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Research Journal of Agricultural Sciences
An International Journal

P- ISSN: 0976-1675
E- ISSN: 2249-4538

Volume: 12
Issue: 06

Res. Jr. of Agril. Sci. (2021) 12: 2236–2243

CARAS

Res. Jr. of Agril. Sci. (Nov-Dec 2021) 12(6): 2236–2243
www.rjas.org

Full Length Research Article

Characterization of Phytochemicals by FT-IR and GC-MS Analysis of *Senna auriculata* (L.) Roxb. Obtained from Natural and Polluted Sources: A Comparative Study

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Received: 10 Sep 2021 | Revised accepted: 20 Nov 2021 | Published online: 15 Dec 2021

ABSTRACT

In this study, Characterization of phytochemicals of the *Senna auriculata* (L.) Roxb. obtained from natural and polluted sources were revealed by using FT-IR and GC-MS analysis. The presence of diverse functional groups such as hydroxyl group, alcohol, amides, amines, carboxylic acids, alkenes, alkanes, alkynes, aldehydes, aromatic compounds, nitriles, alkyl & aryl halides is confirmed by FT-IR spectroscopy of *S. auriculata* leaves and flowers from both sources. GC-MS analysis identified and characterized 38 and 27 components, respectively, from the leaves and flowers of *S. auriculata* collected from natural and polluted sources. The leaves and flowers of *S. auriculata* have a different bio-constituent; only a few compounds 3-O-Methyl-d-glucose, Neophytadiene, Dotriacontane, Phytol, and Squalene appeared in both the plant parts. 3-O-Methyl-d-glucose was the most abundant of these metabolites. According to the findings, the ethanol extract of *S. auriculata* flowers contains more phytocompounds than the leaves. The leaves and flowers of *S. auriculata* from natural sources, on the other hand, contained more components than those from polluted sources. This could be the result of environmental pollution affecting the phytochemical properties of plants in polluted areas. It implies that medicinal plants used for human consumption or the manufacturing of herbal preparations and standardized extracts should be collected from an unpolluted natural habitat.

***Key words*:** FT-IR spectroscopy, GC-MS analysis, Natural sources, Phytochemicals, Polluted sources, *Senna auriculata*

Phytochemicals are biologically active plant-derived compounds. Natural products are our most successful source of medicine. Every plant is like a factory that can mix an infinite number of highly complex and rare chemicals [18]. The importance of plants lies in their active ingredients (secondary metabolites), which are the real healer in the medication process. To obtain pharmacologically active constituents, various parts of medicinal plants such as the root, stem, leaves, flower, fruit, seed, and so on are used [16]. Phytoconstituents have different and varied pharmacological effects, such as anti-inflammatory, antipyretic, anticancerous, antimicrobial, antioxidant, antidiabetic, antitumor, antimutagenic, antidiarrheal, antispasmodic, etc. [17]. Phytochemicals are crucial in the pharmaceutical industry for the development of new drugs and the manufacture of therapeutics, food additives, and agrochemicals [3], [7], [10], [19], [23]. Therefore, the need to study the phytochemicals of various plants has increased exponentially.

In the current study, we chose one of the most important medicinal plants *Senna auriculata* (L.) Roxb. belongs to the Fabaceae family. In traditional medicine, it is commonly used to treat rheumatism, conjunctivitis, and diabetes. Skin conditions are treated with roots and flowers. Its bark is an astringent, its leaves and fruits are antihelminthic, and its seeds are used to treat eye problems [21]. The plant is also known to have antidiabetic, antioxidant, antihyperlipidemic, hepatoprotective, antipyretic, antimicrobial activity [13-14], [26]. This medicinal plant that is rich in bio sources of several drugs in the treatment and prevention of many diseases are constantly exposed to pollutants directly or indirectly. Secondary metabolite production changes in plants exposed to pollution stress. High levels of contamination in plants can either suppress or uncontrollably increase secondary metabolite production, influencing biochemical production.

A phytochemical analysis can be used to investigate the various biochemical changes that occur within a plant. This can be accomplished by conducting a comparative analysis of plants collected from unpolluted and polluted

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areas. Identifying phytocomponents of medicinal plants using various techniques such as FTIR, HPTLC, NMR, and GCMS analysis, etc. [8]. Most of the studies were carried out with phytochemical characterization of *Senna auriculata* [1], [11], [20], [24-25]. Such comparative studies, however, have yet to be conducted in this medicinal plant. So, the objective of this study was to compare the chemical constituents of leaves and flowers of *Senna auriculata* (L.) Roxb. obtained from natural and polluted sources.

