International Journal of Chemical Science
Online ISSN: 2523-2843, Print ISSN: 2523-6075
Impact Factor: RJIF 5.22
www.chemicaljournals.com
Volume 2; Issue 1; January 2018; Page No. 10-15

Essential oil composition of coriander (*Coriandrum sativum* L.) fruits

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Abstract
Coriandrum sativum L. belongs to the family Apiaceae, is an annual herb, known worldwide for its folk medicinal properties. The present research work aimed to appraise the yield and chemical composition of the essential oil isolated from the fruits of Coriander cultivated in Syria. Gas chromatography-mass spectroscopy analysis of the essential oil was performed to authenticate the profile of chemical constituents. Hydrodistilled essential oil content from Coriander ripe fruits was found to be 1.4%. A total of 32 chemical constituents were identified, mostly of monoterpene hydrocarbons compounds. Linalool with contribution of (73.92%) was found to be the principal constituent. The other major compounds were geranyl acetate (4.43%), camphor (2.59%), o-cymene. Overall, *C. sativum* essential oil from Syria is rich in beneficial chemical compounds and the fruits have a health-supporting reputation. An in-depth research work on the antioxidant principles and biological bioactivities of Coriander fruits essential oil is further recommended.

Keywords: apiaceae, *Coriandrum sativum*, essential oil, linalool, geranyl acetate, gas chromatography-mass spectroscopy (GC-MS)

1. Introduction

According to the World Health Organization (WHO) estimate, more than 80% of the population of the developing countries rely on conventional plants for initial health care. Only in Asia, medicinal plants has a big impact on economy and primary health care. There are approximately 6,500 species used for curative purpose in Asia [1]. However, use of herbal drugs in the developed world continue to rise because they are rich source of novel drugs and their bioactive principles form the basis in medicine, nutraceuticals, pharmaceutical intermediates and lead compounds in synthetic drugs [2]. Some of the plant families known as excellent sources of essential oils, Apiaceae (Umbelliferae) is one of them [3]. The Apiaceae family consists of 3000-3700 species and around 300-450 genera. They are aromatic plants and have a distinctive flavor [4]. This family is rich in secondary metabolites and embodies numerous genera of high economic and medicinal value. Numerous compounds, belonging to different chemical classes, have been isolated from essential oils of umbelliferous crops. Many umbelliferous crops have medicinal uses for gastrointestinal complaints, cardiovascular ailments, and as stimulants [3].

The genus *Coriandrum* L. belongs to the family Apiaceae [5], has two species, *C. sativum* L. is Coriander. *C. sativum* is an annual herb, native to south-western parts of Asia to North Africa [6], with botanical classification[7]as shown in (Table 1). *C. sativum* is a soft, hairless plant [8], growing to approximately 30–100 cm in height[6]. The leaves are variable in shape, broadly lobed at the base of the plant and feathery at the top of the flowering stems. The flowers are borne in small umbels,

Table 1: Botanical classification of *C. sativum*

Domain	Eukarya
Kingdom	Plantae
Phylum	Magnoliophyta (Flowering Plants)
Class	Magnoliopsida (Dicotyledons)
Subclass	Asteridae
Superorder	Cornanae
Order	Apiales
Family	Apiaceae
Genus	*Coriandrum*
Species	*C. sativum*

white or very pale pink. The fruit is a globular dry schizocarp (composed of two mericarps) which commonly called seed [9]. Being known as aromatic, medicinal and condimental plant. The whole aerial parts of Coriander, specially the leaves, present essential oil with an unpleasant odour, while the dry fruits are rich in essential oil and have both odor and taste very pleasant. So, they have been widely used in food industry to prepare liqueur [8], and The oil isolated from dried fruits is important ingredient in modern perfumery [10]. There are two longitudinal vittae (oil canal) in each mericarp, containing the essential oil in the ripe fruit as we showed in previous paper (fig.1) [11].

