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Effect of seasonal variation on growth and oil yield in *Ocimumafricanum* Lour

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Abstract
Essential oil extracted from different parts of the *Ocimumafricanum* Lour. and its chemical constituents affected by two seasons namely summer and winter growing variation were investigated. The hydro distilled essential oil content from different parts of the plant obtained from summer and winter season ranges from 0.2% to 0.6%. However, the highest essential oil content (0.3% to 0.6%) was recorded in summer and lowest oil content (0.2% to 0.3%) was recorded in winter season. The essential oil consists of Citral II is the most abundant component followed by Citral I. The highest amount of Citral I obtained from different parts of *O.africanumviz*., whole herb (42.5%), leaf (43.5%), stem (44.8 %) and inflorescence (39.9%) collected during summer was observed and Citral II was followed by Citral I (33.7%, 36.2%, 36.2% and 34.6% respectively). Whereas other essential oil components *viz*., Citronellol, Linalool and geraniol content was higher in different parts of plant obtained during winter season compared to summer season and rest of the essential oil content were higher in summer season compared to winter season. Similarly, growth parameter viz., plant height (65.8 cm), number of branches (23), number of leaves (435 no.) and leaf area (14.68 m^2) were also higher in summer season compared to winter season.

Keywords: summer, winter, essential oil and seasonal variation

Introduction

Ocimumafricanum Lour. (Lemon-scented basilvar. CIM-Jyoti) is a short duration herb with 70-80 days of life span belongs to family Lamiaceae. The variety 'CIM-Jyoti' of *Ocimum*has been developed through intensive breeding efforts for high yield of herb and essential oil with desirable quality of higher citral content (68–75%). The variety CIM-Jyoti consistently shows higher herbage, oil content and citral in the field evaluation trials. The average herb yield and oil yield in CIM-Jyoti were 200 q/ha and 150 kg/ha respectively. The essential oil having good amount of citral is in high demand. The lemongrass crop is the only source of essential oil for the extraction of citral. However, lemongrass is a 4–5 year crop and farmers hesitate to cultivate the lemongrass crop for such a long time in their fields. Farmers would like to take this type of oil from a short duration crop without disturbing their traditional cereal and other crops. This variety will produce citral in a short duration of 70–80 days. It also fits in crop rotation/ intercropping between wheat and paddy and with other vegetable crops of small farmers. Leaves of this variety can also be used in lemon tea.

The variation in chemical composition of the essential oils is known to vary with the seasonal variation (Senthilkumar and Venkatesalu, 2010) [1]. Rao *et al.* 1996 [2] indicated that the lowest values of essential oil content, linalool as well as the maximum values of citronellol for rose-scented geranium (*Pelargonium* species) resulted in summer months. On the other hand the percentage of geraniol was the highest during cool winter season months followed by rainy and autumn season months; isomenthone and γ-eudesmol did not exhibit any definite seasonal trends. *Santolina rosmarinifolia* essential oil yields increased in the months of March, April, May and June (Pala-Paula *et al*., 2006) [3]. Also, Pala-Paula *et al*., 2006 [3] found that there is a significant correlation between *Santolina rosmarinifolia* essential oil and temperature. The composition of essential oil obtained from *O.gratissimum*l eaves in different seasons of the year was reported by Murbach Freire *et al*. 2006 [4], the amounts of phenylpropanoid eugenol and the monoterpene 1, 8-cineole were the maximum in all four seasons. In the essential oil extracted in the spring the sesquiterpene components appear in the highest relative percentage, whereas monoterpene linalool was not detected in autumn. Chemical composition of the essential oils from aerial parts of basil (*Ocimum basilicum* L.) as affected by four seasonal, namely summer, autumn, winter and spring growing variation were investigated. The maximum amounts were observed in winter while minimum in summer, samples collected in winter were found to be richer in oxygenated monoterpenes, while those of summer were higher in sesquiterpene hydrocarbons. The contents of most of the chemical constituents varied significantly with different seasons (Hussain, 2008) [5]. The maximum amount of essential oil extracted from *Tetradeniariparia* Hochst. Could was resulted in winter and the minimum was in spring (Gazim *et al*., 2010) [6]. Independent of season, among which thymol was the main component of *Origanum syriacum*essential oil in the summer and *p*-cymene was the compounds occurred in lower amounts, γ–Terpinene ranged from 0.6 - 19.1% and its maximum level was observed in summer, α–terpinene varied between 0.7 - 4.9% and the maximum level detected in summer season, carvacrol values ranged from 0.7 - 8.9% with the maximal value spring. To obtain favorable phenol content of the oil, *O. syriacum* should be harvested in summer months (Toncer *et al*., 2010) [7]. The chemical composition of the volatile oils of *L. flavescens* and *L. petersonii* did not show any significant seasonal variation in the major components, while for *Leptospermum madidum* subsp. sativum the levels of major constituents of the volatile oils varied with the harvest season (Demuner *et al*., 2011) [8]. The composition of the *Pimentapseudocaryophyllus* (Gomes) essential oil changed month by month. The best yield of oil was obtained in November, and the major component chavicol was present in all samples. The chavicol content showed significant seasonal variation, with the maximum percentages of 69.1% and 70.9% measured in January and November, respectively.