MATERIALS AND METHODS

Plant material collection and identification

The leaves and flowers of *Senna auriculata* were collected from natural sources (Pachaimalai hills & Kolli hills) and polluted sources (Avur road and Samayapuram kariyamanickam road there are many industries near these areas within 500m.) in June 2021. The plant material was identified and authenticated by the Botanical Survey of India (BSI/SRC/5/23/2021/Tech-166), Southern Regional Centre, Coimbatore, Tamil Nadu.

Preparation of plant extract

The plant material (leaves and blossoms) was collected, dried in the shade for a few days, and then processed with an electric blender to make a coarse powder. Soxhlet extraction was employed to extract the active ingredients from the powder. In the jacket of the Soxhlet apparatus, a thimble containing the sample is put. Connect a pipe to the condenser's bottom outlet and the other end of the pipe to a tap. Connect the inlet pipe and allow the water to flow continuously. In the round bottom flask, add 100 ml of analytical grade ethanol. After all the arrangements, turn on the machine. As the flask is heated, the ethanol begins to boil and evaporate, and the vapours are condensed in the condenser and fall on the sample placed in the jacket, and the extract falls back into the flask, completing one cycle. Approximately 10 to 15 such cycles produce complete ethanol extracts. After that, the extract was filtered and evaporated using a rotary evaporator. The dried extracts were refrigerated in preparation for future experiments.

FTIR analysis

The Fourier Transform Infrared (FTIR) spectrophotometer is possibly the most powerful tool for identifying the types of chemical bonds (functional groups) present in compounds. FTIR analysis of *Senna auriculata* powdered samples of leaves and flowers were determined through FTIR spectroscope (PERKIN ELMER, IR), at National College Instrumentation Facility, National College Trichy. Dry powder from ethanol solvent extracts of plant material was utilized for the FTIR examination. 10 mg of the dry extract powder was packed in 100 mg of KBr pellet, to prepare translucent sample disks. The powder sample was placed in a Fourier transform IR spectroscope (PERKIN ELMER, IR) with a scanning range from 500 to 4000 cm^{-1} with a resolution of 4 cm^{-1}. The probable functional groups have been identified based on the maximum values of the IR radiation range [5], [12].

GC-MS analysis

GC-MS is a combination of gas chromatography yet a mass spectrometer. Gas chromatography (GC) is employed to separate and determine the chemical mixtures. Mass spectrometry (MS) is an approach used to clarify molecular mass and structure to identify and quantify compounds. Therefore, the combination of these two techniques enables precise tools for the efficient analysis of complex organic compounds. The GC-MS analysis of ethanol extracts of leaves and flowers of *Senna auriculata* was performed using Gas chromatography-mass spectrometry (Shimadzu QP-2020) at Heber Analytical Instrumentation Facility (HAIF), Bishop Heber College, Trichy. GC-MS (Shimadzu QP-2020) was analyzed using a DB-WAX column that contained a polar stationary phase. A sample injection volume of 1µl with a split ratio of 10: 1 was used. The initial injector temperature was 250°C. The linear velocity to control the flow was kept at 39.7cm/sec, Pressure: 68.1 k Pa, total flow: 16. 2 mL/min, Column flow: 1. 20 mL/min, ion-source temperature: 200°C, and interface temperature: 250°C. The oven temperature was customized from 50°C to 280°C, with a 2 min. ACQ Mode range was 50m/z-500m/z. Mass spectra were examined by electron impact ionization at 70 eV. The complete GC running time for each example was 40 minutes. Mass spectral range understanding in GCMS was performed utilizing the NIST and WILEY library databases. The range of unknown components was compared to the range of known components stored in the NIST and WILEY libraries.

RESULTS AND DISCUSSION

In our study, we performed a comparative phytochemical study for *Senna auriculata* (L.) Roxb. Of polluted sources versus non-polluted sources. The Fourier Transform Infrared Spectrophotometer is one of the most powerful tools for identifying the various types of chemical bonds found in compounds. The FT-IR spectrum of *Senna auriculata* (L.) Roxb. leaves (Fig 1), collected from natural sources confirm the presence of various chemical constituents such as hydroxyl group, alcohol, alkenes, alkanes, aldehydes, thiols, carboxylic acids, nitriles, alkynes, aromatic compounds, alkyl and aryl halides (Table 1) which shows major peaks at 3879.11- 1024.35. The FT-IR spectrum of flower extract shows the frequency range at 3740.48-589.24 (Fig 2), confirm the presence of hydroxyl group, alcohol, amides, amines, carboxylic acids, aromatic compounds, alkanes, aldehydes, nitriles, alkynes, alkenes, alkyl and aryl halides (Table 2).

