Other Uses, and Utilization of Vetiver: Vetiver Oil

U.C. Lavania

Central Institute of Medicinal and Aromatic Plants, Lucknow – 226 015 , India

Abstract: Vetiver, a native of India is known for its perfumery and medicinal value since ancient times, much before the world became familiar with rose scents. The annual world trade in vetiver oil is estimated to be around 250 tons, with Haiti, Indonesia (Java), China, India, Brazil, Japan being the main producers, and USA, Europe, India, and Japan being the main consumers. It is a gift of India to modern world, and finds its greatest use in modern perfume creations. The essential oil distilled from the roots of vetiver, is one of the most complex mixtures of sesquiterpene alcohols and hydrocarbons, and also one of the most viscous oils with an extremely slow rate of volatility. Slow evaporation rate of vetiver oil coupled with its pleasant aroma makes it a perfume by itself. Its high solubility in alcohol that improves its miscibility with other perfumery material, makes it unique perfume resource, for which no synthetic substitute is yet available. The essential oil produced in different countries possesses distinct odor note – Reunion (Bourbon) and Haitian oil with roseate note is highly regarded in perfumery industry, but the vetiver (khus) oil obtained from wild 'Khus' roots in India is considered to be the best for its balsamic woody note. Washed fresh or soaked semidried roots when distilled by hydro-distillation / steam distillation produce an amber or dark brown oil with a viscous texture. When the oil is distilled using traditional copper vessel in conventional slow fire stills, the oil produced is of dark green color. Normally 15 - 18 month old roots, harvested during December - January are most suitable to realize high concentration and good quality of essential oil. Depending upon the biotype, cultural practice, age of roots and mode and duration of distillation, vetiver roots may give an yield of about 0.3 to 2% essential oil on fresh root weight basis. Under ideal steam distillation conditions the economic distillation of essential oil is realized within 15-18 hrs.; but low temperature wood-fired distillers may require over 24 hrs. Lately, molecular extraction by liquid carbon dioxide is gaining preference over hydro-distillation methods to realize high-grade essential oil.

Chemical composition of vetiver oil is extremely complex, mainly comprising of sesquiterpenes and sesquiterpene derivatives, of which vetiverols, their carbonyl compounds and esters, are the main constituents, and their relative abundance normally establishes the oil quality. Three carbonyl compounds, α-vetivone, β-vetivone and khusimone, are considered the primary odor-influencing components; β-vetivone has the better odor, and is considered the most important, while its major isomer nordihydro β-vetivone has a strong, rich, woody-peppery note. The oil and its constituents are used extensively for blending oriental type of perfumes and floral compounds, as well as in other cosmetic and aromatherapy applications. It is very persistent and one of the finest fixatives known. Vetiver oil is a main ingredient in 36 % of all western quality perfumes and 20% of all men's fragrances. Dried roots are used as sachets / stuffing material to prepare ventilating screens that provide cool air effect and pleasant aroma when moistened.

Key words: Khus oil, vetiver oil, vetiver perfume, essential oil, vetiver roots, perfume fixative, perfume blender, aromatic plant, aromatherapy

E-mail Contacts: <lavania@cimap.res.in> and <lavaniauc@yahoo.co.in>

1 INTRODUCTION

Vetiver is the omni-useful plant, almost all parts of which are used in one or more ways having direct as well as multifarious cultural and industrial applications. Of course, the commercial and social utility of this plant was first realized on account of its aromatic roots, and lately overwhelmed by environmental applications of the plant as such, as well as diverse industrial uses of above ground plant parts (Chomchalow and Chapman 2003) . The essential oil obtained from the roots of vetiver is the major source of national economy of at least two nationalities i.e. Haiti island in the Caribbean and Reunion island in the Indian ocean.

2 VETIVER ROOT AND ROOT-OIL

The roots originating from vetiver clumps comprise of tufted fibrous mass. Tremendous diversity exists with respect to pattern of growth, orientation and thickness of roots, as well as for occurrence of secondary roots. The bast region of root is the source of essential oil.