It is known that climatic conditions can change the vegetal secondary metabolism and consequently, alter the composition of essential oils, throughout the seasons of the year. Thus, the aims of the present study were to investigate effect of seasonal variation on growth, quality and composition of essential oil of *O. africanum* Lour. Var. CIM-Jyoti and to identify best season for cultivation.

Material and Methods

The field experiment was conducted at CSIR-Central Institute of Medicinal and Aromatic Plants Research centre, Hyderabad, India during the year 2017 on a red sandy loam soil of poor fertility to study the effect of seasonal variation on growth and quality of essential oil of *O.africanum* Lour. The experimental location is both semi-arid and tropical in climate. The variety CIM-Jyoti used as seed material for evaluation of the growth and quality during summer and winter season. For summer season in the first week of March we established the nursery and then planted in main field with a spacing of 45 cm X 30 cm and recommended doses of fertilizer was applied at the time of planting and during winter we planted in the month November with the spacing of 30 cm X 30 cm. Recommended dose of fertilizer 80:40:40 kg of NPK was applied at the time of planting. These plant samples (500 g) were distilled in modified Clevenger type apparatus for 3 hours for estimation of oil yield. The oil samples, thus collected were dried over anhydrous sodium sulphate and analysed for chemical composition. GCanalyses were performed employing Perkin Elmergas chromatograph (Model 8500) fitted with flame ionization detector (FID), GP-100 printer-plotter and an electronic integrator, using a bonded phase fused silica capillary column BP-1 (25m x 0.5mm; film thickness 0.25 pm) coated with polydimethylsiloxane. Nitrogen at a flow rate of 40.0 mumin (linear velocity 34 cds) and 10 psi inlet pressure was the carrier gas employed. Temperature was programmed from 60-220 °C at 5"C/min ramp rate with a final hold time of 10 min. Injector and detector were maintained at 250 °C and 300 °C, respectively. The oil samples (0.1-0.2 pL) were injected neat with 1:80 split ratio. GC/MS analyses of oil samples were carried out on a Hewlett-Packard 5890 gas chromatograph coupled to a HP 5970 MSD using a fused silica ultra performance cross linked methyl silicone column (50 m x 0.2 mm; film thickness 0.25 pm). Temperature programming was done from 100-280 °C at 4 °C /min. Helium was used as the carrier gas at 1 mu'min flow rate. Mass spectra were recorded over 40-400 amu range at 1 scads with ionization energy 70 eV and ion source temperature 250°C. Essential oil components were identified by comparing retention times of the peaks with those of reference com- pounds run under identical conditions, by comparison of retention indices (retention indices were computed from the gas chromatograms by logarithmic interpolation between n-alkanes. The homologous series of n-alkanes C to C Poly Science Inc., Niles, USA were used as standards) with literature data, peak enrichment on co-injection of authentic compounds and comparison of the mass spectra of the peaks with those of standard compounds reported in literature. Peak areas and retention times were measured by the electronic integrator. The relative amounts of individual constituents were computed from peak areas without FID response factor correction. Growth and yield attributing character were recorded at periodic interval at different stages of plant growth and data were subjected to statistical analysis following analysis of variance (ANOVA) technique as applicable to randomized block design.

