Open Access Journal of Chemistry
Volume 3, Issue 3, 2019, PP 16-21
ISSN 2637-5834

Flavonoids as Chemotaxonomic Markers in the Roots of Plant Family Malvaceae in South Kordofan, Blue Nile and Khartoum States- Sudan

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ABSTRACT

This work is a taxonomic study on Flavonoids in the roots of selected species belonged to family Malvaceae. These species considered as: Abelmoschus esculentus, Hibiscus sabdariffa and Gossypium barbadense. These species distributed in different localities in Sudan. The selected members have nutritive, medicinal and economic importance, extra of that, the present study included botanical and chemical studies. The collected species have been updated due to nomenclature and synonymy. The geographical distribution of the selected members has been indicated. The chemical studies included identification of the flavonoid compounds using Gas Chromatography Mass Spectrophotometer (GC – MS). Ninety two flavonoid compounds were detected in the roots of family Malvaceae. The highest number (38) was detected in the roots of Hibiscus sabdariffa. Two flavonoid compounds were restricted only to the roots of Abelmoschus esculentus. These are: dichloroacetic acid nonyl ester and 1,3-diphenyl-1- (trimethyl siloxy) -1(Z) heptene. There were ten flavonoid compounds identified as taxonomic markers for the roots of Hibiscus sabdariffa. Three flavonoid compounds were restricted only to the roots of Gossypium barbadense.

Keywords: *Chemotaxonomy; Medicinal Plant; South Kordofan; Blue Nile and Khartoum states, Sudan*

INTRODUCTION

Flavonoids or bioflavonoid mean yellow in Latin language with reference to their color in nature and they represent the plant secondary metabolites. Flavonoids are poly phenolic compounds possessing (15) carbon atoms with a leaner three carbon chain. They also constitute one of the most characteristic classes of plant compounds. Flavonoids are easily recognized as "flower pigment" in the most angiosperm plant families. However, their occurrence is not restricted to flowers but included all the parts of plants. This compiled by John *et al*., (2005). The Flavonoids have many classes such as chalcone, flavones, flavanones, flavanoles, anthocyanidins and isoflavonoids. These are synthesized by the plants beside (4000) others compounds identified by their food sources. The Flavonoids may contribute to some of the health benefits associated with diets rich in fruit and vegetable. Offering a wide range view of these classes of plant pigments after brief examination of history and literature of Flavonoids there were sub-classes of Flavonoids using multiple techniques for isolation, purification and determination of structures. Wilkomirsk *et al*.,(1998).

STUDY AREA

South Kordofan state (Western Sudan) lies between latitude 11º - 37.96' N and longitude 29º - 42' E. Blue Nile State lies between latitude 11º - 09' N and longitude 34º - 06' E and khartoum lies between latitude 15º - 33' N and longitude 32º - 31 E. North Kordofan climate characterized as hot days and cold nights, sunny and partly clouds with relatively short rainy seasons.

The area of the study mostly sand of yellowish red sandy loam. Blue Nile state climate depended on change of seasons and with result in a likely decline in stream flow which increases the soil moisture. Khartoum state climate change characterized as temperatures are rising, soil fertility is low and wind blows dusty and also mostly desert with receive barely rainfall.

POPULATION

According to ethno-botanical, South Kordofan is an interesting state; it includes several people such as Arabs and Africans. The tribes in this state depend on (millet, sorghum, groundnuts and sesame) for nutrition, also their activities characterized as pastoral (cattle and goats). Blue Nile state is host to round forty different ethnic groups, its economic activity based on agriculture and livestock and increasing mineral exploitation while Khartoum state composed of various tribes distributed in many localities, most of population works in government services, private sectors and banking. Khartoum represents the capital city because it contains governmental and non-governmental organizations and also includes the main airport.

METHODOLOGY

Field Work

The study was conducted during September – November, 2013 in three localities in Sudan, namely, South Kordofan, Blue Nile and Khartoum. The informations of the present study was gathered through three steps collection, preparation and chemical analysis. The results obtained by a coupled system named (GC – MS) in the central laboratory of the University of Khartoum, 2013. This coupled system was integrated composite analysis to separate and quantify components.

The (GC) apparatus configured by adjusting temperature, pressure and time. The (MS) identified the components. The plant material was washed thoroughly with running tap water followed by rinsing with distilled water. The material was then air-dried and ground manually using a marble mill. The powder of the roots was then passed into sieves of different sizes (Retsch, German). One (ml.) of methanol (70%) was added to one (gm.) of the powdered roots. The solution was then injected to (GC).

