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A Review: Extraction of Oil and Chemical Investigation of Different Species of Eucalyptus Tree in India

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Abstract - *In this study, we have different species of Eucalyptus tree in India. Eucalyptus features a long history in India. It had been first planted around 1790 by Tippu Sultan, , in his castle garden on Nandi hills on the brink of Bangalore. As per one variant, he got seed from Australia and presented around 16 species. Parker has given the list of over 100 species tried in India. According to Bhatia, 170 species of eucalyptus have been tried in India. Scrutiny of literature and herbarium specimens deposited in the herbarium of Forest Research Institute, Dehradun revealed that 70 species of eucalypts were successfully introduced in India. We have studied major Eucalyptus species E. citriodora, E. camaldulensis, E. globulus , E. tereticornis the major chemical constituent found to be 1,8 cinole, citronellal, α-phellandrene, β-pinene. Several methods were used to extract the essential oil from different types of Eucalyptus species even steam distillation method was used to extract the essential oil. Then the data of species as well as chemical composition of Eucalyptus trees were summarized in a table and the most quantity found in E. globulus in which 81% 1,8- Cineol found.*

Key words- Eucalyptus, citronellal, E. Globulus, essential oil and Chemical Investigation.

1. INTRODUCTION

Eucalyptus species belongs to the Myrtaceae family ranging from Australia that was brought into India. The plant is wont to produce different items the leaf is employed to make essential oil, the stem is employed for pulp industry, furniture and therefore, the flower could be utilized as nectar for honey production [1]. Eucalyptus oil $C_{10}H_{18}O$, is one among the foremost significant volatile oil. The oil is separated from new and dried leaves [2]. Essential oil has biological effects, antibacterial, antiviral, and anti-fungal segments and long history of utilization against the impact of cold, flu, other respiratory illnesses, rhinitis, and sinusitis [3]. Essential oil has been cultivated in many parts of the world for the production of medicinal oil. Numbers of reports are available worldwide that show the Eucalyptus Leaves antibacterial[4-7] and antioxidant[8-10]. Eucalyptus features a long history in India. It had been first planted around 1790 by Tippu Sultan, the leader of Mysore, in his castle garden on Nandi hills on the brink of Bangalore. As per one variant, he got seed from Australia and presented around 16 species [11].In India there are a number of Eucalyptus species accessible, for instance, E. tereticornis, E. grandis, E. citriodora, E. globulus, and E. camaldulensis. There are different examinations accessible on compound creation and antimicrobial movement of volatile oil of Eucalyptus of Indian origin [12,13].

2. NATURAL PRODUCTS

A natural product is a chemical compound or substance produced by using a living organism that is observed in nature [14]. the majority of new drugs have been generated from natural products (secondary metabolites) and from compounds derived

from natural products [15]. natural products have performed a key function in pharma research, as many drug treatments are either natural products or derivatives thereof. Indeed, its miles estimated that approximately 40% of all medicines are either herbal products or their semisynthetic derivatives[16].

- **Extraction of natural product**

The extraction of natural merchandise progresses through the following stages:

(1) the solvent penetrates into the strong matrix.

(2) the solute dissolves in the solvents.

(3) the solute is diffused out of the strong matrix.

(4) the extracted solutes are collected. Any factor improving the diffusivity and solubility within the above steps will facilitate the extraction. The properties of the extraction solvent, the particle size of the raw materials, the solvent-to-stable ration, the extraction temperature and the extraction duration will affect the extraction efficiency [17,18,19,20,21].

3. ESSENTIAL OIL

Essential oil is a volatile oil. It occurs in the bearing trees' leaves, blooms, buds, trunks, stems and/or roots; however, very few of the large number of essential oil-bearing species are used to produce the oils commercially, they are very different from conventional vegetable oils, as they are quite dry, non-greasy and easily absorbed into the skin [22]. Essential oil is the volatile part of a tree, which is largely responsible for its characteristic aroma. Essential oil trees are widespread and occur even in remote regions, but most of them are developed by tropical regions. Trees grow in areas other than those where they are native, but often produce oils of different and inferior composition[23]. More than 700 species of trees produce essential oils. Some are Eucalyptus, Lemongrass, Lemon, Peppermint, Lavender, Clove, Jasmine, Geranium, Orange, Rose, Spearmint and Winter Green. Essential oils are present in different parts of their bearing trees. There are major and minor constituents in essential oils, but the different percentages of each constituent give each oil its own unique characteristic [24, 25].

