Analyzing the Chemical Compositions and Yield of Eucalyptus globulus Oil Grown in Various Indian Geographic Locations

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Abstract:

The productivity and quality of eucalyptus oils are affected by different regions geographical climatic conditions. Therefore, this study aims to explore and determine the yield and chemical composition of essential oil extracted from eucalyptus leaves which has grown in various locations of India. The essential oil was extracted from the leaf using a hydro-distillation-Clevenger apparatus technique. The yield of eucalyptus oil varied from 0.70-1.22 % (w/w) which depends on plant growing location. The chemical composition was analyzed using a gas chromatography–mass spectrophotometry (GC-MS). The major components of eucalyptus oil were determined to be 1,8-cineole (eucalyptol) (48.48%–79.6%) and pinene (3.63%–24.84%). The highest composition of 1,8-cineole and pinene was obtained from the extracted eucalyptus oil from Haridwar (Uttarakand) and Kanpur (Uttar Pradesh), respectively.

Keywords: Eucalyptus, Essential oil; Yield; 1,8-cineole ; α-pinene.

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1. INTRODUCTION

Modern perspectives indicate that they are made from natural raw materials through a variety of extraction techniques. Essential oils (EO) primarily consist of hydrocarbons, aromatic compounds, terpenes, and their oxygenated derivatives (alcohols, esters, mono- and sesquiterpenoids) [1,2]. Aromatic herbs and their volatile oils have been used for thousands of years to create flavor and scents, as a condiment or spice, in complementary and alternative medicine, as antibacterial and antifungal agents, and to keep insects away from stored goods [3, 4]. Because consumers are becoming more interested in natural products and are becoming more concerned about synthetic chemical additives that may be hazardous, the use of essential oils (EO) as functional components in beverages, snacks, cosmetics, and toiletries is booming [5, 6]. Volatile oils are definitely promising in terms of their application as effective antibacterial and therapeutic agents because of their bioactive chemical components. The use of EO in the food and pharmaceutical industries is becoming more and more significant, making a comprehensive evaluation of the phytochemical extracts necessary [2,7,8].

In addition, a variety of technological and agrobiological elements, as well as the climate, growing site, length of storage, and storage conditions, all affect the quality of EO. To create natural flavor products, there are a few traditional methods for extracting essential oils. The ratio of components in essential oil (EO) and the amount of unwanted contaminants (pesticides) can be determined by the chemotype of the armatic plant and the apparatus used for EO extraction.

Many volatile oils have been utilized to increase the shelf-life of food, drink, pharmaceutical, and cosmetic items; their antioxidant and antibacterial properties have also suggested a role in plant preservation. These oils are primarily found in spices and herbs, but they can also be found in eucalyptus. The antibacterial qualities of volatile oils and the components that make them up from a wide range of plants have been evaluated and reviewed because of the great diversity of applications, both real and potential [10].

Eucalyptus essential oil, commonly referred to as Nilgiri oil, is extracted from Eucalyptus globulus, a member of the Myrtaceae family. The strong, long, narrow bluegreen leaves, creamy white blooms, and smooth, pale bark of eucalyptus trees are found in approximately 500 species [11]. For instance, Eucalyptus globulus dried leaf extracts dissolved in hot water have long been used as analgesic, anti-inflammatory, and antipyretic treatments for respiratory infection symptoms such nasal congestion, colds, and the flu. The food, pharmaceutical, and cosmetics industries all make extensive use of eucalyptus globulus essential oils [11].

In this context, it is commercially available to treat the common cold and other symptoms of respiratory tract infections using the alcohols and monoterpenoid components of the volatile compounds of Eucalyptus globulus essential oils [12]. Numerous Eucalyptus species have different monoterpene profiles, which may have different therapeutic benefits, according to phytochemical analysis [13]. The concentration of 1,8-cineole (eucalyptol) in medicinal oils is significant, whereas the overall fragrance characteristics and/or the presence of a specific ingredient, like citronellal, are important in perfumery oils.