2.1 Natural diversity and cultivation of vetiver for root oil

Vetiver is native to India and is found in wild state throughout the Indian subcontinent encompassing temperate to tropical climate. For various economic purposes including extraction of essential oil, the roots are dug out from wild resources in northern India, but are obtained under cultivation in south India, and several other countries. Haiti island in the Caribbean is the major source for the supply of vetiver oil to the world market, followed by Java (Indonesia), China, Japan, India etc. Depending upon the country of occurrence, cultivation practices, climatic conditions, and genetic origin, there occurs tremendous diversity with respect to yield and quality of essential oil, ranging from earthy woody balsamic note to sweet roseate note.

2.2 Cultivation for roots and root-oil

Traditionally, in India vetiver roots are obtained by manual digging from about two year old plants occurring in wild to extract high perfumery grade essential oil, called as “khus oil”, but in south India and elsewhere in other countries vetiver is grown under cultivation. For optimum growth the vetiver plant requires long day conditions and plenty of sunlight. Under irrigated conditions vetiver plantations are established any time during the year, but for rain-fed conditions it is advisable that plantations should be established with the onset of rains. In poor soils and waste lands high plant population at 60 x 45 cm plant to row distance may be desirable, and less with improved soil and cultural conditions. During growth period shoots 25-30 cm above the ground need to be harvested intermittently during slow growth period of low temperature conditions. Since, digging of soil for root harvesting may be environmentally undesirable, an alternative means of growing vetiver could be in poly-bags and other containers (Chomchalow 2001). This would not only mitigate soil erosion concerns but also increase cost benefit ratio of vetiver cultivation for its roots and root oil, as well as optimum utilization of degraded lands as poly-bag platforms. 15 – 18 month old roots are ideal for to realize good oil quality and high oil productivity.

2.3 Distillation and processing of essential oil

Age, quality and stage of root harvest, and processing for distillation are vital components for efficient processing of essential oil distillation. Essential oil could be distilled both from fresh and dried roots. Recovery of essential is very high from fresh roots, but leaving the roots in open for 2-3days after harvesting with a day temperature of around 25˚ C yields high quality essential oil, since the undesirable non-polar low boiling components of the oil are naturally evaporated off, although oil recovery is somewhat reduced. Both freshly harvested roots and semidried roots soaked overnight in water could be used for essential oil extraction.

Three methods of distillation are traditionally practiced in India (Singh and Singh 1998). The one for an on site distillation is "*Bhapka*" system which is quite common in north India. The distillation equipment consists of a round bottom copper still "*Deg*" and a receiver "*Bhapka*" also made of copper. The "*Deg*" is connected with "*Bhapka*" by a bamboo called "*Chonga*". The "*Chonga*" serves the purpose of a pipe to allow the steam to reach to the "*Bhapka*" from "*Deg*" for condensation. The "*Bhapka*" is placed in a small water tank for cooling. Depending upon the size of the "Deg" 50 – 100 kg of semidried roots could be distilled. Although, the recovery of oil by "*Bhapka*" system is lower and the distillation requires 4-5 hours longer than the other methods of distillation, but the quality of the oil thus recovered is of much superior quality. Other methods of distillation make use of steam generating boilers and direct wood fired distillers. In directly fired distillers the water coming from the separators may be cohobated. The oil recovered from slow fired "*Bhapka*" distillers is usually light –to- dark green in color, whereas the one obtained from boiler operated and directly fired stills is yellowish brown in color. For optimum recovery and economic productivity of oil, it is suggested that roots may be harvested when the maximum day temperature is 25-27˚ C, roots be distilled at the earliest after the harvest, and distillation performed just for about 15 hrs, and age of roots around 18 months (Aggarwal et al. 1998, Lavania 2003).

In order to improve quality and increase shelf life, the freshly distilled oil need to be dehydrated to remove water either by anhydrous sodium sulphate or natural evaporation by air drying, and then allowed to mature by natural oxidation for about six months in amber color glass bottles with a bit of air trapped inside the container till it develops green coloration. Excessive oxidation is to be avoided as this may lead to malodor formation. However, to obtain vetiver oil truly representative of its occurrence *in planta* modern methods of liquid carbon dioxide extraction may be done. The vetiver 'oleoresin' thus obtained is a very stable more mobile golden liquid, free from residue, enriched with polar compounds and quality odor. Absence of residue makes such oil more soluble in alcohol and improves its miscibility suitable for blending with other perfume materials.

