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Studies on *Coriandrum sativum* linn seed of different origin of Bangladesh for its essential oil, fatty oil and micronutrients

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Abstract

Four varieties of *Coriandrum sativum* Linn seed from different origin of Bangladesh such as Brahmanbaria, Faridpur, Keranigonj, Sirajgonj and one variety of *Coriandrum sativum* Linn seed powder of widely used brand "Radhuni" was collected from the local market. Comparative study of the collected samples and derived oils for proximate analysis, physico-chemical characteristics, essential oils, fatty oils compositions and micronutrient analysis were performed. In proximate analysis carbohydrate, protein, fiber, fat, ash and energy contents were calculated for the five varieties. The samples were extracted by hydro-distillation and it was found that the coriander seed contained 0.15% to 0.25% of essential oils. The chemical constituents of the derived essential oils were determined by FTIR and GC-MS. The fatty oils from the sample were extracted by successive solvent extraction method and the physico-chemical characteristics were determined by usual standard procedure. The chemical compounds of the fatty oil were identified and quantified by FTIR, GC-MS and the micronutrient analysis was conducted using ED-XRF analyzer. The major elements were found to be K, Ca, Cl and percent yield were in the range of 41.74-45.77, 38.77-44.24, 4.30-6.19 respectively.

Keywords: Coriander; Proximate analysis; Essential oil; Fatty oil; Chemical constituents; Micronutrients

Introduction

Coriander (*Coriandrum sativum* Linn), commonly known as dhania in Bangladesh, is an annual herb in the family Apiece. It is a soft, hairless plant growing to about 50 cm tall. It grows abundantly in black soil and arid regions. The fruit is a globular, dry schizocarp 3-5 mm (0.12-0.20 in) in diameter. Coriander is famous for its essential oils and some important chemical constituents like coriandrol, jireniol, carotene, elaidic acid, palmitic acid and for its important medicinal uses like antibacterial, anticarcinogenic, carminative, diuretic, anti-diabetic, cholesterol-lowering, anxiolytic, memory-enhancing etc. reported by Masaada *et al.,* (2007). It is also used as Gripe water, liqueurs, colic, period pain, gargle and headache according to US dept. of Agri. (2012), Gogte (2000), and Verma *et al.,* (2011). Ramstad *et al.,* (1942) reported that the coriander seed contain 1.4 to 1.7 percent of volatile oil, and 12.0 to 12.4 percent of fatty oil. Chernukhin *et al.,* (1928) realized that the importance of grinding the seed prior to distillation when he increased the yield of volatile oil by 17 percent, saving at the same time 10 to 15 percent of steam. Tanasienko and Mezinova (1939) found that with crushed seed they could complete the distillation in 3 to 4 hr. instead of the usual 12 to 15 hr. Ermakon *et al.*, (1929) reported that quantity and properties of coriander oil do not vary at different stages of plant maturity. Walbaum *et al.,* (1909) submitted coriander seed oil to a closer investigation and proved that it contained from 60 to 70 percent of linalool and about 20 percent of hydrocarbon. They also established the presence of the following constituents in coriander seed oil : d-α-Pinene, dl-α-Pinene, β-Pinene, p-Cymene, α-Terpinene and □-Terpinene. Kawalier *et. al.,* (1852) isolated the main constituent a compound of the empirical molecular formula $C_{10}H_{18}O$. This is the first investigation of coriander seed oil date back to the middle of the last century. Leikin *et al.,* (1933) studied the distillation of coriander seed with slightly super heated steam and found that thereby he could reduce the length of distillation from 9 to 6 hr. Rao *et al.,* (1925) examined the essential oils of Indian Coriander seed. Javid Hussain *et al.,* (2009) investigated the Coriander seed for proximate analysis and

