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BIOCHEMICAL CONSTITUENTS IN CORIANDER: A REVIEW

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ABSTRACT

Coriandrum sativum L., commonly known as coriander or Chinese parsley, is an annual herb belonging to the family *Umbelliferae*, renowned for its spice, aromatic, nutritional, and medicinal properties. The plant is cultivated for both its fresh green leaves and dried brown seeds, which are utilized in the production of essential oils and oleoresins. In addition to its culinary applications as a seasoning, coriander has long been employed in traditional medicine and household remedies to treat ailments such as the common cold, seasonal fever, nausea, vomiting, and various digestive disorders. Furthermore, it is used therapeutically to alleviate indigestion, expel intestinal worms, and manage conditions such as rheumatism, joint pain, migraine, hypertension, and diabetes. Many of coriander's therapeutic properties can be attributed to its rich composition of exceptional phytonutrients, making it widely recognized as a valuable reservoir of bioactive compounds.
Keywords **:** Essential oil, oleoresins, bioactive compounds.

Introduction

Coriander (*Coriandrum sativum* L.) is among the oldest known cultivated plants, believed to have originated in the Mediterranean region. Today, it is extensively cultivated across Russia, Central Europe, North Africa, and various parts of Asia (Farooqi *et al*., 2005). Botanically, coriander is an erect, annual herbaceous plant distinguished by a prominent taproot and slender, branched stems that generally attain a height of 20 to 70 cm. As a tropical species, it is well adapted for cultivation during both the kharif and rabi seasons. In India, coriander is typically sown between May and July for the kharif season and from October to January for the rabi season. Harvesting is generally carried out during the flowering and seed maturation stages (Farooqi *et al*., 2005). Commonly known as *dhania* in India, coriander is highly valued for its culinary as well as medicinal properties. All parts of the plant leaves, stems, and seeds are utilized either as flavouring agents or in traditional medicine for treating various human ailments. The fresh green leaves, in particular, are low in saturated fats and cholesterol while being rich in thiamine, zinc, and dietary fiber. Furthermore, coriander leaves serve as a significant source of β-carotene (up to 160 µg/100 g), a precursor of vitamin A, and possess a total carotenoid content of around 1010 µg/100 g (Kandlakunta *et al*., 2008). The seeds are rich in essential oils (0.5–1%) and contain considerable quantities of fatty oils, predominantly composed of monounsaturated fatty acids such as petroselinic acid. In addition, the seeds are abundant in bioactive compounds including polyphenols, phenolic

acids, and flavonoids which contribute to their strong antioxidant and therapeutic properties. Moreover, both the leaves and fruits of *C. sativum* are rich in essential macro- and micronutrients, including proteins, fats, carbohydrates, calcium, phosphorus, sodium, zinc, thiamine, riboflavin, niacin, tryptophan, vitamin B6, folate, and vitamins A, D, B12, C, and E (Nimish *et al*., 2011; Bhat *et al.*, 2014). Beyond its nutritional profile, coriander fruit oil is notably rich in fatty acids such as petroselinic, linoleic, oleic, palmitic, and stearic acids, which enhance its functional and industrial importance. Traditionally, coriander has been used to promote digestive health and relieve gastrointestinal discomfort, helping to reduce bloating, gas, and indigestion. The seeds are also commonly used to prepare herbal teas or infusions that provide soothing digestive benefits.

