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Research Article

# 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 "Dhaman 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 involucres 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 phytocomponents

Identification of phytocomponents 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 | $C_8H_{16}O_2$ | Carboxylic acid | Plasticizer, lubricants |
| 2 | 7.944 | 1-undecanol | 172 | $C_{11}H_{24}O$ | Fatty alcohol | Bactericidal |
| 3 | 8.056 | Naphthalene | 128 | $C_{10}H_{28}$ | Polycyclic aromatic hydrocarbon | Antiseptic, carcinogenic |
| 4 | 9.479 | 2-undecanone | 170 | $C_{11}H_{22}O$ | Ketone | Natural non-toxic insect repellent |
| 5 | 10.806 | 1-tetradecene | 196 | $C_{14}H_{28}$ | Olefins | Antituberculosis |
| 6 | 12.250 | Naphthalene, 2-bromo- | 207 | $C_{10}H_7Br$ | Aryl bromide | Dye preparation |
| 7 | 13.344 | 9-eicosene, (E)- | 280 | $C_{20}H_{40}$ | Alkene | Antimicrobial, cytotoxic property |
| 8 | 13.495 | 1,2-benzene dicarboxylic acid, diethyl ester | 222 | $C_{12}H_{14}O_4$ | Diethyl phthalate | Cosmetics, insecticides, plasticizer |
| 9 | 14.316 | 8-pentadecanone | 226 | $C_{15}H_{30}O$ | Ketone | Hepatotoxic, demyelination, conjunctivitis |
| 10 | 14.585 | Heptadecane, 2,6,10,15-tetramethyl- | 296 | $C_{21}H_{44}$ | Alkane | Sex hormone in algae |
| 11 | 15.617 | n-heptadecanol-1 | 256 | $C_{17}H_{36}O$ | Fatty alcohol | Antiarthritis, skin diseases |
| 12 | 15.686 | Tetradecane | 198 | $C_{14}H_30$ | Alkane | Antifungal, antibacterial, nematicidal |
| 13 | 16.198 | 2-pentadecanone, 6,10,14-trimethyl- | 268 | $C_{18}H_{36}O$ | Sesquiterpenoids | Allelopathic activity, antibacterial |
| 14 | 17.007 | Octadecanoic acid, methyl ester | 298 | $C_{19}H_{38}O_2$ | Fatty acid methyl ester | Antifungal, antibacterial, antimicrobial, emulsifier, perfumery industry |
| 15 | 17.267 | Cis-13-octadecenoic acid | 282 | $C_{18}H_34O_2$ | Elaidic acid | Therapeutic uses in medicine, surgery |
| 16 | 17.354 | Pentadecanoic acid | 242 | $C_{15}H_{30}O_2$ | Palmitic acid | Lubricants, adhesive agents |
| 17 | 19.567 | n-nonadecanol-1 | 284 | $C_{19}H_{40}O$ | Fatty alcohol | Antimicrobial, cytotoxic |
| 18 | 19.074 | Octadec-9-enoic acid | 282 | $C_{18}H_{34}O_2$ | Oleic acid | Antihypertensive increases HDL and decrease LDL |
| 19 | 19.271 | Octadecanoic acid | 284 | $C_{18}H_{36}O_2$ | Stearic acid | Antifungal, antitumor, antibacterial |
| 20 | 22.432 | Octadecanal | 268 | $C_{18}H_{38}O$ | Fatty aldehyde | Sex pheromone |
| 21 | 24.639 | 2-Hexadecyl oxirane | 268 | $C_{18}H_{36}O$ | Epoxide | Antibacterial, antimicrobial, antioxidant, antipyretic, anti-inflammatory, analgesic |
| 22 | 30.936 | γ-tocopherol | 416 | $C_{28}H_{48}O_2$ | Vitamin E compound | Antioxidant, cardioprotective, anticancer, anti-inflammatory |
| 23 | 35.547 | Ergost-5-en-3-ol, (3.beta.,24r)- | 400 | $C_{28}H_{48}O$ | Campesterol | Liver disease, jaundice, arthrosclerosis |
| 24 | 36.461 | Stigmasta-5,22-dien-3-ol | 412 | $C_{29}H_{48}O$ | Stigmasterol | Synthetic progesterone |
