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Gas Chromatography-Mass Spectrometry Analysis of Chemical Compounds in Ethanolic Extracts of *Guiera senegalensis* and *Geigeria alata*

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ABSTRACT

Background and Objective: Plants are considered as the primary source of drugs for humans. Plants are rich sources of primary and secondary metabolites. Over the previous decades, plants possessed biologically active metabolites, which have been proven powerful natural medicines. The objective of this research work was to explore the compounds present in the ethanolic extracts of two important Sudanese plant species, namely *Guiera senegalensis* and *Geigeria alata* by implicating Gas Chromatography-Mass Spectroscopy (GC/MS) technique. **Materials and Methods:** The powdered plants samples were extracted with ethanol using a hot extraction technique. The qualitative and quantitative analysis of the samples were carried out by using Gas Chromatography/Mass Spectrometry (GC/MS). **Results:** The main components of the ethanolic extract of the *Guiera senegalensis* were 1,2,3-benzenetriol (21%), ethyl alpha-d-glucopyranoside (16.72%), 4H-1-benzopyran-4-one, 2-(3,4-dihydroxy (12%) and quinic acid (11.73%). The main components of the ethanolic extract of *Geigeria alata* were azuleno[6,5-b]furan-2,6(3H,4H)-dione,3a (26.69%), n-hexadecanoic acid (8.72%) and 1,3-propanediol, 2-(hydroxymethyl)-2-nitro (5.90%). **Conclusion:** *Guiera senegalensis* is a rich source of sugars, alcohols and ketones whereas *G. alata* is a rich source of ketones, fatty acids, alcohols and steroidal compounds.

KEYWORDS

Guiera senegalensis, *Geigeria alata*, chemical profile, Sudanese medicinal plants, therapeutic potential, spectroscopic analysis

INTRODUCTION

Plants are considered as the primary source of drugs for humans. Plants are rich sources of primary and secondary metabolites. Over the previous decades, plants possessed biologically active metabolites, which have been proven powerful natural medicines.

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Guiera senegalensis L., a plant of the family Combretaceae, commonly known as "Gubeish", has played a very important role in traditional medicine in Africa including West Central Sudan, the leaves can be used as medicine to treat gastrointestinal disorders, cough and topically for wound healing. The leaves contain proanthocyanidins: (-)-epicatechin and (-)-epigallocatechin units. The ethanolic extract contains flavonoids, alkaloids, tannins, phenols, saponins, coumarins and terpenoids[1-3]. The studies of chemical composition showed that the main chemical components were beta-carboline alkaloids, harman, tetrahydroharman, guieranone A (a naphthyl butanone) it was exhibited potent antifungal activity against *Cladosporium cucumerinum*. Ethyl acetate fraction of *Guiera senegalensis* extract found to exhibit fungicidal property[4].

Methanolic extract of *G. senegalensis* extract contain the sugars, phospholipids, phytosterols, guieranone A, porphyrin-containing compounds and phenolics[5]. Alkaloidal extract, beta-carboline from *G. senegalensis* leaves presented an interesting antiplasmodial activity associated with a low cytotoxicity. This findings justified to traditional use of the plant to treat malaria[6]. Investigations on *G. senegalensis* have demonstrated to possess anti-inflammatory, antioxidant, antiasthmatic, anticancer and antimicrobial[1,2].

Geigeria alata, a plant of the family Asteraceae is commonly known as "Gud-gat". It has been used in West Central Sudan as a drug to treat diabetes, cough, epilepsy and intestinal complaints, antispasmodic, rheumatism and antihypertension[7-9]. *Geigeria alata* aerial parts essential oil contains alpha-longipinene, beta-caryophyllene, alpha-oxobisabolene and caryophyllene oxide[10]. The oil showed moderate *in vitro* cytotoxicity against some tumor cells[11]. The Trans-3,5-dicaffeoylquinic acid from *Geigeria alata* roots is slightly toxic and is a potent alpha-glucosidase inhibitor, reduces blood glucose and blood pressure in diabetic hypertension rats and prevents histopathological changes related to diabetes and hypertension[9]. A sesquiterpene lactone, geigerianolide and flavonoids such as axillarin, quercetin and hispidulin were isolated from *G. alata*[12]. Acyquinic acids in *G. alata* exhibit antioxidant and antimicrobial capacity[13].

