



Withdrawal Notice

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The Editorial Board would like to extend its sincere apology for any inconvenience this withdrawal may have caused.



Phytochemical Characterization of Natural Dye Extracted from *Senna siamea* Pods

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Abstract

An increasing eco-consciousness among peoples has been shifting the use of natural dyes for textile dyeing and in other realms too as food, pharmaceuticals and cosmetics. The present study was focussed on aqueous extraction of natural dye from the pod husk of *Senna siamea* (Lam.) H.S. Irwin & Barneby, its characterization through spectroscopic (UV-VIS and FT-IR) and chromatographic (GC-MS/LC-MS) technique. It was noticed that the percent recovery was 16%, while FTIR results indicates different functional groups present in the dye, total 16 constituents were identified in the GC-MS analysis of *Senna* dye such as D-Fructose, 3-O-methyl-, Stigmast-5-en-3-ol, oleate, Benzaldehyde, 2-hydroxy-4-methyl-, 3'-Methoxybenzo[1',2'-b]-1,4-, Tetrapentacontane, n-Hexadecanoic acid, 2,3-Dihydroxypropyl elaidate 3-Hydroxy-4-methoxybenzoic acid, 4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6, 4-Hydroxy-2-methylacetophenone, Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl), Maltol, Methyl 14-methyl-eicosanoate, Bis(2-ethylhexyl) phthalate, 9,12-Octadecadienoic acid (Z,Z)-, 2,3-dihydro, Benzeneacetaldehyde, and the LCMS analysis exhibits the presence of 20 major bioactive compounds among these N-Pentadecylcyclohexanecarboxamide, Docosanedioic acid, Emmotin A, 3 α ,12 α -Dihydroxy-5 β -chol-7-en-24-oic Acid, 4-Hydroxyphenylglyoxylate, Hexadecyl Acetyl Glycerol, 2-oxo-nonadecanoic acid, 1-Monopalmitin, Spisulosine and N,N-dimethyl-Safingol showed highest retention time. Thus the *Senna* dye is a rich source of natural bioactive compounds.

Subject Areas

Plant Science

Keywords

Natural Dye, UV-VIS, FTIR, GC-MS, LCMS

1. Introduction

Since the dawn of civilization, the art of making natural dye is one of the oldest methods known to humankind [1]. The discovery of synthetic dye was almost replaced the natural dyes. This could have happened because of its own drawbacks like divergence of colour, less availability and lack of fastness properties [2]. Due to toxic and allergic reactions associated with synthetic dyes, ban has been imposed on their uses by Germany and other European countries. Hence there is renaissance in the use of natural dyes in the textile dyeing, for food, pharmaceutical and in cosmetics [3].

Natural dyes obtained from flora and fauna are non-toxic, non-carcinogenic and biodegradable in nature and almost non-pollutant so do not pose serious hazards to environment [4]. The colour range is correlated to chemical structure and chromogen–chromophore correlated with auxochrome. In textile coloration chromophore and auxochrome are considered as the most important chemical constituents of dyes [5] [6]. The colour of dyed fabrics depends on the nature of dye constituents [7]. The constituent molecules contain aromatic ring structure coupled with azide chain are usually required for resonance and thus to impart colour. Due to lack of knowledge on the extraction and dyeing of natural dye, it has not been employed commercially like synthetic dyes [8]. But now a day's considerable research work is started throughout the world on the application of natural dyes [9]. Added to this natural dyes are gaining popularity as UV protective and antimicrobial clothing dyes [10].

Nowadays there has been increasing interest in production of antibacterial textiles because clothing and other textile materials provide essential requirements in the form of moisture and nutrients to pathogenic and odour generating microbes. Natural dyes possess antimicrobial properties because of presence of a considerable amount of antimicrobial compounds such as anthraquinones, flavonoids, tannins, naphthoquinones etc [11]. Natural dye extracted from *Punica granatum* reported as antibacterial agent as it possesses a considerable amount of tannins. Some other sources of plant dyes such as lawsone from henna, juglone from walnut and lapachol from alkanet are rich in naphthoquinones also exhibit antibacterial properties [12] [13] [14]. There is need to reinvestigate the renewable resources as the alternative raw material as source of natural dyes [15] [16].

