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### Review

## A Review On *Coriandrum Sativum* L.: It's Ethno Pharmacology, Phytochemistry, Mechanism, Traditional Uses And Cardiovascular Effects

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	<b>Abstract</b>
Published on: 06 Jun 2025	<p><i>Coriandrum sativum</i> L. (coriander) is an aromatic herb widely used in culinary traditions and folk medicine in many cultures. The flavor has been valued not only by itself, but also for its many therapeutic properties. The review of <i>Coriandrum sativum</i> emphasizes the ethnopharmacological significance, phytochemical constituents and cardiovascular effects of the plant. Coriander has a traditional history of use for a number of health conditions: digestive problems like indigestion and flatulence, inflammatory disorders, microbial infections, anxiety and even for hypertension and palpitations. Phytochemical analyses show that coriander is rich in essential oils (especially linalool), flavonoids, phenolic acids, fatty acids and phytosterols. Its potent antioxidant, anti inflammatory, antimicrobial and lipid lowering properties are due to these constituents. Also very significant cardiovascular properties of coriander can be noted: experimental studies have shown its effect on lowering of the blood pressure, improvement of the lipid profile and protection against oxidative stress provoked cardiac damage. Mechanism known of coriander is vasodilator via calcium channel blockade and nitric oxide dependent pathways; inhibition of critical enzymes of cholesterol biosynthesis; modulation of cytokine inflammation. Although these results are encouraging, questions exist regarding how standard coriander extracts may be improved, that coriander phytochemical profiles can be made consistent and broadly applicable clinical</p>
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	<p>trials to assess efficacy and safety in humans can be performed. Moreover, some of the active constituents are poorly available thereby requiring formulation of more sophisticated delivery systems to maximize therapeutic outcomes. There is a lot of room for further phytochemical characterization and rigorous clinical evaluations of <i>Coriandrum sativum</i> and various ways of putting it into formulation to highlight the potential of this natural agent as part of the armamentarium for cardiovascular disease and general health management. In addition, coriander has gained support in its acceptance as functional food ingredient as well as nutraceutical which can be used for preventive healthcare applications. Finally it is concluded that <i>Coriandrum sativum</i> L. can be considered as a significant medicinal plant traditionally used in many ways and having pharmacological activities in cardiovascular health based on the scientific evidences.</p>
	<p><b>Keywords:</b> <i>Coriandrum sativum</i>, Ethnopharmacology, Phytochemistry, cardiovascular effect, antioxidant activity</p>

## INTRODUCTION

*Coriandrum sativum* L. (coriander or cilantro) is an annual herb which is well known as belonging to the Apiaceae family (parsley family). This plant is native to the Mediterranean region and Middle East and has been cultivated for thousands of years and is now cultivated greatly worldwide. Both culinary and medicinal applications, make it widely appreciated[1]. Cilantro is the fresh leaves and coriander is the dried seeds of the same plant but called by different names in different regions. It has a distinctive aroma and taste and is used culinary in cuisines the world over such as in Indian, Middle Eastern, Latin American and Southeast Asian[2].

Besides its culinary importance, *Coriandrum sativum* is also widely mentioned in traditional medicine systems like Ayurveda, Unani and Traditional Chinese Medicine (TCM) or in folk medicine in various cultures[3]. Historically and according to ethnobotanical records, various parts of the plant (seeds, leaves and roots) have been used to treat a considerable array of health issues. This can be digestive disorders, respiratory problems, anxiety, inflammation and cardiovascular issues. Because of their widespread and consistent use for diverse medical indications, the therapeutic potential of *Coriandrum sativum* seems to be considerable and to warrant further investigation concerning its pharmacological properties[4].

In Ayurveda coriander is said to be cool, carminative, diuretic and digestive in action. It is Pitta balancer and is also given in the treatment of hyperacidity, indigestion and urinary tract infections. It is also detoxifying. The seeds are used in Unani medicine since they are aphrodisiac, stomachic and tonic[5]. Coriander is used by Unani practitioners to treat heartburn, dizziness and headaches among other things and to improve digestion. Similarly in Traditional Chinese Medicine coriander is used to promote appetite, to treat measles in children and to help eruption of rashes by expelling wind and heat from body.

Phytochemical composition of plant is rich and diverse and is therefore attributed to its medicinal value. *Coriandrum sativum* possesses therapeutic actions which are a result of several phytoconstituents. Important constituents of medicinal uses include essential oils (especially linalool), flavonoids (e.g. quercetin, rutin and apigenin), phenolic acids (e.g. caffeic acid and chlorogenic acid), fatty acids (e.g. petroselinic and linoleic acid), alkaloids, coumarins, tannins and sterols. Among these, the one which has an important place in coriander essential oil is linalool which is responsible for having antioxidant, antimicrobial, anti-inflammatory and anxiolytic properties. This explains the multi targeted effects of coriander in different health conditions due to presence such a broad spectrum of bioactive compounds[6].

