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# Phytochemical Compounds from the Ethanolic Extract of *Gymnema sylvestre, Senna auriculata* and *Cissus quadrangularis* through GC-MS Analysis

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**Abstract :** Plants are a traditional source of many chemicals used as biochemical, flavors, food, color, and pharmaceuticals in various countries, especially India. Most herbal medicines and their derivatives are often made from crude extracts containing a complex mixture of various phytochemical chemical components (secondary metabolites of the plants). This study aimed to identify bioactive compounds from the different parts of the plant from the ethanolic extract of *Gymnema sylvestre, Senna auriculata,* and *Cissus quadrangularis* (leaves, flower, stem) by gas chromatography-mass spectroscopy (GC-MS). The gas chromatography - mass spectrometry analysis revealed the presence of various compounds like 3,4-dimethylcyclohexanol, hexanoic acid, D-mannose, and N-decanoic acid. Hence, the *Gymnema sylvestre, Senna auriculata,* and *Cissus quadrangularis* may have chemopreventive, anti-cancer, anti-microbial activity, antioxidant, anti-diabetic activity, anti-inflammatory, and antifungal due to the presence of secondary metabolites in the ethanolic extract. These phytochemicals are supported for traditional use in a variety of diseases.

**Keywords :** Phytochemical compounds, *Cissus quadrangularis, Senna auriculata, Gymnema sylvestre*, ethanol extract, GC-MS analysis

## Introduction

Plants have served as a source of pharmaceutical products and inexpensive starting materials for the synthesis of some known drugs. Plant components with medicinal properties play an important role in conventional western medicine. It has been estimated that 14–28% of higher plant species are used medically. Chemical research has been done on 15% of all angiosperms, and 74% of pharmaceutically active plant-derived components were found by looking into how the plants were used in traditional medicine.[1]

Plants provide biologically active molecules and lead structures for the development of modified derivatives with enhanced activity and reduced toxicity. Many of the pharmaceuticals currently available to physicians have a long history of use as herbal remedies, including opium, aspirin, digitalis, and quinine with the development of chemistry and western medicine, the active substances of many species have been isolated and, in some cases, duplicated in the form of synthetic drugs. Plants and their derivatives are the sources of thousands of drugs worldwide. Some useful plant drugs are vinblastine, vincristine, taxol, podophyllotoxin, camptothecin, digitoxigenin, gitoxigenin, digoxigenin, tubocurarine, morphine, codeine, aspirin, atropine, pilocarpine, capsaicin, allicin, curcumin, artemisinin, and ephedrine.[2] In 1993, 57% of the top 150 brand-name products prescribed contained at least one major active compound or were derived from or patterned after compounds, reflecting biological diversity. Many researchers have discussed the importance of medicinal plants as a source of new therapeutic agents, and others have effectively focused on the potential of specific chemical classes in drug discovery.

Recent research continues to validate an ethnobotanically targeted approach to the initial discovery of pharmaceuticals. Among the 119 active compounds currently isolated from the higher plants and widely used in modern medicine are those for therapeutic use and the traditional use of the plants from which they are derived. More than two-thirds of the world's plant species at least 35,000 are estimated to have medicinal value and come from developing countries. At least 7,000 medical compounds in the modern pharmacopoeia are derived from plants. Many modern drugs still come

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from natural sources. About 25% of all prescriptions have at least one active ingredient that comes from a plant.[3]

Herbal medicine is a major component in all traditional medicine systems and a common element in ayurveda, homeopathy, naturopathy, traditional chinese medicine, and native american medicine. Three-quarters of plants provide active ingredients for prescription drugs and came to the attention of researchers because of their use in traditional medicine. Pharmacologists, microbiologists, botanists, and people with natural product permits are searching the earth for phytochemicals and lead that could be used to treat different diseases.[4]

Phytochemicals known as secondary metabolites are compounds synthesised by plants mainly to ensure their survival. Though involved directly in the growth of plants, these compounds are responsible for a number of important functions. The presence of these compounds on a plant and their medicinal properties and secondary metabolites have played a vital role in the field of pharmaceuticals, directly and indirectly, and hence are most important from the therapeutic point of view. Pathogens are becoming more resistant to available drugs, and people are worried about their health. This has made people rely more on drugs made from plants, which has led to the development of plant-based pharmaceuticals. This in turn has led to an exploration of secondary metabolites and their role in medicine.[4]

***Gymnema sylvestre***

*Gymnema sylvestre* stems were analysed using chromatographic techniques and found to contain therapeutically essential compounds such as stigmasterol and triterpenoid saponins. Stigmasterol compounds have multiple therapeutic potentials, including anti-diabetes, hypoglycemia, antioxidants, and anti-cancer effects. Several studies have shown that triterpenoid saponins have antitumor, antifungal, hepatoprotective, and anti-diabetic properties.[5-7] Gymnemic acid and Gymnema saponins are critical chemical constituents of this plant and are classified as oleanane saponins. Oleanane and danmaran-type saponins are found in the leaves of *Gymnema Sylvestre*.[8] The leaves of this plant also contain saponins, anthraquinones, and cardiac glycosides.[9] In addition, it has been observed that this plant contains tannins, quinones, flavonoids, and phenols.[10]

Gymnemic acid prevents the absorption of sugar molecules by the intestines and may lower blood sugar level.[11] One of the compounds of Gymnema sylvestre is gymnemic acid, a mixture of saponins.[12] The atomic arrangement of the gymnemic acid molecule is similar to that of the glucose molecule, blocking the glycosyl acceptor site in the intestine, preventing sugar absorption, and lowering blood glucose levels.[13] Affinity Ultrafiltration-HPLC-MS rapid screening reveals that it contains glucosidase inhibitors.

***Cassia auriculata***

*Cassia auriculata*, commonly known as tanner's cassia, is an essential remedial shrub used in asia. *C. auriculate* (family: cesalpinaceae) is used as a tonic, astringent, and remedy for diabetes, conjunctivitis, and ophthalmia. Flowers treat urinary excretion, nocturnal secretions, and throat irritation. The flowers were crushed and ingested with goat's milk to prevent white discharge in women. The plant's roots are used as a decoction, similar to the medicinal oil made from the bark known in tamil as averai-yennai. Root powder acts as a coagulant and prevents diarrhoea, dysentery, and indigestion from fruit juice. Traditional medicine uses the plant's aerial parts to treat diabetes, conjunctivitis, rheumatism, eye problems, body odor, leprosy, and liver disorders.[14] are used as a traditional medicine to treat diabetes, conjunctivitis, rheumatism, eye troubles, body odor, leprosy, and liver disorders There are some reports available on antidiabetic, acute toxicity, hyperlipidase, cardioprotective, antioxidant, antimicrobial, and hepatoprotective activity.[15] The kashayam of crushed flowers has been mixed with goat's milk and used to treat white discharge in women and diabetes.[16]

