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Studies on oil content and foliage yield of *Eucalyptus pellita* in agro climatic zone -9 of Karnataka*

Lot of research has been conducted on medicinal properties of Eucalyptus species. The genus Eucalyptus was described and named in 1788 by the French botanist Heritier. Out of 700 different species of Eucalyptus in the world, about 500 produce a type of essential oil. Although about 300 species of Eucalyptus have been shown to contain volatile oils in their leaves, only a few are important as far as commercial production of essential oils is concerned.

The Eucalyptus oils and their main component (1,8-sineole) are largely used in the preparation of liniments, inhalants, cough syrups, ointments, toothpaste and also as pharmaceutical flavours in veterinary practice and dentistry. While being used as fragrance component in soaps, detergents and toiletries, they have little use as perfumes. The oils of Eucalyptus species have also antioxidant properties and anti-inflammatory effects because of 1,8-cineole (Santos and Rao, 2000). *Eucalyptus pellita* the specific name comes from the Latin word 'pellitus', meaning 'covered with a skin', which probably refers to the epidermis of the leaves. The type of description refers to the moderately thick covering. The common name refers to the fruit size in comparison with *E. resinifera* and *E. notabilis* (Dombro, 2010).

Eucalyptus pellita is a medium to tall size tree with good form that can grow up to 40 m or more in height and 1 m in diameter. Attributes that make it an attractive species for plantation include fast growth, good coppicing ability, and adaptability to a wide range of environments, good resistance to pests and diseases and suitability for a variety of timber products. Since the 1980s, the species have been tested in many countries including China, Brazil, India, South Africa, Thailand and the Philippines as well as in Australia (Doran and Turnbull, 1997). Natural oil is a by-product of *Eucalyptus pellita* cultivation. Oil obtained from the tree is essentially monoterpenoid. Monoterpenes are emitted by forests and form aerosols that can serve as cloud condensation nuclei. Such aerosols can increase the brightness of clouds and cool the climate, which is important in the struggle against climate change.

Nearly all the species of Eucalyptus have oil producing glands in their leaves which produce oils impact characteristic odour to their leaves. These oils are called "essential oils" and comprise a range of natural oils which together give to the leaves main essential oils. Their properties are as follows: Cineol: used in pharmaceuticals and as stain remover, Phellandrine: used in industry as a solvent and as floatation for metals- its presence is prescribed by pharmacopoeia in essences intended to be used for pharmaceuticals, Terpineol: used in perfumery, Eudesmol: fixative for perfumes and Piperitone: raw material for synthetic thymol and menthol. The percentage and composition of Eucalyptus oils vary from species to species as well as from region to region due to different agro-climatic environments (Zafar *et al.*, 2003).

The present study was conducted in Agro-climatic Zone-9 of Karnataka. An experiment was conducted in the already established four year old Eucalyptus pellita F. Muell plantations. Four experimental plots were chosen in the Western Ghats based on the rainfall data of that area. The Western Ghats constitute a chain of hills that run along the entire West coast of India for about 1200 km. The part of Western Ghats in Karnataka is located between 13^0 to 16^0 N latitude and 74^0 to 76^0 E longitude and extended over an area of 2000 km^2. Uttar Kannada and Shimoga districts exhibit a wide range of climate and topographic situations. These districts come under the Agro-climatic Zone-9 of Karnataka *i.e.,* Hilly Zone, which is highly deforested with consequent laterization forming flat hills with practically no vegetation. The step edge of the plateau occurring at an average altitude of 600 m above MSL is well forested (Table 1).

The Uttar Kannada and Shimoga districts lie between 14^0 09' N to 14^0 41' N latitude and 75^0 02' E to 75^0 14' E longitude. The districts under Hilly zone were divided in to four sites based on the topography and other climatic variables *viz.,* rain fall, number of rainy days, temperature etc. The rainfall in these sites ranges varies 500-3500 mm per year and the altitude ranges between 596 and 622 m. Plantations with uniform spacing of 2 m x 2 m were located in each of the rainfall areas (Table 1).

