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Original Research Article

Phytochemical Analysis and Chemical Characterization of Extracts and Blended Mixture of Palm Oil Leaf

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ABSTRACT

The importance of herbs and plant- related substances in the management of disease cannot be underestimated. The aim of this study was to determine the phytochemicals in oil palm leaf using various extracting solvents: water, methanol, ethanol, acetone and petroleum ether. Phytochemical analysis was carried out by standard procedure, while chemical composition was determined using GC-MS. The results showed that petroleum ether extract had the highest yield and was closely followed by methanol extract while the least yield was water extract. Phytochemicals analysis of crude oil palm leaves revealed the presence of saponins, steroid, flavonoid, reducing sugar, tannin and alkaloids. From the quantitative phytochemical analysis, reducing sugar had the highest percentage content and this was followed by tannin, alkaloids, cardiac glycoside and flavonoid. Saponin and steroid had the least percentage content. The results also showed that petroleum ether was the best extracting solvent compared to the other solvents used. The GC-MS identified a good number of phytochemicals in oil palm leaf. Thus, we suggest the possibility of utilizing oil palm leaf as a source of herbal remedy.

Keywords: GCMS, Oil palm, Phytochemicals, Solvents.

Introduction

Plants are regarded as indispensable and important component of human existence as they abound almost everywhere that humans exists. Simply put, man often lives in a symbiotic relationship with them as several human activities helps in providing the needed nutrient for their survival.[1-3] Plant growth and maturation leads to a continual source of nourishment in form of food and medicines for man.[4, 5] Several medicinal plants are used in different cultures for the purpose of curing, altering physiological and pathological conditions and are regarded as a major component of what is needed to sustain good health.[6-8]

Plant products are continually been explored for the synthesis of pharmaceuticals and their allied products. Thus the World Health Organization (WHO) submits that most developing nations depends on herbal medicines for their health needs.[9]The continual exploration of the characterization, isolation and purification of plant natural products as alternatives to synthetic drugs often harmful to man are increasingly been encouraged.[10,11] Thus the successful identification of chemical constituents of plants is continually an avenue for drug discovery needed to tackle different illnesses threatening human existence.[12]

Oil palm (*Elaeis guineensis*) is characteristically attributed to the tropical environment and isregarded as one of the largest sources of consumable vegetable oil. Its leaf however is a major waste of the palm oil production industry as it is mostly disregarded and allowed to rotten away after the oil palm fruit has been harvested.[13,14] The oil palm leaf is said to have several medicinal properties among which are wound healing,[15,16] antimalarial, antimicrobial,[17,18] anticancer,[11] antihypertensive, anti-diabetic and antidyslipidemic effects.[19,20] Bearing in mind the need to explore the medicinal prospects of this agricultural waste, this study was aimed at the characterization of the chemical constituents of the different solvent extracts of the oil palm leaf.

Materials and Methods

Oil Palm Leaf and Chemicals

Leaves of *Elaeis guineensis* were collected from Ovwor Mixed Secondary School in Ughelli, Delta State, Nigeria in the month of May 11, 2016. The leaves were authenticated and identified at Forestry Research Institute of Nigeria, Ibadan with voucher number of F101173.The solvents and reagentswere products of British Drug House Chemicals, Poole, England.

Preparation of Leaf Extracts and determination of yield

The leaves were rinsed with water to remove sand and unwanted materials. The palm leaves were sundried under partial shade to constant weight and then ground into fine particles using electric blender. One hundred grams (100g) of the powdered palm leaves was macerated in 400 mL of the respective solvents (water (40˚C), ethanol, methanol, acetone and petroleum ether (95% v/v) for 48 hrs. The mixtures were filtered with clean muslin cloth. The filtrate was concentrated using a rotary evaporator at 45^{o}C. The percentage yield of each extract was determined for each solvent. The samples were stored in refrigerator until needed for further analyses. From the crude extracts (water, ethanol, methanol, acetone and petroleum ether extract) 2.5 g of each was mixed together to generate the blended mixture.

Qualitative and Quantitative Phytochemical Analysis

The extracts of oil palm leaves were subjected to qualitative test for the presence of different bioactive components according to the methods described below. Reducing sugar, saponins, steroids and flavonoids were determined as described by Sofowora.[21] While alkaloids, tannins and cardiac glycosides were determined as

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describedby Trease and Evans.[22] The methods outlined by Harborne[23] was adopted in the quantitative determination of alkaloid, cardiac glycosides, reducing sugar and saponin contents. The tannin contents were estimated according to Sofowora[21]using tannic acid as standard.

Gas Chromatography Mass Spectrometry (GC-MS) Analysis

GC-MS was carried out using the method of Dhivya and Manimegalai.[24] Identification and quantification of the compounds based on their mass-to-charge ratio was determined by the mass spectrometer.[25]Chemical analysis was by triple quadruple gas chromatography mass spectrometry. Analysis was performed in TIC scan mode. Oven temperature was set at 50^{o}C for 2 min and programmed at 50^{o}C to 230^{o}C at a rate of 4^{o}C/min and at hold 230^{o}C for 2 min resulting in the complete elution of peaks analysed. The Identification of constituents was based on comparison of constituent of analyte in NIST Libraries using mass Hunter Software.

Results and Discussion

The percentage yield of the crude extracts of *E. guineensis* leaves (Table 1) indicates that petroleum ether extract had the highest yield and was closely followed by methanol extract while the least yield was waterextract. The possible reason for the high yield of petroleum ether in the extraction may be predicated on the type of phytochemical present in the oil palm leaves. The effects of type of phytochemical on yield as well as the efficacy of non-polar solvent have been reported previously.[26, 27] Moreover, the efficacy of methanol in the extraction of various phytochemicals is liberally reported.[28-30] This is predicated onthe polarity as earlier reported by El-mahmood *et al*[31]who noted that solvent polarity is a very significant factor in the extraction of plant active components.

