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Cultivation of Citronella (*Cymbopogon winterianus*) and evaluation of its essential oil, yield and chemical composition in Kannauj region

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Abstract

This study was carried to investigate the essential oil yield and contents of Java Citronella plants grown in the region of Kannauj. Moreover, the main components of essential oil as well as oil yield and percentage of these components were also investigated as a result of ideal cultivation in specific region. The sample for essential oil extraction was collected from cultivated region of Kannauj. The essential oil was extracted and consequently its percentage was calculated. The composition of the Java Citronella essential oil was occurred by using GC-MS. The results of this study showed that the percentages of main components were improved and overall oil yield of Citronella essential oil were 0.79%. Moreover, the percentages of the main components and oil yield improved as a result of traditional cultivation process of Kannauj region. The recovered essential oil was richer in Citronellal (29.15%), geraniol (22.52%), citronellol (7.43%), geranyl acetate (2.63%), neral (6.52%), geranial (5.20%) elemol (1.92%) and limonene (1.27%). Apart from these, several other components were also present.

Keywords: Citronellal, Geranial, Citronellal, steam distillation, GC-MS.

INTRODUCTION

Java Citronella (*Cymbopogon winterianus*) is an important aromatic cum medicinal grass belonging to the *Poaceae* family with proven therapeutic and medicinal values. Different components of its oil are extensively used as a source of cosmetic, flavoring, shop and perfumery industry all over the world [1]. Citronella oil is popularly known for its characteristic insect repellent feature especially against

malaria-causing mosquito species, therapeutic properties against various diseases [2-6] and its anti-fungal property [7]. Strong antifungal activity against several species of *Aspergillus*, *Penicillium* and *Eurotium* due to presence of citronellal and linalool, components of citronella oil, has also been reported [8]. Essential oil of Citronella play an important role in improving human health due to their potential of bioactive components which can act as anti-inflammatory [9], antioxidant [10-11], anticancer, anticonvulsant [12] agents and central nervous system (CNS) disorders [13-14]. The essential oils of Java Citronella are most commonly a blend monoterpenes, monoterpenoids, and phenylpropanoids containing chiefly limonene, linalool, geraniol, elemol, geranyl acetate, α-bisafalol, citronellol, Citronellal etc [15-16]. Citronella herb is found in many parts of India. The land soil, climate condition and plant species affect the components of its essential oil. Recently the demand of Java Citronella essential oil in current industry has been increased due to its bioactive compound that shows various therapeutic effects [17].

Mostly, in the East Indian region, Citronella essential oil is obtained from *Cymbopogon winterianus* and is the valuable oil for commercial importance. The species is considered to have originated southernmost states of India. The essential oil obtained from this plant has very low aldehyde content and is poor in solubility.

Jal Pallavi is the variety of Citronella Java (*Cymbopogon winterianus*) which is improved variety of Citronella. Yield of essential oil from Jal Pallavi Citronella is higher up to 0.8%. The plant height is approx 90 to 95 cm, numbers of tillers per plant are 90 to 95, leaf length is 65 to 70 cm and leaf width is 1 to 1.5 cm. Citronella grass arising from a woody rhizome. Hairy at the junction blade, Leaf sheath smooth, linear, acuminate, glaucous. Panicles are very large, drooping, lax, greyish or greyish green with raceme pairs in dense masses, spreading, slightly hairy, lower glumes of the sessile, obscure intracranial nerves and shallowly concave with one or two depressions.

MATERIALS AND METHODS

This study was conducted in 6 months time period. In which the selection of the *Cymbopogon winterianus* slips, cultivation, steam distillation and GC-MS of the isolated essential oil was take place. The basic guidance for cultivation of the Citronella was taken from Fragrance and Flavor Development Centre (FFDC), Kannauj, Uttar Pradesh, India.

