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Comparative Studies on Physicochemical Properties and GC-MS Analysis of Essential Oil of The Three Varieties of *Coriandrum sativum* Linn

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Abstract: *Coriandrum sativum* (Linn.) which belongs to the family of Apiaceae locally known as 'Dhania' in Bangladesh. In this study essential oil of the three varieties of Dhania from of Brahmanbaria, Faridpur and Radhuni were investigated by GC-MS. Total four chemical constituents were found by gas chromatography and mass spectrometry (GC-MS) analysis from the essential oil of Brahmanbaria Dhania. The oil contained alpha-methyl-alpha-[4-methyl-3-pentenyl]oxiranemethanol; 1,6-octadien-3-ol; 3,7-dimethyl acetate; 2,6-octadien-1-ol; 3,7-dimethyl acetate. Total three chemical constituents were found by gas chromatography and mass spectrometry (GC-MS) analysis from the essential oil of Faridpur Dhania. The oil contained alpha-methyl-alpha-[4-methyl-3-pentenyl]oxiranemethanol; 1,6-octadien-3-ol; 2,6-Octadien-1-ol; 3,7-dimethylacetate. On the other hand total, five chemical constituents were found in the Radhuni Dhania. The oil contained 5-ethenyltetrahydro-alpha-5-trimethyl-cis-2-furanmethanol; 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. The main objective of the present study was focused on identification and quantification of chemical constituents present in the essential oil of *Coriandrum sativum* Linn by GC-MS methods.

Keywords: *Coriandrum sativum* Linn, Dhania, Essential Oil, Physicochemical Properties, Gas Chromatography-Mass Spectroscopy (GC-MS) Analysis

1. Introduction

Essential oils are natural, complex volatile compound mixtures characterized by a strong odour. Essential oils are composed mainly of terpenoids, including monoterpenes and sesquiterpenes, their oxygenated derivatives and a variety of molecules such as aliphatic hydrocarbons, acids, alcohols, aldehydes, acyclic esters or lactones, and exceptionally nitrogen and sulphur containing compounds and coumarins. Known for their antimicrobial medicinal properties and their fragrance, they are invariably used in preservation of foods and asantimicrobial, analgesic, sedative, anti-inflammatory, spasmolytic and local anesthetic remedies [1, 2]. In short, it can be summarized that the essential oils are a product obtained from vegetable raw materials and are complex mixtures whose composition may include volatile terpenic compounds [3]. Many plants used in traditional medicine are as effective as the drugs imported by Africa which are

unknown for the most of the African population [4-6]. Coriander (*Coriandrum sativum*), also known as cilantro, Chinese parsley or Dhania is an annual herb [7]. Coriander is native to regions spanning from southern Europe and North Africa to southwestern Asia. It is a soft, hairless plant growing to 50 cm (20 in) tall. Coriander originated from the Mediterranean region, where it has been grown since ancient times. It is now widely cultivated in Europe, North Africa, India, Bangladesh, South America, Malaysia, Thailand, and China. It grows abundantly in black soil and arid regions. First attested in English late 14th century, the word coriander derives from the Old French coriandre, which comes from Latin Coriandrum [8], in turn from Greek κορίαννον (koriannon) [9, 10]. The earliest attested form of the word is the Mycenaean Greek ko-ri-ja-da-na [11] (written in Linear B syllabic script, reconstructed as koriadnon), similar to the name of Minos' daughter Ariadne, and it is plain how this might later evolve to koriannon or koriandron [12]. Coriander grows wild over a wide area of the Near East and southern Europe, prompting the comment, "It is hard to define exactly where this plant is wild and where it only recently established itself" [13]. Many experience an unpleasant "soapy" taste or a rank smell and avoid the leaves [14, 15]. The flavors have also been compared to those of the stink bug, and similar chemical groups are involved (aldehydes). There appears to be a genetic component to the detection of "soapy" versus "herby" tastes [14]. The juice of coriander is also used as an ayurvedic medicine for treating nausea, and morning sickness. It is also used in the treatment of colitis and some of the liver disorders. Coriander is used along with other herbs such as dry ginger, helps to relieve respiratory tract infections and cough [16]. Oil of coriander seeds is a valuable ingredient in perfumes; its soft, pleasant, slightly spicy note blends into scents of oriental character. Aliphatic (2E)-alkenals and alkanals characterized from the fresh leaves of the *Coriandrum sativum* L. (Umbelliferae) were found to possess bactericidal activity against Salmonella choleraesuis ssp [17]. A significant antibacterial activity, as determined with the agar diffusion method, was shown by C. sativum essential oil [18, 19]. The potential of coriander oil to serve as a natural antimicrobial compound against C. jejuni in food [20]. The antioxidant activity of the aqueous extract of umbelliferous fruit coriander (*Coriandrum sativum*) was investigated in comparison with the known antioxidant ascorbic acid in vitro studies [21, 22]. Time dependent & dose dependent antioxidant activities of fresh juice of *Coriandrum sativum* was evaluated by various methods in vivo [23, 24]. However, many researches have been carried out on Dhania (*Coriandrum sativum* Linn), but no systematic research on comparative studies has been reported on the essential oil of nutmeg in of Brahmanbaria, Faridpur and Radhuni. Some disagreement about the presence of its constituents was observed. Therefore, the present work was undertaken to carry out a complete investigation of the essential oil of three varieties of the Dhania (*Coriandrum sativum* Linn) of Brahmanbaria, Faridpur and Radhuni including its physical & chemical properties along with GC-MS analysis.