Aqueous extract of *G. alata* after 14 days did not produce any significant change ($p<0.05$) on haematological parameters tested relative to their respective control group[14]. Analysis of two medicinal plants, *Guiera senegalensis* and *Geigeria alata* growing wild under Sudanese environmental conditions is important as there is little or no information on their chemical composition of ethanolic extracts.

In this study, the GC/MS technique was used, which is useful in detecting the compounds in studied plants and concentration distribution. The present investigation was carried out to determine the possible chemical components from ethanolic extracts of candidate plants using gas chromatography/mass spectrometry.

MATERIALS AND METHODS

Study area: This study was designed and carried out in the Department of Botany, Faculty of Science and Technology, Omdurman Islamic University, Omdurman, Sudan between November, 2016 and March, 2017.

Plant material: Plants samples, *Guiera senegalensis* and *Geigeria alata* were purchased from Omdurman Local Market in November, 2016. The voucher specimens were at Herbarium (Ref No. 430 and 512, respectively) of Department of Botany, Faculty of Science and Technology, Omdurman Islamic University.

Preparation of ethanolic extracts: The powdered samples were extracted with ethanol using a hot extraction technique. The powder was extracted separately with 50 mL ethanol by gentle reflux for 1 hr. After extraction, it was filtered and then the removal of solvent was done by a rotary evaporator. Then the (15 mL) was kept in a glass container.

Gas Chromatographic-Mass Spectrometry (GC/MS) analysis: The GC was equipped with MS (Shimatzo QP 2010 GC/MS instrument equipped with reference libraries). Packed material for column were 50% phenyl and 50% methyl polysiloscane, column length 30 m, diameter 0.025 mm, the flow rate of helium as carrying gas was 1 mL/min, the temperature of program consisted of 60-270°C , at rate of 4°C/min. The MS were taken at ionization voltage 70 EV. Library Search was carried out using Wiley GC/MS library. Interpretation on mass spectrum GC/MS was conducted using the database of National Institute Standard and Technology (NIST). The spectrum of the unknown component was compared with the spectrum of the known components stored in the NIST library. The retention time (TR), name of compound and area (%) of the components of the test materials were ascertained.

RESULTS AND DISCUSSION

GC/MS Analysis of *Guiera senegalensis*: Table 1 showed twenty nine compounds were identified from *G. senegalensis*. The 1,2,3-Benzenetriol (21%), Ethyl alpha-d-glucopyranoside (16.72%), 4H-1-Benzopyran-4-one, 2-(3,4-dihydroxy (12%), quinic acid (11.73%), sorbitol (7.49%) and n-hexadecanoic acid (5.06%) as the major phytochemical constituents.

GC/MS analysis of *Geigeria alata*: Table 2 showed twenty nine compounds were identified from *G. alata*. Azuleno[6,5-b]furan-2,6(3H,4H)-dione,3a (26.69%), n-hexadecanoic acid (8.72%), 1,3-propanediol, 2-(hydroxymethyl)-2-nitr (5.90%), beta-sitosterol (5.05%), acetic acid, 6,8,9-trimethyl-4-pentyl-3-oxa (5.02%) and 8-isopropenyl-1,3,3,7-tetramethyl-bicyclo (2.50%) as the major phytochemical constituents.

The results showed that six compounds in extracts of the two plants contained the same chemical composition, which was 2,4-dihydroxy-2,5-dimethyl- 3(2H)-furan-3-one, 4H-pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl, 2-methoxy-4-vinylphenol, 1,2,3-benzenetriol (catechol), n-hexadecanoic acid and squalene, but the percentage content was different.