Table 1 FT-IR peak values and functional groups of *Senna auriculata* leaves from natural sources

Frequency range	Molecular motion	Functional group
3879.11 - 3609.38	O-H (Non-bonded)	Hydroxyl group
3540.78 - 3233.78	O-H stretch	Alcohol
3078.52 - 3024.94	=C-H stretch	Alkenes
2976.86 - 2888.70	C-H stretch	Alkanes
2716.11	C-H stretch	Aldehydes
2598.50	R-S-H stretch	Thiols
2491.13 - 2443.39	O-H stretch	Carboxylic acids
2363.40	C≡N stretch	Nitriles
2091.53	C≡C stretch	Alkynes
1602.72	C=C stretch	Aromatic compounds
1233.89 - 1024.35	C-F stretch	Alkyl and Aryl halides

Table 2 FT-IR peak values and functional groups of *Senna auriculata* flowers from natural sources

Frequency range	Molecular motion	Functional group
3740.48 - 3661.56	O-H (Non-bonded)	Hydroxyl group
3599.79 - 3457.95	O-H stretch	Alcohol
3307.36 - 3235.30	N-H stretch	Amides, amines
3171.57	O-H stretch	Carboxylic acids
3081.31 - 3024.59	C-H stretch	Aromatic compounds
2922.29 - 2855.20	C-H stretch	Alkanes
2712.22	C-H stretch	Aldehydes
2522.79 - 2429.25	O-H stretch	Carboxylic acids
2311.37	C≡N stretch	Nitriles
2160.26	C≡C stretch	Alkynes
1594.41-1537.84	C=C stretch	Aromatic compounds
1017.77	C-F stretch	Alkyl & Aryl Halides
905.02 - 723.95	C-H bend	Alkenes
647.81-589.24	C-Br, C-I stretch	Alkyl and Aryl Halides

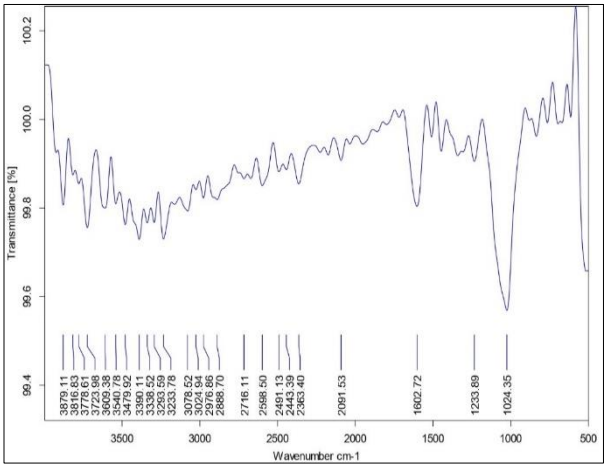

Fig 1 FTIR spectrum of ethanol leaves extract of *Senna auriculata* from natural sources

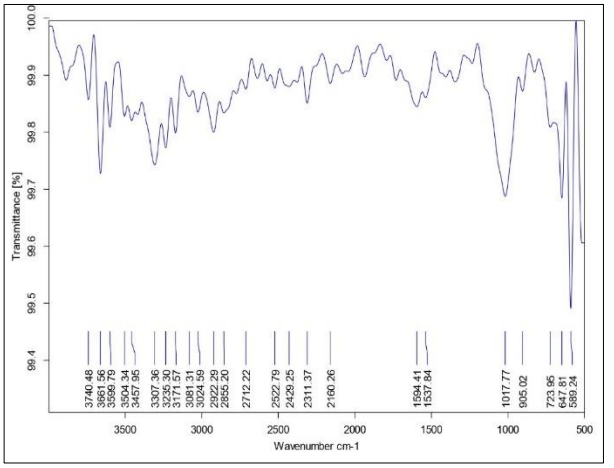

Fig 2 FTIR spectrum of ethanol flowers extract of *Senna auriculata* from natural sources

The data on the peak values and the probable functional groups present in the *S. auriculata* leaves extract obtained from the polluted sources reveals the presence of hydroxyl group, alcohol, amides, amines, carboxylic acids, thiol, alkenes, alkyl and aryl halides (Table 3) with major peaks at 3887.27- 574.56 (Fig 3). While the flower extract obtained from the polluted sources revealed a frequency range of 3852.17-582.05 (Fig 4), it confirmed the following functional groups: hydroxyl group, alcohol, amides, amines, carboxylic acids, alkanes, aldehydes, thiols, nitriles, alkynes, alkenes, aromatic compounds, alkyl and aryl halides (Table 4). When the functional groups or chemical bonds of *S. auriculata* from natural and contaminated sources are compared, the natural source extract has more bonds, implying that more phytochemicals are present in these extracts.