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micronutrient analysis. Parry *et al.,* (1910) examined the essential oils of Coriander seed. The ranges of constants reported by Parry are : sp. gr. 0.870-0.885; n, 1.4635-1.4760; [α], $+7^{o}$ to $+14^{o}$; acid val., 1-5; and ester val., 3-22. Hith Bull *et. al.,* (1913) analyzed the Coriander seed for physico-chemical properties and found the following values: moisture, 11.2; protein, 14.1; fat (ether extract), 16.1; carbohydrate, 21.6; fibre, 32.6; mineral matter, 4.4; calcium, 0.63; and phosphorus, 0.37%; iron, 17.9 mg./100. Thorpe *et al.,* (2001) identified the chemical composition of the essential of Coriander seed. Jamieson *et al.,* (1997) analyzed the fatty oil and determined the chemical constituents of Coriander seed. Bill (1913) found that the residue left after the extraction of volatile oil gave: protein, 11-17; fat, 11-20%. Basu *et al*. (1947) studied on Coriander leaves and found that the leaves constitute a rich source of vitamin C (250 mg./100g.), and of carotene (5,200 mg/100g.). Momin *et al*., (2012) studied on Coriander seed and reported various phytopharmacological evaluations for the important potential of the *Coriandrum sativum*. Althausen, (1940) reported for authentic oils distilled from coriander seed of various origins. Gildemeister and Hoffmann *et. al.,* (2005) extracted volatile oil and fatty oil from Coriander seed and determined their chemical composition. König *et al.,* (1940) examined the physiochemical composition of Coriander seed. Coskuner e*t al.*, (2007) determined the physical properties of Coriander seed. Nano (2011) studied on *Coriandum sativum* for the physical properties and chemical compositions of the seed. Politeo *et. al.,* (2006) examined the Chemical compositions and related total antioxidant capacities of Coriander seed essential oils. Bittera (2010) carried out comparative, large-scale distillation experiments in Hungary and proved that crushed coriander seed after 9½ hr. of steam distillation yielded 0.92 percent of oil, whereas uncrushed seed of the same lot, distilled in the same still and with steam of the same pressure, yielded only 0.88 percent of oil after 12¾ hr.The oil yield ranges from 0.4 to 1.1 percent for crushed Hungarian coriander seed. Varentzov (1929) found that in general smaller coriander seed contains more essential oil than larger sized seed does. Rahul (2011) analyzed the essential oil of Coriander seed for its oleoresins.

Materials and methods

Sample collection

Coriandar (Dhania) seeds were collected from different origin of Bangladesh like Brahmanbaria, Faridpur, Keranigonj, Sirajgonj from the local area and one sample of widely used brand "Radhuni-Dhania powder" was collected from the market.

Sample preparation

The collected samples were washed thoroughly by water to remove dust particles and were dried. Finally the dried Coriander seeds were grind with heavy grinding machine.

P*roximate analysis*

The proximate analyses of all the collected samples were performed. The moisture and ash were determined using weight difference method. The nitrogen value was determined by micro Kjeldahl method involving digestions, distillation and finally titration of the sample. The nitrogen value was converted to protein by multiplying a factor of 6.25. Carbohydrate was determined by difference method. All the proximate values were reported in % basis.

Extraction and analysis of essential oil

One hundred grams of dried seed material was subjected to three-hours of hydro-distillation using a clevenger-type apparatus. The obtained essential oils were dried over anhydrous sodium sulphate and stored under nitrogen in sealed vials at -18°C until required. The chemicals and all applied solvents were of pro analysis purity. The essential oils were then analysis by Shimadzu IR Prestige-21 FTIR and Agilent inert XL Electron Impact lonization (El) GC-MSD with fused silica capillary column (30m x 0.25 mm x 0.25 µm). Essential oil sample was dissolved in chloroform for GC-MS analysis.

Extraction and analysis of fatty oil

The fatty oil sample was extracted by using soxhlet extraction method using 40-60^{o}C petroleum ether as solvent from crushed (essential oil and moisture free) sample. The trace amount of solvent remained in the fatty oil was eliminated by high vacuum. Then dried in an oven at 11^{o}C and stored in a desiccators. Then the chemical properties like acid value, saponification value, iodine value, peroxide value etc. of coriander fatty oil from different origin of Bangladesh were determined by the conventional method. Finally the fatty oils of Coriander seed were analyzed for chemical constituents by Shimadzu IR Prestige-21 FTIR and Agilent inert XL Electron Impact lonization (El) GC-MSD.

