Gas Chromatographic Investigation of *Coriandrum sativum* L. from Indian Himalayas

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Abstract: The essential oils composition of coriander (*Coriandrum sativum* L.) fruits obtained by hydro distillation was studied at three stages of maturity by GC–FID and GC–MS. Essential oil yields showed marked increase during maturation process and forty one compounds were identified. Geranyl acetate (46.27%), linalool (10.96%), nerol (1.53%) and neral (1.42%) were 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%) were reported as the main constituents. Essential oils at the final stage of maturity (mature fruits) consist mainly on linalool (87.54%) and *cis*-dihydrocarvone (2.36%). [New York Science Journal 2010; 3(6):43-47]. (ISSN 1554 – 0200).

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1. Introduction: The wild plants constituted major sources of food for mankind before the dawn of civilization. People have been using roots, tubers, rhizomes, leaves, barks and fruits of wild plants since then as food. The improved varieties of different agricultural and horticultural crops of today are derived from wild plants. The vegetation of Indian Himalaya exhibits remarkable plant diversity and known to host 18,440 species of plants (Angiosperms: 8000 spp., Gymnosperm: 44 spp., Pteridophytes: 600 spp., Bryophytes: 1736 spp., Lichens: 1159 spp. and Fungi: 6900 spp.) as medicinal and aromatic plants. Therefore the diversified topography of Himalaya makes it a bowl of phytofood. An important Indian Himalayan phytofood is *Coriandrum sativum* L. (Family: Apiaceae).

***Coriandrum sativum* L:** The fruit has been used as a drug for indigestion, against worms, and as a component of embrocations for rheumatism and pains in the joints. The fruits of coriander are: alterative, antibilious, antispasmodic, aphrodisiac, appetizer, aromatic, carminative, diaphoretic, diuretic, refrigerant, stimulant, stomachic, tonic **(Norman, J. 1990).**

Fresh leaves are pungent and aromatic. The essential oil of coriander stimulates the secretion of gastric juices and is a carminative and spasmolytic; in vitro it has antibacterial and antifungal effects **(British Pharmacopoeia, 1999 and European Pharmacopoeia, 1997)**. It contains an essential oil (up to 1%) constituted of (3*S*)-linalool (main, 60—70%), other monoterpenoids (citronellol, geraniol, myrcene) gamma -terpinene, limonene, α-phellandrene and β-phellandrene, *p*-cymene, and β-pinene, borneol, and camphor), and fatty acids (oleic, linolenic, and palmitic acids *etc.*)

Ishikawa *et al* investigated water-soluble constituents of spices, and showed the relationship between the essential oil and the water-soluble constituent separate two monoterpenoid triols, seven monoterpenoid glycosides, three norcarotenoid glucosides, an aromatic compound, seven aromatic compound glycosides, two alkyl glucosides, eight glucides, uracil, and two nucleosides **(Toru Ishikawa, 2002 and 2003)**.

Linalool (59.6-71.6%) has been reported as the main constituent of the essential oil of coriander fruits **(Hussain, A., et al., 1998 and Pino, J., et al., 1996)**.

2. Materials and Methods

The plant material (seeds) of *Coriandrum satvium* (Family: Apiaceae) was collected from Almora District, Uttarakhand State (about 1900 m amsl) (India), in the first week of October when their flowering occurs.
The essential oil was obtained by steam distillation of fresh plant material (500 g) using a copper still fitted with spiral glass condensers. The distillate was saturated with NaCl and extracted with hexane. The hexane extract was dried using anhydrous sodium sulphate and the solvent was removed with a rotovap at reduced pressure and at 25 °C to yield oil.

The gc-ms analysis was performed in Agilent 6890 series equipped with MSD 19091S-433 system. It is known that there is a selective loss of low boiling terpenoids by conventional hydro-distillation technique. Headspace-gc is therefore more suitable for quantification of highly volatile compounds than conventional hydro distillation technique.

For the Dynamic Headspace, 1.0 gm of sample was taken in 20 ml headspace vial. Headspace is created and these vapours are injected in GC equipped with MSD. Headspace components were identified by matching their mass spectra with those in NIST 05 MS library search and by comparing with literature reports and GC retention indices (RI).
Determination of antimicrobial activity (minimum inhibitory concentration MIC) of oil extracts by two-fold serial dilution method. The test organisms; bacterial and fungal cultures (*Staphylococcus aureus* (S.a), *Escherichia coli* (E.c), *Cndida albicans* (C.a) and *Cryptococcus neoformans* (C.n.) were obtained from Central Drug Research Institute, Lucknow and maintained as well as experimented in the Microbiology laboratory, Department of Biotechnology, M.B. Govt.P.G.College, Haldwani (Nainital).

