A Wonder plant Vetiveria zizanioides (L.) Nash A Review

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***Abstract*—In Indian medicine, Vetiveria zizanioides (L.) Nash is believed to be the root of Ushir, used to treat fever, dysuria, tiredness syndrome, wound healing, and skin ailments. This will be beneficial to this medicinal plant in the manufacture of several Ayurvedic formulations such as Ushir sava, Yogarajaguggulu, and Sadanga Kvatha Churna. The current study aims to identify the pharmacognostic and phytochemical profiles of Vetiveria zizanioides (L.) Nash root. This study investigates macroscopy, microscopy, preliminary phytochemical analysis, physicochemical assessments, and HPTLC chromatography profiling. The existence of numerous secondary metabolites was established using phytochemical screening and HPTLC profiling. The vetiver oil was extracted by hydrodistillation and its chemical structure was analysed using GC-MS. Oil GC-MS analysis detected a total of sixty-three chemicals. The main chemicals included khusimol, isovalencenol, 2-isopropyl-5-methyl-9-methylene-bicyclo-1-decene (4.4.0), α-vetivol, beta-maalene, vetiselinenol, γ-selinenes, zizanol, khusimol, and β-vatirenes.**

***Index Terms*—Vetiveria zizanioides (L.) Nash, Ushir, HPTLC, GC-MS**

I. INTRODUCTION

In India, Ushir (Vetiveria zizanioides (Linn.) Nash), also known as Andropogon muricatus Retz/Chrysopogon zizanioides), is a member of the Poaceae family and is also referred to as Khas or Khas grass. This perennial grass has thick, fibrous, scented, and highly prized adventitious roots. The word "Viran" has been used for "Ushir" in the Kaushik Sutra and is used to describe a wide range of illnesses. Charaka uses Amrinala as a synonym for Ushir in a single instance among the Brihattrayi. According to Bhava Mishra, Ushir is the root of a plant known as Virana. He has given Ushir (the root) and Virana (the plant) distinct qualities.

India has been familiar with vetiver since ancient times. This well-known South Indian plant is found throughout India, Bangladesh, Burma, Ceylon, and Southwest Asia, as well as tropical Africa. The plant is currently grown in the South Indian states of Kerala and Tamil Nadu as well as the North Indian states of Rajasthan, Uttar Pradesh, and Punjab. The vetiver grass grows in bunches and is sociable. With long, thin, and stiff leaves, this densely tufted grass can reach a height of 1.5 meters.[1] It can be found all throughout India's plains and lower hills, but especially along riverbanks and in fertile marshy soil.

The plant differs from other types of grass in that it develops in big clusters from a branching, "spongy" rootstock with upright culms rather than mat-like root systems. It has been grown for the longest time because of its capacity to hold soil and stop erosion, as well as the fragrant oil that its roots generate.[2] Some cultivars and ecotypes include roots that contain essential oil, which has been used for centuries as a fragrant substance. Additionally, the plant includes active compounds that are utilized as botanical pesticides and in traditional medicine.

The plant's oil, which is used in perfumery and medicinal, is well recognized. In the summer, especially in northern India, roots are utilized to make

sharbat (sherbet) or soft drinks. In addition, Khas Khas is used to make mats, hand fans, and other items, as well as to flavor sharbats and cool down. Additionally, the antioxidant property was reported. The roots have diaphoretic, stomachic, immunogogue, febrifuge, and refrigerant properties.[3]

II. PHYTOCHEMISTRY

Chemical constituents present in the plant are Vetiverol, Vetivone, ß-vetivone, Khusimone, Khusimol, Vetivene, Khositone, Terpenes, Benzoic acid, Tripene-4-ol, ß-Humulene, Epizizianal, vetivenyl vetivenate, vetivazulene, Levojunenol, Vanillin, Vetivenic acid, Zizaene, Zizanol.Vetiver oil sample from Argentina (yield, 1.5%) Contained α and β –Vetivones, vetivenol and vetivenyl Vetevenate as the major constituents.