Micronutrient analysis

The micronutrients contents namely K, Ca, Cl, Si, Fe, Mn, Zn, Cu, Ni etc. of the five varieties was determined by Thermo Scientific ED-XRF analyzer. The results were reported in weight percentage basis of each element in the samples.

Results and discussion

Proximate analysis

The result of proximate analysis shows variation of values in several properties. The comparative result of the proximate analysis of Coriander seeds from different origin of Bangladesh shown in Table I. These variations - (Table I) may be due to the genetic variety, maturity, collection time, climatic condition in geographical location, composition of the soil, water and trend of fertilizer used. All the effects caused the final level of proximate analysis in a plant.

Physico-chemical characteristics

The data obtained on physical and chemical characteristics of the fatty oil of coriander seed from different origin of Bangladesh are shown in Table II and Table III.

Essential oil

The essential oil of Coriander seed was extracted by hydro-distillation process. It was found that the Coriander seed

Table I. Comparative study on the proximate analysis of Coriander seed from different origin of Bangladesh

Parameters of proximate analysis	Sample collected from				
	Brahmanbaria	Faridpur	Keranigong	Sirajgong	'Radhuni powder'
Moisture (wt %)	11.026	9.790	8.750	15.896	4.970
Dry matter (wt %)	88.974	90.210	91.250	84.104	95.023
Total ash (wt %)	6.772	6.470	6.850	6.070	6.926
Acid soluble ash (wt %)	91.006	93.752	92.843	93.303	92.048
Acid insoluble ash (wt %)	8.994	6.248	7.157	6.697	7.952
Water soluble ash (wt %)	38.899	29.252	28.671	39.604	19.505
Water insoluble ash (wt %)	61.100	70.748	71.329	60.396	80.495
Organic matter (wt %)	93.228	93.530	93.150	93.930	93.070
Crude fiber (wt %)	25.436	24.487	26.424	22.423	11.655
Nitrogen (wt %)	1.687	1.740	1.790	1.880	1.700
Protein (wt %)	10.520	10.910	11.160	11.810	10.650
Carbohydrates (wt %)	33.516	36.05	35.807	26.657	43.435
Food energy (cal/gm)	290.714	298.477	286.949	308.164	417.616

Table II. Comparative studies on Physical Characteristics of the fatty oil of Coriander seed from different origin of Bangladesh

Physical Characteristics	Sample collected from				
	Brahmanbaria	Faridpur	Keranigong	Sirajgong	'Radhuni powder'
Taste	Spicy bitter taste	Spicy bitter taste	Spicy bitter taste	Spicy bitter taste	Spicy bitter taste
Odor	Spicy	Spicy	Spicy	Spicy	Spicy
Colour	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown
Appearance at Room temperature (25 °C)	Homogeneous, opaque liquid, lighter than water	Homogeneous, opaque liquid, lighter than water	Homogeneous, opaque liquid, lighter than water	Homogeneous, opaque liquid, lighter than water	Homogeneous, opaque liquid, lighter than water
Specific gravity at 15°C	0.9159	0.9175	0.9155	0.9165	0.9174
Refractive index [$\eta^{40°C}$]	1.46317	1.46353	1.46490	1.46423	1.46280
Optical rotation	$+10^{0}15/$	$+10^{0}36/$	$+10^{0}20/$	$+11^{0}00/$	$+10^{0}24/$

contained 0.15% to 0.25% of essential oil. The Brahmanbaria Coriander seed contained 0.20%, Faridpur Coriander seed contained 0.25%, Keranigong Coriander seed contained 0.25%, Sirajgong Coriander seed contained 0.25% and 'Radhuni Coriander seed powder' contained 0.15% of essential oil. The slight variation of this oil content and the composition of the essential oil depend on several factors such as genotype, stage of maturity, cultivation peculiarities, soil composition and climatic differences in various geographical locations. The GC-MSD with NIST library matching results shows the following (Table IV) composition. Results show that all of the five regions oils are a complex mixture of numerous compounds, many of which are found in trace amounts. It is worth mentioning that there is a great variation in the chemical composition of these five regions essential oil of Coriander seed. This confirms that the reported variation in oil is due to geographic divergence and ecological conditions.