Enumeration of *Eucalyptus pellita* stands was carried out n selected plantations. Four quadrates of size 20 m x 20 m were laid out randomly in each plantation.

For foliage biomass estimation, leaves from the representative trees were collected; fresh weight of the foliage was measured with the help of appropriate Spring Scale, based on which total foliage biomass of the plantation was calculated.

Fresh leaf samples from mature *Eucalyptus pellita* were collected from different regions of Hilly Zone of Karnataka, India. The leaves were packed in polythene bags and transferred to laboratory**.** Freshly collected 100 to 200 g leaves were hydro distilled for three hours for complete extraction of essential oil by using a commercial Clevenger-type apparatus. The moisture in the oil samples was removed by adding anhydrous sodium sulfate.

Table 1. Site factors of the study area

Treatment	Locality	District	Latitude	Longitude	Altitude (in m)	Mean annual rain fall (mm)	Annual No of rainy days	Mean annual temperature (^{0}C)	Relative humidity (%)
T_1	Sammasagi	Uttar Kannada	$14^041'$ N	$75^002'$ E	612	500-1000	75	33	75
T_2	Sorab	Shimoga	$14^022'$ N	$75^005'$ E	597	1500-2000	95	31	79
T_3	Sagar	Shimoga	$14^009'$ N	$75^002'$ E	596	2000-2500	100	29	86
T_4	Teerthahalli	Shimoga	$13^041'$ N	$75^014'$ E	622	3000-3500	115	28	90

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The amount of extracted oil was determined and yield (%) of the extracted oil from each sample was calculated on the basis of Eucalyptus leaves. Colour and aroma of the oil samples were recorded by visual observations and odour. The chemical composition of essential oil was determined by chromatography technique.

The data on growth and foliage yield of *E. pellita* F. Muell were analyzed by Randomized Block Design (RBD) where site conditions were the treatments. The data were analyzed by using MSTAT C programme on a PC.

The four regions of Hilly zone studied in this investigation showed variation in the leaf biomass. Among these regions, Teerthahalli (13,115 kg/ha), showed highest leaf biomass followed by Sagar (10,355 kg/ha), Sorab (5,962 kg/ha) and lowest in Sammasagi (5,685 kg/ha) (Table 2). The yield from Eucalyptus varied from 5.685 to 13.115 tones per ha in all the sites. These results may be attributed to the differential mean annual rainfall of the particular site. The plantation in Teerthahalli had higher leaf yield per hectare because of higher rainfall of the site and it was characterized by higher mean annual rainfall of 3000 to 3500 mm and more number of rainy days (125) and adequate moisture availability (Table 1). It might have enhanced the growth and yield of foliage. The climatic factors, edaphic factors and addition and incorporation of organic matter and high microbial activities in the soil resulting in the production of high amount of leaves might have produced higher biomass.

The observations of Ravat *et al*. (2008) are worth mentioning here. They observed that the biomass yield from Eucalyptus varied from 39.4 to 738.98 kg per tree and from 77.29 to 223.46 tones per ha in all the sites. Productivity varied from 2.57 tones per ha per year (at 32 years) to 9.31 tones per ha per year (at 24 years). The contribution of individual tree components to total biomass varied as leaf (1.41 to 4.29%), twig (2.92 to 6.31%), branch (10.95 to 19.98%), bark (6.65 to 10.69%), root (15.29 to 20.61%), and bole (42.86 to 56.33%). The per cent contribution of all the tree components in all the sites in order of bole followed by root, branch, bark, twig and leaf.

