Review Article

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CORIANDER *(CORIANDRUM SATIVUM)*: A COMMON INDIAN TRADITIONAL SPICE AND AYURVEDIC REMEDY

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ABSTRACT

Coriandrum sativum is commonly known as dhaniya. It is an annual herb and used as a spice from ancient times. The fresh leaves of this plant are called Cilantro. The seeds, leaves, and fruits of this plant are edible and have an aromatic odour, and are used as a flavour in curries, soup, and other Indian dishes. Fruit of this plant is used in the preparation of pastries, buns, cakes and also for the preparation of curry powder and other flavours. Coriander seed is also known for its medicinal importance especially the seeds of this plant are used for the preparation of Ayurveda medicines as well as used traditionally in different tribes for the preparation of various ailments. Coriander plant is considered as a medicinal herb in traditional medicine system as it has various properties like they act as anti-diuretic, anti-diabetic, anti-hypertensive, aphrodisiac, anti-microbial, anti-oxidant, analgesic, anti-inflammatory and anti-asthmatic agent.

Keywords: Dhania, Rasapanchaka, Linalool, Immunomodulatory, Antibacterial, Anthelmintic.

INTRODUCTION

Plants are the main source of traditional as well as modern medicinal systems. Plant-based drugs commonly called phytomedicines have been in use for health benefits since ancient times [1]. As of now, there is a restoration of interest in the utilization of phytomedicines, especially for preventive measures[2]. As per the WHO report, 80% of people depend on traditional medicines mainly on herbs[3,4]. Coriander (*Coriandrum sativum* L.) (as shown in Figure 1) is one of the oldest herbs that has been utilized for over 3,000 years (Ebers papyrus of 1550 BC) for both cuisine and medicinal purposes[5-7]. Coriander is one of the significant and earliest seed spices in the world since the historical backdrop of Queen of Sheba who visited King Solomon referenced in the Holy Bible[8]. India is the greatest producer, purchaser, and exporter of coriander in this world with a yearly production of around three lakh tons[9]. The seeds and green leaves of the plant are consumed and added in the various dishes as garnishee due to their fragrance and colour[10]. Various parts of the coriander plant have been accounted for various health functions and organic activities[11] like coriander oil has been utilized in the cosmetic industry for body care products and perfumes[12]. This review provides broad aspects of coriander including its botanical information, folk usages, Ayurvedic usage, phytochemical compounds and therapeutic potentials, which could be advantageous for multidisciplinary fields.

Taxonomy of *Coriandrum sativum*

Taxonomic rank	Taxon
Kingdom	Plantae
Division	Spermatophyta
Order	Apiales
Class	Magnoliopsida
Family	Apiaceae
Genus	*Coriandrum*
Species	*C. sativum*
Common Name	Coriander[13,14]

Vernacular Name

English	Coriander
Spanish	Cilantro, coriandro, culantrillo
French	Coriander, coriandre cultivee, persil arabe
Arabic	Kusbara, kuzbarah ‘aadyah,kesbour; tabel
Chinese	Hsiang sui, hu sui, xiang sui, yan sui, yuan sui
Portuguese	Coentro
Cambodia	Vannsuy
Cuba	Anisillo, cilantro, culantro de castilla, culantro de España
India	Dhaniya
Germany	Echter Koriander, Garten- Koriander
Indonesia	Katuncar, ketumbar, tumbar
Italy	Coriandolo
Japan	Koendoro, kushiba
Malaysia	Ketumbar, penjilang, wansui
Mexico	Nocuana gueza toti castilla
Netherlands	Almindelig korander, koriander
Thailand	Phakhchi, phakhom, phakhom-noi
USA	Cilantro
Sweden	Koriander
Philippines	Kulantra, kulantro, uan-soi
Telugu	Dhaniyalu
Bengali	Dhane
Gujarati	Dhana
Tamil	Kotthambari
Malayalam	Malli, kothaambala, kothambalari
Kannada	Kotthambari[15-19]

Botanical description of *Coriandrum sativum*

Coriandrum sativum which is commonly known as "dhaniya" belongs to the family Apiaceae (Umbelliferae). It is mainly cultivated through its seeds. It is an annual plant consist of a tap root system. The Stem of the plant is erect and reaches its height up to 20-120 cm. It starts flowering after 45-60 days after sowing[20,21]. The leaves of this plant are green and lanceolate shaped. The flowers are borne in little umbels that are white or

light pink, asymmetrical with the petals pointing away from the center. The coriander seed is an ovate globular dry schizocarp with two mericarps[22].