Essential Oil Composition

Coriander leaves possess fewer essential oil constituents than the seeds; however, the composition of these oils varies markedly with the plant's geographical origin. In coriander cultivated in Bangladesh, essential oil analysis has revealed 44 compounds, primarily consisting of aromatic acids. The major constituents include 2-decenoic acid (30.8%), E-11-tetradecenoic acid (13.4%), and capric acid (12.7%). In contrast, essential oils extracted from Kenyan coriander are predominantly composed of aldehydes (56.1%) and alcohols (46.3%). The principal constituents include (E)-2-decenal (15.9%), decanal (14.3%), (E)-2-decen-1-ol (14.2%), and n-decanol (13.6%). Other notable compounds identified are (E)-2-tridecen-1-al, (E)-2-dodecenal, dodecanal, undecanol, and undecanal. The Brazilian variety of coriander displays a distinct essential oil profile, characterized by major components such as decanal (19.09%), trans-2-decenal (17.54%), 2-decen-1-ol (12.33%), cyclodecane (12.15%), cis-2-dodecane (10.72%), dodecanal (4.1%), and dodecan-1-ol (3.13%). Similarly, essential oil obtained from Indian coriander leaves is primarily composed of (E)-2-decenal (18.02%), followed by decanal (14.36%), dec-9-en-1-ol (11.66%), (E)-2-dodecenal (8.72%), n-tetradecanol (6.09%), dodecanal (5.81%), and decanol (5.77%).

Table 1: Coriander oil compounds

(%)	Main compounds
68.8	Petroselinic acid
16.6	Linoleic acid
7.5	Oleic acid
3.8	Palmitic acid

(Maroufi *et al.* 2010)

Table 2: Coriander essential oil compounds

(%)	**Main compounds**
67.7	Linalool
10.5	α-pinene
9	γ-terpinene
4	Geranyl acetate
3	Camphor
1.9	Geraniol

(Maroufi *et al.* 2010)

Nutritional aspects

Fresh coriander leaves are nutritionally rich, consisting primarily of water, which makes up most of their composition. The remaining components include proteins, carbohydrates, and a small amount of total ash. In addition, these leaves contain essential minerals such as calcium, phosphorus, and iron. They are also an excellent source of vitamins, providing notable amounts of riboflavin, niacin, ascorbic acid (vitamin C), and an especially high content of vitamin A per 100 grams. This impressive concentration of micronutrients makes coriander leaves a valuable and health-promoting addition to the diet. According to USDA data, coriander seeds are free of cholesterol and are a rich source of vitamins, minerals, and healthy fats. Among their minerals, potassium is the most abundant, at 1,267 mg per 100 grams, followed by calcium (709 mg), phosphorus (409 mg), magnesium (330 mg), sodium (35 mg), and zinc (4.70 mg). Coriander seeds contain approximately 200 µg of folate per 100 grams of fresh weight (Iwatani *et al*., 2003). They also provide a notable amount of vitamin C (21 mg per 100 grams), while the fresh green herb form can contain up to 160 mg of vitamin C and 12 mg of vitamin A per 100 grams (Girenko, 1982). Coriander is very low in saturated fat and cholesterol and is an excellent source of thiamine, zinc, and dietary fiber. Fresh green coriander consists of about 84% water.

Flavouring Agent: Coriander leaves and seeds are widely used as flavouring agents in cuisines around the world. The leaves, known as cilantro, have a fresh, citrus-like flavour and are commonly added to salads, salsas, curries, soups, and as garnishes. The seeds possess a warm, slightly sweet, and citrusy taste and are used whole or ground in spice blends, marinades, pickles, and sauces.

Aromatic Herb: Coriander, or cilantro, imparts a distinctive aroma that enhances the overall flavour of dishes. The fresh leaves are particularly fragrant and are often used as a garnish or finishing touch to add a burst of freshness to meals.

Ingredient in Chutneys and Sauces: Coriander leaves and seeds are essential ingredients in many chutneys, sauces, and condiments. They add depth and complexity to the flavour profiles of these preparations and pair well with ingredients such as garlic, chili peppers, and citrus.

Pickling: Coriander seeds are often used in vegetable pickling, adding a distinctive flavour to pickled cucumbers, carrots, and various other vegetables.

Fatty acids

Coriander leaves contain a wide range of bioactive compounds, including essential oils, flavonoids, phenolic acids, lipids, and polyphenols. Among the fatty acids present, α-linolenic acid (C18:3n-3) is the most abundant, representing about 39.4% in the upper leaves and 41.1% in the basal leaves. This predominant fatty acid is accompanied by significant amounts of linoleic, heptadecenoic, and palmitic acids. Minor fatty acids, including oleic, stearic, stearidonic, and both cis- and trans-palmitoleic acids, together account for about 9.6% in basal leaves and 4.7% in upper leaves. Notably, coriander oil contains high levels of petroselinic acid, a compound of particular interest. Studies have shown that dietary intake of petroselinic acid can significantly reduce arachidonic acid levels in heart tissue (Weber *et al*., 1995).

