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Research Article

Flavonoids as Chemotaxonomic Markers in the Leaves 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 leaves 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). Eighty-three flavonoid compounds were detected in the leaves of family *Malvaceae*. The highest number (36) was detected in the leaves of *Abelmoschus esculentus*. Five flavonoid compounds were identified as taxonomic markers for the leaves of *Hibiscus sabdariffa*. Thirteen flavonoids were restricted only to the leaves of *Gossypium barbadense*.

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

Introduction

Flavonoids or bioflavonoids 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. [1]. (The flavonoids have many classes such as chalcone, flavones, flavanones, flavanols, anthocyanidins and is flavonoids. These are synthesized by the plants beside (4000) other 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. [2].

Study Area

South Kordofan state (Western Sudan) lies between latitude 11° - 37. 96' N and longitude 29° - 42' E. Blue Nile State lies

between latitude 11° - 09' N and longitude 34° - 06' E and khartoum lies between latitude 15° - 33' N and longitude 32° - 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 include 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 information's of the present study were 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 leaves. The solution was then injected to (GC).

Data Analysis

Table 1: Medicinal applications of the leaves 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	Leaves	Various diseases and disorders such as: sore throat, asthma, cholesterol levels and prevent cancer	Infusion	Aldebeibat
Malvaceae				
Okra, gumbo and lady's fingers				
Hibiscus esculentus (L.)				
Hibiscus sabdariffa (L.)	Leaves	Reduce blood pressure, dyspepsia, heart ailment, liver disease, abscesses and cough	Infusion	Alsereio
Malvaceae				
Roselle, Rozelle and Karkade				
Hibiscus rosa sinesis (L.)				
Gossypium barbadense (L.)	Leaves	Fibers uses as natural textile	Infusion	Omdurman
Malvaceae				
Cotton				

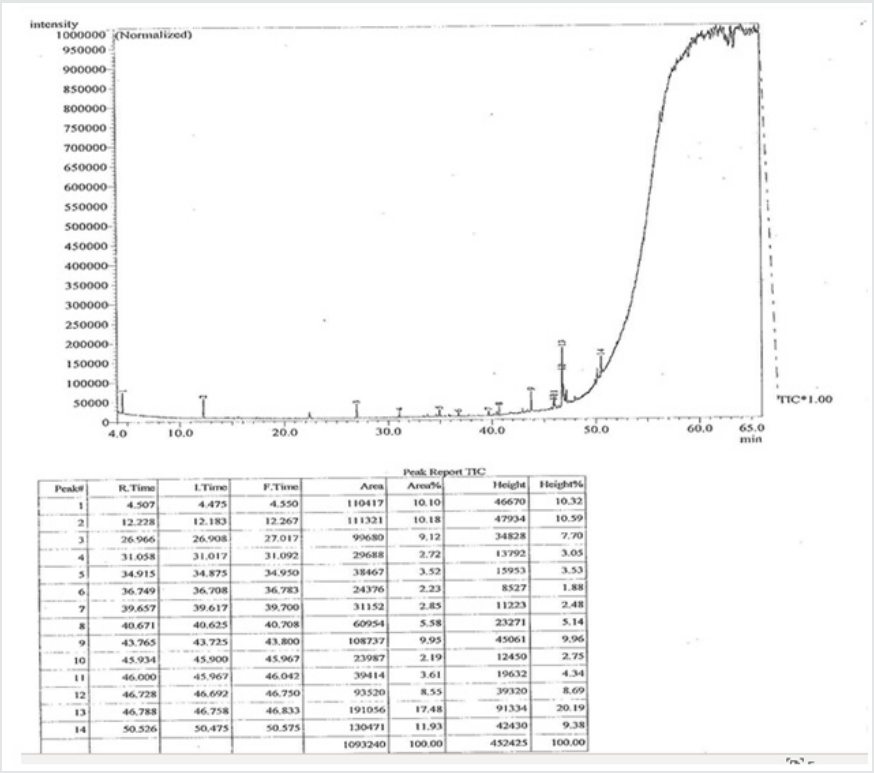
Table 2: Pairing affinity between the studied members of family *Malvaceae* based on the selected flavonoids in the leaves.

