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Phytochemical Profiling of *Tecoma stans* (L.) Juss. ex Kunth. flower extract by GC-MS: Identification of Bioactive Constituents and their Potential Therapeutic Significance

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ABSTRACT

Tecoma stans (L.) Juss. Ex. Kunth commonly known as Yellow Bells is widely distributed across tropical and subtropical regions of India. In various cultures, it has been traditionally used for its medicinal properties, including antioxidant, antimicrobial, and anti-inflammatory effects. *Tecoma stans* flower extract revealed a diverse range of 122 phytoconstituents includes major components based on area percentage were Bis (2-ethylhexyl) phthalate (RT: 40.844, 32.77%), Tetratetracontane (RT: 43.439, 10.93%), Hexatriacontane (RT: 46.227, 5.45%), 2-Hexanone, 3, 3-dimethyl (RT: 6.411, 4.70%), Ether, 3-butenylpropyl (RT: 6.173, 4.70%), 7-Octadecenoic acid, methyl ester (RT: 33.669, 2.62%), Tetracosane (RT: 40.445, 3.15%). The rich chemical variety in the extract directly supports its traditional medicinal uses. Our findings provide a scientific basis for using *Tecoma stans* and confirm its potential as a source of powerful, naturally occurring compounds.

INTRODUCTION

Tecoma stans (L.) Juss. Ex. Kunth, commonly known as Yellow Bells or Yellow Elder, is a perennial shrub belonging to the family Bignoniaceae family. It is widely distributed across tropical and subtropical regions, including India. Traditionally, *Tecoma stans* has been used in various ways due to its medicinal properties, such as diabetes, infections, and inflammatory conditions (**VS et al. 2020**) .Recent phytochemical investigations have revealed that *Tecoma stans* is rich in bioactive compounds. In 2024, using Gas Chromatography-Mass Spectrometry (GC-MS) identified 32 compounds in the hexane extract of *T. stans* flowers, including flavonoids, alkaloids, phenols, and saponins . These compounds are associated with diverse pharmacological properties, such as antioxidant, antimicrobial, and anti-inflammatory activity (**Mohammed et al. 2019**). Both its traditional application and emerging scientific evidence of *T. stans*'s therapeutic potential. The present study aims to perform a comprehensive phytochemical profiling of *T. stans*'s flower extract using GC-MS and evaluate their therapeutic potential, and provide scientific evidence to support its traditional uses.

MATERIALS AND METHODS

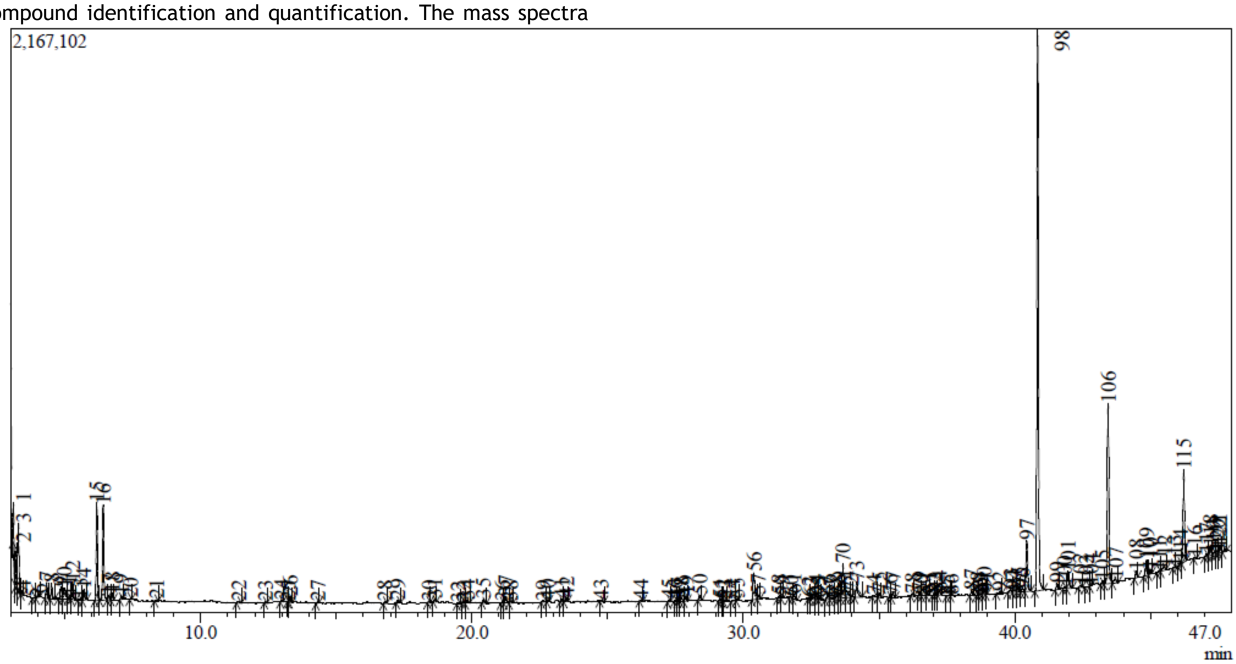
Collection and Identification of Sample the flower (*Tecoma stans*) was collected from Nagercoil, Tamilnadu, India. Using the plantnet addlink application for taxonomic verification.