Senna siamea (Lam.) H.S.Irwin & Barneby Formerly, *Cassia siamea* belongs to family Fabaceae. It is commonly known as kassod tree, cassod tree and cassia tree. In traditional medicine, the fruit is used to prevent convulsion in children. The young fruits and leaves are also eaten as vegetables in Thailand [17]. The plant also possesses antimalarial, antidiabetic [18], antitumor or anticancer [19] [20], laxative [21] anti-inflammatory, analgesic, antipyretic, anxiolytic, antidepressant, and sedative [22] properties. The plants are rich in array of secondary metabolites such as polyphenols, flavonoids, isoflavonoids, phenolic acids, triterpenoids, chromones, anthraquinones, bianthra-quinones, sennosides, steroids, and carotenoids, etc [23], which have been found to possess antimicrobial properties in

vitro. In the present investigation an attempt has been made to extract the natural water soluble dye from pods of *S. siamea*, to characterize the prepared dye for its chemical constituents and to assess its antibacterial potential.

2. Material and Methods

Preparation of Raw Material

Pods of *S. siamea* were collected from campus of Shivaji University, Kolhapur (Figure 1). The plant material was identified using Flora of Maharashtra state [24] and authenticated by referring to type specimen. A voucher specimen (SHP-001) has been deposited at the Department of Botany, SUK herbarium. The material was washed thoroughly to remove adhering dirt and dried at room temperature. Subsequently, dried material was ground into powder. The powder was passed through a sieve of 25 μ mesh size to obtain uniform particle size of material. The sieved powder was used for dye extraction at different experimental conditions.

Extraction of Dye in Powder Form

The dye from the pod husk of *S. siamea* was extracted by heating the husk powder and distilled water (M: 1-10:100) at 80°C - 90°C for 2 hr. The dye solution was filtered and transferred in evaporating dish and dried in oven at 60°C then it is cooled and weighed to determine the weight of extract from which the yield (16%) was calculated. The percentage of the dye powder was calculated from equation [25].

$$\% \text{ dye powder} = \frac{\text{g of purified dye}}{\text{g of plant material}} \times 100$$

Characterization of Dye

UV-VIS spectrum analysis

To detect the UV-VIS spectrum profile of *Senna* dye, aqueous extract was scanned in the wavelength ranging from 200 - 800 nm using UV-VIS spectrophotometer and the characteristic peak were detected.

FT-IR spectral analysis

The most characteristics auxo chromic functional group present in *S. siamea* dye were recorded using FT-IR spectrophotometer (BRUKER ALPHA 100508). The spectrum was located in the range from 500 - 4000 cm^{-1} with a resolution of 4 cm^{-1} and each spectrum composed of 32 scans. Peaks in the spectrum were analysed in accordance with the literature.

GC-MS analysis

GC-MS analysis of the sample was performed on a SHIMADZU GC-2010.GCMS QP-2010. Column used was Restec Rtx-5MS measuring 60 mm \times 0.25 mm ID thickness of 0.25 μm composed of 95% dimethyl polysiloxane. Helium gas was used as carrier gas at a flow rate of 1 ml/min and injection volume of 1 μl was utilized. During the process the oven temperature was programmed initially at 60°C for 5 minutes then an increased to 240°C for 5 minutes then programmed to increased up to 280°C for 2 minutes at a rate of 10°C per minutes ending with

a 5 minutes. Interpretation of mass spectrum of GCMS was done using database of National Institute standard and Technology (NIST) library. Measurement of peak area and data processing were carried out by Real time analysis software ver.2.6.

LC-MS analysis

Aqueous extract of *Senna* dye was subjected to LCMS analysis. An Agilent 6540 UHD QTOF LCMS instrument was used to perform untargeted sample analysis. Zorbax SB-Aq, 3.0 × 100 mm; 3.5 μM column (Agilent 1290 Infinity Binary pump, well plate auto sampler, thermostatted column compartment) with a flow rate of 0.6 ml/min and 20 μl injection volume was used. MS with both positive and negative modes was used (Agilent 6540 UHD QTOF LC/MS/MS). The operating parameters for the LCMS detection were as follows: nebulizing gas flow 30 psi, drying gas pressure 12 Lmin⁻¹ and gas temp. 325 °C, Skimmer voltage 65 v, octapole RF 750 v, capillary voltage 3.5 kv and fragmented voltage 150 v. Data were collected using Mass Hunter Molecular Feature Extractor (MFE) tool.

3. Results and Discussion

UV-VIS spectral analysis of natural dye was performed for qualitative analysis and for identification of certain classes of compound, main hue, and property of dye. The UV-VIS spectrum of *Senna* dye extract showed one peak at 287 nm with the absorption of 1.563. Figure 2 shows absorption spectrum of *Senna* dye powder.