Figure 1: Coriander (*Coriandrum sativum)*

Geographical Distribution *Coriandrum sativum*

Coriander is natal to the Mediterranean and the Middle East and is found wild in Egypt and Sudan. It was one of the first flavors utilized by humankind and has been developed for ages[23]. It is mainly cultivated in tropical regions and various countries like Morocco, Romania, Bulgaria, France, Spain, Italy, the Netherlands, Myanmar, Pakistan, Turkey, Mexico, Canada, Argentina, Australia and some regions in the U.K and the USA[24]. India is the major coriander producing country in the world. It is primarily cultivated in Andhra Pradesh, Rajasthan, and Tamil Nadu[25].

Phytochemical's constituents of *Coriandrum sativum*

The medicinal importance of the Coriander plant is due to the availability of bioactive chemical constituents which are present both in seeds and leaves.

Seed

Volatile oil, Tocol, Sterol, Lipids, polyphenols.

Volatile oil

The study was carried out on the chemical composition of the essential oil of coriander seeds from various parts of the world. Based on this study it was concluded that the main component of coriander was alcoholic monoterpenes, where the main active constituent was (S)- (+)- linalool. 35 different components have been detected in coriander essential oil from Tunisia[26], Bangladesh, India[27] and Pakistan[28] though only 17 components have been recognized in the essential oil from coriander seeds developed in Algeria[29]. The chemical composition of coriander seeds was studied in various regions and it was examined that the essential oil extracted from the coriander seeds is a rich source of oxygenated monoterpenes which represents linalool as the main active constituent present in the seeds of Tunisian coriander with percentage of 87.54.

Moreover, the chemical composition of the essential oil of coriander seeds from Algeria revealed that linalool (73.1%) was the main active constituent but the other principal components: pmentha-1,4-dien-7-ol (6.51%), alpha-pinene (3.41%), and neryl acetic acid derivation (3.22%) were also seen in the Algerian oil. Furthermore, linalool (73.1%), neryl acetic acid derivation (2.3 - 14.2%), gamma-terpinene (0.1 to 13.6%), and alpha-pinene (1.2-7.1%) were recognized as the main component in the coriander seed vital oil developed in Iran[30], while linalool (37.65%), geranyl acetic acid derivation (17.57%), and γ-terpinene (14.42%) were recognized as the prominent ones in Bangladesh coriander seed fundamental oils[31].

One more study on phytochemical constituents of *Coriandrum sativum* identified the volatile oils from coriander seed which were α-Thujene, α-Pinene, Camphene, Sabinene, β-Pinene, Myrcene, Decanal, D-Limonene, 1, 8 Cineol, ρ-Cymene, Limonene, γ-Terpinene, 2-Decenal, Decanol, Linalool, Camphor, Bornel, α-Terpinol, Geraniol, (E)-2-Dodecenal, Geranyl acetate respectively[32].

Tocols

The other chemical constituents present in the coriander seeds are Tocols (327.47 µg/g). The important tocopherol constituent is γ-tocopherol (26.40 µg/g) which is followed by δ-tocopherol (13.50 µg/g) and α-tocopherol (11.70 µg/g). Besides, coriander seed also contains a greater amount of tocotrienol where γ-tocotrienol is the fundamental component (238.40 µg/by), followed by α-tocotrienol (24.90 µg/g) and δ-tocotrienol (12.57 µg/g)[33-35].