3.1. Methods for extraction of essential oil

It is possible to extract essential oils using a variety of methods, although some are not commonly used today. These include methods such as solvent extraction , supercritical fluids extraction ,maceration, cold pressing, enfleurage, hydro distillation. The suitability of the extraction method varies from plant to plant, and the associated capital and operating costs differ considerably[26].

i. **Maceration**: instead of 'essential oil,' this method produces more 'infused oil.' In this method, the plant material is soaked in vegetable oil, heated and then strained so it can be used for massage at this point.

ii. **Cold pressing**: This method is used to extract oils such as lemon, orange, grapefruit and bergamot from citrus rinds. In this method to extract the oil, the rinds are separated from the fruit and the chopped and pressed at 120 o F . The results are a watery mixture of essential elements, which will later be separated.

iii. **Solvent extraction**: To help dissolve the essential oil, hydrocarbon solvent is added to the plant material. The solution is filtered and concentrated through distillation, and later remains a combination of wax and essential oil . Pure alcohol is used to extract the oil from the concentrates, and the oil is left behind when the alcohol is evaporated.

iv. **Enfleurage**: An ancient and intensive way to extract oil from flowers. Enfleurage process involves layering a certain amount of fat over the petals of the flower. Alcohol is used to separate the essential oil after the fat absorbs the essential oil from the flora. Later, the oil is evaporated, and essential oil is produced.

v. **Hydro distillation**: Few processes become obsolete, such as Hydro distillation, which is used in primitive countries to perform extraction n process. There is a risk of drying off the still, or being overheated, burning the aromatics and resulting in an essential oil burnt aroma / smell.

vi. **Steam distillation**: The essence is extracted from the plant in this process using a technique called distillation. The flowers or plants are placed on a screen, steam is passed through the area and the essence becomes 'charged.' Then the steam is passed through the condenser (an area where the steam cools). They separate and bottle this mixture of water and essential oil. plants and flowers contain small quantities of this precious oil, it requires several hundred pounds of raw material to produce a single ounce.

3.2. Extraction of Essential Oil (eucalyptus oil) Using Steam Distillation

In this process, the fresh leaves of eucalyptus plant are cut into pieces less than 2x2 cm within half a day after collection and then placed into the still chamber where steam is being passed from the bottom. The essential oil (eucalyptus oil) is being carried out along with the steam from the top of the still and then sent to the condenser. The cooling water stream is continually supplied in the condenser to cool the mixture (steam and oil). The mixture is then cooled and collected from the condenser bottom. The mixture is then separated by using separating funnel or the water evaporates from the mixture and the residue is pure essential oil of eucalyptus[27].

3.3. Physical Properties of Eucalyptus Oil: (Table 1) [28]

Color	Pale yellow liquid
State	Liquid-oil
Odor	camphoraceous
Taste	pungent and cooling taste
Boiling Point of Cineole (Eucalyptol)	176 ^{0}c to 177 ^{0}c;
Density of oil	0.921 to 0.923
Solubility	1. Insoluble in water; 2. Miscible in alcohol having high concentration or in anhydrous alcohol; 3. Miscible in oil; fats; paraffin's; ether; chloroform and glacial acetic acid.

3.4. Chemical Properties of Eucalyptus Oil [28]

Main constituent: cineole

Chemical formula: $C_{10}H_{18}O$

Chemical Name: 1, 3, 3- Trimethyl-2- Oxabicyclo [2. 2. 2] – octane or 1, 8- epoxy-pmethane.

Molecular Formula of Cineole: C10H18O Molecular Weight: 154.25

Precaution of Storing: Products containing eucalyptus oil should be stored at a temperature not exceeding 25°C in well-filled containers. It should be protect from light. Liquid products containing eucalyptus oil are best stored in child resistant containers.