The comparative data on the peak value with wave numbers and the possible functional groups during FTIR analysis of *Senna* dye powder are presented in Table 1. FTIR spectrum (Figure 3) exhibit characteristic functional groups are present in *Senna* dye powder. Peak at 3852.22 cm⁻¹, 3739.95 cm⁻¹ and 3225.94 cm⁻¹ was indexed to the -OH group, at 2927.76 cm⁻¹ assigned to C-H stretching in -CH₂ group [26]. Presence of C-H bond which usually considered as prominent band for flavonoid pigment [27]. Peak at 2383.75 cm⁻¹ and 2313.33 cm⁻¹ indicates O-H stretching vibration of carboxylic acid [28]. At 1587.22 cm⁻¹ and 1524.80 cm⁻¹ refers to the infrared absorption of C=C while 1259.11 cm⁻¹ indicating C-O [29] [30], Peak at 1389.52 cm⁻¹ denotes the ether group, Other peaks at 1057.20 cm⁻¹ and 661.37 cm⁻¹ indicates fluoroalkane and chloroalkane. The dye had its respective functional group like alcohol, alkane, carboxylic acid, carbonyl, ether, aromatic etc. Hence, the crude extract subjected to UV-VIS and FTIR analysis is used for the identification of chemical constituents present in dye. In addition, UV-VIS and FTIR spectroscopy is proved to be a reliable and sensitive method for detection of bio molecular composition.

The compounds presented in the crude dye powder of *S. siamea* were identified by GC-MS and LCMS analysis. The GC-MS analysis revealed the presence of 16 components presented in Table 2. Figure 4 shows GCMS chromatogram spectrum of *Senna* dye powder. The identification of phytochemicals was based on the peak area, retention time and compound name. The active compounds along with their respective retention time, area percentage, molecular formula,

molecular weight are presented in **Table 2**. The principal constituents were identified in dye extract are D-Fructose, 3-O-methyl-, Stigmast-5-en-3-ol, oleate, Benzaldehyde, 2-hydroxy-4-methyl-, 3'-Methoxybenzo [1', 2'-b]-1, 4-, with percent area of 81.96, 5.41, 3.92 and 3.64 respectively.



Figure 1. Picture off *Senna stamea* Pods.

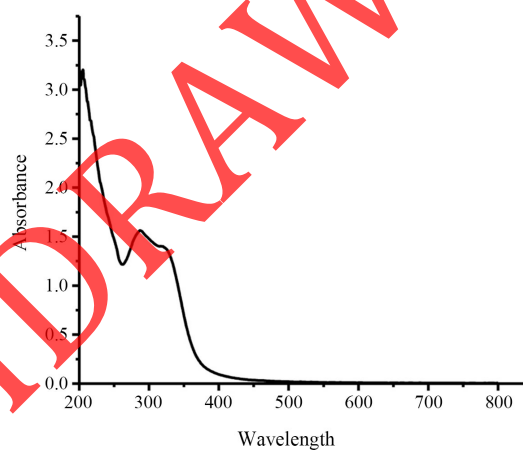


Figure 2. UV-VIS spectrum of *Senna* dye.

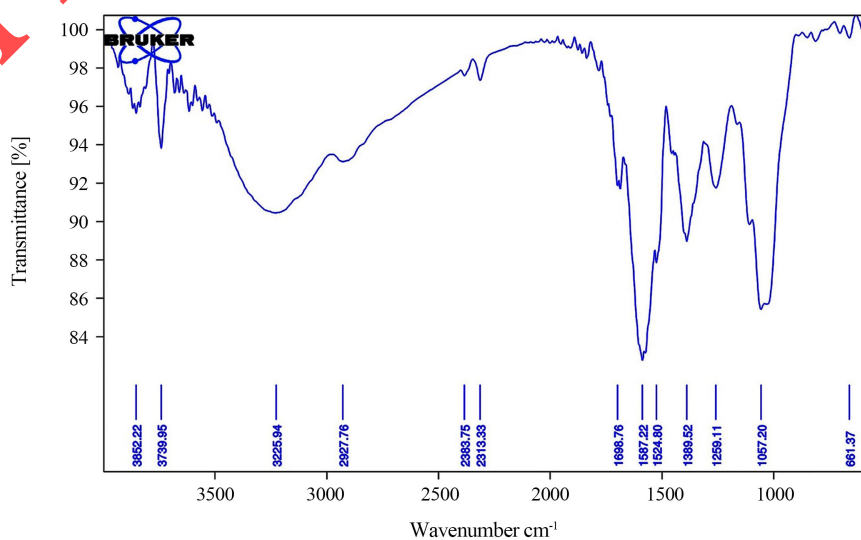


Figure 3. FTIR spectrum of *Senna* dye.

Table 1. Functional group analysis of *Senna* dye using FT-IR spectroscopy.