***Cissus quadrangularis***

The stem is used for constipation, eye diseases, ulcers, and broken bones; the leaf and young shoots are helpful in indigestion.[17] It is indigenous to Africa and Asia and is used for many ailments, especially for the treatment of haemorrhoids.[18] This herb is very beneficial for the treatment of fractures.[19] In addition, methanol extract from plant aerial parts has an anti-inflammatory effect, which could be created by flavonoids, particularly luteolin and sitosterol.[18] The stem and root have high antibacterial action.[20] Alcoholic extracts of aerial sections of the CQ have antiprotozoal efficacy against *Entamoeba histolytica and E. coli*.[21] It has primarily been reported against *Streptococcus pyogenes, Salmonella typhi, Bacillus subtilis, Lactobacillus acidophilus, Streptococcus pyogenes*, *E. coli*, *Proteus mirabilis*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa*.[22] The stem extracts of dichloromethane and (90%) methanol have antibacterial action against *E. coli* and *P. aeruginosa.* It proves that the salmonella microsome is mutagenic. The aerial part of the plant shows an antiprotozoal effect against *E. histolytica* in alcoholic extracts.[23] In Alloxan-induced diabetic rats, the rhizome extract of *Cissus quadrangularis* has a more useful anti-diabetic modulating effect on blood sugar levels[24] say that the anti-inflammatory effects of *Cissus quadrangularis* could be caused by flavonoids, especially beta-sitosterol and luteolin.

Extraction is the crucial first step in the analysis of medicinal plants, because it is necessary to extract the desired chemical components from the plant materials for further separation and characterization.[25]

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**Figure 1.** *Gymnema sylvestre* leaf extract

**Figure 2.** *Senna auriculate* flower extract

**Figure 3.** *Cissus quadrangularis* stem extract

## Material and Methods

### Selected plants and collection

The leaves of *Gymnema sylvestre*, flower of *Senna auriculata*, and stem of *Cissus quadrangularis* were collected from the Vellore district Tamil Nadu, India (Figure 1-3) For phytochemical analysis, fresh and tender leaves, flowers, and stems of selected plants were used.

### Preparation of plants

The selected parts were removed from the plants and washed under running tap water to remove dust. The sample was dried thoroughly under the shade, powdered mechanically, and sieved through a No. 20 mesh sieve. The finely powdered leaves, flowers, stems, and seeds were kept in an airtight container until use.

### Ethanol extract

10 g of each sample was soaked in 200 mL of 95% ethanol at room temperature for 24 hours. The extract was filtered using whatman filter paper; filtrates were collected and poured into a petri dish to keep for 24 hours. It gets semisolid paste form and is stored at room temperature for GC-MS analysis (Figure 4-6).

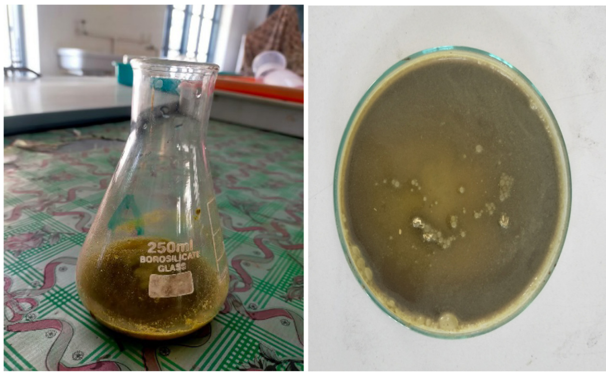



**Figure 4.** Gymnema *sylvestre* Leaf Ethanol extract


**Figure 5.** *Senna auriculata* flower ethanol extract

Figure 6. *Cissus quadrangularis* stem ethanol extract

**GC-MS analysis**

GC-MS analysis of the ethanol extract of *Gymnema sylvestre, Senna auriculata and Cissus quadrangularis* was performed using Clarus 680 GC employed a fused silica column, packed with Elite-5MS (5% biphenyl, 95% dimethylpolysiloxane, 30 m × 0.25 mm ID × 250 μm df). Helium was used as the carrier gas at a constant flow of 1 mL/min using an injection volume of 1 μL. The injector temperature was set to 260$^o$C and the ion source temperature to 240$^o$C, with a scan time 0.2 seconds and scan interval of 0.1 seconds. The spectrums of the components were compared with the database of spectra of known components stored in the GC-MS NIST (2008) library.

## Result and Discussion

The GC-MS studies show the presence of chemical constituents with their molecular weight, molecular formula, and percentage of peak area for *Gymnema sylvestre, Senna auriculata, and Cissus quadrangularis.*

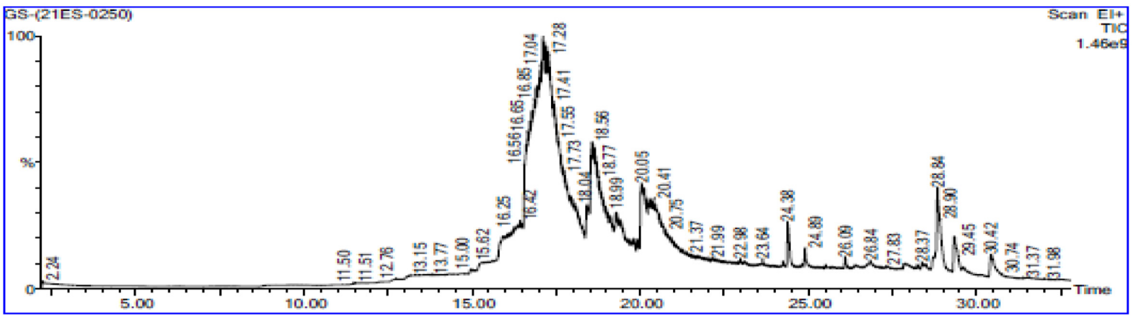
Long before that, ethanol extraction was used to prepare herbal medicinal products. It is one of the safer ways to increase production capacity while allowing good productivity with minimum post-processing steps, thus reducing staff hours and equipment costs which might be counteracted by increased solvent costs

**Analysis of *Gymnema sylvestre***

In *Gymnema sylvestre*, a total of 17 components (Figure 7 and 8) were found 1,2,3,4-cyclohexanetetrol, hexanoic acid, 1,1-dimethylethyl ester, decanoic acid, ethyl ester, n-hexadecanoic acid, e-2-octadecadecen-1-ol, 13-tetradece-11-yn-1-o, 9-octadecynoic acid, squalene, 2r-acetoxymethyl-1,3,3-trimethyl-4t-(3-methyl-2-buten-1-yl), 1t-cyclohexanol, 2r-acetoxymethyl-1,3,3-trimethyl-4t-(3-methyl-2-buten-1-yl),