Sample Preparation for GC-MS analysis: Fresh flower of *T. stans* were brought to the laboratory and manually cleaned to remove dust and foreign materials. 2 gram of the flower sample was weighed into 250 ml conical flask and 10 ml of n-hexane was added. The mixture sonicated for two hours to facilitate the production of phytochemicals. Anhydrous sodium sulphate was added to the extract to remove residual water. The extract was then concentrated to 2 ml using nitrogen concentration for GC-MS analysis (**Adebiyi et al. 2019**).

TSQ GC-MS analysis was performed using a thermos scientific 8000 Triple Quadrupole MS column TG 5MS (30 m × 0.25 mm, 0.25 µm). Helium was used as the carrier gas at a constantly equipped with a flow rate of 1 ml/min. Split/Splitless (S/SL) injector was used with injector temperature at 250˚C. 1.0 µl volume of the concentrated extract was injected for analysis maintained at 230˚C. The oven was programmed as follows initially held at 80˚C for 2 min, then ramped to increase upto

280°C at a rate of 5°C/min ending with a 5 min isothermal at 280 °C. Total run time was approxiametly 3 hour. The MS transfer line was maintained at a temperature of 250°C for TSQ 8000 Triple Quadrupole MS detector was used for analysis and data was evaluated using Total Ion Count (TIC) for compound identification and quantification. The mass spectra of the components were matched with the data available in the National Institute of Standards and Technology (NIST) library. Measurement of peak areas and data processing were carried out by XCALIBER software (**Mohammed et al. 2019**).

Results and Discussion



GCMS analysis of tecoma stans flower extract

Peak#	R.Time	Area	Name	Area%	Height%	Base m/z
1	3.105	443937	2-Hexanone	1.83	3.26	43.00
2	3.226	606157	3-Hexanol	2.50	2.70	59.00
3	3.286	734513	2-Hexanol,(R)-	3.03	3.96	45.00
4	3.414	38393	Cyclohexane, 1, 4-dimethyl-	0.16	0.24	97.10
5	3.825	11105	Cyclopentane, propyl-	0.05	0.04	41.05
6	4.029	55454	Cyclopentanol, 3-methyl-	0.23	0.22	57.00
7	4.327	175979	Ethylbenzene	0.73	0.94	91.00
8	4.505	202221	p-Xylene	0.84	0.88	91.00
9	4.850	148020	Ethanone, 1-(3-ethyloxiranyl)-	0.61	0.70	43.00
10	4.962	252771	p-Xylene	1.04	0.64	91.00
11	5.152	26919	Tetrahydrofuran, 2, 2-dimethyl-	0.11	0.11	43.05
12	5.279	210667	Tetrahydrofuran, 2, 2-dimethyl-	0.87	0.99	43.05
13	5.565	31828	Methyl2-methoxypropenoate	0.13	0.09	43.05
14	5.695	136072	4-Butoxy-2-butanone	0.56	0.63	43.05
15	6.173	1136630	Ether,3-butenylpropyl	4.70	5.72	43.05
16	6.411	1137257	2-Hexanone, 3, 3-dimethyl-	4.70	5.56	43.05
17	6.618	55386	2-Hexanone, 5-methyl-	0.23	0.23	43.00
18	6.746	70880	Cyclopentane, 1-acetyl-1, 2-epoxy-	0.29	0.37	43.05
19	7.076	48062	1-Octen-3-ol	0.20	0.25	56.95
20	7.417	9045	Benzene, 1, 2, 4-trimethyl-	0.04	0.05	105.00
21	8.381	25571	1-Hexanol, 2-ethyl-	0.11	0.08	57.00
22	11.413	37575	2, 2-Dimethylpropanoicacid, 2, 6-dimethylnon	0.16	0.09	32.00
23	12.384	10424	Cyclohexane, 2-iodo-4-methyl-1-(1-methyleth	0.04	0.06	83.05
24	12.981	16927	3-Trifluoroacetoxytridecane	0.07	0.09	41.00
25	13.230	8823	Dodecane	0.04	0.05	57.05
26	13.297	66073	Cyclohexane, 1 ,1'-(1,2-dimethyl-1, 2-ethanedi	0.27	0.33	69.05
27	14.324	26028	Cyclohexane,hexyl-	0.11	0.11	83.10
28	16.783	23022	Cyclohexane, 1, 2, 4, 5-tetraethyl (1.alpha.,2.a	0.10	0.10	83.00
29	17.257	39707	Cyclohexane, 1, 5-diethyl-2, 3-dimethyl-	0.16	0.14	83.05
30	18.407	13856	n-Pentadecanol	0.06	0.07	43.05
31	18.622	31886	Pentadecane	0.13	0.16	57.05
32	19.487	24124	Imidazole-2-carboxylicacid, 4-methyl-	0.10	0.07	43.95
33	19.695	31286	2, 4, 6-Trimethylbenzonitrile, N-oxide	0.13	0.13	161.05
34	19.825	44812	Cyclohexane, Octyl-	0.19	0.16	83.00
35	20.421	59036	Cycloheptasiloxane, tetradecamethyl-	0.24	0.21	281.00
36	21.115	26390	1-Heptanol, 2-propyl-	0.11	0.09	43.05
37	21.233	131644	2, 4-Di-tert-butylphenol	0.54	0.41	191.10