Sterols

The coriander seed is found to be an important source of sterols which showed an inhibitory impact on the intake of dietary cholesterol. The total sterol content is found to be in the range of 36.93-51.86 mg/g oil as per the estimation measured. Stigmasterol (21.7-29.8%) and β-sitosterol (24.8-36.8%) are considered the most prevalent sterol markers in coriander seeds. The other sterols component present is Δ 7 - stigmasterol, Δ 5, 24-stigmastadienol, and campesterol while Δ 7 - avenasterol and Δ 5 - avenasterol are found to be in lesser amount. In Tunisian coriander seeds, a very limited amount of cholesterol is found (1.02-2.18%). However, this component is not found in *Coriandrum sativum* L. seeds from Germany but the two other sterols component that is ergosterol and lanosterol are found. As per studies, Δ 5, 24-stigmastadienol is reported in Tunisian and Canadian coriander oil while it was absent in French coriander oil[36-38].

Lipids

Fatty acids: The most common fatty acid found in lipids were petroselinic (C18:1n-12) (65.70-80.9%), followed by linoleic (C18:2n-6) acids (13.05-16.70%). The other representative unsaturated fatty acids found were oleic (C18:1n-9) (0.20-7.85%), palmitic (C16:0) (0.10-3.96%) and stearic (C18:0) (0.78-2.91%) acids. Additionally, palmitoleic (C16:1n-7) (0.41-1.1%), α-linolenic (C18:3n-3) (0.15-0.50%) and arachidic (C20:0) (0.10-0.25%) acids were also found as minor fatty acids[39].

The other inactive lipids component found in the coriander seed oil are mainly triacylglycerols (95.50%), free fatty acids (2.05%), diacylglycerols (1.88%) and 0.57% diacylglycerols which constitutes 94.88% of the total lipids. Additionally, polar lipids were also found in coriander seeds which were estimated to be present in lower levels with relatively 8.11 and 6.68%. These were mainly composed of phosphatidylcholine as the significant phospholipid subclass (35.98%), supported by phosphatidylethanolamine (33.83%) and phosphatidylinositol (15.40%). Besides this, the most generous galactolipid was digalactosyldiacylglycerol (62.32%) supported by monogalactosyldiacylglycerol (37.68%)[40].

Polyphenols

The phenolic composition present in coriander seed is still in contradiction. However, it was reported that a total of 21 components were detected in different varieties of coriander seed in which 11 phenolic acids were identified which include gallic, chlorogenic, caffeic, vanillic, p-coumaric, ferulic, rosmarinic, o-coumaric, trans-hydroxycinnamic, salicylic and trans-cinnamic acids) and ten flavonoids' components including quercetin-3-rhamnoside, rutin trihydrate, luteolin, quercetin dihydrate, resorcinol, kaempferol, naringin, apigenin, flavone, and

coumarin. From these studies, it was reported that The Tunisian coriander contains prominent phenolic acids (i.e., 81.47%) as compared to Syrian coriander where the flavonoid class is dominant which contain (61.34%) due to the presence of luteolin (18.13%) and rutin trihydrate (13.06%) whereas the Egyptian coriander contains an equal amount of phenolic and flavonoid content in their methanolic extract[41]. Chlorogenic acid, caffeic acid, rosmarinic acid are detected in another study to investigate the phytochemicals of *Coriandrum sativum*[42].