Particularly in recent times its cardiovascular effects have drawn attention. Cardiovascular diseases (CVDs) are the world's leading cause of morbidity and mortality and their development is to a large extent linked to the risk factors including hypertension, hyperlipidemia, oxidative stress, inflammation and thrombosis. Interest is burgeoning to discover what natural, plant based remedies are available to improve cardiovascular health and maybe compliment treatment. Regarding this, *Coriandrum sativum* has shown some encouraging results in preclinical and also limited clinical studies[7].

Written on numerous occasions before, but backed up in this review, it appears that extracts from coriander seeds and leaves have numerous positive effects on the cardiovascular system. They have antihypertensive, hypolipidemic, antioxidant and antiplatelet and diuretic actions. Coriander is believed to possess an antihypertensive activity, inhibition of calcium influx in vascular smooth muscle doses vasodilation

and decreases vascular resistance. In vitro and in vivo studies supporting this action demonstrate a vast drop in systolic and diastolic blood pressure after administration of coriander extract. It also relaxes blood vessels and affects the autonomic nervous system which help in blood pressure regulation[8].

Also, there are records that suggest that coriander has a hypolipidemic effect in animal models and a few human trials. Administration of coriander seeds or coriander seed extract is associated with reductions in total cholesterol, low-density lipoprotein (LDL) and triglycerides, also with increases in high-density lipoprotein (HDL). The lipid lowering effects may be through inhibition of the rate limiting enzyme in cholesterol biosynthesis, HMG-CoA reductase and promotion of bile acid excretion. These findings are in line with the age old use of coriander in promoting heart health and preventing atherosclerosis[9].

In addition, *Coriandrum sativum* also supports cardiovascular health because it has a powerful antioxidant activity. The role of oxidative stress (imbalance between free radicals and antioxidants) is also central in the pathogenesis of CVDs, mainly in endothelial dysfunction and lipid peroxidation. Oxidative damage is reduced by coriander's rich content of flavonoids and phenolic compounds which scavenge free radicals. In addition to helping to preserve the integrity of blood vessels, it can also prevent the inflammation and the processes of plaque formation and vascular remodeling. Also, coriander possesses antiplatelet and antithrombotic abilities that help stop and decrease the chances of blood clotting thus lowering chances of myocardial infarction and stroke. Other studies have demonstrated that coriander extract can inhibit platelet aggregation and stimulate fibrinolysis — both of which would make for greater blood flow and better vascular health. It also has mild diuretic activity which makes it useful for fluid retention and decrease in blood pressure, in cases where there is volume overload[10].

*Coriandrum sativum* appears to have some promising laboratory and animal evidence, but clinical trials are few. And most of them are too small or too short to prove cardiovascular benefits. Although these are very preliminary data, they are encouraging and nicely demonstrate the need for larger, well designed, clinical studies to confirm efficacy, establish dosage and safety profiles in different populations. Due to its prevalence, relative low cost and record for safety of use, coriander has the potential to emerge as a potentially useful adjunct for cardiovascular wellness: based on scientific validation. Finally, *Coriandrum sativum* L. is a special case of a plant at the intersection of culinary practice and herbal medicine. Because of its long history of use across cultures, its multifarious pharmacological activities and its broad (and largely unknown) phytochemical composition, casaba (*Cucumis melo*), is an intriguing agent for further cardiovascular investigation. With interest in melding traditional to medical information such as coriander which could serve as a natural supplement to support cardiovascular function and overall well being, coriander becomes another natural supplement for consideration. It is the purpose of this review to review the ethnopharmacological history, phytochemistry and cardiovascular effects of *Coriandrum sativum* with links between traditional and contemporary use of the drug[11].

## 2. PLANT PROFILE

**Botanical Name:** *Coriandrum sativum* L.

**Family:** Apiaceae (Umbelliferae)

**Common Names:** English: Coriander, Cilantro, Hindi: Dhania, Arabic: Kuzubara, Spanish: Cilantro, French: Coriandre

**Synonyms:** *Coriandrum coriandrum* (L.)

**Description:** Annual, herbaceous up to 50 cm tall herbaceous plant. The stem is slender, hollow and branched and leaves are finely divided, delicate, variable in shape, the lower ones broad and lobed, the upper narrow and thread-like. It has small white or pale pink flowers typical of the Apiaceae family placed in compound umbels. The spice coriander (coriander seeds) is the fruit which is a dry schizocarp, globular in shape, with two seeds per fruit[12].