The qualitative phytochemical screening of *E. guineensis* leaves in different solvents (water, ethanol, methanol, acetone, and petroleum ether) indicates the presence of phytochemical constituents in the different solvent extracts including the blended mixture of the extracts (Table 2).The quantification of phytochemicals present in oil palm leaves further confirmed the presence of saponins, steroids, flavonoids, reducing sugars, tannins and alkaloids (Table 3). Similar phytochemicals have also been previously reported to be present in oil palm leaf methanol extracts by Yin *et al.*[11]The presence of the various phytochemicals in all the solvents corresponds to previous studies which suggested that most organic solvents are able to dissolve many of the plant's chemical constituents.[26,27]The presence of alkaloids, tannins and flavonoids may be responsible for the plants earlier reported antioxidant activity and hence, the medicinal potentials of oil palm leaf as reported byFebrina *et al.*[32]For instance, saponins are reported to possess several anti-inflammatory activities and are often responsible for the anti-lipidemic properties contributing to the reductive capabilities of heart diseases found in most plants.[33-35]

Table 1: Percentage yield of the crude extracts of *E. guineensis* leaves

Extracting solvent	Leaves powder of *E. guineensis* (g)	Yield (%)
Water	100	6.16
Methanol	100	14.4
Ethanol	100	11.12
Acetone	100	12.8
Petroleum ether	100	17.25

Likewise, the alkaloids are said to possess anti-irritant, anti-secretolytic, antimicrobial and anti-parasitic effects.[36]

The GC-MS analysis of *E. guineensis* leaves extracts revealed the presence of various chemical constituents in the different solvent extracts, and were abundant in the following order: water extract < ethanol extract< acetone extract<methanol extract < petroleum ether extract < blended mixture. These chemical constituents are shown in tables 4, 5, 6, 7, 8a, 8b, 9a, 9b, 9c, 9d and 9e.

The possible reason the ethanol extract had more phytochemical than the water extract in the detection of the chemical constituents may be due to the high presence of a number of alkenes and long chain carboxylic acids which were not present in the water extract.[37] The acetone extract on the other hand had more constituents than the ethanol extract. The methanol extract of *E. guineensis* indicates the presence of more compounds and may be more effective than the ethanol extract due to the presence of four alkanol compounds, squalene and benzoic acid ester which were not found in the ethanol extract.[38]

The petroleum ether had the highest level of effectiveness in the detection and characterization of phytochemicals in *E. guineensis* leaf. Some chemicals which were not present in other solvent extracts were detected and this may also have occurred as a result of the high level of non-polarity of the petroleum ether. The higher number of chemicals in the petroleum ether extract may not be unconnected with hydrophobicity of the chemicals thereby making them more soluble in less polar solvents. However, evidence in literature submits that substances containing compounds with high level of hydrophobicity tend to dissolve more in high polar compounds.[39-41]. This may be the basis for the good number of possible chemicals detected in the methanol extract.

Table 2: Qualitative analysis of secondary metabolites of *E. guineensis* leaves

Phytochemicals	Water extract	Methanol extract	Ethanol extract	Acetone extract	Petroleum ether extract	Blended mixture of extracts
Alkaloids	+	+	+	+	+	+
Saponins	+	+	+	+	+	+
Tannin	+	+	+	+	+	+
Cardiac glycoside	+	+	+	+	+	+
Reducing sugar	+	+	+	+	+	+
Flavonoids	+	+	+	+	+	+
Steroids	+	+	+	+	+	+

+ = present.

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Table 3: Quantitative phytochemical screening of *E. guineensis* leaves crude sample.

Phytochemical	Mean ± SD (mg/g)
Alkaloids	3.54 ± 0.23
Saponins	0.45 ± 0.08
Tannins	4.22 ± 0.32
Cardiac glycoside	3.11 ± 0.34
Reducing sugar	7.34 ± 0.33
Flavonoids	2.89 ± 0.02
Steroids	0.36 ± 0.05

The blend of all solvent extracts of *E.guineensis* leaves revealed the presence of higher number of phyto-compounds (Tables 9a -e) which is a conglomeration of all the phyto-compounds present in all the solvent extracts.The presence of these phytochemicals makes oil palm leaf a potential nutraceutical.This assertion is in tandem with studies that opined thatseveral plant materials with pharmacological activities have been reported to have high levels of flavonoids, saponins, alkaloids and polyphenols.[42]

That different solvents detected different phytochemicals are no surprises as different solvents have been associated with different potentials in the dissolution of chemical compounds.[27, 29] Moreover, the current investigation had implicated petroleum ether as a potentially good extracting solvent for the phytochemicals inherent in oil palm leaf. However, it is apparent that combination of solvents is the ideal system for detection of most of the phytochemicals present in oil palm leaf.

Table 4: Possible phytocomponet of *E. guineensis* leaves water extract

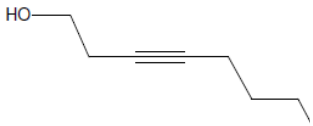
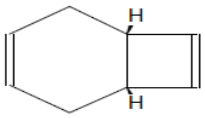
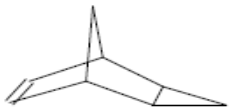
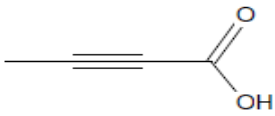
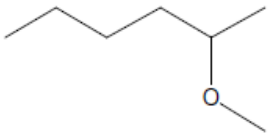
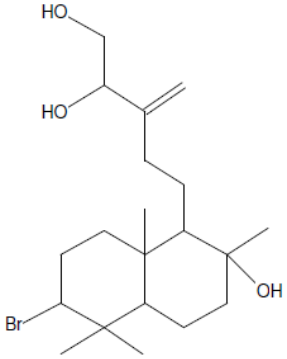
RT (min)	Molecular weight	Names	Formula	Compound nature	Structure
2.764	126	3-Octyn-1-ol	$C_8H_{14}O$	Alkanol	
2.982	106	cis-Bicyclo[4.2.0]octa-3,7-diene	C_8H_{10}	Alkene	
3.657	106	Tricyclo[3.2.1.0<2,4>]oct-6-ene,(1,2,4,5)-	C_8H_{10}	Alkene	
4.939	84	2-Butynoic acid	$C_4H_4O_2$	Carboxylic acid	
5.042	116	2-Hexanol, methyl ether	$C_7H_{16}O$	Alkanone	
14.872	184	11-Dodecenol	$C_{12}H_{24}O$	Alkanone	
22.574	402	1,2-Pentanediol, 5-(6-bromodecahydro-2-hydroxy-2,5,5a,8a-tetramethyl-1-naphthalenyl)-3-methylene-	$C_{20}H_{35}BrO_3$	Alkanol	

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Table 5: Possible phytochemical component of *E. guineensis* leaves acetone extract