Phenols and flavonoids

Indian coriander leaves are rich in phenolic acids, with vanillic, p-coumaric, cis-ferulic, and trans-ferulic acids being the most abundant. Flavonoids such as kaempferol, quercetin, 3'-O-methyl quercetin, 4'-O-methyl quercetin, and acacetin have also been identified, though glycoflavones were not detected. This makes Indian coriander leaves a significant source of quercetin. In comparison, studies on Brazilian coriander leaf extracts have identified caffeic acid (4.34 µg/ml), protocatechuic acid (6.43 µg/ml), and glycitin (3.27 µg/ml) as the main bioactive compounds. Anthocyanins are also present in coriander leaves, playing a role in various biosynthetic pathways. The seeds and essential oils of coriander are rich in beneficial phytonutrients such as geraniol, limonene, borneol, carvone, and linalool. Nutritionally, coriander is an excellent source of dietary fiber and essential minerals, including iron (Fe), magnesium (Mg), and manganese (Mn). The leaves are particularly high in vitamin C (250 mg per 100 g) and retinol (1.56 mg per 100 g), making coriander juice beneficial for correcting deficiencies in vitamins A, B1, B2, ascorbic acid, and iron.

Coriander contains both fixed and essential oils, typically ranging from 0.2–1.5% and 13–20%, respectively. Some cultivars have been shown to produce up to 2.6% essential oil (Bhat *et al*., 2014; Nadeem *et al*., 2013). Studies further indicate that coriander fruits contain about 1% essential oil, with linalool as the predominant monoterpenoid (over 50%), along with significant amounts of limonene and geraniol (Pavli *et al*., 2015).

Pharmacological properties

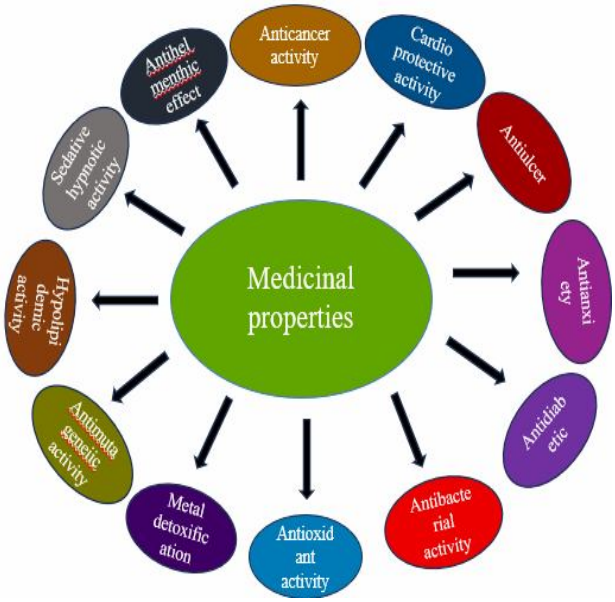

Fig. 1 : Medicinal properties of Coriander

Antioxidant activity

Coriander is a rich source of phytochemicals and bioactive compounds, including polyphenols, flavonoids, and vitamin C (ascorbic acid), all of which contribute to its strong antioxidant properties. Recent research has highlighted essential oils from plants as effective natural antioxidants. Studies have shown a positive correlation between the total phenolic content of coriander extracts and their antioxidant activity. Among the plant's parts, the leaves display stronger antioxidant effects than the seeds, with ethyl acetate extracts from both showing the highest activity.