**Distribution and Habitat:** Its native range is in Mediterranean region and Western Asia, although today it is grown worldwide in temperate and subtropical climates. This can thrive in well drained fertile soil in sunlight. Commercially it is grown in countries like India, Morocco, Egypt, Canada and the United States.

**Cultivation and Propagation:** This plant is mainly spread by the sowing seed to the soil, directly. It likes cooler weather and is usually grown as a winter crop in warmer climates. Coriander needs average amounts of water and well drained soils, lest the roots will rot. At the vegetative stage, the leaves are harvested and in the stage that the fruits mature, they are allowed to dry to harvest the seeds[13].

## 3. ETHNOPHARMACOLOGY

*Coriandrum sativum* L. (coriander) which is famous for its rich history of traditional use in various cultures, is also potential therapeutic. The ethnopharmacological practices from its use in Ayurvedic, Unani, from Traditional Chinese Medicine (TCM) and Persian medicine indicate that it has been used extensively in the treatment of health condition. Traditionally used in the form of teas, decoctions and powders and also poultices. Used alone or with other herbs, seeds, leaves and sometimes roots are used to treat everything from digestive

problems to mental health, to help the cardiovascular system. Due to its versatility in the medicinal arena, it is a compound that includes in a number of traditional systems and also conforms to the rules of holistic healing systems[14].

### 3.1. Traditional Uses

*Coriandrum sativum* L. (commonly called coriander) has been widely used in traditional medical systems because of its widespread properties for therapeutic purposes. From races and continents the coriander plant has played an important role in folk healing of digestive, inflammatory, infectious, neurological and cardiovascular disorders. It is also one of its most common, most well known traditional uses and is for the management of digestive complaints. ayurvedic, unani, Chinese and Middle Eastern medicine have used the coriander seeds and leaves for its carminative property and for treating symptoms of indigestion, flatulence, bloating and diarrhea. Decoctions, teas and infusions are mostly administered after meals to stimulate appetite, improve digestion and for relief of the gastrointestinal system. In some cultures roasted coriander seeds are chewed raw or made into herbal mixtures used to facilitate the digestion of heavy meals and to prevent abdominal cramps. But coriander has long been used for far more than just digestive health; it's also been used for its anti inflammatory effects. In traditional practice, both topical and oral preparations of coriander had been used to treat inflammatory conditions such as arthritis, rheumatism and muscle pain. Crushed coriander seeds are used to make pastes which are applied to swollen joints and inflamed skin; decoctions are taken to reduce systemic inflammation. Coriander is cooling in nature (as per Indian and Middle Eastern traditional medicine) and is used to tone down excess heat associated with inflammatory disorders like gastritis, burning micturition, skin rashes etc. These uses have been passed down through many generations sometimes in complex polyherbal formulations[15].

Ethnomedicine has also well documented coriander antimicrobial properties. As the antiseptic and antibacterial properties have also been used for wounds, cuts and skin infections. Coriander seed oil or crushed seeds are used as natural disinfectants by traditional healers especially in rural and tribal areas where access to modern antibiotics is limited. Further, the ability of coriander to inhibit growth of pathogenic microbes also explains why it is often used in the treatment of gastrointestinal infections, food poisoning and dysentery in many traditional systems[16].

It has been regarded for ages, in the world of mental health, as a relaxant and an anxiolytic herb. In traditional Persian and Indian medicine systems coriander is used as a remedy to relieve stress, anxiety and insomnia. More commonly, it's used in a tea, as part of an herbal blend meant to relax the nervous system. The the texts from traditional Unani and Siddha medicine mention coriander as a mild sedative which is good for promoting mental clarity and emotional stability. But in all its forms, the usage reaches particular importance in holistic medical systems in which physical and emotional well being are viewed together[17].

Traditional cardiovascular treatments also place a role for coriander. In Ayurvedic and Unani practices it is used to support heart health by decreasing palpitations, lowering blood pressure and circulation. Its diuretic properties help relieve (water) retention commonly associated with hypertension. Coriander seed (*Coriandrum sativum* L.) water or powder is administered by traditional healers to patients with high blood pressure and has been demonstrated to possess cardiovascular benefits in combination with other herbs such as fennel (*Foeniculum vulgare*) and cumin (*Cuminum cyminum*). Additionally, most people believe that coriander cleanses the blood and aids with the liver's function which also helps to explain the plant's systemic health benefits[18].

