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**BIOACTIVE CONSTITUENTS OF CORIANDER ESSENTIAL OIL, THEIR VARIATION  
WITH MATURITY AND CONTRIBUTION TO AROMA**

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**ABSTRACT**

*Volatile oil are present in the oil canals in all organs of coriander plant. The essential oil is obtained on steam distillation of coriander fruit containing seeds. The aromatic odour and taste of coriander fruit is due to its volatile oil which is clear, colourless to light yellow liquid. Volatile oil levels in the fruit are generally in the range of 0.34-1.49 ml/100 g. 133 components are detected in essential oil with linalool as the main component having a maximum concentration of 81% of the total volatile fraction. Other constituents include p-cymene, camphene,  $\Delta$ -3-carene, limonene, myrcene, cis- and trans-ocimene,  $\alpha$ -phellandrene,  $\beta$ - phellandrene,  $\alpha$ -pinene, ,  $\beta$ -pinene, sabinene,  $\alpha$ - terpinene, terpinolene,  $\alpha$ -thujene, camphor, 1,8-cineole, linalol oxide, carvone, geranial, bornyl acetate, geranyl acetate, linalyl acetate,  $\alpha$ -terpinyl acetate,  $\beta$ -caryophyllene, caryophellene oxide, elemol, nerolidol, anethole, myristicin, thymol, acetic acid,  $\alpha$ -p-dimethy styrene, heptadecane, octadecane, decanol, dodecanol, octanal, nonanal, decanal, undecanal, dodecanal, tridecanal, tetradecanal, 3-octenal, 2-decenal, 5-decenal, 8-methyl-2-nonenal, 8-methyl-5-nonenal, 6- undecenal, 2-dodecenal, 8-tridecenal, 9-tetradecenal, 10-pentadecenal, 3,6-undecadienal and 5,8-tridecadienal. The concentration of these compounds changes with maturity. Monoterpene hydrocarbons, Monoterpene ketones, Monoterpene ethers and Sesquiterpenes are at their maximum levels at intermediate stage of maturity, the concentration of Monoterpene alcohols, Phenols and Non terpenic compounds increases with maturity while the content of Monoterpene esters and Monoterpene aldehydes reduces with maturity.*

**Keywords** – Essential Oil, Linalool, Concentration, odour, Maturity

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## I. INTRODUCTION

Coriander is a herbaceous plant widely grown as a spice crop. It is popular for its distinct sweet fragrance in fruits and leaves. It is a good source of vitamins and minerals. The composition is different in different parts of the plant. Coriander Fruit contains two small seeds, each enclosed in a mericarp. The essential oil is obtained on steam distillation of the spice. The major constituent of coriander volatile oil is an alcohol named, coriandrol, which is an optically active form (dextrorotary) of monoterpene alcohol, linalool [10]. The aromatic odour and taste of coriander fruit is due to its volatile oil which is clear, colourless to light yellow liquid. The flavour of oil is warm, spicy – aromatic, sweet and fruity [3]. Coriander oil comprises of a wide range of bioactive compounds which show remarkable changes with changing stage of maturity of the fruit as well as with the method of extraction of the oil [10].

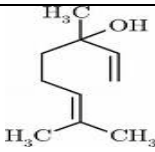
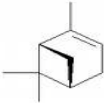
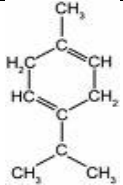
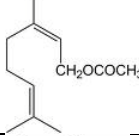

