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A review on the medicinal and aromatic Plant- *Cymbopogon martinii* (Roxb.) Watson (Palmarosa)

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Abstract
In recent years there has been an increasing interest in the replacement of synthetic compounds by natural products due to environmental, health and safety concerns. Among natural products, essential oils of aromatic plants are gaining much interest as food additives due to their relatively low or negligible toxicity, high volatility and biodegradability. *Cymbopogon martini* (Gramineae) is very important medicinal and aromatic plant and is rich in essential oils. Essential oils derived from Palmarosa have been reported to exhibit exceptionally good antimicrobial, antifungal, antiviral, antihelmintic, antioxidant and cytotoxic properties. Thus the main aim of present review article is to uncover the various therapeutic activities of Palmarosa essential oil and chemical compounds responsible for such properties.

Keywords: *Cymbopogon martini*, Palmarosa, essential oil, medicinal and aromatic plants, chemical compounds

Introduction
Cymbopogon martinii is very important member of Gramineae family which is very famous for its high oil content. Essential oils (Volatile oils, Ethereal oils, aetherolea) are concentrated hydrophobic liquids containing volatile aromatic compounds from plants. An oil is "essential" in the sense that it contains the "essence of" the plant's extract-the characterstic fragrance of the plant from which it is derived. Plants synthesize numerous kind of secondary metabolites or specialized phytochemicals, of which essential oils (EOs) constitute an important group [1]. These compounds can be extracted from plant tissues (e.g., stem, leaves, flowers, and roots) by several procedures (e.g., hydrodistillation and steam distillation) [2].

Fig 1: *Cymbopogon martini* (Palmrosa)

Terpenes, alkaloids (*N*-containing compounds) and phenolics constitute the largest groups of secondary metabolites. The shikimic acid pathway is the basis of the biosynthesis of phenolics while the terpenes which are comprised of isoprene units arise from the mevalonate pathway [3]. Essential oils contains mainly terpenes, which are commonly used in pharmaceutical industries and have therapeutic benefits and promote welfare, especially when used in aromatherapy procedures [4]. The essential oils of *Cymbopogon martini* are rich in monoterpenes. Essential oils from Cymbopogon species and their components are known for their antimicrobial [5, 6] antihelmintic [7], antiparasitic [8], anti-inflammatory [9], anticonsulvant [10]. and antioxidant activities. Several reports published earlier have revealed the presence of citral (a mixture of geranial and neral), geraniol, citronellol, citronellal, linalool, elemol, 1, 8-cineole, limonene, geraniol, β-caryophyllene, methyl heptenone, geranyl acetate and geranyl formate in the essential oils of *Cymbopogon martini.* Moreover,

the composition of the essential oil components is greatly influenced by genetic, environmental and geographical conditions [11, 12]. The essential oils in *Cymbopogon martini* are biosynthesized in the rapidly growing leaves and stored in specific oil cells in the parenchymal tissues [13, 14].

Phytochemical analysis

Chemical studies of the palmarosa oil reveals that it contains monoterpenes, sesquiterpenes and alcohols like geraniol, eranylacetate, (E, Z)-farnesol, nerolidol, geranial, cymbodiacetal, limonene, terpinene, myrcene, caryophyllene, humulene, selinenes, linalool and fatty acid 16-hydroxypentacos-14-(z)-enoic acid [15, 16], Studies on the chemical composition of citronella oil have found it contains a mix of more than a dozen monoterpenes, with the major components being aldehydes and alcohols. Other compounds predominant in citronella oil include citronellyl acetate, β-bourbonene, geranyl acetate, elemol, l-borneol, and nerol [17, 18, 19]. Terpenes with more than 23,000 known compounds are the largest group of natural substances [20]. They are abundantly found in fruits, vegetables, aromatic and medicinal plants where their important function is protection against infections, parasites and other stress conditions.

