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Chemical and Biological study of Coriander (*Coriander sativum*)

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Prepared by: Huda Jawhar Muhamad

Supervised By: Mrs: Jala Bahjat Ziwar

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

وَهُوَ الَّذِي أَنْزَلَ مِنَ السَّمَاءِ مَاءً فَأَخْرَجْنَا بِهِ نَبَاتَ كُلِّ شَيْءٍ فَأَخْرَجْنَا مِنْهُ
خَضِرًا نُخْرِجُ مِنْهُ حَبًّا مُتَرَاكِبًا وَمِنَ النَّخْلِ مِنَ النَّخْلِ مِنْ طَلْعِهَا قِنْوَانٌ دَانِيَةٌ وَجَنَّاتٍ
مِّنْ أَعْنَابٍ وَالزَّيْتُونَ وَالرُّمَّانَ مُشْتَبِهًا وَغَيْرَ مُتَشَابِهٍ ۚ انظُرُوا إِلَى ثَمَرِهِ إِذَا
أَتَمَرَ وَيَنْعِهِ ۚ إِنَّ فِي ذَٰلِكُمْ لَآيَاتٍ لِّقَوْمٍ يُؤْمِنُونَ

سورة الانعام (٩٩)

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ABSTRACT

Coriander, also known as cilantro, is an herb widely used in culinary dishes and traditional medicine. This plant has been the subject of numerous studies due to its diverse biological and chemical properties. The chemical composition of coriander includes essential oils, phenolic compounds, flavonoids, and fatty acids. These components have demonstrated significant antioxidant, anti-inflammatory, antimicrobial, Biological studies on coriander have investigated .and anticancer activities its potential therapeutic effects on a variety of conditions such as diabetes, hypertension, hyperlipidemia, and neurological disorders. In particular, coriander has been shown to possess hypoglycemic and The essential .hypolipidemic effects, as well as neuroprotective properties oils found in coriander have also been the focus of numerous studies, with investigations into their antimicrobial and antifungal activities, as Overall, the .well as their use as natural preservatives in the food industry chemical and biological studies of coriander highlight its potential as a natural source of bioactive compounds that may have therapeutic applications. However, further research is needed to fully elucidate the mechanisms behind these effects and to optimize the use of coriander in various settings.

Keyword:

Coriander sativum L, apiaceous, cilantro, GC-MS, umbelliferae, essential oil, antioxidant, antimicrobial, linalool.

INTRODUCTION

1.1 Natural products chemistry

Many higher plants produce economically important organic compounds such as oils, resins, tannins, natural rubber, gums, waxes, dyes, flavors and fragrances, pharmaceuticals, and pesticides. However, most species of higher plants have never been described, much less surveyed for chemical or biologically active constituents, and new sources of commercially valuable materials remain to be discovered. Advances in biotechnology, particularly methods for culturing plant cells and tissues, should provide new means for the commercial processing of even rare plants and the chemicals they produce. These new technologies will extend and enhance the usefulness of plants as renewable resources of valuable chemicals. In the future, biologically active plant-derived chemicals can be expected to play an increasingly significant role in the commercial development of new products for regulating plant growth and for insect and weed control. (2-Balandrin, 1985.) The above-mentioned studies indicate the importance of our study concerning one of this (الكزبرة) natural products which is coriander sativum.

1.2 The use of medicinal plants

Medicinal plants have been known as immunostimulants for thousands of years. The application of medicinal plants as natural and innocuous compounds has potential in aquaculture as an alternative to antibiotics and immunoprophylactics. The growing interest in these plants has increased world-wide because they are easy to prepare, cheap, and have few side effects on animals and the environment. A wide range of medicinal plants such as herbs, spices, seaweeds, herbal medicines, herbal extracted compounds, traditional Chinese medicines, and commercial plant-derived products has been studied in various aquatic animals. The whole plant or its parts viz. roots, leaves, seeds, flowers or extract compounds can be used. The extraction process is simple, with ethanol and methanol being commonly used. Various chemicals used to extract compounds may lead to different degrees of effects on aquatic animals. Application methods can be either single or in combination, or even in a mixture with other immunostimulants, via water routine or feed additives and enrichment, where single administrations are as practical as combinations.

2. Description of the plant

The bright green plant is erect and glabrous (hairless) reaching heights of 16 to 24 inch. (40 - 60 cm). The compound lower leaves are roundish and lobed, while the upper leaves are finely divided into very narrow, lacy segments. The small white or pink flowers are borne in compound umbels that measure approximately 1.6 inch (4cm) across.