4. DIFFERENT SPECIES OF EUCALYPTUS TREES IN INDIA

Eucalyptus was first planted around 1790 by Tipu Sultan, the ruler of Mysore, in his palace garden on Nandi Hills near Mysore. According to one version, he received seeds from Australia and introduced about 16 species [29]. Plantations of *E. globulus* were raised to meet the demand for firewood from 1856 [30]. *Eucalyptus* was one such species meeting the desired qualities [31]. From 1951 to 1954, large scale trials were conducted in Uttar Pradesh, Bihar, Assam, Madhya Pradesh, Maharashtra and Kerala [32], however, during 1959-1979 the area under eucalypt plantations increased significantly [33]. Parker (1925) has given the list of over 100 species tried in India [34]. According to Bhatia (1984), 170 species/varieties/provenances of eucalypts have been tried in India [35]. The species, which have received countrywide acceptance, are *E. tereticornis*, *E. camaldulensis*, *E. grandis*, *E.citriodora* and *E. globulus*. Sahni and Bahadur (1972) have suggested trial of eucalypts in different climatic zones of India based on their climatological requirements [36]. Scrutiny of literature and herbarium specimens deposited in the herbarium of Forest Research Institute, Dehradun revealed that the following 70 species (Table 2) of eucalypts were successfully introduced in India.

4.1. Eucalyptus species introduced in India: [Table2] [37]

S.no.	Biological name	Common name	Place of introduction in India
1.	E. alba Reinw. ex Bl. (=E. platyphylla F.v.M)	Timor white gum	Dehradun (U.K.)
2.	E. albens MiQ.	White box	Nilgiri (T.N.)
3.	E. albina Lindl.	Grampians stringy bark	Nilgiri (T.N.)
4.	E. amygdalina Labill.	Black peppermint	Chaubbatia (U.K), Nilgiri (T.N.)
5.	E. bicolor A. Cunn.	River black box peppermint	Dehradun (U.K.)
6.	E. bicolor A. Cunn.	Bosisto's box	Nilgiri (T.N.)
7.	E. bosistoana F.v.M.	Bangalay, southern mahogany	Nilgiri (T.N.)
8.	E. botryoides Sm.	Flooded box	Dehradun (U.K.), Delhi and Ludhiana (P.B.)
9.	E. brachypoda Turcz. (=E.microthica F.v.M.)	Marri	Nilgiri, Shillong (M.L.), Satna (M.P.)
10.	E. calophylla R.Br. ex Lindl.	Murray red gum, river red gum	Saharanpur (U.P), Nasik (M.H.), Shimla (H.P), Ambala (P.B.), Delhi, Nandi Hills, Mysore, Banglore (K.A.), Haryana
11.	E. capitellata Sm	Brown stringy bark	Chakrata (U.K.)
12.	E. citriodora Hook.(Corymbia citriodora (Hook.) Hill and Johnson	Lemon scented spotted gum	Dehradun (U.K.), Lucknow, Saharanpur (U.P.), Chandigarh, Poona (M.H.), Madhya Pradesh, Sriharikota, (A.P.), Dandeli,

			Mysore (K.A.), Valpoi, (Goa); Haryana, Tripura
13.	E. cladocalyx F.v.M.	Sugar gum	Nilgiri (T.N.)
14.	E. crebra F.v.M.	Narrow-leaved ironbark	Dehradun (U.K.); Punjab; Nandi Hills (K.A.), Nilgiri (T.N.); Haryana.
15.	E. cosmophylla F.v.M	Cup gum	Nilgiri (T.N.)
16.	E. dealbata A. Cunn.	Trumble down gum	Almora, Ranikhet (U.K.)
17.	E. deglupta Blume	Mindanao gum	Dehradun (U.K.)
18.	E. diversicolor F.v.M	Karri	Nilgiri (T.N.)
19.	E. drepenophylla F.v.M	Bowen Ironbark	Dehradun (U.K.), Hassan (K.A.); Nilgiri (T.N.)
20.	E. eugenoides Sieb. ex Spreng	white stringybark	Nilgiri (T.N.), Shimla (H.P.)
21.	E. eximina Schau	Yellow blood wood	Shimla (H.P.)
22.	E. exserta F.v.M.	Bendo	Saharanpur (U.P.)
23.	E. ficifolia F.v.M. (Corymbia ficifolia (F.v.M.) Hill and Johnson)	Red flowering gum	Nilgiri (T.N.)
24.	E. globulus Labill	Tasmanian blue gum, southern blue gum	Almora, Ranikhet, Pithoragarh, Nawagon (U.K.), Northeast India; Mysore (K.A.), Nilgiri (T.N.); Haryana
25.	E. grandis (Hill.) Maiden	Toolur	Dehradun (U.K.), Kerala, Kollimalais and Sevarayans (T.N.), Kerala
26.	E. goniocalyx F.v.M	Spotted mountain gum, Monkey gum, mountain gray gum	Ranikhet, Almora (U.K.)
27.	E. gummifera (Gaertn.) Hochr	Blood wood, red blood wood	Nilgiri (T.N.)
28.	E. hemiphloa F.v.M	White box, grey iron box, gum topped box	Shimla (H.P.), Nilgiri (T.N.)
29.	E. intermedia R.T. Baker	Pink blood wood	Nandi Hills (K.A.)
30.	E. kirtoniana F.v.M.	Bastard mahogany	Dehradun, Ranikhet (U.K.); Lucknow (U.P.)
31.	E. leucoxylon F.v.M	White iron bark, yellow gum, blue gum	Shimla (H.P.), Panchgani, (M.H.), Nilgiri (T.N.).
32.	E. liniaris Dehn	White peppermint	Shimla (H.P.)
33.	E. longifolia Link and Otto	Woollybutt	Shimla (H.P.), Bangalore (K.A.)
34.	E. macarthurii Deane and Maiden	Camden, woollybutt, paddy's riverbox	Nilgiri
35.	E. maculata Hook	Spotted gum	Dehradun (U.K.), Srirangam island, Nilgiri (T.N), Bilaspur (M.P.).
36.	E. maculosa R.T. Baker	Red spotted gum	Shimla (H.P.)
37.	E. maideni F.v.M	Maiden's gum,	Shimla (H.P.)

