

## GAS CHROMATOGRAPHY-MASS SPECTROSCOPY ANALYSIS OF ROOT OF AN ECONOMICALLY IMPORTANT PLANT, *CENCHRUS CILIARIS* L. FROM THAR DESERT, RAJASTHAN (INDIA)

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### ABSTRACT

**Objective:** The study was carried out with an objective to characterize the possible bioactive phytochemical constituents from the root of *Cenchrus ciliaris* L. using various solvents of different polarities, i.e., methanol, ethyl acetate, and hexane by gas chromatography-mass spectroscopy (GC-MS) analysis.

**Methods:** Plant material was collected from harsh, xeric conditions of "Thar" during August to October. The shade-dried plant root powder was extracted with solvents using Soxhlet extractor. The phytochemical compounds were investigated using PerkinElmer GC-MS, while the mass spectra of the compounds found in the extract was matched with the National Institute of Standards and Technology and Willey 8 library.

**Results:** Maximum % area is found for stigmasta-5,22-dien-3-ol and present in maximum amount (12.68%) with reaction time (RT)=36.461 minutes in the methanolic extract. 1,2,3-propanetriol, 1-acetate is present in maximum amount (13.15%) with RT=6.582 minutes in the ethyl acetate extract. Tetracontane is present in maximum amount (16.70%) with RT=18.744 minutes in the hexane extract of root of *C. ciliaris* L.

**Conclusions:** Green plants synthesize and preserve a variety of biochemical compounds. Plant secondary metabolites are commercially important and are used by pharmaceutical industry as well as the traditional practitioners. The GC-MS study helps to predict the formula and structure of phytoconstituents that can be used for drug design, and further investigation may lead to the development of various drug formulations.

**Keywords:** *Cenchrus ciliaris* L., Gas chromatography-mass spectroscopy, Secondary metabolites, Pharmaceutical, Polarity.

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### INTRODUCTION

*Cenchrus ciliaris* L. (*Poaceae*) is one of the important forage plants, commonly known as "Dhama grass." It is perennial  $C_4$  grass with a deep, adventitious root system and tough culms that are erect to somewhat prostrate branched with swollen bases. Leaves are basal, cauline with sharp blades arranged at nodes, rough textured, and blades have prominent midribs with keeled leaf sheaths. The inflorescence is erect, dense, cylindrical, and spike-like. The rachis bears lanceolate spikelets enclosed by diamond-shaped involucre of prickly bristles. Seeds are obovoid and of caryopsis type.

The plant is the most suitable and highly nutritive grass for environmental conditions of desert gaining attention in the various fields of research. It is more competitive under the conditions of high temperature, solar radiation, and low moisture [1]. These grasses are more efficient at gathering  $CO_2$  and utilizing nitrogen from the atmosphere and for recycling N in the soil. Grasses have an excellent soil binding capacity which helps to conserve soil in the desert areas [2]. Dry hot summers and pleasant dry winters are prominent features of the Thar desert. The mean daily maximum temperature in summer ranges from 41°C to 46°C and can reach up to 50°C during the hot summer noon. Rainfall is sparse, ranging from 127 to 254 mm annually, and is confined mainly to the rainy season [3].

Earlier reports suggest that *C. ciliaris* L. is a potential grass of "Thar desert." However, to date, there are no reports regarding exploitation of root with methanol, ethyl acetate, and hexane as solvents.

### METHODS

#### Collection and processing of plant material

Fresh plants free from diseases were collected from Jodhpur district, Rajasthan, India, during rainy season from August to October. Plants

were identified and authenticated by Botanical Survey of India, Jodhpur. Fresh roots were incised, washed, air dried, and powdered in an electric grinder. The coarse powdered plant material was stored in airtight containers.

Soxhlet assembly was used to prepare root extract [4] in various solvents (methanol, ethyl acetate, and hexane). Repeated extraction was done until a colorless extract was obtained. All the plant extracts under study were evaporated to dryness and stored at 4°C for future use. The gas chromatography-mass spectroscopy (GC-MS) analysis was performed at Advanced Instrumentation Research Facility (AIRF), Jawaharlal Nehru University, New Delhi, India.

