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Variation in the Essential Oil Yield and Chemical Composition of Palmarosa Biomass *Cymbopogon martini* (Roxb.) wats. var. *Motia* Burk) Under Different Location in Semi Arid Tropic Regions of India

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ABSTRACT

Palmarosa is an essential oil bearing aromatic grass, rich in geraniol and geranyl acetate with abundant pharmacological and aroma properties. This study encompasses variation in the essential oil yield and chemical composition of palmarosa grown under different location. From the data, it is found that Palmarosa grown in Ranga Reddy district recorded significantly higher herbage yield (3.9 t acre^{-1}), oil yield (27.3kg acre^{-1}) and oil content (0.7%) and was followed by Yadadri location (3.7t acre^{-1}, 22.2 kg acre^{-1}, 0.6 % respectively). Similarly, Geraniol content was significantly higher in Ranga Reddy district (76.1 %) followed by Yadadri district (75.8 %). However, Geranyl acetate content was higher in Nalgonda district (21.7 %) followed by Yadadri district (18.3 %). Whereas, Farnesol was higher in Ranga Reddy district (3.6 %) followed by Nalgonda district (2.4 %). The sample collected from Yadadri recorded higher linalool content (2.3 %) followed by Nalgonda district (1.8 %). However, Nalgonda district recorded higher Cis β ocimene (2.0 %) compared to rest of the places.

Keywords: *Essential oil, Geraniol, Geranyl acetate, Farnesol and Cis β ocimene*

INTRODUCTION

Palmarosa [*Cymbopogon martini* (Roxb.) Wats. Var. *motia* Burk., family: Poaceae;] commonly known 'Rosha' grass or 'Russa' grass is a multi-harvest perennial aromatic grass cultivated for its essential oil. The palmarosa is a native of most parts of subtropical India and India is the principal producer and exporter of palmarosa essential oil. The essential oil, isolated from the flowering shoot biomass through steam distillation has rose-like aroma, finds extensive application in high grade perfumery, cosmetic, flavouring and aromatherapy industries (Adams, 2007; Akhila et al., 1984).

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The characteristic odour of Palmarosa oil is due to its high content of total alcohol, mainly geraniol and a small but varying amount of esters associated with geraniol. The trace constituents present in the oil are responsible for the characteristic olfactory note of Palmarosa oil. In India, the palmarosa oil is produced mainly in Semi-arid Tropical (SAT) regions of Andhra Pradesh, Telangana, Karnataka, Kerala, and Maharashtra (Ashish & Jnanesha, 2017). The Deccan Plateau is a large plateau in western and southern India (Ashish & Jnanesha, 2017). India is the main producer of Palmarosa oil, while other countries producing this oil include Brazil and Madagascar. Indian production ranges from 40 to 60 tons of essential oil per year. France is the major importer of Palmarosa oil from India by UAS, UK, Germany, Spain, Switzerland, Srilanka and Philipines (Davies, 1990). The area under cultivation of palmarosa was increasing further due to ease of cultivation especially in marginal, wasteland and underutilized lands without affecting the production of cereals and other food crops. As a part of our studies to know the variation in chemical constituents of palmarosa oil from three different locations in Telanagana state *viz*., Ranga Reddy, Nalgonda and Yadadri districts samples were studied for their volatile constituents.

MATERIALS AND METHODS

Experimental site, Location and sample: The experimental location is semi arid tropic regions of India. Collection of Palmarosa sample and analysis of whole parts (Stems, leaves and inflorescence) of *Cymbopogon martini* (Roxb.) Wats. Var. *Motia* were done during summer season of 2018-19 and was collected from three districts of Telanagana state, India *viz*., Ranga Reddy ($17^{0}25^{1}$ N latitude and $78^{0}33^{1}$E longitude), Nalgonda ($17^{0}14^{1}$ N latitude and $79^{0}16^{1}$ E longitude) and Yadadri ($17^{0}30^{1}$ N latitude and $79^{0}16^{1}$ E longitude). It was collected from site of an area of 100 sq. Mt and estimated herbage yield and oil content per acre.

Essential oil isolation: Harvested fresh biomass of palmarosa (Leaf, stem & inflorescence) were sub sampled (500 gram each) and hydro distilled separately for 3 h in a Clevenger-type glass apparatus for essential oil isolation. The distillations were carried out in triplicate for all the samples. The moisture from the oil was removed by anhydrous sodium sulphate, then measured and stored at 4°C prior to isolation.