The objective of this research is to quantify the comparative yield percentage and extract essential oil from the leaves of Eucalyptus globulus plants grown in Gwalior, Madhya Pradesh, Kanpur, Uttar Pradesh, and Hardwar, Uttarakhand. After that, the chemical composition of the extracted Eucalyptus globulus essential oil was assessed using Gas Chromatography Mass Spectrometry (GC-MS).

2. MATERIALS AND METHODS

2.1 Extraction and Yield of Essential Oils

Leaves of Eucalyptus globulus that were collected from three different locations: Gwalior, Madhya Pradesh; Kanpur, Uttar Pradesh; and Hardwar, Uttarakhand.Eucalyptus essential oil was extracted by hydrodistillation - Clevenger distillation method (Figure 1.). The basic hydrodistillation process is conducted on 2500 mL of water was added to 300 g of Eucalyptus leaves. The mixture then was put into a Clevenger distillation flask (5000 ml.). The volume of essential oil (mL) was collected after 8 hrs distillation continuously. Finally, the essential oil was dehydrated (de-moisture) by sodium sulphate. The distillation yield of the obtained essential oil was calculated using following equation:

$$\textbf{Yield\% of Essential oil} = \frac{\textbf{Weight of Oil}}{\textbf{Weight of material}} \times \textbf{100}$$

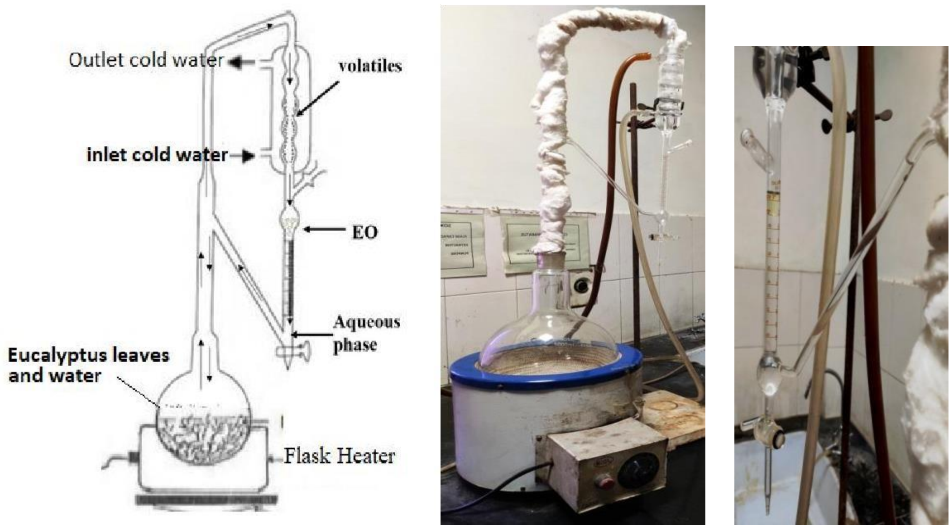
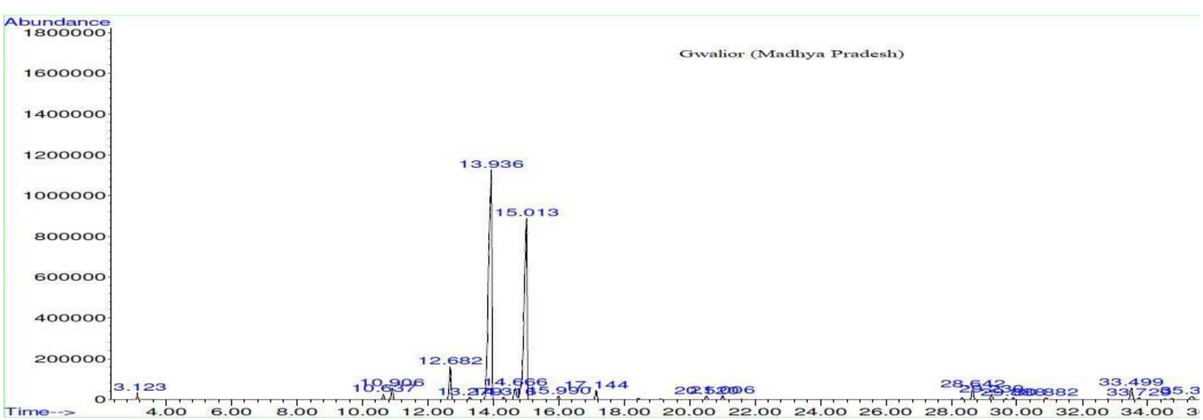