The chemical components of the oil obtained from the plant is benzoic acid, furfurol, vetivene, vetivenyl vetivenate, Terpinen-4-ol, 5-epiprezizane, Khusimene, a-muurolene, Khusimone, Calacorene, ß-humulene, a-longipinene, d-Selinene, d-cadinene, valencene, Calarene,-gurjunene, a-Amorphene, Epizizanal, 3-epizizanol, Khusimol, Iso- Khusimol, Valerenol, ß-vetivone, a-vetivone, vetivazulene.[4]

III. MACROSCOPY

Fibrous, wiry, long, slender, and frequently connected with robust root stock, the roots can reach a diameter of 2 mm. They have a smooth or longitudinally grooved surface, are creamish yellow-light brown in color, have a strong, aromatic smell, and taste slightly bitter.[5]

Fig No.1: Fibrous roots with its stocks

IV. MICROSCOPY

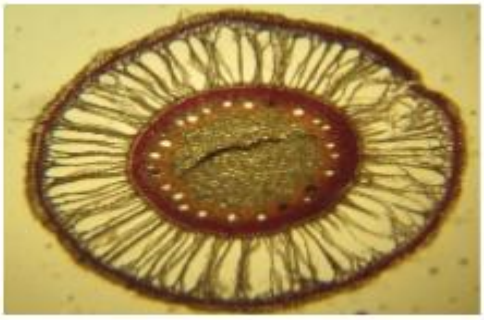

Fig No.2: Schematic arrangement

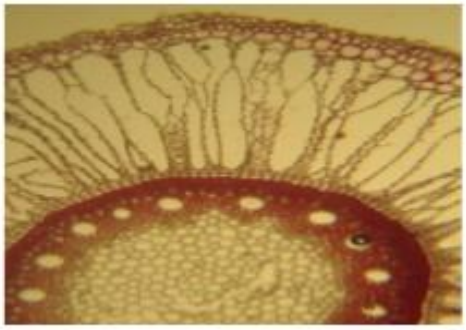

Fig No.3: Transverse section

The root's detailed TS reveals that the outermost oval to rectangular cells of epiblema, which occasionally have unicellular root hairs, are surrounded by two to three layers of circular to polygonal, lignified, thick-walled exodermis. Below this is a wide cortex that is divided into two regions: the innermost region is made up of radially elongated, giant, lacunated cells, which frequently alternate with a fully or partially split column of spherical parenchyma, with its cells collapsed at places and yellowish brown globular contents scattered throughout the cortex region, below that, there is a clear layer of endodermis and pericycle; the pith, which is in the center, is composed of parenchyma cells with thick and thin walls, encircled by sclerieds and a polyarch vascular bundle; simple and compound starch grains are dispersed throughout the pith region.[5]