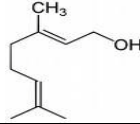
## II. ESSENTIAL OIL COMPOSITION

133 components are detected in the essential oil and extracts of coriander fruit. Linalool is the main component detected, with a maximum concentration of 81% of the total volatile fraction in the aqueous extract. Other constituents such as Camphor (5.6%), geranyl acetate (4%) and geraniol (1.5%) occur at high amounts in essential oil; sesquiterpene hydrocarbons occur at concentration >13%. 44 minor components are identified in coriander essential oil and extracts. These include myrtenyl acetate, verbenone, myrtenol, p-cymen-8-ol and several diols (including 2,6-dimethyl-3,7-octadiene-2,6-diol and 2,6-dimethyl-1,7-octadiene-3,6-diol). Two isomers of 6,7-epoxylinalool were identified in essential oil, while 2,3-dihydroepoxygeranyl acetate is determined in the alcoholic extract only [4]. The flavonoid constituents of the oil contain quercetin 3-glucuronide, isoquercitrin and rutin [5]. Volatile oil levels in the fruit are generally in the range of 0.34-1.49 ml/100 g and the proportion of the main compound, linalool, is around 48.7-72.7%. Larger fruits have higher oil content. Oil content of seeds varies with geographical origin. Higher volatile oil content is found in Norwegian coriander (1.4 – 1.7%) followed by Bulgarian coriander (0.1- 0.5%). Indian fruits are poor in volatile oil content (0.1-0.4%) [3]. Climatic conditions have a weaker effect on the essential oil composition of coriander seeds than the region of growth. Climatic conditions, geographic position of the growth region, agrotechnology of growing, as well as the vegetation stage of plants at the moment of harvesting and the extraction technique applied, influence both the qualitative composition and contents of the individual components of the isolated essential oil. The growth region exercise more influence on the essential oil composition than the weather conditions of the year [7].

### A. Linalool

It is the major component of the coriander essential oil. It is also known as Coriandrol; 3,7-dimethyl-1,6-octadien-3-ol; 2,6-dimethyl-2,7-octadien-6-ol; licareol; linalol; 1,6-octadien 3-ol. It is a colourless to very pale yellow liquid. Its vapour pressure is 0.05 mm Hg at 20°C, its flash point is 71°C, boiling point is 198°C, refractive Index ranges between 1.460–1.463 (at 20°C), and specific gravity is between 0.860–0.864 (at 20°C). Linalool is used as a fragrance ingredient in decorative cosmetics, fine fragrances, shampoos, toilet soaps and other toiletries as well as in non-cosmetic products such as household cleaners and detergents. Its worldwide use is in the range of >1000 metric tons per annum [1].

Table I  
Major Components of Coriander Essential Oil

Compound	Concentration (%)	Molecular Structure
Linalool	67.7	
$\alpha$ – Pinene	10.5	
$\gamma$ - Terpinene	9.0	
Geranyl acetate	4.0	
Camphor	3.0	
Geraniol	1.9	

[3]

### B. Minor Components In Oil

$\beta$  – Pinene, camphene, myrcene, limonene, p- cymol, dipentene,  $\alpha$  – terpinene, n-decylaldehyde, borneol & acetic acid esters are present in minor concentrations in the oil [9]. Unripe fruits and other parts of plant yield small amounts of inferior oil with a bug like odour which disappears on keeping evidently due to polymerization of odoriferous principle. Small coriander fruit has relatively higher volatile oil content.

### C. Major groups of constituents identified in coriander essential oils

- Monoterpene hydrocarbons – p-cymene, camphene,  $\Delta$ -3-carene, limonene (dipentene), myrcene, cis- and trans-ocimene,  $\alpha$ -phellandrene,  $\beta$ - phellandrene,  $\alpha$ -pinene,  $\beta$ -pinene, sabinene,  $\alpha$ - terpinene, terpinolene,  $\alpha$ -thujene.
- Monoterpene oxides and carbonyls – camphor, 1,8-cineole, linalol oxide, carvone, geraniol.
- Monoterpene esters – Bornyl acetate, Geranyl acetate, Linalyl acetate,  $\alpha$ -Terpinyl acetate.
- Sesquiterpenes –  $\beta$ -Caryophyllene, Caryophellene oxide, Elemol, Nerolidol.
- Phenols – Anethole, Myristicin, Thymol.
- Miscellaneous compounds – Acetic acid,  $\alpha$ -p-Dimethy styrene.
- Aliphatic hydrocarbons – Heptadecane, Octadecane
- Aliphatic alcohols – Decanol, Dodecanol
- Aliphatic aldehydes – octanal, nonanal, decanal, undecanal, dodecanal, tridecanal, tetradecanal, 3-octenal, 2-decenal, 5-decenal, 8-methyl-2-nonenal, 8-methyl-5-nonenal, 6-undecenal, 2-dodecenal, 8-tridecenal, 9-tetradecenal, 10-pentadecenal, 3,6-undecadienal, 5,8-tridecadienal. [10]

### III. VARIATIONS DUE TO MATURITY

Essential oil composition of coriander fruits changes during three stages of maturity. The essential oils obtained by hydrodistillation are studied at three stages of maturity by GC-FID and GC-MS. Essential oil yields show marked increase during maturation process. Geranyl acetate (46.27%), linalool (10.96%), nerol (1.53%) and neral (1.42%) are the main compounds at the first stage of maturity (immature fruits). At the middle stage, linalool (76.33%), cis-dihydrocarvone (3.21%) and geranyl acetate (2.85%) are the main constituents. Essential oils at the final stage of maturity (mature fruits) consist mainly of linalool (87.54%) and cis-dihydrocarvone (2.36%). Additionally, accumulation of monoterpene alcohols and ketones is there during maturation process of coriander fruit [2].