Coriandrum sativum* L*: Fuits of coriander are alterative, antbilious, antispasmodic, aphrodisiac, appetizer, aromatic, carminative, diaphoretic, diuretic, refrigerant, stimulant, stomachic and tonic. It contains an essential oil (up to 1%) constituted mainly linalool (60—70%), other monoterpenoids are (citronellol, geraniol, myrcene, α-and γ -terpinene, limonene, α-phellandrene and β-phellandrene, *p*-cymene, and β-pinene, borneol and camphor) and fatty acids. *Coriandrum sativum* L. (Umbelliferae) were found to possess bactericidal activity against *Salmonella choleraesuis* ssp. The spice showed significant hypoglycemic action.

3. Result and discussion:

Coriandrum sativum

Fifteen main volatile compounds in *Coriandrum sativum* L. were separated and identified by headspace SPME-GC-MS analysis The main compounds in headspace of *Coriandrum sativum* L. identified by mass spectrometry included decanal, 2-decenal, 1-decanol,*trans*-2-decen-1-ol,*trans*-2-decen-1-al,*trans*-2-tridecenal etc **(Deng, C. et al. 2003)**.

The essential oils composition of coriander (*Coriandrum sativum* L.) fruits obtained by hydrodistillation was studied at three stages of maturity by GC–FID and GC–MS. Essential oil yields showed marked increase during maturation process and forty one compounds were identified. Geranyl acetate (46.27%), linalool (10.96%), nerol (1.53%) and neral (1.42%) were 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%) were reported as the main constituents. Essential oils at the final stage of maturity (mature fruits) consist mainly on linalool (87.54%) and *cis*-dihydrocarvone (2.36%). Additionally, accumulation
of monoterpene alcohols and ketones was observed during maturation process of coriander fruit **(Msaada, K. et al. 2007).**

GC-MS Analysis of Essential Oil:

The seeds of *coriandrum satvium* yielded 0.8% by weight of yellow oil with a pleasant aroma. The gc and gc-ms analysis of the essential oil from the seeds of *coriandrum satvium* revealed the presence of forty five compounds and all of them were identified by comparing their mass spectra with ms library except one. The oil is rich in oxygenated monoterpenes. The oxygenated monoterpenes, monoterpene hydrocarbon, fatty acids and long chain alcohols amounted to 80.47%, 6.45%, 5.06% and 3.54% respectively. The major constituents are 70.11% β-linalool, 6.63% geraniol acetate, 4.01% (+)-2-pinene, 3.54% 1-octanol, 3.18% o-cymen-5-ol, 3.1% tetradecanoic acid, 1.1% biosol and 0.96% hexadecanoic acid. (Table 1, Figure 1)

Discussion:
Earlier studies on *Coriandrum sativum* L. have reported linalool (59.6-71.6%) as the main constituent of the essential oil of coriander fruit.
Coriander *Coriandrum sativum* L. (Umbelliferae) were found to possess bactericidal activity against *Salmonella choleraesuis* ssp. *choleraesuis* ATCC

35640. (2*E*)-Dodecenal (C_{12}) was the most effective against this food-borne bacterium with the minimum bactericidal concentration (MBC) of 6.25 µg/mL (34 µM), followed by (2*E*)-undecenal (C_{11}) with an MBC of 12.5 µg/mL (74 µM). The time−kill curve study showed that these α,β-unsaturated aldehydes are bactericidal against *S. choleraesuis* at any growth stage and that their bactericidal action comes in part from the ability to act as nonionic surfactants **(Kubo, I., et al. 2004)**.

Essential oils were extracted from the fruits of *Coriandrum sativum L*. assayed in vitro for antibacterial activity to *Escherichia coli* and *Bacillus megaterium*, bacteria routinely used for comparison in the antimicrobial assays, and 27 phytopathogenic bacterial species and two mycopathogenic ones responsible for cultivated mushroom diseases. A significant antibacterial activity, as determined with the agar diffusion method, was shown by *C. sativum* essential oil **(Cantore,P. L., et al. 2004).**

