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CONSTITUENTS OF *CYMBOPOGON* SPECIES

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ABSTRACT

A comprehensive review of the *Cymbopogon* species including the essential oils and their constituents is given. An account of the other components *viz.* non volatile terpenoids and phenolic compounds is also given. The biological activities of the studied *Cymbopogon* species are also reported.

Volatile oil :

A number of *Cymbopogon* species produce aromatic oils, some of which are known to man for a long time. The aromatic character of some of these oils persists for a very long time.

When the tombs of certain Egyptian kings of the 20th and 21st dynasties (3,000 years ago) were opened in 1881, the scent of *Cymbopogon schoenanthus* grass was readily detected by smell[1].

The essential oils, obtained from a number of *Cymbopogon* species, are used as such in perfumery or yield pure isolates that are used in high – grade perfumery. Some species are commercially grown for oil, like *C. nardus*[2–6] and *C. winterianus*[7–10] yielding Cylon and Jave citronella respectively and containing varying proportions of citronellal, citronellol and geraniol; *C. martini* var. *motia* and var. *sofia,* yielding palmarosa and gingergrass oils respectively, the main constituent being geraniol (80 to 90 % in var *motia* and 53 to 65 % in var. sofia)[11,12] while C. *flexuosus,* yielding lemon grass oil, the main constituent being citral and geraniol[11,13–16].

Other species which are of commercial interest but are not cultivated on a large scale, include *C. citratus* (citral)[3,5,11,17–20], *C. jawarancusa* (piperitone)[11,21,22], C. pendulus (citral)[3,14,16,23,24], *C. proximus* (piperitone)[38,42], *C. caesius*

(borneol, carvone and perillyl alcohol)[11,20,25,26], *C. travacorensis* (borneol), *C. parkeri* (geraniol and nerol)[19,27] *C. tortilis* (methyl eugenol)[11].

Generally, several members of the genus *Cymbopogon* are known for the presence of economically important compounds of their volatile oils, such as citral, citronellol, geraniol, piperitone and methyl eugenol which are highly valued as a flavouring agents and in the pharmaceutical industry. Geraniol is highly valued as a perfume and a starting material for a large number of synthetic aromatic chemicals. Citral is used as a starting material for synthesis of perfumary grade ionones and vitamin A; citronellal similarly forms the base for many other synthetics. Piperitone is an important starting material for synthesis of L–menthol and thymol. Methyl eugenol is both a perfumery chemical and a starting material for the synthesis of methyl dopa, an important hypotensive drug.

Commercially available oils from *Cymbopogon* species (i.e. palmarosa, lemon grass, ginger grass and citronella oils inter alia) either fall into a 'geraniol' type containing acylic monoterpenes (geraniol, citral, citronellol) or a 'menthane' class with predominantly monocyclic monoterpenes (e.g. limonene, piperitone, menthone, etc.)[28–31], this dichotomy occurs in oils from other species that have been screened[19,29,30,32–34]. Apart from reports of up to 6.0 % elemol, caryophyllene and humulene in certain oils, some sesquiterpene components have also been characterised[19,20,22,26,35–37].

The essential oils of C. *excavatus, C. commutatus* and *C. nervatus* were found to be of the menthane type and its monoterpenes, as well as a large number of its sesquiterpenes, were acyclic and bicyclic[38]. Unusual menthadien – ols, similar to those found only in *C. densiflorus* and *C. martini*[19,39] were the predominant components of the oils (up to 89 %). Table (1) summarises the constituents of the volatile oils of the different *Cymbopogon* species.

Non–volatile terpenoids :

Other constituents of *Cymbopogon viz* terpenoids (non–volatile) and flavonoids received but little attention. Two triterpenoids, a ketone named cymbopogone and an alcohol cymbopogonol were isolated from *C. citratus*[40,41]. A bicyclic sesquiterpene diol, proximadiol, with unique antispasmodic properties has been isolated from *C proximus*[42], and was later found to be identical with

cryptomeridiol, a sesquiterpene of the eudesmane type[43,44]. The latter compound together with eremoligenol were identified in *C parkeri,* growing in Qatar[19,45]. Arundoin a triterpene was isolated from *C. flexuosus* leaves[46].