Fatty oil

The fatty oil was extracted from residue obtained after hydro-distillation by successive solvent extraction method using light pet-ether (40°-60°C) as an extracting solvent in a Soxhlet apparatus. It was found that the Brahmnbaria Coriander seed contained 12.73%, Faridpur Coriander seed contained 12.29%, Keranigong Coriander seed contained 11.01%, Sirajgong Coriander seed contained 17.144% and 'Radhuni' Coriander seed powder contained 22.36% of fatty oil. The physical characteristics such as colour, appearance, specific gravity, optical rotation, solubility, refractive index and chemical characteristics such as acid value, saponification value, iodine value, peroxide value etc of the fatty oil were determined by conventional methods. The result of the physical characteristics and chemical characteristics of the fatty oil of *Coriandum sativum* Linn (Dhania) seed from different origins of Bangladesh appeared in Table II and Table III. The GC-MSD with NIST library and FTIR functional group analysis showed the following composition (Table V). Typical GC-MS and FT-IR spectrum of coriander seed oil are shown in Figs.1 and 2 respectively. The GC-MS analysis was done to ensure better identification and quantification of different components of essential oil. The percentages of various components have been determined from their peak areas. It is worth mentioning that there is a little variation in

Table III. Comparative studies on chemical characteristics of the fatty oil of coriander seed from different origin of Bangladesh

Chemical Characteristies	Sample collected from				
	Brahmanbaria	Faridpur	Keranigong	Sirajgong	'Radhuni powder'
Acid value (no. of mg KOH/ g oil)	12.56	11.29	12.60	12.52	11.14
Saponification value	183.360	186.387	189.654	190.514	188.002
Unsaponifiable matter (wt %)	2.2	2.4	2.6	2.5	2.3
Iodine value	112.19	116.65	113.46	115.25	117.547
Peroxide value	74.46	60.64	77.63	69.46	68.25

Table IV. Chemical composition of essential oils derived from different origin samples

Sample collected from	Chemical composition
Brahmanbaria	alpha-Methyl-alpha-[4-methyl-3-pentenyl]oxiranemethanol alpha-Methyl-alpha-[4-methyl-3-pentenyl]oxiranemethanol 1,6-Octadien-3-ol,3,7-dimethyl- 2,6-Octadien-1-ol,3,7-dimethyl-,acetate,(E)-
Faridpur	alpha-Methyl-alpha-[4-methyl-3-pentenyl]oxiranemethanol alpha-Methyl-alpha-[4-methyl-3-pentenyl] oxiranemethanol 1,6-Octadien-3-ol,3,7-dimethyl- 2,6-Octadien-1-ol,3,7-dimethyl-,acetate
Keranigonj	alpha-Methyl-alpha-[4-methyl-3-pentenyl]oxiranemethanol alpha-Methyl-alpha-[4-methyl-3-pentenyl] oxiranemethanol 1,6-Octadien-3-ol,3,7-dimethyl- Bicyclo[2.2.1]heptan-2-one,1,7,7-trimethyl-,(1R)-
Sirajgonj	9-(2,2,- Dimethylpropanoilhydrazono)-3,6-dichloro-2, 7-bis-[2-(diethylamino)-ethoxy]fluorine 1,2-Benzenedicarboxylic acid,mono(2-ethylhexyl)ester 2,6-Octadien-1-ol,3,7-dimethyl-,acetate,(E)-2-Dodecenal
"Radhuni"	2-Furanmethanol,5-ethenyltetrahydro-alpha,alpha,5-trimethyl-,cis- alpha-Methyl-alpha-[4-methyl-3-pentenyl] oxiranemethanol 1,6-Octadien-3-ol,3,7-dimethyl- Myrtenyl acetate 2,6-Octadien-1-ol,3,7-dimethyl-,acetate

