4.72	95
13	30.833	Eicosane	282.6	$C_{20}H_{42}$	4.30	95
14	32.183	Octadecane	254.5	$C_{18}H_{38}$	1.45	95
Total					94.53	

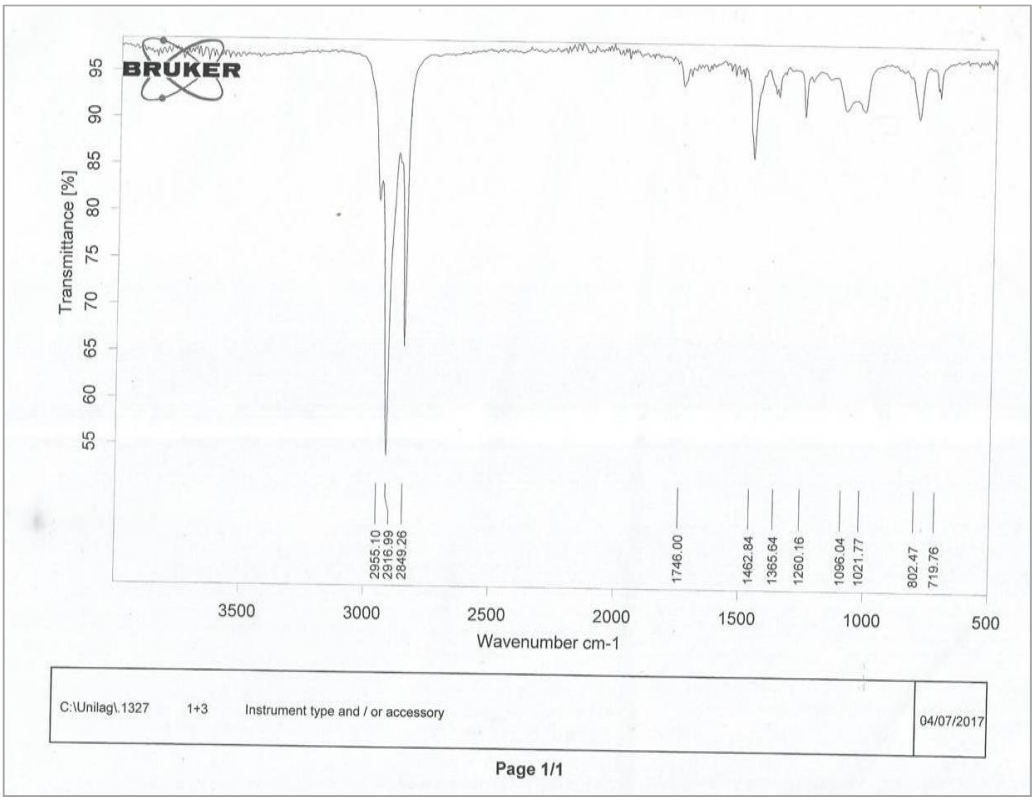

Fig. 1. FTIR spectrum of Methanol Isolate 1 of *Solenostemon monostachyus* (SMM1)

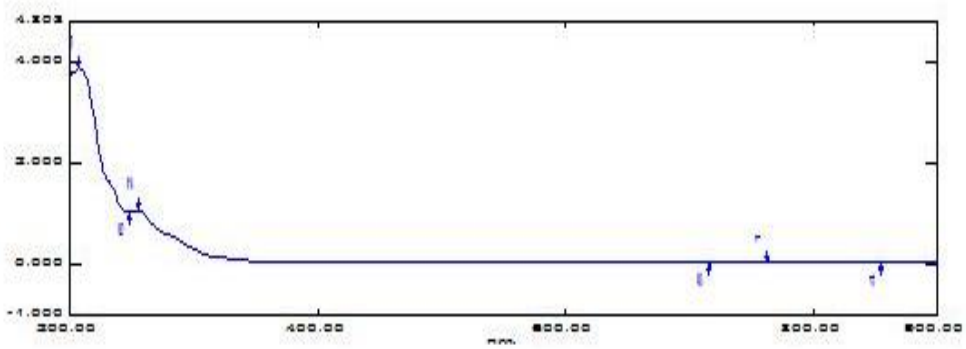

Fig. 2. UV-Vis spectrum of Methanol Isolate 1 of *Solenostemon monostachyus* (SMM1)