Phenolic compounds :

A number of flavonoids have been identified in *Cymbopogon* species *viz.* tricin and flavone C–glycosides in *C. bombycinus, C. confertiflorus, C. procerus, C. refractus and C. schoenanthus,* luteferol in *C. procerus* and *C. schoenanthus,* and a flavonoid sulphate and apigiferol in *C. procerus* and *C. schoenanthus* respectively[47]. The detection of other flavonoids has also been reported; rutoside, quercetin and kaempferol from *C. densiflorus* and *C. giganteum*[19,32], rutin in *C. citratus, C. proximus* and *C. nardus* and quercetin in *C. proximus*[20]. Luteolin and its *C– glucoside* were isolated from the aerial parts of *C. citratus*[19].

Umbelliferone, P–coumaryl alcohol and quercetin dimethyl ether were isolated from *C. parkeri*[19].

Uses and biological activities :

Because a host of medicinal properties have been ascribed to *Cymbopogon* species, folk medicine records many applications for this genus. *Cymbopogon* species have been used as a blood purifer, in rheumatism and cholera; the essential oils of some of their species have been reported to be used as carminatives, stimulatives, antiseptics, suedorofics and as applications in rheumatism and neuralgia[19]. Roots and stems of these species are useful in the antidotal treatment of snake bite and scorpion sting[19].

Cymbopogon citratus has been used as a diuretic, emenagogue, diaphoretic, stomachic, carminative, tonic, antirheumatic, refrigerant and anti–diarrhetic[48]. It is one of the commonest plants used in the form of an equeous decoction for treating feverish conditions.[49]. It is said to possess stimulant and antispasmodic effects and it is employed as a rubefacient in some East Asian contries[50]. The leaf contains an essential oil which is used as an external application in treating rheumatism[19].

Since the essential oil of *Cymbopogon nardus* possesses sedative properties[51],

Seth studied the effect of the essential oil of *Cymbopogon citratus* on the central nervous system of experimental animals[52]. The study revealed that the essential oil exerted a marked depressent effect on the central nervous system (CNS). The fact that the essential oil of *Cymbopogon citratus* is a CNS depressent was further confirmed by its potentiation of the pentobarbitone–induced hypnosis in mice and its hypothermic activity in rats. Apart from the pentobarbitone–induced hypnosis in mice, the effect of the essential oil of *Cymbopogon citratus* appears to be slightly better than that of the essential oil of *Cymbopogon nardus*[52].

The lemon–grass oil of *Cymbopogon citratus* was used as a carminative and an antispasmodic[48]. Kató and Guzsy[19] reported that lemongrass oil was inactive against guinea pig tuberculosis, but Marzulla and Balter[19] stated that the oil was active against phytopathogenic fungi. In niew of this and the fact that the chief constituents of both the oil of *Cymbopogon nardus* and that of *Cymbopogon citratus* are acyclic terpenes, Kokate[5] studied the antimicrobial activity of these two oils. The two oils showed good activity against many gram–positive bacteria and fungi, but they do not seam to be very effective against the gram–negative bacteria[5].

The essential oil of some *Cymbopogon* species showed a remarkable antibacterial and antifungal activity, e.g. *Cymbopogon* nardus[53], *Cymbopogon pendulus*[54], *Cymbopogon flexuosus*[55] and *Cymbopogon olivieri*[36].

The essential oil of *Cymbopogon caesius* has been found effective against *Escherchia coli,* the causative agent of the intestinal infections, and *Shigella beydii,* the bacterium which is responsible for bacillary dysentry. Some of the constituents of the essential oil, such as citral, d–limonene, carvacrol, dipentene and citronellol, have also been found to be growth inhibiting against *Staphylococcus aureus, Bacillus sibtilis* and *Salmonella typhi*[19]. The antifungal properties of the essential oil and some of its constituents have been shown by their growth inhibiting role in the fungal species of *Trichophyton mentagrophyte, Trichophyton unmbrum, Trichophyton semii* and *Microsporum gypseum*[56].

The oils of *Cymbopogon martini* (Ginger–grass oil), *Cymbopogon olivieri* and *Cymbopogon Sp.* (Rosa Sofia oil) were tested for their antifungal activity[57]. The essential oils exhibited strong fungitoxicity and showed a wide range of activity.

