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Unveiling the beauty of *Vetiveria zizanioides*: The amazing benefits of vetiver as neutraceutical

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Abstract
Vetiver (*Vetiveria zizanioides*) is gaining popularity in cosmetics due to its skin and hair benefits, as well as its fewer side effects compared to synthetic ingredients. This perennial grass has anti-inflammatory, antioxidant, antibacterial, and cooling properties, making it a staple in Ayurveda, Unani, and Siddha medicine. Vetiver oil, extracted via steam distillation, is rich in phytochemicals like khusimol and α-vetivone, offering revitalising and calming effects. Its benefits include reducing inflammation, promoting skin hydration, and fighting oxidative stress. Vetiver stimulates collagen synthesis, maintaining skin elasticity, and prevents acne due to its antibacterial properties. In hair care, it improves scalp health and reduces dandruff. Being drought-resistant and eco-friendly, vetiver aligns with the growing demand for sustainable cosmetics. Its versatility makes it an ideal natural ingredient for soothing and anti-ageing formulations, highlighting its potential in safe, natural cosmetic compositions.

Keywords: Vetiver oil, skin care, hair care

Introduction
The use of herbal remedies is becoming increasingly common these days. Because medicinal plants and herbs have fewer adverse effects than synthetic chemicals, researchers have concentrated on incorporating them into cosmetics over the past few decades. Herbs and plants serve as the foundation for Ayurveda, Unani, Siddha, and homoeopathy. Many plants have applications in cosmetics, according to Ayurveda, Unani, Siddha, and homoeopathy [1]. Approximately 500 plants have been utilised medicinally in ancient texts, and about 800 plants are employed in traditional medical systems. India possesses an extensive collection of medicinal plants that are employed in conventional medicine [2]. A new field of study called "Cosmetic Phytognosy," which examines the biochemical characteristics of plant-derived components used in herbal cosmetics, has been established to investigate the uses and effectiveness of organically derived ingredients for use in cosmetics [3].
Vetiveria zizanioides (L.) Nash syn. *Chrysopogon zizanioides* (L.) Roberty or Vetiver (Family Poaceae) is a fastgrowing perennial grass known as Abhaya, Amrinata, Bala, Lamaja, Lamajjaka, Reshira, Sugandhimulu, Usira, Ushira, Virana(in Sanskrit), Bala, Balah, Bena, Ganrar, Khas, Khas Khas, Khus Khus, Panni(in Hindi), Valo(in Gujarati), Ramaccham, Ramachehamver, Vettiveru(in Malayalam), Ayurugaddiveru, Kuruveeru, Lamajja Kamuveru, Vettiveellu, Vattiveeru, Vettiveerum, Vidavaliveru(in Telugu), Ilamichamver, Vattiver, Vettiver, Vettiveru, Vilhalver, Viranam, Virkal, Vujal(in Tamil), Vala, Vala Khas Khas(in Marathi), Panni(in Punjabi) [4]. Vetiver is frequently grown in tropical areas, despite its Indian origins. Nearly all vetiver cultivated globally, according to reports, is a single clone (same DNA) [5]. The leaves of this grass are long, thin, and rather firm, with a tall stem. The blossoms of vetiver have a brownish-purple hue, and their roots can reach a depth of two to four meters. These days, the world's top producers of vetiver are Reunion, Haiti, and India [2]. It has been demonstrated to ease breathing, decrease heart rate, and calm the nervous system. It also manages diabetes, has been shown to have anti-inflammatory qualities, and is effective in treating skin conditions. The plant's roots are traditional herbs for their cooling and diuretic properties. The decoction of roots is utilised as an antituberculosis, antipyretic, analgesic, anthelmintic, and antioxidant [6]. Vetiveria whole plant aqueous extract has antioxidant properties [7]. Vetiver oil is widely utilised in the food and fragrance industries as a flavouring agent and as a primary odour contributor [8].