The essential oil content of the leaf samples of *Eucalyptus pellita* from Agro-climatic Zone-9 (Hilly Zone) of Karnataka state showed significant variations in the oil potential as well as in the chemical composition of essential oils. The amount of essential oil was obtained by hydro distillation using a Clevenger-type apparatus. All the extracted essential oils from all the *E. pellita* plants under study were of pale yellow to yellow coloured mobile liquids having camphor like smell predominantly of 1, 8-cineole (Table 2). It may be recalled here that the highest oil yield was obtained with fresh leaves of *E. pellita* F. Muell from Sorab samples (0.44%), while the lowest was from Teerthahalli samples (0.26%). The odour of oils from Sorab and Sagar was characteristic perfume, while it was perfume for oils from Sammasagi and Teerthahalli. Oil colour was found to be pale yellow to yellow of Sammasagi samples and that of Sorab was yellow, while it was pale yellow for oils from Sagar and Teerthahalli.

The oil yield in any given situation is determined by the rate at which foliage biomass accumulates between successive harvests and the concentration of oil in the leaves. On the other hand, biomass production in oil plantations is strongly influenced by the climatic and edaphic features of a given planting site and the quality of establishment of plantings (Wildy *et al.*, 2000). The bioactivity of the essential oil depends upon the type and nature of the constituents and their individual concentrationas and which are highly determined by the genotype. However, the environment may also influence the oil yields. Leaf oil yield further varies markedly between seasons and in relation to site-specific edaphic factors including season, location, climate, soil type, leaf age, fertility regime, the method used for drying the plant material and the method of oil extraction (Doran and Bell, 1994).

The four regions of Hilly zone showed different oil yields (0.26 - 0.44%). Among these regions, Sorab, showed highest oil percentage in *Eucalyptus pellita* leaves followed by Sagar, Sammasagi and lowest in Teerthahalli (Table 2). Zafar *et al*. (2003) also reported higher results regarding oil potential of different Eucalyptus species (0.58 - 1.47%) from Faisalabad (Pakistan). Wildy *et al*. (2000) investigated four promising Eucalyptus species from Western Australia at six locations and reported 0.01 - 13.0 per cent oil production. They attributed these observations to different agro-climates and soil composition.

It may be inferred from the present study that *E. pellita* is a potential source of essential oil with ability to grow in diverse type of climatic conditions. Looking at its potential it may be further characterized for inclusion in various cosmetics, medicinal and pharmacological attributes.

Abd EL Mageed *et al.* (2011) reported that 2.5 ml was the highest value of oil yield obtained with the dry leaves of *Eucalyptus camuldulensis*, while the lowest value of 1.4 ml from *E. resinifera*. Oil odour of *E. citrodera* and *E. gomphocephala* was characteristic perfume, while it was perfume for *E. camuldulensis* and *E. resinifera*. Oil colour was found to be pale yellow to yellow. They observed that the production of

Table 2. Leaf biomass, oil yield, oil colour and odor from *Eucalyptus pellita* and market value of oil

Treatment	Locality	Leaf biomass	Oil (%)	Oil yield (lit/ha)	Market value (`/lit)	Market value of oil (`/ha)	Oil colour	Oil odour
T_1	Sammasagi	5685	0.33	18.76	1900	35,644	Yellow	Perfume
T_2	Sorab	5,962.5	0.44	26.24	1900	49,856	Yellow	Characteristic Perfume
T_3	Sagar	10,355	0.39	41.25	1900	78,299	Pale Yellow	Characteristic Perfume
T_4	Teerthahalli	13,115	0.26	34.10	1900	64,790	Pale Yellow	Perfume

essential oil depended on the site conditions and the yield of the species. The oil yield also depended on the geographical location, climatic factors, age (maturity of plants), parts of the plant etc.

Haq *et al.* (2007) reported highest (1.33%) and lowest (0.29%) oil content in the leaves of *Eucalyptus crebra* collected from Shekhupura and Bahawalnagar, respectively. The soil of district Shekhupura and Lahore was found to be very fertile for essential oil production from *E. crebra* leaves. Chalchat *et al.*, 2001 reported that the amount of essential oil obtained by hydro distillation from the dried leaves varied from 0.63 to 1.59 per cent and compared well with available literature.

The present study focuses on less utilized Eucalyptus leaves for extraction of economically useful medicinal oils. The cultivators need to be informed about the importance of Eucalyptus leaves for getting value based bye-products.

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