| 25 | 38.346 | Stigmast-5-en-3-ol, (3.beta.)- | 414 | $C_{29}H_{50}O$ | β-sitosterol | Anti-inflammatory, antipyretic, anti-ulcer, antiarthritic |
| 26 | 43.463 | Androst-4-en-3-one, 17-hydroxy-, (17.beta.)- | 288 | $C_{19}H_{28}O_2$ | 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 | $C_5H_{10}O_4$ | Monoacetin | Antiadipogenic |
| 2 | 8.056 | Naphthalene | 128 | $C_{10}H_8$ | Polycyclic aromatic hydrocarbon | Antiseptic, carcinogenic |
| 3 | 10.909 | Tetradecane | 198 | $C_{14}H_{30}$ | Alkane | Antismicrobial, |
| 4 | 12.206 | Pentadecane | 212 | $C_{15}H_{32}$ | Alkane | Suger-phosphatase inhibitor, chymosin inhibitor, antibacterial |
| 5 | 12.546 | 1-tridecanol | 200 | $C_{13}H_{28}O$ | Fatty alcohol | Natural mosquito control agent |
| 6 | 13.430 | Hexadecane | 226 | $C_{16}H_{34}$ | Alkane | Antifungal, antibacterial, antioxidant |
| 7 | 13.498 | 1,2-benzene dicarboxylic acid, diethyl ester | 222 | $C_{12}H_{14}O_4$ | Diethyl phthalate | Cosmetics, insecticides, plasticizer |
| 8 | 14.173 | 2-methyl tetracosane | 352 | $C_{25}H_{52}$ | Alkane | Free radical scavenger |
| 9 | 14.264 | Heptadecane, 2,6,10,15-tetramethyl- | 296 | $C_{21}H_{44}$ | Alkane | Sex hormone in algae |
| 10 | 14.589 | Heptadecane | 240 | $C_{17}H_{36}$ | Alkane | Antioxidant |
| 11 | 14.657 | Pentadecane, 2,6,10,14-tetramethyl- | 268 | $C_{19}H_{40}$ | Alkane | Pathogenesis of rheumatoid arthritis and lupus |
| 12 | 15.224 | Eicosane | 282 | $C_{20}H_{42}$ | Alkane | Antifungal, antitumor, antibacterial, larvicidal, antimicrobial, cytotoxic |
| 13 | 15.291 | Tricosane | 324 | $C_{23}H_{48}$ | Alkane | Antibacterial |
| 14 | 15.383 | Heptadecane, 3-methyl- | 254 | $C_{18}H_{38}$ | 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 | $C_{17}H_{34}O_2$ | Ester of isopropanol and myristic acid | Skin care lotion, emollient |
| 16 | 16.132 | 2-hexadecen-1-ol, 3,7,11,15-tetramethyl-, [R-[R*R*,-(E)]] | 296 | $C_{20}H_{40}O$ | Phytol | Antimicrobial, sedatives, and Anesthetics |
| 17 | 16.525 | 1,2-benzene dicarboxylic acid, BIS (2-methyl propyl) ester | 278 | $C_{16}H_{22}O_4$ | Isobutyl phthalate | Antimicrobial, antifouling |
| 18 | 16.733 | Nonadecane | 268 | $C_{19}H_{40}$ | Alkane | Antimicrobial, cytotoxic |
| 19 | 17.011 | Hexadecanoic acid, methyl ester | 270 | $C_{17}H_{34}O$ | Fatty acid methyl ester | Antioxidant, nematicide, 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 | $C_{17}H_{24}O_3$ | Oxaspiro compound | Antimicrobial |
| 21 | 17.360 | Hexadecanoic acid | 256 | $C_{16}H_{32}O_2$ | Palmitic acid | Antitumor |
| 22 | 17.443 | Octadecanoic acid | 284 | $C_{18}H_{36}O_2$ | Stearic acid | Antifungal, antitumor, antibacterial |
| 23 | 17.485 | Dibutyl phthalate | 278 | $C_{16}H_{22}O_4$ | Phthalic acid dibutyl ester | Antifungal, antimicrobial, antimalarial, plasticizer, ectoparaciticide |
| 24 | 18.570 | n-pentadecanol | 228 | $C_{15}H_{32}O$ | Fatty alcohol | Antioxidant, antimicrobial |
| 25 | 22.439 | Octadecanal | 268 | $C_{18}H_{36}O$ | Fatty aldehyde | Sex pheromone |