Data Analysis

All the data illustrated have been integrated and analyzed. The results have been structed according to these categories: number of plant mentioned with (scientific names, botanical families and vernacular names). The references were complete in central laboratory. Study of quantitative was also performed using frequency per species and was estimated by calculation of the plant sites.

DISCUSSION

The data detected in this study were compared with the related literature and also published reports on the traditional medicinal uses of the plants. The species named as: *Abelmoschus esculentus*, *Hibiscus sabdariffa* and *Gossypium barbadense*. The selected parts were roots. The number of the flavonoid compounds of the selected members of family Malvaceae in the roots were (92) compounds. The major flavonoid compounds myricetin occurred in many species and reported by John et *al*., (2005). This result was confirmed in the present study. The number of the flavonoid compounds in the roots of *Abelmoschus esculentus* was (23), the numbers of the flavonoid compounds in the roots of *Hibiscus sabdariffa* were (38) and this concerned as the highest number and the number of the flavonoid compounds in the roots of *Gossypium barbadense* was (31). The major flavonoid {(triisopropyl siloxy) tricyclo 3.0.0 (3,7)}was detected in the roots of *Hibiscus sabdariffa* while the major flavonoid (5s,8R)-5-isopropyl-8-methyl-2-methylene-3,9-decadien was detected in the roots of *Gossypium barbadense* and there was not any major Flavonoids detected in the roots of *Abelmoschus esculentus*. The flavonoid myricetin and kaempferol were reported by many authors in different plant parts of plants such as William *et al*., (1993). and Buttery *et al*., (1973). However, none of these Flavonoids were found in the roots of the selected members. This may be due to environmental factors or soil moisture. The phenolic acids: malic, tartaric and citric acids were found in the calyx of *Hibiscus sabdariffa* and not found in the roots of the same plant. The flavonoid compounds benzoic acid-2,5-bis (trimethyl siloxy) trimethyl silyl ester and 9-octadecenoic acid-1,2,3-propanetriyl ester E,E,E were detected in all of the roots selected species of family Malvaceae. The flavonoid 9-octadecenoic acid -1, 2, 3- propanetriyl ester E, E, E was found by Donatus *et al*., (2010). in different species named *Alstonia boonei*. The flavonoid compound decanoic acid-8-methyl methyl ester found by Christy *et al*., (2012) in the roots of *Eupatorium triplinerve*. This compound detected in the present study in the roots of *Hibiscus sabdariffa*. A single flavonoid compound 3-isopropoxy-1, 1, 1, 7, 7, 7-hexamethyl-3, 5, 5-trimethyl siloxy tetrasiloxane was found in the roots of *Abelmoschus esculentus* and *Gossypium barbadense* and not detected in the roots of *Hibiscus sabdariffa*. The major

flavonoid compounds detected in the roots of *Abelmoschus esculentus* and *Hibiscus sabdariffa* were: hendecane, 2-mthoxy-3-methyl butaric acid methyl ester and 3-ethoxy-1, 1, 1, 7, 7, 7-hexamethyl-3, 5, 5-tris (trimethyl siloxy) tetrasiloxane.

CONCLUSION

The modern health care services in South Kordofan and Blue Nile are not adequate because of few care centers and hospitals and the most people cannot afford to buy drugs prescribed due to their low income. Roots of the selected members of family Malvaceae were recommended because of their high flavonoid contents specially the roots of *Hibiscus sabdariffa*. Due to this informations Flavonoids can be used as antifungal, antibacterial, antiviral and strengthen of muscles beside antioxidant to prevent the most types of cancers.

ACKNOWLEDGEMENT

The author is very grateful to the laboratorists in the central laboratory for sharing their knowledge through this study.