2.1 Names of coriander

Table (1) other name and family of coriander

Synonyms (Other names)	Coriander fruits, Cilantro, DhaniaChinese Parsley, Coriandre, Coriandri Fructus, Coriander Essential Oil, Dhanyaka, Koriander, Kustumburi, Persil Arabe, Persils chinois.
Botanical Name	Coriandrum sativum Linn
Family	Apiaceae or Umbelliferae
Geographical Source	Holland , Russia, Hungary,Egypt, Morocco and India (Andhrapradesh , Maharashtra, West Bengal , ,Uttar Pradesh,Rajasthan)
Hazarads	Narcotic effect , Photosensitivity and Allergic reactions

2.2 Distribution of plant

Coriander has been known since very ancient times. Coriander seeds have been found in Egyptian tombs of the twenty-first dynasty who ruled Egypt some 3000 years ago (Holland et al., 1991). The origin of coriander is uncertain, the area suggested by most authors being the Near East (Diederichsen, 1996; Arif et al., 2014). Some authors Vavilov (1992) and Mengesha (2010) for example suggested a much wider origin for coriander which includes central Asia, the Near East and Abyssinia. The others mention central Asia and Mediterranean countries (Vaidya et al. 2000; Meena et al., 2014; Laribiet al., 2015). Balasubramanian et al. (2011) stated coriander is native to southern Europe and North Africa to southwestern Asia. Coriander is now reported to be cultivated in Argentina, Brazil, India Italy, Linia, Mexico, Morocco, the Netherlands and Paraguay, Peru, Poland, Rumania, Somalia, Spain, USA, former Soviet Union, north African countries and Yugoslavia (Rubatzskey et al., 1999; Khan et al., 2014). Cultivation of coriander over many continents indicates its wider adaptability to different agro ecological conditions and economic significance of the crop in diversified societies of the world. The major producers are India, Morocco, Canada, Pakistan, Romania, Ukrain, Russia (Priyadarshi et al., 2016), United States, Canada, Argentina and Mexico, and more than 80% of total world production of coriander seeds is from India.



Fig (1) coriander plant, coriander seeds and essential oil

2.3 Botanical of coriander

The *C. sativum* L. (family Umbelliferae/Apiaceae) is an erect annual herb with pronounced taproot, and slender branching stems up to 20–70 cm in height. There are two varieties of *C. sativum*: *vulgare* and *microcarpum*; the former has larger fruits (3–5 mm diameter) with EO yields of 0.1%–0.35% (v/w) while the latter has smaller fruits (1.5–3 mm diameter) with EO yields of 0.8%–1.8% (v/w) [4]. However, Ravi et al. [5] documented that the weight of 1000 fruits, with fruit diameter >3 mm, is >10 g for *C. sativum* L. var. *sativum*, while for *C. sativum* L. var. *microcarpum* DC, the weight of 1000 fruits is <10 g, with fruit diameter \times 3 mm. The leaves are lanceolate, green or dark green, glabrous on both surfaces and are variable in shape and lobed. The flowers are borne in small umbels, white or light pink, asymmetrical, with the petals pointing away from the centre. The coriander seed, is almost ovate globular dry schizocarp with two mericarps [6], and multiple longitudinal ridges on the surface possessing a sweet, slightly pungent, citrus like flavor with a hint of sage [3].

2.4 Nutritional value

Coriander is rich in vitamin A, vitamin K, vitamin C, dietary minerals and fibers. It contains minerals like manganese, iron, magnesium, calcium and selenium. The essential oils present in the herb are known to stunt bacterial production and multiplication. Rich in ascorbic acid and 11 types of essential oils that render antirheumatic and antiarthritic properties to coriander, the herb on a whole is packed with nutritional benefits.

2.5 Varieties of coriander sativum

Coriander (*Coriandrum sativum* L.) is one of the most important spice and cash crop produced in Ethiopia. However, information related to potential of the midland areas of Guji zone for Coriander production is limited. This experiment was conducted in the Kiltu sorsa, Gobicha and Dole areas at three farmers' field to evaluate the growth and yield performance of Coriander varieties and to select and recommend high yielding as well as diseases resistant Coriander variety(s). Five improved Coriander varieties Walta'i, Batu, Tulu, Indium 01 and Denkinesh were cultivated. The treatments were arranged in randomized completed block design (RCBD) with three replications.