| 26 | 25.297 | Tetratetracontane | 618 | $C_{44}H_{90}$ | Alkane | Hypoglycemic, antioxidant |
| 27 | 27.002 | Squalene | 410 | $C_{30}H_{50}$ | Triterpene | Antibacterial, antioxidant, antitumor, cancer preventive, immunostimulant, pesticide |
| 28 | 27.893 | Heptadecane, 8-methyl- | 254 | $C_{18}H_{38}$ | Alkane | Anticancer |
| 29 | 31.586 | Tetracontane | 562 | $C_{40}H_{82}$ | Alkane | Anti-inflammatory, analgesic activity |
| 30 | 35.567 | Ergost-5-en-3-ol, (3.beta.,24r)- | 400 | $C_{28}H_{48}O$ | Campesterol | Liver disease, jaundice, artherosclerosis |
| 31 | 36.480 | Stigmasta-5,22-dien-3-ol | 412 | $C_{29}H_{48}O$ | Stigmasterol | Synthetic progesterone |
| 32 | 38.361 | Stigmast-5-en-3-ol, (3.beta.)- | 414 | $C_{29}H_{50}O$ | 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 | $C_{13}H_{28}$ | Alkane | Fragrance agent |
| 2 | 9.643 | 2-isopropyl-5-methyl-1-heptanol | 172 | $C_{11}H_{24}O$ | Alcoholic compound | Antimicrobial |
| 3 | 9.908 | Octadecane | 254 | $C_{18}H_{38}$ | Alkane | Lubricants, anticorrosion agents |
| 4 | 10.906 | Tetradecane | 198 | $C_{14}H_{30}$ | Alkane | Antifungal, antibacterial |
| 5 | 12.204 | Pentadecane | 212 | $C_{15}H_{32}$ | Alkane | Suger-phosphatase inhibitor, chymosin inhibitor, antibacterial |
| 6 | 12.736 | Eicosane | 282 | $C_{20}H_{42}$ | Alkane | Antifungal, antitumor, antibacterial, larvicidal, cytotoxic, antimicrobial |
| 7 | 13.428 | Hexadecane | 226 | $C_{16}H_{34}$ | Alkane | Antifungal, antibacterial, antioxidant |
| 8 | 14.107 | Pyrrolidine | 71 | $C_4H_9N$ | Cyclic secondary amine | Antimicrobial, antitumor, anti-HIV-1, anticonvulsant |
| 9 | 14.170 | 2-methyl tetracosane | 352 | $C_{25}H_{52}$ | Alkane | Free radical scavenger |
| 10 | 14.379 | Heneicosane | 296 | $C_{21}H_{44}$ | Alkane | Oviposition-attractant pheromone |
| 11 | 14.587 | Heptadecane | 240 | $C_{17}H_{36}$ | Alkane | Antioxidant |
| 12 | 14.656 | Pentadecane, 2,6,10,14-tetramethyl- | 268 | $C_{19}H_{40}$ | Pristane | Pathogenesis of rheumatoid arthritis and lupus |
| 13 | 14.737 | Tricosane | 324 | $C_{23}H_{48}$ | Alkane | Antibacterial |
| 14 | 14.795 | Pentadecanal | 226 | $C_{15}H_{30}O$ | Fatty aldehyde | Nutrient stabilizers, surfactants, and emulsifier |
| 15 | 15.073 | 1-dodecanol, 2-octyl- | 298 | $C_{20}H_{42}O$ | Branched alcohol | Emollients, perfuming agents, cosmetics |
| 16 | 15.217 | Hexadecane, 2,6,10,14-tetramethyl- | 282 | $C_{20}H_{42}$ | 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 | $C_{14}H_{28}O_2$ | Myristic acid | Antioxidant, anticancer, hypocholesterolemic |
| 18 | 15.685 | Nonadecane | 268 | $C_{19}H_{40}$ | Alkane | Antimicrobial, cytotoxic |
| 19 | 15.958 | Isopropyl myristate | 270 | $C_{17}H_{34}O_2$ | Ester of fatty acid alcohol | Skin care lotion, emollient |
| 20 | 16.200 | 2-penta decanone, 6,10,14-trimethyl- | 268 | $C_{18}H_{36}O$ | Sesqui-terpenoids | Allelopathic activity |
| 21 | 16.522 | 1,2-benzenedicarboxylic acid, BIS (2-methylpropyl) Ester | 278 | $C_{16}H_{22}O_4$ | Isobutyl phthalate | Antimicrobial, antifouling |