To sum up it is proved that the traditional use of *Coriandrum sativum* demonstrates a wide spectrum of its pharmacological potential in the field of digestive, anti inflammatory, antimicrobial, anti anxiolytic and cardiovascular. Ancient medical cultures, especially India, Persia, China and the Middle East, are replete with these time-honored applications, now increasingly confirmed by modern scientific research. Extensive ethnopharmacological use of coriander not only indicates its therapeutic versatility, but points out need for continuous exploration of its bioactive compounds as to fully merge the traditional wisdom with the modern medicine[19,20].

## 4. PHYTOCHEMISTRY OF *CORIANDRUM SATIVUM* L.

Coriander or *Coriandrum sativum* L.: is a well known culinary and medicinal herb of the Apiaceae (Umbelliferae) family. The chemical constituents responsible for its wide pharmacological properties are well studied. Bioactive compounds found in different parts of the plant either seeds (fruits), leaves, stems and roots are essential oil, flavonoids, phenolic acids, fatty acids, sterols and terpenoids. These components contribute to plant's antioxidant, antimicrobial, anti inflammatory, anxiolytic and cardioprotective activities[21].

### 4.1. Essential Oils

*Coriandrum sativum* is of most studied phytochemical ingredients of the plant such as its essential oils that are found in high amounts in the seeds (fruits). These oils are complex mixtures of monoterpenes and sesquiterpenes (and occasional other terpenoids such as diterpenes and geranyl analogs). The major components

of coriander essential oil are linalool (up to 60–70%),  $\alpha$ -pinene,  $\gamma$ -terpinene, camphor, geranyl acetate and limonene. Of these, linalool is the major bioactive molecule and the plant's hallmark odor, along with many of its pharmacological actions (antimicrobial, antioxidant, anxiolytic, anti-inflammatory), is attributed to it[22]. According to the geographic origin, cultivation conditions and maturity stage, the composition of coriander essential oil can be quite diverse. One particular form of essential oil – with rich levels of Linalool – has been noticed to have strong antioxidant and free radical scavenging properties. In addition to these, linalool has been demonstrated to have neuroprotective and sedative properties which backs up its traditional use in the treatment of anxiety and insomnia.

#### 4.2. Flavonoids

Polyphenolic compounds flavonoids are important role in the antioxidant potential of *Coriandrum sativum*. The dietary consumption of such non steroidal compounds include quercetin, kaempferol, apigenin and rutin. Flavonoids are present in both the aerial parts and seeds of these plants in which are anti-inflammatory, cardioprotective and anticancer[23].

Especially quercetin and kaempferol have been demonstrated to be able to reduce oxidative stress and lipid peroxidation, to modulate activity of enzymes involved in inflammatory processes and to protect from endothelial dysfunction, all making them of high importance in cardiovascular diseases.

#### 4.3. Phenolic Acids

Phenolic acids such as caffeic acid, chlorogenic acid, ferulic acid and gallic acid are present in considerable amounts in *Coriandrum sativum*. High antioxidant capacity and also in modulating inflammatory pathways, detoxification and cellular protective mechanisms are some of the roles played by these compounds. In particular, chlorogenic acid and ferulic acid, are able to neutralize free radicals and inhibit lipid peroxidation[24].

In addition, phenolic acids help to prevent oxidative stress induced organ damage (such as the liver, heart and brain). In chronic conditions such as diabetes, cardiovascular diseases and neurodegenerative disorders, this is most important.

#### 4.4. Fatty Acids and Lipids

*Coriandrum sativum* seed oil contains high amount of unsaturated fatty acids including petroselinic acid, oleic acid, linoleic acid and palmitic acid. A rare fatty acid with therapeutic properties is petroselinic acid which can make up to 70% of the total fatty acid content.

Coriander oil possesses anti inflammatory and hypolipidemic and cardioprotective properties which these fatty acids contribute to. A good example would be the linoleic and oleic acids which are essential fatty acids which help reduce LDL cholesterol levels and help promote overall cardiovascular health[25].

#### 4.5. Sterols and Terpenoids

Coriander also contains phytosterols such as  $\beta$ -sitosterol which have cholesterol lowering properties as we have seen. They mimic the structure of cholesterol and compete for absorption in the intestines and reduced serum cholesterol levels.

Coriander oil has important volatile constituents, especially monoterpenes (linalool and limonene) that are terpenoids. They have robust antimicrobial, anti inflammatory and anticancer activities. Furthermore, sesquiterpenes such as  $\beta$ -caryophyllene have analgesic and anti inflammatory activity[26].

#### 4.6. Vitamins and Minerals

In addition, the essential vitamins and minerals can also obtained from *Coriandrum sativum*. Vitamin C, vitamin A, vitamin K and small amounts of B complex vitamins, as folate and riboflavin, are found in fresh leaves. The plant antioxidants have these nutrients and they play a role in many of the following physiological functions: immunity, vision, blood clotting, red blood cell formation.