		spotted blue gum	
38.	E. marginata Sm	Jarrah	Nilgiri (T.N.)
39.	E. melanophloa F.v.M	Silver leaved iron bark	Mandi (H.P.)
40.	E. melliodora A.Cunn	Yellow box	Dehradun (U.K.), Shimla (H.P.), Nilgiri (T.N.)
41.	E. microcorys F.v.M.	Tallow wood	Dehradun (U.K.), Nandi Hills (K.A.)
42.	E. nova-anglica Deane and Maiden	New England peppermint	Nandi Hills (K.A.)
43.	E. obliqua L'Herit	Messmate, messmate string bark	Nilgiri (T.N.)
44.	E. ovata Labil	Swamp gum	Saharanpur (U.P.), Shimla (H.P.)
45.	E. paniculata Sm.	Grey iron bark, iron bark	Dehradun, (U.K.), Saharanpur (U.P.), Nilgiri (T.N.), Poona (M.H.), Morni Hills (Haryana)
46.	E. pauciflora Sieb. ex Spr. (E. coriacea A. Cunn.)	Cabbage gum	Nilgiri (T.N.)
47.	E. pilularis Sm	Blackbutt	Nilgiri (T.N.)
48.	E. piperita Sm.	Sydney peppermint	Nilgiri (T.N.)
49.	E. polycarpa F.v.M	Longfruited blood wood	Yercad (T.N.)
50.	E. polyanthemos Sch.	Red Box	Almora, Dehradun (U.K.); Shimla (H.P.)
51.	E. propinqua Daene and Maiden	Small fruited grey gum, grey gum	Dehradun (U.K.), Kollimalais, Nilgiri (T.N.)
52.	E. punctata DC	Grey gum	Dehradun (U.K.), Shimla (H.P); Nashik (M.H.).
53.	E. radiata Sieb. ex DC	Grey peppermint	Dehradun (U.K.), Kulu (H.P.); Nilgiri (T.N.)
54.	E. regnans F.v.M.	Giant gum	Shimla (H.P.), Nilgiri (T.N.)
55.	E. resinifera Sm.	Red mahogany	Dehradun (U.K.), Shimla (H.P.), Nilgiri (T.N.)
56.	E. risdoni Hook.f.	Silver peppermint	Shimla (H.P.)
57.	E. robusta Sm	Swamp mahogany, swamp messmate	Ranikhet. Dehradun (U.K.), Barilly, Saharanpur (U.P.), Maharashtra, Nilgiri (T.N.)
58.	E. rossii Baker and Sm.	White gum	Nilgiri (T.N.)
59.	E. rudis Endl.	Moitch	Dehradun (U.K.), Hassan, Banglore (KA.), Delhi
60.	E. saligna Sm	Syney blue gum, blue gum	Ranikhet, Dehradun (U.K.), Amritsar (P.B), Shimla (H.P.), (M.H.)
61.	E. siberiana F.v.M	Silvertop ash, mountain ash, coast ash	Nilgiri (T.N.)