Results and Discussion

Effect of seasonal variation on essential oil and its constituents

An experiment was conducted at CSIR-CIMAP, CRC, Hyderabad to study the effect of seasonal variation on oil yield and chemical constituents of *Ocimumafricanum* Lour. Var. CIM-Jyoti during 2017. There was significant difference with regard to oil yield obtained from different parts of Ocimum *viz*., Whole herb, leaves, stem and inflorescence was noticed during different season. Among different season summer season recorded significantly higher oil content compared to winter season was noticed. The hydro distilled essential oil content from different parts of the plant obtained from summer and winter season ranges from 0.2 to 0.6. However, the highest essential oil content (0.3% to 0.6%) was recorded in summer and lowest oil content (0.2% to 0.3%) was recorded in winter season (Fig 1). The essential oil consists of Citral II is the most abundant component followed by Citral I. The highest amount of Citral I obtained from different parts of *O. africanum* Lour. CIM-Jyoti *viz*., whole herb (42.5%), leaf (43.5%), stem (44.8%) and inflorescence (39.9%) collected during summer and was followed by Citral I (33.7 %, 36.2%, 36.2% and 34.6% respectively) (Table 1). Whereas other essential oil components *viz*., Citronellol, Linalool and geraniol content was higher in different parts of plant obtained during winter season compared to summer season and rest of the essential oil content were higher in summer season compared to winter season. Similarly, the growth parameters such as plant height, No. of branches, No.

of leaves and leaf area were significantly higher during summer season (65.8 cm, 23, 435.8 and 14.68 m^2 respectively) (Fig 2) compared to winter season (30.2 cm, 14, 257.4 and 11.18 m^2 respectively). These results are in agreement with the findings of Otan *et al* (1994) [9].

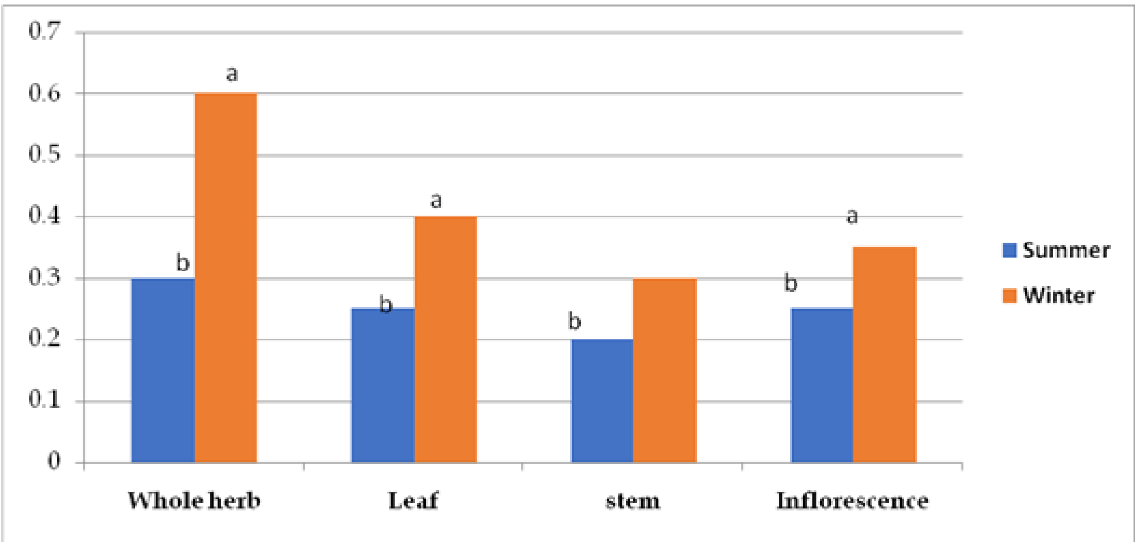

Fig 1: Effect of seasonal variation on essential oil content of *O.africanum* Lour.