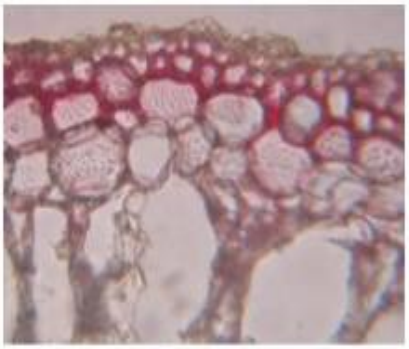

Fig. 4

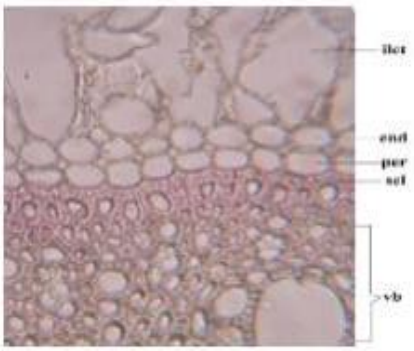

Fig. 5

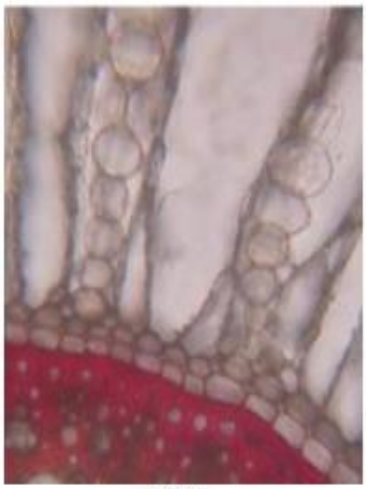

Fig.6

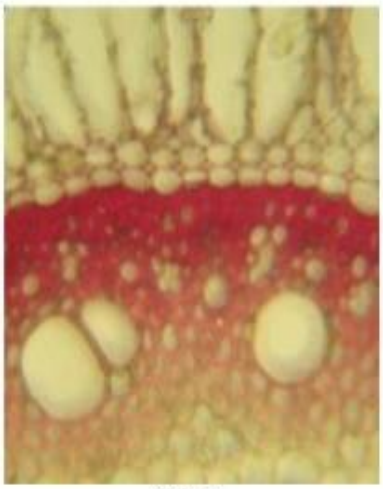

Fig. 7

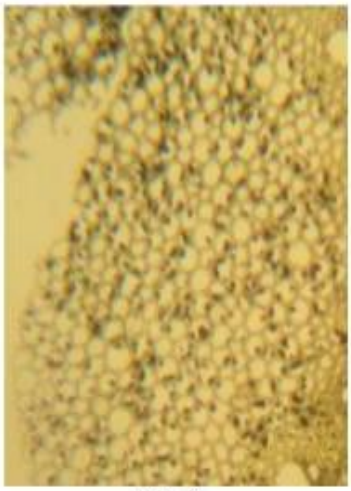

Fig. 8

Fig. 4 epiblema with inner and outer cortex.
Fig. 5 inner cortex, endodermis, pericycle end stelar region. ilct – inner lacunated cortex end – endodermis per – pericycle scl – sclereid vb – vascular bundle
Fig. 6 & 7enlarge view as shown in figure 2.
Fig. 8 parenchymatous pith embedded with starch grain.

V. POWDER

Fibrous, light to dark brown, highly fragrant, and mildly bitter. Two to four granules of starch grains scattered as such or embedded in parenchymatous cells, annular, pitted, and reticulately thickened vessels, fragments of root hair, thin to thick-walled fibers, sclereids of various sizes and shapes, parenchymatous cells with orange to dark brown globules, and a fragment of lignified exodermis are among the powder's diagnostic characteristics.[5]