**Qualitative Report**

File: C:\TurboMass\2021.PRO\Data\GS-(21ES-0250).raw
Acquired: 18-Mar-21 09:31:00 PM
Printed: 30-Mar-21 09:49 AM
Description:
GC/MS Method: GC: METHOD-1.mth MS: METHOD-1.EXP
Page 1 of 1
Sample ID: GS-(21ES-0250)
Vial Number: 7




| # | RT | Scan | Height | Area | Area % | Norm % |
|---|---|---|---|---|---|---|
| 1 | 16.419 | 2843 | 125,188,312 | 60,403,452.0 | 4.365 | 6.68 |
| 2 | 17.104 | 2980 | 1,139,416,320 | 903,915,584.0 | 65.326 | 100.00 |
| 3 | 18.415 | 3242 | 186,055,664 | 14,811,675.0 | 1.070 | 1.64 |
| 4 | 18.560 | 3271 | 515,206,624 | 135,347,296.0 | 9.782 | 14.97 |
| 5 | 20.046 | 3568 | 371,235,840 | 65,380,064.0 | 4.725 | 7.23 |
| 6 | 20.281 | 3615 | 251,573,904 | 26,918,156.0 | 1.945 | 2.98 |
| 7 | 20.406 | 3640 | 232,225,712 | 45,000,828.0 | 3.252 | 4.98 |
| 8 | 24.382 | 4435 | 258,472,688 | 17,186,558.0 | 1.242 | 1.90 |
| 9 | 28.839 | 5326 | 479,153,344 | 69,168,008.0 | 4.999 | 7.65 |
| 10 | 29.334 | 5425 | 204,294,528 | 24,675,512.0 | 1.783 | 2.73 |
| 11 | 30.425 | 5643 | 130,284,912 | 20,893,160.0 | 1.510 | 2.31 |

**Figure 7.** Chromatogram identified in the ethanolic extract of *Gymnema sylvestre* by GC-MS analysis

3,7,11-trimethyl-9-(phenyl)-; (e, e) -1t-cyclohexanol; 2,6, 10-dodecatrien-1-ol; 3,7,11-trimethyl-9-(phenyl)-; (Figure 9 and 10) shows that 1,1-dimethyl ethyl ester ($C_{10}H_{20}O_2$) fell at retention time 17.104 and had a high area percentage of 65.326 compared to other compounds with high significance for hexanoic acid (Table 1).

**Analysis of *Senna auriculata***

In *Senna auriculata*, a total of nine significant components (Figure 11 and 12) were found 1,4-bis (acetoxymethyl)-benzene, resorcinol, 4-(4-methyl-[1,3,2]dioxaborinan-2-yloxy)-phenol, 3-O-methyl-D-glucose, 3-methyl-mannoside, decanoic acid, 3-methyl, [1,1-Bicyclopropyl] 2-hexyl-, 2-methyl-esters, 1-octadecyne, 4-methyl-1-hepten-4-olacetate, 4-methyl-6-methylene-octa-1, 7-dien-3-ol, [1,1-bicyclopropyl] (Figure 13 and 14) among 9 compounds were significant 3-O-methyl-D-glucose ($C_7H_{14}O_6$) compound was present in a high percentage of 30.732% when compared to

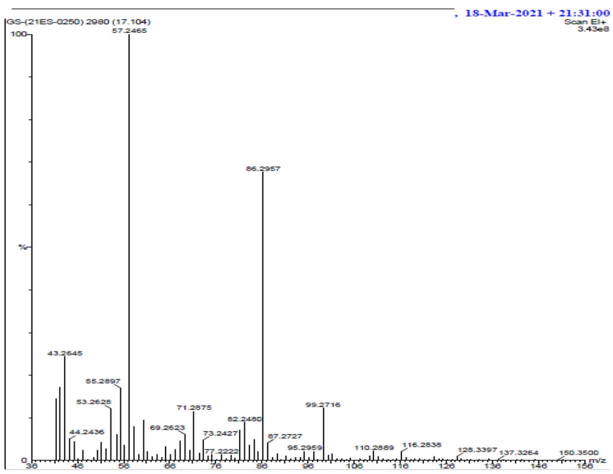



**Figure 8.** GC-MS peak of test *Gymnema sylvestre*

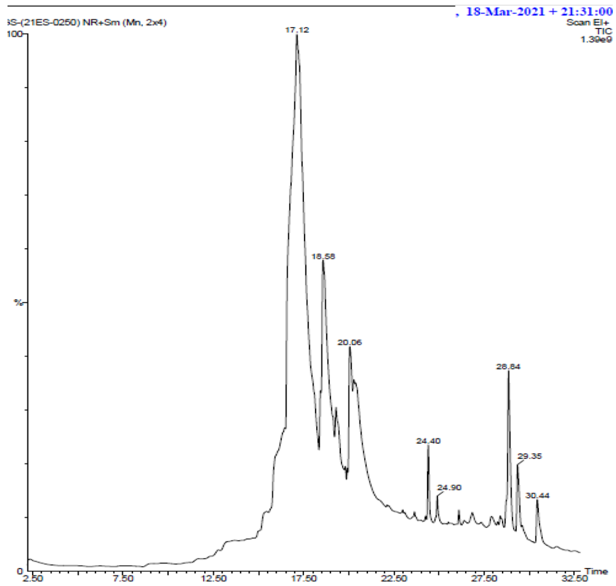
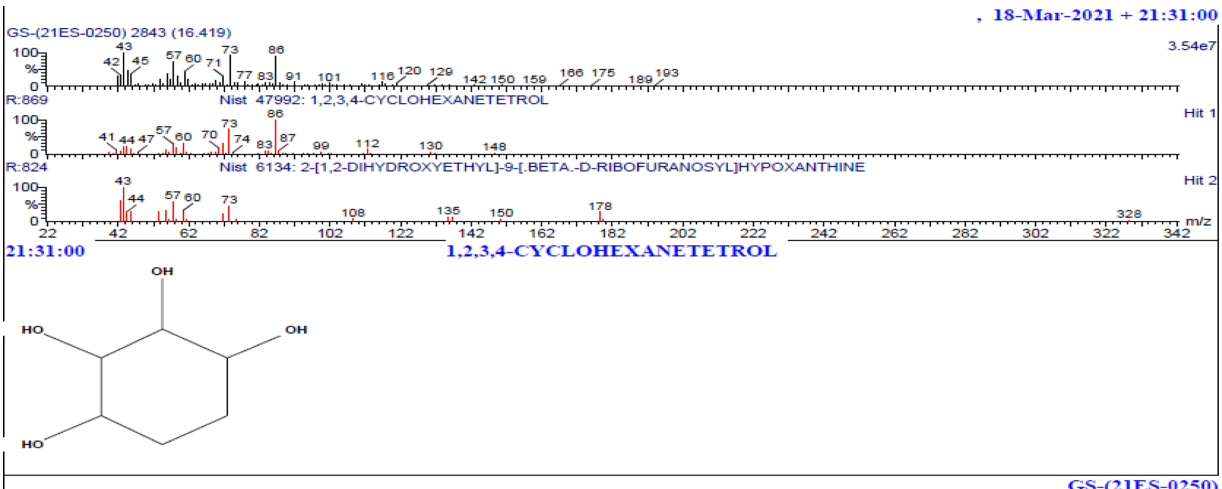