Fig 1: Image of *Vetiveria zizanioides* [2]

Fig 2: Dried root of *Vetiveria zizanioides* [2]

Taxonomical Hierarchy

- Kingdom- Plantae,
- Subkingdom - Tracheobionta (vascular plant),
- Super division - Spermatophyte (seed plant),
- Division - Magnoliophyta (flowering plant),
- Class - Liliopsida (monocotyledon),
- Subclass - Commelinidae,
- Order - Cyperales,
- Family - Poaceae (grass family),
- Genus - Vetiveria Bory (vetiver grass),
- Species - *Vetiveria zizanioides* (L.) *Nas* [2].

Macroscopy And Microscopy

Vetiveria zizanioides does not contain stolon and rhizome in its root, and it grows only in a downward direction. It has a very complex and strong structure; it is wiry and very fibrous within 2 mm of diameter. *Vetiveria zizanioides* grows longitudinally, and it will be light yellow to cream in appearance. It has a strong aromatic smell and is slightly bitter [6].

A. Transverse section of root: It contains the sequence towards a centre in this series, the first is the epidermis, then the cortex, the vascular region, and at the centre, the pith is present. The outer cortex contains 3-4 thin layers, and the inner cortex contains 5-9 thin layers. The endodermis is made up of a single parenchymatous layer, which contains tangential and radial bands. The vascular ring contains metaxylem vessels and 4-6 layers of pericyclic consisting of sclereids and thick pericyclic fibres. The central region, known as pith, is parenchymatous and contains a large amount of starch grains and a little bit of cystolith [6].

B. Powder microscopy: The fine powder of the root is slightly bitter, strongly aromatic in odour, and has a brownish-yellow appearance. The fine powder of the root contains rectangular cells of the epidermis with a wavy wall, complicatedly elongated parenchyma with a group of parenchymatous cells, cork cells, sclereids, and pitted stone cells. Prismatic types of calcium oxalate crystals are present, and their diameter was 20-40 microns. Pith cells contain starch grains that starch grains have a diameter of 10-12 microns [6].

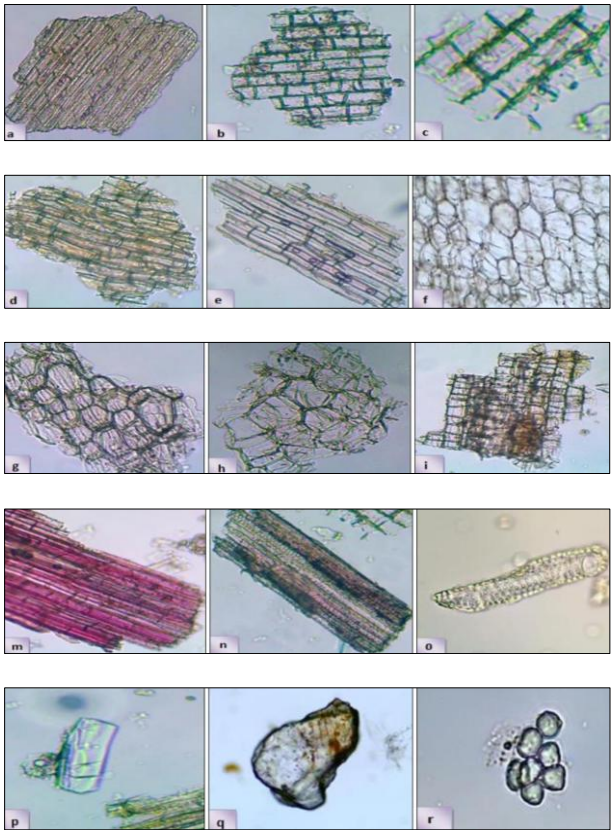


Fig 3: Powdered microscopy of roots of *Vetiveria zizanioides:* a, b, c: Epidermal cells (in 40X,100X,400X magnification); d,e: Parenchymatous cells (in 100X magnification); f: Polygonal Parenchymatous cells (in 100X magnification); g, h: Oval aerenchyma cells (in 100X magnification); i: Cork cells (in 100X magnification) [6]