2.4 Essential oil composition and qualitative differentiation

The main fibrous smooth roots are more important for oil quality. The oil accumulated in the secondary hairy roots, although enhances oil concentration *per se*, but the perfumery value of the oil is drastically reduced on account of the presence of higher concentration of non-polar compounds. Further, to minimize the presence of such unwanted non-polar compounds in the oil, it is advisable that either (i) the roots after the harvest may be left in open for air drying for a day or two with a day temperature not exceeding 27˚ C to allow natural evaporation of undesirable lighter oil fraction, (ii) the essential oil fraction recovered in the initial 15-30 min. of distillation may be dispensed with, (iii) the essential oil be extracted as 'oleoresin' by molecular methods of liquid carbon dioxide extraction to get rid of residual components.

Chemical composition of vetiver oil is extremely complex, said to contain some 100 sesquiterpene-type compounds and their derivatives, belonging to 11 structural classes; an

exhaustive account of which could be found in Akhila and Rani (2002). The main constitutents of vetiver oil comprise of : sesquiterpene hydrocarbons such as, γ-cadenene, clovene, α-amorphine, aromadendrine, junipene; their alcohol derivatives – vetiverols such as , khusimol, epiglobulol, spathulenol, khusinol; carbonyl derivatives – vetivones (ketones) such as, α-vetivone, β-vetivone, khusimone; and ester derivative such as, khusinol acetate. Three carbonyl compounds, α-vetivone, β-vetivone and khusimone, are considered the primary odor-influencing components; β-vetivone has the better odor, and is considered the most important, while its major isomer nordihydro β-vetivone has a strong, rich, woody-peppery note. All these components individually and collectively contribute to the characteristic odor of the vetiver (Lavania, 2003). Of course, α-vetivone, β-vetivone and khusimol can be considered as the 'finger print' of vetver oil (Demole et al. 1995).

There are distinct geographical differences in quality and perfumery note of essential oil obtained from different geographic regions of the world. In a broad sense, the essential oil of vetiver having high specific gravity, negative optical rotation, high vetiverol concentration and higher ester value is considered superior from perfumery view point. Reunion oil with roseate note is highly regarded in perfumery industry, but the vetiver oil (khus oil) obtained from the roots occurring in wild state in north Indian plains, commonly known as 'khus' is considered to be the best for its balsamic woody note. Lately, vetiver genotypes producing vetiver oil with roseate and saffron note have also been identified from north Indian plains (Lal et al. 1998).

3 UTILIZATION

Vetiver is such a unique plant that almost whole of the plant is utilized through its raw material, as well as by way of biological and environmental implications. Of all its plant parts, its odoriferous roots have been in usage since ancient times.

3.1 Roots

Vetiver roots comprise of tufted mass of fibrous, odoriferous spongy material having high tensile strength. Owing to pleasant aroma and refrigerant properties, the vetiver roots are variously used for household and coolant purposes. Dried roots are employed to scent linen and clothes as such, or in the form of sachets, and burned as incense. In India, the vetiver roots have been in use since ancient times for making woven screens, mats, blinds (*chik*), hand fans, broom hangers, and baskets. Root-mats designed in the form of panels called '*khus-tatti'* are used to prepare makeshift huts / cabins, that are variously used during summers to provide cooling effect. Such woven products made from dried roots when sprinkled with water and hung at the proper ventilating space provide cooling effect and pleasant aromatic air. Lately, vetiver roots have become common stuffing item in ventilating panels used in electric desert coolers (Lavania 2003). Also, compressed hard panels could be made from the roots of vetiver (Chomchalow and Chapman 2003). Probably high tensile strength of vetiver roots and the inherent anti-microbial property on account of its essential oil, make vetiver roots an ideal natural material for making compressed hard boards and panels. Decoction of roots is believed to dissolve kidney stones, and a paste made from pounded fresh roots is considered an abortifacient (Weiss 1997).