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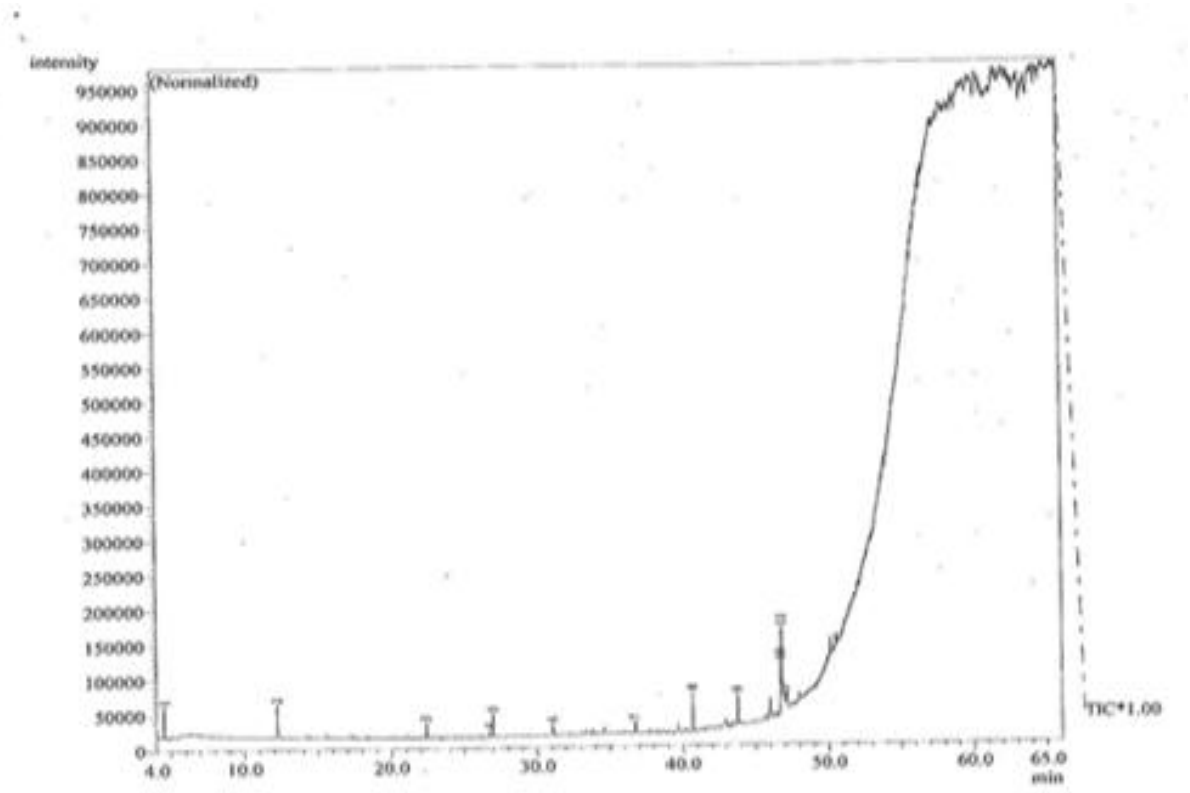
Table1. *Medicinal applications of the roots of the selected species of plant family Malvaceae in South Kordofan, Blue Nile and Khartoum states.*

Scientific name / Family/ Local name/ syn.	Part used	Uses/ Ailments/ Treated	Preparations/ Administrations	Locality
Abelmoschus esculentus (L.) Moench Malvaceae Okra, gumbo and lady's fingers *Hibiscus esculentus* (L.)	Roots	Various diseases and disorders such as: sore throat, asthma, cholesterol levels and prevent cancer	Infusion	Aldebeibat
Hibiscus sabdariffa (L.) Malvaceae Roselle, Rozelle and Karkade *Hibiscus rosa sinesis* (L.)	Roots	Reduce blood pressure, dyspepsia, heart ailment, liver disease, abscesses and cough	Infusion	Alsereio
Gossypium barbadense (L.) Malvaceae Cotton	Roots	Fibers uses as natural textile	Infusion	Omdurman

Table2. *Pairing affinity between the studied members of family Malvaceae based on the selected flavonoids in the roots.*

Species	Flavonoid compounds	Pairing affinity (Roots) Index (PA %)
Between *Abelmoschus esculentus* and *Hibiscus sabdariffa*	Esters Ethers Alkanes Fatty acids Aldehydes	25% 44.4% 22.2% 25% 25%
Between *Abelmoschus esculentus* and *Gossypium barbadense*	Esters Ethers Alkanes Fatty acids	40% 42.9% 33.3% 33.3%

	Aldehydes Ketones	33.3% 0%
Between *Hibiscus sabdariffa* and *Gossypium barbadense*	Esters Ethers Alkanes Fatty acids Aldehydes	33.3% 37.5% 25% 0% 33.3%



Peak Report TIC

Peak#	R.Time	I.Time	F.Time	Area	Area%	Height	Height%
1	4.507	4.475	4.575	123271	11.99	44175	11.09
2	12.226	12.175	12.267	110118	10.71	47938	12.03
3	22.397	22.317	22.442	75040	7.30	20030	5.03
4	26.742	26.692	26.792	32147	3.13	10641	2.67
5	26.968	26.917	27.017	89309	8.68	33688	8.46
6	31.060	31.017	31.100	28710	2.79	14039	3.53
7	36.745	36.708	36.800	50885	4.95	17153	4.31
8	40.671	40.617	40.717	156330	15.20	57489	14.44
9	43.768	43.723	43.808	109371	10.63	42205	10.60
10	46.732	46.683	46.758	83986	8.17	34503	8.66
11	46.790	46.758	46.833	169304	16.46	76392	19.18
				1028471	100.00	398242	100.00

Fig (4 – 1). *The relationship between time and intensity of fragmentation which produced peaks in the roots of Abelmoschus esculents.*

Abbreviations and formulae of calculation.