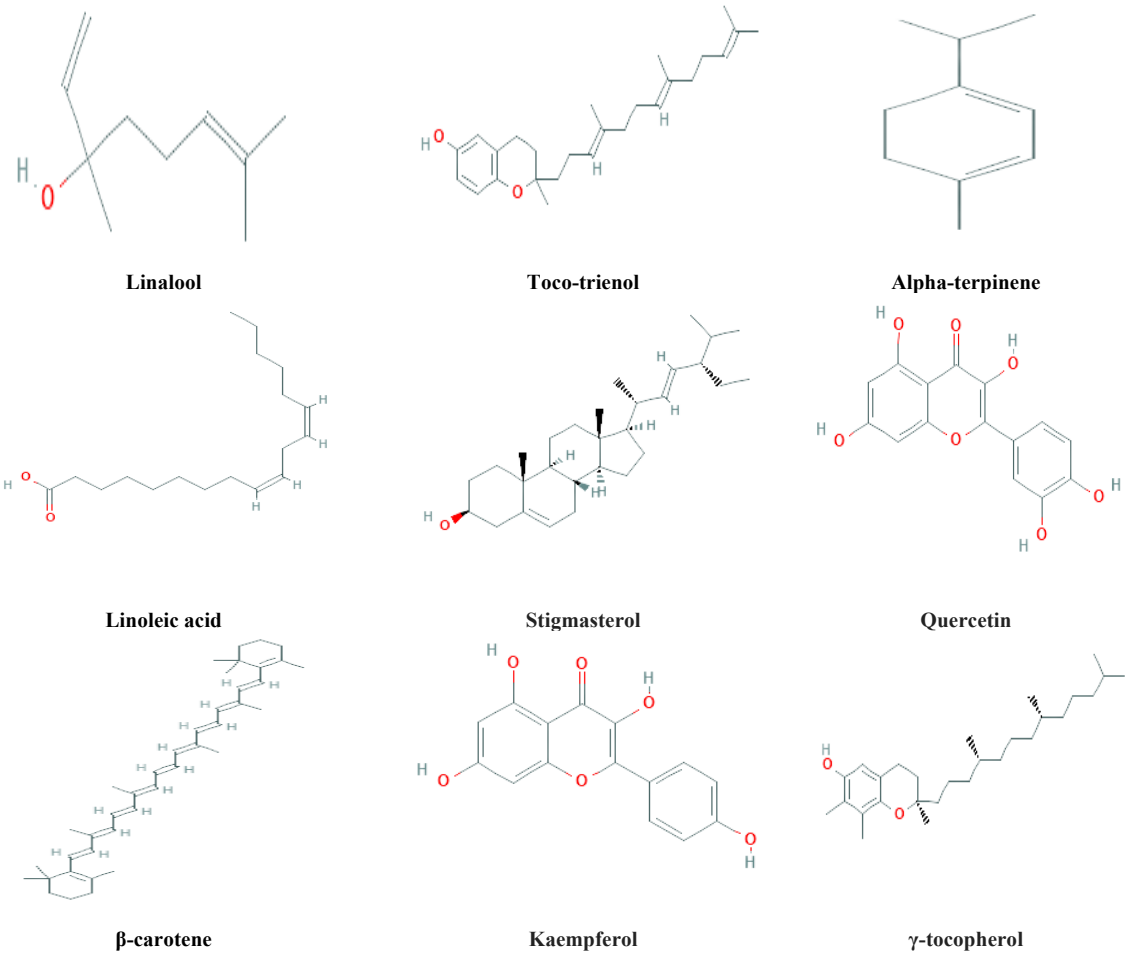

Figure 2: Chemical Structures of some important Phytochemical constituents of *Coriandrum sativum*

Leaf

The essential oil, flavonoids, phenolic acids, lipids, and polyphenols are also detected in the leaf part of the coriander plant however it was not much studied as compared to its seeds[43].

Lipids Polyunsaturated fatty acids are found to be the most predominant fatty acids in coriander leaves. A-linolenic (C18:3n-3) was the most prominent fatty acid, with a percentage of 39.4 and 41.1% was found in both the upper and basal leaves which is supported by linoleic, heptadecenoic, and palmitic acids. The other acids found were oleic, stearic, stearidonic, cis, and trans-palmitoleic acids which were present in very less amount, and together they contribute approximately 9.6% and 4.7% of the total fatty acids present in both basal and upper leaves[44].