2. Materials and Methods

The fresh Brahmanbaria, Faridpur and Radhuni Dhania are available in the local markets of Dhaka city (collected from Chalkbazar area). The collected samples were washed clearly by water to remove dust materials. Then they were dried. Finally, the dried Dhania were ground by Fritsch mortar grinder, Germany for one hour. Then the powder was sieved prior to the extraction process. The particle diameters obtained were 0.25 and 0.50mm. The yield percentage of essential oil was determined using the formula described by Rao et at [25] where the amount of essential oil recovered (g) was determined by weighing the oil after moisture was removed.

$$\text{Percentage of yield (\%)} = \frac{\text{Amount of essential oil recovered (g)} \times 100}{\text{Amount of plant material distilled (100g)}}$$

2.1. Extraction of Essential Oil

There are a number of methods employed for the extraction of essential oil or volatile oil from the plant. In the present study the stream distillation method was used. This extraction procedure was simple and itself could also provide a valuable means of producing flavor extracts from Brahmanbaria, Faridpur and Radhuni Dhania under mild conditions which preserve the natural characteristics of the product. In this process, the definite amount of sample (dirt free powder Dhania) was taken in a distillation flask (Clevenger's apparatus). Then distilled water was added two third of its volume to the flask. Then the flask was heated by electric heating mental for four hours. Volatile substances of Dhania (*Coriandrum sativum* Linn) and generated steam in the flask were condensed by water condenser. The essential oil was lighter than water and so could be separated out. The steam distilled essential oil layer which was collected over water, extracted and washed with analytical grade ether or chloroform. The ether extract of the oil was dried over anhydrous Na_2SO_4 and then filtered. It was collected in the vial. The ether or chloroform was removed in vacuum condition. Finally, the essential oil of fresh Dhania was collected.

2.2. Preparation of Samples and GC -MS Analysis

A number of studies with leaf´s essential oil of plants collected at different regions of the globe have shown distinct chemotypes by GC/MS analyses, and prevalence of distinct chemical compounds. For example, α -pinene (51.82%) in Indian plants, α-phellandrene (24.2%) in Egypt plants, limonene (17.7%) and *p*-cymene (15.7%) in Reunion Island plants [26]. The essential oil of *Coriandrum sativum* Linn (Dhania) of three varieties were diluted to 7% by chloroform (w/v) and analyzed by Electron Impact Ionization (EI) method on GC-17A gas chromatograph, coupled to a GC-MS 2010 plus mass spectrometer; fused silica capillary column temperature of 400°C (was held 2 min) was maintained with carrier gas helium at a constant pressure of 90KPa. The

samples were injected by splitting with the split ratio 10. The essential oil sample was dissolved in chloroform. The operating condition were as follows: name of column (RTS-5MS) with diameter 30cm, length 0.25mm, column-initial temperature 400°C (was held 2 min), injector temperature 220°C, holding 5 min, column packing was done with 10% diethylene glycol succinate on 100-120 mesh diatomic CAW, splitting samples were injected by splitting with the split ratio 10, helium carrier gas at constant pressure 90 KPa, sample dissolved in chloroform, range of linear temperature increase 10°C per min.

The GC-MS analysis of the samples was carried out as follows: the flow rate of the carrier gas was adjusted to ensure reproducible retention time and to minimize detector dirt. The samples were then injected by a micro-syringe through a heated injection part when it was vaporized and carried into the column. The long tube of the column was tightly packed with solid particles. The solid support was uniformly covered with a thin film of a high boiling liquid (the stationary phase). The mobile and stationary phases were then partitioned by the samples and it was separated into the individual components. The carrier gas and sample component was then emerging from the column and passed through a detector. The amount of each component as concentration by the device and generates a signal which was registered electrically. The signal was passed to a detector.

2.3. Identification of the Components

Interpretation of mass spectroscopy (GC-MS) was conducted using the data base of National Institute Standard and Technology (NIST) having more than 6200 patterns. The spectrum of the unknown component was compared with the spectrum of the known component stored in the NIST library. The retention time, molecular weight, molecular formula and composition percentage of the sample material was recorded and presented in Table 2 the essential oil of *Coriandrum sativum* Linn (Dhania) from Brahmanbaria, Faridpur, and Radhuni.