**Figure 9.** GC-MS peak of test *Gymnema sylvestre*

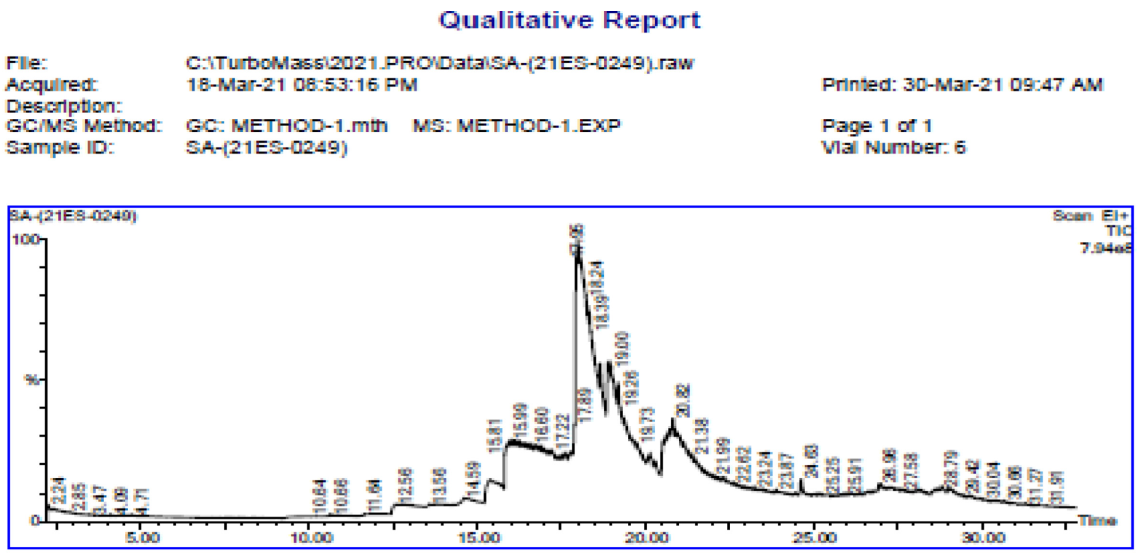



| Hit | REV | for | Compound Name | M.W. | Formula | CAS |
|---|---|---|---|---|---|---|
| 1 | 869 | 778 | 1,2,3,4-CYCLOHEXANETETROL | 148 | C6H12O4 | 3877-34-7 |
| 2 | 824 | 548 | 2-[1,2-DIHYDROXYETHYL]-9-[.BETA.-D-RIBOFURANOSYL]HYPOXANTHINE | 328 | C12H16O7N4 | 110851-58-6 |
| 3 | 819 | 716 | METHYL-.ALPHA.-D-RIBOFURANOSIDE | 164 | C6H12O5 | 900129-83-1 |
| 4 | 812 | 674 | SUCROSE | 342 | C12H22O11 | 57-50-1 |
| 5 | 795 | 634 | 2-HYDROXYMETHYL-9-[.BETA.-D-RIBOFURANOSYL]HYPOXANTHINE | 298 | C11H14O6N4 | 185377-94-0 |
| 6 | 794 | 684 | D-GLYCERO-D-IDO-HEPTOSE | 210 | C7H14O7 | 900130-14-3 |
| 7 | 788 | 692 | L-LYXOSE | 150 | C5H10O5 | 1949-78-6 |
| 8 | 787 | 681 | D-GLYCERO-D-GALACTO-HEPTOSE | 210 | C7H14O7 | 77770-51-5 |
| 9 | 785 | 559 | L-GALA-L-IDO-OCTOSE | 240 | C8H16O8 | 900130-12-1 |
| 10 | 784 | 667 | D-GLYCERO-D-TALLO-HEPTOSE | 210 | C7H14O7 | 900130-14-7 |
| 11 | 781 | 664 | GALACTO-HEPTULOSE | 210 | C7H14O7 | 900130-14-5 |
| 12 | 779 | 654 | L-GLUCOSE | 180 | C6H12O6 | 921-60-8 |
| 13 | 776 | 663 | D-MANNOSE | 180 | C6H12O6 | 3458-28-4 |
| 14 | 769 | 632 | 1-DEOXY-2,4:3,5-DIMETHYLENE-D-XYLITOL | 160 | C7H12O4 | 75096-37-6 |
| 15 | 769 | 661 | D-RIBOSE | 150 | C5H10O5 | 50-69-1 |
| 16 | 766 | 661 | DL-ARABINOSE | 150 | C5H10O5 | 20235-19-2 |
| 17 | 764 | 681 | 2,3,4,5-TETRAHYDROXYPENTANAL | 150 | C5H10O5 | 53106-52-8 |

**Figure 10.** Phytocomponents identified in the ethanolic extract of *Gymnema sylvestre* by GC-MS analysis

**Table 1.** Phytocomponents identified in the ethanolic extract of *Gymnema sylvestre* by GC-MS

| No. | RT (min) | Name of Compounds | Molecular formula | Molecular weight | % of total |
|---|---|---|---|---|---|
| 1 | 17.104 | hexanoic acid-1,1-dimethylethyl ester | $C_{10}H_{20}O_2$ | 172 | 65.326 |
| 2 | 16.419 | 1,2,3,4-cyclohexanetrol | $C_6H_{12}O_4$ | 148 | 4.365 |
| 3 | 30.425 | 2,6,10-dodecatrien-1-ol,3,7,11-trimethyl-9-(phenylsulfonyl) | $C_{21}H_{30}O_3S$ | 362 | 1.510 |
| 4 | 28.839 | 2R-acetoxymethyl-1,3,3-trimethyl-4T-(-3-methyl-2-buten-1-yl)-1T-cyclohexanol. | $C_{17}H_{30}O_3$ | 282 | 4.999 |
| 5 | 24.382 | Squalene | $C_{30}H_5O$ | 410 | 1.242 |
| 6 | 20.406 | 13-tetradece-11-yn-1-ol | $C_{14}H_{24}O$ | 208 | 3.252 |
| 7 | 18.560 | n-hexanoic acid | $C_{16}H_{32}O_2$ | 256 | 9.782 |
| 8 | 18.415 | 1,2,3,4-cyclohexanetetrol | $C_6H_{12}O_4$ | 148 | 1.070 |
| 9 | 20.046 | e-2-octadecadecen-1-ol | $C_{18}H_{36}O$ | 268 | 4.725 |




| # | RT | Scan | Height | Area | Area % | Norm % |
|---|---|---|---|---|---|---|
| 1 | 15.404 | 2640 | 67,054,060 | 30,563,636.0 | 2.273 | 7.40 |
| 2 | 16.099 | 2779 | 175,995,680 | 239,170,656.0 | 17.786 | 57.88 |
| 3 | 17.595 | 3078 | 136,924,240 | 38,678,852.0 | 2.876 | 9.36 |
| 4 | 17.985 | 3156 | 734,981,504 | 413,249,792.0 | 30.732 | 100.00 |
| 5 | 18.665 | 3292 | 383,356,128 | 60,590,384.0 | 4.506 | 14.66 |
| 6 | 18.935 | 3346 | 389,661,280 | 107,732,288.0 | 8.012 | 26.07 |
| 7 | 19.195 | 3398 | 327,506,144 | 154,485,616.0 | 11.489 | 37.38 |
| 8 | 20.141 | 3587 | 126,662,272 | 43,314,088.0 | 3.221 | 10.48 |
| 9 | 20.826 | 3724 | 220,775,136 | 207,937,088.0 | 15.464 | 50.32 |
| 10 | 22.341 | 4027 | 52,492,984 | 32,696,502.0 | 2.432 | 7.91 |
| 11 | 26.978 | 4954 | 29,548,082 | 16,260,141.0 | 1.209 | 3.93 |