Sr. No.	Wavenumbers cm^{-1}	Assignments
1	3852.22	
2	3739.95	Alcohol (OH)
3	3225.94	
4	2927.76	Alkane (C-H)
5	2383.75	
6	2313.33	Carboxylic acid (O-H)
7	1698.76	Carbonyl (C=O)
8	1587.22	Aromatic (C=C)
9	1524.80	Aromatic (C=C)
10	1389.52	Alkane (C-H)
11	1259.11	Akyl aryl ether (C-O)
12	1057.20	Fluroalkane (C-X)
13	661.37	Chloroalkane (C-X)

Table 2. Bioactive compounds detected in *Senna* dye extract by GC-MS.

Peak No.	RT	Name of Compound	Molecular Formula	Molecular Weight	Area%
1	18.683	D-Fructose, 3-O-methyl-	$\text{C}_6\text{H}_{14}\text{O}_6$	194	81.96
2	25.241	Stigmast-5-en-3-ol, oleate	$\text{C}_{47}\text{H}_{82}\text{O}_2$	678	5.41
3	14.036	Benzaldehyde, 2-hydroxy-4-methyl-	$\text{C}_8\text{H}_8\text{O}_2$	136	3.92
4	25.571	3'-Methoxybenzo[1',2'-b]-1,4-diazabicyclo[2.2.2]	$\text{C}_{11}\text{H}_{14}\text{N}_2\text{O}$	190	3.64
5	27.623	Tetrapentacotane	$\text{C}_{54}\text{H}_{110}$	758	0.70
6	19.945	n-Hexadecanoic acid	$\text{C}_{16}\text{H}_{32}\text{O}_2$	256	0.69
7	30.822	2,3-Dihydroxypropyl elaidate	$\text{C}_{21}\text{H}_{40}\text{O}_4$	356	0.67
8	15.565	3-Hydroxy-4-methoxybenzoic acid	$\text{C}_8\text{H}_8\text{O}_4$	168	0.63
9	9.828	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6	$\text{C}_6\text{H}_8\text{O}_4$	144	0.51
10	12.290	4-Hydroxy-2-methylacetophenone	$\text{C}_9\text{H}_{10}\text{O}_2$	150	0.37
11	28.613	Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)	$\text{C}_{19}\text{H}_{38}\text{O}_4$	330	0.27
12	8.843	Maltol	$\text{C}_6\text{H}_6\text{O}_3$	126	0.18
13	19.516	Methyl 14-methyl-eicosanoate	$\text{C}_{22}\text{H}_{44}\text{O}_2$	340	0.16
14	28.842	Bis (2-ethylhexyl) phthalate	$\text{C}_{24}\text{H}_{38}\text{O}_4$	390	0.15
15	30.757	9,12-Octadecadienoic acid (Z,Z)-,2,3-dihydro	$\text{C}_{21}\text{H}_{38}\text{O}_4$	354	0.14
16	8.162	Benzeneacetaldehyde	$\text{C}_8\text{H}_8\text{O}$	120	0.08

The LCMS analysis exhibit 20 different major compounds listed in **Table 3**, among these Docosanedioic acid used in antiseptics, top-grade coatings, painting materials, corrosion inhibitors, surfactants, and engineering plastics such as nylon 612 [31], 3α , 12α -Dihydroxy- 5β -chol-7-en-24-oic acid displays cholesterol elevating activity [32]. Hexadecyl Acetyl Glycerol inhibits the growth of HL-60 cells and induces differentiation to cells resembling mononuclear phagocytes [33]. Spisulosine has antiproliferative activity toward advanced malignant solid tumors [34] [35]. Whereas DL-3-Phenylactic acid is used as natural antibiotic agent. Carnosol is known for its high antioxidative capacities, and have many industrial applications in the fields of foods and beverages, nutrition, and health

[36]. The compound like 5, 7, 2', 3'-Tetrahydroxyflavone and Nodifloretin displays the antiviral, insecticidal activities [37] [38]. The presence of these compounds (Figure 5) in *Senna* dye shows a potential source of these bioactive compounds which might be utilized in the development of various pharmaceutical formulations as well as basis of anticancerous and antiviral drugs. Further study of these phytoconstituents may prove the medicinal importance.

Table 3. Bioactive compounds detected in *Senna* dye extract by LC-MS.