Selection of lemongrass slips

The people of Kannauj region are using *Cymbopogon winterianus* (Jal Pallavi) species plant [18] which is an improved verity. The slips were collected from FFDC, Kannauj for nursery preparation. After nursery preparation the child plants were transferred into the selected field. Seeds of Citronella were not used to avoid the genetic variations [19].

Cultivation of Citronella

Selection of land was favorable for the optimum growth of citronella plant and satisfactory recovery of oil. For the cultivation of Citronella, well drained, deep and fertile soil is suitable. *Cymbopogon winterianus* (Jal Pallavi) can be cultivated on almost every type of the soil. But soil of specific and experimental field of Kannauj was loamy sand, with pH 6.5, organic mater 1.6% and field holding capacity 40%. Planting of slips were done in 100 square meter area of the field. Slips were planted on the distance of 75×60 cm for the proper irrigation [19]. Plants were fertilized with nitrogen, phosphorus and potassium (NPK) at a ratio of annually. 180 kg N, 80 kg P_2O_5 and 50 kg K_2O per hectare were used for proper plant fertilization [19]. Before plantation, 5 tanks cow dung compost per hectare was applied into the soil. The favorable time for planting of this crop is the onset of rains, in sub-tropical climates with assured irrigation. Planting can also be done in the month of Jan to March and June-July. The growth percentage of crop is increase and the plants do not face weed competition because of the control soil moisture.

Weed Control

Citronella plants are susceptible for weed competition for earlier months after plantation. This problem is increase in rainy season. The plants should be kept weed free for 60-75 days for batter growth. Weeds were removed by manual removal herbicides and regional hand work process.

Irrigation and Harvesting

Citronella crop requires regular irrigation during rain free period therefore; plants were irrigated 9 times according to local and regional common practices. Harvesting was done after 120 days of plantation.

Isolation of Citronella essential oil

Freshly harvested leaves were taken for the distillation process. Harvested leaves were spread in shade or sun dried for 24 hours to reduce the moisture from the plants. For isolation of essential oil of Citronella, the herbs were used for the steam distillation [20-21]. Distillation process was completed within 4 hours with boiler operated plant.

Assessment of oil components

The identification of components of Citronella essential oil were carried out by gas chromatography mass spectrometry (GC-MS)[22] on a gas chromatograph Agilent 6890 coupled to selective mass detector Agilent 5976 using ultra performance HP-5Methyl Silicone column (50 m × 0.25 mm i.d; 0.25 µm film thickness) and a split/splitless injector at 4^0 C/ min ramp rate. NIST Mass Spectral Search Program library were used for recognizing different components. Split injection ratio 70:1, injecting 0.2 µl. The test was carried out at 250°C, the oven at initial 50°C for 2 minutes increasing 10 °C per minute till 200°C was reached. The flow was of 0.7 µl/min at a constant speed of 30 cm/s with a 250°C interface.

RESULTS

The Citronella slips were successfully planted in selected field. Citronella was harvested from the field after 120 days of planting. The cultivation methods and the measures were taken during cultivation of Citronella Java give good yield of herbage and better oil recovery from the leaves. Citronella essential oil was isolated from Citronella herbage through steam distillation. In this distillation technique, 1.78 kg of lemongrass oil is being isolated from 225 kg of the Citronella. It means the oil content in Citronella herbage in the Kannauj region was 0.79%.

Assessment of oil component

The different components of Citronella essential oil were identified through gas chromatography mass spectrometry (GC-MS). There are around 50 chemical components were recorded which are mention in the table.