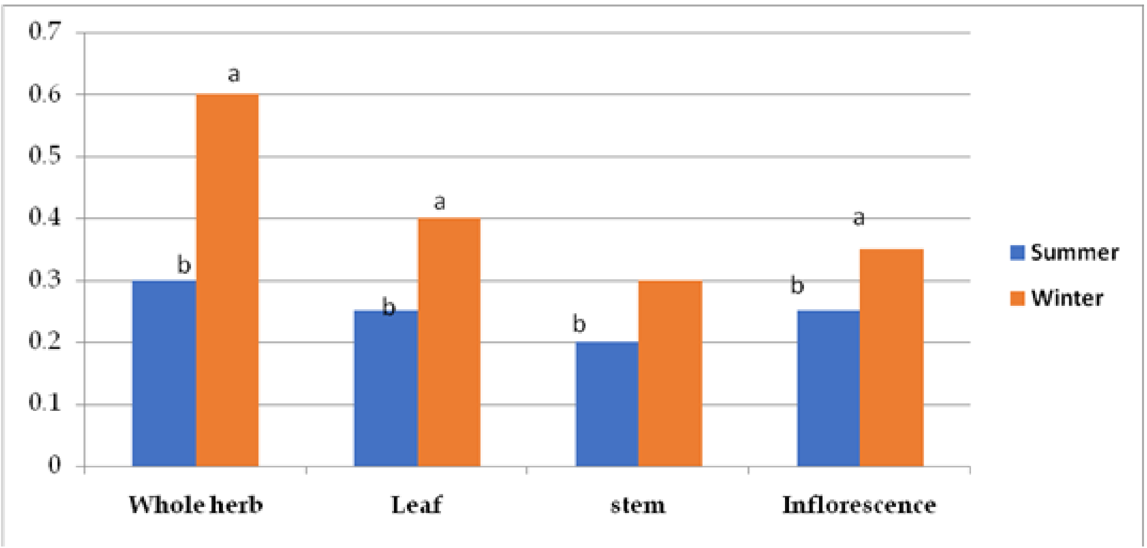

Fig 2: Effect of seasonal variation on growth parameters of *O. africanum* Lour.

Table 1: Effect of seasonal variation on essential oil chemical composition of *Ocimumafricanum* Lour. Var. CIM-Jyoti

Chemical constituent	RI^{np}*	Season							
		Winter				Summer			
		Whole herb	Leaf	Stem	Inflorescence	Whole herb	Leaf	Stem	Inflorescence oil
Limonene	1030	0.677	0.475	0.569	0.573	0.677	0.728	0.461	0.412
Linalool	1105	1.432	3.064	2.004	5.403	1.313	1.774	1.544	1.556
Camphor	1130	1.305	1.470	1.347	1.033	1.525	2.210	1.880	2.113
Methyl Chavicol	1186	0.186	0.191	0.200	1.755	0.119	0.297	0.183	1.031
Citronellol	1211	6.648	7.203	5.582	4.985	6.065	2.423	2.706	2.522
Citral I	1222	30.714	26.659	30.042	27.033	33.73	36.230	36.21	34.55
Geraniol	1238	4.992	3.537	2.489	2.502	6.184	1.320	1.366	1.534
Citral II	1240	38.600	37.430	39.601	35.996	42.45	43.484	44.75	39.85
Eugenol	1340	0.975	0.535	0.390	0.764	3.140	0.419	0.521	0.866
Methyl Eugenol	1376	0.209	0.120	0.303	0.181	0.227	0.250	0.300	0.450
β-Elemene	1396	0.356	0.247	0.256	0.428	0.216	0.285	0.223	0.414
Caryophyllene	1422	1.804	2.834	0.2898	3.533	1.980	1.442	1.180	2.228

(*RI^{np}, Retention index; non-polar column)