Figure-1. Hydrodistillation-Clevenger method

2.2 Assessment of Chemical Composition

2.2.1 Gas Chromatography Mass Spectrometry (GCMS)

Gas chromatography mass spectrometry (GCMS) was used to determine the chemical composition of the extracted EO from Eucalyptus globulus. The gas chromatograph Agilent 6890 was coupled to a selective mass detector Agilent 5976. The ultra performance HP-5Methyl Silicone column (50 m × 0.25 mm i.d.; 0.25 µm film thickness) and split/splitless injector at 40 C/min ramp rate, along with the Library NIST Mass Spectral Search Program were utilized. Injecting 0.2 µl with a split injection ratio of 70:1. The oven was set to 50°C for two minutes, then increased by 10°C every minute until 200°C was reached. The test was conducted at 250°C. The flow was of 0.7 µl/min at a constant speed of 30 cm/s with a 250°C interface. spectral database and from retention times and mass spectra of standard compounds. Figure 2 shows the relative amounts of detected compounds were calculated based on GC-MS peak areas.



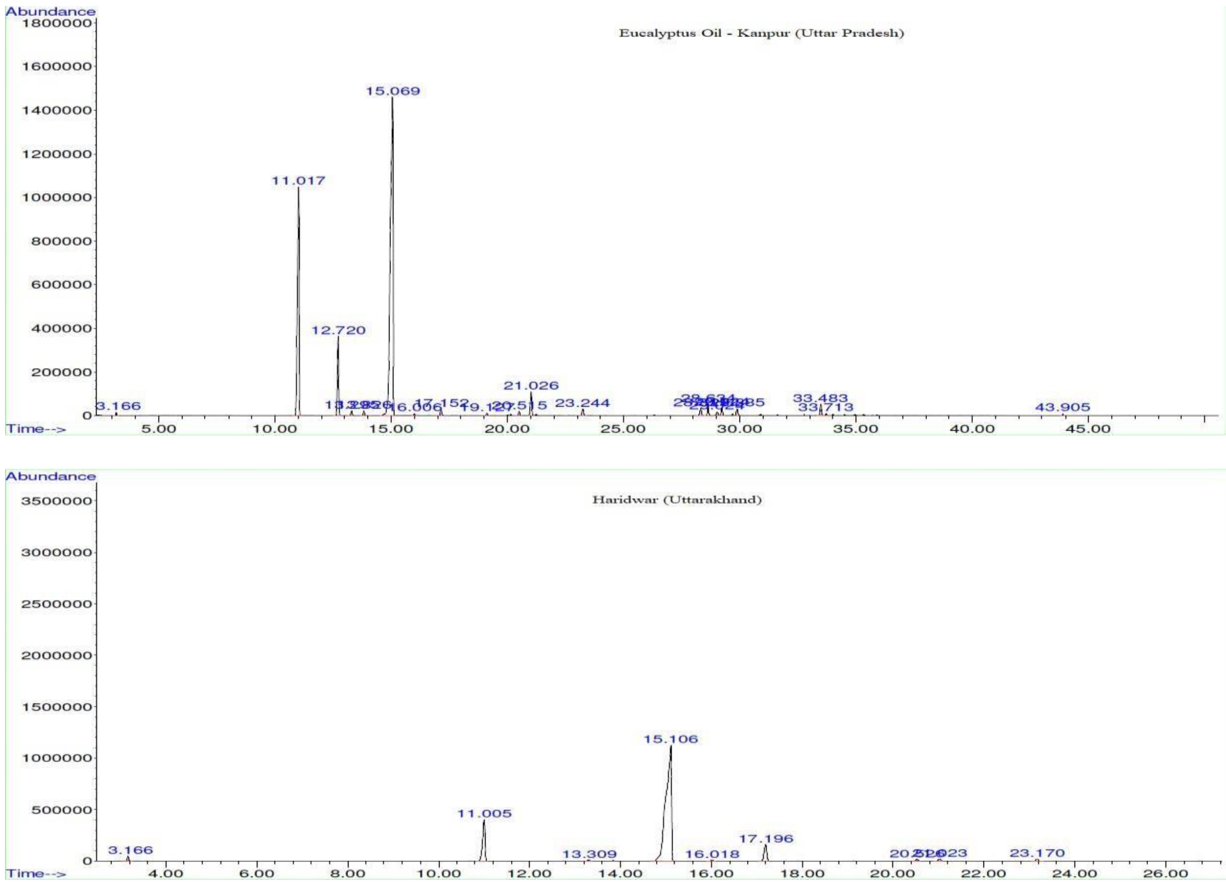


Figure 2: Relative amounts of the compounds based on GC-MS peak areas.

3. RESULTS AND DISCUSSION

The yield of essential oil eucalyptus In Gwalior (M.P.), Kanpur (U.P.), and Haridwar (U.K.), the percentage yield of essential oil obtained from the Clevengar-hydro distillation process of the fresh leaves of E. globules was 0.70%, 0.95%, and 1.22% (w/w), respectively. According to reference [14], the fresh leaves of Eucalyptus globulus had the highest EO value of 1.63% and the lowest value of 0.15%.