Table 1: Chemical constituents of *Guiera senegalensis* leaves ethanolic extract

Compound name	RT	Area (%)
2,4-Dihydroxy-2,5-dimethyl-3(2H)-furan-3-one	4.039	0.67
7-Tridecanone	4.882	0.83
2,5-Dimethyl-4-hydroxy-3(2H)-furanone	5.490	0.38
4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	6.346	3.18
1,2,3-Propanetriol, 1-acetate	7.809	0.98
2-Methoxy-4-vinylphenol	8.672	0.64
1,2,3-Benzenetriol	10.022	21.02
Quinic acid	12.665	11.73
Ethyl alpha-d-glucopyranoside	12.766	16.72
2-Amino-3-hydroxypyridine	14.080	0.29
7-Oxabicyclo[4.1.0]heptane, 1-methyl-4-(2-methyloxiranyl)-	14.300	0.29
3,7,11,15-Tetramethyl-2-hexadecen-1-ol	14.736	0.77
2-Pentadecanone, 6,10,14-trimethyl-	14.821	0.37
9-Eicosyne	14.994	0.23
Phytol, acetate	15.183	0.35
Sorbitol	15.716	7.49
n-Hexadecanoic acid	16.012	5.06
Hexadecanoic acid, ethyl ester	16.289	1.31
Phytol	17.449	5.05
Oleic acid	17.699	3.28
Octadecanoic acid	17.890	0.41
Ethyl oleate	17.923	0.44
Octadecanoic acid, 2,3-dihydroxypropyl ester	20.846	1.06
1H-Indole-3-carboxylic acid, 5-(acetyloxy)-1-butyl-2-methyl-, ethyl ester	20.969	0.50
Andrographolide	21.236	0.47
2-(1-Methoxynaphthyl-2)quinoline	21.522	0.93
4H-1-Benzopyran-4-one, 2-(3,4-dihydroxyphenyl)-5,7-dihydroxy-6-methoxy-	21.652	12.00
Gamma-sitosterol	21.863	1.79
Squalene	23.158	1.76

RT: Retention time

Table 2: Chemical constituents of *Geigeria alata* aerial parts ethanolic extract

Compound name	RT	Area (%)
2,4-Dihydroxy-2,5-dimethyl-3(2H)-furan-3-one	4.040	0.37
4,5-Dimethyltetrahydro-1,3-oxazine-2-thione	6.286	0.53
4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	6.361	0.44
Octanoic acid, ethyl ester	6.911	0.12
Catechol	7.524	0.81
2-Methoxy-4-vinylphenol	8.679	0.56
Decanoic acid, ethyl ester	9.593	0.21
1,6-Cyclodecadiene, 1-methyl-5-methylene-8-(1-methylethyl)-, [S-(E,E)]-	10.112	0.27
1,3-Propanediol, 2-(hydroxymethyl)-2-nitro-	10.527	5.90
1H-Indene, 2,3-dihydro-1,1,5,6-tetramethyl-	10.951	0.30
Phenol, 3,5-bis(1,1-dimethylethyl)-	11.175	0.10
1,2,3,5-Cyclohexanetetrol, (1.alpha.,2.beta.,3.alpha.,5.beta.)-	12.663	1.79
Ethyl alpha-d-glucopyranoside	12.786	1.66
Cyclopentene, 1,2-dimethyl-4-methylene-3-phenyl-	13.860	0.72
Naphthalene, 1,1'-methylenebis[decahydro-	13.926	1.63
n-hexadecanoic acid	16.017	8.72
6-(p-Tolyl)-2-methyl-2-heptenol, trans-	16.290	0.95
Benzene, 1-methyl-4-(2-propenyl)-	16.769	1.16
Linoleic acid ethyl ester	17.675	1.63
Acetic acid, 6,8,9-trimethyl-4-pentyl-3-oxabicyclo[3.3.1]non-6-en-1-ylmethyl ester	17.701	5.02
Epibolin	17.784	1.46
Octadecanoic acid	17.895	1.65
Beta-nootkatol	18.045	2.06
Azuleno[6,5-b]furan-2,6(3H,4H)-dione, 3a,7,7a,8,9,9a-hexahydro-3,5,8-trimethyl-, [3R-(3.alpha.,3a.alpha.,7a.beta.,8.beta.,9a.a	18.838	26.69
8-Isopropenyl-1,3,3,7-tetramethyl-bicyclo[5.1.0]oct-5-en-2-one	19.437	2.50
1,1'-Bis(cyclooct-2-en-4-one)	19.977	2.24
Azuleno[6,5-b]furan-2,6(3H,4H)-dione, 3a,7,7a,8,9,9a-hexahydro-4-hydroxy-3,5,8-trimethyl-, [3R-(3.alpha.,3a.alpha.,4.alpha.,7a	20.843	24.47
Beta-sitosterol	21.872	5.05
Squalene	23.159	0.99