Species	Flavonoid compounds	Pairing affinity (leaves) Index (PA %)
Between *Abelmoschus esculentus* and *Hibiscus sabdariffa*	Esters	20%
	Ethers	28%
	Alkanes	25%
	Fatty acids	0%
	Aldehydes	0%

Between *Abelmoschus esculentus* and *Gossypium barbadense*	Esters	17%
	Ethers	16.70%
	Alkanes	20%
	Fatty acids	0%
	Aldehydes	25%
	Ketones	33.30%
Between *Hibiscus sabdariffa* and *Gossypium barbadense*	Esters	20%
	Ethers	0%
	Alkanes	0%
	Fatty acids	0%
	Aldehydes	0%

All the data illustrated have been integrated and analyzed. The results have been structed according to these categories: number of plants 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 [Table 1&2].

Discussion



Peak Report TIC

Peak#	R.Time	I.Time	F.Time	Area	Area%	Height	Height%
1	4.507	4.475	4.550	110417	10.10	46670	10.32
2	12.228	12.183	12.267	111321	10.18	47934	10.59
3	26.966	26.908	27.017	99680	9.12	34828	7.70
4	31.058	31.017	31.092	29688	2.72	13792	3.05
5	34.915	34.875	34.950	38467	3.52	15953	3.53
6	36.749	36.708	36.783	24376	2.23	8527	1.88
7	39.657	39.617	39.700	31152	2.85	11223	2.48
8	40.671	40.625	40.708	60954	5.58	23271	5.14
9	43.765	43.725	43.800	108737	9.95	45061	9.96
10	45.934	45.900	45.967	23987	2.19	12450	2.75
11	46.000	45.967	46.042	39414	3.61	19632	4.34
12	46.728	46.692	46.750	93520	8.55	39320	8.69
13	46.788	46.758	46.833	191056	17.48	91334	20.19
14	50.526	50.475	50.575	130471	11.93	42430	9.38
				1093240	100.00	452425	100.00

Figure 1: The relationship between time and intensity of fragmentation which produced peaks in the leaves of *Abelmoschus esculentus*. Abbreviations and formulae of calculation.

R. time = retention time.

I. time = initial time.

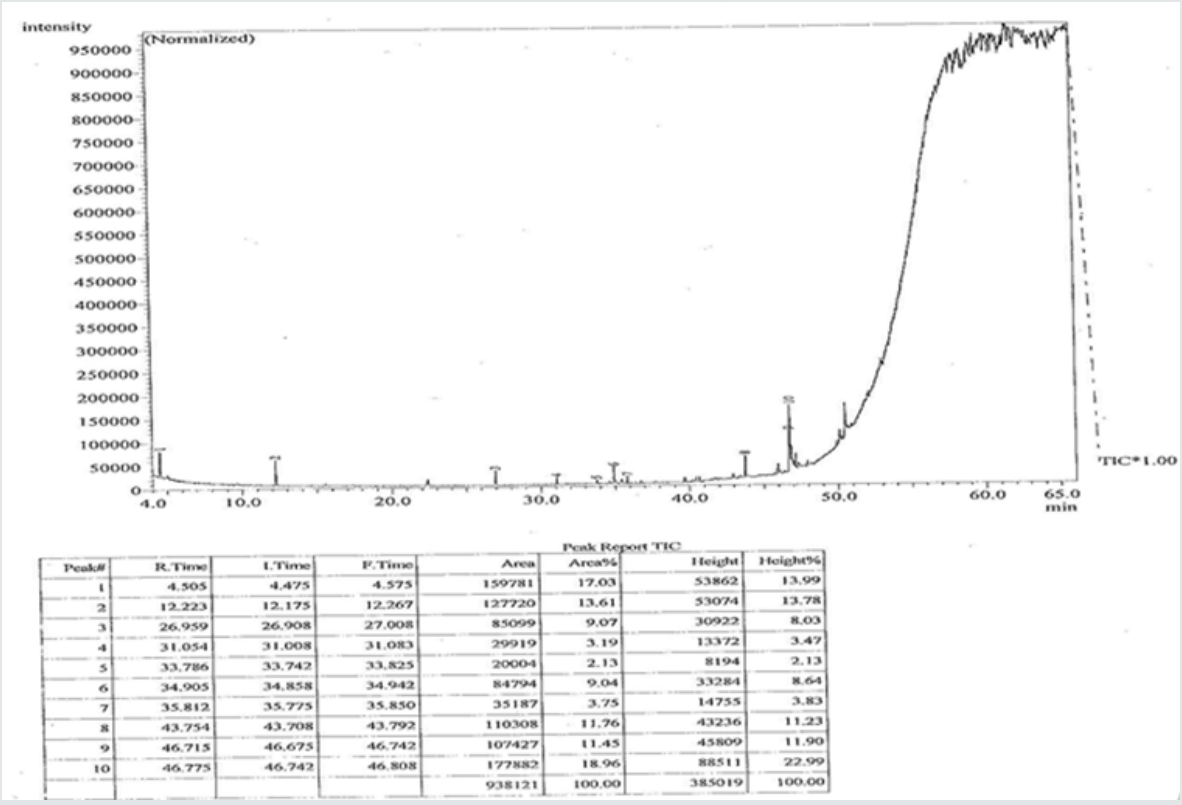
F. time = full time.