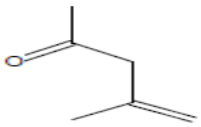
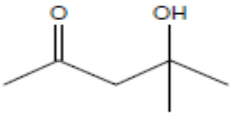
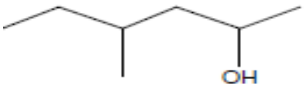
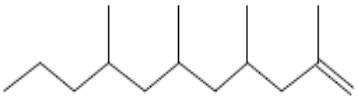
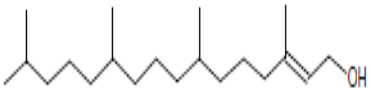
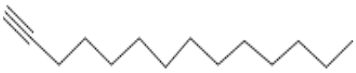
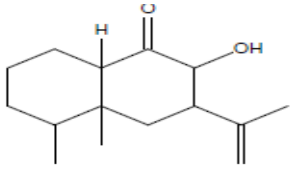
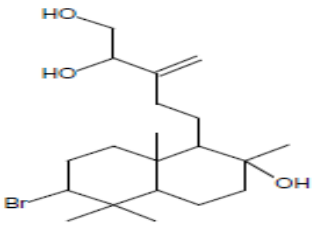
No.	RT (min)	Molecular weight	Names	Formula	Compound nature	Structure
1	4.309	98	4-Penten-2-one, 4-methyl-	$C_6H_{10}O$	Alkanone	
2	4.933	116	2-Pentanone, 4-hydroxy-4-methyl-	$C_6H_{12}O_2$	Alkanone	
3	14.872	116	4-Methyl-2-hexanol	$C_7H_{16}O$	Alkanol	
4	14.941	210	2,4,6,8-Tetramethyl-1-undecene	$C_{15}H_{30}$	Alkene	
5	15.335	278	Neophytadiene	$C_{20}H_{38}$	Alkene	
6	15.782	296	3,7,11,15-Tetramethyl-2-hexadecen-1-ol	$C_{20}H_{40}O$	Alkanol	
7	16.154	194	1-Tetradecyne	$C_{14}H_{26}$	Alkyne	
8	17.744	222	1-Hexadecyne	$C_{16}H_{30}$	Alkyne	
9	21.836	236	2R,3R,4aR,5S,8aS)-2-Hydroxy-4a,5-dimethyl-3-(prop-1-en-2-yl)octahydronaphthalen-1(2H)-one	$C_{15}H_{24}O_2$	Alkanone	
10.	24.742	402	1,2-Pentanediol, 5-(6-bromodecahydro-2-hydroxy-2,5,5a,8a-tetramethyl-1-naphthalenyl)-3-methylene-	$C_{20}H_{35}BrO_3$	Alkanol	

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Table 6: Possible phytocomponentof *E. guineensis* leaves ethanol extract

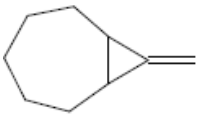
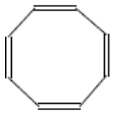
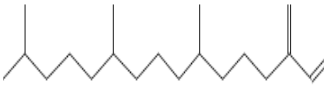
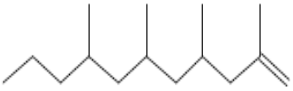
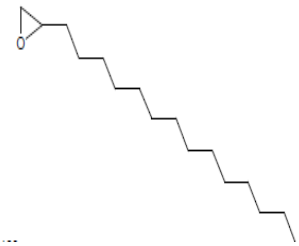
No.	RT (min)	Molecular weight	Names	Formula	Compound nature	Structure
1	2.861	122	Bicyclo [5.1.0] octane, 8-methylene-	C_9H_{14}	Cycloalkane	
2	10.901	104	1,3,5,7-Cyclooctatetraene	C_8H_8	Cyclolkene	
3	11.896	194	1-Tetradecyne	$C_{14}H_{26}$	Alkyne	
4	14.886	278	Neophytadiene	$C_{20}H_{38}$	Alkene	
5	14.964	210	2,4,6,8-Tetramethyl-1-undecene	$C_{15}H_{30}$	Alkene	
6	15.135	222	1-Hexadecyne	$C_{16}H_{30}$	Alkyne	
7	16.165	256	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	Carboxylic acid	
8.	17.750	240	Oxirane, tetradecyl-	$C_{16}H_{32}O$	Alkane	

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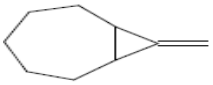
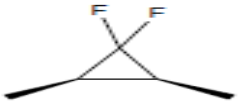
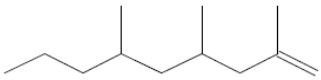
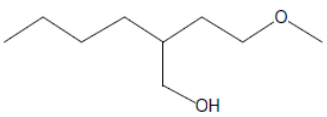
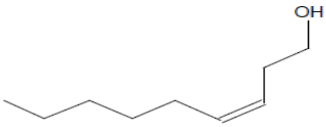
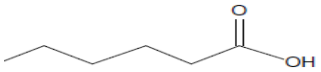
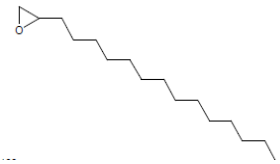
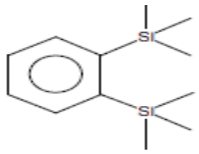
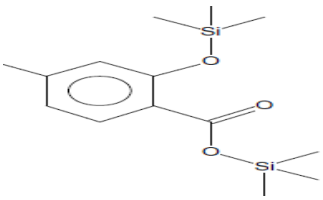
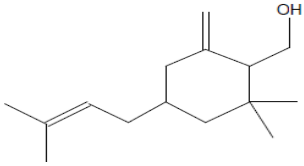
Table 7: Possible phytocomponentof *E. guineensis* leaves methanol extract

No.	RT (min)	Molecular weight	Names	Formula	Compound nature	Structure
1	2.861	122	Bicyclo [5.1.0] octane, 8-methylene-	C_9H_{14}	Cycloalkane	
2	5.150	106	1,1-Difluoro-cis-2,3-dimethyl-cyclopropane	$C_5H_8F_2$	Alkane	
3	14.872	168	2,4,6-Trimethyl-1-nonene	$C_{12}H_{24}$	Alkene	
4	14.941	160	1-Methoxy-3-hydroxymethylheptane	$C_9H_{20}O_2$	Alkane	
5	15.135	142	3-Nonen-1-ol, (Z)-	$C_9H_{18}O$	Alkanol	
6	15.347	142	2-Nonen-1-ol	$C_9H_{18}O$	Alkanol	
7	16.154	116	Hexanoic acid	$C_6H_{12}O_2$	Carboxylic acid	
8	16.159	184	Z-2-Dodecenol	$C_{12}H_{24}O$	Alkanol	
9	17.750	240	Oxirane, tetradecyl-	$C_{16}H_{32}O$	Alkane	
10	21.155	222	1,2-Bis(trimethylsilyl)benzene	$C_{12}H_{22}Si_2$	Benzene	
11	21.166	296	Benzoic acid, 4-methyl-2-trimethylsilyloxy-, trimethylsilyl ester	$C_{14}H_{24}O_3Si_2$	Benzoic acid ester	
12	22.516	222	1-Methylene-2b-hydroxymethyl-3,3-dimethyl-4b-(3-methylbut-2-enyl)-cyclohexane.	$C_{15}H_{26}O$	Cycloalkane	

ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

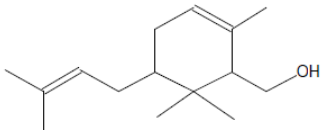
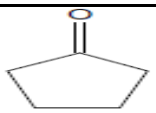
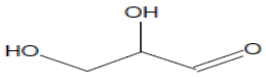
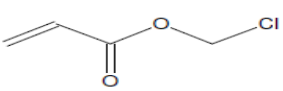
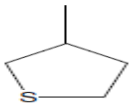
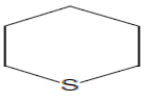
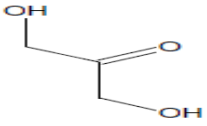
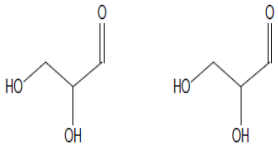
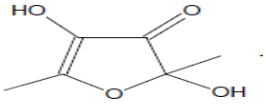
13	22.522	222	2,4,4-Trimethyl-3-hydroxymethyl-5a-(3-methyl-but-2-enyl)-cyclohexene	$C_{15}H_{26}O$	Cycloalkene	
14	24.147	222	Farnesol isomer a	$C_{15}H_{26}O$	Alkanol	
15	24.731	410	Squalene	$C_{30}H_{50}$	Squalene	

Table 8a: Possible phytocomponentof *E. guineensis* leaves petroleum ether extract

No.	RT (min)	Molecular weight	Names	Formula	Compound nature	Structure
1	3.623	84	Cyclopentanone	C_5H_8O	Alkanone	
2	4.778	90	Glyceraldehyde	$C_3H_6O_3$	Aldehyde	
3	5.213	120	2-Propenoic acid, chloromethyl ester	$C_4H_5ClO_2$	Alkanoate	
4	5.608	102	Thiophene, tetrahydro-3-methyl-	$C_5H_{10}S$	Thiophene	
5	5.614	102	Thiopyran, tetrahydro-	$C_5H_{10}S$	Thiopyran	
6	5.751	90	Dihydroxyacetone	$C_3H_6O_3$	Alkanone	
7	5.751	180	dl-Glyceraldehyde dimer	$C_6H_{12}O_6$	Aldehyde	
8	6.707	144	2,4-Dihydroxy-2,5-dimethyl-3(2H)-furan-3-one	$C_6H_8O_4$	Alkanoate	

ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

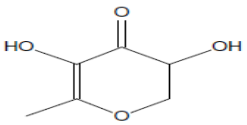
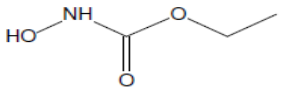
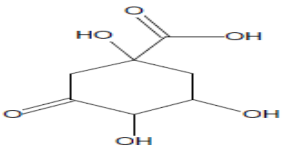
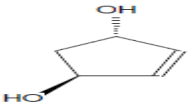
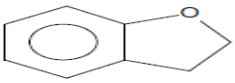
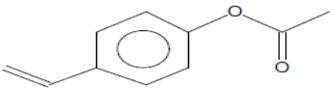
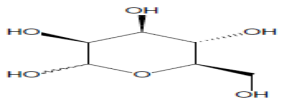
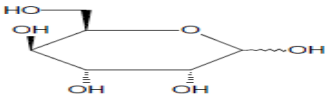
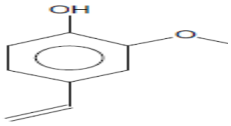
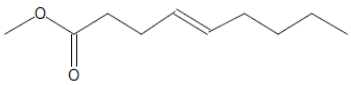
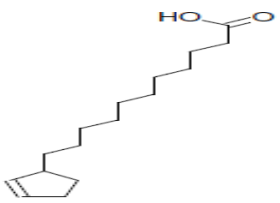
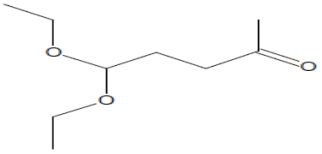
9	8.463	144	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	$C_6H_8O_4$	Alkanoate	
10	8.624	105	Carbamic acid, hydroxy-, ethyl ester	$C_3H_7NO_3$	Alkanoate	
11	9.030	190	Cyclohexan-1,4,5-triol-3-one-1-carboxylic acid	$C_7H_{10}O_6$	carboxylic acid	
12	9.104	100	4-Cyclopentene-1,3-diol, trans-	``$C_5H_8O_2$	Alkanol	
13	9.110	120	Benzofuran, 2,3-dihydro-	C_8H_8O	Furan	
14	9.305	162	Phenol, 4-ethenyl-, acetate	$C_{10}H_{10}O_2$	Phenol	

Table 8b: Possible phytocomponent of E. *guineensis* leaves petroleum ether extract

No.	RT (min)	Molecular weight	Names	Formula	Compound nature	Structure
15	9.591	180	D-Mannopyranose	$C_6H_{12}O_6$	Pyranose	
16	9.854	180	d-Gulopyranose	$C_6H_{12}O_6$	Pyranose	
17	9.860	150	2-Methoxy-4-vinylphenol	$C_9H_{10}O_2$	Phenol	
18	10.140	170	4-Nonenoic acid, methyl ester	$C_{10}H_{18}O_2$	Carboxylic acid	
19	10.489	252	11-(2-Cyclopenten-1-yl) undecanoic acid, (+)-	$C_{16}H_{28}O_2$	Carboxylic acid	
20	10.495	174	2-Pentanone, 5,5-diethoxy-	$C_9H_{18}O_3$	Ketone	

ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

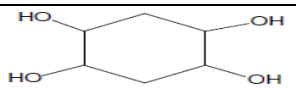
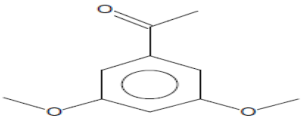
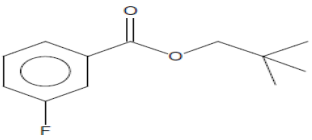
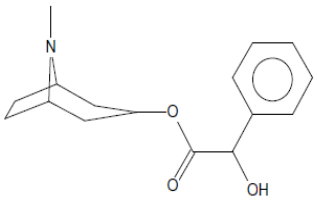
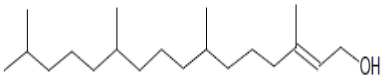
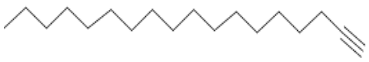
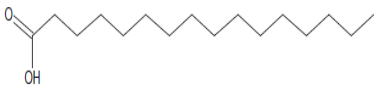
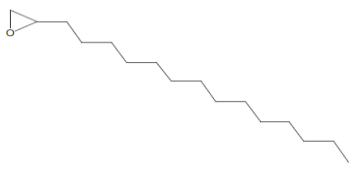
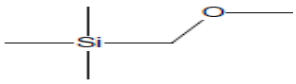
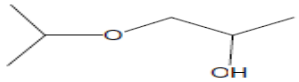
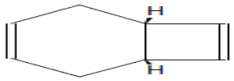
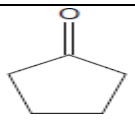
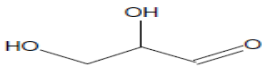
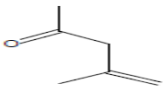
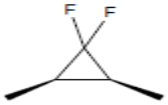
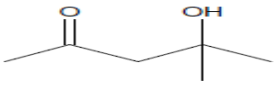
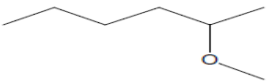
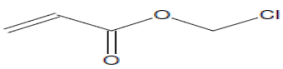
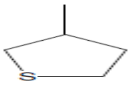
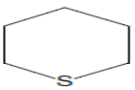
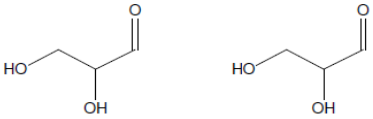
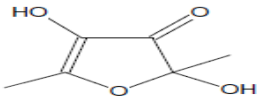
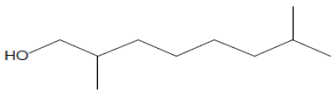
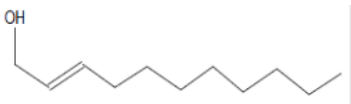
21	10.998	148	1,4,2,5 Cyclohexanetetrol	$C_6H_{12}O_4$	Polyhydric alcohol	
22	11.897	138	3-Methyl-2-(2-oxopropyl)furan	$C_8H_{10}O_2$	Furan	
23	12.068	180	3',5'-Dimethoxyacetophenone	$C_{10}H_{12}O_3$	Ketone	
24	13.207	210	3-Fluorobenzoic acid, 2,2-dimethylpropyl ester	$C_{12}H_{15}FO_2$	Benzoic acid	
25	14.540	275	Homatropine	$C_{16}H_{21}NO_3$	Amine	
26	14.866	296	3,7,11,15-Tetramethyl-2-hexadecen-1-ol	$C_{20}H_{40}O$	Alkanol	
27	15.341	250	1-Octadecyne	$C_{18}H_{34}$	Alkyne	
28	16.165	256	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	Carboxylic acid	
29	17.750	240	Oxirane, tetradecyl-	$C_{16}H_{32}O$	Alkane	

Table 9a: Possible phytocomponent of E. *guineensis* leaves extract of blended mixture

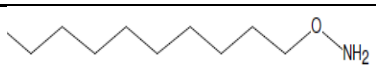
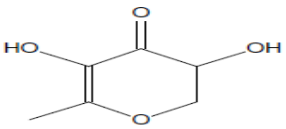
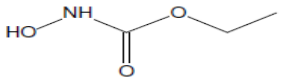
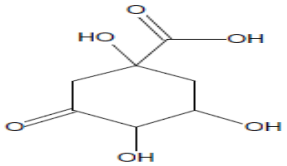
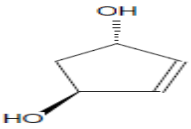
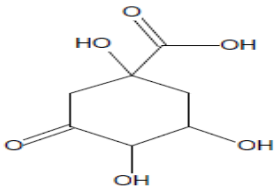
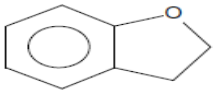
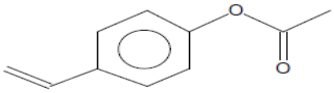
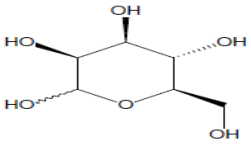
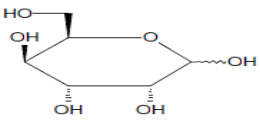
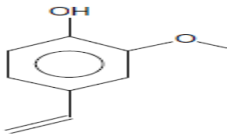
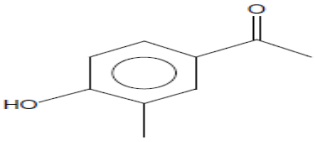
No.	RT (min)	Molecular weight	Names	Formula	Compound nature	Structure
1	2.839	118	Methoxymethyl) trimethyl silane	$C_5H_{14}OSi$	Alkoxyl alkane	
2	2.844	118	2-Propanol, 1-(1-methylethoxy)-	$C_6H_{14}O_2$	Alkanol	
3	2.982	106	cis-Bicyclo[4.2.0]octa-3,7-diene	C_8H_{10}	Alkene	

ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

4	3.789	84	Cyclopentanone	C_5H8O	Alkanone	
5	4.286	90	Glyceraldehyde	$C_3H_6O_3$	Aldehyde	
6	4.887	98	4-Penten-2-one, 4-methyl-	$C_6H_{10}O$	Alkanone	
7	4.910	106	1,1-Difluoro-cis-2,3-dimethyl-cyclopropane	$C_5H_8F_2$	Alkane	
8	4.962	166	2-Pentanone, 4-hydroxy-4-methyl-	$C_6H_{12}O_2$	Alkanone	
9	5.022	116	2-Hexanol, methyl ether	$C_7H_{16}O$	Alkanone	
10	5.213	120	2-Propenoic acid, chloromethyl ester	$C_4H_5ClO_2$	Alkanoate	
11	5.606	102	Thiophene, tetrahydro-3-methyl-	$C_5H_{10}S$	Thiophene	
12	5.672	102	Thiopyran, tetrahydro-	$C_5H_{10}S$	Thiopyran	
13	5.786	180	dl-Glyceraldehyde dimer	$C_6H_{12}O_6$	Aldehyde	
14	6.312	128	1H-Indene, 1-methylene-	$C_{10}H_8$	Indene	
15	6.707	144	2,4-Dihydroxy-2,5-dimethyl-3(2H)-furan-3-one	$C_6H_8O_4$	Alkanone	
16	7.474	158	1-Octanol, 2,7-dimethyl-	$C_{10}H_{22}O$	Alkanol	
17	7.645	170	trans-2-Undecen-1-ol	$C_{11}H_{22}O$	Alkanol	