3.2 Oil

The vetiver oil is traditionally known as "vetivert oil" in trade, and is obtained from the aromatic roots of vetiver. The annual world trade in 'vetivert oil" is estimated around 250 tons, with Haiti,

Indonesia (Java), China, Japan, India, Brazil being the main producers, and USA, Europe, India and Japan being the main consumers. The essential oil is produced in the bast region of the root, and is distilled mainly through hydro-distillation. From qualitative angle two distinct types of essential oil is obtained in India; (i) north Indian type obtained from profuse flowering seed forming race of vetiver (khus) occurring in wild, and is called as "khus oil", and (ii) south Indian type called "vetiver oil / vetivert oil" obtained from non-flowering / late-flowering / non-seeding / low-seed forming type available in cultivation. The "khus oil" from north India is distinctly superior on account of high ester value and higher concentration of heavier carbonyl fractions compared to the "vetiver oil" from all other sources. Former fetches the market price by over two fold than the latter. A rare C14 class of terpenoid 'khusilal' is unique to north Indian 'khus oil" that imparts strong negative rotation to the oil and enhanced perfumery value. A brief account of physicochemical characteristics of vetiver oil from different geographical regions of the world is given in Lavania (2003), and the chemical profile provided by Lemberg and Halley (1978).

3.3 Perfumery and related applications

Vetiver is known for its perfumery value in India since ancient times. It is a Gift of India (Morris 1983) to the world of perfumes, and its use in scents (*attar*) is known in India much before the world became familiar with rose scents. On account of its pleasing aroma and slow evaporation rate falling under the category of lower 'base note' vetiver oil as such is a 'perfume in its own right' for which no synthetic substitute is yet available.

Pure vetiver (khus) root-oil known in trade as "Ruh-Khus" could be easily found in the perfumery shops in India. "Ruh-Khus" is duly matured pure khus oil. The khus oil distilled from wildly occurring vetiver (khus) roots by traditional slow fired copper vessel "*Bhapka*" distillation units, is air dried to remove traces of water as well as the lighter non-polar fractions that may be trapped in the oil during distillation. Subsequently, the oil is stored in aerated leather made containers called "*Kuppi*" and allowed to mature till the color of the oil turns dark green. Natural aeration available in the leather made containers facilitates evaporation of water if any, and the undesirable lighter fractions, as well as facilitates oxidation to add perfumery value to the oil through optimum esterification. Vetiver oil is the basis of the Indian perfume 'Majmua' and is the major ingredient in some 36 % of all western perfumes (e.g. Caleche, Chanel No. 5, Dioressence, Parure, Opium) and 20 % of all men's fragrances. A 15 – 30 % dilution of vetiver oil in alcohol is good enough to make true vetiver perfume, and its further dilutions have value as vetiver 'eau de cologne' and 'eau de toilette' . ' Vetiver pour Homme' by Carven 1957, and 'Vetivert' by Guerlain 1961, are the two famous 'eau de toilette' for men prepared from vetiver oil (Groom 1992).

Further, the vetiver oil is very persistent and one of the finest fixatives known. Its complex chemical composition and oil odor, high solubility in alcohol that improves its miscibility with other perfumery material, makes it a unique perfumery resource for which no synthetic substitute is yet available. In addition to its own perfumery value on account of vetiver hydrocarbons and carbonyl compounds, their alcohol derivatives i.e. vetiverols lend unique position to vetiver oil for perfumery applications as a valuable resource. Because of clear-cut differences in boiling point of the various constituents of vetiver oil, its vetiverol fraction could be easily separated by fractional distillation of oil under high vacuum. Also, vetiverol could be acetylated with acetic anhydride to produce vetiveryl acetate. Both vetiverols and acetates have softer odors and fixative qualities, and are used as blender with high-class perfumery products. They blend well with ionone, linalool, cinnamic alcohol, oak-moss, vanila, sandalwood, patchouli and rose bases, and are frequently used in western

type of fragrances having chypre, fougere, rose, violet and amber aldehyde base, and oriental fragrances and floral compounds (Lavania 2003).

In addition to its direct perfumery applications, vetiver oil in its diluted form is extensively used in after-shave lotions, air freshners and bathing purposes, as well as flavoring syrups, ice cream, cosmetic and food preservation. Khus essence is used in cool drinks, and for reducing pungency of chewing tobacco preparations, providing sweet note to other masticatories and incense sticks.