**Figure 11.** Chromatogram identified in the ethanolic extract of *Senna auriculata* by GC-MS analysis

other compounds at retention time 17.985, followed by Resorcinol ($C_7H_{14}O_6$) compound, which was present in a high percentage of 17.78% at retention time 16.099, and 4-methyl-1-hepten-4-olacetate ($C_{10}H_{18}O_2$) compound, which was present in a high percentage of 16 (Table 2).

**Analysis of *Cissus Qudrangularis***

In *Cissus quadrangularis*, three principal components were found (Figure 15,16) cyclohexanol, 5-methyl-2-(1-methyllethyl), [1R-(1. alpha., 2. beta., 5. alpha.]; butanoic acid, 3,7-dimethyl-6-octenyl ester; 1-bromo-3-(2-bromoethyl)-nonane. a significant 1-bromo-3-(2-bromoethyl)-nonane ($C_{14}H_{26}O_2$) compound fell at reaction time 13.563, (Figure 17) followed by cyclohexanol and a high area percentage of 29.334 at reaction time 13.563 (Table 3).

Our current research work was identified and applied for

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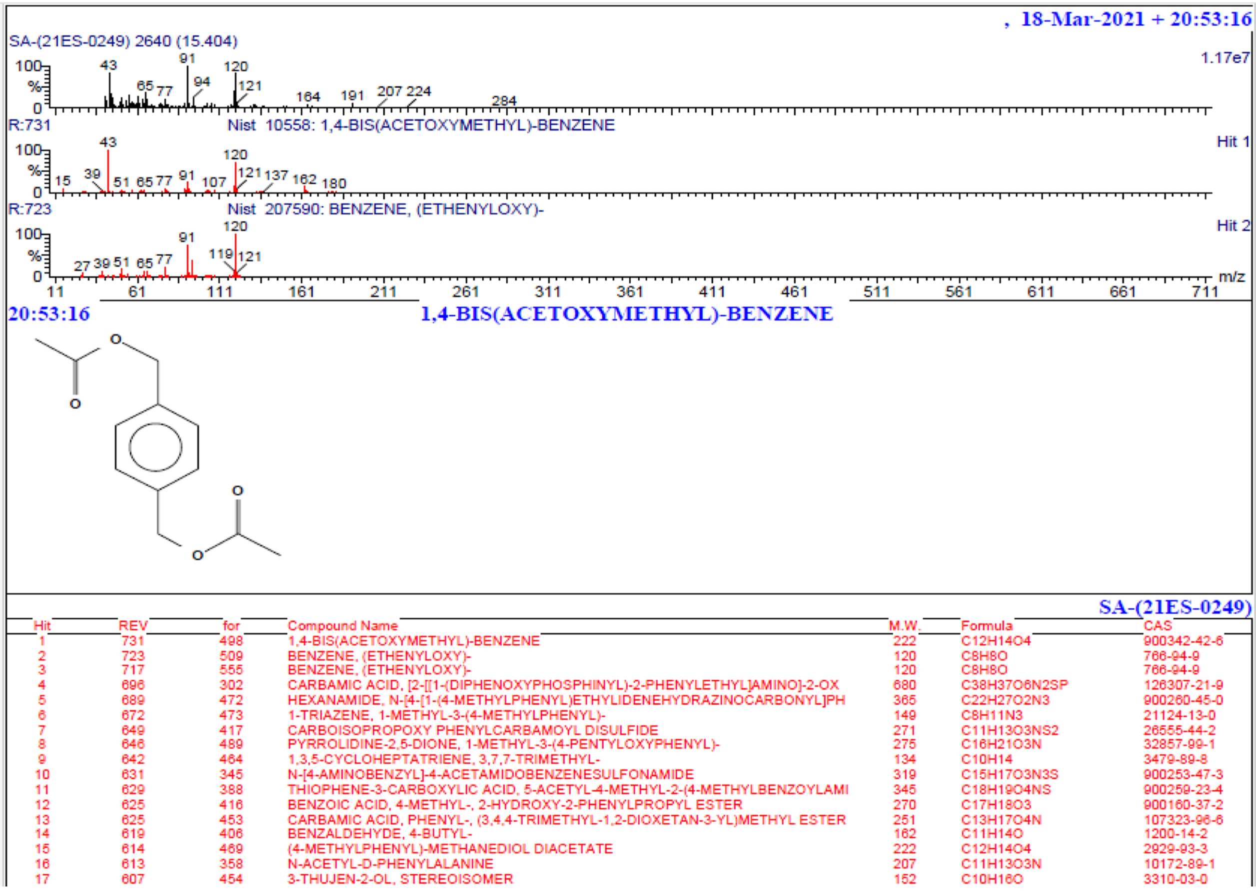