Table 4. IR Bands for SMH1 (*S. monostachyus* hexane extract Isolate 1)

S/N	Peak frequency(cm^{-1})	Bond	Functional group Suspected
1	2919.14	C-H stretch	Alkyl (CH_3, CH_2,CH)
2	2850.21	C-H stretch	Alkyl (CH_3, CH_2, CH)
3	1741.21	C=O	Esters RC(=O)OR
4	1461.69	C-H bend	Alkyl
5	1366.01	C-H stretch	methyl
6	720	C-H bend	Mono substituted benzene

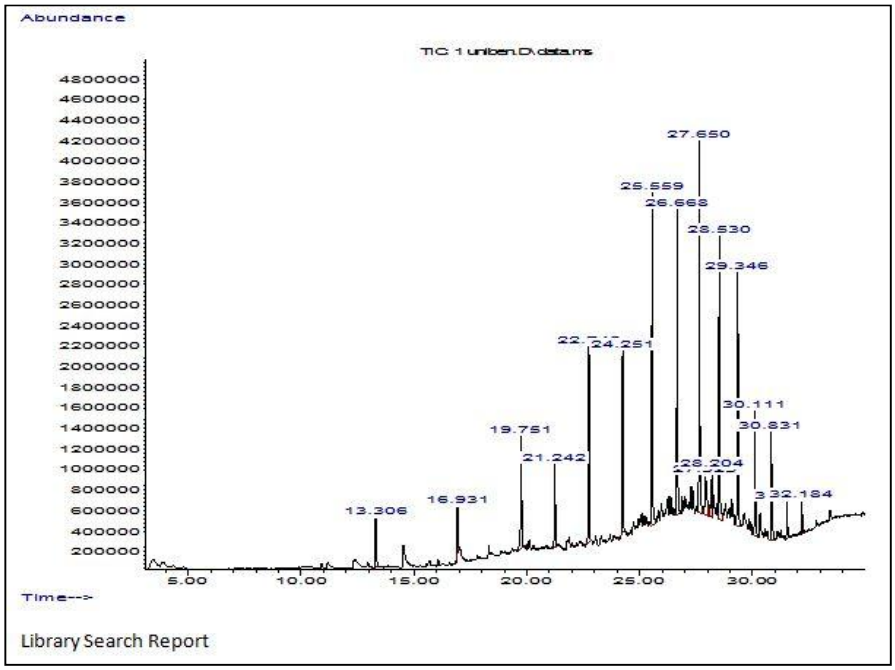

Fig. 3. GC-MS spectrum of Methanol Isolate 1 of *Solenostemon monostachyus* (SMM1)