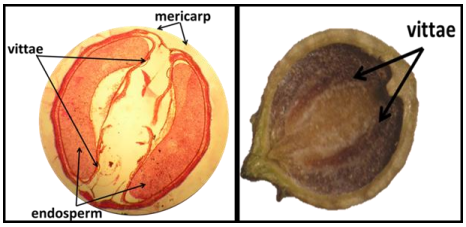

Fig 1: Oil canals (vittae) in *C. sativum* ripe fruit

C. sativum is an important spice occupies a prime position in flavoring substances [6].The stems, leaves and fruits have a pleasant aromatic odor. The entire young plant of the Coriander is used in preparing chutneys and the leaves are also used for flavouring sauces, soups and curries, Coriander oil is primarily used in seasonings for sausages and other meat products. It is also used in baked goods, condiments, chewing gums and in curry mix [5].

Coriander has known worldwide for its folk medicinal properties including uses as antioxidant, hypoglycemic, hypolipidemic, antibacterial, anti-mutagenic potential [6], stimulant, diuretic and diaphoretic activity, so it is used in disorders of respiratory, digestive and urinary systems in the Indian traditional medicine. It also has been indicated for a number of medical problems in Iranian traditional medicine such as convulsion, dyspeptic complaints, insomnia, loss of appetite[5], to cure ulcer, inflammation, spasm and acts as an expectorant, protects and soothes liver. Coriander fruits have a health-supporting reputation that is high on the list of the healing spices. They are used in medicine as a carminative, diuretic and also used in the preparation of many house hold medicines to cure bed cold, seasonal fever, nausea, and stomach disorders [6]. Linalool compound (fig.2) which was the major constituent in the essential oil of *C. sativum* ripe fruits was reported as anti-inflammatory, anti-microbial and sedative properties [12].

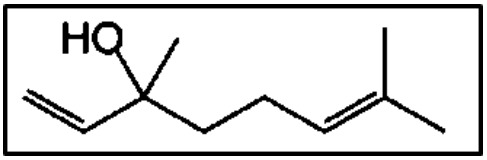

Fig 2: Linalool, terpene alcohol, the major compound of the ripe fruits of *C. sativum* essential oil

The knowledge of the chemical composition of an essential oil is of key importance for determining its potential industrial or medicinal applications. As far as we know, there are no reports available on the composition of essential oil of Coriander fruits from Syria. Therefore, the present research work was under taken with the main objective to appraise the yield and chemical composition of the essential oil isolated from the fruits of Coriander (*C. sativum*) cultivated in Syria. Gas chromatography-mass spectroscopy (GCMS) analysis of the essential oil was performed to authenticate the profile of chemical constituents.

2. Materials and methods:

2.1 Chemicals and Equipment

-Chemicals

Anhydrous sodium sulphate (BDH, UK).
Diethyl ether (ACROS organics, USA).

-Equipments

Clevenger's apparatus (Duran, Germany), gas chromatography coupled with mass spectrometry (Shimadzu, Japan), heater (Snijders, Holland), Distillation (Lotun Co. Ltd, Taiwan), Balance (Sartorius, Germany), grinder (Moulinex, France).

2.2 Plant Material Collection

The study was done in the experimental field of Science Faculty, Campus of Aleppo, Syria. Commercial Coriander fruits (seeds) were authenticated by Dr. Kattaa, working at the Department of Horticulture, Faculty of Agriculture Engineering, University of Aleppo, Syria.

Coriander fruits were cultivated within strictly defined environmental conditions on February 17th in 2014. Three parallel rows were designed, each of them was 2.45m in length with 35 cm apart within rows and 35 cm apart among rows. Harvest was held on June 8th in 2014. Coriander ripe fruits were cleaned and then powdered using mechanical grinder.

2.3 Essential oil isolation

Hydrodistillation in Clevenger apparatus has been used for essential oil extraction. About 100 g of powdered dried fruits were set in flat bottom flask with 1000 ml of distillated water. The process of hydrodistillation lasted 3 consecutive hours. The distilled essential oil was dried over anhydrous sodium sulphate (Na_2SO_4), filtered using Millipore filter paper (45 µm pore size) and stored in a sealed vial at -4 °C until analyzed[3].