3.1 Chemical composition of essential oil

Gas Chromatography-Mass Spectroscopy was used to determine the chemical composition of the extracted essential oil (EO) from Eucalyptus globulus. Under the previously mentioned circumstances, the EGEO's GC/MS total ion chromatogram was acquired; the results are displayed in Table 1. GC-MS analyses demonstrated that the main component was 1,8-cineole (79.6%) from Haridwar (U.K.), followed by α-pinene (12.76%), 1,8-cineole (59.27%) from Kanpur (UP), and 1,8-cineole (48.48%) from Gwalior (MP), followed by α-pinene (3.63%). Climate and geography have been identified as contributing factors to these variations. Additional factors could be the distillation method, plant age, and harvest time.

Its importance as a raw material for a variety of industries and its business value are assessed by 1,8-cineole. A variety of 1,8-cineole percentages have been reported for E. globules leaf oil: 64.5% in Uruguay, 77% in Cuba, 86.7% in California, 58% to 82% in Morocco, 48.7% in Africa, and 50% to 65% in Argentina [15]. These findings demonstrate that each species of tree's volatile oil has a unique chemical composition, both quantitatively and qualitatively. The components that were found to be dominant were 1,8-cineole, α, and β-pinene. Also ascertained were the constituents mentioned in Table 1 [11,13, 16].

Table 1. Chemical Compositions of Eucalyptus globulus oil from growing different Geographical Location in India