#### Identification of phytoconstituents

Identification of phytoconstituents was done using Willey 8 and National Institute of Standards and Technology library that remains attached to the GC-MS. Retention indices of analyzed compounds were compared with stored components, and the phytoconstituents were identified as per their structure, % area, molecular formula, and spectrum. Phytoconstituents exhibit a broad spectrum of effects. Some may be beneficial and used for the treatment of various diseases while others may be toxic [5].

### RESULTS AND DISCUSSION

GC-MS analysis of the root extracts of *C. ciliaris* in solvents with different polarities, i.e., methanol, ethyl acetate, and hexane revealed 46, 70, and 80 peaks in chromatogram (Figs. 1-3) indicating the presence of 42, 64, and 71 active compounds, respectively. Confirmation of these compounds was based on their retention time, molecular formula, and molecular weight. These bioactive compounds show various biological activities that have been reported earlier. Medicinal plant-based drugs exhibit several broad spectrum activities [6].

Table 1: Bioactivity of compounds identified in methanol root extract

S.No.	RT (minutes)	Compounds	Molecular weight	Molecular formula	Nature	Bioactivities
1	6.767	Hexanoic acid, 2-ethyl-	144	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Carboxylic acid	Plasticizer, lubricants
2	7.944	1-undecanol	172	C <sub>11</sub> H <sub>24</sub> O	Fatty alcohol	Bactericidal
3	8.056	Naphthalene	128	C <sub>10</sub> H <sub>8</sub>	Polycyclic aromatic hydrocarbon	Antiseptic, carcinogenic
4	9.479	2-undecanone	170	C <sub>11</sub> H <sub>22</sub> O	Ketone	Natural non-toxic insect repellent
5	10.806	1-tetradecene	196	C <sub>14</sub> H <sub>28</sub>	Olefins	Antituberculosis
6	12.250	Naphthalene, 2-bromo-	207	C <sub>10</sub> H <sub>7</sub> Br	Aryl bromide	Dye preparation
7	13.344	9-eicosene, (E)-	280	C <sub>20</sub> H <sub>40</sub>	Alkene	Antimicrobial, cytotoxic property
8	13.495	1,2-benzene dicarboxylic acid, diethyl ester	222	C <sub>12</sub> H <sub>14</sub> O <sub>4</sub>	Diethyl phthalate	Cosmetics, insecticides, plasticizer
9	14.316	8-pentadecanone	226	C <sub>15</sub> H <sub>30</sub> O	Ketone	Hepatotoxic, demyelination, conjunctivitis
10	14.585	Heptadecane, 2,6,10,15-tetramethyl-	296	C <sub>21</sub> H <sub>44</sub>	Alkane	Sex hormone in algae
11	15.617	n-heptadecanol-1	256	C <sub>17</sub> H <sub>36</sub> O	Fatty alcohol	Antiarthritis, skin diseases
12	15.686	Tetradecane	198	C <sub>14</sub> H <sub>30</sub>	Alkane	Antifungal, antibacterial, nematocidal
13	16.198	2-pentadecanone, 6,10,14-trimethyl-	268	C <sub>18</sub> H <sub>36</sub> O	Sesquiterpenoids	Allelopathic activity, antibacterial
14	17.007	Octadecanoic acid, methyl ester	298	C <sub>19</sub> H <sub>38</sub> O <sub>2</sub>	Fatty acid methyl ester	Antifungal, antibacterial, antimicrobial, emulsifier, perfumery industry
15	17.267	Cis-13-octadecenoic acid	282	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	Elaidic acid	Therapeutic uses in medicine, surgery
16	17.354	Pentadecanoic acid	242	C <sub>15</sub> H <sub>30</sub> O <sub>2</sub>	Palmitic acid	Lubricants, adhesive agents
17	19.567	n-nonadecanol-1	284	C <sub>19</sub> H <sub>40</sub> O	Fatty alcohol	Antimicrobial, cytotoxic
18	19.074	Octadec-9-enoic acid	282	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	Oleic acid	Antihypertensive increases HDL and decrease LDL
19	19.271	Octadecanoic acid	284	C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	Stearic acid	Antifungal, antitumor, antibacterial
20	22.432	Octadecanal	268	C <sub>18</sub> H <sub>38</sub> O	Fatty aldehyde	Sex pheromone
21	24.639	2-Hexadecyl oxirane	268	C <sub>18</sub> H <sub>36</sub> O	Epoxide	Antibacterial, antimicrobial, antioxidant, antipyretic, anti-inflammatory, analgesic
22	30.936	γ-tocopherol	416	C <sub>28</sub> H <sub>48</sub> O <sub>2</sub>	Vitamin E compound	Antioxidant, cardioprotective, anticancer, anti-inflammatory
23	35.547	Ergost-5-en-3-ol, (3.β.,24r)-	400	C <sub>28</sub> H <sub>48</sub> O	Campesterol	Liver disease, jaundice, artherosclerosis
24	36.461	Stigmasta-5,22-dien-3-ol	412	C <sub>29</sub> H <sub>48</sub> O	Stigmasterol	Synthetic progesterone
25	38.346	Stigmast-5-en-3-ol, (3.β.)-	414	C <sub>29</sub> H <sub>50</sub> O	β-sitosterol	Anti-inflammatory, antipyretic, anti-ulcer, antiarthritic
26	43.463	Androst-4-en-3-one, 17-hydroxy-, (17.β.)-	288	C <sub>19</sub> H <sub>28</sub> O <sub>2</sub>	Steroid	Regulation of spermatogenesis