3. Results and Discussion

The physicochemical analysis is performed according to the procedure described by Atti-Santos et al. [27] by using five parameters: specific gravity (SG), optical rotation (OR), refractive index (RI), solubility in ethanol (SE), and residue on evaporation (RE). Different results were reported by [28, 29] who mentioned that GC-MS analysis of most leaves EO samples originating from India revealed α-pinene (15.01-51.82%) as the major component [30]. Nowadays, the essential oils are attracting substantial interest from scientists because of their use in the treatment of certain infectious diseases for which synthetic antibiotics are becoming less and less active, or for preserving food against oxidation as alternatives to synthetic chemicals [31]. The chemical properties such as acid value, ester value, saponification value and iodine value are examined.

Table 1. *Comparative studies on physical properties of essential oil of Dhania from Brahmanbaria, Faridpur and Radhuni.*

Physical Properties		Sample of Brahmanbaria	Sample of Faridpur	Sample of Radhuni
Oil yield (%) g/1000g		0.20	0.25	0.15
Organol-eptic	Taste	Pungent	Pungent	Pungent
	Odor	Spicy	Spicy	Spicy
	Color	Colorless	Colorless	Colorless
	Appearance at room temperature (30°C)	Homogeneous, opaque liquid, lighter than water	Homogeneous, opaque liquid, lighter than water	Homogeneous, opaque liquid, lighter than water
Specific gravity at 30°C		0.9159	0.9175	0.9174
Refractive index [$\acute{\eta}^{t\,c}$]		1.46317	1.46353	1.46280
Optical rotation $[\alpha]^{26}$		$+10°15^{/}$	$+10°36^{/}$	$+10°24^{/}$
Solubility in	60% alcohol	Not soluble	Not soluble	Not soluble
	70% alcohol	Cloudy up to 9.8 volume	Cloudy up to 9.8 volume	Cloudy up to 9.8 volume
	80% alcohol	Soluble in 5.0 volume	Soluble in 5.0 volume	Soluble in 5.0 volume
	90% alcohol	Soluble in 0.1 volume	Soluble in 0.1 volume	Soluble in 0.1 volume
	95% alcohol	Soluble in 0.08 volume	Soluble in 0.08 volume	Soluble in 0.08 volume
	100% alcohol	Soluble at any volume	Soluble at any volume	Soluble at any volume
	Distilled water	Not Soluble	Not Soluble	Not Soluble
	Chlorofrom	Soluble at any volume	Soluble at any volume	Soluble at any volume
	$CC1_4$	Soluble at any volume	Soluble at any volume	Soluble at any volume
	Pet-ether	Soluble at any volume	Soluble at any volume	Soluble at any volume
	Diethyl ether	Soluble at any volume	Soluble at any volume	Soluble at any volume
	n-hexane	Soluble at any volume	Soluble at any volume	Soluble at any volume
Chemical Properties				
Acid value		18.56	17.90	17.46
Ester value		185.78	183.63	184.28
Saponification value		181.37	179.16	180.05
Iodine value		51.67	52.34	50.72

3.1. Acid Value

The acid value (AV) of *S. terebinthifolius* leaves and fruits essential oil was calculated according to the standard ISO 1242-1973. AV number of milligrams of potassium hydroxide required to neutralize the free acids contained in

1g of the essential oil.

3.2. Ester Value

The ester value (EV) was calculated according to the standard ISO 709-1980. EV is the number of milligrams of potassium hydroxide required to neutralize the acids liberated by the hydrolysis of esters present in 1g of the essential oil.

3.3. Saponification Value

The saponification value is the number of mg of potassium hydroxide required to neutralize the fatty acids resulting from the complete hydrolysis of 1g of the substance.

3.4. Iodine Value

The iodine value of a substance is the weight of halogens expressed as iodine absorbed by 100 parts by weight of the substance. Iodine value or adulteration of the essential oils was estimated by Winkler's Bromate method (Lakhani et al., 1916).

The result of the physicochemical properties of *Coriandrum sativum* Linn (Dhania) essential oil of Brahmanbaria, Faridpur and Radhuni appeared in Table 1.

The essential oil depend on several factors such genotype, stage of maturity, cultivation peculiarities, soil composition and climate differences in various geographical locations. Fluctuation of the oil composition can import change in the organoleptic properties of the plant belonging to the botanical spices and variety. So far we aware till now no systemic investigation on the *Coriandrum sativum* Linn (Dhania) have not been investigated in Bangladesh by using modern analytical techniques. GC-MS analyzed results which include the active principles with their retention time, molecular formula, molecular weight and composition of the essential oil of *Coriandrum sativum* Linn (Dhania) of three varieties are presented in Table 2.

