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ORIGINAL RESEARCH ARTICLE

Evaluation of *Mentha arvensis* L. cultivars for essential oil yield in Southern tropical regions of India

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ABSTRACT

A field experiment was conducted during 2017-18 at CSIR-CIMAP Research Centre, Bengaluru to study the oil yields of Mentha arvensis L. cultivars viz., CIM-Saryu, CIM-Kranti and Kosi for assessing their suitability of cultivation under southern climatic condition. The experiment was laid out in a Randomized Complete Block Design with three treatments, replicated seven times. The three cultivars were hydro distilled for ascertaining their essential oil contents and analysis for quality evalauation. The results revealed that the oil content in Kosi and CIM-Kranti was 1.30%, while that of CIM-Saryu was 1.1 %. Gas Chromatography-Mass Spectrometry (GC-MS) was performed for analysing the menthol content in the essential oils, which showed that there was no significant variation in the menthol content in the three cultivars. The menthol content in Kosi, CIM-Kranti, and CIM-Saryu were estimated to be 77.59%, 78.68 % and 77.86 %, respectively.

INTRODUCTION

Mentha species produce some of the most economically important essential oils throughout the world. Commonly grouped as mints, the genus belongs to the family Lamiaceae (Kumar et al., 2011). *Mentha* comprises a group of 25-30 species (Ali et al., 2002). These plants are of great economic importance since ancient times, because of their therapeutic, culinary and aromatic properties (Dorman et al., 2003). Distillation of aerial parts of these herbs yield an essential oil containing a large number of terpene compounds such as menthol, menthone, isomenthone etc. Angola, Australia, Argentina, Bulgaria, Brazil, France, Hungary, Italy, Czechoslovakia, Paraguay, India, USA, Thailand and Switzerland are main producers of mint oils (Bahl et al., 2000).

Among these *Mentha* species, *Mentha arvensis* (menthol mint) is an important crop for the plains of North India, providing livelihood to the thousands of farmers across Haryana, Uttar Pradesh, and Punjab. It occupies more than 16000 hectares of cultivation area, and account for nearly 90% of the total menthol mint oil production of the world (Singh et al., 2005; Khanuja, 2007). Under North Indian climatic conditions, *M. arvensis* is mainly cultivated as a spring–summer crop. In recent years, an increasing need for the natural

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menthol of its oil for various industrial requirements has lead to the increased demand for oil production. Mint oil production can be increased through the development of high-yielding varieties, and by increasing the cultivation area beyond the traditional cropping limits with suitable cultivation strategies and packages.

Three most popular menthol mint varieties under commercial cultivation in the North Indian region are Kosi, CIM-Kranti and CIM-Saryu. CIM-Kranti is a cold tolerant genotype, suitable for generating extra income without any additional input and extra land use for cultivation during both winter (100 kg/ha oil yield and 250-300 q/ha suckers) as well as summer (170-210 kg/ha oil yield) seasons. Kosi is an early maturing variety which is tolerant to the leaf spot and powdery-mildew diseases in mint. It has the ability to produce a herb yield of 260 q/ha with an oil yield of 200 kg /ha. CIM-Saryu is one of the oldest and robust varieties, producing a huge biomass and large canopy cover. These three menthol mint varieties *viz.*, Kosi, CIM-Kranti and CIM-Saryu were selected for the present study to evaluate the essential oil content and quality in the non-traditional Southern tropical climatic conditions of Karnataka, India.

MATERIALS AND METHODS

Location of experimental site

Field experiment was conducted at CSIR-CIMAP Research Centre, Bengaluru. The experimental area lies between 13°081' longitude North and 77°571' East at an altitude of 930 meters above mean sea level, which receives an average annual rainfall of about 928 mm.

Experimental Details

Field experiment was laid out in Randomized Complete Block Design during 2017-2018 with three treatments (CIM-Saryu, CIM-Kranti and Kosi), replicated seven times. The varieties were planted in the first week of March, at a spacing of 45×45 cm. The experiment was conducted following the recommended agricultural practices.

Plant sampling for distillation

The crop was harvested at maturity stage for the extraction of essential oil. Harvested fresh herb was hydro-distilled with the help of Clevenger's apparatus for 3 hrs. The oil samples were dried over anhydrous sodium sulphate and stored in refrigerator (4°C) until further analysis.