| 22 | 16.671 | Tetratetracontane | 618 | $C_{44}H_9O$ | Alkane | Hypoglycemic, antioxidant |
| 23 | 17.105 | 7,9-di-tert-butyl-1-oxaspiro (4,5) deca-6,9-diene-2,8-dione | 276 | $C_{17}H_{24}O_3$ | Oxaspiro compound | Antimicrobial |
| 24 | 17.406 | Pentadecanoic acid | 242 | $C_{15}H_{30}O_2$ | Saturated fatty acid | Lubricant, Adhesive agents |
| 25 | 18.333 | Heptadecanoic acid | 270 | $C_{17}H_{34}O_2$ | Margaric acid | Antimicrobial |
| 26 | 18.744 | Tetracontane | 562 | $C_{40}H_{82}$ | Alkane | Anti-inflammatory |
| 27 | 19.287 | Octadecanoic acid | 284 | $C_{18}H_{36}O_2$ | Stearic acid | Antifungal, antitumor, antibacterial |
| 28 | 19.470 | 2,6,10,15,19,23-hexamethyl tetracosane | 332 | $C_{30}H_{62}$ | Squalane | Antibacterial, antioxidant, antitumor, anticancer, immunostimulant |
| 29 | 20.616 | n-nonadecanol-1 | 284 | $C_{19}H_{40}O$ | Fatty alcohol | Antimicrobial, cytotoxic |
| 30 | 21.517 | Eicosanoic acid | 312 | $C_{20}H_{40}O_2$ | Arachidic acid | Anticancer, anti-inflammatory |
| 31 | 23.202 | 1-heptacosanol | 396 | $C_{27}H_{56}O$ | Fatty alcohol | Nematicidal, anticancer, antioxidant, antimicrobial |
| 32 | 23.490 | Hexadecanoic acid, 2-hydroxy-1-(hydroxyl methyl) ethyl ester | 330 | $C_{19}H_{38}O_4$ | Palmitoyl glycerol | Antioxidant |
| 33 | 23.869 | 1,2-benzene dicarboxylic acid | 390 | $C_8H_6O_4$ | Phthalic acid | Antioxidant, antimicrobial, antifouling |
| 34 | 25.300 | Pentatriacontane | 492 | $C_{35}H_{72}$ | Alkane | Antibacterial, antiviral |
| 35 | 25.631 | Octadecanoic acid, 2,3-dihydroxy propyl ester | 358 | $C_{21}H_{42}O_4$ | 1-glyceryl stearate | Anticancer, antimicrobial |
| 36 | 33.042 | Docosyl trifluoroacetate | 422 | $C_{24}H_{45}F_3O_2$ | Fatty acid ester | Anti-inflammatory, antiatherosclerotic |
| 37 | 34.072 | Cholest-22-ene-21-ol, 3,5-dehydro-6-methoxy-, pivalate | 498 | $C_{33}H_{54}O_3$ | Steroid | Antimicrobial, anti-inflammatory, antiarthritic, antiuretic, antiasthmatic |
| 38 | 35.588 | Ergost-5-en-3-ol, (3.beta.,24r)- | 400 | $C_{28}H_{48}O$ | Campesterol | Liver disease, jaundice, artherosclerosis |
| 39 | 36.531 | Stigmasta-5,22-dien-3-ol | 412 | $C_{29}H_{48}O$ | Stigmasterol | Synthetic progesterone |
| 40 | 38.391 | Stigmast-5-en-3-ol, (3.beta.)- | 414 | $C_{29}H_{50}O$ | β-sitosterol | Anti-inflammatory, antipyretic, anti-ulcer, antiarthritic |
| 41 | 41.285 | Lupeol | 426 | $C_{30}H_{50}O$ | Triterpenoids | Anti-inflammatory, anticancer, antiprotozoal, chemopreventive |
| 42 | 41.875 | Stigmasta-3,5-dien-7-one | 410 | $C_{29}H_{46}O$ | β-saccharostenone | Free radical scavenging, antidiabetic, anticancer |
| 43 | 43.551 | Stigmast-4-en-3-one | 412 | $C_{29}H_{48}O$ | 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.beta., 24r)-, stigmast-5-en-3-ol, (3.beta.)-, and tetradecane are common compounds. Mass spectrum of these phytocompounds 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.beta.)- (8.50%), ergost-5-en-3-ol, (3.beta.,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.beta.,24r)- (4.43%), and tetracontane (3.73%) in ethyl acetate