Sr.No.	Name of Compound	Molecular Formula	Score	Mass	RT
	N-Cyclohexanecarbonylpentadecylamine	C ₂₂ H ₄₃ N O	98.47	337.3343	22.0719
	Docosanedioic acid	C ₂₂ H ₄₂ O ₄	96.87	370.3073	21.9896
	Emmotin A	C ₁₆ H ₂₂ O ₄	99.24	278.1522	21.9358
	3 α ,12 α -Dihydroxy-5 β -chol-7-en-24-oic Acid	C ₂₄ H ₃₈ O ₄	99.02	390.2769	21.935
	4-Hydroxyphenylglyoxylate	C ₈ H ₆ O ₄	98.72	166.0271	21.9336
	Hexadecyl Acetyl Glycerol	C ₂₁ H ₄₂ O ₄	99.11	358.3082	20.7433
	2-oxo-nonadecanoic acid	C ₁₉ H ₃₆ O ₃	95.76	312.2664	18.9349
	1-Monopalmitin	C ₁₉ H ₃₈ O ₄	98.28	330.2768	18.9327
	Spisulosine	C ₁₈ H ₃₆ N O	96.49	285.3029	12.9222
	N,N-dimethyl-Safingol	C ₂₀ H ₄₃ N O ₂	98.63	329.3292	12.832
	DL-3-Phenyllactic acid	C ₉ H ₁₀ O ₃	96.35	166.0634	11.7741
	Estra-1,3,5 (10)-triene-3,6 α ,17 β -triol triacetate	C ₂₄ H ₃₀ O ₆	99.4	414.2041	11.6812
	C16 Sphinganine	C ₁₆ H ₃₅ N O ₂	99.77	273.2666	8.8219
	Carnosol	C ₂₀ H ₂₆ O ₄	99.47	330.1831	8.3337
	5,7,2',3'-Tetrahydroxyflavone	C ₁₅ H ₁₀ O ₆	99.03	286.0479	7.8794
	PGE3 1,15-lactone	C ₂₀ H ₂₈ O ₄	97.69	332.1991	7.8
	5,7-nonadienal	C ₉ H ₁₄ O	99.22	138.1045	7.792
	Longicaudatin	C ₂₆ H ₂₂ O ₇	99.4	446.1365	7.5569
	Nodifloretin	C ₁₆ H ₁₂ O ₇	99.4	316.0586	7.455
	Emodic Acid	C ₁₅ H ₈ O ₇	96.72	300.0276	7.1173

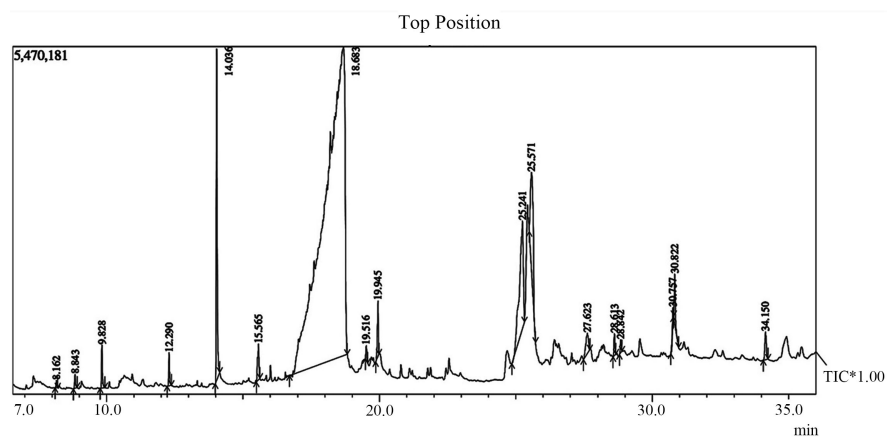


Figure 4. Chromatogram of *Senna* dye by GC-MS.