RT: Reaction time

Table 2: Bioactivity of compounds identified in ethyl acetate root extract

S.No.	RT (minutes)	Compounds	Molecular weight	Molecular formula	Nature	Bioactivity
1	6.582	1,2,3-propanetriol, 1-acetate	134	C <sub>5</sub> H <sub>10</sub> O <sub>4</sub>	Monoacetin	Antiadipogenic
2	8.056	Naphthalene	128	C <sub>10</sub> H <sub>8</sub>	Polycyclic aromatic hydrocarbon	Antiseptic, carcinogenic
3	10.909	Tetradecane	198	C <sub>14</sub> H <sub>30</sub>	Alkane	Antismicrobial,
4	12.206	Pentadecane	212	C <sub>15</sub> H <sub>32</sub>	Alkane	Suger-phosphatase inhibitor, chymosin inhibitor, antibacterial
5	12.546	1-tridecanol	200	C <sub>13</sub> H <sub>28</sub> O	Fatty alcohol	Natural mosquito control agent
6	13.430	Hexadecane	226	C <sub>16</sub> H <sub>34</sub>	Alkane	Antifungal, antibacterial, antioxidant
7	13.498	1,2-benzene dicarboxylic acid, diethyl ester	222	C <sub>12</sub> H <sub>14</sub> O <sub>4</sub>	Diethyl phthalate	Cosmetics, insecticides, plasticizer
8	14.173	2-methyl tetracosane	352	C <sub>25</sub> H <sub>52</sub>	Alkane	Free radical scavenger
9	14.264	Heptadecane, 2,6,10,15-tetramethyl-	296	C <sub>21</sub> H <sub>44</sub>	Alkane	Sex hormone in algae
10	14.589	Heptadecane	240	C <sub>17</sub> H <sub>36</sub>	Alkane	Antioxidant
11	14.657	Pentadecane, 2,6,10,14-tetramethyl-	268	C <sub>19</sub> H <sub>40</sub>	Alkane	Pathogenesis of rheumatoid arthritis and lupus
12	15.224	Eicosane	282	C <sub>20</sub> H <sub>42</sub>	Alkane	Antifungal, antitumor, antibacterial, larvicidal, antimicrobial, cytotoxic
13	15.291	Tricosane	324	C <sub>23</sub> H <sub>48</sub>	Alkane	Antibacterial
14	15.383	Heptadecane, 3-methyl-	254	C <sub>18</sub> H <sub>38</sub>	Alkane	Pest repellent, sex pheromone

(Contd...)