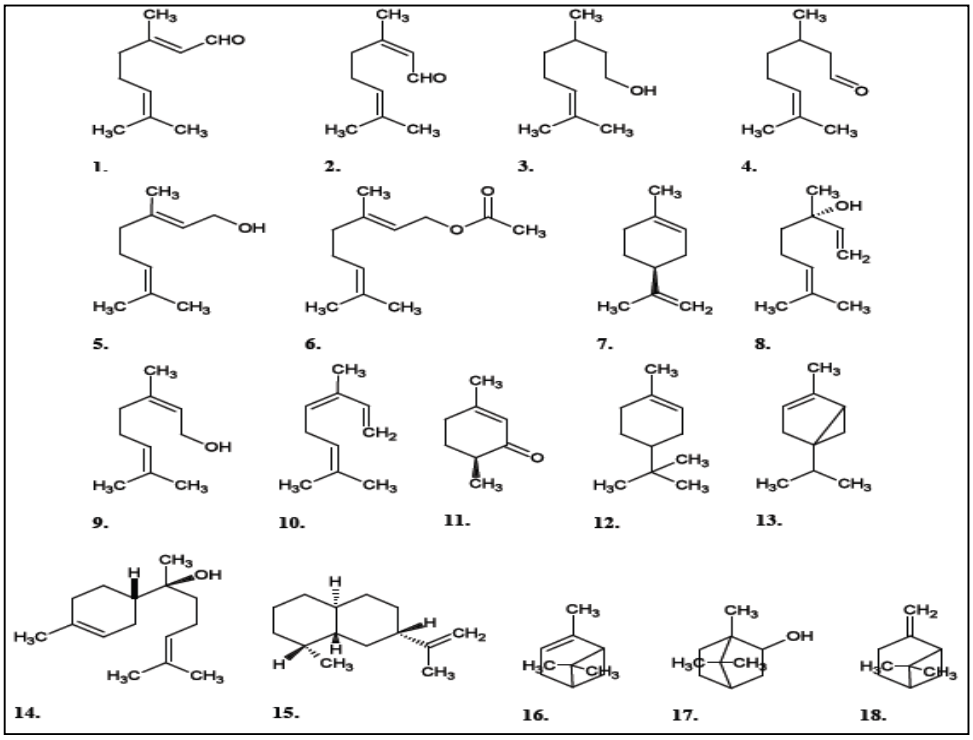

Fig 2: Chemical structures of Cymbopogon essential oil constituents [11]

1, citral a; 2, citral, b; 3, citronellol; 4, citronellal; 5, geraniol; 6, geranyl acetate; 7, limonene; 8, linalool; 9, nerol; 10, cis-ocimene; 11, piperitone; 12, α-terpineol, 13, thujane; 14, α-bisabolol, 15, isointermedeol; 16, borneol; 17, α-pinene; 18, β-pinene.

Pharmacological activities

- The essential oils of *C. martinii* have been studied and found to display high anthelmintic activity against *Caenorhabditis elegans* at ED50 value of 125.4 µg/mL [21]. This was mainly due to geraniol (a major chemical constituent). Palmarosa oil has also showed anthelmintic activity against the Indian earthworm *Pheretima posthuma* [7] where it causes paralysis and death in a short time.
- *C. martinii* (palmarosa) essential oil is used as fumigation to control beetles like *Callosobruchus chenesis* and *Tribolium castaneum*, which grow in stored grain [22]. In medicine, Palmarosa oil is used as a remedy for lumbago and stiff joints and in skin diseases. Oil of *C. martinii* leaves obtained by distillation was given orally to study its effect on the exudative phase of the inflammatory reactions, using the technique of Carrageenan-induced paw oedema. Oil of *C. martini* showed dose-dependent anti-inflammatory activity comparable to that of diclofenac sodium [23].
- Palmarosa showed significant beneficial effects on several central nervous system pathologies, mainly neuralgia, epileptic, and anorexia [24]. There are a few reports on its effects; still *C. martinii* has attracted many researchers' attention due to its antimicrobial, antigenotoxic, and antioxidant activities [25, 26, 27, 28].
- Geraniol, the major constituent of *C. martinii* EO, is an acyclic monoterpenoid that is abundant in many plants [29]. It may represent a new class of therapeutic agents against pancreatic [30], and colon cancers [31] and has several biological properties, including antimicrobial, antioxidant and anti-inflammatory activities [32].
- Sinha *et al.* studied the potential antigenotoxic and antioxidant properties of essential oils of palmarosa and citronella in human lymphocytic cells. The anti-oxidant activity of the essential oils was revealed by two spectrophotometric methods; DPPH + free radical scavenging and lipid peroxidation assays. Palmarosa and Citronella oils showed high antiradical activity, with Palmarosa exhibiting higher activity. The IC_{50} values of the Palmarosa and Citronella oils are 187.503 and 215.763 µg/ml, respectively. IC_{50} value is inversely related to the scavenging activity of the test sample. Egg yolk lipids undergo rapid non-enzymatic peroxidation when incubated in the presence of ferrous sulphate. Palmarosa and Citronella oils inhibited lipid peroxidation

in a concentration dependent manner with IC_{50} values of 198.109 and 206.286 µg/ml, respectively. The inhibition of lipid peroxidation by ascorbic acid (100 µM) was about 2 times higher than the essential oils. The antigenotoxic effect on human lymphocyte cells (measurement of cell viability, DNA damage) was studied using trypan blue dye exclusion test, plasmid pBR322 DNA strand scission, and comet assay [33]. The essential oils showed a good antigenotoxic activity against methyl methanesulphonate (MMS) and hydrogen peroxide.