Essential oil analysis

Gas Chromatography (GC) analysis of the essential oil was performed on a Centurion Scientific Gas Chromatograph (model CS-5800), equipped with FID and a polar (Supelcowax-10) fused silica capillary column (30 m × 0.25 mm internal diameter, film thickness 0.50 µm). Nitrogen was used as the carrier gas at 1.0 ml/min. Oven temperature was programmed from 70°C to 170°C with ramp of 4°C/min, and then programmed to 240°C with ramp of 5°C/min with initial and final hold times of 5 and 15 min, respectively. Injector and detector temperatures were set at 240°C and 250°C, respectively. The samples of 0.1µL were injected in the split mode (1:70). Identification of the essential oil constituents was carried out on the basis of retention index (RI) determined with reference to homologous series of *n*-alkanes (C_7-C_{30}) and mass spectral data. The relative amounts of individual components were calculated based on the relative % peak areas (FID response), without using correction factor.

Statistical analysis

The data was analyzed using SPAR-2 software (Ahuja et al., 2008) and graphical representation was performed using GraphPad Prism version 5.00 for Windows (GraphPad Software, La Jolla California USA, www.graphpad.com.).

RESULTS AND DISCUSSION

Essential oil content

Distillation of whole herb of the three tested varieties yielded an oil content ranged from 1.10% to 1.30%. CIM-Kranti and Kosi performed better while CIM-Saryu recorded a lower oil content of 1.10% (Fig. 1). Analytical results revealed that there is no significant statistical difference among the

Table 1. Analysis of variances for oil content (%)

SV	df	MSS	F(Cal)	P-value (5%)	F (Critical)	CV (%)
Replication	6	0.009	1.158	0.389	2.996	
Treatments	2	0.075**	9.916	0.003	3.885	8.470
Error	12	0.008				

SV: Sources of variation, df: Degrees of freedom MSS: Mean Sum of squares, CV: Coefficient of variance

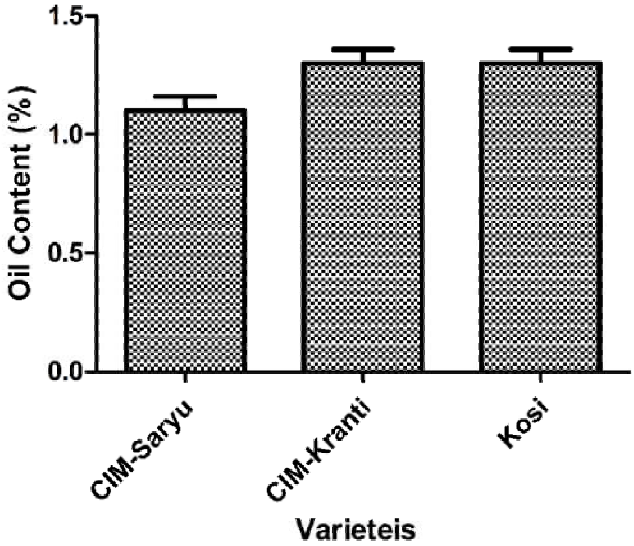

Figure 1: Mean values of essential oil content (%)

three cultivars of Menthol mint under Bangaluru condition for the oil content (Table 1). However, the varieties CIM-Kranti and Kosi yielded more essential oil than CIM-Saryu.

Essential oil composition

The essential oils obtained upon hydro-distillation of harvested herbs were subjected to GC analysis. Around 20-30 constituents were identified that accounted for 92-95% of the total oil. Menthol, menthone, limonene and isomenthone (Monoterpenoids) were identified as the main constituents in the essential oil of all the three tested varieties. The major volatile constituents of these