2.4 Determination of percentage (%) yield

The yield of the oil (w/w %) was calculated based upon Eq. (1) [13]:

$$\text{Percentage yield of oil} = \frac{\text{Weight of oil}}{\text{Weight of sample}} \times 100 \quad (1)$$

2.5. GC-MS analysis of the oils

The essential oil from *C. sativum* ripe fruits was analyzed by gas chromatography coupled with mass spectrometry (analysis conditions are shown in (table2)). The sample was dissolved in diethyl ether $C_2H_5OC_2H_5$ and injected into a capillary column [8].

Table 2: Analysis conditions by gas chromatography coupled with mass spectrometry

60 °C for 0 min	Solvent Delay: 4.00 min
then 3 °C/min to 180 °C for 0 min	
then 10 °C/min to 260 °C for 2 min	EMV Mode: Relative
Run Time 50 min	Resulting EM Voltage: 1282
HP-5MS 5% Phenyl Methyl Silox	[Scan Parameters]
325 °C: 30 m x 250 µm x 0.25 µm	Low Mass: 35.0
	High Mass: 450.0
Pressure 8.2317 psi	Threshold: 150
Flow 1 mL/min	
Average Velocity 36.623 cm/sec	Plot 2 low mass:20.0
	Plot 2 high mass:550.0
General Information	
------- ----------	[MSZones]
Acquistion Mode: Scan	
	MS Source: 230 C maximum 250 C
MS Information	MS Quad: 150 C maximum 200 C
	MS 5975C Agilent
	GC 7890A Agilent

3. Results & Discussion

3.1 The yield of *Coriandrum sativum* essential oil

The Coriander oil obtained by hydrodistillation from ripe fruits showed a pale-yellow color with liquid like appearance (fig.3), and bearing the characteristic aromatic strong odor of Coriander. The essential oil yield of *C. sativum* L. ripe fruits was 1.4% (w:w).

Fig 3: The pale-yellow essential oil of the ripe fruits of *C. sativum*.

The essential oil yield from Syrian Coriander fruits, was in line to that reported in the literature from some other regions in the world.

The content of essential oil from Turkey *C. sativum* fruits, was 0.3 to 1.2%, and 60–70% of this essential oil is linalool, which gives the pleasant characteristic odor to the oil [14]. In another study, the content of the essential oil from Coriander fruits, grown in Sudan, was 0.8% (v/w) [3]. Other authors have shown that the content of essential oil from Coriander fruits, grown in Bangladesh was 0.42% (w/w) [15]. The essential oil content of *C. sativum* varieties (var. vulgare Alef and var. microcarpum DC.) from Turkey was investigated, and the authors reported that the oil content studied varied between 0.31-0.43% for microcarpum, and 0.15-0.25% for the vulgare [16]. The essential oil content from different cultivars of Coriander fruits (Jantar and Alekseevski) native to Atlantic Canada was ranged from 0.8 to 2.2% (v/w) for both cultivars [17]. In a study carried out in Canada, the oil content varied depending on fruit size. Large fruits contained less oil (0.83-0.91%) than small fruits (1.17-1.30%) [18].

Literature revealed that the yield of Coriander essential oil differs in relation to the origin and cultivars of fruits as well as due to agroclimatic and geographical variations [19]. In a study carried out in in the region of Menzel Temime (Northeastern Tunisia) aimed to investigate the composition of volatile components of the essential oils extracted from *C. sativum* fruits, found that the highest yield of the oil were observed at final stages of maturity[20]. We concludes that the yield of the essential oil was affected by the growing region, stages of maturity and their interaction.