(Table 2: Continued)

S.No.	RT (minutes)	Compounds	Molecular weight	Molecular formula	Nature	Bioactivity
15	15.963	Isopropyl myristate	270	C <sub>17</sub> H <sub>34</sub> O <sub>2</sub>	Ester of isopropanol and myristic acid	Skin care lotion, emollient
16	16.132	2-hexadecen-1-ol,	296	C <sub>20</sub> H <sub>40</sub> O	Phytol	Antimicrobial, sedatives, and Anesthetics
17	16.525	3,7,11,15-tetramethyl-, [R-[R*R*,-(E)]]	278	C <sub>16</sub> H <sub>22</sub> O <sub>4</sub>	Isobutyl phthalate	Antimicrobial, antifouling
18	16.733	1,2-benzene dicarboxylic acid, BIS (2-methyl propyl) ester	268	C <sub>19</sub> H <sub>40</sub>	Alkane	Antimicrobial, cytotoxic
19	17.011	Nonadecane	270	C <sub>17</sub> H <sub>34</sub> O	Fatty acid methyl ester	Antioxidant, nematocidal, insecticide, lubricant, antiandrogenic, hemolytic, hypo -cholesterolemic
20	17.107	7,9-di-tert-butyl-1-oxaspiro (4,5) deca-6,9-diene-2,8-dione	276	C <sub>17</sub> H <sub>24</sub> O <sub>3</sub>	Oxaspiro compound	Antimicrobial
21	17.360	Hexadecanoic acid	256	C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	Palmitic acid	Antitumor
22	17.443	Octadecanoic acid	284	C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	Stearic acid	Antifungal, antitumor, antibacterial
23	17.485	Dibutyl phthalate	278	C <sub>16</sub> H <sub>22</sub> O <sub>4</sub>	Phthalic acid dibutyl ester	Antifungal, antimicrobial, antimalarial, plasticizer, ectoparasiticide
24	18.570	n-pentadecanol	228	C <sub>15</sub> H <sub>32</sub> O	Fatty alcohol	Antioxidant, antimicrobial
25	22.439	Octadecanal	268	C <sub>18</sub> H <sub>36</sub> O	Fatty aldehyde	Sex pheromone
26	25.297	Tetratetracontane	618	C <sub>44</sub> H <sub>90</sub>	Alkane	Hypoglycemic, antioxidant
27	27.002	Squalene	410	C <sub>30</sub> H <sub>50</sub>	Triterpene	Antibacterial, antioxidant, antitumor, cancer preventive, immunostimulant, pesticide
28	27.893	Heptadecane, 8-methyl-	254	C <sub>18</sub> H <sub>38</sub>	Alkane	Anticancer
29	31.586	Tetracontane	562	C <sub>40</sub> H <sub>82</sub>	Alkane	Anti-inflammatory, analgesic activity
30	35.567	Ergost-5-en-3-ol, (3.β.,24r)-	400	C <sub>28</sub> H <sub>48</sub> O	Campesterol	Liver disease, jaundice, atherosclerosis
31	36.480	Stigmasta-5,22-dien-3-ol	412	C <sub>29</sub> H <sub>48</sub> O	Stigmasterol	Synthetic progesterone
32	38.361	Stigmast-5-en-3-ol, (3.β.)-	414	C <sub>29</sub> H <sub>50</sub> O	β-sitosterol	Anti-inflammatory, antipyretic, anti-ulcer, antiarthritic

