IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 4, January 2026
Impact Factor: 7.67

A Comprehensive Analysis of the Diverse Components of Essential Oils in *Chromolaena odorata* L.

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Abstract: *Chromolaena odorata is luxuriantly growing weed, found open spaces, roadsides, railway station tracks sides and wastelands. Flowers f this plant has peculiar smell. This articles reviews on essential oil components studied in different countries form different plant parts. It is found that variations of components of essential oil in different countries and even in different locations of same country. Some components are same but their percentage are different. Difference in yield, number of components and percentage is due to difference in climatic conditions and geographical locations. Certain components such as germacrene D, geijerene, pinene, pregeijerene, caryophyllene, murolene are common in most of countries. Because of these components aroma is similar. Variation in components suggest derivatives of the compounds due to disparity in climatic and edaphic conditions. This difference in components of essential oil will create a new research idea to find out mechanism of essential oil formation, factors affecting the mechanism or pathways of essential oil formation.*

Keywords*:* Chromolaena odorata, essential oil components, climatic variation, geographical variation

I. INTRODUCTION

Essential oils are concentrated hydrophobic liquids that contain volatile chemical compounds extracted from plants. They are also referred to as volatile oils or ethereal oils, these substances generate the characteristic fragrance of the plants from which they are derived. They are the mixtures of hydrocarbons an oxygenated compound, derived from hydrocarbons. Many essential oils contain a mixture of alcohols, aldehydes, ketones, phenols, ether and ester. Essential oils have long been utilized for their therapeutic benefits in human medicine.

Chromolaena odorata (*C. odorata*) (L.) R.M. King & H. Rob, belongs to family Asteraceae. Previously it is known as *Eupatorium odoratum* L. It is a scandent or semi-woody shrub originally native to South America but has since spread to many tropical countries, where it is widely recognized as one of the most problematic weeds in the world. Due to fast growth of this plant spreads quickly in open areas such as grasslands, wastelands, roadsides, forests etc. (Putri and Fatmawati, 2019) [1] *C. odorata* exhibit significant morphological variability within its native range, characterized by differences in flower colour, leaf shape, and the scent of crushed leaves. This variability is evident in some regions where multiple forms and their intermediates coexist, while in other areas, the population appears relatively homogeneous (Zahara, 2019) [2].

It is used for treatment of diverse ailments. Several papers have reported on the constituents of *C. odorata*, including both volatile and non-volatile compounds, and their pharmaceutical potential. The literature indicates that the composition of the volatile oil extracted from this plant varies by region, exhibiting differences in both the percentages and types of compounds present. Present review is due to curiosity to know the components and variability of essential oil of *C. odorata* from different regions.

DOI: 10.48175/IJARSCT-31045

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II. LITERATURE SEARCH METHODOLOGY

This review was conducted through searches using Scopus, PubMed, Science Direct, Research gate and Science hub, Google Scholar etc. Information about essential oils components in *C. odorata* was gathered from the database using various keywords.

III. DISCUSSIONS

Data collected from databases on components essential oils of *C. odorata* studies found in 7 countries and in same country at different locations. Studies conducted for antimicrobial od essential oils, components of essential oil, medicinal value etc. following tables through light on essential oil components.

Essential oil component of *C. odorata* from India.

Table I. presents summary of essential oil major components of *C. odorata* (EOCO)from India. The dried leaves of *C. odorata* from Dehradun, Uttarakhand, contain several major components, including tau-cadinol (20.10%), α-bisabolol (15.33%), cis-muurola-5-diene (10.79%), isobornyl acetate (6.40%), and isocaryophyllene (5.39%). The essential oil major components of the aerial parts of *C. odorata* from Karnataka include pregeijerene (14.2%), epi-cubebol (9.8%), cubebol (8.6%), and cis-sabinene hydrate. In the flowers, the major components of the essential oils are germacrene D (24.8%), geijerene (12.6%), pregeijerene (12.5%), and cyperene (7.8%). Essential oil major components of fresh aerial parts of North East India were Geijerene (26.34 %), α-Copaene (17.87 %), Caryophyllene (11.14 %), 3-Carene (10.63 %), Cadinene (7.98 %). The essential oil compositions (EOCO) of *C. odorata* from Karnataka and North East India showed similarities, with geijerene, cadinene, and muurolol being common major components.