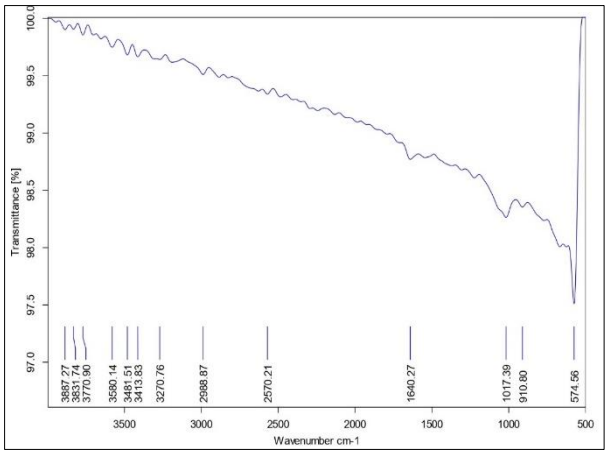

Fig 3 FTIR spectrum of ethanol leaves extract of *Senna auriculata* from polluted sources

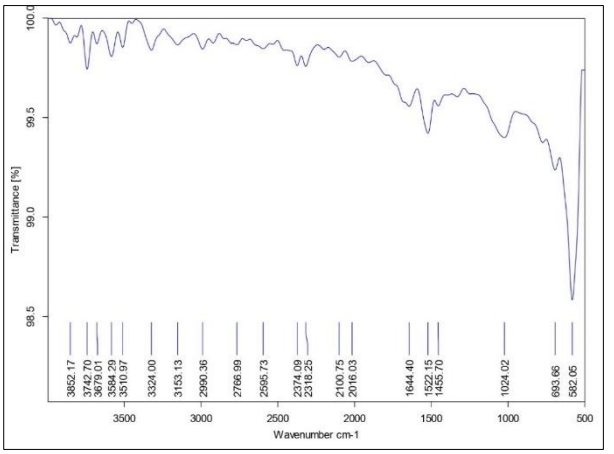

Fig 4 FTIR spectrum of ethanol flowers extracts of *Senna auriculata* from polluted sources

Table 3 FT-IR peak values and functional groups of *Senna auriculata* leaves from polluted sources

Frequency range	Molecular motion	Functional group
3887.27 - 3770.90	O-H (Non-bonded)	Hydroxyl group
3580.14	O-H stretch	Alcohol
3481.51 - 3270.76	N-H stretch	Amides, Amines
2988.87	O-H stretch	Carboxylic Acids
2570.21	R-S-H stretch	Thiol
1640.27	C=C stretch	Alkenes
1017.39	C-F stretch	Alkyl and Aryl Halides
910.80	C-H bend	Alkenes
574.56	C-I stretch	Alkyl and Aryl Halides

Table 4 FT-IR peak values and functional groups of *Senna auriculata* flowers from polluted sources

Frequency range	Molecular motion	Functional group
3852.17 - 3679.01	O-H (Non-bonded)	Hydroxyl group
3584.29 - 3510.97	O-H stretch	Alcohol
3324.00	N-H stretch	Amides, Amines
3153.13	O-H stretch	Carboxylic Acids
2990.36	C-H stretch	Alkanes
2766.99	C-H stretch	Aldehydes
2595.73	R-S-H stretch	Thiols
2374.09 - 2318.25	C≡N stretch	Nitriles
2100.75	C≡C stretch	Alkynes
2016.03	C≡N stretch	Nitriles
1644.40	C=C stretch	Alkenes
1522.15 -1455.70	C=C stretch	Aromatic Compounds
1024.02 - 582.05	C-F, C-Br stretch	Alkyl and Aryl Halides