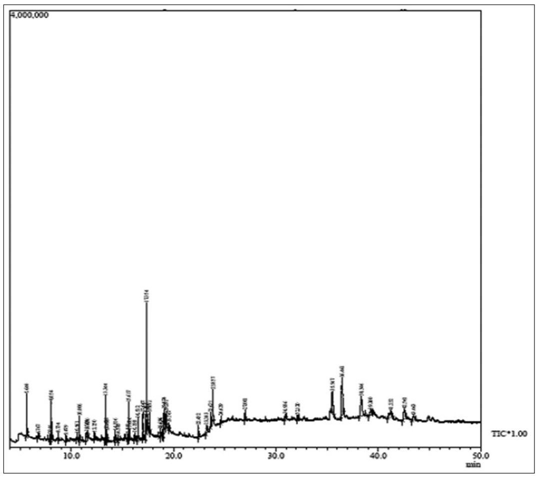

**Fig. 1: Gas chromatography-mass spectroscopy chromatogram of the methanol extract of root of *Cenchrus ciliaris* L.**

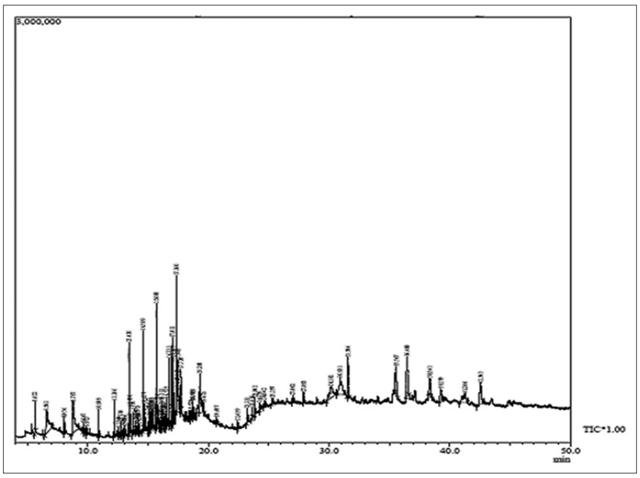

**Fig.2: Gas chromatography-mass spectroscopy chromatogram of the ethyl acetate extract of root of *Cenchrus ciliaris* L.**