38	21.413	36273	16-Hentriacontanol	0.15	0.11	32.00
39	22.610	30390	N.omega. -Nitro-L-arginine	0.13	0.08	43.95
40	22.791	15882	Heneicosane	0.07	0.09	57.05
41	23.302	29539	Trichloroaceticacid, dodecylester	0.12	0.15	43.05
42	23.482	61579	Hexadecane	0.25	0.23	57.05
43	24.749	24809	Decane, 2-cyclohexyl-	0.10	0.08	83.00
44	26.216	12640	Decanoicacid, methylester	0.05	0.07	73.95
45	27.258	30325	Hexadecane, 1-iodo-	0.13	0.13	57.05
46	27.480	18555	4-{[3-(Furan-2-yl)propyl] carbamoyl} butanoic	0.08	0.04	41.05
47	27.589	26172	Cyclononasiloxane, Octadecamethyl-	0.11	0.11	73.00
48	27.721	56267	9-Eicosene, (E)-	0.23	0.20	43.05
49	27.875	70209	Heptadecane	0.29	0.28	57.05
50	28.395	72251	1-Hexacosanol	0.30	0.29	43.05
51	29.143	35039	Cyclopentane, heneicosyl-	0.14	0.13	144.05
52	29.230	13348	1H-Imidazole, 2-ethyl-4, 5-dihydro-4-methyl-	0.06	0.06	83.00
53	29.331	20497	8-Octadecanone	0.08	0.09	57.00
54	29.605	27667	Octadecanoicacid, 2-hydroxy-1,3-propanediy	0.11	0.06	41.05
55	29.772	13779	3-Heptadecanone	0.06	0.07	57.00
56	30.386	479559	Hexadecanoicacid, methylester	1.98	1.57	74.00
57	30.545	52351	2-(3-Hydroxy-2-nitro-1-phenylbutyl) cyclohex	0.22	0.21	91.00
58	31.312	33317	Octadecane, 1-iodo-	0.14	0.14	57.00
59	31.428	24424	2,6-Dimethyl-4-nitro-3-phenyl-cyclohexanone	0.10	0.12	118.05
60	31.729	26672	1-Nonadecene	0.11	0.11	43.05
61	31.863	74217	Heneicosane	0.31	0.32	57.05
62	32.420	15535	trans-2-Decen-1-ol, trifluoroacetate	0.06	0.05	44.00
63	32.515	67931	Pregabalin	0.28	0.12	32.00
64	32.694	59240	Benzeneethanol, beta. -1-octynyl-	0.24	0.22	118.15
65	32.796	28727	Oxirane, decyl-	0.12	0.13	41.00
66	33.116	87885	1-Hexadecanol	0.36	0.24	69.05
67	33.215	25957	15-Octadecenal	0.11	0.08	44.00
68	33.455	62510	2-Oxopropionicacid, dimethylhydrazone,me	0.26	0.19	44.00
69	33.530	95109	9,12-Octadecadienoicacid(Z,Z)-, methyleste	0.39	0.33	67.00
70	33.669	633308	7-Octadecenoicacid, methylester	2.62	1.96	55.00
71	33.790	160749	cis-12-Octadecenoicacidmethylester	0.66	0.42	43.00
72	33.970	9628	3-Hexenoicacid, 3-methyl-, methylester	0.04	0.06	85.10
73	34.177	284235	Methyl stearate	1.17	0.91	74.00
74	34.794	27901	4,5-Diphenylocta-1, 7-diene(dl)	0.12	0.07	131.10
75	35.006	56267	Nonacosane	0.23	0.25	57.05
76	35.402	39023	1-Hexacosene	0.16	0.15	43.05
77	35.510	84142	Eicosane	0.35	0.33	71.05
78	36.226	27355	1-Decanol, 2-hexyl-	0.11	0.14	57.00
79	36.488	29568	2-Propenoicacid, 3-(4-methylphenyl)-, ethyl	0.12	0.14	145.10
80	36.585	11227	3,3-Diethylheptadecane	0.05	0.04	57.05
81	36.781	27680	Cyclopentane, heneicosyl-	0.11	0.13	69.05
82	37.000	13603	Octane, 4, 5-dimethyl-	0.06	0.05	70.05
83	37.087	33585	Dodecyl octylether	0.14	0.12	57.10
84	37.219	55865	Dotriacontane, 1-iodo-	0.23	0.21	57.00
85	37.510	10954	2-Butoxyethylbutyrate	0.05	0.04	56.00
86	37.653	8034	Decanoicacid, methylester	0.03	0.05	74.00
87	38.409	69721	2-Methyltetracosane	0.29	0.30	57.00
88	38.631	31548	Hexanedioicacid, bis(2-ethylhexyl)ester	0.13	0.14	129.00
89	38.769	24917	1-Tetracosene	0.10	0.07	97.15
90	38.862	93578	Heneicosane	0.39	0.37	57.05
91	38.955	18781	5,8-Tridecadione	0.08	0.10	71.05
92	39.444	44136	OleicAcid,(Z)-, TMSderivative	0.18	0.07	73.00
93	39.859	56937	Cyclohexadecane	0.24	0.16	55.00
94	39.950	41558	Tridecanedial	0.17	0.10	55.00
95	40.122	68181	1-Cyclopentyleicosane	0.28	0.25	68.05
96	40.278	61510	2-Dodecenal, (E)-	0.25	0.18	70.00
97	40.445	761988	Tetracosane	3.15	2.98	57.05
98	40.844	7932187	Bis (2-ethylhexyl)phthalate	32.77	32.69	149.00
99	41.555	98170	3-Methylpentacosane	0.41	0.39	57.05
100	41.825	37966	Acetoaceti cacid isoamylester	0.16	0.08	70.05
101	41.968	265427	Eicosane	1.10	0.97	71.05
102	42.414	29684	Hexadecanoicacid, 2-(octadecyloxy)ethylest	0.12	0.09	57.05
103	42.620	3351	Octanoicacid,3-oxo-4-(2-propenyl)-,methyl	0.01	0.03	55.00
104	42.800	4852	4-(4-Fluorobenzyl)-1-methylpiperidine	0.02	0.03	206.95
105	43.226	42737	1-Cyclopentyleicosane	0.18	0.19	68.00
106	43.439	2645239	Tetratetracontane	10.93	10.51	57.05
107	43.705	92932	trans-2-Undecen-1-ol	0.38	0.20	57.05
108	44.477	89693	Octacosane, 2-methyl-	0.37	0.39	57.05