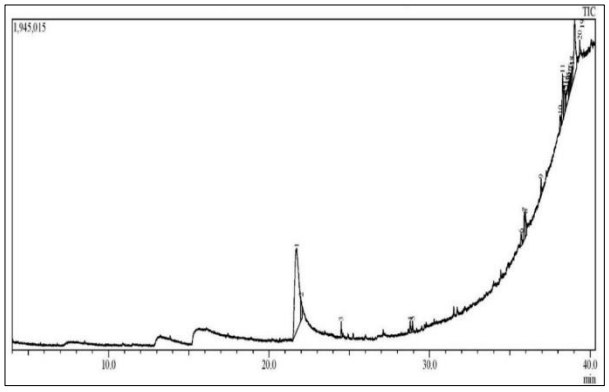

Fig 5 GC-Chromatogram of ethanol leaves extract of *Senna auriculata* from natural sources

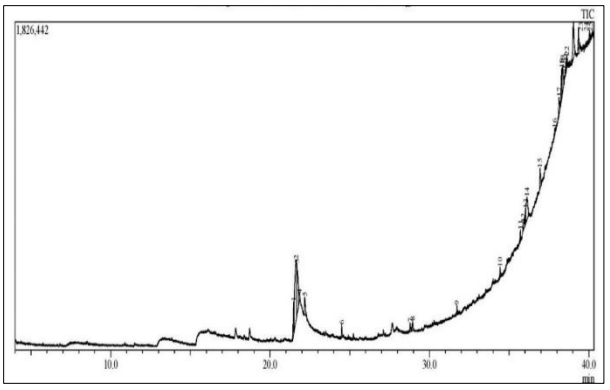

Fig 6 GC-Chromatogram of ethanol flowers extracts of *Senna auriculata* from natural sources

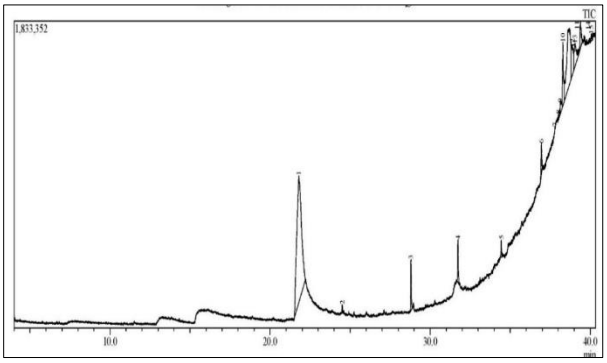

Fig 7 GC-Chromatogram of ethanol leaves extract of *Senna auriculata* from polluted sources

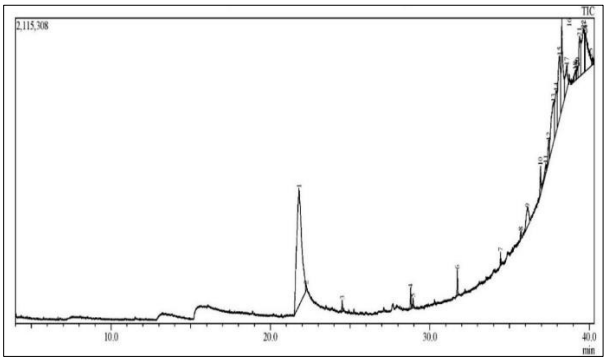

Fig 8 GC-Chromatogram of ethanol flowers extracts of *Senna auriculata* from polluted sources

In GC-MS analysis, ethanol extract of S. *auriculata* leaves obtained from the natural sources produced 20 peaks in the chromatogram (Fig 5) and the flowers showed the occurrence of 24 peaks in the chromatogram (Fig 6). In leaves extract 20 compounds were identified (Table 5), 3-O-Methyl-d-glucose (43.89%), Stigmasterin (13.06%), Squalene (5.58%) as the major compounds. In flower extracts 24 compounds were identified (Table 6), major compounds are 3-O-Methyl-d-glucose (23.77%), 1-Deoxy-d-altritol (10.59%), Stigmasterin (8.92%), and Lupeol (7.68%). The GC-MS spectra of ethanol extract of *S. auriculata* leaves obtained from polluted sources showed the peaks of 13

compounds in the chromatogram (Fig 7), and flowers confirmed the presence of 20 components with different retention times (Fig 8). The active phytocompounds identified in both sources are tabulated with their peak retention time, peak area (%), molecular weight, and molecular formula (Table 7-8). Major compounds which were reported from leaves were 3-O-Methyl-d-glucose (51.01%), Stigmastane-3, 6-dione, (5.alpha.)- (20.41%), and flowers were 3-O-Methyl-d-glucose (32.82%), Dodecanoic acid, 1, 2, 3-propanetriyl ester (24.65%), Squalene (8.17%).