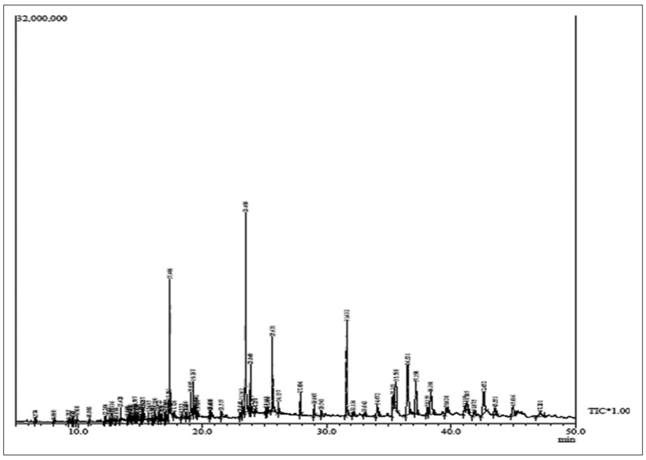

**Fig. 3: Gas chromatography-mass spectroscopy chromatogram of the hexane extract of root of *Cenchrus ciliaris* L.**

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*.

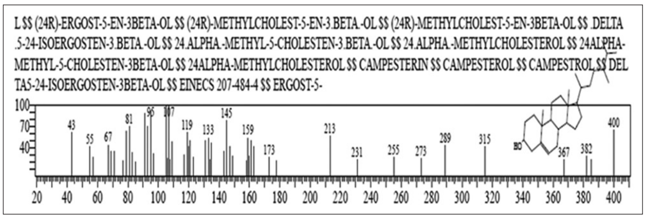


**Fig. 4: Mass spectrum of ergost-5-en-3-ol, (3.beta., 24r)-**

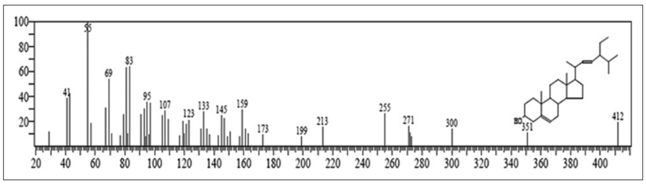

**Fig. 5: Mass spectrum of stigmasta-5,22-dien-3-ol**

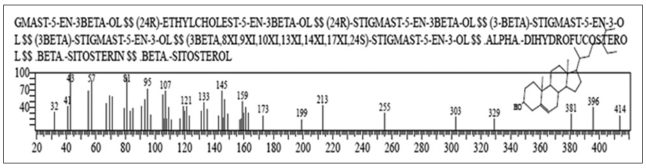


**Fig. 6: Mass spectrum of stigmast-5-en-3-ol, (3.beta.)-**

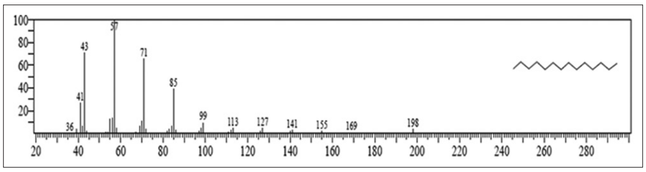

**Fig. 7: Mass spectrum of tetradecane**

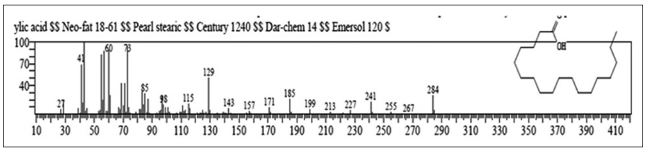


**Fig. 8: Mass spectrum of octadecanoic acid**

## 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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