Table II indicates major common components of the essential oil of *C. odorata* of Africa are α-pinene and β-caryophyllene, with exception of those found in the Republic of Benin (West Africa). Common essential oil components in different regions of Africa are **α-pinene, β -pinene, β-caryophyllene, Geijerene, Pregeijerene, Germacrene D.** However, their concentrations are dissimilar in different regions. The major components in volatile oil are diverse in different regions. Essential oil composition also vary region to region in Africa.

The essential oil components of Vietnam Table III indicate Geijerene (42.5%) and β-caryophyllene (7.4%) are the prominent essential oil components. The volatile oil evaluated in year 2025 shows α-Pinene (11.47–19.24%, Germacrene D (11.67–15.12%), (E)-β-caryophyllene (9.56–11.24%) and Geijerene (8.96–10.55%) as major constituents of essential oil.

Aerial plant parts of *C. odorata* from Thailand shows major essential oil components (Table IV) such as Pregeijerene (17.6%), Germacrene D (11.1%), α-pinene (8.4%), β-caryophyllene (7.3%), Vestitenone (6.5%), and β-pinene (5.6%).

Table V presents major components of essential oil of fresh leaves of Tarai from Nepal. These were Linalool (21.64%); β-pinene (9.43%); 1,3-cycloheptadiene (8.92%); β-cubebene (7%); cinnamaldehyde (5.30%) and caryophyllene oxide (4.94%).

Major components of the volatile oil of leaves of China (Table VI) identified were trans-caryophyllene (16.58%), delta-cadinene (15.85%), alpha-copaene (11.58%), caryophyllene oxide (9.63%), germacrene-D (4.96%), and delta-humulene (4.32%).

Components of essential oils like Germacrene D, Geijerene and caryophyllene found almost all studied countries. The composition of essential oil also differs in different parts of plant like leaves, flowers etc. The chemical profile variability in regions of same country or different countries maybe due to geographical conditions, such as location of the plant, difference in altitude, soil, time of collection or method of extraction of the oil.

Major chemical components of essential oils of China (table VI) were trans-caryophyllene (16.58%), delta-cadinene (15.85%), alpha-copaene (11.58%), caryophyllene oxide (9.63%), germacrene-D (4.96%), and delta-humulene (4.32%).

Table VI indicates essential oil components of C. *odorata* plant from Malysia. These were β-pinene (23.35%),

IV. CONCLUSION

C. odorata is predominant cosmopolitan weed. Hence, in several countries and researchers studies it as a part of curiosity and utilisation point of view. Flowers of these plants are aromatic. Aromatic plants have various potentials as

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insecticides, pesticides, herbicides, medicine or other purposes. This article focuses components of essential oils in various countries. This review article will be beneficial for researcher those work on essential oil components studies, mechanisms, pathways etc. Article provides data essential oil components of *C. odorata* studied at different countries together. It will give directions to researcher working on *C. odorata.*

Table I. Essential oil components of *C. odorata* in India

Locality	Part	Yield	Identification (No., %)	Major Components	Reference
Karnataka (India)	Fresh Aerial and Flower	Aerial 0.11 % Flowers- 0.14 %	Aerial- 52, 94.9 Flowers- 34, 95.2	**Aerial- Pregeijerene** (14.2 %), *epi*-cubebol (9.8 %), cubebol (8.6 %), *cis*sabinene hydrate (5.7%),10-*epi*-γ-eudesmol (3.8 %), **Germacrene-D-4-ol (3.6 %)** and δ-cadinene (3.5 %) **Flowers -** **Germacrene D (24.8 %), Geijerene** (12.6 %), **Pregeijerene** (12.5 %), Cyperene (7.8 %), 10-*epi*-γ-eudesmol (4.7 %), α-**muurolol** (3.6 %) and khusimone (3.4 %).	Joshi (2013) [3]
North East India	Fresh aerial	0.85 % (w/w)	24, 95.32%	**Geijerene** (26.34 %), α-Copaene (17.87 %), **Caryophyllene** (11.14 %), 3-Carene (10.63 %), Cadinene (7.98 %), Cyclohexane, 1-Methylene-4-(1-methylethenyl)- (3.37 %), Elemol (2.89 %), τ-**Muurolol** (2.77 %)	Gogoi *et al.* (2020) [4]
India-Dehradun, Uttarakhand	Dried Leaf	0.010%.	15, 76.33	tau.Cadinol (20.10%), α Bisabolol (15.33%), cis-muurola-4 (14) 5- diene (10.79%), Isobornyl acetate (6.40%), and Isocaryophyllene (5.39%).	Choudhary *et al.* 2023[5]