3. Coriander seed powder

Coriander (*Coriandrum sativum* L.) being an annual herb is most commonly used for seasoning purpose. Its plant seeds, leaves and roots are edible, although they have very distinct flavors and uses. The herb has a light and fresh flavor. Coriander can be used as whole plant and can be processed because of its perishable nature of leaves and to increase the palatability of ripe fruits (seeds) before using it as flavoring agent in different food preparations. Whole plant of coriander mainly fresh leaves and ripe fruits are used for culinary purposes. Coriander leaves have different taste than its seeds, with citrus overtones. Coriander plant is a rich reservoir of micronutrients and nutritional elements which leads us to focus our study on this herb. Coriander is very low in saturated fat however, contains good amount of linoleic acid which is a good source of α -tocopherol and vitamin K. Leaves of plant are rich source of vitamins while seeds are rich in polyphenols and essential oils. Coriander taste is devoted to its essential oil comprising a significant content of linoleic and furanocoumarins (coriandrine and dihydrocoriandrine).

4. Pharmacological activity

4.1-Diuretic

The aqueous extract of coriander seed possesses diuretic and saluretic activity, thus, validating the use of coriander as a diuretic plant in Moroccan pharmacopoeia aqueous extract of coriander seed was administered by continuous intravenous infusion (120 min) at two doses (40 and 100 mg/kg) to anesthetized Wistar rats. Furosemide (10 mg/kg), a standard diuretic was used as the reference drug. Excretion of water and electrolytes (sodium, potassium and chloride) in urine was measured, and glomerular filtration rate (equal to creatinine clearance) was determined. (Aissaoui Abderahim et al., 2008).

4.2-Antioxidant Activity

The antioxidant activity was assessed in the aldehyde/carboxylic acid test. This method is based on inhibition of autoxidation of aldehyde to carboxylic (hexanoic) acid in the presence of compounds exhibiting anti oxidanactivity This method combine with capillary GLC makes it possible to study antioxidant properties and to determine quantitative changes in the content of each component of essential oils during their autoxidation. (Misharina T. A et al., 2008; Wangenstein Helle et al., 2004).

4.3-Antidiabetic activity

Coriandrum sativum seeds incorporated into diet and the effect of the administration of coriander seeds on the metabolism of lipids was studied in rats fed with high fat diet and added cholesterol. The seeds had a significant hypolipidemic action. In the experimental group of rats (tissue) the level of total cholesterol and triglycerides increased significantly. (Dhanapakiam P et al., 2008)

4.4-Anti-convulsant activity

The anti-convulsant effects of aqueous and ethanolic extracts of coriander sativum seeds were studied in order to evaluate the folkloric use of this plant. two anti-convulsant evaluation test, namely the pentylenetetrazole (PTZ) and the maximal electroshock test, were used for assessing antiseizure effect in the pentylenetetrazole test, aqueous and ethanolic extracts prolonged onset of clonic convulsions and anti convulsant activity of high dose (5mg/kg) were similar to that of phenobarbital at a dose of 20mg/kg in the PTZ test. (Hosseinzadeh Hossein et al., 2005).

4.5-Sedative Hypnotic Activity

Coriandrum sativum L. has been recommended for relief of insomnia in Iranian traditional medicine. To determine sedative & hypnotic activity Aqueous and hydroalcoholic extract & essential oil administer to rat. The results of experiment shows that aqueous extract prolonged pentobarbital-induced sleeping time at 200, 400 and 600 mg/kg. (Emamghoreishi M et al., 2006).

4.6-Anti-microbial Activity

Aqueous infusions and aqueous decoctions of *Coriandrum sativum* (coriander) against 186 bacterial isolates belonging to 10 different genera of G +ve bacterial population and 2 isolates of *Candida albicans* isolated from urine specimens. The well diffusion technique was employed. The aqueous infusion and decoction of coriander did not show any antimicrobial activity against G -ve urinary pathogens as well as against *Candida albicans* (Sabahat saeed perween tariq et al., 2007).

4.7-Anti mutagenic activity

Aromatic amines are metabolically activated into mutagenic compounds by both animal and plant systems. The 4- nitro-o-phenylenediamine (NOP) is a well-known direct-acting mutagen whose mutagenic potential can be enhanced by plant metabolism; m-phenylenediamine (m-PDA) is converted to mutagenic products detected by the *Salmonella typhimurium* TA98 strain, and 2-aminofluorene (2-AF) is the plant-activated promutagen most extensively studied. Plant cells activate both 2- AF and m-PDA into potent mutagens producing DNA frame shift mutations.