109	44.854	252914	Hexatriacontane	1.04	0.91	57.05
110	44.990	58384	5, 9, 13, 17-Tetramethy l4, 8, 12, 16-octadecatetr	0.24	0.27	69.00
111	45.330	24568	1, 1, 3, 3-Tetraallyl-1 ,3-disilacyclobutane	0.10	0.07	206.95
112	45.510	95979	Hexacosylnonylether	0.40	0.17	71.05
113	45.884	16129	Heneicosane, 3-methyl-	0.07	0.08	281.00
114	46.106	43338	Cyclopentane, undecyl-	0.18	0.20	68.05
115	46.227	1319693	Hexatriacontane	5.45	5.35	57.05
116	46.635	18904	Heneicosanoic acid, methylester	0.08	0.09	74.00
117	47.055	44280	Fumaricacid, pent-4-en-2-yltridecylester	0.18	0.13	281.00
118	47.207	159340	Octacosane, 1-iodo-	0.66	0.52	57.05
119	47.320	46256	Propane, 3-bromo-1, 1, 1-trichloro-	0.19	0.12	281.00
120	47.455	47648	2-Nonanol, 5-ethyl-	0.20	0.14	57.00
121	47.571	127952	Tetracosane	0.53	0.45	57.05
122	47.738	43611	5, 5-Diethylpentadecane	0.18	0.15	71.05
		24204348		100.00	100.00	

GC-MS Analysis of *Tecoma stans* Flower Hexane Extract

Gas Chromatography-Mass Spectrometry (GC-MS) analysis of the *Tecoma stans* flower hexane extract revealed a diverse range of 122 phytoconstituents, indicating the complex chemical profile of the plant. The compounds were identified based on their retention times(RT), peak areas, Percentage and mass fragmentation patterns by comparison with the National Institute of Standards and Technology (NIST) mass spectral library.