R. time = retention time.

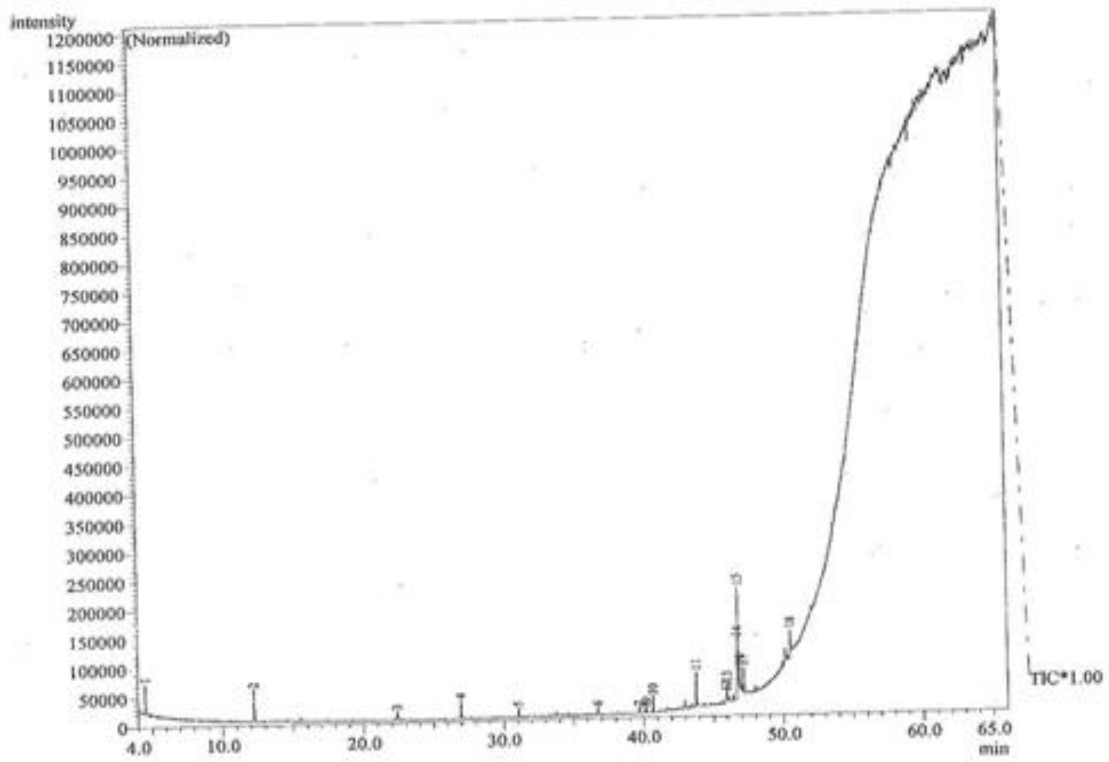
I. time = initial time.

F. time = full time

$$\% \text{ area} = \frac{\text{area of peak}}{\text{Total area}} \times 100\%$$

$$\% \text{ height} = \frac{\text{height of peak}}{\text{Total height}} \times 100\%$$

TIC = (total ions chromatography



Peak Report TIC

Peak#	R.Time	I.Time	F.Time	Area	Area%	Height	Height%
1	4.506	4.475	4.583	156388	9.96	51453	8.40
2	12.222	12.175	12.258	121833	7.76	53201	8.68
3	22.400	22.325	22.433	42951	2.74	11491	1.87
4	26.961	26.908	27.017	88470	5.63	31344	5.11
5	31.053	31.000	31.092	37961	2.42	15661	2.56
6	36.743	36.708	36.792	32877	2.09	12574	2.05
7	39.650	39.608	39.700	29800	1.90	11167	1.82
8	40.091	40.050	40.133	24629	1.57	8650	1.41
9	40.194	40.150	40.233	33984	2.16	14593	2.38
10	40.663	40.625	40.708	73507	4.68	27813	4.54
11	43.759	43.708	43.808	151701	9.66	57132	9.32
12	45.930	45.892	45.950	22945	1.46	9299	1.52
13	45.994	45.958	46.033	50902	3.24	23909	3.90
14	46.723	46.683	46.742	107497	6.85	42216	6.89
15	46.781	46.750	46.833	278404	17.73	127795	20.85
16	46.891	46.842	46.933	102513	6.53	35544	5.80
17	47.168	47.125	47.208	109433	6.97	42365	6.91
18	50.523	50.475	50.567	104282	6.64	36657	5.98
				1570077	100.00	612864	100.00