Gas chromatography (GC) analysis:

GC analyses of the oil samples were performed on Varian Star 3400 CX gas chromatograph (Varian Inc., Middelburg, The Netherlands) fitted with a flame ionization detector (FID), KX-P1150 Panasonic printer-plotter (Panasonic India Pvt. Ltd., Chennai, India) and an electronic integrator. Separation of compounds was achieved by using two capillary columns, SPB-1 and Supelcowax-10 (both 30 m × 0.25 mm, 0.25 μm film thickness), with distinct polarity. The columns were coated with dimethylpolysiloxane and Carbowax 20M, respectively, and were purchased from Supelco Inc., Bellefonte, USA. Nitrogen was employed as carrier gas with a flow rate of 1 mL/min and 10 psi inlet pressure. The column temperature programming was: 80°C (2 min) at 5°C/min to 150°C at 7°C/ min to 220°C (5 min). The injector and the detector were maintained at 200°C and 240°C, respectively. The samples (0.1 μL) were injected neat with 1:50 split ratio. Retention indices were generated by using series of n-alkanes from C8 to C23 (Jennings & Shibamoto, 1989).

Gas chromatography/mass spectrometry (GC/MS) analysis:

GC/MS analyses of the oil samples were carried out using a Hewlett-Packard 5850 gas chromatograph coupled to an HP-5850 mass-selective detector (MSD) system (Hewlett-Packard Asia Pacific Ltd., Singapore) using an HP-1 column (25 m × 0.20 mm, 0.25 μm film thickness) coated with methyl silicone. Helium was employed as the carrier gas at 1 mL/min flow rate. The temperature program was the same as in GC analyses. Mass spectra were recorded over 40–400 amu range at 1 span/s with 70 eV ionization energy, EI mode of ionization and ion source temperature was maintained at 250°C. The samples (0.1 μL) were injected with 1:50 split ratio (Jnanesha et al., 2019; Raina et al., 2003).

Identification of constituents:

The oil components were identified by comparison of their RRIs and mass spectra with published literature and those stored in NIST (Version 2.1) and Wiley (7th edn) libraries (Raina et al., 2003).

Statistical analysis: The statistical analysis was done for obtained data using Analysis of Variance (ANOVA).

RESULTS AND DISCUSSION

Herbage, oil yield and oil content of palmarosa

From the data, it is found that the palmarosa sample collected from Ranga Reddy district recorded significantly higher herbage yield (3.9 t/acre) compared to sample collected from Nalgonda district (3.0 t/acre) and was followed by Yadadri district (3.7 t/acre). The yield obtained in Rangareddy district was higher to an extent of 23.1%, 5.1% over palmarosa sample collected from Nalgonda and Yadadri district. Similarly, Oil yield obtained from Rangareddy district sample is also significantly higher (27.3 kg acre^{-1}) compared to rest of the samples and was followed by Yadadri district. Similar trend was noticed with regard to oil content with Ranga reddy district recorded significantly higher oil per cent (0.7 %) compared to rest of the sample and was on par with the sample collected from Yadadri district (0.6 %). This attribute is might be due to variation in climate, harvesting time and other management factors influence the variation in herbage yield, oil yield and oil content in this location (Rajeswara Rao et al., 2000; Rajeswara et al., 2005; Sharma et al., 2009). These results are in agreement with the findings of Sharma et al. (2009) who found that due to higher temperature in Ranga reddy district favours higher herbage yield, oil content and oil percentage.