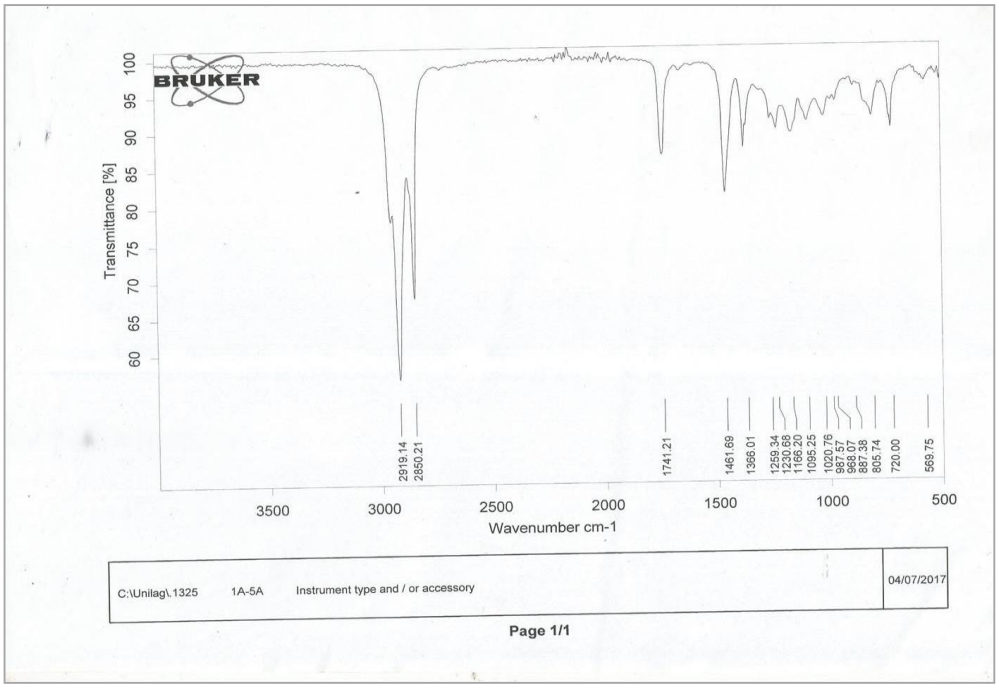

Fig. 4. FTIR spectrum of Hexane Isolate 1 of *Solenostemon monostachyus* (SMH1)

Table 5. UV Absorption maximum of SMH1 (*S. monostachyus* hexane isolate 1)

Maximum wavelength (nm)	Emax	Absorbance	Peak	Chromophore suspected
224	13000	4.18	Sharp	$-COO^-$

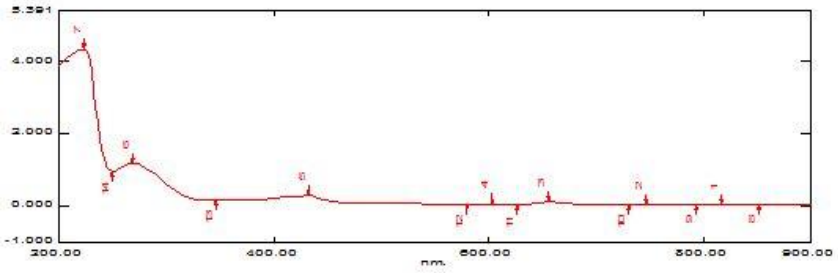

Fig. 5. UV-Vis spectrum of Hexane Isolate 1 of *Solenostemon monostachyus* (SMH1)