C. Plant parts used in cosmetic activity

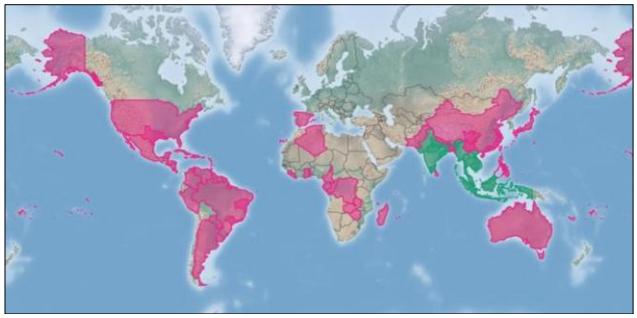
Table 1: Pharmacological activities of various solvent extractions of Phytoconstituents of *Vetiveria zizanioides*

Sr. No.	Solvents used for extraction	Parts of a plant	Activity	
1	Methanolic	Roots	Anticancer	[9]
2	Aqueous		Anticancer	
3	Essential oil		Antibacterial Antioxidant Anti-inflammatory Anti melanin Mosquito repellent Protective Sedative	
4	Ethanolic		Anti-tuberculosis Anti-convulsant Hypoglycaemic Anti-depressant	
5	Khusimol		Antidiuretic	

Geographical Distribution

Vetiveria zizanioides originated from India; nowadays, it grows in tropical and subtropical regions of Asia, America, and Africa. It is a native of South and Southeast Asia. It is a tree that belongs to ancient times. Haiti, Reunion, and Indonesia are the countries that produce the highest amount of vetiver oil. Fragrant oil is produced from the root of *Vetiveria*

zizanioides, which is cultivated in India. In India, this variety is seen in Rajasthan, Haryana, Uttar Pradesh, Gujarat, Bihar, Odisha, and Madhya Pradesh. The crop of *Vetiveria zizanioides* is collected in southern states such as Kerala, Tamil Nadu, Karnataka, and Andhra Pradesh and northern states such as Rajasthan, Uttar Pradesh, and some regions of Madhya Pradesh. Two unique groups of *Vetiver zizanioides* have recently been seen in India one is observed continuously in Andhra Pradesh, Karnataka, Tamil Nadu, and Kerala, in south runs along the east and west shores of the Indian peninsula, and the remaining group is mostly seen at the regions of Rajasthan, Madhya Pradesh, Uttar Pradesh, Bihar and in the Indo-Gangetic plains and its surrounding regions. The *Vetiveria zizanioides*, which is seen in South India, has a characteristic of being highly useful for erosion control, wider leaves, and Dextrorotary root oil, and its type is the domesticated type / Bharatpur type. The *Vetiveria zizanioides*, which is seen in northern India, has characteristics like profuse flowering, propagated through seeds, sets fertile seeds, and superior quality oil [10].



Parts in pink colour: Distribution of vetiver
Parts in green colour: Origin of vetiver

Fig 4: Origin and distribution throughout the globe [10].

Cultivation and Collection

Khas grass has been widely used for many different uses, but despite this, it doesn't seem that any systematic large-scale cultivation has been attempted, especially in North India, where the grass is widely used. There, the wild populations provide the majority of what Khas need. The primary reason Khas is grown in South Indian states like Kerala, Tamil Nadu, Andhra Pradesh, and Karnataka is to produce vetiver oil, which is made by distilling the roots [11]. Nearly any type of soil can be used to cultivate vetiver. Red lateritic and well-drained sandy loam soils with a high organic matter content are ideal for cultivation. It grows in a wide pH range. It grows in a wide temperature range of 25°C. It can withstand floods and drought, and ideally requires around 1000-2000mm of rainfall. Vetivers are commonly propagated by vegetative means through slips, but can also be grown by seed propagation, which ensures variations in the genome of the plant. Optimally, it is planted around the months of June-August in lands that are ploughed around 20-25cm deep. Adequate fertilisers and pesticides are used to ensure the desired quality and quantity of the plant. Around 27,800 to 1,10,000 plants per hectare [12].

The timing of vetiver root harvesting is crucial since variations in environmental conditions affect both the proportion of oil and the root production. After 15 to 24 months of planting, roots are collected; however, for high-quality oil, the harvesting should occur after 18 months. The roots are then harvested and separated, after which it gets cut into small pieces. It is further dried to obtain enhanced olfactory properties. Distillation occurs after drying, and the desired constituents are obtained by the distillation process. Vetiver oil is a viscous amber brown-colored liquid with a smoky or woody odour [12].