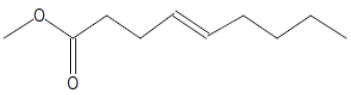
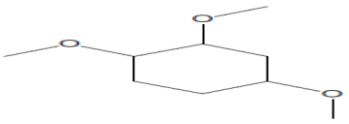
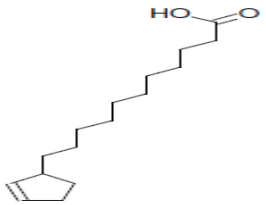
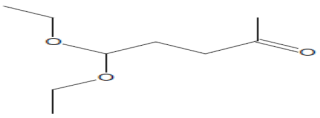
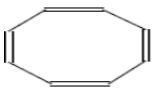
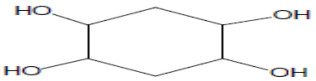
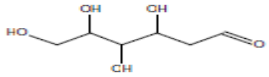
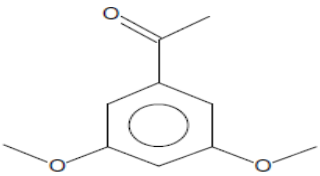
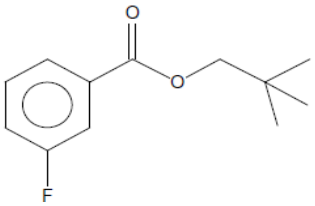
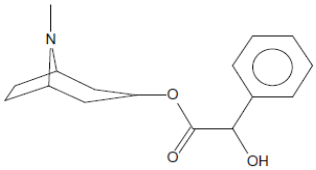
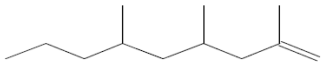
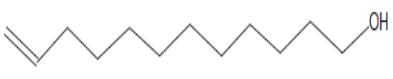
ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

Table 9b: Possible phytocomponentof*E.guineensis*leaves extract of blended mixture

No.	RT (min)	Molecular weight	Names	Formula	Compound nature	Structure
18	7.920	173	Hydroxylamine, O-decyl-	$C_{10}H_{23}NO$	Amine	
19	8.436	144	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	$C_6H_8O_4$	Alkanone	
20	8.458	73	o-Allylhydroxylamine	C_3H_7NO	Amine	
21	8.687	105	Carbamic acid, hydroxy-, ethyl ester	$C_3H_7NO_3$	Alkanoate	
22	8.767	190	Cyclohexan-1,4,5-triol-3-one-1-carboxylic acid	$C_7H_{10}O_6$	Carboxylic acid	
23	8.944	100	4-Cyclopentene-1,3-diol, trans-	$C_5H_8O_2$	Alkanol	
24	9.030	190	Cyclohexan-1,4,5-triol-3-one-1-carboxylic acid	$C_7H_{10}O_6$	Carboxylic acid	
25	9.087	120	Benzofuran, 2,3-dihydro-	C_8H_8O	Furan	
26	9.596	162	Phenol, 4-ethenyl-, acetate	$C_{10}H_{10}O_2$	Phenol	
27	9.705	180	D-Mannopyranose	$C_6H_{12}O_6$	Aldehyde	
28	9.837	180	d-Gulopyranose	$C_6H_{12}O_6$	Aldehyde	
29	9.905	150	2-Methoxy-4-vinylphenol	$C_9H_{10}O_2$	Phenol	
30	9.963	150	4-Hydroxy-3-methylacetophenone	$C_9H_{10}O_2$	Alkanone	

ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

Table 9c: Possible phytocomponentof*E.guineensis* leaves extract of blended mixture

No.	RT (min)	Molecular weight	Names	Formula	Compound nature	Structure
31	10.129	170	4-Nonenoic acid, methyl ester	$C_{10}H_{18}O_2$	Carboxylic acid	
32	10.495	174	Cyclohexane, 1,2,4-trimethoxy-, stereoisomer II	$C_9H_{18}O_3$	Cycloalkane	
33	10.563	252	11-(2-Cyclopenten-1-yl)undecanoic acid, (+)-	$C_{16}H_{28}O_2$	Carboxylic acid	
34	10.666	174	2-Pentanone, 5,5-diethoxy-	$C_9H_{18}O_3$	Alkanone	
35	10.878	104	1,3,5,7-Cyclooctatetraene	C_8H_8	Cyclolkene	
36	10.941	148	1,4,2,5 Cyclohexanetetrol	$C_6H_{12}O_4$	Polyhydric alcohol	
37	10.998	164	2-Deoxy-D-galactose	$C_6H_{12}O_5$	Aldehyde	
38	12.063	180	3',5'-Dimethoxyacetophenone	$C_{10}H_{12}O_3$	Alkanone	
39	13.236	210	3-Fluorobenzoic acid, 2,2-dimethylpropyl ester	$C_{12}H_{15}FO_2$	Alkanoate	
40	13.527	275	Homatropine	$C_{16}H_{21}NO_3$	Amine	
41	13.659	168	2,4,6-Trimethyl-1-nonene	$C_{12}H_{24}$	Alkene	
42	14.815	184	11-Dodecenol	$C_{12}H_{24}O$	Alkanol	

ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

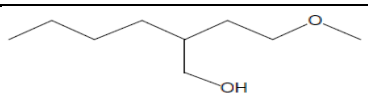
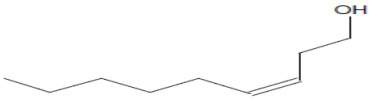
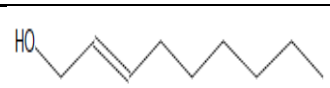
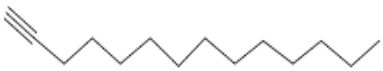
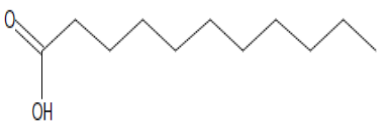
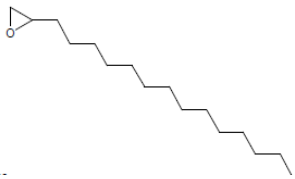
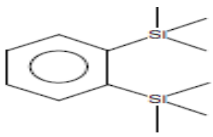
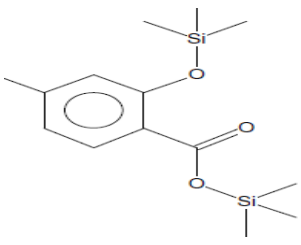
43	14.872	160	1-Methoxy-3-hydroxymethylheptane	$C_9H_{20}O_2$	Alkane	
44	14.941	142	3-Nonen-1-ol, (Z)-	$C_9H_{18}O$	Alkanol	

Table 9d: Possible phytocomponentof *E. guineensis* leaves extract of blended mixture

