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Natural Products Chemistry & Research

Mini Review

A Review on the Chemical Constituent, Pharmacological and Medicinal Properties of Coriandrum sativum

Melese Damtew Asfaw*

Department of Chemistry, College of Natural and Computational Sciences, Mekdela Amba University, Tulu Awulia, Ethiopia

ABSTRACT

Coriandrum sativum L. (C. sativum) is one of the most useful essential oil bearing spices as well as medicinal plants, belonging to the family Umbelliferae/Apiaceae. The leaves and seeds of the plant are widely used in folk medicine in addition to its use as a seasoning in food preparation. The phytochemical screening of Coriandrum sativum showed that it contained essential oil, tannins, terpenoids, reducing sugars, alkaloids, phenolics, flavonoids, fatty acids, sterols and glycosides. It also contained high nutritional values including proteins, oils, carbohydrates, fibers and wide range of minerals, trace elements and vitamins. Various parts of this plant such as seed, leaves, flower and fruit, possess Diuretic, Antioxidant Activity, Anti-diabetic Anti-convulsant activity, Sedative Hypnotic Activity, Anti-microbial Activity, Anti mutagenic, Anthelmintic activity. Due to the easy collection of the plant and being widespread and remarkable biological activities, this plant has become both food and medicine in many parts of the world. This review presents comprehensive analyzed information on the botanical, chemical, and pharmacological aspects of C. sativum.

Keywords: Coriandrum sativum; Pharmacological properties; constituents; Apiaceae; coriander

INTRODUCTION

Coriander (Coriandrum sativum L.) is an annual plant that belongs to the family Umbelliferae possessing spice, aromatic, nutritional as well as medicinal properties [1]. The origin of coriander is uncertain, the area suggested by most authors being the near east [2]. Some authors suggested central Asia and Mediterranean countries [3]. [4] Stated that coriander is native to southern europe, North Africa and southwestern Asia. Major producers are India, Morocco, Canada, Pakistan, Romania, Ukrain, Russia [5], United States, Canada, Argentina and Mexico [6].

Coriander is one of the important and earliest seed spices crop known to humankind [7], which can be dated back to the history of Queen of Sheba who visited king Solomon mentioned in the Holy Bible. The aromas and flavors have for many years attracted the attention of man is due to the presence of pleasant aromatic odoror essential oil rich in linalool found in the stem, leaves and fruits of coriander [8]. It can be used directly or indirectly for diverse purposes. It can be used as a spice in culinary [9], medicine [10], food industry [11] in perfumery, beverage and pharmaceuticals industries [5]. Coriander is also a good melliferous plant and studies indicated that coriander could be used for honeybee production [12].

The herb as young plants is used to prepare curry, soups, salads, and sauces, whereas the fruit is mainly used as a seasoning for pickles, cold meats, confectionery products and seasoning mixtures [13, 14]. It is the most widely consumed popular ingredient in the world as a domestic spice, a traditional medicine, and a flavoring agent [15]. Coriander is available throughout the year providing a fragrant flavor that is reminiscent of both citrus peel and sage. It's essential oil is used in pharmaceutical recipes and as a fragrance in cosmetics [16, 17]. In addition to culinary value, coriander is known for its wide range of healing properties. It is generally used in gastrointestinal complaints such as anorexia, dyspepsia, flatulence, diarrhea, griping pain and vomiting. Coriander fruit is also reputed as refrigerant, tonic, diuretic, and aphrodisiac, while, its essential oil is considered useful in flatulent colic, rheumatism, neuralgia, etc. Coriander is also used as antiedemic,

***Correspondence to:** Melese Damtew Asfaw, *Department of Chemistry, College of Natural and Computational Sciences, Mekdela Amba University, Tulu Awulia, Ethiopia*, Tel No: 251914336919; E-mail: Beteraba21egmail.com

Received Date: August 06, 2021**; Accepted Date:** October 12, 2021; **Published Date:** October 22, 2021

Citation: Asfaw MD (2021) A Review on the Chemical Constituent, Pharmacological and Medicinal Properties of Coriandrum sativum. Nat Prod Chem Res 09:p419.

anti-inflammatory, antiseptic, emmenagogue, antidiabetic, antihypertensive, lipolytic and myorelaxant, and possess nerve soothing property [18]. Coriander is used to flavor several alcoholic beverages like gin [19]. The German name Schwindelkorner or dizziness grains seem to be connected with the former practice of using coriander fruits to flavour beer, which increased its inebriating effect [20].