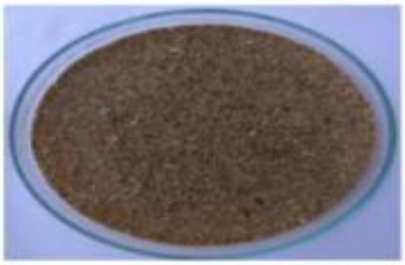

Fig No.9: Powder

Fig. 10

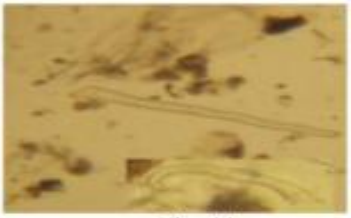

Fig. 11

Fig. 12

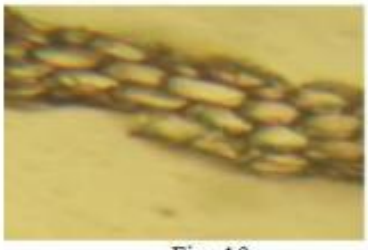

Fig. 13

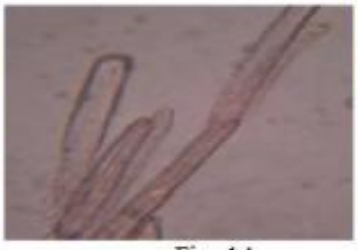

Fig. 14

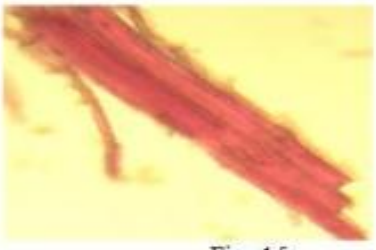

Fig. 15

Fig. 16

Fig. 17

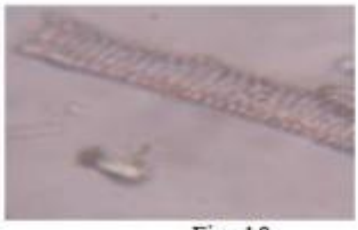

Fig. 18

Fig. 10 fragment of parenchymatous cells containing orange – dark brown globules.
Fig. 11 fragments of root hairs.
Fig. 12 parenchymatous cells containing starch grains.
Fig. 13 fragment of lignified exodermal cells.
Fig. 14 groups of sclereids of various sizes and shapes.
Fig. 15 fragment of groups of fibres.
Fig. 16, 17 & 18 vessels with pitted, annular and reticulated thickening.

VI. PHYSICO-CHEMICAL PARAMETERS

Physico-chemical study are presented in Table below.

Table No:1 Physico-chemical parameters

Sr.No.	Parameters	Result
1	Foreign matter	NIL
2	Loss on drying	1.09% w/w
3	Total ash	7.83% w/w
4	Acid-insoluble ash	3.43% w/w
5	Water soluble extractive	13.7% w/w
6	Alcohol soluble extractive	14.8% w/w
7	Volatile oil content	1.5% w/w

All the values obtained are within the prescribed limits of quality standards of Indian medicine.

VII. PHYTOCHEMICAL ANALYSIS

Table 2: Qualitative phytochemical analysis of Vettiver zizaninoides extracts

Test	Aqueous	Ethanol	Acetone	Chloroform
Saponins	+	+	-	+
Flavonoids	+	+	-	+
Steroids	+	+	-	+
Alkaloids	+	+	-	-
Carbohydrate	+	+	+	+
Protein	+	+	-	+
Glycosides	+	+	-	-

+: Presence - Absence

VIII. HPTLC

HPTLC fingerprinting of EVZ (Ethanolic Extract) and HVZ (Hydroalcoholic Extract)

In the stationary phase, EVZ and HVZ were dissolved in a 70:30 ethanol: water mixture in a 10X10 silica gel 60F 254 HPTLC plate. The mobile phase consisted of petroleum ether, ethyl acetate, toluene, and formic acid (5:5:1:1). The mobile phase was first saturated in the thin layer chromatography chamber for two hours at 25°C. The sample was placed 1 cm from the side and bottom of the silica gel 60F 254 HPTLC plate. Up to 8 cm of the plate was developed. After being taken out, the plate was allowed to dry at room temperature before being scanned at 254 and 366 nm.[6]

Table 3: HPTLC peak table of ethanolic extract of VZ

Sr. No.	Max position (Rf)	Max height (AU)	Area %	Assigned substance
1	0.09	16.9	0.59%	Unknown
2	0.12	23.0	0.97%	Unknown
3	0.19	39.7	2.98%	Gallic acid
4	0.26	22.8	1.03%	Unknown
5	0.29	53.0	3.95%	Unknown
6	0.37	42.5	3.23%	Unknown
7	0.43	25.8	6.86%	Unknown
8	0.49	54.4	0.28%	Unknown
9	0.53	91.2	0.07%	Unknown
10	0.64	41.3	4.51%	Unknown
11	0.71	11.7	0.57%	Unknown
12	0.81	5.2	6.20%	Unknown
13	0.83	36.1	7.84%	Unknown
14	0.88	26.9	0.91%	Unknown

HPTLC: High-performance thin layer chromatography, VZ: Vetiveria zizanioides

Table 4: HPTLC peak table of hydroalcoholic extract of VZ

Sr. No.	Max position (Rf)	Max height (AU)	Area %	Assigned substance
1	0.12	21.7	0.85%	Unknown
2	0.16	25.9	1.02%	Unknown
3	0.20	56.0	3.25%	Gallic acid
4	0.30	96.4	7.36%	Unknown
5	0.38	00.6	5.95%	Unknown
6	0.44	13.0	1.24%	Unknown
7	0.51	05.7	1.92%	Unknown
8	0.55	33.9	9.81%	Unknown
9	0.72	14.9	0.57%	Unknown
10	0.84	88.5	8.04%	Unknown