3.2 GC-MS analysis of *Coriandrum sativum* L. essential oil from ripe fruits

The essential oil was analyzed by GC-MS. A typical GC-MS chromatogram showing the separation of the tested essential oil chemical constituents, together with their actually recorded retention times, is presented as (fig. 4 and Table3). A total of 32 compounds were identified in the essential oil, mostly of Monoterpene hydrocarbons compounds. The essential oil tested contained high amount of linalool (73.92%). The other major compounds were geranyl acetate (4.43%), camphor (2.59%), o-cymene (2.39%) propanal, 2-methyl-3-pheny-l (1.69%), carvone (1.66%). Other compounds including geraniol (1.62%), apiol (1.55%), d-limonene (1.33), gamma-terpinen (1.22%), alpha pinene (1.09%), beta-pinene (0.96%), borneol (0.83%), 3-caren-10-al (0.56%), cis-linalyl oxide (0.52%), alpha-methyl-alpha-[4-methyl-3-pentenyl] oxiranemethanol (0.48%), alpha-terpineol (0.44%), z)-2-decenal (0.38%), decanal (0.33%), beta-myrcene (0.25%), 2-dodecenal (0.24%), 1-terpinen-4-ol (0.23%), 2-octen-1-ol, 3,7-dimethyl (0.21%), 2-caren-10-al (0.16%), 1-decanol (0.15%), camphene (0.13%), beta-phellandrene (0.12%),1,7-octadien-3-ol, 2,6-dimethyl (0.12%), carvacrol (0.12%), nonanal (0.11%), trans-2-decenol (0.11%), myrtenyl acetate (0.08%) were also detected.

Table 3: Chemical compounds identified in the essential oil of *C. sativum* ripe fruits by GC-MS

Peak	Sample components	R.T.	Area	PCT Total%
1	Alpha-pinene	5.257	429249	1.09
2	Camphene	5.637	49931	0.13
3	Beta-Phellandrene	6.278	46969	0.12
4	Beta-pinene	6.384	375566	0.96
5	Beta-Myrcene	6.745	97818	0.25
6	o-Cymene	7.809	938932	2.39
7	D-Limonene	7.949	519792	1.33
8	Gamma-Terpinen	8.979	477953	1.22
9	Alpha-Methyl-alpha-[4-methyl-3-pentenyl]oxiranemethanol	9.485	187145	0.48
10	cis-Linalyl Oxide	10.067	204540	0.52
11	Beta-Linalool	10.568	28997766	73.92
12	Nonanal	10.674	41317	0.11
13	Camphor	12.215	1016085	2.59
14	Borneol	13.067	326771	0.83
15	1-terpinen-4-ol	13.554	90133	0.23
16	Alpha-Terpineol	14.103	171155	0.44
17	1,7-Octadien-3-ol, 2,6-dimethyl	14.396	45570	0.12
18	Decanal	14.719	130751	0.33
19	2-Octen-1-ol, 3,7-dimethyl	15.677	81511	0.21
20	Propanal, 2-methyl-3-pheny-l	16.12	662112	1.69
21	(-)-(R)-Carvone	16.298	651848	1.66

22	Geraniol	16.77	634702	1.62
23	Z)-2-Decenal	17.05	149931	0.38
24	trans-2-Decenol	17.382	44364	0.11
25	1-Decanol	17.517	60196	0.15
26	2-Caren-10-al	17.974	62998	0.16
27	3-Caren-10-al	18.258	218920	0.56
28	Carvacrol	18.773	45462	0.12
29	Myrtenyl acetate	19.741	29637	0.08
30	Geranyl acetate	22.202	1739544	4.43
31	2-Dodecenal	25.496	92804	0.24
32	Apiol	31.621	607283	1.55