Table II. Essential oil components of *C. odorata* in Africa

Locality	Part	Yield	Identification (No., %)	Major Components	Reference
Nigeria (Western coast of Africa)	Fresh leaf	0.40%	22, 81.71	**α -pinene (19.32%),** (+)-camphor **(15.46%),** cadinene **(19.09%),** limonene **(10.22%),** P-**caryophyllene (7.05%),** and cadinol isomer **(6.36%).**	Inya-Agha *et al.* (1987) [6]
Cameroon and the Congo (Central Africa)	Fresh leaves	0.25%-Cameroonian and O.l% Congolese	Cameroon-22, 88 Congo-23, 95.4	**Cameroon-Pregeijerene** (25.1%), **α-pinene** (14.3%), **β-pinene (8.0%)** γ-muurolene (9.8%), **Geijerene** (9.00%) (E)-β-ocimene (5.2%), **β-caryophyllene** (4.3%) **Congo-** ρ-cymene (22.2%), thymyl acetate (15.8%), **Pregeijerene** (14.8%), **β-caryophyllene** (9.8%), α-	Lamaty et al., 1992[7]

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				pinene (8.5%), geijerene (4.2%)	
Ivory Coast	Fresh plant	0.3%	38, 88%	**α-pinene (18.8%), β-pinene (10.5%)** Pregeijerene (14%) and Geijerene (4.7%)	Bamba et al. (1993) [8]
Ivory Coast	Leaves	--	-----	**α-pinene (21.15%), pregeijerene (11.68%), β-pinene (10.12%) and germecrene D (9.50%)**	Bedi et al. 2001[9]
Cameroon	Leaves	0.06%	17, 71.58	bicyclogermacrene (12.55%), geijerene (11.85%), (Z)-β-farnesene (9.98%) and α-pinene (9.36%)	Tedonkeng et al. (2004) [10]
Ivory Coast Southern coast of West Africa (7 locations*)			41-18, 66 to 90	**Germacrene D** (14-13.9 %), **β - caryophyllene** (9.5-17.2 %), **β-caryophyllene oxide** (8.3- 11.3 %), **pregeijerene** (9.7-8.1 %) and **geijerene** (8-9.5.0 %)	Tonzibo et al. (2007) [11]
Ivory Coast	Leaves	0.12%	-------	**pregeijerene (19.9%), α-pinene (17.9%), geijerene (11.4%), β-inene(10.6%) and germacrène D (9.8%)**	Noudogbessi, et al. (2008) [12]
Nigeria (Western coast of Africa)	Dried leaves	0.16%	56, 99.3%	**α-pinene** (42.2%), **β -pinene (10.6%), germacrene** D (9.7%), _-copaen-4_-ol (9.4%), (*E*)-**caryophyllene** (5.4%), and **Geijerene/ pregeijerene** (7.5%).	Owolabi et al. (2010) [13]
Benin	Fresh leaves		32 57	<u>**Hot season**</u>**- Pregeijerene (16.3 %), β-Caryophyllene (14.3 %) and Germacrene D (13.3 %), α-Pinene (8.0 %), Geijerene (10.1 %),** <u>**Cold season**</u>**- Pregeijerene (29.9 %), β-Caryophyllene (7.3 %), Germacrene D (21.6 %), α-Pinene (4.1 %), β-Pinene (3.0 %),**	Kossouoh et al. (2011) [14]
Benin	Fresh leaves	0.1%	23, 99.3	**a-pinene (20.7%), pregeijerene (14.6%), Geijerene (12.0%), β - pinene (10.3%), Germacrene-D (9.7%).**	Felicien et al.2012 [15]
Ivory (5 locations)	Fresh leaves	0.13 and 0.20%	52-54, 95.3-99.65	**germacrene D** (15 to 20%), **geijerene** (14 to 17%), **pregeijerene** (11 to 12%), ***α*-pinene** (7 to 10%), ***β*-caryophyllene** (7 to 10%), ***β*-pinene** (4 to 5%) **and *δ*-cadinene** (3 to 5%)	Toure et al. (2014) [16]
Nigeria (4 Solvents- Hexane, Chloroform,	Air dried leaves	Hexa- 1.2%	21, 96.4	phytol (23.1%)**, caryophyllene oxide** (12.7%), **germacrene D** (9.0%)**,** 2,5-bis-(1,1-dimethyl) phenol (7.8%) **and β-**	Lawal et al. (2015) [17]