HPTLC: High-performance thin layer chromatography, VZ: Vetiveria zizanioides

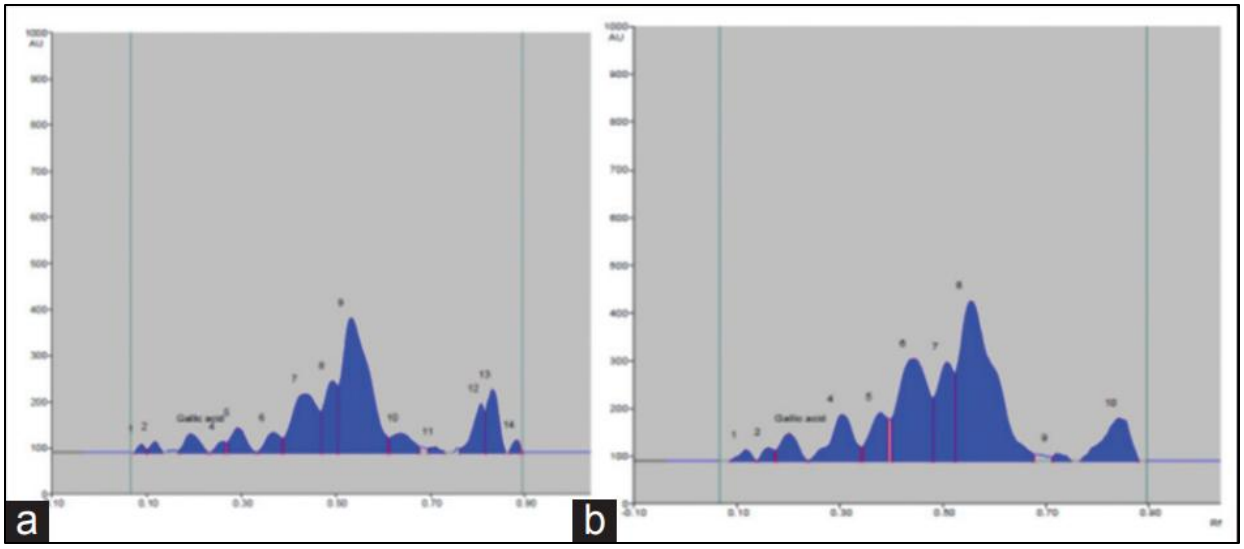

Fig. 19: High-performance thin layer chromatography profile of ethanolic (a) and hydroalcoholic extract of Vetiveria zizanioides (b)

HPTLC plate containing EVZ and HVZ was developed with same mobile phase. Five compounds with Rf value 0.09, 0.26, 0.64, 0.81, and 0.88 have been observed in EVZ sample and not in HVZ. Likewise, a compound with Rf value 0.16 has not been observed in EVZ. The chemical nature of those compounds should be further evaluated.

Gas chromatography mass spectroscopy (GC/MS)

GC/MS- MS analysis of vetiver essential oil was performed using an Agilent 7000 Series Triple Quad gas chromatograph linked to a mass spectrometer (GC/MSMS). An Elite 5MS (5% diphenyl/95% dimethylpolysiloxane) fused to a capillary column (30 x 0.25um ID x 0.25um df) is part of the gas chromatograph. An electron ionization device with ionization energy of 70ev was employed for GC-MS detection. Injector temperature: 250° C; ion source temperature: 200° C; carrier gas: helium gas (99.999%) with a fixed flow rate of 1 ml/min and injection volume of 2 ul (split ratio: 30:1).

A 2-minute isothermal at 110° C was followed by a 109° C/min climb to 2009° C, a 5° C/min increase to 2809° C, and a 9-min isothermal at 280° C. The GC run time was 36 minutes, and mass spectra were obtained at 70ev with a scan interval of 0.5 seconds with fragments ranging from 45 to 450Da. By comparing the average peak area to the total areas, the relative fraction of each component was determined. Turbo Mass was the program used to process the chromatograms and mass spectra. The National Institute of Standards and Technology database (NIST), which has over 62,000 samples, was used to assess GC/MS-MS mass spectra. In the NIST library, the spectrum of the unidentified components was kept. The components of the test materials were identified by name, molecular weight, and structure.[7]