Variation in the essential oil composition of palmarosa oil

From the analysis of palmarosa oil collected from different location found that, among different sample. The sample collected from Ranga Reddy district recorded higher geraniol percentage (76.1%) compared to rest of the sample and was followed by Yadadri district (75.8 %) and lower geraniol content was noticed in Nalgonda sample (67.9 %). Similarly, farnesol content is also higher in Ranga Reddy district (3.6 %) was noticed and was followed by Nalgonda district (2.4 %). However, the sample collected from Nalgonda district recorded higher percentage of geranyl acetate (21.7 %) compared to rest of the sample and was followed by Yadadri district (18.3 %). Lower geranyl acetate percentage was noticed in Ranga Reddy district (11.4 %). Whereas, Yadadri district sample recorded higher linalool content (2.3 %) compared to rest of the sample and was followed by Nalgonda (1.8 %) and Ranga Reddy district (1.2 %). Cis β ocimene, β Myrcene and Trans β Ocimene was higher in sample collected from Nalgonda district (2.0 %, 0.2 % and 0.3 %). It is evident from the study that the Palmarosa sample collected from Ranga Reddy district is the best among the three dues to its higher geraniol content and lower geranyl acetate contents. The higher geraniol content imparts a sweet floral rose like odour to the oil, while the heavy notes of geranyl acetate will suppresses the sweet smell of geraniol and are considered undesirable for the Palmarosa oil (Rajeswara Rao et al., 2000; Rajeswara et al., 2005; Sharma et al., 2009; Suresh et al., 2014; Vyshali et al., 2015). Probably this is the reason the quality of oil in Ranaga Reddy is considered as superior and fetches higher price in the market. The presence of other minor constituents such as linalool, Cis β ocimene, β Myrcene and Trans β Ocimene also add characteristic olfactory note of Palmarosa oil. These results are corroborated with the findings of Raina et al. (2003).

Table 1: Herbage yield, Oil yield and Oil content of *Cymbopogon martini* (Roxb.) Wats. Var. *Motia* herb collected from three districts of semi arid tropic region

Location	Herbage yield (tonnes acre^{-1})	Oil yield (kg acre^{-1})	Oil content (%)
RangaReddy	3.9	27.3	0.7
Nalgonda	3.0	12	0.4
Yadadri (Bhongir)	3.7	22.2	0.6
SEm$\pm$	**0.20**	**1.13**	**0.07**
CD (P=0.05)	**0.65**	**3.69**	**0.23**

Table 2: Chemical compositions of the essential oils of *Cymbopogon martini* (Roxb.) Wats. Var. Motiaherb collected from three districts of Telanagana state, India

Sr. No.	Compound	Retention index(RI)		Retention time (RT)	Content (%)			Identification method
		Non-polar	Polar		Ranga Reddy	Nalgonda	Yadadri	
1.	Beta Myrcene	984	1162	9.19	0.1	0.2	0.1	RI, PE, MS
2.	Cis Beta Ocimene	1030	1239	9.62	1.4	2.0	0.6	RI, PE, MS
3.	Trans Beta Ocimene	1042	1253	9.78	0.2	0.3	0.1	RI, PE, MS
4.	Linalool	1088	1562	10.37	1.2	1.8	2.3	RI, PE, MS
5.	Neral	1217	1676	12.26	0.2	0.1	0.1	RI, PE, MS
6.	Geraniol	1245	1879	12.59	76.1	67.9	75.8	RI, PE, MS
7.	Geranial	1248	1743	12.71	0.3	0.4	0.3	RI, PE
8.	Geranyl Acetate	1362	1763	14.28	11.4	21.7	18.3	RI, PE, MS
9.	Caryophyllene	1422	1584	15.55	1.1	0.2	0.2	RI, PE, MS
10.	Geranyl Isobutyrate	1489	1788	16.84	0.1	0.1	0.04	RI, PE, MS
11.	Farnesol	1695	1387	19.41	3.6	2.4	0.7	NS

RI= Retention index; MS= Mass spectra; PE= Peak enrichment on co-injection with authentic; NS= Not significant.