No	Compound	Content (%)		
		Gwalior (M.P.)	Kanpur (U.P.)	Haridwar (U.K.)
1.	Butanal, 3-methyl	3.36	3.16	0.78
2.	1-Butanol, 3-methyl	0.20	-	-
3.	1-Butanol, 3-methyl-, acetate	0.10	-	-
4.	Bicyclo[3.1.0]hexane, 4-methyl-1-1-methylethyl), didehydro deriv.	0.48	-	-
5.	alpha.-Pinene	3.63	24.84	12.76
6.	5-Hexyn-1-ol	-	-	0.21
7.	Bicyclo[3.1.1]heptane, 6,6-dimethy l-2-methylene-,	8.32	-	-
8.	Beta pinene	-	6.70	-
9.	beta.-Myrcene	0.82	0.36	-
10.	alpha.-Phellandrene	17.83	0.36	-
11.	1,3-Cyclohexadiene, 1-methyl-4-(1-methylethyl)	0.32	-	-
12.	Benzene, 1-methyl-2-(1-methylethyl)	1.84	-	-
13.	1, 8- cineole	48.48	59.27	79.61
14.	(+)-4-Carene	-	0.49	0.66
15.	Bicyclo[4.2.0]oct-1-ene, 7-exo-ethenyl	-	0.15	5.08
16.	Cyclopropane	-	-	0.36
17.	1,4-Cyclohexadiene, 1-methyl-4-(1-methylethyl)	0.59	-	-
18.	2-Furanmethanol, 5-ethenyltetrahydro	0.05	-	-
19.	Dimethyl(1-methylvinyl)chlorosilan	-	0.34	-
20.	Cyclohexene, 1-methyl-4-(1-methylethylidene)	2.71	-	--
21.	1-Butene, 3-chloro-2-methyl	-	-	0.54
22.	Bicyclo[3.1.1]hept-2-ene, 3,6,6-trimethyl	0.07	-	-
23.	1,4-Cyclohexadiene, 1-methyl-4-(1-methylethyl)	0.22	-	-
24.	1,4-Cyclohexadiene, 1-methyl-4-(1-methylethyl)	0.14	-	-
25.	Isoborneol	0.11	-	-
26.	3-Cyclohexen-1-ol, 4-methyl-1-(1-methylethyl)	0.89	-	-
27.	3-Cyclohexene-1-methanol,	0.93	2.18	-
28.	2-Cyclohexen-1-one, 3-methyl-6-(1-methylethyl)-	-	0.57	-
29.	Cyclohexene, 1-methyl-5-(1-methylethenyl)	0.06	-	-
30.	2-Butyn-1-ol	0.13	-	-
31.	2-Oxabicyclo[2.2.2]octan-6-ol	0.08	-	
32.	Cyclohexene, 1-methyl-4-(1-methylehylidene)	5.55	-	
33.	Eugenol	0.10	-	
34.	Phenol, 2,2'-[(hydroxyimino)bis(4,5-dihydro-5,3-isoxazolediyl)]bis	0.04	-	
35.	Cyclohexanol, 2-methyl-5-(1-methylethenyl)	0.10	-	
36.	3H-3a,7-Methanoazulene, 2,4,5,6,7, 8-hexahydro-1,4,9,9-tetramethyl	-	0.61	

37.	1H-Cycloprop[e]azulene, decahydro1,1,7-trimethyl-4-methylene	0.16	1.57	
38.	1-Methylene-2b-hydroxymethyl-3,3-dimethyl-4b-(3-methylbut-2-enyl)-cyclohexane	0.04	-	
39.	Caryophyllene	-	1.01	
40.	Tricyclo[4.1.0.0(2,4)]heptane, 3,3,7,7-tetramethyl-5-(2-methyl-1-propenyl)	0.11	-	
41.	Azulene, 1,2,3,3a,4,5,6,7-octahydro-1,4-dimethyl-7-(1-methylethenyl)	1.77	-	
42.	Naphthalene, 1,2,3,4,4a,5,6,8a-octahydro-4a,8-dimethyl-2-(1-methylethenyl)	0.30	0.71	
43.	1H-Indene, 1-ethylideneoctahydro-7a-methyl	0.09	-	
44.	Cyclohexanemethanol, 4-ethenyl-.alpha.,.alpha.,4-trimethyl-3-(1-methylethenyl)	0.12	-	
45.	1H-Indene, 1-ethylideneoctahydro-7a-methyl-, cis	0.23	-	
46.	2,4,4-Trimethyl-1-hexene	--	0.07	

4. CONCLUSIONS

This work compares the yield and chemical properties of essential oils that Eucalyptus globulus produces when it grows in three different locations in India. Notwithstanding the type oil similarity between the subspecies, climatic, edaphic, and altitude variations in both quality and quantity have been observed. The overall findings showed that the two main molecules in all of the samples under study were α-pinene and eucalyptol, also known as 1,8-cineole. By inhibiting pro-inflammatory cytokines, eucalyptol can help patients with asthma and regulate hypersecretion of mucus in their airways. Accordingly, this analysis indicates that eucalyptus essential oils may meet market demands and have applications in the pharmaceutical and commercial domains. Furthermore, our findings represent a first step toward the establishment of standard chemical profile values for a locally produced good that is of industrial interest.

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