The oils were found more active than some of the prevalent synthetic fungicides and might exploited as natural fungicides if successful in field trials. In addition, these oils were found to be toxic to various human pathogens.

Cymbopogon flexuosus is beleived by the Kukuto people in the eastern highlands of papua New Guinea to prevent sickness[58]. The essential oil is used for the manufacture of vitamine-A and medicines for heart diseases[59].

Cymbopogon proximus is widely used in folk medicine for the treatment of digestive ailments and as a flavouring agent. A decoction, prepared from the leaves of the plant, is used as a remedy against renal Pains[19]. Earlier preliminary investigations of the plant revealed that it contained an active diuretic oleo-resin[60,61]. The activity was later proved to be due to a saturated dicyclic sesquiterpenoid-diol[42], which was given the name proximadiol. Pharmacological studies[42] showed that proximadiol has unique antispasmodic property as it produces relaxation of smooth muscle fibres without abolishing the propulsive movement of the tissue.

Cymbopogon parkeri, growing in Qatar, has been recently reported to contain several active constituents, two of which possess antispasmodic activities and were identified as cryptomeridiol and eremoligenol[19,45].

Table 1

Chemical constituents of volatile oils from different *Cymbopogon* species

	C. caesius	*C. citratus*	*C. coloratus*	*C. commutatus*	*C. densiflorus*	*C. distans*	*C. excavatus*	*C. flexuosus*	*C. javanensis*	*C. jawarancusa*	*C. khasianus*	*C. martini*	*C. nardus*	*C. nervatus*	*C. olivieri*	*C. parkeri*	*C. pendulus*	*C. proximus*	*C. schoenanthus*	*C. sennaarensis*	*C. winterianus*
HYDROCARBONS:																					
γ – Amorphene						+															
Bazzanene										+											
α – Bergamotene						+															
α – Bisabolene								+		+											
β – Bisabolene						+		+		+											
Bourbonene																					+
α – Cadinene																					
γ – Cadinene						+		+													+
δ – Cadinene	+					+		+													+
α – Calamene										+											
Calaminene																					+
Camphene	+		+			+				+		+	+								+
Δ^2 – Carene										+											
Δ^3 – Carene								+		+		+				+	+				
Δ^4 – Carene	+									+											
α – Caryophyllene						+				+											
β – Caryophyllene						+		+		+		+	+								
γ – Caryophyllene																					
α – Celanene																					+

Table 1 Cont.

	C. caesius	*C. citratus*	*C. coloratus*	*C. commutatus*	*C. densiflorus*	*C. distans*	*C. excavatus*	*C. flexuosus*	*C. javanensis*	*C. jawarancusa*	*C. khasianus*	*C. martini*	*C. nardus*	*C. nervatus*	*C. olivieri*	*C. parkeri*	*C. pendulus*	*C. proximus*	*C. schoenanthus*	*C. sennaarensis*	*C. winterianus*
α - Chamigrene										+											
α - Copaene										+											
α - Cubebene										+											
Cuparene										+											
α - Curcumene								+													
o - Cymene										+											
p - Cymene	+			+		+		+		+		+	+	+		+					
Decane																+					
Diethylbenzene																+					
Dipentene	+	+								+		+									+
Dodecane																+					
γ - elemene								+													
β - elemene								+		+											+
δ - elemene								+		+											
eudesmene																					
α - farnesene										+											

Table 1 Cont.

	C. caesius	*C. citratus*	*C. coloratus*	*C. commutatus*	*C. densiflorus*	*C. distans*	*C. excavatus*	*C. flexuosus*	*C. javanensis*	*C. jawarancusa*	*C. khasianus*	*C. martini*	*C. nardus*	*C. nervatus*	*C. olivieri*	*C. parkeri*	*C. pendulus*	*C. proximus*	*C. schoenanthus*	*C. sennaarensis*	*C. winterianus*
β – Farnesene						+				+											
Germacrene – D										+											
β – Gurjunene																+					
Limonene	+			+	+	+	+	+		+		+	+	+	+	+		+		+	+
Longifolene										+											
Methylethylbenzene																+					
1 – Methyl–4–isopropenylbenzene				+										+							
α – Muurolene						+				+											
Myrcene		+				+		+		+			+		+	+					+
Ocimene								+					+								
α – Phellandrene						+							+								
β – Phellandrene						+		+													
δ – Phellandrene	+																				
α – Pinene	+					+		+	+	+		+	+		+			+			+
β – Pinene						+		+		+			+		+						
Sabinene						+															
β – Santalene										+											

Table 1 Cont.