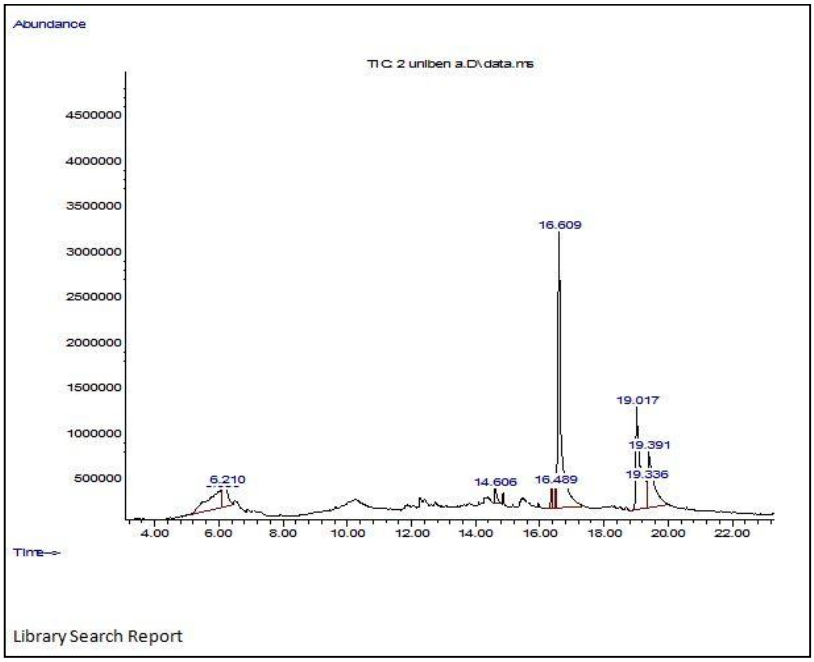

Fig. 6. GC-MS spectrum of Hexane Isolate 1 of *Solenostemon monostachyus* (SMH1)

Table 6. GC MS Spectrum analysis of SMH1

Peak no	Retention time (mins)	Compound	Molecular weight (g/mol)	Molecular formular	Area percent (%)	Quality index
1	16.385	Palmitoleic acid	254.4	$C_{16}H_{30}O_2$	1.49	98
2	16.471	Palmitoleic acid	254.4	$C_{16}H_{30}O_2$	2.04	99
3	16.488	9- Hexadecenoic acid	254.4	$C_{16}H_{30}O_2$	1.27	99
4	16.608	n- Hexadecanoic acid	256.4	$C_{16}H_{32}O_2$	40.16	99
5	19.017	Oleic acid	282.5	$C_{18}H_{34}O_2$	21.54	99
6	19.337	Oleic acid	282.5	$C_{18}H_{34}O_2$	1.02	98
7	19.389	Octadecanoic acid	284.5	$C_{18}H_{36}O_2$	14 25	99
Total					81.77	

3.3 GC-MS Spectrophotometric Analysis

The GC-MS chromatogram of the methanol isolate showed fourteen peaks. The chemical compounds identified in the isolate are present in Table 3.

SMH1 (*S. monostachyus* hexane Isolate 1)

This was a yellow oily liquid obtained from hexane fraction of *S. monostachyus.*

3.4 UV-Vis Spectrophotometric Analysis

The UV-VIS profile of plant extract was studied over the 200 to 900 nm wavelength due to the sharpness of the peaks and proper baseline.

3.5 GC-MS Spectrophotometric Analysis

The GC-MS chromatogram of the hexane isolate showed seven peaks. The chemical compounds identified in the isolate are present in Table 6.

4. DISCUSSION AND CONCLUSION

Spectroscopic data for methanol isolate gave UV max at 215 nm (Emax 21000) with an average sharp peak indicating the chromophore –C=C- (K-band, Emax > 10000). There was a major I.R band of 2955.10 cm^{-1} (C-H Stretch) of alkyl group among others. The GC-MS detected Octacosane (RT: 27.651, 13.25%) which is a large molecular weight hydrocarbon and hexadecane (RT: 25.557, 13.00%).

For the hexane isolate the UV max was at 224nm (Emax 13000) with an average sharp peak indicating the chromophore $–COO^{-}$ (^{1}K band, Emax > 10000). Major I.R bands were 2919.14cm^{-1} (C-H Stretch), 1741.21cm^{-1} (C=O) among others. The GC-MS detected Hexadecanoic acid (RT: 16.608, 40.16%) a large molecular fatty acid and Oleic acid (RT: 19.017, 21.54%). The combined I.R, UV and GC-MS analysis suggest that *Solenostemon monostachyus* hexane isolate 1 (SMH1) is a constituent of a fatty acid.

Further research should be aimed at performing the structural elucidation of the compounds by using different analytical methods such as NMR (^{1}H-NMR and ^{13}C-NMR).

In conclusion, the constituents of *S. monostachyus* have been analyzed and the whole plant of *S. monostachyus* displayed a significant qualitative and quantitative chemical profile of hydrocarbons and fatty acids.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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