Cultivation calendar for Khas grass

- May to June - Land preparation (2-3 deep ploughing & removal of perennial weeds).
- May to June - Manure and fertiliser application (Application of basal dose of the recommended dose of FYM/ Compost and fertilisers).
- June to July - Plantation (Slips from healthy, disease-free clumps with rhizome portion intact, having 1520 cm of aerial portion are planted at a spacing of 60×30 cm/60×45 cm/60×60 cm).
- June to July - Irrigation (Irrigation should be given immediately after transplanting and up to establishment. Later on, 8-10 irrigations are required throughout the cropping period).
- July to August - Fertiliser application (Application of the first top dressing of nitrogen 25 kg/ha one month after planting).
- July to August - Intercultural operations (2-3 weeding and earthing up at an interval of one month during the initial period of establishment).
- October to November - Intercultural operations (Trimming of aerial portion at a height of 20-30 cm above ground, 4-5 months after planting).
- March to April - Intercultural operations (Trimming of aerial portion at a height of 20-30 cm above ground just before flowering).
- March to April - Fertiliser application (Application of second top dressing of nitrogen 25 kg/ha).
- October to November - Intercultural operations (Trimming of aerial portion at a height of 20-30 cm above ground one month before digging).
- December to February - Harvesting (Digging the clumps along with their roots at eighteen months after planting, either by manual or mechanical means [12].

Phytoconstituents

Since the Vedas, vetiver oil has been extracted from grass in India. This dense, light to dark brown oil is extracted from the aromatic roots through steam distillation. The amount of essential oil that vetiver can yield, based on fresh root weight, can vary greatly depending on various factors such as biotype, cultural practices, age of roots, distillation method, and length. Phytoconstituents of vetiver oil from 2 of those varieties in India, namely the North Indian and South Indian varieties are mentioned below in the table [13].

Table 2: Phytoconstituents of 2 Indian vetiver oil varieties

Sr. No.	Components	Concentration (In percentage)		Reference
		North Indian Variety	South Indian Variety	
1	Khusimol	16.25	15.77	[13].
2	Khusinol	10.28	-	
3	Germacrene-D	9.73	-	
4	Junipene	5.54	1.60	
5	γ-Muurolene	4.56	-	
6	Bicyclovetivenol	2.88	10.76	
7	Farnesol	2.65	-	
8	Cedrene-13-ol-8	2.23	1.05	
9	α-Vetivone	2.01	3.04	
10	Epiglubulol	1.95	-	
11	β-Cedren-9-α-ol	1.76	-	
12	Cubenol	1.64	-	
13	Calerene	1.57	-	
14	γ-Maaline	1.57	-	
15	α-Cadinol	1.46	1.74	
16	γ-Cadinene aldehyde	1.28	-	
17	Spathulene	1.28	2.37	
18	Guaiol	1.03	1.58	
19	β-Eudesmol	0.97	1.28	
20	Humulene 1,6-diene-ol	0.87	1.42	
21	γ-Cadinene	0.82	-	
22	E-Caryophyllene	0.74	-	
23	Khusimene	0.66	1.59	
24	Sativen	0.65	-	
25	β-Bisabolol	0.57	1.00	
26	α-Eudesmol	0.49	-	
27	β-Ionol	0.46	-	
28	10 Epi-γ-eudesmol	0.46	-	
29	β-Caryophyllene oxide	0.28	-	
30	γ-Himachalene	0.23	-	
31	α-Amorphene	0.22	1.68	
32	α-Bisabolol	0.19	-	
33	Allo-aromadendrene	0.17	-	
34	Viridiflorene	-	4.64	
35	Velerenol	-	3.44	
36	Caryophyllenyl alcohol	-	2.30	
37	Selina-6-en-4ol	-	2.11	
38	Cyclosativene	-	2.06	
39	Globulol	-	1.91	
40	Patchouli alcohol	-	1.61	
41	δ-Guaiene	-	1.42	
42	Valencene	-	1.31	
43	γ-Gurjunepoxide	-	1.14	
44	Allo-aromadendren oxide	-	0.83	
45	β-Vatirenene	-	0.72	
46	β-caryophyllene	-	0.37	
47	Cedryl acetate	-	0.29	
48	β-Vetivenene	-	0.14	
49	α-Humulene	-	0.03	