The leaves and flowers of *S. auriculata* have a different bio-constituent; only a few compounds 3-O-Methyl-d-glucose, Neophytadiene, Dotriacontane, Phytol, and Squalene appeared in both the plant parts. 3-O-Methyl-d-glucose was the most abundant compound in *S. auriculata*. In total, 38 and 27components were detected and characterized, from the leaves and flowers of *S. auriculata* obtained from natural and polluted sources respectively. As a result, the differences in phytochemicals observed in these plants suggest that environmental pollution is impacting the plants.

Table 5 Phytochemicals identified in the ethanol leaves extract of *Senna auriculata* from natural sources

R.T. (min)	Area %	Molecular formula	Molecular weight	Compound name
21.730	43.89	$C_7H_{14}O_6$	194	3-O-Methyl-d-glucose
21.985	3.35	$C_{10}H_{17}NO_6S$	279	Desulphosinigrin
24.500	1.22	$C_{20}H_{38}$	278	Neophytadiene
28.800	1.12	$C_{32}H_{66}$	450	Dotriacontane
28.940	1.11	$C_{20}H_{40}O$	296	Phytol
35.705	1.48	$C_{23}H_{48}O$	340	Eicosyl isopropyl ether
35.910	3.61	$C_{29}H_{50}O_2$	430	dl-.alpha.-Tocopherol
35.975	3.49	$C_{35}H_{60}O_7$	592	alpha.-Tocopherol-.beta.-D-mannoside
36.945	1.67	$C_{36}H_{74}$	506	Hexatriacontane
38.135	1.67	$C_{24}H_{50}$	338	Tetracosane
38.285	5.58	$C_{30}H_{50}$	410	Squalene
38.385	4.78	$C_{28}H_{48}O$	400	Ergost-5-en-3-ol, (3.beta.)-
38.470	1.88	$C_{27}H_{46}$	370	Cholest-23-ene, (5.beta.)-
38.625	3.97	$C_{13}H_{22}O_3Si_2$	282	4-Hydroxybenzoic acid, 2TMS derivative
38.670	1.97	$C_{19}H_{32}O_2Si$	320	Bicyclo[6.3.0]undeca-1(8),2-dien-7-one,5,5-dimethyl-3-(t butyldimethylsilyloxy)-
38.775	1.61	$C_{20}H_{60}O_{10}Si_{10}$	740	Cyclodecasiloxane, eicosamethyl
38.795	1.55	$C_{21}H_{37}NO_4$	367	Glycine, N-allyloxycarbonyl-, pent-10-enyl ester
38.875	1.84	$C_{17}H_{14}N_2O_2S_2$	342	5-Oxo-7-[4-(trifluoromethyl)phenyl]-4H,6H,7H-[1,2]thiazolo[4,5-b]pyridine
39.050	13.06	$C_{29}H_{48}O$	412	Stigmasterin
39.355	1.14	$C_{26}H_{54}$	366	Octadecane, 3-ethyl-5-(2-ethylbutyl)-

Table 6 Phytochemicals identified in the ethanol flower extracts of *Senna auriculata* from natural sources

R.T. (min)	Area %	Molecular formula	Molecular weight	Compound name
21.480	4.92	$C_{15}H_{20}O$	216	Ar-tumerone
21.640	23.77	$C_7H_{14}O_6$	194	3-O-Methyl-d-glucose
21.685	10.59	$C_6H_{14}O_5$	166	1-Deoxy-d-altritol
21.850	3.23	$C_6H_{10}O_2$	114	2-Hexenoic acid
22.180	3.09	$C_{15}H_{22}O$	218	Curlone
24.495	1.49	$C_{20}H_{38}$	278	Neophytadiene
28.790	1.53	$C_{32}H_{66}$	450	Dotriacontane
28.945	1.53	$C_{20}H_{40}O$	296	Phytol
31.730	0.73	$C_{13}H_{28}$	184	Nonane, 5-butyl-
34.440	1.24	$C_{29}H_{60}$	408	Nonacosane
35.720	1.11	$C_{32}H_{65}I$	576	Dotriacontane, 1-iodo-
35.890	2.58	$C_{29}H_{50}O_2$	430	Vitamin E
36.030	1.61	$C_{22}H_{32}O_7$	408	1-Oxo-forskolin
36.125	7.68	$C_{30}H_{50}O$	426	Lupeol
36.945	2.86	$C_{30}H_{61}I$	548	Triacontane, 1-iodo-
38.135	2.91	$C_{20}H_{42}$	282	Eicosane
38.295	4.7	$C_{25}H_{42}$	342	2,6,10,14,18-Pentamethyl-2,6,10,14,18-eicosapentaene
38.370	6.01	$C_{28}H_{48}O$	400	Ergost-5-en-3-ol, (3.beta.)-
38.440	0.53	$C_{26}H_{41}NO_3$	415	3.beta.-Acetoxy-5-cholenamide
38.550	1.2	$C_{21}H_{23}BrFNO_2$	419	Bromperidol
38.625	1.61	$C_{14}H_{22}O_2$	222	Menthol, 1'-(butyn-3-one-1-yl)-, (1S,2S,5R)-
39.030	8.92	$C_{29}H_{48}O$	412	Stigmasta-5,23-dien-3.beta.-ol
39.360	3.71	$C_{18}H_{38}$	254	Octadecane
40.060	1.98	$C_{20}H_{38}O_3$	326	Cyclopropanedecanoic acid, 2-hexyl-.alpha.-hydroxy-, methyl ester