RT: Reaction time

Table 3: Bioactivity of compounds identified in hexane root extract

S.No.	RT (minutes)	Compound	Molecular weight	Molecular formula	Nature	Bioactivity
1	9.527	Tridecane	184	C <sub>13</sub> H <sub>28</sub>	Alkane	Fragrance agent
2	9.643	2-isopropyl-5-methyl-1-heptanol	172	C <sub>11</sub> H <sub>24</sub> O	Alcoholic compound	Antimicrobial
3	9.908	Octadecane	254	C <sub>18</sub> H <sub>38</sub>	Alkane	Lubricants, anticorrosion agents
4	10.906	Tetradecane	198	C <sub>14</sub> H <sub>30</sub>	Alkane	Antifungal, antibacterial
5	12.204	Pentadecane	212	C <sub>15</sub> H <sub>32</sub>	Alkane	Suger-phosphatase inhibitor, chymosin inhibitor, antibacterial
6	12.736	Eicosane	282	C <sub>20</sub> H <sub>42</sub>	Alkane	Antifungal, antitumor, antibacterial, larvicidal, cytotoxic, antimicrobial
7	13.428	Hexadecane	226	C <sub>16</sub> H <sub>34</sub>	Alkane	Antifungal, antibacterial, antioxidant
8	14.107	Pyrrolidine	71	C <sub>4</sub> H <sub>9</sub> N	Cyclic secondary amine	Antimicrobial, antitumor, anti-HIV-1, anticonvulsant
9	14.170	2-methyl tetracosane	352	C <sub>25</sub> H <sub>52</sub>	Alkane	Free radical scavenger
10	14.379	Heneicosane	296	C <sub>21</sub> H <sub>44</sub>	Alkane	Oviposition-attractant pheromone
11	14.587	Heptadecane	240	C <sub>17</sub> H <sub>36</sub>	Alkane	Antioxidant
12	14.656	Pentadecane, 2,6,10,14-tetramethyl-	268	C <sub>19</sub> H <sub>40</sub>	Pristane	Pathogenesis of rheumatoid arthritis and lupus
13	14.737	Tricosane	324	C <sub>23</sub> H <sub>48</sub>	Alkane	Antibacterial
14	14.795	Pentadecanal	226	C <sub>15</sub> H <sub>30</sub> O	Fatty aldehyde	Nutrient stabilizers, surfactants, and emulsifier
15	15.073	1-dodecanol, 2-octyl-	298	C <sub>20</sub> H <sub>42</sub> O	Branched alcohol	Emollients, perfuming agents, cosmetics
16	15.217	Hexadecane, 2,6,10,14-tetramethyl-	282	C <sub>20</sub> H <sub>42</sub>	Phytane	Biomarkers in petroleum studies

(Contd...)

(Table 3: Continued)