	C. caesius	*C. citratus*	*C. coloratus*	*C. commutatus*	*C. densiflorus*	*C. distans*	*C. excavatus*	*C. flexuosus*	*C. javanensis*	*C. jawarancusa*	*C. khasianus*	*C. martini*	*C. nardus*	*C. nervatus*	*C. olivieri*	*C. parkeri*	*C. pendulus*	*C. proximus*	*C. schoenanthus*	*C. sennaarensis*	*C. winterianus*
β – Selinene						+		+													
α – Terpinene				+		+		+					+								+
γ – Terpinene						+															
Terpinolene						+		+		+			+								
α – Terpinolene																+					
α – Thujene										+											
α – Thujiene													+								
Toluene																+					
Tricyclene												+									
Sesquiterpenes	+		+	+		+	+			+	+	+	+	+		+	+				+
Xylene																	+				
α – Ylangene										+											
β – Ylangene										+											
Undecane																+					

Table 1 Cont.

	C. caesius	*C. citratus*	*C. coloratus*	*C. commutatus*	*C. densiflorus*	*C. distans*	*C. excavatus*	*C. flexuosus*	*C. javanensis*	*C. jawarancusa*	*C. khasianus*	*C. martini*	*C. nardus*	*C. nervatus*	*C. olivieri*	*C. parkeri*	*C. pendulus*	*C. proximus*	*C. schoenanthus*	*C. sennaarensis*	*C. winterianus*
ALCOHOLS :																					
∝ – Bisabolol						+															
Borneol	+	+				+		+		+			+								
Cadinol																					+
Carvacrol	+																				
Carveol				+			+					+		+				+			
Citronellol								+	+				+						+		+
Dihydrocarveol												+						+			
Dihydrocumenyl alcohol												+									
Elemol								+		+			+					+			+
Eudesmol										+						+					
ß – Eudesmol								+										+			
Farnesol	+					+		+											+		
Geraniol		+	+			+		+	+	+	+	+	+			+			+		+
Guaiol																+					
n – Hexanol																					+
3 – Hexen – 1 – ol																					+
Isoamyl alcohol																					+
Isoborneol										+											
Isobutyl alcohol																					+

Table 1 Cont.

	C. caesius	*C. citratus*	*C. coloratus*	*C. commutatus*	*C. densiflorus*	*C. distans*	*C. excavatus*	*C. flexuosus*	*C. javanensis*	*C. jawarancusa*	*C. khasianus*	*C. martini*	*C. nardus*	*C. nervatus*	*C. olivieri*	*C. parkeri*	*C. pendulus*	*C. proximus*	*C. schoenanthus*	*C. sennaarensis*	*C. winterianus*
Isointermediol								+													
Isopulegol								+							+						+
Lavandulol										+											
Limonenediol												+									
Linalool		+						+		+		+	+		+	+		+			+
P – Menth – 1 (7), 8 – dien – 2 – ol				+	+		+					+		+							
P – Menth – 1 (7), 8 – dien – 3 – ol				+			+							+							
P – Menth – 1,8 – dien – 3 – ol					+																
P – Menth – 8 – ene – 1,2 diol												+									
P – Menth – 2,8 – dien – 1 – ol				+	+		+			+		+		+							
Menthene – 1 – ol													+								
Methyl heptenol		+																			
Nerol	+	+										+	+			+					
Nerolidol	+																				
Perillyl alcohol	+				+							+									
Piperitol										+			+								
n – Propyl alcohol													+								
α – Terpineol						+				+			+			+					

Table 1 Cont.