4.8-Anthelmintic activity

In vitro anthelmintic activities of crude aqueous and hydro-alcoholic extracts of the seeds of *Coriandrum Sativum* (Apiaceae) were investigated on the egg and adult nematode parasite *Haemonchus contortus*. The aqueous extract of *Coriandrum Sativum* was also investigated for in vivo anthelmintic activity in sheep infected with *Haemonchus contortus*.

5. Health benefits of coriander

5.1-Keeps cholesterol level in check

The acids present in coriander – ascorbic acid, oleic acid, stearic acid, palmitic acid and linoleic acid are known to be highly efficient in reducing the cholesterol levels of the body. It ensures that there is no cholesterol deposition along the walls of arteries and veins that could lead to chronic problems like heart attack, strokes and arteriosclerosis. At the same time, coriander enables a rise in levels of healthy cholesterol that prevent the body from of serious health conditions.

5.2-Cures diarrhea

Coriander consumption aids in digestion, enhances liver functions and eliminates fungal and microbial invasion that cause diarrhea. Oils such as borneol and linalool help prevent nausea, vomiting and stomach disorders

5.3-Prevents from allergies

Owing to the presence of anti-histamine properties, coriander is an efficient herb to treat seasonal allergies and hay fever. It is known to prevent skin infections in addition to keeping at bay problems like hives, throat swelling, anaphylaxis, etc.

5.4-Soothes inflammation of the skin

Cineole present in coriander lends antirheumatic and antiarthritic properties. These properties enable the herb to reduce swelling caused due to kidney disorders, anemia, arthritis, etc. It enables the body to flush out toxins by inducing frequent urination. This makes the skin healthy, improves body functioning and an overall healthy body.

5.5-Makes bones healthy

Coriander is rich in calcium and other compounds that are imperative for the development and durability of bones. It tackles symptoms causing osteoporosis and other debilitating diseases that affect bone strength. The center part of the coriander leaf contains calcium in high concentration.

5.6-Treats smallpox

The essential oils that coriander is composed of are rich in antimicrobial, anti-infectious and antioxidant properties in addition to the high levels of vitamin C and iron presence. These nutrients come together to treat and prevent small pox. Vitamin C is widely known as a cure to smallpox which is abundantly present in coriander.

5.7-Maintains blood pressure

Research suggests that consumption of coriander is extremely beneficial for people suffering from hypertension. It lowers the blood pressure by means of the acetylcholine process that is a result of an interaction between the calcium ions and cholinergic.

5.8-Prevents from the bacteria Salmonella

Coriander is an extremely powerful antibiotic and twice as efficient as required to fight the deadly bacteria Salmonella. Owing to the abundance of dodecenal present in coriander, it helps prevent the body from contracting any problems spread by the said bacteria. Salmonella is known to cause rather horrible and sometimes even fatal disorders.



Figure (2) health benefits of coriander

6.1 Chemical and biological study of coriander

Coriander (*Coriandrum sativum* L.) also called as Cilantro, Arab parsley, Chinese parsley; Kasbour is cultivated for its seeds and foliage for extraction of essential oil using hydrodistillation. The GC-MS compositional analysis of coriander seed essential oil showed the presence of many compounds viz linalool, camphor, geraniol, α -pinene, γ -terpinene, geranyl acetate and limonene. Essential oil of coriander is known to exhibit wide range of biological activities like antibacterial, antifungal, antioxidant, insecticidal and in addition it also exhibit pharmacological activities such as anti-inflammatory, anxiolytic, antimicrobial, diuretic, cognition improvement, antidiabetic, antiseptic, antihypertensive, lipolytic, myorelaxant, anticancerous, antimutagenic, and free radical scavenging activities.