Table 2. *Chemical constituents of the essential oil of Dhania from Brahmanbaria, Faridpur and Radhuni.*

Sl. No	Retent-ion time	Name of the compounds	Mol. Weight	Mol. Formula	Prob (%)		
					Brahm-anbaria	Farid-pur	Radhuni
1	10.7	alpha-Methyl-alpha-[4-methyl-3-pentenyl]oxiranemethanol	170	$C_{10}H_{18}O_2$	37.3	37.3	
2	11.4	alpha-Methyl-alpha-[4-methyl-3-pentenyl]oxiranemethanol	170	$C_{10}H_{18}O_2$	37.3	37.3	37.3
3	12.00	3,7-dimethyl-1,6-Octadien-3-ol	154	$C_{10}H_{18}O$	84.8	84.8	84.8
4	25.2	3,7-dimethylacetate, (E)- 2,6-Octadien-1-ol	196	$C_{12}H_{20}O_2$	30.1	30.1	40.3
5	22.4	Myrtenyl acetate	194	$C_{12}H_{18}O_2$			15.2
6	10.8	5-ethenyltetrahydro-alpha, alpha, 5-trimethyl-cis-2-furanmethanol	170	$C_{10}H_{18}O_2$			30.5

For Brahmanbaria's Dhania four chemical constituents were found. The oil in The oil contained alpha-methyl-alpha-[4-methyl-3-pentenyl]oxiranemethanol; 1,6-octadien-3-ol; 3,7-dimethyl acetate; 2,6-Octadien-1-ol; 3,7-dimethyl acetate. For Faridpur's Dhania four chemical constituents were found as like as Brahmanbaria's Dhania. The oil in the oil contained alpha-methyl-alpha-[4-methyl-3-pentenyl]oxiranemethanol; 1,6-octadien-3-ol; 2,6-octadien-1-ol; 3,7-dimethyl acetate. On the other hand total, five chemical constituents were found the Radhuni Dhania. The oil contains 5-ethenyltetrahydro-alpha 5-trimethyl-cis-2-furanmethanol; 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. Results show that the essential oil from of two areas is a similar of numerous. It is worth monitoring that it is similar in the chemical composition of these three region oil of *Coriandrum sativum* Linn (Dhania). This confirms that the reported similar in oil is due to geographic divergence and ecological conditions. In the present study, essential oil was extracted by steam distillation from the Brahmanbaria, Faridpur and Radhuni Coriander and investigated for their chemical composition by GC-MS. Based on the present study findings, the total three chemical constituents were found by gas chromatography and mass spectrometry (GC-MS) analysis from the essential oil of Brahmanbaria Coriander.

4. Conclusions

Essential oil bearing plants are important source of secondary metabolites that are used extensively in our daily life and play an important role in the economy of man. The oil of Coriander also has antimicrobial, cytotoxic, anticancer, chemoprotective, antioxidant, anti-inflammatory antithrombotic, hypolipidaemic, ant atherosclerotic and behavioral effects. The oil contained alpha-methyl-alpha-[4-methyl-3-pentenyl]oxiranemethanol (37.3%); 3,7-dimethyl-1,6-octadien-3-ol (84.8%); 2,6-Octadien-1-ol; 3,7-dimethylacetate (E) (30.1%). Total three chemical constituents were found by gas chromatography and mass spectrometry (GC-MS) analysis from the essential oil of Faridpur Coriander. The oil contained alpha-methyl-alpha-[4-methyl-3-pentenyl]oxiranemethanol (37.3%); 1,6-octadien-3-ol; 3,7-dimethyl-(84.8%); 2,6-Octadien-1-ol; 3,7-dimethyl-acetate (E) (30.1%). On the other hand total five chemical constituents were found the Radhuni Coriander. The oil contains 5-ethenyltetrahydro-alpha, alpha, 5-trimethyl-cis-2-furanmethanol (30.5%); alpha-methyl-alpha-[4-methyl-3-pentenyl]oxiranemethanol (37.3%); 3,7-dimethyl-1,6-octadien-3-ol (84.8%); 2,6-octadien-1-ol; 3,7-dimethyl-acetate (E) (40.3%); Myrtenyl acetate (15.2%). Among the common chemical constituents, the Radhuni oil contains the

highest percentage of 2; 6-Octadien-1-ol; 3, 7-dimethyl-acetate (E) (40.3%). The specific gravity of the essential oil of Brahmanbaria, Faridpur and Radhuni Coriander were 0.9159, 0.9175 and 0.9174 respectively. Whereas, the refractive index found 1.46317, 1.46353 and 1.46280 respectively. Hence, the physical and chemical aspects of the essential oil of *Coriandrum sativum* Linn was revealed. This leads to the interpretation of vast medicinal value of this plant due to these constituents. The newly detected constituents can be studied for possible therapeutic abilities.

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