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Ethyl actate, Methanol)				**caryophyllene** (8.2%).	
		Chlor-1.1%	27, 91.2	dodecyl acetate (13.6%)**,** oleic acid methyl ester (11.2%)**,** di-*n*-octyl phthalate (11.1%)**,** hexadecanoic acid methyl ester (6.6%) **and** stearic acid methyl ester (6.3%)**.**	
		Etace-0.8%	39, 91.1	**Phytol** (11.1%), **caryophyllene oxide** (9.9%), **γ-muurolene** (6.4%) **and hexadecanoic acid** (5.4%)	
		Meth-0.9%	30, 93.4	**hexadecanoic acid (11.2%), caryophyllene oxide (8.5%), α-terpineol (7.8%) and α-cubebene (7.7%).**	
Ghana West Africa	Headspace		33,	**Germacrene D (21.06%), Pregeijerene (13.71%), Caryophyllene (9.12%), Isojeijerene (8.89%), γ-Murolene (8.34%),**	Osei-owusu (2017) [18]
Abomey-Calavi (Republic of Benin), West Africa			15, 95%	**Caryophyllene oxide** (3.75%), naphthalene (9.09%), **Germacrene D** (7.39%), Anisole (7.39%), **Geijerene**, trans-Verbeno (4.55%), Linalool (3.98%)	Dougnon et al., (2021) [19]

**Seven locations from Ivory Coast: Bonoua (South-east), Abengourou (east), Yamoussokro (Centre), Divo (centre-West), Agboville (South-west), Guiglo (West) and Man (West)*

Table III. Essential oil components of *C. odorata* in Vietnam

Locality	Part	Yield	Identification (No., %)	Major Components	Reference
Vietnam	Fresh leaves	-	22, 81.5%	**Geijerene (42.5%) β-Cubebene (12.5%), β-caryophyllene** (7.4%)	Dung *et al.* (1992) [20]
Vietnam	Leaves		44, 99 %	α-**Pinene (11.47–19.24%, Germacrene D** (11.67–15.12%), **(E)-β-caryophyllene (9.56–11.24%) and Geijerene (8.96–10.55%), β-pinene (3.95–7.50%), δ-cadinene (4.38–5.73%), caryophyllene oxide (4.40–5.33%) and α-copaene (4.02–5.26%).**	Vo *et al.* (2025) [21]

Table IV. Essential oil components of *C. odorata* in Thailand

Locality	Part	Yield	Identification (No., %)	Major Components	Reference
Thailand	Aerial	-	22, 81.5%	**Pregeijerene** (17.6%), **Germacrene D** (11.1%),	Pisutthanan *et al.* (2006)

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				α -pinene (8.4%), **β-caryophyllene** (7.3%), Vestitenone (6.5%), β--pinene (5.6%), ẟ-cadinene (4.9%), **Geijerene** (3.1%), Bulnesol (2.9%), and Transocimene (2.2%)	[22]
Thailand	Leaves		20,	**Pregeijerene** (40.60%), dauca-58-diene (16.75%), **α-Pinene (9.67%)**, (E)-Caryophyllene (6.11%) and **β-Pinene (5.37%)**	Pitakpawasutthi (2016) [23]

Table V. Essential oil components of *C. odorata* in Nepal

Locality	Part	Yield	Identification (No., %)	Major Components	Reference
Tarai, Central Nepal	Fresh Leaves	-	19, 83.86%	Linalool (21.64%); **β-pinene (9.43%)**; 1,3-cycloheptadiene (8.92%); β-cubebene (7%); cinnamaldehyde (5.30%) and **caryophyllene oxide (4.94%).**	Thapa *et al.* (2021) [24]

Table VI. Essential oil components of *C. odorata* in China

Locality	Part	Yield	Identification (No., %)	Major Components	Reference
China	Leaves	-	--	trans-caryophyllene (16.58%), delta-cadinene (15.85%), alpha-copaene (11.58%), **caryophyllene oxide (9.63%), germacrene-D** (4.96%), and delta-humulene (4.32%).	Ling *et al.* (2003) [25] Cross reference from Thapa *et al*. (2021)

Table VII. Essential oil components of *C. odorata* in Malaysia

Locality	Part	Yield	Identification (No., %)	Major Components	Reference
Malaysia	Fresh Leaves	2.10%	13	α-murolene (2.32%), caryophyllene (5.39%), Bicyclo [7.2.0] undec-4-ene, 4,11,11-trimethyl-8-methylene-, [1R-(1R ∗,4Z,9S ∗)]- (7.43%), germacrene D (3.89%), β-pinene (23.35%), α-pinene (0.76%)	Alara and Abdurahman. (2019) [26]

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