No.	RT (min)	Molecular weight	Names	Formula	Compound nature	Structure
45	15.004	142	2-Nonen-1-ol	$C9H_{18}O$	Alkanol	
46	15.135	194	1-Tetradecyne	$C_{14}H_{26}$	Alkyne	
47	15.273	222	1-Hexadecyne	$C_{16}H_{30}$	Alkyne	
48	15.336	250	1-Octadecyne	$C_{18}H_{34}$	Alkyne	
49	15.341	256	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	Carboxylic acid	
50	15.782	240	Oxirane, tetradecyl-	$C_{16}H_{32}O$	Alkane	
51	16.177	184	Z-2-Dodecenol	$C_{12}H_{24}O$	Alkanol	
52	17.842	222	1,2-Bis(trimethylsilyl)benzene	$C_{12}H_{22}Si_2$	Benzene	
53	17.945	296	Benzoic acid, 4-methyl-2-trimethylsilyloxy-, trimethylsilyl ester	$C_{14}H_{24}O_3Si_2$	Benzoic acid ester	

ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

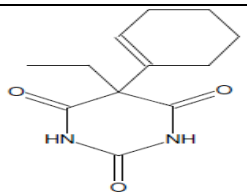
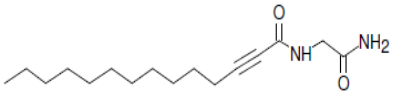
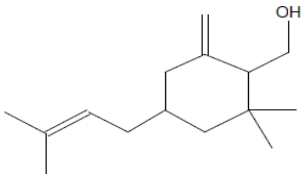
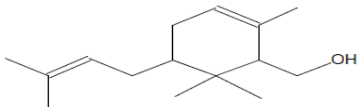
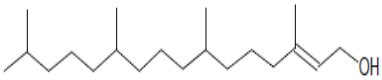
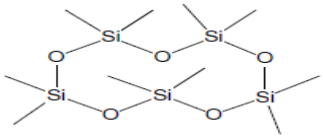
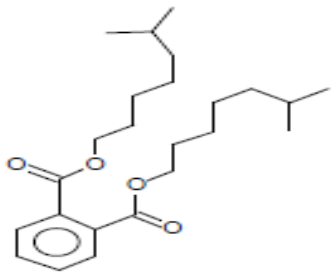
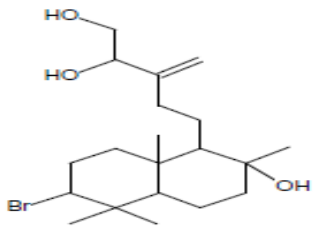
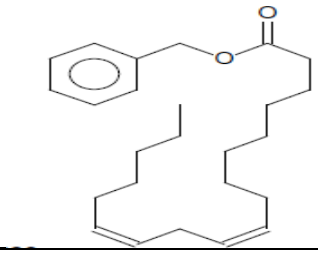
54	21.155	236	Cyclobarbital	$C_{12}H_{16}N_2O_3$	Amide	
55	21.166	280	2-Myristynoyl-glycinamide	$C_{16}H_{28}N_2O_2$	Amide	
56	21.418	222	1-Methylene-2b-hydroxymethyl-3,3-dimethyl-4b-(3-methylbut-2-enyl)-cyclohexane.	$C_{15}H_{26}O$	Cycloalkane	
57	21.830	222	2,4,4-Trimethyl-3-hydroxymethyl-5a-(3-methyl-but-2-enyl)-cyclohexene	$C_{15}H_{26}O$	Cycloalkane	

Table 9e: Possible phytocomponent of *E. guineensis* leaves extract of blended mixture.

RT (min)	Molecular weight	Names	Formula	Compound nature	Structure
22.516	296	3,7,11,15-Tetramethyl-2-hexadecen-1-ol	$C_{20}H_{40}O$	Alkanol	
22.522	370	Cyclopentasiloxan, decamethyl-	$C_{10}H_{30}O_5Si_5$	Cycloalkane	
22.591	390	Diisooctyl phthalate	$C_{24}H_{38}O_4$	Alkanoate	
24.722	402	1,2-Pentanediol, 5-(6-bromodecahydro-2-hydroxy-2,5,5a,8a-tetramethyl-1-naphthalenyl)-3-methylene-	$C_{20}H_{35}BrO_3$	Alkanol	
24.731	370	9,12-Octadecadienoic acid (Z,Z)-, phenylmethyl ester	$C_{25}H_{38}O_2$	Alkanoate	

Conclusion

This study revealed the presence of several phytochemicals of biological relevance and a good number of chemicals were identified in the different solvent extracts of oil palm leaves using GC-MS. The study also indicated that petroleum ether had the highest capability for extracting the components of the plant leaves, and the presence of these chemicals may suggest the possible utilization of the plant material in herbal medicine.