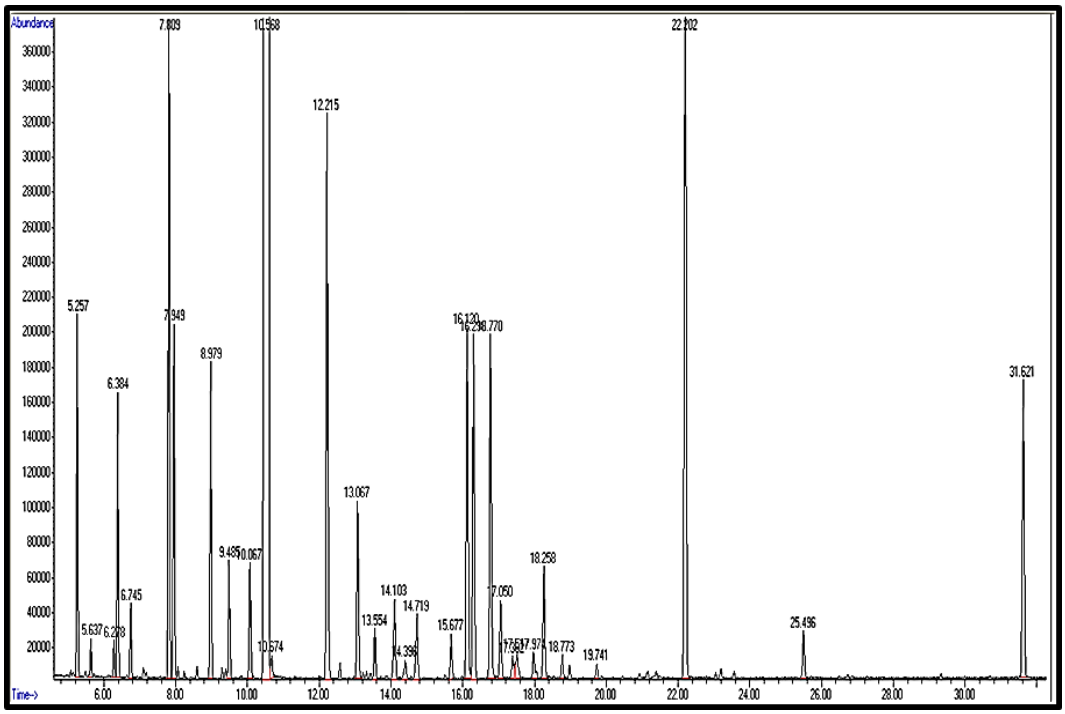

Fig 4: Gas chromatogram of the essential oil of the ripe fruits of *C. sativum*.

The number of compounds identified in Coriander oil in various research studies varies significantly and ranges from 16 to 53 compounds [15, 21].

The literature reports that linalool is the main compound in the oil from the fruit of Coriander grown in different parts of the world [21, 22].The linalool content may depend on the plant growth stage. The oil from immature seeds contained the lowest amount of linalool (10.96%), and there was over six times more linalool in the oil from not fully mature seeds (76.33%), whereas the content of this compound in the obtained from mature seeds was 87.54% [20, 21]. Other authors have shown that the linalool content is greatly affected by the size fruit from which the oil is extracted. The oil from small fruits contained more linalool (63.5-71.0%) than that from large fruits (42.1-52.7%) [16, 21].

The present study revealed that the oil isolated from Syrian fruits are often similar to the others in respect of the presence of linalool and geranyl acetate [16, 21, 23, 24, 25, 26].

The chemical composition of Coriander fruits essential oil from Syria was somewhat comparable with that examined by authors in India, who identified 52 components in the Coriander fruits essential oil, accounting for 98.45% of the total oil**.** In agreement with our present data, the major chemical components which they detected in the essential oil were**:** linalool (75.30%), geranyl acetate (8.12%) and α-pinene (4.09%) [27].

In another study, 26 compounds were identified in the essential oil from Coriander fruits from New Zealand. The oil had on average (64.61%) of linalool, (5.94%) of α-pinene, (4.73%) of (+)-2-bornanoneand, (6.79%) of α-terpinolene, (5.94%) of α-pinene, and (2.46%) of geranyl acetate[3]. In a study carried out in Iraqi, 35 compounds were identified in the essential oil from Coriander fruits, mostly of phenolic compounds and aromatic acids. The main compound was linalool (59.14 %), The other major compounds were gamma-terpinen (8.92 %), α-pinene (5.86.10%), geraniol (3.74%), nerol (3.51%), p-propenylanisole (3.41%), bicyclo-heptan-2-one (3.09 %) and d-limonene (1.99 %) [28]. In another study, Identified 53 compounds in the essential oil from Coriander fruits from Bangladesh. Linalool amounting to (37.7%) was found to be the principle component in the oil. Other main components detected were geranyl acetate (17.6%) and γ-terpinene (14.4%) [15].