S.No.	RT (minutes)	Compound	Molecular weight	Molecular formula	Nature	Bioactivity
17	15.265	Tetradecanoic acid	228	C <sub>14</sub> H <sub>28</sub> O <sub>2</sub>	Myristic acid	Antioxidant, anticancer, hypocholesterolemic
18	15.685	Nonadecane	268	C <sub>19</sub> H <sub>40</sub>	Alkane	Antimicrobial, cytotoxic
19	15.958	Isopropyl myristate	270	C <sub>17</sub> H <sub>34</sub> O <sub>2</sub>	Ester of fatty acid alcohol	Skin care lotion, emollient
20	16.200	2-penta decanone, 6,10,14-trimethyl-	268	C <sub>18</sub> H <sub>36</sub> O	Sesqui-terpenoids	Allelopathic activity
21	16.522	1,2-benzenedicarboxylic acid, BIS (2-methylpropyl) Ester	278	C <sub>16</sub> H <sub>22</sub> O <sub>4</sub>	Isobutyl phthalate	Antimicrobial, antifouling
22	16.671	Tetratetracontane	618	C <sub>44</sub> H <sub>90</sub>	Alkane	Hypoglycemic, antioxidant
23	17.105	7,9-di-tert-butyl-1-oxaspiro (4,5) deca-6,9-diene-2,8-dione	276	C <sub>17</sub> H <sub>24</sub> O <sub>3</sub>	Oxaspiro compound	Antimicrobial
24	17.406	Pentadecanoic acid	242	C <sub>15</sub> H <sub>30</sub> O <sub>2</sub>	Saturated fatty acid	Lubricant, Adhesive agents
25	18.333	Heptadecanoic acid	270	C <sub>17</sub> H <sub>34</sub> O <sub>2</sub>	Margaric acid	Antimicrobial
26	18.744	Tetracontane	562	C <sub>40</sub> H <sub>82</sub>	Alkane	Anti-inflammatory
27	19.287	Octadecanoic acid	284	C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	Stearic acid	Antifungal, antitumor, antibacterial
28	19.470	2,6,10,15,19,23-hexamethyl tetracosane	332	C <sub>30</sub> H <sub>62</sub>	Squalane	Antibacterial, antioxidant, antitumor, anticancer, immunostimulant
29	20.616	n-nonadecanol-1	284	C <sub>19</sub> H <sub>40</sub> O	Fatty alcohol	Antimicrobial, cytotoxic
30	21.517	Eicosanoic acid	312	C <sub>20</sub> H <sub>40</sub> O <sub>2</sub>	Arachidic acid	Anticancer, anti-inflammatory
31	23.202	1-heptacosanol	396	C <sub>27</sub> H <sub>56</sub> O	Fatty alcohol	Nematicidal, anticancer, antioxidant, antimicrobial
32	23.490	Hexadecanoic acid, 2-hydroxy-1-(hydroxyl methyl) ethyl ester	330	C <sub>19</sub> H <sub>38</sub> O <sub>4</sub>	Palmitoyl glycerol	Antioxidant
33	23.869	1,2-benzene dicarboxylic acid	390	C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	Phthalic acid	Antioxidant, antimicrobial, antifouling
34	25.300	Pentatriacontane	492	C <sub>35</sub> H <sub>72</sub>	Alkane	Antibacterial, antiviral
35	25.631	Octadecanoic acid, 2,3-dihydroxy propyl ester	358	C <sub>21</sub> H <sub>42</sub> O <sub>4</sub>	1-glyceryl stearate	Anticancer, antimicrobial
36	33.042	Docosyl trifluoroacetate	422	C <sub>24</sub> H <sub>45</sub> F <sub>3</sub> O <sub>2</sub>	Fatty acid ester	Anti-inflammatory, antiatherosclerotic
37	34.072	Cholest-22-ene-21-ol, 3,5-dehydro-6-methoxy-, pivalate	498	C <sub>33</sub> H <sub>54</sub> O <sub>3</sub>	Steroid	Antimicrobial, anti-inflammatory, antiarthritic, antiuretic, antiasthmatic
38	35.588	Ergost-5-en-3-ol, (3.β.,24r)-	400	C <sub>28</sub> H <sub>48</sub> O	Campesterol	Liver disease, jaundice, arteriosclerosis
39	36.531	Stigmasta-5,22-dien-3-ol	412	C <sub>29</sub> H <sub>48</sub> O	Stigmasterol	Synthetic progesterone
40	38.391	Stigmast-5-en-3-ol, (3.β.)-	414	C <sub>29</sub> H <sub>50</sub> O	β-sitosterol	Anti-inflammatory, antipyretic, anti-ulcer, antiarthritic
41	41.285	Lupeol	426	C <sub>30</sub> H <sub>50</sub> O	Triterpenoids	Anti-inflammatory, anticancer, antiprotozoal, chemopreventive
42	41.875	Stigmasta-3,5-dien-7-one	410	C <sub>29</sub> H <sub>46</sub> O	β-saccharostenone	Free radical scavenging, antidiabetic, anticancer
43	43.551	Stigmast-4-en-3-one	412	C <sub>29</sub> H <sub>48</sub> O	3-keto-steroid	Hepatoprotective, antimicrobial, anti-inflammatory, anticancer

RT: Reaction time

Phytosterols are cholesterol-like molecules found in plants; the most common phytosterols are stigmasterol, β-sitosterol, and campesterol [7]. They have been clinically proved to reduce blood cholesterol and scientific reports suggest that they possess anticancerous and antioxidant activity [8,9]. Stigmast-5-en-3β-ol (β-sitosterol), a phytosterol shows anti-inflammatory, antipyretic, antiarthritic, anti-ulcer, insulin-releasing, and estrogenic effects. β-sitosterol is used for its cholesterol-lowering property [10]. Tetradecane shows antifungal, antibacterial, and nematicidal activity [11]. Octadecanoic acid (stearic acid) shows hypocholesterolemic property and is used in cosmetics, flavor, lubricant, perfumery, and suppository [12]. Stearic acid shows antifungal, antitumor, and antibacterial activity [13,14]. The demand for pharmaceuticals and nutraceuticals is growing quickly worldwide, and globally attracting consumers [15].