Coriander contains several phenolic acids, including caffeic acid and chlorogenic acid, as well as a variety of flavonoids such as quercetin, kaempferol, rhamnetin, and apigenin. These compounds are known for their ability to neutralize free radicals in the body when consumed as part of the diet. Reactive oxygen species (ROS), which are linked to cellular damage and various degenerative diseases, can harm tissues and vital biomolecules. Antioxidants counteract this damage by acting as reducing agents, metal chelators,

free radical scavengers, or singlet oxygen quenchers. Previous epidemiological studies (Madsen and Bertelsen, 1995) have shown that herbs and spices can serve as valuable natural alternatives to synthetic antioxidants, which are often associated with negative health effects. Incorporating coriander into the diet may improve the antioxidant profile of foods and help prevent undesirable oxidative reactions. Polyphenols, a major subgroup of phenolic compounds found abundantly in plants, are known for their wide range of biological activities. They exhibit strong antioxidant properties that protect against lipid peroxidation and also possess anti-inflammatory and anticancer effects. Additionally, polyphenols may contribute to the management of obesity and metabolic disorders.

One study reported that a Syrian coriander variety contained a high total phenolic content of 1.09 mg GAE per gram, followed by varieties from Tunisia and Egypt, with 1.00 and 0.94 mg GAE per gram (dry weight), respectively (Neffati *et al*., 2011). However, another study showed very different results, indicating that a Canadian coriander variety contained 15.16 mg GAE per gram (dry weight) of total phenolic content (Sriti *et al*., 2011; Wangensteen *et al*., 2004). However, a Norwegian coriander variety was found to contain nearly 2.00 g GAE per 100 g of ethyl acetate extract (Barros *et al*., 2012). The phenolic composition of coriander, however, remains not fully clarified or understood. In the literature, total tannin and flavonoid contents are expressed as mg CE per g dry weight (DW). In methanolic extracts of coriander seeds, total tannin and flavonoid levels were reported to range between 0.09–0.17 mg CE/g DW and 2.03–2.51 mg CE/g DW, respectively.

Antibacterial Properties

Coriander exhibits notable antibacterial activity against *Staphylococcus aureus*, *Salmonella typhi*, and *Escherichia coli* (Al Jedah *et al*., 2000). According to research by Delaquis *et al*. (2002), coriander essential oil shows limited effectiveness against gram-negative bacteria such as *Pseudomonas fragi*, *E. coli*, and *S. typhi*, but demonstrates significantly stronger antibacterial effects against gram-positive bacteria, including *S. aureus* and *Listeria monocytogenes***.** One of the primary antimicrobial compounds found in coriander is dodecanal, which has been shown to be about twice as effective as the commonly used antibiotic gentamicin in eliminating *Salmonella* species (Kubo *et al*., 2004). Further research by Wong and Kitts (2006) evaluated the antibacterial activity of water and methanol extracts of coriander leaves against *Bacillus subtilis* and *E. coli*, revealing that these extracts caused significant cell damage and markedly inhibited bacterial growth and proliferation.

Anti-diabetic

The anti-diabetic properties of coriander (*Coriandrum sativum*) are well-documented in scientific research. Extensive studies have validated its traditional use as a natural therapeutic agent for diabetes management. Experiments on streptozotocin-induced diabetic rats have shown that coriander exhibits strong blood glucose-lowering (anti-hyperglycemic) activity. This effect is attributed to its ability to stimulate insulin secretion, enhance glucose uptake, and improve glucose utilization in muscle tissues, largely due to the bioactive compounds found in the aqueous extracts of coriander fruits (Gray & Flatt, 1999). Additional evidence indicates that regular consumption of coriander fruit at suitable therapeutic doses can effectively reduce blood glucose levels and rectify lipid imbalances in individuals with non-insulin-dependent diabetes mellitus. Moreover, studies suggest that coriander possesses therapeutic potential for managing liver disorders, including chronic liver disease and hepatic fibrosis (Wijayagunawardanea *et al*., 2015).

Coriander decoctions have been traditionally employed in various medicinal systems for the management of diabetes. Scientific research has revealed that coriander extracts exhibit both insulin-mimetic and insulin-releasing properties. In animal studies, dietary supplementation with powdered coriander seeds led to a significant reduction in blood glucose levels (Deepa & Anuradha, 2011). The aqueous extract of coriander was found to stimulate insulin secretion by 1.3 to 5.7 times, reinforcing its potent anti-hyperglycemic activity. Additionally, ethanol extracts of coriander seeds have demonstrated promising efficacy in lowering blood glucose levels in streptozotocin-induced diabetic rats (Eidi *et al*., 2009).