The content and composition of essential oil is influenced by various climatic and soil conditions like geography of growing region, season, and other environmental features, variety,

stage of maturity at time of harvesting, nature of fruit part, abiotic stress such as salinity, water stress and process of extraction of oils[5].

4. Conclusions

Essential oil extracted from the fruits of Syrian Coriander contained 32 compounds after GC-MS analysis. Coriander (*C. sativum* L.) volatile oil is rich in beneficial chemical compounds and the fruits have a health-supporting reputation that is high on the list of the healing spices. The main component of the Syrian Coriander fruits oil was linalool, similarly as in the research studies of other authors. The dominant compounds were also geranyl acetate and camphor. In the available literature, the authors also indicated these constituents as the compounds of Coriander oil. An in-depth research work on the antioxidant principles and biological bioactivities of Coriander fruits essential oil is further recommended.

5. Acknowledgments

The authors are grateful to the Research Laboratories of Chemistry Department University of Damascus for research facilities. This work was also supported by the Research Laboratories of Pharmacognosy Department- Aleppo Pharmacy Faculty. We express our gratitude to these laboratories for the technical support of the research.

6. References

1. Joujeh D, Lahdo R, and Ghrewaty A. Evaluation of Hemolytic and Anti-Hemolytic Activity of the Aerial Parts of *Sonchus Oleraceus* Extracts. International Journal of Pharmaceutical Sciences and Nanotechnology. 2017; 10(3):3745-3751.
2. Hossain MM, Ahamed SK, Dewan SMR, Hassan MM, Istiaq A, Islam MS, *et al*. *In vivo* antipyretic, antiemetic, in vitro membrane stabilization, antimicrobial, and cytotoxic activities of different extracts from Spilanthes paniculata leaves. Biological Research. 2014; 47(4):2-9.
3. Hassan OM, Elhassan IA. Characterization of essential oils from fruits of umbelliferous crop cultivated in Sudan II. *Coriandrum sativum* L. (Coriander) and *Foeniculum vulgare* Mill (Fennel). Journal of Pharmacognosy and Phytochemistry. 2017; 6(1):113-116.
4. Ebadollahi A. Plants Essential Oils from Apiaceae Family as Alternatives to Conventional Insecticides. Ecologia Balkanica. 2013; 5(1):149-172.
5. Priyadarshi S, Borse BB. Effect of the Environment on Content and Composition of Essential oil in Coriander. International Journal of Scientific & Engineering Research. 2014; 5(2):57-65.
6. Rajeshwari U, Andallu B. Medicinal benefits of coriander (*Coriandrum sativum* L). Spatula DD. 2011; 1(1):51-58.
7. Takhtajan A. Flowering Plants. Springer Science &Business Media B.V., Russia. 2009, 871.
8. Figueiredo RO, Nakagawa J, Ming LC, Marques MOM. Composition of Coriander Essential Oil from Brazil. Can. Int. Dev. Agency. 2004; 1(4):135-137.
9. Ebrahimi SN, Hadian J, Ranjbar H. Essential oil compositions of different accessions of *Coriandrum sativum* L. from Iran. Nat Prod Res. 2011; 24(14):1287–1294.
10. Orav A, Arak E, Raal A. Essential Oil Composition of *Coriandrum sativum* L. Fruits from Different Countries. Journal of Essential Oil Bearing Plants. 2011; 14(1):118-123.
11. Olabi MN, Kattaa A, Jojah R. Taxonomic Study of *Coriandrum sativum* L, and *Anethum graveolens* L. Related to Apiaceae. Research Journal of Aleppo University. 2015; 103:1-18.