3.4 Aromatherapy

Vetiver oil owes several beauty benefits and emotional effects. It balances the activity of the sebaceous oil glands, has deodorizing properties, and helps normalize oily skin and clear acne. It replenishes moisture in dry and dehydrated skin and has a rejuvenation effect on mature skin, as well as cuts / wounds / irritated and inflamed skin. When used regularly during pregnancy, vetiver oil reportedly prevents stretch marks. The oil strengthens the central nervous system, and is helpful in overcoming depression, insomnia, anxiety, stress, tension and nervousness (Wilson 1995).

When locally applied in rheumatism, lumbago, headache, sprain, it is a relieving embrocation . Infusion of roots is a refreshing drink in fever, inflammation and irritability of the stomach. Some people use vetiver oil as aphrodisiac (Wilson 1995).

4 DISCUSSION

Vetiver has been in use since ancient times for its aromatic roots and its essential oil. Lately, this has become a plant of choice for environmental protection and industrial applications. Utilization of vetiver plant for both of the aforesaid applications appears to be in antagonistic juxtaposition. Digging of roots for essential would offset the very purpose of utilization of this plant for environmental applications. Therefore, definite complementary strategies need to be developed. For utilization of vetiver for environmental and industrial applications of above ground plant parts, it may desirable to identify vetiver genotype so that the digging becomes unattractive i.e. the roots produce little or no oil but root geometry and growth is commensurate with the environmental requirement. And vetiver for oil, should have high oil productivity and improved quality suiting to perfumery requirements. It is also important that emphasis is laid to develop non-seeding cultivars suiting to specific situation, so that vetver does not become weed to non-target areas. This could be attempted through triploid breeding, as opined by Lavania and Kumar (1998).

Further, the high viscosity and low evaporation rate of vetiver oil makes it a perfume in its own right. Therefore, it may be worthwhile to hunt for diversity for different perfumery notes, to further enhance the perfumery value of vetiver.

5 REFERENCES

Aggarwal, K.K., Singh, A., Kahol, A.P. and Singh, M. 1998. Parameters of vetiver oil distillation. J. Herbs Spices Med. Plants 6: 55-61.

Akhila, A. and Rani, M. 2002. Chemical constitutents and essential oil biogenesis in *Vetiveria zizanioides*. *In* : Maffei, M. ed. Vetiveria. Pp. 73-109, Taylor and Francis, London.

Chomchalow, N. 2001. The Utilization of Vetiver as Medicinal and Aromatic Plants with Special Reference to Thailand. PRVN Tech.Bull. No. 2001/1, ORDPB, Bangkok.

Chomchalow, N. and Chapman, K. 2003. Other uses, and utilization of vetiver. Paper presented at ICV-3 held in Guangzhou, China, 6-9 Oct. 03.

Demole, E.P., Holzner, G.W., Youssefi, M.J. 1995. Malodor formation in alcoholic perfumes containing vetiveryl acetate and vetiver oil. Perfum. Flav. 20: 35-40/

Groom, N. 1992. The Perfume Book. Chapman & Hall, London.

Lal, R.K., Sharma, J.R., Naqvi, A.A. anf Misra, H.O.1998. Development of new varities – Dharani, Gulabi, Kesari of vetiver (Vetiveria zizanioides). J. Med. Arom. Plant Sci. 20 : 1067-1070.

Lavania, U.C. and Kumar, S.1998.Genomic manipulation in vetiver to realize non-seeding eco-friendly cultivars for soil-water conservation and essential-oil production. Proc. Ist Intl. Conf. On Vetiver, Chiang Rai, Thailand, pp. 137-140.

Lavania, U.C. 2003. Vetiver Root – Oil and Its Utilization. PRVN Tech. Bull. No. 2003/1, ORDPB, Bangkok.

Lemberg, S. and Halley, R.B.1978. Vetiver oils of different geographical origins. Perfum. Flav. 3: 23-27.

Morris, E.T. 1983. Vetiver : Gift of India. Dragoco Report 6:158-165.

Singh, S. and Singh, D.P. 1998. Cultivation & distillation technologies of vetiver. Technical Bulletin No. 6, Fragrance & Flavour Development Centre, Kannauj, India.

Weiss, E.A. 1997. Vetiver. In: Essential Oil Crops, pp. 117-137. CAB International, Oxford.

Wilson, R. 1995. Aromatherapy for Vibrant Health and Beauty. Penguin Putnam Inc., New York.