62.	E. siderophloia Benth	Broad-leaved ironbark	Dehradun (U.K.), Saharanpur (U.P.), Shillong (M.L.), Banglore (K.A.)
63.	E. sideroxylum (A.Cunn.) Benth	Mugga	Dehradun, Ranikhet (U.K.)
64.	E. staigeriana F.v.M	Lemon-scented ironbark	Dehradun (U.K.), Saharanpur (U.P.)
65.	E. stuartiana F.v.M	But But or apple	Shimla (H.P.), Dehradun (U.K.)
66.	E. tereticornis Sm. (=E. umbellata (Gaertn) Domin	Forest red gum, blue gum	Lalkua, Dehradun, Haldwani (U.K.); Saharanpur, Barilly, Lucknow, Plibhit (U.P.), Hazaribagh (C.G.), Mt. abu (R.J.), Srihrikota (A.P.); Hoshiarpur (P.B.), Sambhalpur (O.R.), Delhi, Mysore (K.A.), Ker., Bilaspur, Balaghat, Indore, Shivpuri (M.P.), Raipur (C.G.), Faridabad (Haryana).
67.	E. terminalis F.v.M.	Kulch or long fruited Bloodwood	Dehradun (U.K.), Mandla (M.P.)
68.	E. tessellaris F.v.M.	Carbeen or Moreton Bay ash	Banglore (K.A.), Coimbatore (T.N.)
69.	E. torelliana F.v.M.(Corymbia torelliana (F.v.M.) Hill and Johnson)	Cadagi	Dehradun (U.K.), Kollimalais (T.N.); Palghat (K.L.)
70.	E. viminalis Labill.	Ribbon gum, manna gum, white gum	Almora (U.K.), Shimla (H.P.)

4.2. Chemical composition of essential oil from eucalyptus leaves :(Table3)

S.no.	Eucalyptus species	Chemical composition
1.	E. citriodora	citronellal (48.3%), citronellol (21.9%), iso-isopulegol (12.7%) [38] citronellal (52.2%), citronellol (12.3%), isopulegol (11.9%) [38]
2.	E. camaldulensis	α-phellandrene (27.5%), β-pinene (23.5%), m-cymene (9.5%), 1,8-cineole (8.7%) 1,8-cineole (74.7%) [39]
3.	E. globulus	1,8-cineole (81.9%), limonene (6.6%),[40] 1,8-cineole (66.3%), cis-ocymene (21.3%), α-terpinyl acetate (3.4%) [41] 1,8-cineole (44.4%), limonene (17.8%), p-cymene (9.5%) [42] Á-thujene (0.26%), Á-pinene (11.46%), Camphene (0.12%), Beta-Pinene (18.54%), Beta-myrcene (0.30%), Alpha-phellandrene (2.06%),Para-cymene (1.60%),Eucalyptol (54.79%),Gamma-terpinene (0.97%),Alpha-terpinolene (0.15%),Alpha-pinene epoxide (0.04%),Alpha fenchyl alcohol (0.27%),Trans-pinocarveol (0.12%),Camphene hydrate (0.07%),Borneol (0.27%),4-terpineol (0.54%),Aplpha-terpineol (0.86%),Alpha-gurjunene(0.10%),Beta-caryophyllene

		(0.40%),Alloaromadendrene (0.34%),Alpha-humulene (0.07%),Trans-caryophyllene (0.09%),Epiglobulol (0.09%),Globulol (0.58%),Ledol (0.03%),Gamma-eudesmol (1.20%),Beta-eudesmol (4.68%) [43]
4.	E. tereticornis	caryophyllene, eudesmol, globulol, spathulenol and virdiflorol,1, 8-cineole, citronellal, citronellol, limonene, pinene, pinene, trans-pinocarveol, terpinolene, thujene[44]

5. CONCLUSION

This study has shown that essential oil of Eucalyptus different species grown in India possesses rather a good amount of eucalyptol (1, 8-Cineole) which determine the commercial value of oil. Beta-eudesmol is present in highest amount in India essential oil which is absent in all other countries. This study has to investigate essential oil components from Eucalyptus different species in India. Chemical composition of Eucalyptus trees were summarized in a table and the most quantity found in *E.globulus* in which 81% 1, 8- Cineol found.