Table 7 Phytochemicals identified in the ethanol leaves extract of *Senna auriculata* from polluted sources

R.T. (min)	Area %	Molecular formula	Molecular weight	Compound name
21.796	51.01	$C_7H_{14}O_6$	194	3-O-Methyl-d-glucose
24.505	0.39	$C_{20}H_{38}$	278	Neophytadiene
28.800	2.58	$C_{21}H_{44}$	296	Heneicosane
31.735	2.3	$C_{34}H_{70}$	478	Tetratriacontane
34.445	0.83	$C_{29}H_{60}$	408	Nonacosane
36.945	2.05	$C_{38}H_{69}F_7O_2$	690	Triacontyl heptafluorobutyrate
37.790	0.1	$C_{27}H_{42}O_4$	430	Propanoic acid, 2-(3-acetoxy-4,4,14-trimethylandrost-8-en-17-yl)-
38.125	1.33	$C_{24}H_{51}NO_2Si$	413	Propanamide, N-octadecyl-3-[(trimethylsilyl)oxy]-
38.290	5.02	$C_{30}H_{50}$	410	Squalene
38.705	20.41	$C_{29}H_{48}O_2$	428	Stigmastane-3, 6-dione, (5.alpha.)-
38.895	5.07	$C_{21}H_{41}$ NO_4	371	Beta,-Alanine, N-neopentyloxycarbonyl-, dodecyl ester
39.035	4.74	$C_{15}H_{26}O$	222	1H-cyclopenta[a]pentalen-7-ol, decahydro-3,3,4,7a-tetramethyl-
39.395	2.87	$C_{26}H_{45}F_7O_2$	522	Docosyl heptafluorobutyrate

Table 8 Phytochemicals identified in the ethanol flower extract of *Senna auriculata* from polluted sources

R.T. (min)	Area %	Molecular formula	Molecular weight	Compound name
21.795	32.82	$C_7H_{14}O_6$	194	3-O-Methyl-d-glucose
22.255	0.44	$C_7H_9D_3O_2$	131	4-D1-5-D2-Methyl 2-hexenoate
24.505	0.4	$C_{20}H_{38}$	278	Neophytadiene
28.800	0.75	$C_{21}H_{44}$	296	Heneicosane
28.945	0.52	$C_{20}H_{40}O$	296	Phytol
31.730	0.81	$C_{20}H_{42}$	282	Eicosane
34.435	0.45	$C_{34}H_{70}$	478	Tetratriacontane
35.715	0.34	$C_{19}H_{40}O$	284	Hexadecyl isopropyl ether
36.120	2.86	$C_{30}H_{50}O_2$	442	Betulin
36.950	1.47	$C_{60}H_{122}$	842	Hexacontane
37.275	1.28	$C_{18}H_{54}O_9Si_9$	666	Cyclononasiloxane, Octadecamethyl-
37.460	1.87	$C_{39}H_{74}O_6$	638	Dodecanoic acid, 1,2,3-propanetriyl ester
37.760	8.51	$C_{39}H_{74}O_6$	638	Dodecanoic acid, 1,2,3-propanetriyl ester
37.920	5.23	$C_{39}H_{74}O_6$	638	Dodecanoic acid, 1,2,3-propanetriyl ester
38.135	9.04	$C_{39}H_{74}O_6$	638	Dodecanoic acid, 1,2,3-propanetriyl ester
38.285	8.17	$C_{30}H_{50}$	410	Squalene
38.585	3.66	$C_{31}H_{52}O$	440	9, 19-Cyclolanostan-3-ol, 24-methylene-, (3.beta.)-
39.200	0.22	$C_{15}H_{24}O$	220	6-Methyl-2-(4-methylcyclohex-3-en-1-yl)hepta-1,5-dien-4-ol
39.390	4.37	$C_{26}H_{45}F_7O_2$	522	Docosyl heptafluorobutyrate
39.630	6.63	$C_{21}H_{33}BrO_2$	396	3-Bromobenzoic acid, 3-tetradecyl ester
39.720	1.25	$C_{23}H_{28}O_6$	400	Glutaric acid, di(2-isopropoxyphenyl) ester
39.770	6.85	$C_{15}H_{24}O_2$	236	2R,3R,4aR,5S,8aS)-2-Hydroxy-4a,5-dimethyl-3-(prop-1-en-2yl)octahydronaphthalen
40.220	0.38	$C_{12}H_{36}O_4Si_5$	384	Pentasiloxane, dodecamethyl-