| Hit | REV | for | Compound Name | M.W. | Formula | CAS |
|---|---|---|---|---|---|---|
| 1 | 731 | 498 | 1,4-BIS(ACETOXYMETHYL)-BENZENE | 222 | C12H14O4 | 900342-42-6 |
| 2 | 723 | 509 | BENZENE, (ETHENYLOXY)- | 120 | C8H8O | 766-94-9 |
| 3 | 717 | 555 | BENZENE, (ETHENYLOXY)- | 120 | C8H8O | 766-94-9 |
| 4 | 696 | 302 | CARBAMIC ACID, [2-[[1-(DIPHENOXYPHOSPHINYL)-2-PHENYLETHYL]AMINO]-2-OX | 680 | C38H37O6N2SP | 126307-21-9 |
| 5 | 689 | 472 | HEXANAMIDE, N-[4-[1-(4-METHYLPHENYL)ETHYLIDENEHYDRAZINOCARBONYL]PH | 365 | C22H27O2N3 | 900260-45-0 |
| 6 | 672 | 473 | 1-TRIAZENE, 1-METHYL-3-(4-METHYLPHENYL)- | 149 | C8H11N3 | 21124-13-0 |
| 7 | 649 | 417 | CARBOISOPROPOXY PHENYLCARBAMOYL DISULFIDE | 271 | C11H13O3NS2 | 26555-44-2 |
| 8 | 646 | 489 | PYRROLIDINE-2,5-DIONE, 1-METHYL-3-(4-PENTYLOXYPHENYL)- | 275 | C16H21O3N | 32857-99-1 |
| 9 | 642 | 464 | 1,3,5-CYCLOHEPTATRIENE, 3,7,7-TRIMETHYL- | 134 | C10H14 | 3479-89-8 |
| 10 | 631 | 345 | N-[4-AMINOBENZYL]-4-ACETAMIDOBENZENESULFONAMIDE | 319 | C15H17O3N3S | 900253-47-3 |
| 11 | 629 | 388 | THIOPHENE-3-CARBOXYLIC ACID, 5-ACETYL-4-METHYL-2-(4-METHYLBENZOYLAMI | 345 | C18H19O4NS | 900259-23-4 |
| 12 | 625 | 416 | BENZOIC ACID, 4-METHYL-, 2-HYDROXY-2-PHENYLPROPYL ESTER | 270 | C17H18O3 | 900160-37-2 |
| 13 | 625 | 453 | CARBAMIC ACID, PHENYL-, (3,4,4-TRIMETHYL-1,2-DIOXETAN-3-YL)METHYL ESTER | 251 | C13H17O4N | 107323-96-6 |
| 14 | 619 | 406 | BENZALDEHYDE, 4-BUTYL- | 162 | C11H14O | 1200-14-2 |
| 15 | 614 | 469 | (4-METHYLPHENYL)-METHANEDIOL DIACETATE | 222 | C12H14O4 | 2929-93-3 |
| 16 | 613 | 358 | N-ACETYL-D-PHENYLALANINE | 207 | C11H13O3N | 10172-89-1 |
| 17 | 607 | 454 | 3-THUJEN-2-OL, STEREOISOMER | 152 | C10H16O | 3310-03-0 |

**Figure 12.** Phytocomponents identified in the ethanolic extract of *Senna auriculata* by GC-MS analysis

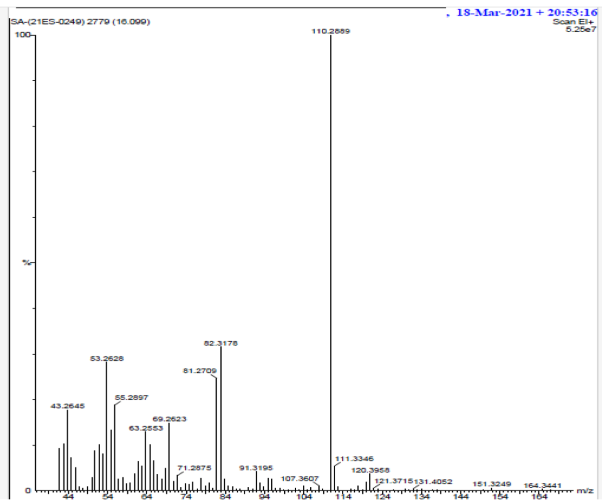



**Figure 13.** GC-MS peak of test *Senna auriculate*

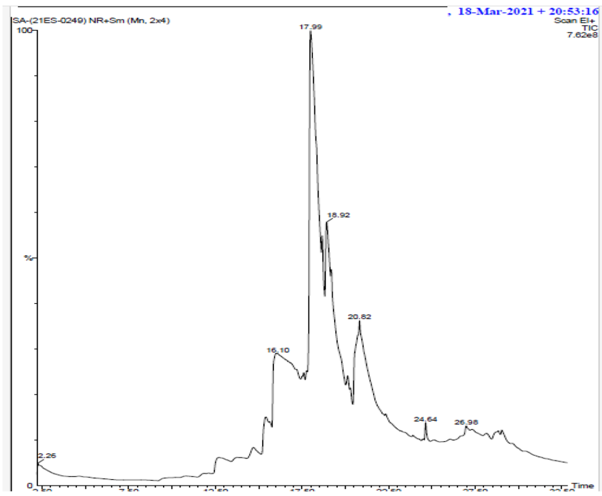


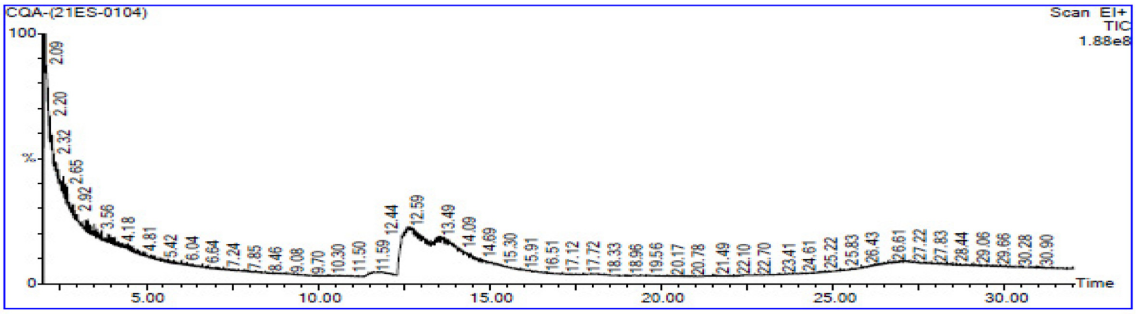

**Figure 14.** GC-MS peak of test *Senna auriculata*

**Table 2.** Phytocomponents identified in the ethanolic extract of *Cissus quadrangularis* by GC-MS

| No. | RT min | Name of Compounds | Molecular formula | Molecular weight | % of total |
|---|---|---|---|---|---|
| 1 | 12.658 | cyclohexanol, 5-methyl-2-(-1-methylethyl),[1R-(1.alpha.,2.beta.,5.alpha)] | $C_{10}H_{20}O$ | 156 | 29.334 |