Similar constituents were found by Senthilkumar and Venkatesalu (2010) [1] of *Plectranthus Amboinicus* (Lour.) under Indian conditions. Our results are in agreement with the findings of Otan *et al.* (1994) [9] and Kokkini (1996) [10] stated that, the season of collecting may strongly affect the essential oil yield of the plants and the concentration of its main components. The variations in essential oil content and composition could be due to its effect of different seasons on enzymes activity and metabolism improvements (Burbott and Loomis, 1969) [11]. Studies conducted by Lima *et al.* (2003) [12] showed that the number of special metabolites produced during the development of the plant can be affected by radiation (high or low), temperature (high or low), precipitation (high, low, and total dry matter), winds, altitude, soil, and time of harvest, among other factors. Temperature, relative humidity, the total duration of exposure to sun, and wind patterns have a direct influence, especially in species that have histological structures for the storage of essential oil on the leaf surface (Valmorbida *et al*., 2006) [13].

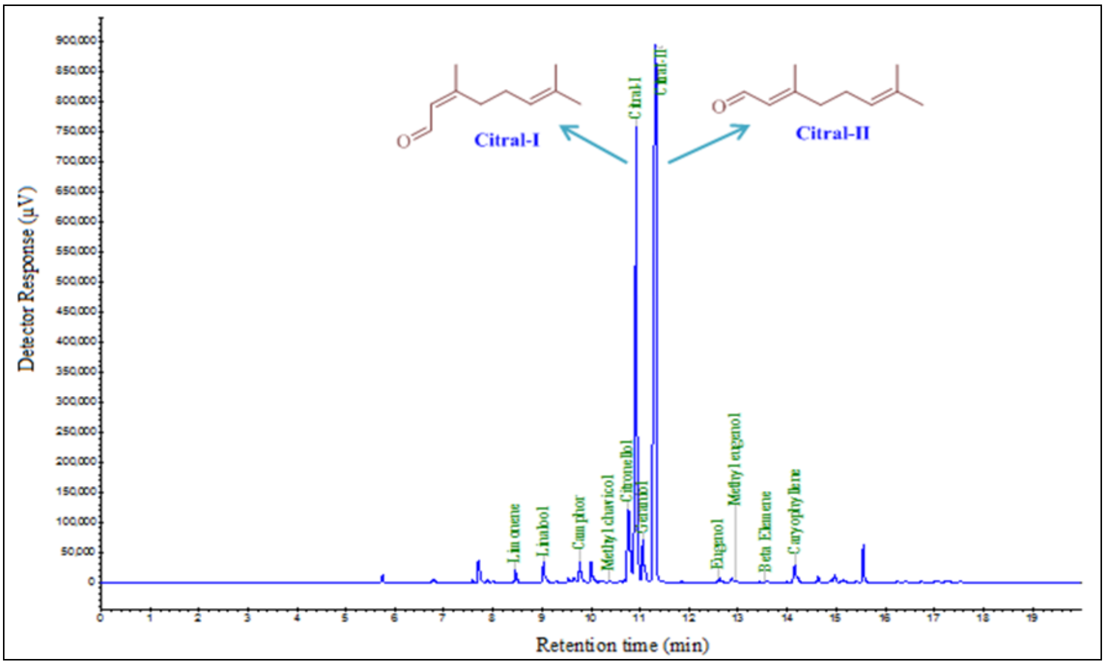

Fig 3: GC–chromatogram of the essential oil of *O.africanum* Lour. and structure of major compounds

The variation in chemical composition of the essential oil is known to vary with the seasonal variation (Senthilkumar and Venkatesalu, 2010) [1]. Hussain *et al.* (2008) [5] observed that the temperature influenced the decrease in oil yield of *O. basilicum*.From the experiment it can be concluded that the growing of *O.africanum* Lour. Var. CIM-Jyoti during summer season gave significantly higher growth parameter in turn herbage yield, oil content and its chemical composition compared to winter season. So, cultivating of this crop instead of lemongrass gave citral in a short duration of 70–80 days and also it fits well in crop rotation/intercropping between wheat and paddy and with other vegetable crops of small farmers. Leaves of this variety can also be used in lemon tea and gives additional income to the farmer within shot time span.

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