- Similarly, *C. martinii* essential oil exhibited repellent action against *Anopheles sundaicus* [34]. Palmarosa oil is safe for human use and is thus recommended for protection from malaria due to its potent repellent action against mosquitoes. Beside mosquito repellent activity, Palmarosa essential oil also showed strong pesticidal activity against insect infestation and is used to protect stored wheat and grain from the beetles *Callosobruchus chenesis* and *Tribolium castaneum* [22]. Essential oils are strong antimicrobial agents with broad spectrum activity with possible potential for the control of pathogens in plants as of post harvest spoilage of many crops and also to human pathogenic diseases. As an antimicrobial agent they are more economic and environmentally viable [35]. Lodhia *et al.* showed that essential oil extracted from flower petals of Palmarosa showed good antimicrobial activity against both gram positive and gram negative bacteria. With increase in concentration of essential oil, an increase in zone of inhibition was observed thus dose-dependent response was clear for essential oil from Palmarosa [26].
- Essential oil from flower petals of Ppalmarosa is used for gargles in throat infection and skin care [36].
- *In vitro* antioxidant activity of Palmarosa essential oil was done by Lawrence *et al.* by using DPPH assay, nitric oxide assay, reducing power assay, β-carotene bleaching assay and FRAP method. They found out that IC_{50} values observed for DPPH and NO assay were 0.125 mg/mL and 12.5 µg/mL, respectively. In β-carotene bleaching assay, the oil showed 93.15 % bleaching for the first hour and it increased to 51.1 % in second hour. There was a constant increase in the reducing activities with the increase in concentration in both reducing activity and FRAP methods. The result clearly indicated that Palmarosa essential oil is effective in scavenging free radicals and is potent antioxidant [37].
- Mishra *et al.* studied the antifungal and antiaflatoxigenic efficacy of chemically characterized *Cymbopogon martinii* essential oil (CMEO) against aflatoxigenic *Aspergillus flavus* causing infestation to stored raw materials. In addition, the antioxidant activity and safety profile of CMEO were also assessed to recommend it as ideal preservative for stored herbal raw materials. The GC-MS of CMEO showed nerol as the major component (79.91%). CMEO inhibited growth and aflatoxin secretion of *A. flavus* $LHPA_9$ at 0.5 & 0.4 µL/mL respectively, showing better efficacy over synthetic antimicrobial Propineb 70. It also exhibited broad fungitoxic spectrum against fungi causing postharvest deterioration of raw materials. The CMEO also exhibited pronounced antioxidant activity (IC_{50}= 49 µL/mL) better than nerol, the major component of CMEO. The LD_{50} of CMEO, determined through oral administration on mice was calculated as 2569.16 mg/Kg body weight indicating its favourable safety profile as preservative [38].
- Aromatherapy is a traditional treatment in which the aromatic molecule from essential oils passes through the nasal cavity and adheres to the olfactory epithelium, causing nerve stimulation directly to the hippocampus and limbic amygdaloidal body. This consequently triggers stimuli that control the autonomic nervous system and internal secretory control by changing a number of vital reactions [39]. The inhalation of aromatic compounds present in essential oils is the reason for the name "aromatherapy" and this therapy may have sedating or stimulating effects on the individual [40]. Reports in the literature describe the benefits of using essential oils in aromatherapy on the wellbeing of individuals, including improvements in mood, stress, anxiety, depression, and chronic pain, and promote so therapeutic, psychological, and physiological effects. The inhalation of essential oils elevated blood pressure and renal sympathetic activity, which enforces the idea that these components act in the central nervous system and pass through the blood-brain barrier.[41] Volatile organic compounds are highly lipophilic and may easily cross the blood-brain barrier and easily exert their neuropharmacological effects.

Conclusion

Various compounds have been isolated and identified from *Cymbopogon martini* essential oil. A detailed chemical study can further be carried out for finding the pharmaceutical activity responsible for such properties. In other words, elaborated studies can be propagated for searching that whether it is single compound or compounds are responsible for such actions.

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