	C. caesius	*C. citratus*	*C. coloratus*	*C. commutatus*	*C. densiflorus*	*C. distans*	*C. excavatus*	*C. flexuosus*	*C. javanensis*	*C. jawarancusa*	*C. khasianus*	*C. martini*	*C. nardus*	*C. nervatus*	*C. olivieri*	*C. parkeri*	*C. pendulus*	*C. proximus*	*C. schoenanthus*	*C. sennaarensis*	*C. winterianus*
4 – Terpineol										+			+								
Terpinen – 4 – ol										+											
Thuj – 2 – ene – 4 – ol										+											
Thujyl alcohol																					+
Sesquiterpene alcohols			+			+		+					+			+		+	+		
ALDEHYDES :																					
Benzaldehyde																					+
ß – Cadinal																					+
Citral	+	+	+			+		+	+		+	+	+			+	+	+			+
Citronellal						+		+		+			+								+
Decylaldehyde		+																			
Farnesal																+					
Furfural		+																			+
Isovaleraldehyde																					+
Methyl vanillin									+												
Myrtenal										+											
Perillaldehyde	+																				
Vanillin																					+
Octanal						+															

Table 1 Cont.

	C. caesius	*C. citratus*	*C. coloratus*	*C. commutatus*	*C. densiflorus*	*C. distans*	*C. excavatus*	*C. flexuosus*	*C. javanensis*	*C. jawarancusa*	*C. khasianus*	*C. martini*	*C. nardus*	*C. nervatus*	*C. olivieri*	*C. parkeri*	*C. pendulus*	*C. proximus*	*C. schoenanthus*	*C. sennaarensis*	*C. winterianus*
KETONES:																					
Camphor								+		+											
Carvomenthone						+															
Carvone	+			+	+		+					+		+							
Cymbopol																					+
Dihydrocarvone												+									
Eucarvone										+											
Fenchone										+											
Δ – Menthenone																				+	
Menthone						+															
1 – Methyl – 3 – cyclohexanone																					+
Methyl heptenone		+						+		+			+								+
Piperitenone												+			+						
Piperitone						+				+			+	+	+			+			
Piperitone oxide												+									
Pulegone															+						
Verbenone										+											

Table 1 Cont.

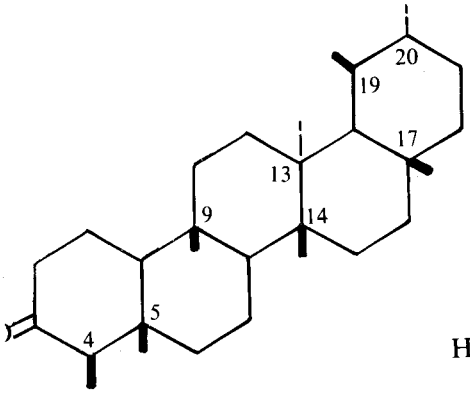
	C. caesius	*C. citratus*	*C. coloratus*	*C. commutatus*	*C. densiflorus*	*C. distans*	*C. excavatus*	*C. flexuosus*	*C. javanensis*	*C. jawarancusa*	*C. khasianus*	*C. martini*	*C. nardus*	*C. nervatus*	*C. olivieri*	*C. parkeri*	*C. pendulus*	*C. proximus*	*C. schoenanthus*	*C. sennaarensis*	*C. winterianus*
ESTERS:																					
Bornyl acetate						+		+								+					
Butyl acetate																+					
Carvyl acetate												+									
Citronellyl acetate													+								+
Citronellyl butyrate									+												
Citronellyl formate									+												
Citronellyl caprylate									+												
Citronellyl valerate									+												
Geranyl acetate		+	+			+		+		+		+	+			+					+
Geranyl butanoate																+					
Geranyl butyrate												+	+								
Geranyl heptanoate																+					
Geranyl hexanoate																+					
Geranyl octanoate																+					
Geranyl valerate																+					
Linalyl acetate	+														+						
Neryl acetate																+					

Table 1 Cont.