Pharmacological Activity

A. Antitubercular activity

The antitubercular activity was shown by the ethanolic and hexane extracts of the *Vetiveria zizanioides* root. The evaluation of antitubercular activity is done by testing different strains that are responsible for the growth of tuberculosis infection, such as H37Rv and H37Ra strains. In both strains, the ethanolic and hexane extracts are added to see the effect of the extract of *Vetiveria zizanioides* root. These extracts showed a positive effect on the strains. The ethanolic extract will show an effect at 500 µg/ml, and the hexane extract shows an effect at a 50 µg/ml dose. This extract shows zone inhibition and exhibits potent antimycobacterial activity [14].

B. Antioxidant activity

The ethanolic extract of *Vetiveria zizanioides* root showed antioxidant activity. In the case of oxidation, free radicals are generated inside the body, which may cause DNA damage. To prevent this condition, antioxidants are required to balance the level of free radicals inside the body. The extract *Vetiveria zizanioides* also shows this antioxidant by maintaining the level of free radicals in the body and preventing DNA damage [15].

C. Anxiolytic activity

The anxiolytic activity was shown by the ethanolic extract of *Vetiveria zizanioides* root. The dried root of *Vetiveria zizanioides* is used in this estimation of anxiolytic activity. For estimation, different doses of the extract were given to the mice, such as 100, 200, and 300 mg/kg body weight, which showed activity like time spent in the lightened area and the number of mistakes that things are compared with diazepam (as a standard), 1mg/kg body weight and scopolamine 0.3 mg/kg body weight. All are similar effects that prove that the extract of *Vetiveria zizanioides* shows anxiolytic activity [16].

D. Antidiabetic activity

The antidiabetic activity was shown by the ethanolic extract of *Vetiveria zizanioides* root. The estimation of antidiabetic activity of intraperitoneally administered alloxan monohydrate (150 mg /kg) is given to induce the diabetic level in rats. These rats are divided into 6 groups, and all receive different treatments. The group that received the treatment from this root extract in those groups significantly decreased the level of blood sugar on examination, and this shows the antidiabetic activity of the extract [17].

E. Hepatoprotective activity

The hepatoprotective activity was shown by the methanolic extract of *Vetiveria zizanioides* root. In the estimation of hepatoprotective activity, the rats are pretreated with the methanolic extract and then given the carbon tetrachloride, which leads to damage to the hepatic levels, like serum bilirubin level, etc. In rats that are treated with methanolic extract before administration of carbon tetrachloride in those rats, the level is maintained, proving the antidiabetic activity [18].

F. Mosquito Repellent Activity

The mosquito-repellent activity was shown by the essential oil extraction of *Vetiveria zizanioides* root. The estimation of mosquito repellent activity is shown by the *Vetiveria zizanioides* at different concentrations. It shows different effects (5% and 7.5%) at the higher doses. It shows more effects like antibacterial, astringent, and antifungal, and it gives rapid relief from the insect bite [19].

G. Anti-inflammatory activity

The anti-inflammatory activity was shown by the methanolic extract of *Vetiveria zizanioides* root. The evaluation of the anti-inflammatory activity is done by using different experimental methods, such as carrageenan-induced rat paw oedema and the chronic cotton pellet method. For estimation, 300 and 600 mg/kg doses are given to rats. The 300 mg/kg

dose shows the maximum effect (66.17%) after 6 hours of drug treatment in carrageenan-induced rat paw oedema, and in the chronic cotton pellet method, 600 mg/kg shows the maximum effect. The model showed the decreased formation of granuloma tissue. This experiment potentially shows the anti-inflammatory effect, and also shows the analgesic effect in both types of inflammation, acute inflammation and chronic inflammation, in rats [20].

H. Antibacterial activity

The essential oil extract of *Vetiveria zizanioides* showed antibacterial activity. The estimation of antibacterial activity in different concentrations is prepared like 7.81, 15.62, 31.25, 62.5, 125, 250, and 500 µg/ml. The experiment is performed by the disk diffusion method. At the end of the specified period, transparent inhibition zone diameters around the standard discs were measured and recorded, proving the antibacterial activity of the essential oil of *Vetiveria zizanioides* [21].