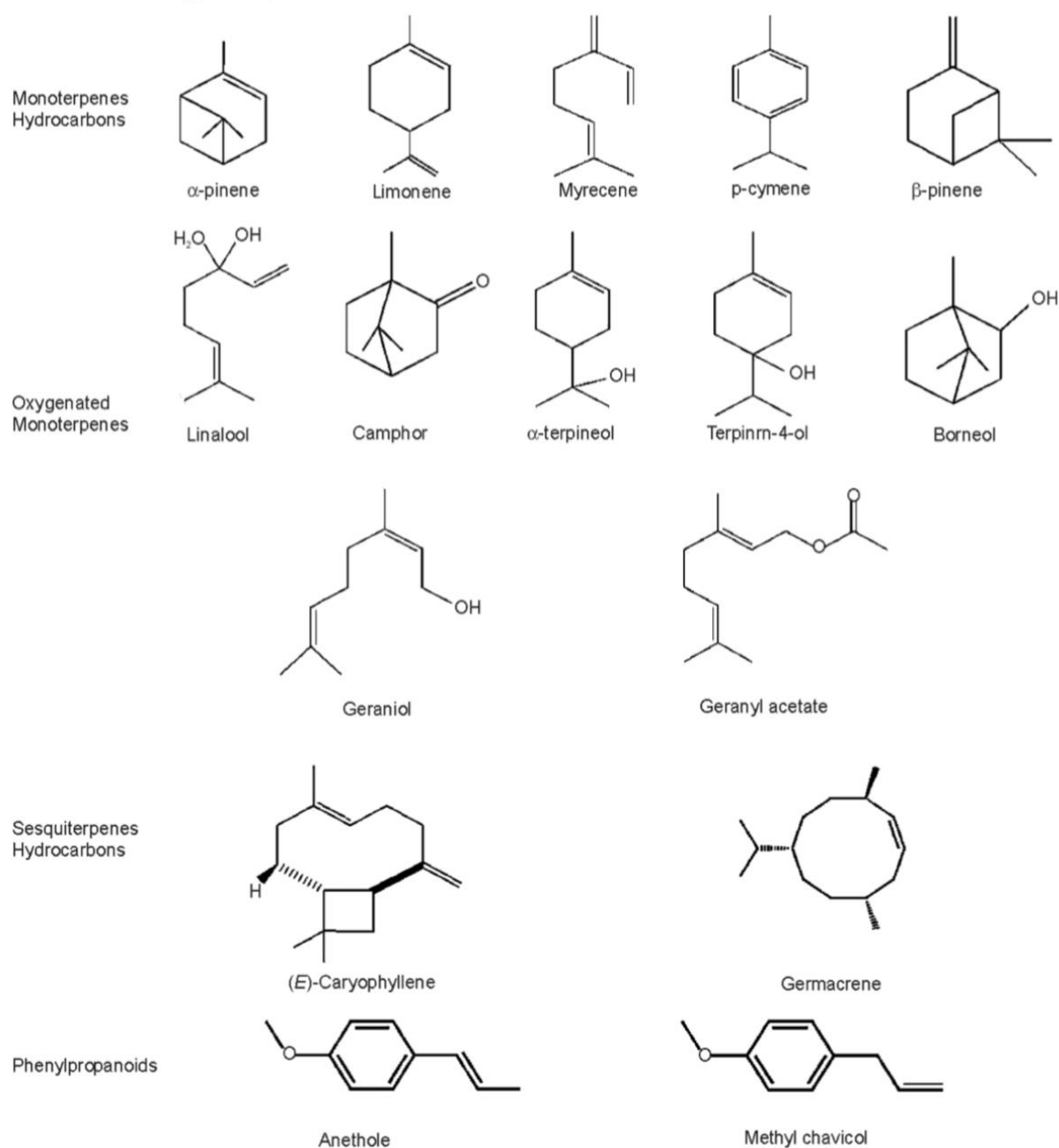


Figure (3) coriander leaves

Table (2) chemical composition of coriander

No.	Compounds	percentage%
1-	Linalool	55.49
2-	gama-terpinene	7.47
3-	α -pinene	7.14
4-	camphor	5.59
5-	decanal	4.69
6-	Geranyl acetate	4.24
7-	limonene	3.10
8-	Geraniol	2.23
9-	Camphene	1.78
10-	D-limonene	1.36
11-	Myrcene	0.98
12-	p-cymene	0.90
13-	a-terpinol	0.81
14-	Decanol	0.81
15-	(E)-2-Decanal	32.23
16-	Linalool	13.97
17-	(E)-2-Dodecenal	7.51
18-	(E)-2-tertadecenal	6.56
19-	2-decen-1-ol	5.45
20-	(E)-2-undecenal	4.31
21-	Dodecenal	4.07
22-	(E)-2-tridecenal	3.00
23-	(E)-2-hexadecenal	2.94
24-	pentadecenal	2.47