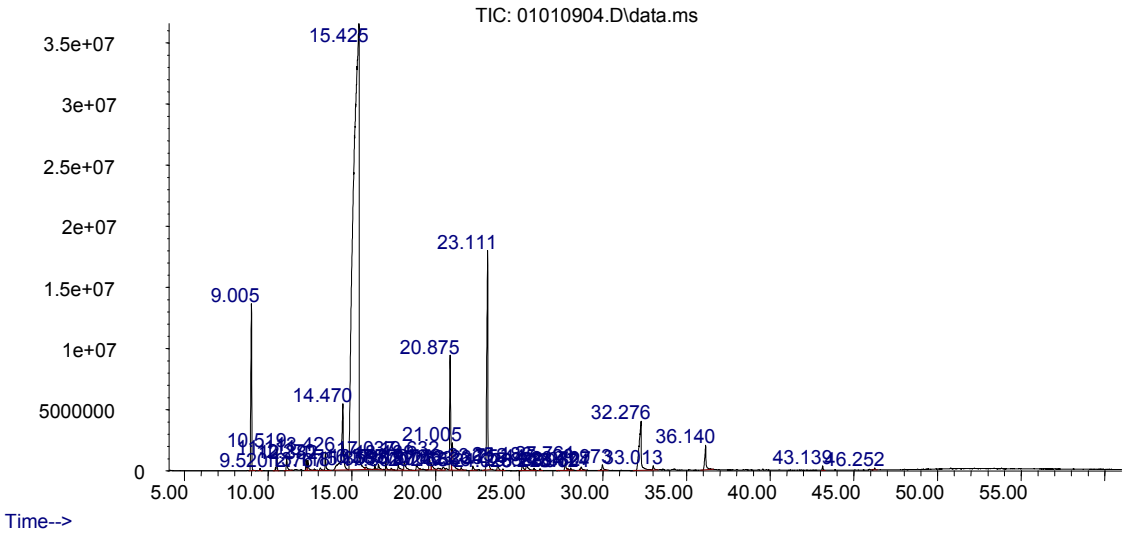
The effect of coriander seeds (*Coriandrum sativum*) on carbohydrate metabolism was studied in rats fed a high fat cholesterol diet. The spice showed significant hypoglycemic action. There was an increase in the concentration of hepatic glycogen as was evident from the increased activity of glycogen synthase. Activity of glycogen phosphorylase, and gluconeogenic enzymes, revealed decreased rates of glycogenolysis and gluconeogenesis. The increased activities of glucose-6-phosphate dehydrogenase and glycolytic enzymes suggest the utilization of glucose by the pentose phosphate pathway and glycolysis. **(Hussain, A. et al. 1988 and Pino, J. A. et al. 1996).** Present study also shows 70.11% β-linalool, 6.63% geraniol acetate of total gc area.

Table 1. Chemical Composition (%) of essential oil of *Coriandrum sativum* L. (Seed).
a = Retention Index; b = MS (GC-MS) Library

Pk	RT	Area%	Common Name	Method of Identification
1	9.006	4.01	(+)-2-pinene	a,b
2	9.519	0.05	camphene	a,b
3	10.522	0.49	(1s)-(-)-2(10)-pinene	a,b
4	11.11	0.4	β-thujene	a,b
5	12.27	0.25	o-cymene	a,b
6	12.381	0.31	d-limonene	a,b
7	12.766	0.06	β-ocimene	a,b
8	13.115	0.1	β-cis-ocimene	a,b
9	13.468	0.45	1,4-p-menthadiene	a,b
10	14.468	3.54	1-octanol	a,b
11	15.423	70.11	β-linalool	a,b
12	15.855	0.17	2,2,7-trimethyl bicyclo(2.2.1) hept-2-ene	a,b
13	16.385	0.12	(-)-camphor	a,b
14	16.595	0.19	3,7-dimethyl-6-octenal	a,b
15	17.038	0.25	(1s-endo)-borneol	a,b
16	17.359	0.06	1-p-menthen-4-ol	a,b
17	17.778	0.25	1-p-menthen-8-ol	a,b
18	18.14	0.5	decanal	a,b
19	18.874	0.24	(r)-(+)-β-citronellol	a,b
20	19.632	0.5	(e) geraniol	a,b
21	19.777	0.3	geraniol	a,b
22	20.156	0.16	2-heptene, 4-methyl-, (e)-	a,b
23	20.465	0.016	nonanoic acid	a,b

24	20.873	3.18	o-cymen-5-ol	a,b
25	21.007	1.11	biosol	a,b
26	21.538	0.09	(-)-myrtenyl acetate	a,b
27	22.237	0.17	2,6-dimethyl 2,6-octadiene	a,b
28	23.111	6.63	geraniol acetate	a,b
29	23.712	0.22	lauraldehyde	a,b
30	24.027	0.03	caryophyllene	a,b
31	25.186	0.27	2-dodecenal	a,b
32	25.186	0.27	undecanoic acid	a,b
33	25.892	0.07	2-n-octylfuran	a,b
34	26.241	0.05	tetradecanal	a,b
35	27.763	0.28	dodecanoic acid	a,b
36	27.914	0.07	n-decanoic acid	a,b
37	28.083	0.05	caryophyllene oxide	a,b
38	28.625	0.3	tetradecanal	a,b
39	28.707	0.15	trans-2-tridecenoic acid	a,b
40	29.972	0.25	2-dodecenal	a,b
41	32.274	3.1	tetradecanoic acid	a,b
42	33.014	0.15	myristoleic acid	a,b
43	36.138	0.96	hexadecanoic acid	a,b
44	43.139	0.09	unidentified	a,b
45	46.251	0.05	2,4-dimethyl-1-decene	a,b

Figure 1. GC of essential oil of *coriandrum satvium* (seed).



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