#### 4.7. Alkaloids and Glycosides

The fractions of *Coriandrum sativum* that have been less extensively studied than the essential oil and flavonoid fractions include alkaloids and glycosides and these components may also be involved in the pharmacological activities. Generally, alkaloids are often of broad biological activity as analgesic, antiinflammatory, antispasmodic. Coriandrin and other glycosides have been isolated with antioxidant and therapeutic potential. But further study is needed to fully elucidate their pharmacokinetics and bioavailability[27].

#### 4.8. Antioxidant Phytoconstituents

Antioxidant profile of coriander is attributed to the presence of wide array of phytoconstituents in coriander which play key role in its protective effects in oxidative stress related diseases. Flavonoids, phenolic acids, vitamins and terpenes work synergistically to neutralize free radicals, reduce lipid peroxidation together with protection of cellular integrity.

Aqueous and ethanolic extracts of coriander seeds and leaves showed high antioxidant activity in several in vitro models such as DPPH, FRAP and ABTS assays. The resulting properties underline its possible use as a natural preservative in food and pharmaceutical industries[28].

## 5. CARDIOVASCULAR EFFECTS OF *CORIANDRUM SATIVUM L.*

*Coriandrum sativum* L. (coriander) has recently attracted much attention owing to the potential cardiovascular benefits. In various cultures, coriander is traditionally used in treating heart related problems like palpitations and high blood pressure which has been substantially researched in modern research for its cardio active properties. The therapeutic effects are the attribution of many phytochemicals (essential oils, flavonoids, phenolic acids and fatty acids) with antioxidant, antihypertensive, hypolipidemic, anti inflammatory and cardioprotective activities. In this section pharmacological mechanisms and scientific evidence for the cardiovascular benefits of coriander are highlighted[29].

### 5.1. Antihypertensive Effects

*Coriandrum sativum* is one of the most well documented cardiovascular effect, that lowering blood pressure. Coriander seed extracts from animal studies have significant vasorelaxant and hypotensive properties. The effects of the drugs are thought to occur through several mechanisms such as calcium channel blockade, stimulation of nitric oxide (NO) production and decrease in sympathetic tone.

Aqueous extract of coriander seeds has been reported to exhibit a marked hypotensive effect on systolic and diastolic blood pressure on spontaneously hypertensive rats (SHR). Bioactive compounds present in them such as linalool act upon the vascular smooth muscle to cause a direct relaxing effect by inhibiting the calcium influx hence reducing blood pressure. Besides that, coriander boosts endothelium dependent vasodilation; possibly via increasing nitric oxide bioavailability and decreasing oxidative stress in the vascular endothelium[30].

Traditional knowledge on Ayurveda & Unani systems also supports this finding as its common practice to take coriander water as a home remedy for high blood pressure. It may also contribute to lowering blood pressure through its mild diuretic action which reduces plasma volume and the peripheral resistance.

### 5.2. Hypolipidemic and Antihyperlipidemic Activity

*Coriandrum sativum* likewise has robust ability in administration of dyslipidemia. A major risk factor for cardiovascular disease is dyslipidemia which is associated with elevated total cholesterol, low density lipoprotein (LDL) and triglycerides and reduced high density lipoprotein (HDL). Modulation of lipid metabolism and improvement of antioxidant defenses have been demonstrated for coriander which improves lipid profiles. A number of animal studies have shown that coriander seed powder or extract significantly lowers total cholesterol, LDL cholesterol and triglycerides with a concomitant increase in HDL cholesterol. Primary hypolipidemic activity is attributed to the presence of polyphenols, flavonoids and essential fatty acids e.g. linoleic and oleic acids. Inhibition of HMG-CoA reductase, the rate limiting enzyme in cholesterol biosynthesis, as well as increased excretion of cholesterol in the bile appear to be the mode of action of these compounds. In one experimental comparative study, coriander extract rich meal to the rats on high fat diet, resulted in reduction of serum lipid levels in conjunction with increased antioxidant enzymes status.  $\beta$  sitosterol is a phytosterol found also in seeds which is reported to inhibit cholesterol absorption in the intestines in addition to its lipid lowering effect[31].

### 5.3. Antioxidant and Anti-atherosclerotic Properties

Cardiovascular diseases such as atherosclerosis, hypertension and myocardial infarction involve oxidative stress as a basic pathogenic mechanism. *Coriandrum sativum* has strong antioxidant properties that prevent the oxidative modification of lipids, especially the low density lipoproteins (LDL) which is a key step in the pathogenesis of atherosclerosis.