6.2 Structure of major organic compound that present in coriander



**Figure (4) The major compounds isolated from the
.Coriandrum sativum L**

7. Essential oil

Essential oils are colorless or slightly yellow complex mixtures of odorous and volatile compounds which are found in plants in the subcuticular space of glandular hairs, in cell organelles, in excretory cavities and canals (Rehman et al., 2016). Coriander seed oil is included among the major essential oils in the world market (ITC, 2016). The major constituents of coriander fruit essential oils are linalool α -pinene γ -terpinene geranyl acetate camphor terpinolene and Geraniol. The variation in composition of the volatile oil, which determines the odor and flavor character of coriander, is influenced by the genetic origin and ontogenesis. Misharina (2001) found the coriander seed in Russia has more concentration of camphor and less concentration of linalool while seed from New Zealand have camphor and linalool (Smallfield et al., 2001). On the other hand, Bhuiya et al. (2009) and Msaada et al. (2009) indicated that the chemical composition of essential oil undergoes changes during ontogenesis, which affects the aroma of the plant, and thus the coriander fruit aroma is completely different from the aroma of the herb (Neffati and Marzouk, 2008).

8. Coriander oil as a source for linalool

The different parts of this plant contain linalool, α -pinene, monoterpenes, limonene, γ -terpinene, borneol, p -cymene, camphor, citronellol, geraniol, coriandrin, coriandrons A-E, dihydrocoriandrin, flavonoids and essential oils (Pathak et al., 2011). Linalool is the main volatile compound in coriander seeds; typically constituting more than 50 percent of total essential oil (Gil et al., 2002) which has been investigated for its safety. The seeds contain on average 18 percent oil (fatty acids/triglycerides); however, the essential oil content of seeds is approximately 0.84 percent. Beyond essential oil, coriander also contains fatty acid oil which contains oleic, petroselinic and linolenic fatty acids. It forms approximately two-thirds of the oil (Gil et al., 2002; Grosso et al., 2008).

9. Essential oil composition of the coriander herb depending on the development stage

The herbal material of *Coriandrum sativum* is the fruit. Fresh herb is also used as an aromatic spice. The aim of the present study was to evaluate the content and chemical composition of coriander herb obtained at different plant growth stages. Coriander plants were grown in a glasshouse, the herb was harvested at the initial stage of flowering and from regrowing shoots. Essential oil extraction from the herb was performed by the hydro distillation method, whereas the assessment of the chemical composition – using GC-MS method. The examined material contained 0.17–0.29 ml $\times 100\text{g}^{-1}$ of essential oil, depending on the stage of plant development when the harvest was done. 61 (generative phase) and 65 (vegetative phase) compounds were found in the examined coriander oil.

10. Chemical composition of leaf and seed essential oil of *Coriandrum sativum* L

The essential oils from leaves and fruits of *Coriandrum sativum* L. were analyzed by gas chromatography mass spectroscopy (GC-MS). The leaf oil contained 44 compounds mostly of aromatic acids containing 2-decenoic acid (30.8%), E-11-tetradecenoic acid (13.4%), capric acid (12.7%), undecyl alcohol (6.4%), tridecanoic acid (5.5%) and undecanoic acid (7.1%) as major constituents. The seed oil contains 53 compounds where the major compounds are linalool (37.7%), geranyl acetate (17.6%) and γ -terpinene (14.4%). The compositions of both oils varied qualitatively and quantitatively.

Table (3) chemical composition of essential oil of coriander

Compound	Percentage %
2-decenoic acid	30.8
e-11-tetradecenoic acid	13.4
Capric acid	12.7
Undecyl alcohol	6.4
Tridecenoic acid	5.5
Undecenoic acid	7.1

11. Conclusion

Coriander is a commonly used herb in many cuisines around the world, and it has been the subject of various chemical and biological studies. These studies have revealed that coriander contains a diverse array of chemical compounds, including volatile oils, flavonoids, and phenolic acids. These compounds have been found to have various biological activities, such as antioxidant, anti-inflammatory, antimicrobial, and anticancer properties. Furthermore, coriander has been shown to have potential therapeutic effects on several health conditions, including diabetes, cardiovascular diseases, and neurological disorders. The herb's ability to regulate lipid metabolism and reduce blood glucose levels has been of particular interest in the treatment of metabolic disorders. Overall, the chemical and biological studies of coriander have highlighted its potential as a natural source of bioactive compounds with various health benefits. Future research may focus on identifying the specific compounds responsible for the observed biological activities and exploring their mechanisms of action, which could lead to the development of new therapeutic agents derived from coriander.

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