As per the data, coriander leaves are also a good source of β-carotene (vitamin A precursor) serving as 61.4% of the carotenoids identified in the etheric extract. The other compounds isolated were β- cryptoxanthin epoxide, lutein-5,6-epoxide, violaxanthin, and neoxanthin. Before the flowering stage, the total carotenoids and β-carotene were found to be in a greater amount (i.e., 217.50 mg/100 g and 73.64 mg/100 g) respectively[45].

Polyphenols

In Indian coriander leaves the main phenolic acids detected are vanillic, p-coumaric, cis-ferulic, and trans-ferulic acids. Additionally, the flavonoids are also identified in coriander leaves named as kaempferol, quercetin, 3'-OMe quercetin, 4'-OMe quercetin, and acacetin but glycoflavones were not detected in coriander leaves. Hence, Indian coriander leaves are found to be a good source of quercetin. Previously, it was also reported that the main bioactive components in aqueous extract of coriander leaves from brazil include phenolic acids which consist of caffeic acid (4.34 µg/ml, protocatechuic acid (6.43 µg/ml), and glycitin (3.27 µg/ml)[46]. Coriander leaves also contain anthocyanin which helps in the biosynthesis process[47]. A comparative study was conducted on green leaves of three herbs i.e., coriander leaves (*Coriandrum sativum*), Red Amaranthus *(A. paniculatus*) and Green Amaranthus *(Amaranthus frumentaceus*) for the analysis of polyphenolic content. From the study, it was found that coriander leaves possess kaempferol, quercetin, 3'-OMe quercetin, 4'-OMe quercetin, and acacetin as polyphenolic

content. While in phenolic content coriander has vanillic acid, p-Coumaric acid, cis-Ferulic acid, trans-Ferulic acid in its leaves[48].

Essential oil

The coriander leaf contains a fewer number of essential oils as compared to its seeds. From various studies, it was reported that the main components of essential oil extracted from its leaves are alcohols and aldehydes. It was also shown that the essential oil extracted from the coriander plant of Bangladesh consists of 44 compounds that mainly represent aromatic acids, including 2-decanoic acid (30.8%), E-11-tetradecenoic acid (13.4%), capric acid (12.7%). Besides this, the essential oil from the coriander plant of Kenyan mostly contains aldehydes (56.1%) and alcohols (46.3%). The active components of which contain (E)-2-decenal (15.9%), decanal (14.3%), (E)-2-decen-1-ol (14.2%) and n-decanol (13.6%). The other chemical constituents found were (E)-2-tridecen-1-al, (E)-2-dodecenal, dodecanal, undecanol and undecanal The Brazilian variety of coriander species consists of decanal (19.09%), trans-2-decenal (17.54%), 2-decen-1-ol (12.33%) and cyclodecane (12.15%), cis-2-dodecane (10.72%), Dodecanal (4.1%), dodecan-1-ol (3.13%) as essential oils[49]. In Indian coriander plant, the principle volatile component found in leaf essential oil were (E)-2-decenal (18.02 %), 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 %)[50]. The structures of some of the phytochemicals present in both seeds and leaves are shown below in Figure 2.

Folk uses of *Coriandrum sativum*

Coriandrum sativum is a very common herb. Each part of coriander is used to add flavour to the food and used as a folk remedy in many cultures for various ailments[51]. Greek and Roman cultures used coriander as a spice. It was used to add flavour as well as the preservation of meat and bread. Coriander was introduced in Britain by the Romans. Its use is also noticed in Chinese, American, Indian cuisine[52]. In some folk practices, the preparations made up of coriander leaves are applied topically in the treatment of chest pain, gall bladder problems, cough and used to enhance sexual behaviour[53]. Coriander fruits are used as a folk remedy in bronchitis, vomiting, dysentery, gout, rheumatism, intermittent fever and giddiness, indigestion, inflammation, diarrhoea[54]. It is also utilized in arthritis as an ointment[55]. A large portion of the population in Saudi Arabia uses coriander seed infusion against diabetes. The seed extract is used as an antifertility and contraceptive[56,57]. In Fiji, coriander leaves and fruits are used in folk practices. They use the leaf juice for skin-related problems, while the seed infusion is used for eye diseases as an eyewash. They also use seeds in headaches. For bad breath and mouth disorders, they use seed decoction. Whereas fruits are utilized as aphrodisiac, stomachic, stimulating, carminative, diuretic agents[58]. In Iran, anxiety, and insomnia are treated with the juice of young coriander leaves and fruits are used in anxiety, insomnia as well as to enhance the appetite and treat convulsion[59,60]. Coriander leaves and fruits are used as a digestive aid in Germany[61]. Turkish people also use coriander fruits as an appetizer, digestive, carminative agent[62]. In Palestine, people use coriander fruits to boost up the strength after childbirth and to improve milk production, also to treat urinary tract infections[63]. The Tamilian population of Sri Lanka uses coriander to maintain the proper hormone level which helps in regulating the menstrual cycle and reduces cramps[64,65].