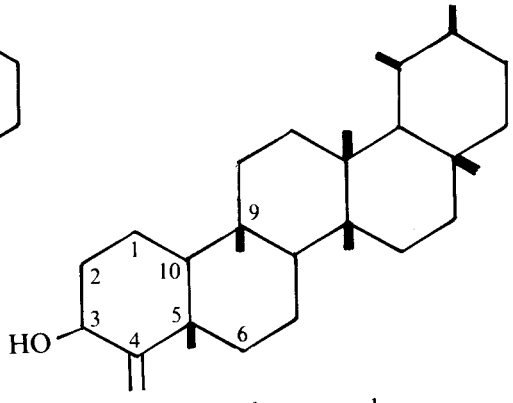
	C. caesius	*C. citratus*	*C. coloratus*	*C. commutatus*	*C. densiflorus*	*C. distans*	*C. excavatus*	*C. flexuosus*	*C. javanensis*	*C. jawarancusa*	*C. khasianus*	*C. martini*	*C. nardus*	*C. nervatus*	*C. olivieri*	*C. parkeri*	*C. pendulus*	*C. proximus*	*C. schoenanthus*	*C. sennaarensis*	*C. winterianus*
Neryl butanoate															+						
Neryl hexanoate															+						
Neryl octanoate															+						
Neryl propionate					+																
PHENOLS :																					
Carvacrol																					
Chavicol													+								
Elemicine		+						+													
Eugenol								+					+								
Methyl eugenol						+		+					+								+
Methyl isoeugenol									+				+								+
Phenol			+																		

Table 1 Cont.

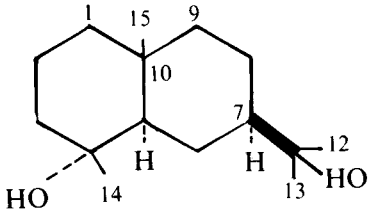
	C. caesius	C. citratus	C. coloratus	C. commutatus	C. densiflorus	C. distans	C. excavatus	C. flexuosus	C. javanensis	C. jawarancusa	C. khasianus	C. martini	C. nardus	C. nervatus	C. olivieri	C. parkeri	C. pendulus	C. proximus	C. schoenanthus	C. sennaarensis	C. winterianus
ACIDS :																					
Acetic acid			+									+									
Butyric acid												+									
n – Caproic acid						+															+
Citronellic acid						+							+								
Decanoic acid										+											
Formic acid												+									
Hexadecanoic acid										+											
Octanoic acid										+											
Perillic acid					+																
MISCELLANEOUS																					
Caryophyllene oxide								+		+		+	+								
1 : 8 – Cineole					+					+		+									
(+) – Epoxy – 1,2 – p–menthene–8					+																
Limonene oxide												+									



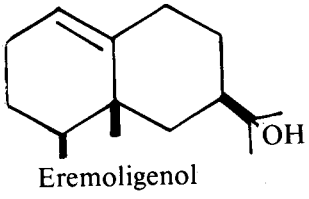
Cymbopogone



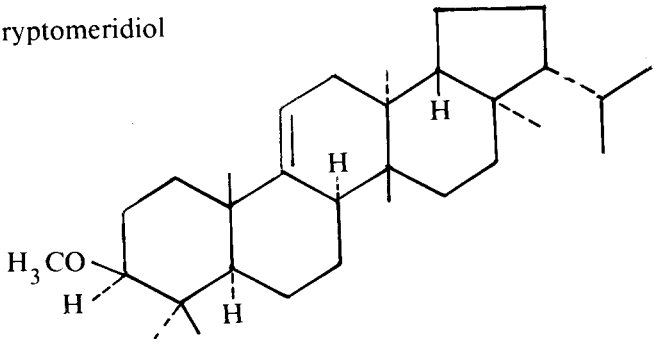
Cymbopogonol



Cryptomeridiol



Eremoligenol



Arundoin

Some Non–volatile terpenoids of *Cymbopogon* species

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مكونـــات نبـــاتات الســـيمبوبوجن

حلـمي إسـماعيل هيـبة و عبـد الفتـاح محمـد رزق

نباتـات السيمبوبوجن تشتهر بـاحتوائهـا على زيوت عطريـة (طيـارة) والكثير من زيوتهـا أو مكوناتها له إستخدامات عديدة في صناعة العطور ، ويتناول هـذا البحث عرضاً لمكونـات الزيوت الطيارة للأنواع المختلفة التي تنتمي إلى جنس السيمبوبوجن وكـذا المركبـات الأخرى مثل التربينـات الثلاثيـة والمواد الفينوليـة (الفلافونيـدات ، الكومـارينـات وغيرهـا) كما يتنـاول البحث إستعراضاً للإستخدامات الطبية لهذه النباتات والخواص البيولوجية للمواد المفصولة منها .