26 phytochemicals in methanolic extract (Table 1), 32 in ethyl acetate extract (Table 2), and 43 in hexane extract (Table 3) were identified with various biological activities. Stigmasta-5, 22-dien-3-ol, octadecanoic acid, ergost-5-en-ol, (3.β., 24r)-, stigmast-5-en-3-ol, (3.β.)-, and tetradecane are common compounds. Mass spectrum of these phytochemicals is shown in Figs. 4-8.

Stigmasta-5, 22-dien-3-ol is present in maximum amount (12.68%), followed by pentadecanoic acid (11.35%), stigmast-5-en-3-ol, (3.β.)- (8.50%), ergost-5-en-3-ol, (3.β.,24r)- (7.08%), and octadec-9-enoic acid (4.55%) in methanolic extract. 1,2,3-propanetriol, 1-acetate is present in maximum amount (13.15%), followed by stigmasta-5,22-dien-3-ol (6.45%), hexadecanoic acid (5.54%), ergost-5-en-3-ol, (3.β.,24r)- (4.43%), and tetracontane (3.73%) in ethyl acetate

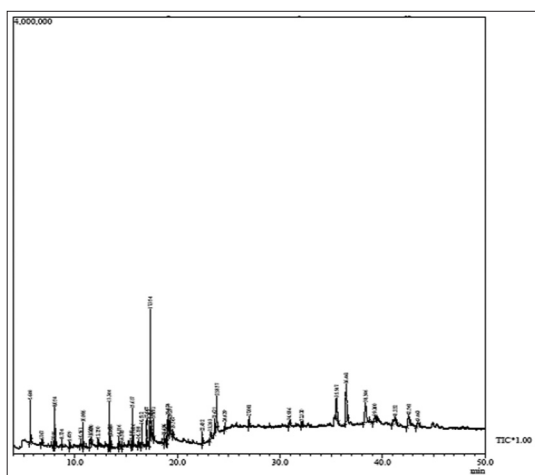


Fig. 1: Gas chromatography-mass spectroscopy chromatogram of the methanol extract of root of *Cenchrus ciliaris* L.

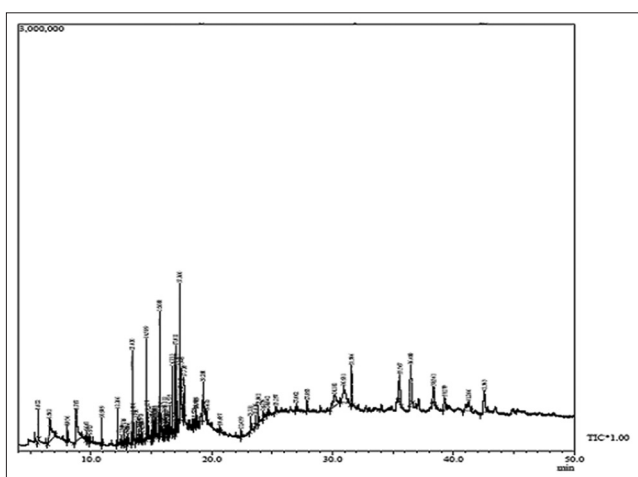


Fig. 2: Gas chromatography-mass spectroscopy chromatogram of the ethyl acetate extract of root of *Cenchrus ciliaris* L.