The major components (based on area percentage) were:

1. Bis (2-ethylhexyl) phthalate (RT: 40.844, 32.77%)
2. Tetratetracontane (RT: 43.439, 10.93%)
3. Hexatriacontane (RT: 46.227, 5.45%)
4. 2-Hexanone, 3, 3-dimethyl- (RT: 6.411, 4.70%)
5. Ether, 3-butenylpropyl (RT: 6.173, 4.70%)
6. 7-Octadecenoic acid, methyl ester (RT: 33.669, 2.62%)
7. Tetracosane (RT: 40.445, 3.15%)

The extract contained moderate amounts of several bioactive fatty acid esters, including Hexadecanoic acid, methyl ester, cis-12-Octadecenoic acid methyl ester, and Methyl stearate. Phthalate esters – Bis (2-ethylhexyl) phthalate was the most abundant compound identified in the extract. While this substance is widely recognized as an environmental contaminant or plasticizer, its occasional detection in plant extracts raises questions about its origin, suggesting it could be a legitimate phytochemical or a result of processing contamination. It is known to occur in hexane plant extracts and exhibits various biological activities, including antibacterial, larvicidal, and antimutagenic effects. Bis (2-ethylhexyl) phthalate is naturally produced by certain bacteria, fungi, and algae, and it is also recognized as a widespread environmental pollutant (**Adebiyi et al., 2019**). Long-chain alkanes and alkenes – Compounds such as *tetratetracontane*, *hexatriacontane* and *tetracosane* are commonly found in plant waxes. These long chain hydrocarbon are known to contribute to medicinal properties such as antimicrobial, anti-inflammatory, and insecticidal activities (**Rhetso et al., 2020**). Fatty acid esters and alcohols – Methyl esters like *Hexadecanoic acid, methyl ester* and *7-Octadecenoic acid, methyl ester* are well-documented for their antioxidant, anti-inflammatory, and hypolipidemic effects. For instance, Hexadecanoic acid methyl ester (methyl palmitate) are a saturated fatty acid methyl ester, has shown antioxidant and anti-inflammatory properties in some studies. It has also been linked to beneficial effects on lipid metabolism, potentially reducing cholesterol levels (**Hamed et al., 2020; LS et al., 2024**). Terpenoids and aromatic compounds – Compounds such as *2, 4-Di-tert-butylphenol* and *Ethylbenzene* reflect potential antioxidant and antimicrobial actions. The provided text highlights the potential antioxidant and antimicrobial properties of certain terpenoids and aromatic compounds, specifically mentioning 2, 4-Di-tert-butylphenol and Ethylbenzene. These compounds, often found in plants and other natural sources, are known for their ability to combat oxidation and protect against microbial infections (**Yamaguchi et al. 2022; Hoang et al. 2024**).

Heterocyclic compounds and nitrogenous substances – The presence of imidazole derivatives and amino acid analogs such as *N.omega.-Nitro-L-arginine* may indicate potential enzyme inhibition and antioxidant activity. N.omega.-Nitro-L-arginine (L-NNA or L-NAME) is an inhibitor of nitric oxide synthase (NOS), an enzyme responsible for the production of nitric oxide (NO). Inhibition of (NOS) can lead to increased blood pressure and may also contribute to antioxidant effects (**Santamaria et al. 1999; Seif-El-Nasr et al. 2001**). The chemical diversity observed in the *Tecoma stans* flower extract supports its traditional medicinal application. Notably, the presence of fatty acid methyl esters, hydrocarbons, and alcohols aligns with the extract's reported antioxidant, anti-inflammatory, and antimicrobial properties documented in ethnobotanical practices.

CONCLUSION

The GC-MS analysis of the *Tecoma stans* flower extract confirmed a complex composition of 122 constituents, with notable amounts of fatty acid esters, hydrocarbons, and phthalates. This indicates potential for pharmacological applications. Future work should focus on bioassay-guided isolation and toxicity profiling to substantiate its biological efficacy and safety.

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