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REFERENCES

1. Zrira, S. S., Benjilali, B. B., Fechtal, M. M. and Richard, H. H. (1992). Essential oils of twenty-seven Eucalyptus species grown in Morocco. Journal of Essential Oil Research, 4, 259-264.
2. Najem Ali, (2010), "Antagonistic activity evaluation of some plants extracts in control of algae and associated organisms" MSc. Thesis, Biology Department, of the College of Science, University of Baghdad .
3. A.E. Sadlon and D.W.Lamson, (2010), "Immune-Modifying and Antimicrobial Effects of Eucalyptus Oil and simple Inhalation Devices", Alternative Medicine Review, Vol.15 (1), pp. 33-47.
4. Bachheti, R. K.; Joshi, A.; Singh, A. International Journal of Chem Tech Research, 2011, 3(2), 625-628.
5. Elaissi, A.; Salah, K. H.; Mabrouk, S.; Larbi, M. K.; Chemli, R.; Skhiri, F. H. Food Chemistry, 2011, 129, 1427–1434.
6. Gilles, M.; Zhao, J.; Agboola, M. An. M. Food Chemistry, 2010, 119, 731–737.
7. Bachheti, R. K. Der Pharma Chemica, 2015, 7(2), 209-214.
8. Sulaiman, G. M.; Marzoog, T. R.; Mohammed, W. H.; Bagnati, R. American Journal of Agricultural and Biological Sciences, 2014, 9 (1),78-88.
9. Nasrabadi, M. R.; Pourmortazavi, S. M.; Nazarian, S.; Ahmadi F.; Batooli, International Journal of Food Properties, 2013, 16 (5), 1080-1091.
10. Madouri, L. H.; Asma, B.; Madani, K.; Ould, Z. B.; Said, Si.; Rigou, P,; Grenier, D.; Allalou, H.; Remini, H.; Adjaoud, A.; Makhlouf. L. B. Industrial Crops and Products, 2015, 78 148–153.
11. Sundar, S. S. Forest Development and Eucalyptus controversy in Karnataka, Workshop on Eucalyptus plantation, Indian Statistical Institute, Bangalore. 1984.