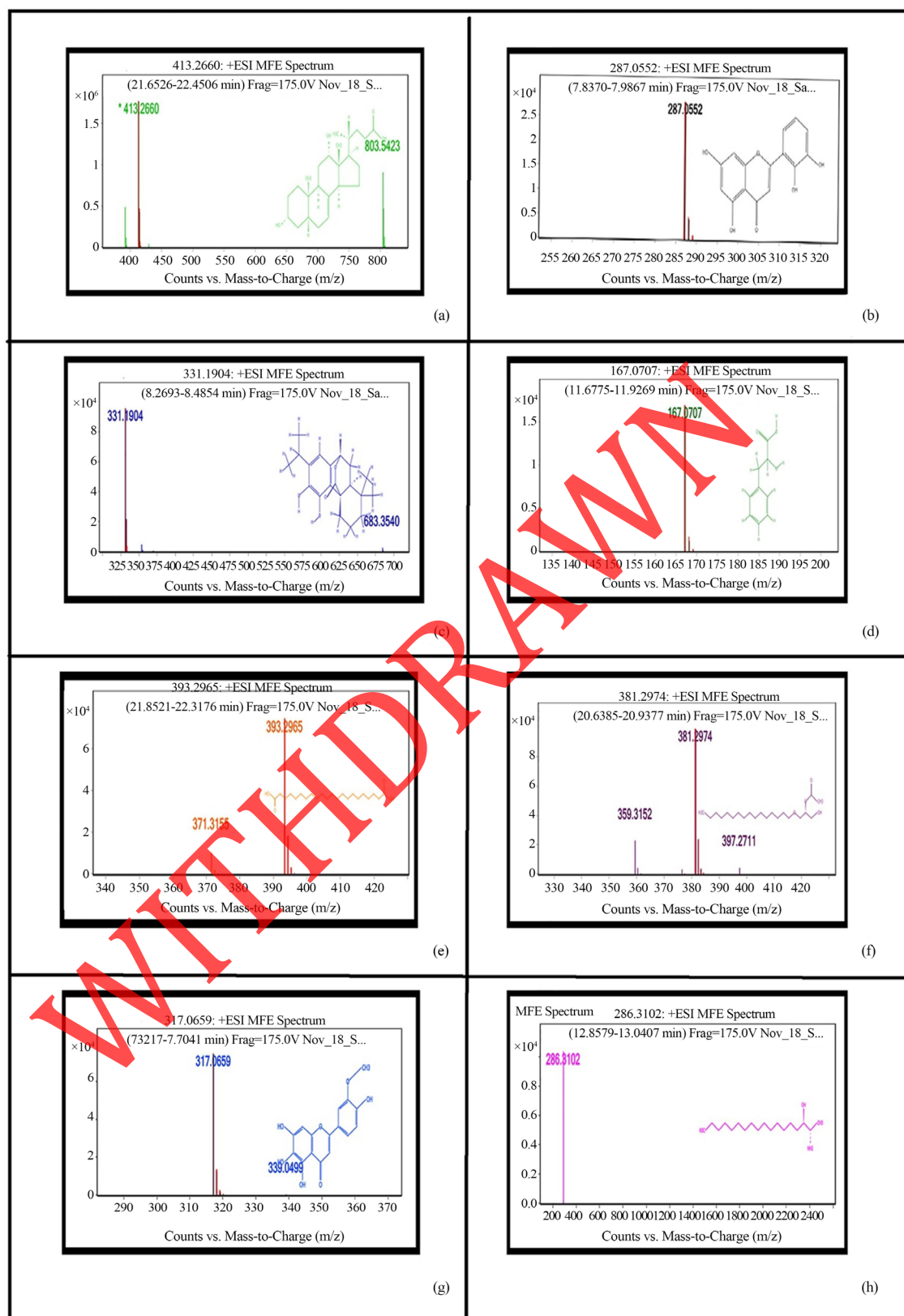


Figure 5. MS spectrum of LCMS compounds: (a) Docosanedioic acid, (b) 3 α ,12 α -Dihydroxy-5 β -chole-7-en-24-oic Acid, (c) Hexadecyl Acetyl Glycerol, (d) Spisulosine, (e) DL-3-Phenyllactic acid, (f) Carnosol, (g) 5,7,2',3'-Tetrahydroxyflavone, (h) Nodiflorethin.

4. Conclusion

The results of GC-MS and LCMS analysis highlighted that the *Senna* dye is good source of phytochemicals which have a variety of medicinal properties that can be useful for the cure of various diseases. It is clear from the study high bioactive compounds present in dye and also exhibits effective biomedical properties which might be helpful in the development of various drugs as well as pharmaceuticals and bio cosmetic ingredients. The data generated through this work may be used as a basis for studying the economic viability of producing the dyes on a commercial scale.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Kannanmarikani, Kannan, U.S. and Kanniappan, R. (2010) Assessment of Dyeing Properties and Quality Parameters of Natural Dye Extracted from *Lawsonia inermis*. *European Journal of Experimental Biology*, **7**, 62-70.
- [2] Singh, S.V. and Purohit, M.C. (2012) Applications of Eco-Friendly Natural Dye on Wool Fibres Using Combination of Natural and Chemical Mordants. *Universal Journal of Environmental Research and Technology*, **2**, 48-55.
- [3] Kumaresan, M., Palanisamy, P.N. and Kumar, P.E. (2012) Application of Eco-Friendly Natural Dye on Cotton Using Combination of Mordants. *Indian Journal of Fibre & Textile*, **37**, 194-198.
- [4] El-Amoudy, E.S. and El-Ebissy, A.A. (2014) Characterization of a New Natural Dye Applied on Wool Fabrics. *MSAJJ*, **12**, 491-504.
- [5] Trotman, E.R. (1993) *Dyeing and Chemical Technology of Textile Fibres*. 6th Edition, Springer, Berlin, 254-286.
- [6] Foulds, J. (1995) *Dyeing and Printing. A Handbook on Small Scale Textiles*. Intermediate Technology Publications, London, 1-27.
- [7] Padma, S.V. (2000) Chemistry of Natural Dyes. Facility for Ecological and Analytical Testing (FEAT) at the Indian Institute of Technology, Kanpur, India, Resonance, 73-80. <https://doi.org/10.1007/BF02836844>
- [8] Siva, R. (2007) Status of Natural Dyes and Dye-Yielding Plants in India. *Current Science*, **7**, 916-925.
- [9] Acguah, S.B. and Oduru, K.A. (2012) Traditional Cloth Dyeing Enterprise at Ntonso: Challenges and Opportunities. *West African Journal of Applied Ecology*, **1**, 25-36.
- [10] Ali, N.F., El-Khatib, E.M. and El-Mohamedy, R.S.S. (2011) Antimicrobial Activity of Wool Fabric Dyed with Natural Dyes. *Research Journal of Textile and Apparel*,