Table no. 5: The percentages of peak areas of vetiver essential oil GC- MS analysis

Peak	Name of the compound	Molecular weight (g/mol)	Formula	Peak area (%)
1	Linalool	154.25	$C_{10}H_{18}O$	0.15
2	Trans-Rose oxide	154.2493	$C_{10}H_{18}O$	0.05
3	Menthone	154.25	$C_{10}H_{18}O$	0.04
4	Trans Menthone	154.2493	$C_{10}H_{18}O$	0.25
5	Citronellol	156.26	$C_{10}H_{20}O$	1.55
6	D-Carvone	150.22	$C_{10}H_{14}O$	0.14
7	Geraniol	154.25	$C_{10}H_{18}O$	0.47
8	Citronellyl formate	184.27	$C_{11}H_{20}O_2$	0.35

9	Geranyl formate	182.26	$C_{10}H_{18}O_2$	0.10
10	Zizanal	218.33	$C_{15}H_{22}O$	0.12
11	Beta- Bourbonene	204.35	$C_{15}H_{24}$	0.07
12	Acora-3(7),14-diene	204.3511	$C_{15}H_{24}$	0.29
13	Caryophyllene	204.35	$C_{15}H_{24}$	0.21
14	Daucene	204.35	$C_{15}H_{24}$	0.16
15	(+)-Epi-bicyclosesquiphellandrene	204.35	$C_{15}H_{24}$	0.24
16	Prezizaene	204.35	$C_{15}H_{24}$	0.68
17	Khusimene	204.3511	$C_{15}H_{24}$	0.89
18	Alpha-Gurjunene	204.35	$C_{15}H_{24}$	0.21
19	(1R,5R)-1-Isopropyl-8-methyl-4-methyl lenespiro [4.5] dec-7-ene	204.3511	$C_{15}H_{24}$	0.19
20	Selina-3,7(11)-diene	204.35	$C_{15}H_{24}$	0.06
21	α- Amorphene	204.3511	$C_{15}H_{24}$	1.36
22	Cis-Eudesma-6,11-diene	204.35	$C_{15}H_{24}$	0.17
23	Beta-Vetispirene	202.33	$C_{15}H_{24}$	0.74
24	Beta-Cadinene	204.35	$C_{15}H_{24}$	0.60
25	Gamma-Muurolene	204.35	$C_{15}H_{24}$	0.34
26	D-Cadinene	204.35	$C_{15}H_{24}$	0.89
27	Iso ledene	204.35	$C_{15}H_{24}$	0.95
28	Cadina-1(10),4-diene D-Amorphene	204.35	$C_{15}H_{24}$	0.20
29	11,12,13-tris-nor-trans-Eud esm-5-en-7-one	178.2707	$C_{12}H_{18}O$	0.33
30	Alpha-Calacorene	200.32	$C_{15}H_{20}$	0.23
31	B-Vatirenene	202.33	$C_{15}H_{20}$	2.06
32	4,5,9,10-dehydroisolongifolene	200.32	$C_{15}H_{20}$	0.14
33	4(1,3,3-Trimethyl-bicyclo [4.1.0]hept-2-yl)-but-3-en-2-one	206.324	$C_{14}H_{22}O$	0.09
34	γ- Vetivenene	202.3353	$C_{15}H_{22}$	0.80
35	Ylangene	204.35	$C_{15}H_{24}$	0.53
36	Beta-Maaliene	204.35	$C_{15}H_{24}$	3.95
37	13-nor-Eremophil-1(10)-en-11-one	206.32	$C_{14}H_{22}O$	0.18
38	Junenol	222.37	$C_{15}H_{26}O$	1.78
39	Γ-selinene	204.35	$C_{15}H_{24}$	2.98
40	Beta-Cadinene	204.35	$C_{15}H_{24}$	0.70
41	Valencene	204.35	$C_{15}H_{24}$	1.61
42	Beta-Guaiene	204.35	$C_{15}H_{24}$	0.62
43	2-Isopropyl-5-methyl-9-methylenebicylo-1-decene(4.4.0)	204.35	$C_{15}H_{24}$	4.11
44	Cyclocopacamphenol	220.35	$C_{15}H_{24}O$	1.41
45	Spiro[4.5]dec-8-en-7-ol,4,8-dimethyl-1-(1-methyl lethyl)	222.3663	$C_{15}H_{26}O$	0.96
46	Zizanol	220.35	$C_{15}H_{24}O$	2.54
47	Khusiol	222.37	$C_{15}H_{26}O$	2.53
48	Juniper camphor	222.37	$C_{15}H_{26}O$	0.75
49	Cycloheptane,4-methylene-1-	204.35	$C_{15}H_{24}$	0.60