TABLE 2  
Essential Oil Composition (%W/W) of Coriander Fruit at Three Stages of Maturity

S.No	Compound	Immature	Intermediate	Mature
1.	Heptanal	t	t	t
2.	$\alpha$ -Thujene	t	t	t
3.	$\alpha$ -Pinene	0.01	t	0.02
4.	Sabinene	t	t	0.03
5.	$\beta$ -Pinene	t	0.20	0.05
6.	$\delta^3$ -Carene	0.09	0.10	0.02
7.	$\alpha$ -Terpinene	t	t	0.01
8.	p-Cymene	t	t	t
9.	Limonene	0.04	t	0.02
10.	1,8-Cineole	0.23	0.14	0.20
11.	(z)- $\beta$ -ocimene	0.08	t	t
12.	$\gamma$ -Terpinene	t	t	t
13.	Cis-Linalool oxide (furanoid)	0.32	0.32	0.27
14.	Terpinolene	0.02	0.18	0.15
15.	Linalool	10.96	76.33	87.54
16.	trans-Linalool oxide (furanoid)	0.27	T	T
17.	Camphor	0.86	0.13	0.17
18.	Borneol	0.08	0.28	0.34
19.	Menthol	0.14	0.16	0.05
20.	Terpinene-4-ol	T	T	T
21.	p-Cymen-8-ol	1.36	T	T
22.	Cis-hex-3-Enyl butyrate	T	T	0.01
23.	$\alpha$ -terpineol	0.39	T	0.05
24.	cis-Dihydrocarvone	0.01	3.21	2.36
25.	Nerol	1.53	T	T
26.	$\beta$ -Citronello	0.11	T	0.52
27.	Neral	1.42	0.10	0.13
28.	Carvone	0.10	0.09	0.08

29.	Geraniol	T	T	T
30.	Geranial	0.65	T	0.03
31.	Anethol	0.05	1.41	0.01
32.	Thymol	0.02	0.99	1.85
33.	Carvacrol	1.04	0.11	0.46
34.	$\delta$ -Elemene	T	0.05	0.01
35.	Eugenol	0.09	T	0.01
36.	Neryl acetate	T	T	T
37.	Geranyl acetate	46.27	2.85	0.83
38.	$\beta$ -Caryophyllene	0.02	0.07	0.03
39.	$\alpha$ -Humulene	0.09	T	0.02
40.	Germacrene-D	0.04	0.19	0.05
41.	Eugenyl acetate	T	T	0.07
TOTAL IDENTIFIED		66.29	86.91	95.39

T= trace(&lt;0.01%)

[10]

TABLE III

Percentage of Major Classes of Volatile Compounds at Three Stages of Maturity

Class	Immature	Intermediate	Mature
Monoterpene hydrocarbons	0.24	0.48	0.30
Aromatic hydrocarbons	T	T	T
Monoterpene alcohols	14.66	76.77	88.51
Phenols	1.06	1.10	2.31
Monoterpene esters	46.27	2.85	0.90
Monoterpene ketones	0.97	3.43	2.61
Monoterpene aldehydes	2.07	0.10	0.16
Monoterpene ethers	0.87	1.87	0.48
Sesquiterpenes	0.15	0.31	0.11
Non-terpenic	T	T	0.01

T=trace (&lt;0.01%)

[10]

#### IV. AROMA OF CORIANDER

The aroma and flavour of coriander are due to essential oil present in oil glands in the mericarp. Essential oil content of coriander ranges from 0.18 to 0.39%. Linalool, the major component (56.71–75.14%) has floral and pleasant odour. Higher  $\alpha$ -pinene leads to the higher turpentine note. Sweet and rose-like odour notes could be due to occurrence of higher levels of geranyl acetate and lemonol. Principal components include  $\alpha$ -pinene, myrcene and undecanal.