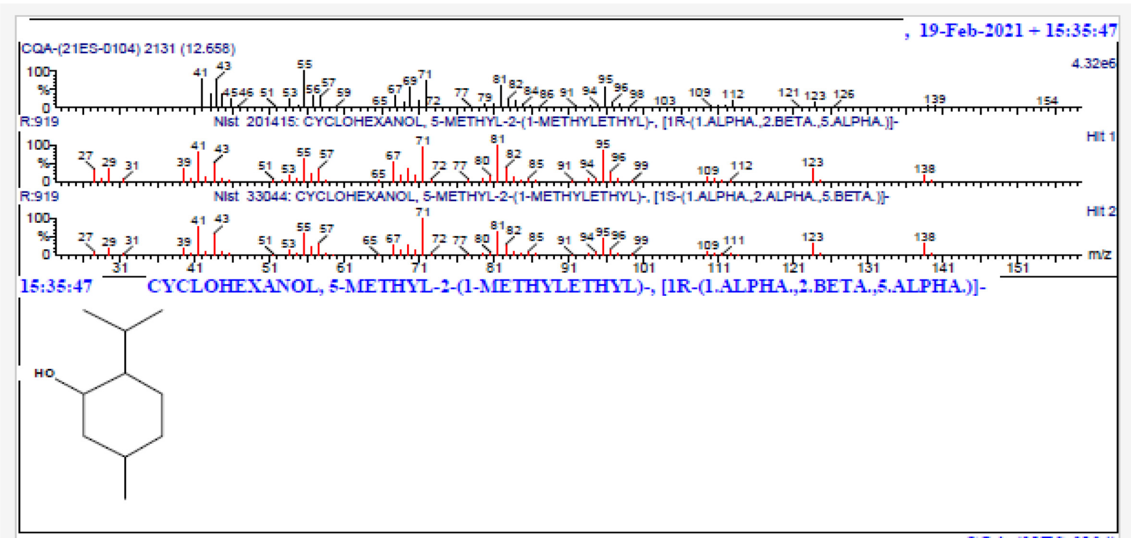
**Qualitative Report**

| | | | |
|---|---|---|---|
| File: | C:\TurboMass\2021.PRO\Data\CQA-(21ES-0104).raw | | |
| Acquired: | 19-Feb-21 03:35:47 PM | | Printed: 25-Feb-21 10:49 AM |
| Description: | | | |
| GC/MS Method: | GC: METHOD-1.mth | MS: METHOD-1.EXP | Page 1 of 1 |
| Sample ID: | CQA-(21ES-0104) | | Vial Number: 6 |




| # | RT | Scan | Height | Area | Area % | Norm % |
|---|---|---|---|---|---|---|
| 1 | 12.658 | 2131 | 36,284,948 | 17,522,788.0 | 29.334 | 53.20 |
| 2 | 12.923 | 2184 | 30,918,684 | 9,278,400.0 | 15.532 | 28.17 |
| 3 | 13.563 | 2312 | 28,123,526 | 32,934,522.0 | 55.134 | 100.00 |

**Figure 15.** Chromatogram identified in the ethanolic extract of *Cissus qudrangularis* by GC-MS analysis




CQA-(21ES-0104)

| Hit | REV | for | Compound Name | M.W. | Formula | CAS |
|---|---|---|---|---|---|---|
| 1 | 919 | 852 | CYCLOHEXANOL, 5-METHYL-2-(1-METHYLETHYL)-, [1R-(1.ALPHA.,2.BETA.,5.ALPHA | 156 | C10H20O | 2216-51-5 |
| 2 | 919 | 865 | CYCLOHEXANOL, 5-METHYL-2-(1-METHYLETHYL)-, [1S-(1.ALPHA.,2.ALPHA.,5.BETA | 156 | C10H20O | 2216-52-6 |
| 3 | 917 | 845 | CYCLOHEXANOL, 5-METHYL-2-(1-METHYLETHYL)-, [1S-(1.ALPHA.,2.ALPHA.,5.BETA | 156 | C10H20O | 2216-52-6 |
| 4 | 916 | 830 | CYCLOHEXANOL, 5-METHYL-2-(1-METHYLETHYL)-, (1.ALPHA.,2.BETA.,5.ALPHA.)- | 156 | C10H20O | 89-78-1 |
| 5 | 910 | 841 | CYCLOHEXANOL, 5-METHYL-2-(1-METHYLETHYL)-, (1.ALPHA.,2.BETA.,5.BETA.)- | 156 | C10H20O | 490-99-3 |
| 6 | 910 | 855 | CYCLOHEXANOL, 5-METHYL-2-(1-METHYLETHYL)-, [1R-(1.ALPHA.,2.BETA.,5.ALPHA | 156 | C10H20O | 2216-51-5 |
| 7 | 906 | 851 | CYCLOHEXANOL, 1-METHYL-4-(1-METHYLETHYL)- | 156 | C10H20O | 21129-27-1 |
| 8 | 904 | 835 | CYCLOHEXANOL, 5-METHYL-2-(1-METHYLETHYL)-, (1.ALPHA.,2.BETA.,5.BETA.)- | 156 | C10H20O | 490-99-3 |
| 9 | 902 | 843 | CYCLOHEXANOL, 5-METHYL-2-(1-METHYLETHYL)-, [1S-(1.ALPHA.,2.BETA.,5.BETA.) | 156 | C10H20O | 23283-97-8 |
| 10 | 902 | 836 | (+)-ISOMENTHOL | 156 | C10H20O | 900152-08-3 |
| 11 | 896 | 830 | CYCLOHEXANOL, 5-METHYL-2-(1-METHYLETHYL)-, (1.ALPHA.,2.ALPHA.,5.ALPHA.)- | 156 | C10H20O | 491-02-1 |
| 12 | 892 | 813 | 2-OCTEN-1-OL, 3,7-DIMETHYL- | 156 | C10H20O | 40607-48-5 |
| 13 | 892 | 799 | BUTANOIC ACID, 3,7-DIMETHYL-6-OCTENYL ESTER | 226 | C14H26O2 | 141-16-2 |
| 14 | 891 | 826 | 3,4-DIMETHYLCYCLOHEXANOL | 128 | C8H16O | 5715-23-1 |
| 15 | 886 | 837 | MENTHOL | 156 | C10H20O | 1490-04-6 |
| 16 | 884 | 816 | 7-OCTEN-1-OL, 3,7-DIMETHYL-, (S)- | 156 | C10H20O | 6812-78-8 |
| 17 | 882 | 809 | 3,4-DIMETHYLCYCLOHEXANOL | 128 | C8H16O | 5715-23-1 |

**Figure 16.** Phytocomponents identified in the ethanolic extract of *Cissus qudrangularis* by GC-MS analysis

further study. GC-MS analysis was done using the organic solvent ethanol, and it showed the presence of different components present in the selected medicinal plants. This study used GC-MS analysis to find more than twenty fine chemical constituents in an ethanol extract of the upper parts of *Gymnema sylvestre, Senna auriculata, and Cissus*


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**Table 3.** Phytocomponents identified in the ethanolic extract of *Senna auriculata* by GC-MS

| No. | RT min | Name of Compounds | Molecular formula | Molecular weight | % of total |
|---|---|---|---|---|---|
| 1 | 15.404 | 1,4-bis(acetoxymethyl)-benzene | $C_{12}H_{14}O_4$ | 222 | 2.273 |
| 2 | 16.099 | resorcinol | $C_6H_6O_2$ | 110 | 17.786 |
| 3 | 17.595 | 4-(4-methyl-[1,3,2]dioxaborinan-2-yloxy)-phenol | $C_8H_{16}O$ | 128 | 2.876 |
| 4 | 17.985 | 3-O-methyl-D-glucose | $C_7H_{14}O_6$ | 194 | 30.732 |
| 5 | 18.665 | 3-methylmannoside | $C_7H_{14}O_6$ | 194 | 4.506 |
| 6 | 18.935 | decanoic acid,3-methyl | $C_{11}H_{22}O_2$ | 186 | 8.012 |
| 7 | 20.141 | [1,1-bicycloprophy]-2-octanoic acid,2-hexyl,methyl ester | $C_3H_7$O3N | 105 | 11.489 |
| 8 | 20.826 | 1-octadecyne | $C_{18}H_{34}$ | 250 | 15.464 |
| 9 | 22.341 | 4-methyl-1-hepten-4-ol-acetate | $C_8H_{16}O$ | 128 | 2.432 |