Conflict of interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

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References

1. Liu RH. Health benefits of fruit and vegetables are from additive and synergistic combinations of phytochemicals. Am J Clin Nutr. 2003; 78:517S–520S.
2. Probst YC, Guan VX, Kent K. Dietary phytochemical intake from foods and health outcomes: A systematic review protocol and preliminary scoping. BMJ Open. 2017; 7:e013337.
3. Elujoba AA, Odeleye, OM, Ogunyemi CM. Traditional medicine development for medical and dental primary health care delivery system in Africa. Afr J Trad Med. 2005; 2(1):46-61.
4. Aderogba MA, Akinkunmi EO, Mabusela WT. Antioxidant and antimicrobial activities of flavonoid glycosides from *Dennettia tripetala* G. Baker leaf extract. Nig J Nat Prod Med.2011; 15:49-52.
5. Lee KW, Bode AM, Dong Z. Molecular targets of phytochemicals for cancer prevention. Nat Rev Cancer. 2011; 11:211.
6. Chiwuzie J, UKoli F, Okojie O, Isah E, Eriator I. Traditional medicine has come to stay. Trad Med 1987; 8: 240-244.
7. Chelikani P, Fita I, Loewen P. Diversity of structures and properties among catalases. Cell. Mol. Life Sci. 2004; 61(2):192–208.
8. Upadhyay S and Dixit M. Role of polyphenols and other phytochemicals on molecular signaling. Oxid Med Cell Longev. 2015; 2015:1-15.
9. González-Vallinas M, González-Castejón M, Rodríguez-Casado A, Ramírez de Molina A. Dietary phytochemicals in cancer prevention and therapy: A complementary approach with promising perspectives. Nutr Rev. 2013; 71:585–599.
10. WHO. WHO monographs on selected medicinal plants. 1999; 1:1-295.
11. Yin NS, Abdullah S, Phin CK. phytochemical constituents from leaves of *Elaeis guineensis* and their antioxidant and antimicrobial activities. Int J Pharm Pharm Sci. 2013;5:137-140
12. Rout SP, Choudary KA, Kar DM, Das L and Jain A. Plants in traditional medicinal system - future source of new drugs. Int J Pharm Pharm Sci. 2009; 1:1-23.
13. Dauda Z, Hattaa MZM, Awang H. Oil palm Leaf and corn stalk – Mechanical properties and surface characterization. Procedia - Social Behav Sci. 2015; 195: 2047 – 2050.
14. Abdullah R. An examination of sources of instability in export earnings of Malaysia palm oil. Oil Palm Ind Econ J. 2011; 11(2):1-7.
15. Sasidharan S, Logeswaran S, Latha, LY. Wound healing activity of *Elaeis guineensis* leaf extract ointment. Int J Mol Sci. 2012; 13(1):336-347.
16. Rajoo A, Sasidharan S, Jothy SL, Ramanathan S,Mansor SM. Ultrastructural study of *Elaeis guineensis* (oil palm) leaf and antimicrobial activity of its methanol extract against *Staphylococcus aureus*. Trop J Pharm Res. 2013; 12:419-423.
17. Chonga KH, Zurainia Z, Sasidharanb S, Devib PVK, Lathac LY, Ramanathand S. Antimicrobial activity of *Elaeis guineensis* Leaf. Pharmacol online. 2008; 3:379-386.
18. Soundararajan V, Zuraini Z, Yeng C, Lachimanan YL, Jagat RK, Sreenivasan S. The antimicrobial efficacy of *Elaeis guineensis*: Characterization, *in vitro* and *in vivo* studies. Mol. 2012; 17:4860-4877.
19. Mohamed S. Oil palm leaf: A new functional food ingredient for health and disease prevention. J Food Proc Technol. 2014; 5:300.
20. Abdul-Razak M. The effects of Oil Palm Fronds (*Elaeis guineensis*) extract on Lipid Profile and antioxidant enzyme activity in Sprague dawley rats. 2009; MSc Thesis, Universiti Putra Malaysia
21. Sofowora A. Medicinal plants and traditional medicine in Africa, Spectrum Books Ltd, Ibadan, Nigeria. 1993. 289-290 p.
22. Trease GE and Evans WC. Pharmacognosy. 11th Ed, Bailliere Tindall Ltd, London. 1989. 60-75 p.
23. Harborne JB. Phytochemical Methods, London, Chapman and Hall, Ltd. 1973. 49-188 p.
24. Dhivya R and Manimegalai K. Preliminary phytochemical screening and GC-MS profiling of ethanolic flower extract of *Calotropis gigantean* Linn. (Apocynaceae). J Pharmacog Phytochem. 2013; 2(3):28-32.
25. Felhi S, Daoud A, Hajlaoui H, Mnafgui K, Gharsallah N, Kadri A. Solvent extraction effects on phytochemical constituents profiles, antioxidant and antimicrobial activities and functional group analysis of *Ecballium elaterium* seeds and peels fruits. Food Sci Technol.2017; 37(3):483-492.
26. Truong D, Nguyen DH, Ta NTA, Bui AV, Do TH, Nguyen HC. Evaluation of the use of different solvents for phytochemical constituents, antioxidants, and *in vitro* anti-inflammatory activities of *Severinia buxifolia*. J Food Qual. 2019, Article ID 8178294, 9 pages, 2019.
27. Kannamba B, Winnie TD, Surekha M, Lavanya B. Effect of extraction methods and solvent on phytochemical composition of medicinal plant extracts. Der Pharma Chemica. 2017; 9(9):152-156.
28. Thouri A, Chahdoura H, Arem AE, Hichri AOH, Hassin RB, Achour L. Effect of solvents extraction on phytochemical components and biological activities of Tunisian date seeds (var. Korkobbi and Arechti). BMC Compl Altern Med. 2017; 17:248.
29. Altemimi A, Lakhssassi N, Baharlouei A, Watson DG, Lightfoot DA. Phytochemicals: extraction, isolation, and identification of bioactive compounds from plant extracts. Plants 2017; 6:42.
30. Mahmood MA, Doughari JH, Chanji FJ. In vitro antibacterial activities of crude extract of *Nauclo alantifolia* and *Daniella oliveri.* Sci Res Essays. 2008; 3(3):102-105.
31. Febrina D, Febriyanti R, Zam SI, Handoko J, Fatah A, Juliantoni J. Antibacterial activity testing and ethanol

extract characterization of oil palm fronds (*Elaeis guineensis* Jacq). Pak J Nutr. 2018; 17:427-433.
32. Abiola MA, Sarah OO, Osasenaga MI, Okikiola HD, Omotayo MO. Phytochemical, minerals and free radical scavenging profiles of *Phoenix dactilyfera* L. seed extract. J Taibah Univ Med Sci. 2016; 11(1):1-6.
33. Moukette BM, Pieme CA, Njimou JR, Nya Biapa, CP, Marco B, Ngogang JY. In vitro antioxidant properties, free radicals scavenging activities of extracts and polyphenol composition of a non-timber forest product used as spice: *Monodora myristica*. Biol Res. 2015; 48:15.
34. Silva S, Gomes L, Leitão F, Coelho V, Boas L. Phenolic compounds and antioxidant activity of *Olea europaea* L. fruits and leaves. Food Sci Technol Int. 2006; 12:385-396.
35. Kumar M, Gupta V, Kumari P, Reddy C, Jha B. Assessment of nutrient composition and antioxidant potential of *Caulerpaceae* seaweeds. J Food Comp Anal. 2011; 24:270-278.
36. Ngo TV, Scarlett CJ, Bowyer MC, Ngo PD, Vuong QV. Impact of different extraction solvents on bioactive compounds and antioxidant capacity from the root of *Salacia chinensis* L.J Food Qual. 2017;Article ID 9305047, 8 pages, https://doi.org/10.1155/2017/9305047.
37. Dhawan D and Gupta J. Comparison of Different solvents for phytochemical extraction potential from *Datura metel* plant leaves. Int J Biol Chem. 2017; 11:17-22.
38. Spink CH and Wyckoff JC. The apparent hydration numbers of alcohols in aqueous solution. J Phys Chem. 1972; 76:1660–1666.
39. Snehlata K, Sheel R, Kumar B .Evaluation of phytochemicals in polar and non-polar solvent extracts of leaves of Aegle marmelos (L) . IOSR J Biotechnol Biochem. 2018; 4(5):31-38.
40. Widyawati PS, Budianta TDW, Kusuma FA, Wijaya EL .Difference of Solvent Polarity to phytochemical content and antioxidant activity of Pluchea indicia Less leaves extracts Int J Pharmacog Phytochem Res. 2014-15; 6(4); 850-855.
41. Nawaz H, Aslam M, Muntaha ST. Effect of solvent polarity and extraction method on phytochemical composition and antioxidant potential of corn silk. Free Rad Antioxid. 2019; 9(1):5-11.
42. Aziz NA, Halim UN, Abdullah NS. Phytochemical screening and *in vitro* antibacterial activity of *Elaeis guineensis* leaves extracts against human pathogenic bacteria. Malay J Anal Sci. 2015; 19(4):775 – 780.