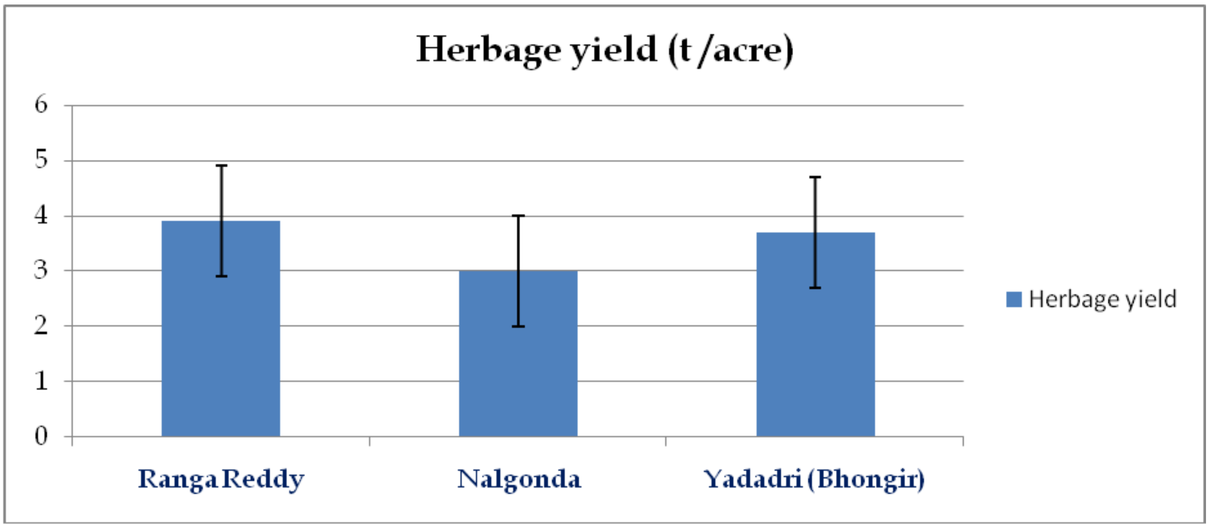

Fig. 1: Variation in the herbage yield of Palmarosa in different District of semi arid tropic region

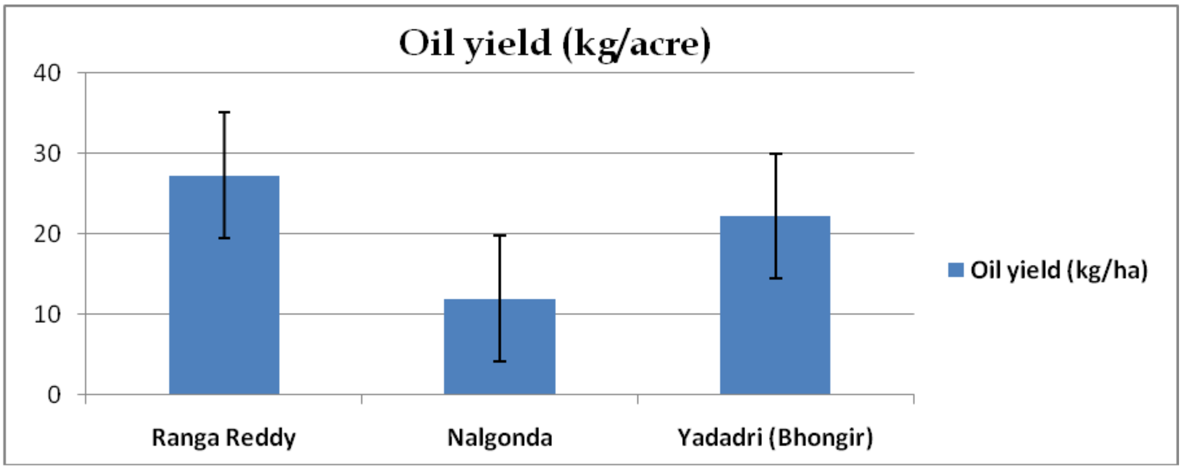

Fig. 2: Variation in the oil yield of Palmarosa in different district of semi arid tropic region