Coriander also contain a high level of flavonoids (including quercetin and kaempferol), phenolic acids (such as ferulic acid, caffeic acid) and vitamin C. These compounds will scavenge free radicals, inhibit lipid peroxidation and protect vascular endothelium from oxidative injury. In addition, coriander has been found to further augment the activity of endogenous antioxidant enzymes of the heart tissues like superoxide dismutase (SOD), glutathione peroxidase (GPx) and catalase[32].

### 5.4. Anti-inflammatory Effects and Endothelial Protection

Atherosclerosis and heart failure are both further contributed by chronic inflammation. With significant anti inflammatory activity, *Coriandrum sativum* may protect blood vessels and the heart from injury. Some of these bioactive components are known to be COX-2 inhibitors and to downregulate proinflammatory cytokines TNF- $\alpha$ , IL-6 and CRP (C-reactive protein). The action of this anti-inflammatory aspect is a protective plus in maintaining the integrity of the vascular endothelium, reduce plaque formation and help in vasodilation. Furthermore, coriander was also reported to reduce endothelial dysfunction (impaired nitric oxide signaling and pro-inflammatory vascular state). Coriander restores normal endothelial function and is therefore useful to protect from hypertension, thrombosis and atherosclerosis[33].

### 5.5. Cardioprotective Effects and Myocardial Function

*Coriandrum sativum* besides lipid and blood pressure control has direct cardioprotective effects. Animal models of isoproterenol-induced myocardial infarction have led to studies which showed that coriander extract improves cardiac function, reduces infarct size and preserves the architecture of cardiac tissue. The plant's combined antioxidant, anti inflammatory and membrane stabilising effects are all attributed to its cardioprotective activity. Presence of antioxidant properties of coriander have been observed which aids in

maintaining mitochondrial function, limiting calcium overload and reducing oxidative damage to cardiac myocytes. Because of this, it could be an adjunctive therapy in such conditions as ischemic heart disease, heart failure and arrhythmias. In addition, coriander can possibly have antiarrhythmic effects by the alteration of cardiac ion channels which still needs to be more clearly elucidated with pharmacological studies[34].

#### **5.6. Antithrombotic and Anticoagulant Effects**

A major cause of events such as myocardial infarction and stroke is thrombosis — blood clot formation. Preliminary studies have shown that *Coriandrum sativum* has antiplatelet and anticoagulant activities lowering the risk of thromboembolic events. In vitro studies demonstrate extracts of coriander to inhibit platelet aggregation induced by ADP and collagen. It may be because it disrupts calcium signalling in platelets and diminishes the ability of thromboxane A2 synthesis, a strong aggregator. Although lacking human trials these findings promise further investigation.

#### **5.7. Clinical Implications and Future Directions**

*Coriandrum sativum* is an attractive candidate for functional foods, nutraceuticals and herb drug development on account of multiple cardiovascular benefits underpinning them. Its role for heart health is traditionally used which is intuned with recent pharmacological data supporting its use as a natural cardioprotective agent. But unfortunately, clinical trials in humans are limited, although there is a large amount of animal and in vitro studies. Further research into standardized coriander extracts, best dosages, pharmacokinetics and long term safety in CV population is needed. In addition such studies can illuminate synergies that would encourage expanded use of coriander in integrative medicine, in conjunction with standard cardiovascular therapies[35].

### **6. MECHANISMS OF ACTION**

*Coriandrum sativum* L. (coriander) has a wide spectrum of pharmacological activities especially on the cardiovascular, antioxidant, antiinflammatory and antimicrobial activities. Various biological activities credited to its rich phytochemical profile (essential oils especially linalool, flavonoids, phenolic acids, fatty acids, terpenoids and phytosterols) have been reported. The mechanisms of action of *Coriandrum sativum* are multicausal, going through several biochemical pathways[36].

#### **6.1. Antioxidant Mechanism**

Coriander possesses antioxidant action and this represents one of the key pharmacological mechanisms underlying coriander effects. Flavonoids (quercetin, kaempferol), phenolic acids (caffeic, chlorogenic) and vitamins (C, A) act as free radical scavengers, hinder lipid peroxidation and elevate endogenous antioxidant enzymes (e.g., superoxide dismutase, catalase and glutathione peroxidase). This reduces oxidative stress to protect tissues, including cardiovascular system, liver and nervous system from the damage brought on by reactive oxygen species (ROS)[37].