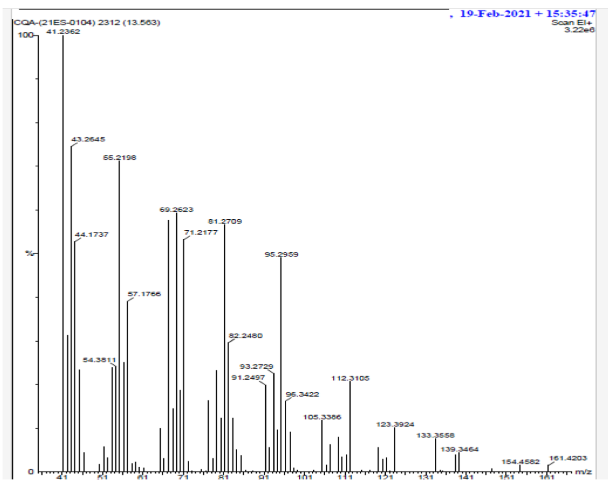

**Figure 17.** GC-MS peak of test *Cissus quadrangularis*

*quadrangularis*. The plant has been widely used in the traditional system of medicine as a cure for rheumatism. People have also said that the plant has anti-diabetic, anti-peroxidative, anti-hyperglycemic, and anti-microbial properties.

As a potential eligible lead component to inhibit the α-amylase enzyme and predict an effective antihyperglycemic potential,[26] hexanoic acid plays an important role in antifungal and antihyperglycemic properties. 3-O-methyl-D-glucose is a non-metabolizable glucose analogue that is not phosphorylated by hexokinase. 3-O-methyl glucose is used as a marker to assess glucose transport by evaluating its uptake within various cells and organ systems.[27] Resorcinol is used as a chemical intermediate for the synthesis of pharmaceuticals and other organic compounds. Antibacterial, anti-inflammatory, hypocholesterolemic, cancer preventive, hepatoprotective, nematicide, antihistaminic, antiarthritic, and nematicide properties of octadecanoic acid (stearic acid); cis-9-hexadecenal (antimicrobial); 9, 12, and 15-octadecatrienoic acids; and methyl ester (linolenic acid, methyl ester) 5-alpha reductase inhibits androgenic hormones. Heptadecanoic acid (antimicrobial), hexadecanoic acid, and methyl ester (palmitic acid methyl ester) have antioxidant, hypocholesterolemic nematicide, pesticide, antiandrogenic flavor, hemolytic, and antiandrogenic flavor properties. 5-alpha reductase.[2] Butanoic acid (1,1-dimethyl ethyl ester), one of the identified phyto-compounds, has anti-diabetic properties.[28]

In this aspect, *Cassia auriculata, Gymnema sylvestre, and Cissus quadrangular* revealed the presence of alkaloids, flavonoids, glycosides, proteins, saponins, tannins, phenols, and terpenoids. Flavonoids have attracted a great deal of attention for their potential for beneficial effects on health,[29] anti-inflammatory,[30] antioxidant and anti-tumor effects,[31] which are linked to actions that get rid of free radicals.[32]

*G. Sylvestre* by where terpenes, saturated and unsaturated fatty acids such as 9-Octadecenoic acid (Z), methyl ester were predominantly found antimicrobial, antibacterial, and antiviral.[4] A similar study on the essential oil of *Gymnema sylvestre* indicated the major compounds to be palmitic acid, hydroquinone, phytol, pentadecanoic acid,4-vinyl guaiacol and eugenol.[33] 1,2,3,4-cyclohexanetrol, D-mannose, resorcinol dimethyl ether,[34] methyl acetate.[35] Squalene is effective in the treatment of diabetes mellitus type 2 and can potentiate the activity of some antitumor (anti-blastoma) preparations and reduce their undesired side effects and LDP which protects skin and is adjunctive to cancer.[36] Gymnemic acid, Stigmasterol, Gurmarin, betaine, gymnemosides action of Regeneration of pancreatic β cells, α-glucosidase inhibitor, insulin secretion shows antidiabetic agent.[36]

CQ showed the presence of single constituents which were characterized and identified. Cyclohexanol, 5-methyl-2-(-1-methyl ethyl), [1R-(1. alpha., 2. beta., 5. alpha)] showed remarkable antimicrobial activity against *E. coli, Acinetobacter baumannii, Bacillus subtilis* and *Candida pseudotropicalis* weak to moderate antibacterial activity.[37]

The major compounds noticed were Hexadecanoic acid (antioxidant), methyl ester; N-hexadecanoic acid has prostaglandin-E2 9-reductase) inhibitor.[38] 9,12-octadecanoic acid, methyl ester; octadecanoic acid. Hexatriacontane have plant metabolite,[38] 3-O-methyl-D-glucose showed metabolism and insulinotropic action of D-glucose.[39] Hence, the presence of some of the important bioactive volatile compounds will certainly prove the use of ethanol extract of selected medicinal plants. the presence of such volatile compounds in selected parts of highly demanded pharmaceuticals, 4-methyl-1-hepten-4-ol-acetate investigated for plant growth promoter and antibacterial activity.[40]

*C. auriculata* is gaining much importance in diabetic control as it has been used as a traditional medicine (Avaarai panchaga chooranam) for diabetes. The preliminary investigation on the anti-diabetic efficacy of ethanol extract of *C. auriculata* flowers will be significant to proceed further in this path for the isolation of active principles responsible for antidiabetic activity. Further studies will be carried out to elucidate the exact mechanism of action of the water-soluble fraction of ethanol extract of *C. auriculata* flowers on diabetes and its antiperoxidative effect. Diazoprogesterone, 9-octadecenoic acid (Z), hexyl ester, and oleic acid were the n-hexane tuber fraction components with cytotoxic potential.[41]

Diglycerol shows antimicrobial activity,[42] Tau-Muurolol shows anti-HIV activity,[43] Alpha-cadinol shows antibacterial and antifungal.[44] methyl ester shows antifungal, intestinal lipid regulating, nematicide and anti-inflammatory agent.[45] The antibacterial and antioxidant activities of hexadecanoic acid.[46]

## Conclusion

The investigation in this study involves the leaves of *Gymnema sylvestre, Flower of Senna auriculata* and *stem of Cissus quadrangularis*. As per the literature, this shows the presence of more identified Phytocomponents and a few compounds that showed biological activity. Cyclohexanol and 1,2,3,4-cyclohexanetrol and oleic acid shows antimicrobial activity , antibacterial, and antioxidant. Butanoic acid, 3-O-methyl-D-glucose, 3-methylmannodise and decanoic acid, 3-methyl,1,2-dodecanediol and diacetate shows antidiabetic activity.

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