Ayurvedic View of *Coriandrum sativum* (Dhanyaka)

The Dhanyaka is a tridoshik Ayurveda spice. It is a cooling spice that is suggested for good digestion, enhances the appetite, supports a healthy response to allergens and also purifies the blood. According to Ayurveda, the active constituents present in the plant effectively balances all three doshas i.e., Vata (air), Pitta (digestion), and Kapha (Earth and Water)[66].

Rasa Panchaka / Properties of *Coriandrum sativum* as per Ayurveda

Sanskrit / English	Sanskrit / English
Virya / Potency	Ushna/Hot
Vipaka / Metabolic Property	Madhura/Sweet
Guna / Physical property	Laghu/ Light, Unctuous oily/Snigdha
Rasa / Taste	Kashaya/Astringent, Bitter/Tikta[67]

Properties of Dhanyaka

Avrishya – It decreases the sexual desires. / It has anti-aphrodisiac property. does not have aphrodisiac property.
Mutrala – Diuretic, increase urine volume
Deepana – Improve digestion strength
Jwaraghna – Useful in fever
Rochana – Improves taste, useful in anorexia
Grahi – Absorbent, Useful in malabsorption syndrome and diarrhea
Daurgandhya Hashana – Helps to get relief from bad odor (Bad Breath)
Hridya – Good for heart, cardiac tonic
Trushna – Excessive thirst
Daha – Burning sensation
Vami – Antiemetic
Shwasa – Asthma, Chronic Obstructive Pulmonary Disease (COPD), wheezing, breathing difficulty
Kasa – Cough, cold
Arsha – Haemorrhoids
Krimi – Worm infestation[68,69]

Modern View

The primary issue faced by the herbal drug industry in today's scenario is the adulteration practice. It is the major drawback in promoting herbal drugs and thus people are losing their faith in these drugs[70-75]. Intentional adulteration has become very common in today's time and it is done in many ways, for example, adulteration by using already manufactured substances, by substituting an inferior variety, or by using exhausted drugs and by adding toxic materials.

Therapeutic plant vendors have found some techniques of contaminating herbal drugs by adulteration that without examination on a microscopic level and chemical analysis, it is very hard to detect these contaminations[76-78]. Herbal drugs have been accounted for causing serious antagonistic responses because of adulteration[79]. Toxicity and inadequacy and high cost are the associated factors of adulteration[80]. Some of the reported therapeutic properties of *Coriandrum sativum* are summarized in Table 1.