12. Wierdak RN. Essential Oil Composition of the Coriander *(Coriandrum sativum* L.*)* Herb Depending On the Development Stage. Acta Agrobotanica. 2013; 66(1):53-60.
13. Nkafamiya II, Maina HM, Osemeahon SA, Modibbo U. U. Percentage oil yield and physiochemical properties of different groundnut species (*Arachis hypogaea*). African Journal of Food Science. 2010; 4(7):418 -421.
14. Kiralan M, Calikoglu E, Ipek A, Bayrak A, Gurbuz B. Fatty Acid and Volatile Oil Composition Of Different Coriander (*Coriandrum sativum*) Registered Varieties Cultivated In Turkey. Chemistry of Natural Compounds. 2009; 45(1):100-102.
15. Bhuiyan NI, Begum J, Sultana M. Chemical composition of leaf and seed essential oil of *Coriandrum sativum* L. from Bangladesh. Bangladesh Journal Pharmacol. 2009; 4(3):150-153.
16. Telci I, Toncer OG, Sahbaz N. Yield, Essential Oil Content and Composition of *Coriandrum sativum* Varieties (var. *vulgare* Alef and var. *microcarpum* DC.) Grown in Two Different Locations. Journal of Essential Oil Research. 2006; 18(5):189-193.
17. Zheljazkov VD, Pickett KM, Caldwell CD, Pincock JA, Roberts JC, Mapplebeck L. Cultivar and sowing date effects on seed yield and oil composition of coriander in Atlantic Canada. industrial crops and products. 2008; 28:88-94.
18. Arganosa GC, Soulski FW, Slikard AE. Seed Yields and Essential Oil of Northern-Grown Coriander (Coriandrum sativum L.). Species & Medicinal plants. 1998; 6:23-32.
19. Anwar F, Sulman M, Hussain A I, Saari N, Iqbal S, and Rashid U. Physicochemical composition of hydro-distilled essential oil from coriander (*Coriandrum sativum* L.) seeds cultivated in Pakistan. Journal of Medicinal Plants Research. 2011; 5(15):3537-3544.
20. Msaada K, Taarit MB, Hosni K, Hammami M, Marzouk B. Regional and maturational effects on essential oils yields and composition of coriander (*Coriandrum sativum* L.) fruits. Scientia Horticulturae. 2009; 122(1):116-124.
21. Zawislak G. The Chemical Composition of Essential Oil from the Fruit of Coriander (Coriandrum sativum L.). SECTIO DDD. 2011; 2(21):169-175.
22. Ravi R, Prakash M, Bhat KK. Aroma characterization of coriander (*Coriandrum sativum* L.) oil samples. European Food Research and Technology. 2007; 3(5):225-367.
23. Coleman WM, Lawrence BM. Comparative automated static and dynamic quantitative headspace analysis of coriander oil. J.Chromatogr Sci. 1992; 30:396-398.

24. Pino JA, Rosado A, Fuentes V. Chemical composition of the seed oil of *Coriandrum sativum* L. from Cuba. Journal Essentl Oil Research. 1996; 8:97-98.
25. Leung AY, Foster S. Encyclopedia of common natural ingredients used in food. drugs and cosmetics. 1996; 2(3):193-95.
26. Tashinen J, Nykanen L. Volatile constituents obtained by the extraction with alcohol-water mixture and by steam distillation of coriander fruit. Acta Chem Scand. 1975; 20:425-29.
27. Singh G, Maurya S, De LMP, Catalan CAN. Studies on essential oils Chemical composition, antifungal, antioxidant and sprout suppressant activities of coriander (*Coriandrum sativum*) essential oils and its oleoresin. Flav. Frag. J. 2006; 21(3):472-479.
28. Niamah AK, Alali HA. Antibacterial and antioxidant activities of essential oils extracted from Iraqi coriander (*Coriandrum sativum* L.) seeds. International Journal of Scientific & Engineering Research. 2016; 7(2):1511-1515.