RT: Retention time

Two sugar compounds were identified in the ethanolic extract of *G. senegalensis* (24.21%). The results revealed that ethyl alpha d-glucopyranoside (16.72%) was formed as a major component. Three alcoholic compounds were identified (22%) and ketonic compounds (13%) were identified.

Five ketonic compounds were identified in the ethanolic extract of *G. alata* (56.7%). The results revealed that Azuleno-dione (26.69%) was formed as a major component. Six fatty acids were identified (17.35%), three alcoholic compounds (8.64%) and two steroidal compounds were identified 8.64 and 6.04%, respectively.

The biological activities of some components, n-hexadecanoic acid (palmitic acid) possesses some activity like antioxidant, hypercholesterol, nematicidal and pesticide[15]. Gamma-sitosterol was previously reported to possess antihyperglycemic activity by increasing insulin secretion in response to glucose[16]. Linoleic acid was found to possess antibacterial activity against *Bacillus megaterium* at MICs of 0.2 and 0.05 mM[17].

Recent investigations with phytol demonstrated anxiolytic, metabolism-modulating, cytotoxic, antioxidant, autophagy and apoptosis-inducing, antinociceptive, anti-inflammatory, immune-modulating and antimicrobial effects[18]. The beta-sitosterol was found to possess anti-inflammatory, anticancer, antioxidant, hepatoprotective, cardioactive and antidiabetic[19]. The 1,2,3-benzenetriol (Pyrogallol) has the ability to perform antibacterial and antioxidant activities[20]. The ethyl-alpha-d-glucopyranoside, skin moisturing agent[21]. The consumption of a food or beverage enriched with sucrose has been associated with improve mental alertness, memory, reaction time, as well as a reduction in the feeling of fatigue[22]. Oleic acid was found to have antibacterial activity, particularly in inhibiting the growth of several Gram-positive bacterial species[23].

CONCLUSION

The ethanolic extracts from *Guiera senegalensis* and *Geigeria alata* has revealed a wealth of diverse bioactive compounds, identified and quantified through Gas Chromatography-Mass Spectrometry (GC/MS). *Guiera senegalensis* displayed a significant presence of sugars, alcohols and ketones, suggesting its potential for therapeutic applications. Conversely, *Geigeria alata* exhibited a distinct chemical profile rich in ketones, fatty acids, alcohols and steroidal compounds, hinting at its potential for various physiological activities. These findings underscore the importance of botanical exploration in the search for new therapeutic agents and highlight the chemodiversity inherent in Sudanese plant species, thus offering valuable insights into the potential utilization of these botanical resources in drug discovery and development efforts.

SIGNIFICANCE STATEMENT

This study aimed to explore the compounds present in the ethanolic extracts of two important Sudanese plant species namely, *Guiera senegalensis* and *Geigeria alata* by implicating Gas Chromatography-Mass Spectroscopy (GC/MS) technique. The present study revealed that the ketonic, alcoholic, fatty acids and sugar derivatives compounds in studied two plants may be explored for manufacturing industrial products.

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