Table 1: Therapeutic properties of *Coriandrum sativum*

Antioxidant activity	Both the leaves and seeds of the coriander plant show anti-oxidant properties but the leaves of the plant have a greater anti-oxidant effect. The phenolic and carotenoids extract of the plant is found to be more effective in protecting the cells from oxidative damage as it shows higher hydroxyl radicals scavenging potential[81].
Anti-diabetic effect	The flavonoids, terpenoids, and phenolic extract of the coriander plant are proven to have anti-diabetic agents[82]. The seed extracts of the Coriander plant are customarily used as an anti-diabetic agent as a remedy in some countries like south Arabia, Morocco[83,84].
Diuretic effect	The methanolic extract of coriander seeds shows an anti-diuretic effect when examined in anesthetized rats and proved to show the same results similar to that of standard drug furosemide[85]. The fruit of the coriander plant also possesses have anti-diuretic effect in conscious rats[86].
Insecticidal effect	Pascual Villalobos found the capability of plant fundamental oils against stored item scarab bugs. Coriander oil (10 µl) demonstrated insecticidal action against the bruchid *Callosobruchus maculates*, the cereal storage pest[87].
Aflatoxin control	Coriander oil has the potential to control *A. niger*, *Saccharomyces cerevisiae*, *Mycoderma sp.,* L. *acidophilus,* and *Bacillus cereus*[88]. The inhibitory effect may also produce on the mycelial growth and ochratoxin NRRL 3174[89].
Antibacterial Activity	Various research has been done on the essential oil of coriander for their different properties like antibacterial, anti-fungal, and cell reinforcement[90]. The analytical examination (GC-MS) showed a high degree of inhibition against the microorganism[91]. Various research has been done on the essential oil of coriander for their different properties like antibacterial, anti-fungal, and cell reinforcement. The analytical examination (GC-MS) showed a high degree of inhibition against the microorganism. The coriander oils also have influenced the microbiological pointer of meat products[92]. The anti-bacterial compound present in the coriander ends up being a protector against Salmonella[93,94].
Menstrual Disorder	It helps in the proper secretion of hormones from the endocrine glands, reducing pain during periods[95].
Anti-Diabetics	The ethanolic extract of seeds possesses the anti-diabetic property[96,97]. In a study, the mice were injected with a high dosage of glucose after that extract of seeds (200-250 mg/kg) was given as a supplement[98]. The result showed a decrease in serum glucose concentration and increase activity of beta-cells[99,100].
Anti-inflammatory effect	A traditional formulation from Sri Lanka, Maharasnadhi Quather (MRQ) which contains coriander seeds as the main component reported to have anti-inflammatory and analgesic properties[101] both in human and animal models. The effective result comes when supplementation of MRQ is given to the patients suffering from rheumatoid arthritis, inflammation on liver functions and gastrointestinal activates[102]. Coriander oil was also described where 40 humans have tested the anti-inflammatory effect of a lipolotion supplemented with 0.5% and 1% of coriander oil. Lipolotion effectively reduced the UV-induced erythema[103].
Lead-detoxifying potential	The capacity of coriander against lead toxicity has been analysed in mice exposed to lead polluted drinking water and then medication with different dosages of coriander for 25 days. The outcomes indicate improvement in lead toxicity[104].
Diuretic	The utilization of coriander as a traditional diuretic or to treat renal illnesses has been reported in many cultures[105,107]. The chemical constituents of coriander seeds were analysed for the diuretic effect in anesthetized rats, the outcome indicated an increased infiltration rate with a mechanism similar to the standard drug[108]. The extract of fruits of coriander was also exhibited a diuretic effect in the rats[109].
Anti-hypertensive activities	The anti-hypertensive property of coriander found in anesthetized rats, with vasodilator effect mediated through in the combination of endothelial –depended and independent pathways[110].
Anti-fungal	A reported study *Candida* sp. was done to check the anti-fungal property of *Coriandrum sativum*. It was found that the essential oil extracted from coriander leaves possesses anti-fungal properties[109].

CONCLUSION

Coriandrum sativum an ancient spice that is used globally in various cultures due to its culinary and therapeutic properties. It is used in almost all the traditional systems of medicines. In Ayurveda, it is mainly used for balancing all three doshas and for the enhancement of appetite and digestion. Whereas in the folk system it is used mainly in cooking and bakery. It is utilized in different forms in a different culture. Each part of the coriander has an aroma and important phytochemicals comprising of significant biological properties like antimicrobial, antioxidant, anti-mutagenic, anxiolytic, sedatives, anti-depressant, neuro-protective, anti-diabetic, diuretic, anti-hypertensive.

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