The compounds identified in the leaves and flowers of *Senna auriculata* (L.) Roxb. belong to different classes such as alkaloids, glycosides, saponins, polyphenols, tannins, terpenoids, triterpenes, carbohydrates, fatty acids, amino acids, carboxylic acid, and phytosterols, etc. [22]. These metabolites are attributed to the pharmacological action in many diseases. The biological activity of some of the main constituents includes, 3-0-Methyl-D-glucose, a nontoxic non-metabolizable derivative of glucose, is effective in reducing the toxicity of streptozotocin (SZ) with an enhancement of antitumor activity [29], and has been shown to protect rats against the development of SZ-induced diabetes [6]. Stigmasterol is a phytosterol. It is associated with a reduction in blood LDL cholesterol of 8–10%, possibly lowering cardiovascular disease risk [2]. Squalene is an isoprenoid and was evaluated for its antidiabetic potential and reported with their mechanistic pathways involved in the amelioration of diabetes [15], [25]. Phytol is diterpenoid alcohol that can be used as a precursor for the manufacture of synthetic forms of vitamin E and vitamin K1. Tetratetracontane is an alkane

having antibacterial properties [9]. Neophytadiene is an alkene and a diterpene. It has a role as an anti-inflammatory agent, an antimicrobial agent. Eicosane is an alkane that has high antioxidants [28]. Ar-turmerone is a sesquiterpenoid that has extensive biological activities such as, antimicrobial, allelopathic, cytotoxic, and antifeedant activity [4]. Lupeol is a lupane-type triterpene reported to possess several biological activities such as anti-inflammatory, antiprotozoal, anticancer, and anti-oxidant. Propanoic acid is a carboxylic acid that showed potential hypoglycemic effects [27]. Based on the results obtained in the present investigation, it may be concluded that the biological activities of the identified phytocomponents used for anti-microbial, anti-inflammatory, antidiabetic, hepatoprotective, antihypercholesterolemic, and anti-cancer activities.

On comparing the results, we found that from the phytochemical analysis, the plant collected from the natural sources had more bioactive compounds than the polluted sources. These findings suggest that some environmental contaminants may cause stress in these plants, causing the pathways for the synthesis of these metabolites to be deregulated in plants exposed to pollution. A considerable decrease in biochemical contents could be the result of DNA mutation, which could potentially lead to a change in metabolic pathways. The presence of heavy metals in medicinal plants as a result of pollution may increase the development of bioactive chemicals in many plant species. Furthermore, some research findings imply that heavy metals may play an essential role in triggering plant genes to change the type of secondary plant metabolites, even though further research is needed. Although the actual mechanism by which this occurs is unknown. The quantitative determination of different types of contaminants presents in the air, water, and soil in contaminated places where the plants were taken can also be done utilizing atomic absorption spectroscopy techniques in this study.

CONCLUSION

According to FT-IR and GC-MS analyses, the ethanol extract of *Senna auriculata* flowers contains more phytocompounds than the leaves. The leaves and flowers of *Senna auriculata* from natural sources, on the other hand, contained more components than those from polluted sources. As a result of this finding, it is reasonable to conclude that environmental pollution affects the biochemical and phytochemical properties of plants in polluted areas, limiting their therapeutic potential. According to the findings of this study, medicinal plants used for human consumption or to manufacture herbal products and standardized extracts should be collected from an unpolluted natural habitat.

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