	methyl-2-(2-methyl-1-prpoen-1-yl)-1-vinyl			
50	Delta-selinene	204.35	$C_{15}H_{24}$	0.60
51	Vetiselinenol	220.35	$C_{15}H_{24}O$	3.11
52	α- Isonootkatol	220.35	$C_{15}H_{24}O$	1.10
53	Khusimol	220.35	$C_{15}H_{24}O$	12.77
54	α- Vetivol	220.35	$C_{15}H_{24}O$	4.07
55	α- Costol	218.33	$C_{15}H_{22}O$	0.29
56	Valerenol	220.35	$C_{15}H_{24}O$	0.17
57	β- Vetivenene	202.33	$C_{15}H_{22}$	0.11
58	(E)- Eremophila-1(10),7(11)-dien-12-ol(Isovalencenol)	220.35	$C_{15}H_{24}O$	7.34
59	(Z)-Isovalencenal	218.33	$C_{15}H_{22}O$	0.33
60	β- Vetivone	218.33	$C_{15}H_{22}O$	1.87
61	(E)- Isovalencenal [eremophila-1(10),7(11)-di en-12-al	218.3346	$C_{15}H_{22}O$	1.67
62	α- vetivone	218.33	$C_{15}H_{22}O$	1.77

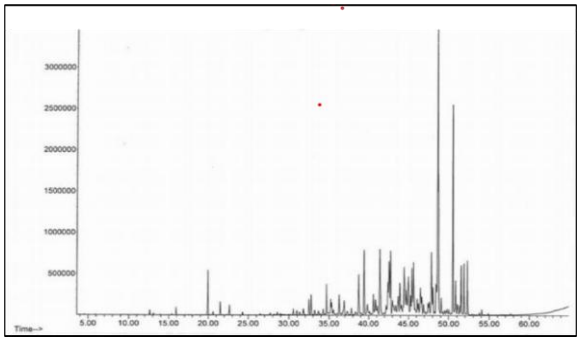

Fig no. 20: Chromatogram GC of vetiver essential oil.

GC- MS analysis provided qualitative and quantitative results, which are presented in Table 5. and Figure 20.

As a result of the analysis, a total of sixty-three compounds were identified. The major compounds were khusimol (12.77%), (E)-Eremophila1(10),7(11)-dien-12-ol (isovalencenol) (7.34%), 2-isopropyl-5-methyl-9-methylene-bicyclo-1-decene (4.4.0) (4.1%), α-vetivol (4.07%), beta-maalene (3.95%), vetiselinenol (3.11%), γ-selinenes (2.98%), zizanol (2.54%), khusiol (2.53%), β-vatirenes (2.06%).

IX. CONCLUSION

V.zizanoides improves all bodily systems, including digestion, respiratory, circulatory, excretory, endocrine, neurological, and neurotic. The therapeutic potential of Ushir, mentioned in ancient Ayurvedic texts, has been validated by modern experiments and clinical trials. Despite their recognised medicinal potential and ease of availability, the grass family has limited therapeutic use in modern Ayurveda. Vetiver should be used carefully in treatments to benefit those in need. Phytochemical screening of aqueous, methanolic, and ethanol extracts revealed the presence of alkaloids, flavonoids, saponin, protein, oils, and resins through positive reactions with appropriate reagents. The study analysed the pharmacognostical profile and HPTLC fingerprinting of dried Vetiveria zizanioides roots. Furthermore, GCMS analysis detected 63 chemicals in the essential oil of the plant's roots, indicating a distinct chemical profile.

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