I. Antimicrobial activity against some bacteria and fungi:

The root and leaf extract of the *Vetiveria zizanioides* showed antimicrobial activity. The estimation of antimicrobial activity in bacterial and fungal species was performed using the agar diffusion method. In this method, two species of bacteria, *E. coli* and *Staphylococcus aureus*, and two potent species of fungi, *Candida albicans* and *Cryptococcus neoformens*, are studied. Extracting *Vetiveria zizanioides* shows zone inhibition in both, of which the root extract showed larger zone inhibition and the leaf extract showed smaller zone inhibition. The root showed a maximum zone inhibition of 30 mm against *S. aureus* and 33 mm against *C. albicans* and a minimum zone inhibition of 24 mm against *E. coli* and 28 mm against *C. neoformens*, but the leaf extract showed a maximum zone inhibition of 22 mm against *E. coli* and 32 mm against *C. neoformens*. This result of zone inhibition showed the antimicrobial activity of *Vetiveria zizanioides* in fungi and bacterial species [22].

Patents available on *Vetiveria zizanioides*

1. The vetiver oil, which was extracted from the exhausted vetiver root, provides an antimicrobial activity and improves skin conditions (Scandolera, Lambert, Reynaud, 2019) [24].
2. The extract from the root of *Vetiveria zizanioides* is useful as a hair care composition, together with a pharmaceutically acceptable topical carrier other than water (Porras *et al* Feb 27, 2001) [23].

Homemade Remedies

Vetiveria zizanioides is mostly used in rural areas and is mostly useful in socio-economic life. Different parts of the plant are used in the form of paste, decoction, juice, and inhalation [25].

A. Root: The paste of the root is used to prevent headache, rheumatism, and sprain in the area of West Bengal. The vapour of the root is inhaled to prevent malaria infection in Varanasi. Root ash is used to treat acidity. The root is also used to treat the stimulant and carminative effects. Also, the root is used as a cooler in North India. The root is also used to prepare soft drinks, which are generally taken in summer [25].

B. Stem: The decoction of the stem is used to prevent urinary tract infection. Decoction is applied locally, then it will be used in the treatment of rheumatism, lumbago and sprain. It is a good embrocation and affords relief [25].

C. Leaf: The juice of leaves is used as an anthelmintic agent in the area of Madhya Pradesh [25].

All of these formulations contain vetiver oil, which is used to treat inflammatory bowel disease, urinary tract infection, and to make insect repellents. The diluted form of vetiver oil is used in after-shave lotions, air fresheners, and bathing purposes, as well as flavouring syrups, ice cream, cosmetics, and food preservation. This is mostly used in cosmetics as well as in medication. Vetiver oil is used in perfumes, cosmetics, and soup preparation, and this oil has a softer odour, so it is widely used in perfumes and fragrances [25].

Conclusion

Vetiveria zizanioides, or vetiver, is a highly prized and adaptable perennial grass with a wide range of possible uses in both conventional and contemporary contexts. As an important source of essential oil utilised in numerous industries, such as cosmetics, perfumes, and food flavouring, *Vetiveria zizanioides* is an Indian plant that is commonly grown in tropical and subtropical locations. The plant is an excellent erosion management method because of its strong root system, which also helps to preserve soil. According to phytochemical research, vetiver oil contains a wide range of bioactive substances, including khusimol, vetivone, and other sesquiterpenes, which are responsible for its unique scent and medicinal qualities. These substances have a variety of pharmacological properties, such as antibacterial, antidiabetic, anti-inflammatory, and antioxidant properties. Vetiver oil is a beneficial ingredient in both medicinal and cosmetic compositions since studies have demonstrated its potential benefits in reducing anxiety, boosting skin health, and offering natural mosquito-repellent characteristics. The rising interest in herbal remedies and natural products has boosted the demand for vetiver, highlighting its economic value and potential for widespread cultivation. Further research into vetiver's various uses and sustainable farming methods could enhance its application across different industries. In essence, vetiver is a promising natural resource that offers considerable benefits for health, well-being, and environmental sustainability, in line with the global shift towards plant-based and eco-friendly solutions.

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