S. No.	Retention Time	Name of the oil components	Percentage of components
1.	5.26	Bergamal	0.06
2.	11.70	Terpineol	1.21
3.	12.63	Linalool	1.62
4.	14.41	Ctronellol isobutanoate	0.11
5.	15.57	Lavandulyl acetate	0.50
6.	16.04	Citronellal	29.15
7.	16.21	Mentha-2,8-dien-1-ol	0.30
8.	16.43	Limonene	0.45
9.	16.78	Decenal	0.16
10.	17.41	Decenal-1-ol	0.06
11.	17.79	Citronellol	7.43
12.	18.19	Neral	6.52
13.	19.20	Geraniol	22.52
14.	19.52	Geranial	5.20
15.	19.78	Neryl acetate	1.86
16.	20.12	Elemene	1.26
17.	20.42	Dodecanal	0.10
18.	20.55	Caryophyllene	0.12
19.	24.00	Germacrene	1.02
20.	24.22	geranyl acetate	2.63
21.	24.51	Bergamotene	0.11
22.	24.72	Isoeugenol	0.03
23.	25.04	Germacrene	1.09
24.	25.32	Elemol	1.92
25.	25.51	Elemol acetate	1.32
26.	26.02	Limonene	1.27

27.	26.88	Cadinene-γ	0.04
28.	28.04	Methyl linolate	0.02
29.	28.23	Damascene-α	0.52
30.	28.54	Eudesmol -γ	0.30
31.	28.92	Eremoligenol	0.46
32.	29.26	Bisabolene-α	0.01
33.	29.58	Damascene-α	0.02
34.	29.89	Farnesol	0.60
35.	30.09	Methyl isoeugenol	1.30
36.	30.31	Isophorene	1.40
37.	30.64	Myrtanol	0.60
38.	30.89	Linalyl acetate	0.54
39.	31.09	α - pinene	0.16
40.	31.26	Camphene	0.20
41.	31.64	β- pinene	0.21
42.	32.08	Sabinene	0.04
43.	32.32	β- caryophyllene	0.57
44.	32.53	4- Terpineol	1.05
45.	33.20	Cis- ocimene	0.07
46.	33.58	Trans- ocimene	0.70
47.	33.87	p- cymene	0.55
48.	34.56	Terpinolene	1.24
49.	34.95	1- hexanol	0.09
50.	35.09	1- borneol	0.14

DISCUSSION

Kannauj is illustrious place for the essential oil, fragrance and perfumery. The Citronella *Cymbopogon winterianus* (Jal Pallavi) is one of the most important and valuable crop for the farmers in this region. There are around 50 different chemical components are present in Citronella oil of Kannauj region.

The present research work is confined to the cultivation, extraction and chemical analysis of Citronella oil. Citronella grass was earlier grown predominantly in the southern countries and present time cultivated mainly in India. As earlier explained, essential oil of Citronella contains a number of fragrant fractions of which citronellal, geraniol, and citronellol are the major components which is responsible for the real chemistry of this essential oil [23-24]. Java citronella (*C. winterianus*) Jal Pallavi consists of Citronellal (29.15%), geraniol (22.52%), citronellol (7.43%), geranyl acetate (2.63%), neral (6.52%), geranial (5.20%) and many more chemical components. The high percentage of citronellal and geraniol in the Java type citronella make them as better therapeutic and perfumery derivatives [25-26].

The main components of essential oil of citronella differed significantly at different harvesting stages [27]. According to the FFDC Kannauj literature the harvesting of citronella crop should be done after 100 to 120 days of planting. The farmers of Kannauj region are following the FFDC literature information so we have also followed the FFDC literature and we found the 98.85% essential oil of citronella was composed of 50 different chemical components.

CONCLUSION

Kannauj is the famous place for essential oil and perfumery. The farmers nearby Kannauj use to cultivate aromatic cum medicinal plants. The present research work of cultivation of citronella and evaluation of its oil yield and chemical components is based on the regional process of cultivation process (Agriculture of lemongrass and its sustainable management brochure of FFDC Kannauj) resulting high percentage of Citronellal, Geraniol and Citronellol in citronella essential oil i.e. valuable components for pharmaceutical and perfumery industry. The high percentage of Citronellal, Geraniol and Citronellol in this essential oil indicates that the essential oil of citronella have valuable and effective properties.

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