12. Joshi, R. K. Aroma profile of Eucalyptus globulus: collected from northwest Karnataka, India Scientific World, 2012, 10, (10), 89-90.
13. Tyagi, A. K.; Malik, A. Food Chemistry 2011, 126 (1), 228-235.
14. Samuelson G (1999). Drugs of Natural Origin: A Textbook of Pharmacognosy. Taylor & Francis Ltd.
15. M. Lahlou, "Screening of Natural Products for Drug Discovery," Expert Opinion on Drug Discovery, Vol. 2, No. 5, 2007, pp. 697-705. doi:10.1517/17460441.2.5.697
16. E. J. Jacob, "Natural Products-Based Drug Discovery: Some Bottlenecks and Considerations," Current Science, Vol. 96, No. 6, 2009, pp. 753-754.
17. Li P, Xu G, Li SP, Wang YT, Fan TP, Zhao QS, Zhang QW. Optimizing ultra performance liquid chromatographic analysis of 10 diterpenoid compounds in Salvia miltiorrhiza using central composite design. J Agric Food Chem. 2008;56(4):1164–71.
18. Li P, Yin ZQ, Li SL, Huang XJ, Ye WC, Zhang QW. Simultaneous determination of eight flavonoids and pogostone in Pogostemon cablin by high performance liquid chromatography. J Liq Chromatogr Relat Technol. 2014;37(12):1771–84.
19. Yi Y, Zhang QW, Li SL, Wang Y, Ye WC, Zhao J, Wang YT. Simultaneous quantification of major flavonoids in "Bawanghua", the edible flower of Hylocereus undatus using pressurised liquid extraction and high performance liquid chromatography. Food Chem. 2012;135(2):528–33.
20. Zhou YQ, Zhang QW, Li SL, Yin ZQ, Zhang XQ, Ye WC. Quality evaluation of semen oroxyli through simultaneous quantification of 13 components by high performance liquid chromatography. Curr Pharm Anal. 2012;8(2):206–13.
21. Du G, Zhao HY, Song YL, Zhang QW, Wang YT. Rapid simultaneous determination of isoflavones in Radix puerariae using high-performance liquid chromatography-triple quadrupole mass spectrometry with novel shell-type column. J Sep Sci. 2011;34(19):2576–85. Guenther, E; "The Essential Oils", Vol.l; Robert E. Kreiger Publishing Co., New York, 1972
22. William, M, "McGraw-Hill Encyclopedia of Science and Technology", Vol.5, McGraw-Hill Inc ., U.S.A, 1982
23. Austin, G.T, "Shreve's Chemical Process Industries", 51 H edition; McGraw-Hill Book Company, Singapore, 1984
24. Fairman, R.M, "Distillation of Essential Oils; Bulletin No.94 ofFAO Agricultural Services, Rugby, UK, 1999
25. J. Kabuba and R. Huberts, (2009), " Steam Extraction of Essential Oils: Investigation of Process Parameters", The Canadian Journal of chemical Engineering, Vol. 87, PP. 915-920.
26. Rahul Khandge, Sushank Sane, Nikhil Khatri, Nitin Satao Extraction of Essential oils: Eucalyptus Oil Extraction Techniques and methods.
27. Jiangxi Province Jishui County Hongda Natural Perfume Co.,(2010), " DATA SHEET OF EUCALYPTOL".
28. Shyam Sunder. 1984. Forest development and Eucalyptus controversy in Karnataka. In: Workshop on Eucalyptus plantations, Banglore, 29 June 1984. Proceedings. Bangalore, Indian Statistical Institute.
29. Wilson, J. 1973. The need for a rational utilization of the montane temperate forests of South India. Indian Forester, 99(12): 707-716.
30. Dabral, B.G.; Raturi, A.S. and Singhal, R.M. 2000. Water balance in Eucalyptus plantations. In: Singhal, R.M. and Rawat, J.K. Eds. Effect of growing Eucalyptus. Dehradun, F.R.I. pp. 105-126. Chaturvedi, A.N. 1976. Eucalyptus in India. Indian Forester, 102(1): 57-63. FAO (Food and Agriculture Oganisation of the United Nations). 1979. Eucalyptus for planting. Rome, Food and Agriculture Organisation of the United Nations. 677p.
31. Parker, R.N. 1925. Eucalyptus in the plains of North West India. Indian Forest Bulletin,(New Series) Botany, 61: 1-34.
32. Bhatia, C.L. 1984. Eucalyptus in India – Its status and research need. Indian Forester,110(2): 91-96.
33. Sahni, K.C. and Bahadur, K.N. 1972. In: Symposium on Man Made Forests in India,Dehradun , 8-10 June, 1972. Proceedings and technical papers. Dehradun, Society of Indian Foresters. pp.1-13.
34. H.B. Naithani, Botany of Genus Eucalyptus, page no 16-18.
35. Batish D.R., Singh H.P., Setia N., Kaur S., Kohli R.K. Chemical composition and phytotoxicity of volatile essential oil from intact and fallen leaves of Eucalyptus citriodora. Z. Naturforsch. 2006;61:465–471. doi: 10.1515/znc-2006-7-801.

36. Debbarma J., Kishore P., Nayak B.B., Kannuchamy N., Gudipati V. Antibacterial activity of ginger, Eucalyptus and sweet orange peel EOs on fish-borne bacteria. J. Food Process. Preserv. 2013;37:1022–1030.
37. Gupta A., Sharma S., Naik S.N. Biopesticidal value of selected EOs against pathogenic fungus, termites, and nematodes. Int. Biodeterior. Biodegard. 2011;65:703–707. doi: 10.1016/j.ibiod.2010.11.018.
38. Pant M., Dubey S., Patanjali P.K., Naik S.N., Sharma S. Insecticidal activity of Eucalyptus oil nanoemulsion with karanja and jatropha aqueous filtrates. Int. Biodeterior. Biodegard. 2014;91:119–127. doi: 10.1016/j.ibiod.2013.11.019.
39. Tyagi A.K., Malik A. Antimicrobial potential and chemical composition of Eucalyptus globulus oil in liquid and vapour phase against food spoilage microorganisms. Food Chem. 2011;126:228–235. doi: 10.1016/j.foodchem.2010.11.002.
40. Joshi A, Sharma A, Bachheti R. K, Pandey D. P. A comparative study of the chemical composition of the essential oil from Eucalyptus globulus growing in Dehradun (India) andaround the world. Orient J Chem 2016;32(1)
41. Zhang J, An M, Wu H, Stanton R, Lemerle D. Chemistry and bioactivity of Eucalyptus essential oils. Allelopathy Journal. 2010 Apr 1; 25(2).