#### **6.2. Anti-inflammatory Pathways**

Anti inflammatory effects are exerted by *Coriandrum sativum* by inhibition of pro inflammatory mediators. The constituents of cedar oil, primarily linalool, suppress the synthesis of cytokines interleukin-6 (IL-6), tumor necrosis factor- $\alpha$  (TNF- $\alpha$ ) and prostaglandins mainly by downregulation of cyclooxygenase-2 (COX-2) and nuclear factor -kappa B (NF- $\kappa$ B) pathways. Coriander modulates these pathways to reduce inflammation and at the cellular level as well as at the systemic level, therefore preventing chronic disease like atherosclerosis and arthritis[38].

#### **6.3. Hypolipidemic and Cardioprotective Actions**

Coriander shows a hypolipidemic effect which is mediated via through the inhibition of HMG-CoA reductase, the rate limiting enzymes in cholesterol biosynthesis. In the intestine, phytosterols such as  $\beta$ -sitosterol competitively inhibit cholesterol absorption. The bile acid synthesis and excretion also stimulated by coriander which lowers the serum cholesterol level further. Improved lipid profiles and protection against cardiovascular diseases are also contributed by these mechanisms. Also, its essential fatty acids (e.g., oleic and linoleic acids) are involved in the maintenance of lipid homeostasis and improve the membrane fluidity[39].

#### **6.4. Antihypertensive Effect**

Antihypertensive effects of coriander are mainly attributed to its effects on direct vascular smooth muscle relaxation by blocking calcium channels and increased of nitric oxide (NO) production. Vascular smooth muscle cells function by inhibiting calcium influx (which causes relaxation) and serves as a vasodilator leading to decreased vascular resistance and blood pressure. In addition, coriander releases NO from the endothelium cells increasing endothelium dependent vasodilation.

#### **6.5. Antimicrobial Activity**

Antimicrobial effect of coriander essential oils and phenolic compounds is to disrupt bacterial cell membranes, to inhibit the enzyme action and to cause cell contents leakage. Of interest is the bactericidal and fungicidal properties of linalool which has been shown to disrupt the integrity of microbial plasma membranes[40].

## 7. CHALLENGES AND FUTURE PROSPECTS

Coriander (*Coriandrum sativum* L.) has been characterized for therapeutic potential including in cardiovascular health, antimicrobial activity, anti-inflammatory effects. Though ample pharmacological data are promising and it has been used in traditional medicine for a long time, several major roadblocks have prevented its full utilization as a standard medicinal agent. In one of the biggest challenges, there is no standardization and quality control. Some factors on the phytochemical variation of coriander are factors like use of different geographic origin, cultivation conditions, harvesting time and extraction methods. The variability results in the inconsistency of active compounds concentrations (linalool, phenolic acids, flavonoids) and hinders the reproducibility of its therapeutic efficacy. Hence rigorous standardization protocols and validated quality control measures need to be established to ensure batch to batch consistency and reliable clinical outcomes.

There is also another major limitation which is the lack of robust clinical evidence. In vitro and animal studies have elucidated coriander's pharmacological properties while human clinical trials are lacking. Very little is known about most of the current knowledge is extrapolated from preclinical data that may fail to capture the heterogeneous complexities of human physiology. Because of this lack of clinical validation, coriander acceptance in mainstream medicine and regulatory approvals remains limited. Given this, well designed, large scale clinical trials therefore have to be conducted to determine efficacy, safety, correct dosage and long term effects in a diverse population.

Attention is also due to the issue of safety and toxicity. While coriander is mostly thought to be safe if it's eaten as a spice or culinary herb, there hasn't been enough research done on the safety profile of concentrated extracts or individual compounds used as therapeutic doses. However, potential adverse effects, herb–drug interactions and contraindications are grossly underdocumented and therefore the effects of these issues on vulnerable patient groups such as those with comorbidities or those on concurrent medications remain a risk. It is necessary to have detailed toxicological studies as well as pharmacovigilance to define safe therapeutic windows in order to alleviate the unintended side effects.

In addition, the bioavailability and pharmacokinetics of coriander's active constituents are difficult. Due to its poorly absorbed, rapidly metabolized and eliminated phytochemicals (flavonoids and essential oils) when administered by the oral route. These factors will limit clinical benefits via their reduction of the systemic bioefficacy. The bioavailability of coriander's therapeutics could potentially be improved, increase targeted drug delivery and extend the therapeutic concentration through advancement of drug delivery systems like nanoencapsulation, molecule encapsulation in liposomes and other novel carriers thus maximizing the medicinal potential of coriander. It is sure that looking forward the future perspectives for *Coriandrum sativum* are promising and various. New advances in phytochemical research using the technology of advanced analytical techniques such as liquid chromatography mass spectrometry (LC-MS), nuclear magnetic resonance (NMR) and metabolomics can lead way in the discovery of novel bioactive molecules and also identify how and what are the targets of action. This is important in developing standardized extracts with a definite profile of bioactive properties.