% area = area of peak X 100%
Total area

% height = height of peak X100%
Total height

TIC = (total ions chromatography)

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* [Figure 1], *Hibiscus sabdariffa* and *Gossypium barbadense*. The selected parts were leaves. The number of the flavonoid compounds of the selected members of family Malvaceae in the leaves were (83) compounds. The major flavonoid compounds in the leaves of *Abelmoschus esculentus* and *Hibiscus sabdariffa* [Figure 2]were: hendecane, 2-methoxy-3-methyl butaric acid methyl ester, decane-1,1-oxy bis decyl ether and 3-ethoxy-1,1,1,7,7,7-hexamethyl-3,5,5-tris (trimethyl siloxy) tetrasiloxane. This result was confirmed in the present study. The number of the flavonoid compounds in the leaves of *Abelmoschus esculentus* were (36), the numbers of the flavonoid compounds in the leaves of *Hibiscus sabdariffa* were (21) and the number of the flavonoid compounds in the leaves of *Gossypium barbadense* [Figure 3]were (26). The flavonoid myricetin and kaempferol were reported by many authors in different plant parts of plants such as William & Buttery [3,4]. However, none of these flavonoids were found in the leaves 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 leaves of the same plant. The flavonoid compounds octadecanoic acid-2,3- dihydroxy propyl ester, citronelly propionate, 1,5- diazacycloheptadecan-6-one {(4-methyl phenyl) sulfonyl} and 7-hexadecenal, (Z) were detected in all the leaves of the selected species of family *Malvaceae*. The flavonoid 9-octadecenoic acid -1,2,3- propanetriyl ester E, E, E was found by Donatus et al. [5]. in different species named *Alstonia boonei.* The flavonoid compound decanoic acid-8-methyl methyl ester found by Christy et al. [6] in the leaves of *Eupatorium triplinerve*. This compound detected in the present study in the leaves of *Hibiscus sabdariffa* [7-9].



Peak Report TIC

Peak#	R.Time	I.Time	F.Time	Area	Area%	Height	Height%
1	4.505	4.475	4.575	159781	17.03	53862	13.99
2	12.223	12.175	12.267	127720	13.61	53074	13.78
3	26.959	26.908	27.008	85099	9.07	30922	8.03
4	31.054	31.008	31.083	29919	3.19	13372	3.47
5	33.786	33.742	33.825	20004	2.13	8194	2.13
6	34.905	34.858	34.942	84794	9.04	33284	8.64
7	35.812	35.775	35.850	35187	3.75	14755	3.83
8	43.754	43.708	43.792	110308	11.76	43236	11.23
9	46.715	46.675	46.742	107427	11.45	45809	11.90
10	46.775	46.742	46.808	177882	18.96	88511	22.99
				938121	100.00	385019	100.00

Figure 2: The relationship between time and intensity which produced peaks in the leaves of *Hibiscus sabdariffa*.