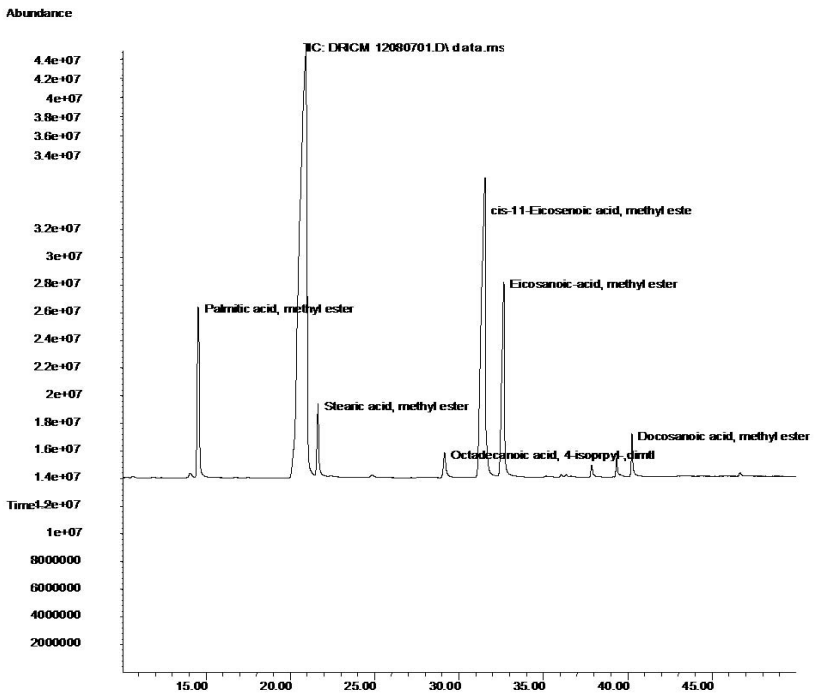

Fig. 1. Typical GC-MS total ionic chromatogram (TIC) of coriander seed oil

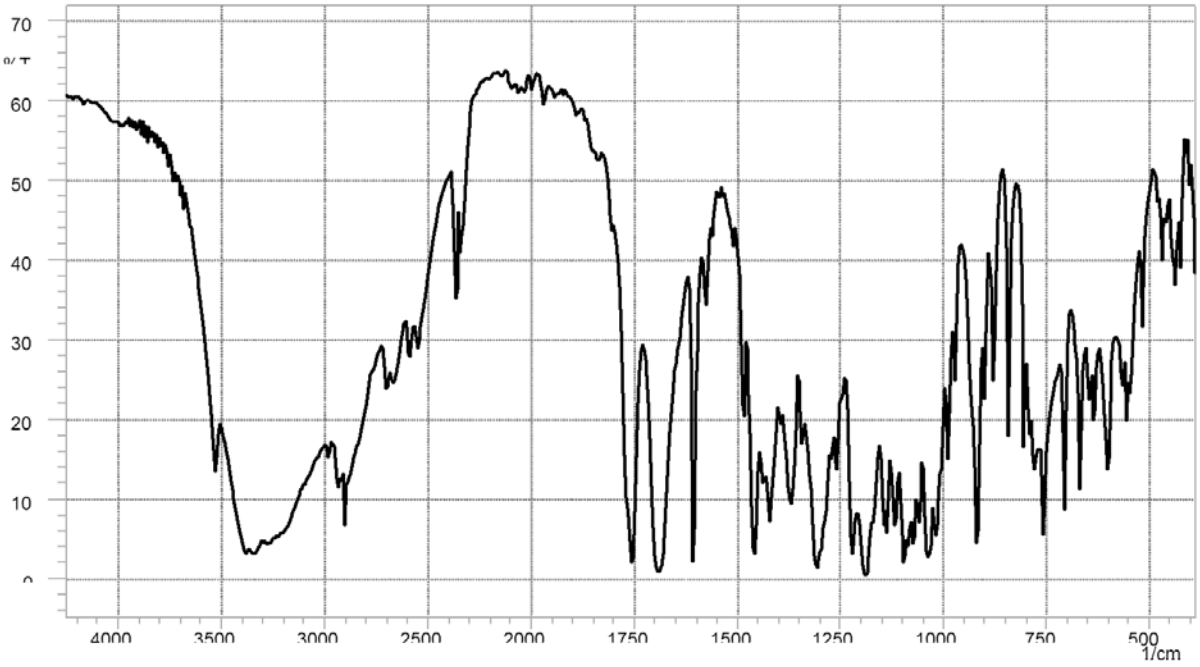

Fig. 2. Typical FT-IR spectrum of coriander seed oil

Table V. Chemical composition of fatty oils derived from different origin samples

Sample collected from	Chemical composition
Brahmanbaria	Hexadecanoic acid,methyl ester 9-Octadecenoic acid, methyl ester, (E)-Octadecanoic acid, methyl esterPropanedioic acid,dibutyl-,diethyl ester
Faridpur	Hexadecanoic acid,methyl ester9-Octadecenoic acid, methyl ester,(E)-Octadecanoic acid, methyl ester Propanedioic acid,dibutyl-,diethyl ester
Sirajgonj	Hexadecanoic acid,methyl ester9-Octadecenoic acid, methyl ester,(E)-Octadecanoic acid, methyl ester Propanedioic acid,dibutyl-,diethyl ester
Keranigonj	Hexadecanoic acid,methyl ester 9-Octadecenoic acid, methyl ester,(E)-Octadecanoic acid, methyl ester
"Radhuni"	Hexadecanoic acid,methyl ester 9-Octadecenoic acid, methyl ester,(E)-Octadecanoic acid, methyl ester

Table VI. Comparative elemental analysis of coriander seed from different origin of Bangladesh (% in total amount of elements found)

No	Component as Element (wt %)	Name of the origin				
		Brahmanbaria	Faridpur	Keranigong	Sirajgong	'Radhuni powder'
1	K	44.93	45.77	41.74	42.34	45.72
2	Ca	40.03	42.57	44.17	42.24	38.77
3	Cl	6.19	4.74	4.30	5.63	5.23
4	Si	2.80	1.63	2.12	5.00	4.87
5	Px	2.02	2.34	3.08	--	2.28
6	Fe	2.00	1.61	2.18	3.79	2.39
7	Sx	0.84	0.76	0.87	0.34	0.40
8	Mn	0.379	0.015	0.664	0.013	--
9	Zn	0.201	0.196	0.395	0.175	0.192
10	Rb	0.197	0.134	0.106	0.281	0.190
11	Cu	0.0406	0.0482	0.0949	0.0483	0.0499
12	Ni	0.0117	--	0.0259	--	0.0031

the chemical composition of these five regions fatty oil of Coriander seed.

Micronutrient analysis

The micronutrients analysis of the coriander seed from different origin of Bangladesh showed significant variation among different micronutrients. The result of minerals content of Coriander seed from different origin of Bangladesh appeared as element basis in Table VI. Result showed that the nutrients like K, Ca, Cl, Si, Fe had higher concentration levels while the remaining nutrients like Zn, Cu, Ni had negligible concentration levels.

Conclusion

Coriander is one of the largely used spices which is cultivated in almost everywhere of Bangladesh. In the present study, four samples were taken from different areas of Bangladesh and another sample was from commercially available brand of powder coriander 'Radhuni'. The proximate analysis of the samples gives us an idea about the status as well as the substances present in those. GC-MS results show that all of the five regions oils are a complex mixture of numerous compounds, many of which are found in significant amounts. It is worth mentioning that there is a great variation in the chemical composition of these five types' essential oil and fatty oil of coriander seed. This confirms that the reported variation in oil is due to the geographic divergence and

ecological conditions. Many of the compounds present in the essential oils and fatty oils of coriander seed have medicinal activity. However, little have been done so far to verify the uses in this regard. The present research is an effort in doing so. Further research in this topic will certainly leads to the consequential success in the new drug discovery.

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