Moreover, more focus on clinical and translational research is needed to affirmed coriander's therapeutic activities in human populations. The scientific basis for integration of coriander into evidence based practice can be provided with well structured clinical trails which will investigate impacts on cardiovascular parameters, lipid profiles, inflammatory markers and safety. It is also expected that parallel development of innovative formulations will overcome current bioavailability challenges. The therapeutic efficacy could be optimized while minimizing the adverse effects, using the nanotechnology based delivery systems, encapsulated formulations and the synergistic combinations with other natural or synthetic agents. Finally, its widespread culinary use and health benefits make coriander an ideal candidate for its use in the functional foods and nutraceutical products. Consumer interest is growing in natural health supplements and coriander enriched products for cardiovascular health, metabolic balance and immune function can be developed. All in all, despite the standardization, clinical validation, safety and bioavailability issues, *Coriandrum sativum* L. is experiencing the time when continuous research and technological development provides great opportunities for its overcoming barriers. Continued efforts might bring coriander into a position as a promising natural agent in modern therapeutics and preventive healthcare.

## 8. CONCLUSION

Coriander (*Coriandrum sativum* L.) is a medicinal and culinary herb with a long tradition of use by people in different cultures around the world. These ethnopharmacological applications cover an extremely broad spectrum of ailments including digestive disturbance, inflammatory conditions, microbial infections, anxiety and cardiovascular disorders. A large body of scientific evidence is now increasing in support of this broad traditional usage owing to coriander's rich phytochemical composition (primarily consisting of essential oils predominantly linalool flavonoids, phenolic acids, fatty acids and sterols). Its diverse pharmacological

activities validate many of its traditional claims and these are linked to the presence of a large variety of bioactive compounds. Of all, the cardiovascular benefits of coriander are unique considering that they may alleviate some of the most serious health problems such as hypertension, hyperlipidemia and oxidative stress induced cardiac injury.

The coriander phytochemical profile is integral to therapeutic effects. Coriander essential oil (mainly linalool) shows strong antioxidant, anti-inflammatory and vasodilatory properties. Flavonoids especially and phenolic acids contribute to scavenging of free radicals, reduction of lipid peroxidation and modulation of important inflammatory pathways. In addition, these compounds affect lipid metabolism by decreasing cholesterol biosynthesis and increasing cholesterol excretion, thereby overall improving blood lipid profiles. Also, coriander's fatty acids and phytosterols help maintain membrane integrity and actually support cardiovascular health. Taken collectively, these phytochemicals work in synergy contributing to positive effects in regard to blood pressure regulation, lipid management and vascular function.

Cardiovascular research on coriander shows many ways that it protects against damage. These comprise calcium channel blockade resulting in smooth muscle relaxation, nitric oxide mediated vasodilation, inhibition of pro-inflammatory cytokines and antioxidant defence against oxidative damage. In addition to this, coriander has been shown to have the potential to prevent HMG-CoA reductase enzyme and thus prevent cholesterol absorption leading to a natural hypolipidemic agent. These are such multifaceted actions for managing cardiovascular diseases which continue to be leading causes of morbidity and mortality in developed and developing world.

Since extracts from any natural products have a tendency to display variations in their phytochemical content, standardization of these extracts is relevant even to ensure reproducible therapeutic outcomes. There are still not many extensive human clinical trials of it and so there is still not definitive conclusions about its efficacy and its safety in patient populations. Furthermore, the bioavailability of active compounds is low in part because of poor absorption and rapid metabolism and efforts are needed to develop delivery systems that promote active compounds therapeutic action. Their safety profiles and potential interactions with other conventional medications need thorough evaluation, in order to be integrated into modern therapeutic regimens.

Throughout this investigation, phytochemicals in coriander will continue to be investigated and combined with rigorous clinical research, will provide increased evidence as to coriander's use in cardiovascular and other health contexts moving forward. The use of formulation science advances, i.e. nanoencapsulation and synergistic combinations, are able to optimize bioavailability and therapeutic efficacy. On the other hand, coriander's natural appeal and good culinary versatility have made same a good candidate for functional foods and nutraceuticals directed at promoting cardiovascular wellness.

Finally, *Coriandrum sativum* L. is a very important botanical resource of great ethnopharmacological importance, diverse phytochemical constituents and proven cardiovascular benefits. Coriander has significant potential to enhance preventive and therapeutic strategies related to cardiovascular health and beyond and through continued research and development it is poised to bridge traditional knowledge with modern science to improve global health outcomes.

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