Antianxiety actions

Aqueous extracts of coriander (*Coriandrum sativum*) have exhibited significant antianxiety effects, along with mild sedative and muscle-relaxant properties, particularly in animal studies. In rat experiments, administration of 0.10 g/kg of coriander extract produced anxiolytic effects comparable to those of 0.03 g/kg of diazepam, as determined by the elevated plus maze test. Based on these results, the estimated effective dose for humans is approximately 7.5 grams of dried coriander fruit extract for an average adult (Emamghoreishi *et al*., 2005).

Cardioprotective activity

Hydro-methanolic extracts of coriander fruits have demonstrated notable cardioprotective potential in experimental studies. These beneficial effects are primarily attributed to the abundance of polyphenolic compounds present in the fruit. Administration of coriander fruit extract led to a significant reduction in total cholesterol and other lipid fractions, while also enhancing high-density lipoprotein (HDL) cholesterol levels. Furthermore, coriander extract effectively alleviated dyslipidemia in rabbit models, underscoring its potential therapeutic value in supporting cardiovascular health (Abascal *et al*., 2012).

Antiulcer action

Coriander plays an important role in safeguarding the human body against the detrimental effects of heavy metals and other dietary toxins. It has also been recognized for its potential in preventing gastric ulcers induced by *Helicobacter pylori*. Research has underscored the plant's anti-ulcer and antisecretory properties, which are thought to be associated with its rich antioxidant profile. These antioxidants aid in neutralizing reactive oxygen species (ROS) at the gastric mucosal surface, potentially facilitating the formation of a protective barrier through hydrophobic interactions. This protective activity helps preserve the integrity of the gastric lining and contributes to the prevention of ulcer formation.

Anticancer activity

The influence of coriander fruit on lipid metabolism was investigated using a rat model of colon cancer induced by 1,2-dimethylhydrazine. In the group treated with coriander, a significant reduction in cholesterol absorption and in the cholesterol-to-phospholipid ratio was observed, accompanied by a notable increase in phospholipid levels compared to the control group exposed solely to the carcinogen. Additionally, coriander supplementation led to a marked elevation in faecal dry weight, neutral sterol content, and bile acid excretion, indicating enhanced lipid elimination and improved metabolic regulation. These findings suggest that coriander may exert a protective effect on lipid metabolism during the process of colon carcinogenesis (Sahib *et al*., 2012). Although research on the anticancer properties of coriander remains limited, the available evidence underscores its potential as a beneficial dietary component in the prevention of cancer.

Anthelmintic effect

Helminthosis, a parasitic worm infection commonly affecting small ruminants, causes severe illness and elevated mortality rates, leading to considerable economic losses. Research conducted by Eguale *et al*. (2007) revealed that coriander seed extracts possess both *in vivo* and *in vitro* anthelmintic activity against *Haemonchus contortus* at concentrations below 0.5 mg/mL. Furthermore, crude aqueous and hydroalcoholic extracts of *Coriandrum sativum* seeds completely inhibited nematode egg hatching at concentrations below 0.005 g/mL, with no significant difference in efficacy between the two extract types. Nonetheless, the hydroalcoholic extract exhibited superior *in vitro* effectiveness against adult parasites compared to the aqueous extract.

Sedative Hypnotic Activity

Coriandrum sativum L. has been traditionally recommended in Iranian medicine for the management of insomnia. To evaluate its sedative and hypnotic properties, aqueous and hydroalcoholic extracts, along with the essential oil, were administered to rats. The experimental results demonstrated that the aqueous extract significantly prolonged pentobarbital-induced sleeping time at doses of 200, 400, and 150 mg/kg. Similarly, the hydroalcoholic extract, at doses of 400 and 150 mg/kg, extended pentobarbital-induced sleep duration when compared to the saline-treated control group. The essential oil also increased pentobarbital-induced sleeping time, but only at the 150 mg/kg dose. These findings indicate that the extracts and essential oil of coriander seeds possess notable sedative and hypnotic activities (Momin *et al*., 2012).