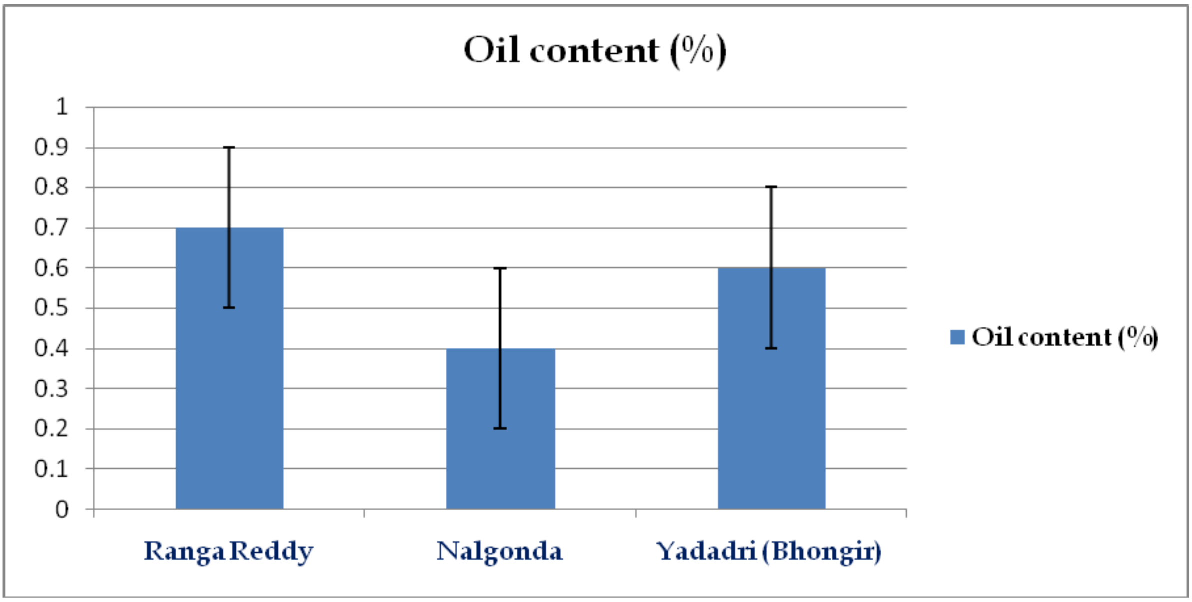

Fig. 3: Variation in oil content of Palmarosa in different district of semi-arid tropic region

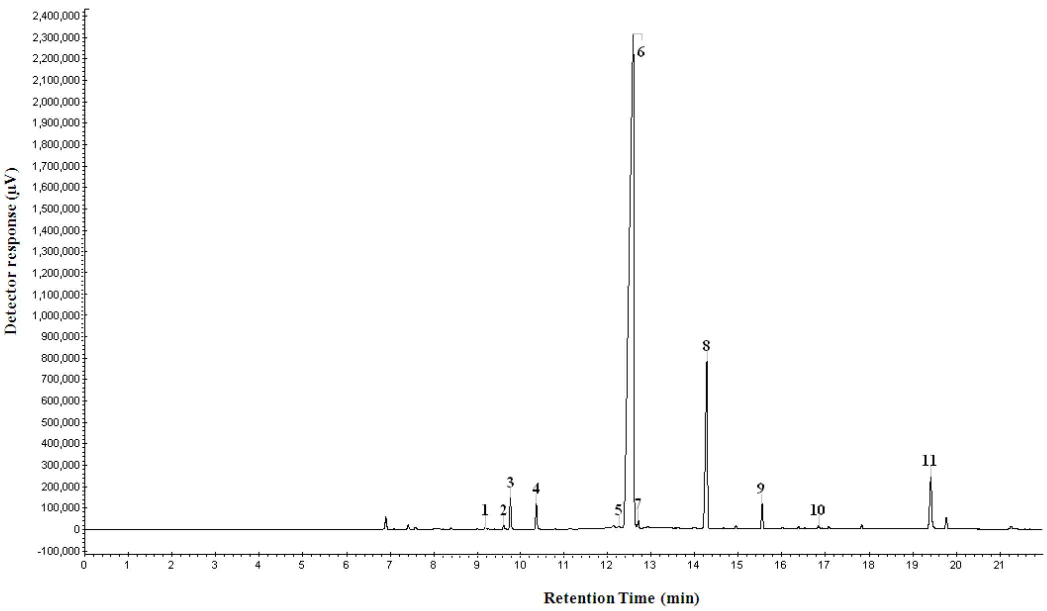

Fig. 4: The Gas chromatography of the palmarosa oil collected from Ranga Reddy district

CONCLUSION

From the result, it can be concluded that the sample collected form Ranga Reddy district recorded higher herbage yield, oil yield and oil content compared to other district sample and with regard to chemical composition the sample collected from Ranga Reddy district recorded higher geraniol content and lower geranyl acetate content compared to other sample and quality wise Ranga Reddy Palmarosa oil sample is best due to higher geraniol and low geranyl acetate content The higher geraniol content imparts a sweet floral rose-like odour to the oil, while the heavy notes of geranyl acetate and the citrus-like odour of geranial suppresses the sweet smell of geraniol and are considered undesirable for the palmarosa oil. Due to suitable temperature in Ranga reddy district favours the accumulation of higher biomass and good quality oil. Meanwhile, buyer will prefer higher geraniol content and fetches higher price in the market.

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