- 15, 1-10. <https://doi.org/10.1108/RJTA-15-03-2011-B001>
- [11] Baliarsingh, S., Panda, A.K., Jena, J., Das, T. and Das, N.B. (2012) Exploring Sustainable Technique on Natural Dye Extraction from Native Plants for Textile: Identification of Colourants, Colourimetric Analysis of Dyed Yarns and Their Antimicrobial Evaluation. *Journal of Cleaner Production*, **37**, 257-264. <https://doi.org/10.1016/j.jclepro.2012.07.022>
- [12] Gerson, H. (1975) Fungi Toxicity of 1, 4-Napthoquinones to *Candida albicans* and *Trichophyton mentagrophytes*. *Canadian Journal of Microbiology*, **21**, 197-205. <https://doi.org/10.1139/m75-198>
- [13] Schuerch, A.R. and Wehrli, W. (1978) b-Lapachone an Inhibitor of Oncorna-Virus Reverse Transcriptase and Eukaryotic DNA Polymerase Inhibitory Effect, Thiol Dependence And Specificity. *European Journal of Biochemistry*, **84**, 197-205. <https://doi.org/10.1111/j.1432-1033.1978.tb12157.x>
- [14] Wagner, H., Kreher, B., Lotter, H., Hamburger, M.O. and Cordell, G.A. (1989) Structure Determination of New Isomeric Naphthol [2, 3-b] Furan-4, 9-Diones from *Tabebuia avellanedae* by the Selective INEPT Technique. *Helvetica Chimica Acta*, **72**, 659-667. <https://doi.org/10.1002/hlca.19890720406>
- [15] Gupta, D., Khareb, S.K. and Lahaa, A. (2004) Antimicrobial Properties of Natural Dyes against Gram-Negative Bacteria. *Coloration Technology*, **120**, 167-171. <https://doi.org/10.1111/j.1478-4408.2004.tb00224.x>
- [16] Sarkar, R.K., Purushottam, D. and Chauhan, P.D. (2003) Bacteria-Resist Finish on Cotton Fabrics Using Natural Herbal Extracts. *Indian Journal of Fibre & Textile*, **28**, 322-331.
- [17] Kiepe, P.L. (2001) Effect of Cassia Sianea Hedgerow Barriers on Soil Physical Properties. *Geoderma*. *Journal of Integrative Medicine*, **68**, 113-720.
- [18] Odason, E.E. and Kolawole, J. (2007) Anti-Diabetic Properties and Brine Shrimp Toxicity of the Aqueous Extract of the Root of Cassia Siamea Lam. (Ceasalpinaceae). *Nigerian Journal of Pharmaceutical Research*, **6**, 66-69.
- [19] Kupradinun, P., Tepsuwan, A., Tantasi, N., Meesiripun, N., Rungsipipat, A. and Kusamran, W.R. (2011) Anticlastogenic and Anticarcinogenic Potential of Thai Bitter: Gourd Fruits. *Asian Pacific Journal of Cancer Prevention*, **5**, 1299-1305.
- [20] Nsonde Ntandou, G.F., Banzouzi, J.T., Mbatchi, B., Elion-Itoua, R.G.D., Etou Ossibi, A.W., Ramos, S., Benoit-Vicale, B., Abena, A.A. and Ouamba, J.M. (2010) Analgesic and Anti-Inflammatory Effects of *Cassia siamea* Lam. Stem Bark Extracts. *Journal of Ethnopharmacology*, **127**, 108-111. <https://doi.org/10.1016/j.jep.2009.09.040>
- [21] Morales, M.A., Hernández, D., Bustamante, S., Bachiller, I. and Rojas, A. (2009) Is Senna Laxative Use Associated to Cathartic Colon, Genotoxicity, or Carcinogenicity? *Journal of Toxicology*, 1-8. <https://doi.org/10.1155/2009/287247>
- [22] Wongwitdecha, N. (2007) Neuro-Psychopharma-Cological Studies the Effects of Barakol, a Traditional Thai Medicine. *Srinagarind Medical Journal*, **22**, 325-332.
- [23] Eddouks, M., Bidi, A., El Bouhali, B., Hajji, L. and Zeggwagh, N.A. (2014) Antidiabetic Plants Improving Insulin Sensitivity. *The Journal of Pharmacy and Pharmacology*, **9**, 1197-1214. <https://doi.org/10.1111/jphp.12243>
- [24] Singh, N.P., Lakshminarasimhan, P., Karthikeyan, S. and Prasanna, P.V. (2001) Flora of Maharashtra State. Botanical Survey of India, Calcutta.
- [25] Muangthai, P., Promrong, N. and Wannawong, C. (2010) Preparation of Purified Dye Powder from the Bark of *Livistona speciosa*. *Science Journal Ubon Ratchathani*