Abbreviations and formulae of calculation.

R. time = retention time.

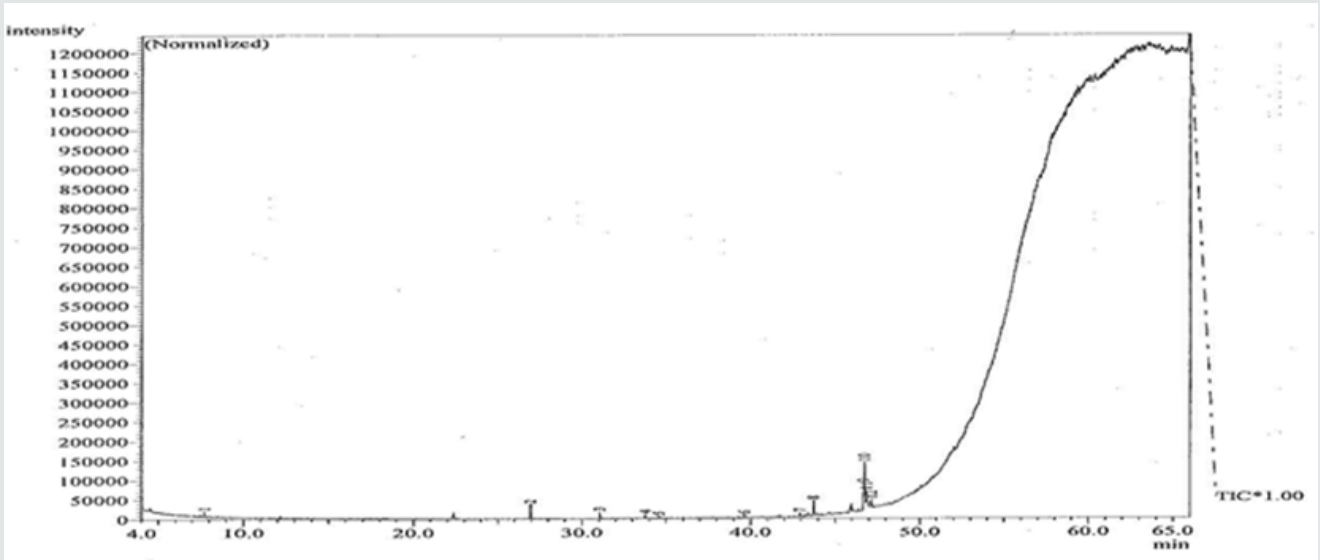
I. time = initial time.

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	7.730	7.700	7.758	24307	3.62	11833	4.33
2	26.949	26.892	27.000	97191	14.48	35681	13.07
3	31.045	31.000	31.075	34075	5.08	15738	5.76
4	33.775	33.742	33.817	18961	2.83	8939	3.27
5	34.589	34.550	34.633	12400	1.85	5049	1.85
6	39.636	39.592	39.683	19610	2.92	6390	2.34
7	42.935	42.892	42.975	24973	3.72	9152	3.35
8	43.744	43.700	43.792	93642	13.96	34308	12.57
9	46.709	46.658	46.725	65252	9.72	24040	8.80
10	46.763	46.733	46.808	162417	24.20	74833	27.41
11	46.876	46.842	46.917	68796	10.25	28295	10.36
12	47.152	47.108	47.192	49383	7.36	18783	6.88
				671007	100.00	273041	100.00

Figure 3: The relationship between time and intensity of fragmentation that produced peaks in the leaves of *Gossypium barbadense*.

Abbreviations and formulae of calculation.

R. time = retention time.

I time = initial time.

F. time = full time.

% area = area of peak X100%
Total area

% height = height of peak X100%
Total height

TIC = (total ions chromatography)

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. Leaves of the selected members of family *Malvaceae* were recommended because of their beneficial health. Due to this information's flavonoids can be used as antifungal, antibacterial, antiviral and strengthen of muscles beside antioxidant to prevent the most types of cancers.

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