Fig (4 – 1). *The relationship between time and intensity of fragmentation that produced peaks in the roots of Hibiscus sabdariffa.*

Abbreviations and formulae of calculation.

R. time = retention time.

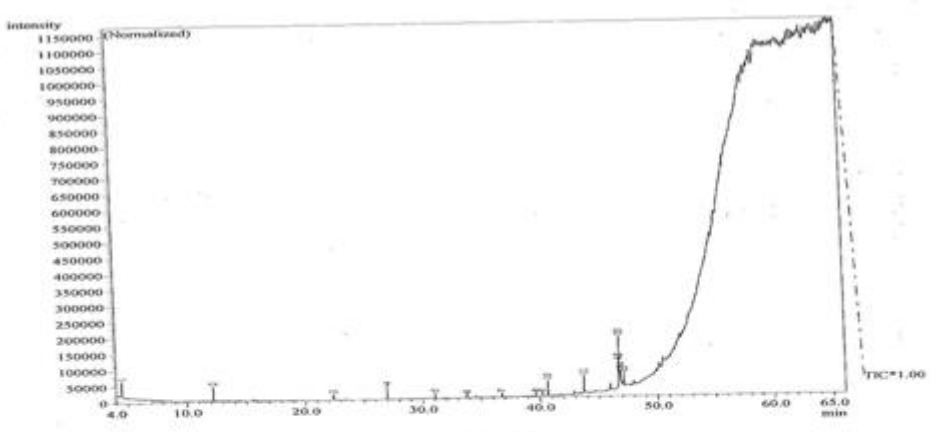
I. time = initial time.

F. time = full time.

$$\% \text{ area} = \frac{\text{area of peak}}{\text{Total area}} \times 100\%$$

$$\% \text{ height} = \frac{\text{height of peak}}{\text{Total height}} \times 100\%$$

TIC = (total ions chromatography)



Peak Report TIC

Peak#	R.Time	I.Time	F.Time	Area	Area%	Height	Height%
1	4.501	4.467	4.558	125547	8.91	46156	8.54
2	12.214	12.158	12.350	104183	7.39	45160	8.35
3	22.388	22.283	22.450	85302	6.05	18929	3.50
4	26.952	26.908	27.008	111279	7.90	41005	7.58
5	31.046	31.000	31.083	40011	2.84	17135	3.17
6	33.775	33.733	33.808	26158	1.86	11062	2.05
7	36.731	36.683	36.775	39342	2.79	13783	2.55
8	39.640	39.600	39.683	30937	2.20	11787	2.18
9	40.183	40.142	40.217	20895	1.48	9363	1.73
10	40.651	40.600	40.700	132754	9.42	49279	9.11
11	43.746	43.693	43.783	128961	9.15	49696	9.19
12	46.709	46.658	46.733	94759	6.72	38960	7.21
13	46.767	46.733	46.817	254626	18.07	111445	20.61
14	46.879	46.833	46.917	101213	7.18	37943	7.02
15	47.157	47.100	47.200	113201	8.03	38950	7.20
				1409068	100.00	540655	100.00

Fig (4 – 6). *The relationship between time and intensity of fragmentation that produced peaks in the roots of Gossypium barbadense.*

Abbreviations and formulae of calculation.

R. time = retention time.

I. time = initial time.

F. time = full time.

$$\% \text{ area} = \frac{\text{area of peak}}{\text{Total area}} \times 100\%$$

$$\% \text{ height} = \frac{\text{height of peak}}{\text{Total height}} \times 100\%$$

TIC = (total ions chromatography)

Citation: *Asaad Alsiddig Ahmed, Abdelgabbar Nassir Guma'a, Mahdi Abd elmageed Mohammed, Hatim M.Y hamadnalla, "Flavonoids as Chemotaxonomic Markers in the Roots of Plant Family Malvaceae in South Kordofan, Blue Nile and Khartoum States- Sudan", Open Access Journal of Chemistry, 3(3), 2019, pp. 16-21.*