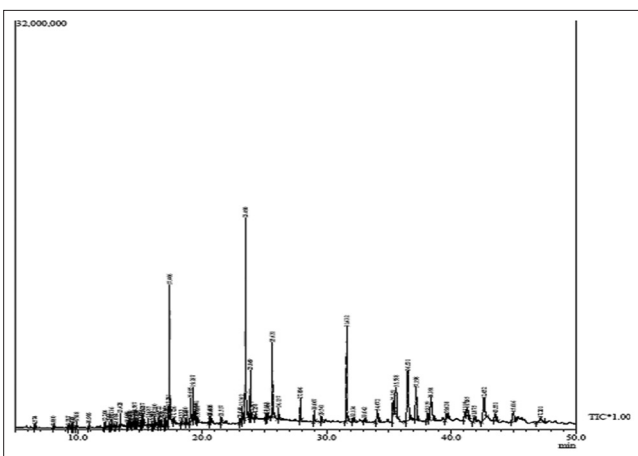


Fig. 3: Gas chromatography-mass spectroscopy chromatogram of the hexane extract of root of *Cenchrus ciliaris* L.

extract. Tetracontane is present in maximum amount (16.70%), followed by hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl) ethyl ester (14.96%), stigmasta-5,22-dien-3-ol (9.34%), pentadecanoic acid (7.84%), and octadecanoic acid, 2,3-dihydroxypropyl ester (6.56%) in hexane extract of *C. ciliaris*.

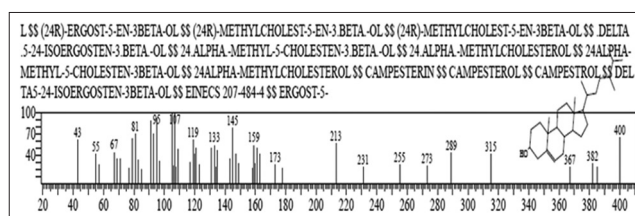


Fig. 4: Mass spectrum of ergost-5-en-3-ol, (3.beta., 24r)-

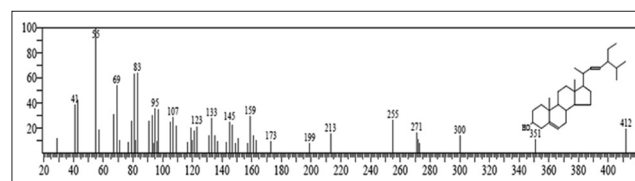


Fig. 5: Mass spectrum of stigmasta-5,22-dien-3-ol

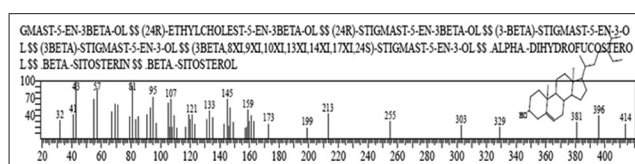


Fig. 6: Mass spectrum of stigmast-5-en-3-ol, (3.beta.)-

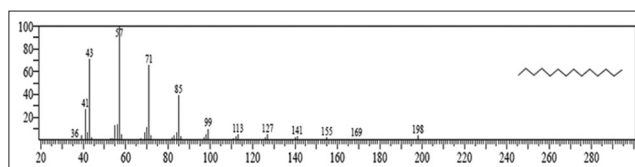


Fig. 7: Mass spectrum of tetradecane

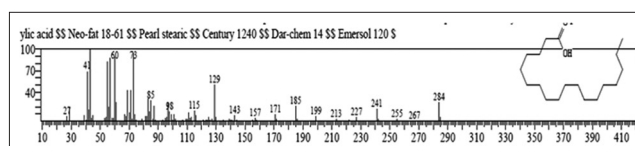


Fig. 8: Mass spectrum of octadecanoic acid

## CONCLUSION

GC-MS study has exploited the potential of *C. ciliaris*. This plant can be a good source of phytoconstituents such as alkane, carboxylic acid, phytosterol, aldehyde, ketone, fatty acid ester, fatty alcohol, and terpenes. Ergost-5-en-3-ol, (3.beta., 24r)- (campesterol) and stigmasta-5, 22-dien-3-ol (stigmasterol).

We are first to analyze these compounds from this forage plant using hexane like solvents of high polarity. This study suggests that solvents varying in polarity can extract various amounts of phytochemicals. Root extracts in hexane eluted highest number of compounds as compared to methanol and ethyl acetate extracts. The analysis suggests that solvent-linked polarity and extraction potentiality are the best tool for extraction of bioactive compounds. Ethico-legal issues require further discussions and considerations before practical use.

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