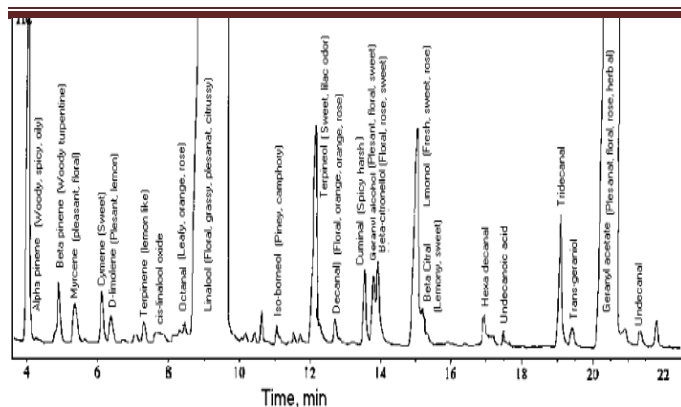


Fig. 1 Aromagram of coriander oil

TABLE 4

Compounds describing sensory characteristics of essential oil

S.no	Descriptor	Reference compound
1	Turpentine	$\alpha$ -Pinene
2	Pleasant	Cinnamyl alcohol, Myrcene
3	Floral	Phenyl ethyl alcohol
4	Green	1-Hexanal
5	Herbal	iso- Propyl quinoline
6	Cooling	Menthol, Spearmint
7	Earthy	iso- Propyl quinoline
8	Spicy	Coriander powder
9	Sweet	Terpineol
10	Rose like	Limonol

TABLE 5

Major Volatile Components of Essential Oil

Compound	Concentration range (%)	Odour descriptors
$\alpha$ -Pinene	2.36 – 23.23	Woody, spicy, oily
Linalool	57.52 – 75.14	Floral, grassy, pleasant, citrusy
Terpineol	0.08 – 5.37	Sweet, lilac odour
Cuminal	0.13 – 0.54	Spicy, harsh
Citronellol	0.65 – 1.67	Strong floral, rose, sweet like
Geraniol	0.45 – 2.35	Fresh, sweet, rose like
Geranyl acetate	8.95 – 24.51	Pleasant, floral rose, herbal

[6]

#### IV. CONCLUSIONS

Coriander, the important and commonly used spice contains oil in all organs of the plant. Coriander fruits are commonly processed for the extraction of essential oil by steam distillation. The Indian variety of coriander usually contains up to 0.4% of essential oil. Out of 133 compounds detected in the essential oil, linalool is the major component with a concentration of 57.52-75.14%. Other significant compounds include p-cymene, camphene,  $\Delta$ -3-carene, limonene, myrcene, cis- and trans-ocimene,  $\alpha$ -phellandrene,  $\beta$ - phellandrene,  $\alpha$ -pinene, ,  $\beta$ -pinene, sabinene,  $\alpha$ - terpinene,

terpinolene,  $\alpha$ -thujene, camphor, 1,8-cineole, linalol oxide, carvone, geranial, bornyl acetate, geranyl acetate, linalyl acetate,  $\alpha$ -terpinyl acetate,  $\beta$ -caryophyllene, caryophellene oxide, elemol, nerolidol, anethole, myristicin, thymol, acetic acid,  $\alpha$ -p-dimethyl styrene, heptadecane, octadecane, decanol, dodecanol, octanal, nonanal, decanal, undecanal, dodecanal, tridecanal, tetradecanal, 3-octenal, 2-decenal, 5-decenal, 8-methyl-2-nonenal, 8-methyl-5-nonenal, 6-undecenal, 2-dodecenal, 8-tridecenal, 9-tetradecenal, 10-pentadecenal, 3,6-undecadienal and 5,8-tridecadienal. Essential oil composition of coriander fruits changes during three stages of maturity. Geranyl acetate (46.27%), linalool (10.96%), nerol (1.53%) and neral (1.42%) are the main compounds at the first stage of maturity (immature fruits). At the middle stage, linalool (76.33%), cis-dihydrocarvone (3.21%) and geranyl acetate (2.85%) are the main constituents. Essential oils at the final stage of maturity (mature fruits) consist mainly of linalool (87.54%) and cis-dihydrocarvone (2.36%). Additionally, accumulation of monoterpene alcohols and ketones is there during maturation process of coriander fruit. The major bioactive compounds responsible for the characteristics aroma of coriander include  $\alpha$ -Pinene, Linalool, Terpeneol, Cuminal, Citronellol, Geraniol and Geranyl acetate. Out of these linalool and geranyl acetate are the main contributors responsible for the Floral, grassy, pleasant, citrusy and herbal aroma.

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