University, **2**, 65-70.

- [26] Patel, B.H., Desai, K.U. and Jha, P.K. (2014) *Azadirachta indica* Mediated Bioactive Lyocell Yarn: Chemical and Colour Characterization. In: *Advances in Chemistry*, Springer, Berlin, 1-8. <https://doi.org/10.1155/2014/259171>
- [27] Aksoz, B.E. and Ertan, R. (2012) Spectral Properties of Chalcone II, FABAD. *Journal of Pharmaceutical Sciences*, **4**, 205-216.
- [28] Saravanakumar, K., Adaikala, R. and Umaiyambigai, D. (2016) GC-MS and FT-IR Profiling of Leaves Methanol Extract from the *Pleiospermium alatum* (Wall. ex Wt. & Arn) Swingle Rutaceae Family. *The Journal of Phytopharmacology*, **5**, 201-204.
- [29] Ramprasath, R., Kavi, G.G. and Rathi, T.S. (2017) Isolation of Natural Dyes from *Hibiscus Rosa Sinensis* and Marigold Flower and Dyeing Properties of the Dyes on Cotton Cloth. *IOSR Journal of Applied Chemistry*, **5**, 74-79. <https://doi.org/10.9790/5736-1005017479>
- [30] Ludin, N.A., Mahmoud, A.M., Al-Alwani, Mohamad, A.B., Abd Kadhun, A.H., Norul Hamid, N.H., Ibrahim, M.A., Teridi, M.A.M., Tarik, M., Hakeem, A., Mukhlus, A. and Sopian, K. (2018) Utilization of Natural Dyes from *Zingiber officinale* Leaves and *Clitoria ternatea* Flowers to Prepare New Photosensitisers for Dye-Sensitised Solar Cells. *International Journal of Electrochemistry*, **13**, 7451-7465. <https://doi.org/10.20964/2018.08.04>
- [31] https://en.wikipedia.org/wiki/Dodecanedioic_acid
- [32] <https://www.trc-canada.com/product-detail/?A727553while>
- [33] <http://www.bertin-20bioreagent.com/pr11529/hexadecyl-acetyl-glycerol>
- [34] Cuadros, R., Montejo, D., Garcini, E., Wandosell, F., Faircloth, G., Fernández, Sousa, J.M. and Avila, J. (2000) The Marine Compound Spisulosine, and Inhibitor of Cell Proliferation Promotes the Disassembly of Actin Stress Fibers. *Cancer Letters*, **152**, 23-29. [https://doi.org/10.1016/S0304-3835\(99\)00428-0](https://doi.org/10.1016/S0304-3835(99)00428-0)
- [35] Faircloth G., Cuevas, C.D. and Marchante, M. (2006) Molluscs: From Chemo-Ecological Study to Biotechnological Application. In: *Potent Anticancer Agents from Marine Molluscs*, Volume 43, Springer, Berlin, Germany, 363-379. https://doi.org/10.1007/978-3-540-30880-5_16
- [36] Birtic, S., Dussort, P., Pierre, F.X., Bily, A.C. and Roller, M. (2015) Carnosic Acid. *Phytochemistry*, **115**, 9-19. <https://doi.org/10.1016/j.phytochem.2014.12.026>
- [37] Singh, S., Jatav, V.K. and Sharma, S. (2015) Virtual Screening & Molecular Docking of Glycoprotein b Inhibitor as a Treatment of Herpes Simplex Virus. *International Research Journal of Humanities, Engineering & Pharmaceutical Sciences*, **10**, 20-24.
- [38] Zheng, L. (2008) Application of *Lippia nodiflora* Extract to Preparing Medicinal Preparation for Treating Hepatitis. China Patent Application CN2007-10084260 20070224.