Hypolipidemic activity

The biochemical impact of coriander seeds on lipid parameters was investigated in rats with 1,2-dimethylhydrazine (DMH)-induced colon cancer. The study revealed that cholesterol concentrations and the cholesterol-to-phospholipid ratio decreased, while phospholipid levels significantly increased in the coriander-treated group compared to the DMH control group. Additionally, faecal dry weight, neutral sterol content, and bile acid excretion were markedly elevated in the coriander-fed group relative to the DMH-administered group. These findings suggest that coriander exerts a protective effect against lipid metabolism disturbances associated with experimental colon cancer (Nalini *et al*., 1998).

Antimutagenic potential

The antimutagenic potential of coriander juice against the mutagenic effects of 4-nitro-o-phenylenediamine, m-phenylenediamine, and 2-aminofluorene was evaluated using the Ames reversion mutagenicity assay (his^- to his^+) with *Salmonella*

typhimurium strain TA98 as the indicator organism. The plant cell/microbe co-incubation assay served as the activation system to investigate aromatic transformation and plant extract interactions. Aqueous crude coriander juice markedly reduced the mutagenicity of metabolized aromatic amines (AA) in the following order: 2-AF (92.43%) > m-PDA (87.14%) > NOP (83.21%). The chlorophyll concentration in the juice was also measured and exhibited a positive correlation with the observed antimutagenic activity. Furthermore, coriander juice concentrations ranging from 50 to 1000 µl per co-incubation flask were found to be neither toxic nor mutagenic. The similarity in the shape of the antimutagenic response curves obtained with coriander juice and chlorophyllin (used as a surrogate molecule for chlorophyll) suggests that comparable mechanisms of mutagenic inhibition may be involved. The observed negative correlation between chlorophyll content and the mutagenic response of the promutagenic and direct-acting amines indicates a potential chemical interaction between these two molecules, resulting in the inactivation of the mutagenic moiety (Cortes *et al*., 2024).

Metal detoxification

Coriander can serve as a natural detoxifying agent due to its ability to eliminate toxic metals from the body. The chemical constituents present in coriander bind to heavy metals and facilitate their removal from cells (Abidhusen, 2012). Arunasagar *et al*. (2005) reported that the plant is highly effective in removing inorganic mercury (Hg^{2+}) and methylmercury (CH_3Hg^+) from aqueous solutions. This efficacy is attributed to the binding interaction between the carboxylic groups in coriander compounds and mercury ions. These findings clearly indicate that coriander-derived sorbents can be utilized to eliminate inorganic and methylmercury from contaminated water. Furthermore, Kansal *et al*. (2011) demonstrated that coriander significantly reduced oxidative stress induced by lead nitrate exposure.

Conclusion

Coriandrum sativum L., commonly known as coriander, is a versatile plant of considerable agronomic, nutritional, medicinal, and industrial importance. Traditionally cultivated across diverse climatic regions including the Mediterranean, Asia, and parts of Europe and Africa coriander is a well-established crop valued for its leaves, seeds, and essential oils. It possesses a rich nutritional composition, being abundant in vitamins, minerals, fatty acids, flavonoids, and polyphenols, which contribute to its potent bioactive potential. In addition to its culinary significance, coriander exhibits a broad spectrum of pharmacological properties. These include antibacterial, antioxidant, antidiabetic, anxiolytic, cardioprotective, anti-ulcer, anticancer, and anthelmintic activities, primarily arising from its diverse and complex phytochemical profile. Notably, bioactive compounds such as linalool, dodecanal, petroselinic acid, and various phenolic acids play a pivotal role in enhancing the therapeutic potential of coriander. Scientific research has substantiated many of its traditional medicinal applications, confirming its efficacy against bacterial pathogens, oxidative stress, metabolic disorders, and parasitic infections. Overall, coriander is not merely a flavourful culinary herb but also a potent natural agent that contributes significantly to human health and overall well-being.

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