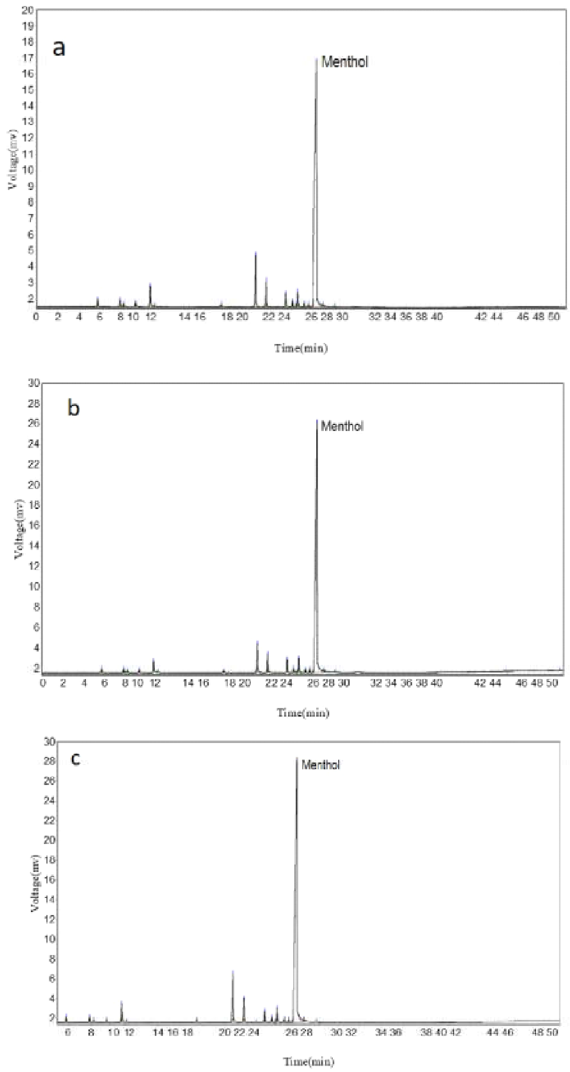

Figure 2: Chromatogram of a) CIM-Sarayu, b) CIM-Kranti and c) Kosi varieties

Table 2. Chemical composition of *Mentha arvensis* essential oil of the three tested varieties under southern tropical conditions

Compound	CIM-Saryu (%)	CIM-Kranti (%)	Kosi (%)
Limonene	2.2	2.8	3.2
1,8-Cineole	0.1	0.1	0.2
Menthone	4.9	7.3	7.8
Isomenthone	2.8	3.1	3.7
Menthyl acetate	1.9	1.4	1.7
Menthol	77.86	78.68	77.59

oil samples are presented in Table 2. Menthol is the major compound present in all the cultivars (Fig. 2). The highest menthol content recorded is in CIM-Kranti (78.68 %) followed by CIM-Saryu (77.86 %) and Kosi (77.59%). The menthone content in the three cultivars varies between 4.98-7.80 %, being the highest in Kosi (7.80 %) followed by CIM-Kranti (7.6%), and Sarayu (4.5%).

Evaluation of *Mentha arvensis* cultivars under southern tropical regions of India showed that no significant quantitative variation exist among them for their oil content. According to earlier research reports, essential oil yield in aromatic plants are influenced by several agricultural and environmental factors such as nutrient availability, meteorological variations, soil micro-flora, genetic factors, and geographical variables that influences the expression of genes controlling growth and development (Verma et al., 2016; Jamzad et al., 2013; Martin and Chang, 2013). The data pertaining mid-hills of Uttarakhand (Verma et al., 2010; Padalia et al., 2015), foothill conditions (Singh et al.,2015),western Himalayan region (Padalia et al., 2013). *Mentha arvensis* cv. Shivalik grown in the tropical climate of India shows menthol (53.2-82.3%), menthone (5.2-30.2%), isomenthone (2.1-3.5%) and neomenthol (0.9-2.0%) as major constituents (Rao et al., 2000). The genotype and agronomic conditions, such as harvesting time, plant age and crop density greatly influence the quantitative composition of the essential oils of many aromatic crops (Verma et al., 2010).

It can be concluded from the present study that the quality of the essential oil obtained from three cultivars, viz Kosi, CIM-Kranti and CIM-Saryu in southern tropical region of India are comparable with that obtained in the North Indian plains. Both CIM-Kranti and Kosi are comparatively better suited for the southern climatic conditions, as they yielded a better essential oil content than CIM-Saryu.

Table 3. Comparison of the major chemicals components (% composition) of menthol mint oil in previously reported studies (Akhil and Subhan, 2012)

Constituent	Karnataka	Andhra Pradesh	Tamil Nadu	Madhya Pradesh	Uttar Pradesh	Uttarakhtrand
3-Octanol	0.10-0.20	0.10	0.90	1.40	-	0.00-0.50
Limonene	2.20-3.20	1.0 0	-	0.70	-	0.00-0.30
Menthone	4.90-7.80	9.6 0	15.00	25.10	4.00-11.70	0.30-7.90
Isomenthone	2.80-3.70	4.0 0	4.60	-	2.00-4.20	0.00-6.10
Menthol	77.50-78.68	73.0 0	69.50	48.80	72.30-83.80	77.50-89.30
Menthyl acetate	1.40-1.90	4.00	0.90	1.80	2.00-5.90	0.00-0.80
Cultivar	Kosi, CIM-Sarayu and CIM-Kranti	Shivalik	Shivalik	-	6 cultivars	6 cultivars
Reference	Present study	Rajeswara Rao (1999a)	Rajeswara Rao et al., (1999b)	Pandey and Chowdhury 2000	Shasany et al., 2010	Singh et al., 2005

to the GC analysis of the essential oil samples (Fig. 2) obtained by us also illustrate that menthol is the major chemical constituent, followed by menthone. Even though statistically there is not much qualitative difference in the major essential constituents and oil content in all three varieties, considerable variations in the quantitative make-up of the essential oil constituents were observed. Similar results are also reported by many researchers (Table 3). Menthol, menthone, isomenthone, limonene and methyl acetate are the major constituents in *Mentha arvensis* from the

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