REGIONAL AND OTHER NAMES

Gujarati (Dhana), Arab (kuzbara, kuzbura), Armenian (chamem), Chinese (yuan sui, hu sui), Czech (koriandr), Danish (coriander), Dutch (coriander), english (coriander, collender, chinese parsley), ethiopian (dembilal), Georgian (kinza, kindza, kindz), German (Koriander), Greek (koriannon, korion), Hindi (dhania, dhanya), Hungarian (coriander), Italian (coriandolo),Japanese (koendoro), Malay (ketumbar), Persian (geshnes), Polish (kolendra), Portugese (coentro), Rumanian (coriándru), Russian (koriandr, koljandra, kinec, kinza, vonjueezel'e, klopovnik), Sanskrit (dhanayaka,), kusthumbari (Serbokroatian korijander), Spanish (coriandro, cilantro, cilandrio, cilantro), Swiss (Chrapfechörnli, Böbberli, Rügelikümmi), Turkish(kisnis), english(Coriander fruits), Hindi(Dhaniya), Sanskruit (Dhanika, Dhania Vitunnaka), Kashmiri (Dhaniwal, Dhanawal), Oddiya (Dhania), Punjabi (Dhania), Bengali (Dhane, Dhania), Marathi(Dhaue, Kothimbir),Tamil (Kottamalli, Viral dhania), Telagu (Dhaniyalu), Urdu (Kishneez) [21].

BOTANICAL DESCRIPTION

Coriander (Coriandrum sativum L.) it is an annual herb belonging to the family of Umbelliferae
(Apiaceae). Coriander is a soft plant that growth up to 50cm (20in) tall and is native to southern
europe, Norther Africa, and south west Asia. The leaves vary in form, from thick lobed at the
plant's base to slender & feathery higher up on the flowering stems. Coriander is a perennial and
an annual herb. It is flowered herb and is usually distinguished with vertical, glabrous, and
profusely branching plant. The height of the coriander's plant is in the range from 0.2 to 1.4 m
with a well-developing taproot. The stem of coriander usually erect, sympodial and monochasial branched; sometimes it has several side branches at the basal node. Each branch is finished with an inflorescence. The ribbed stem has the green color, but it turns to red or violet when it is in the flowering period. The stem of full-grown plant is hollow; its basal parts diameter can reach to 2cm.

Figure1: coriander (Coriandrum sativum L.).

The coriander's leaves are variable in shape, size and number. They have yellow-green color and
sheath surrounding and are curiously margined. The supporting stem is up to three quarters of its
circumference.

Figure2: coriander leaves.

The flowers are in umbels with shortly-stalks and five to ten rays, pale mauve, almost white,
delicately pretty. The seed clusters are very symmetrical and the seeds fall as soon as ripe. The
fruit is a cremocarp, which splits up into two mericarps, which remain suspended on the
carpophores for some time. The plant is bright green, shining, glabrous and intensely fetid.

Figure3: coriander flower and seed.

Table1: Taxonomical description of coriander.

Kingdom	Plantae
Subkingdom	Trachaeobinta(vascular plants)
Division	Magnoliophyte(flowering plants)
Subdivision	Spermatophyte(seed plants)
Class	Magnolipsida (dicotyledons)
Subclass	Rosidae
Order	Apiales
Family	Apiaceae(umbellifera Juss)
Genus	Corianderum
Species	Sativuum

NUTRITIONAL ASPECTS

Coriander nutrition is due to its green leaves and dried fruits. Like all other green leafy vegetables, its leaves are a rich source of vitamins, minerals and iron. Its leaves contain high amount of vitamin A (β-carotene) and vitamin C. The green herbs contain vitamin C up to 160 mg/100 g and vitamin A upto 12 mg/100 g [22]. It is very low in saturated fat, cholesterol, and a very good source of thiamine, zinc and dietary fiber. Green coriander contains 84% water.

Major chemical constituents

Its seeds contain up to 1.8% volatile oil according to origin. The distilled oil (coriander oil BP) contains 65 to 70% of (+)-linalool (coriandrol), depending on the source [23].

Minor chemical constituents

The minor chemical constituent of coriander includes Monoterpene hydrocarbons viz α- pinene, β- pinene, limonene, γ-terpinene, ρ-lymene, borneol, citron wllol, Xmphoe, Geraniol and Geranylacetate; Heterocyclic compounds viz – pyrazine, pyridine, thiazole, furan, tetrahydrofuran derivatives; Isocoumacin viz coriandrin, dihyrocoriandrin, coriandrones A-e, glazonoids; Phthalides viz -neochidilide, Z-digustilide; Phenolic acids and sterols, flavonoids [24]. Carotenoids are of ubiquitous occurrence in all plants with higher concentrations in reproductive organs. In green leafy vegetables, carotenoids, particularly β-carotene is deposited mainly in leaves. Carotenoids can also be processed and used as coloring agents as well as good source of antioxidants. Besides other roles, carotenoids chiefly function as scavengers of the free radicals produced by chlorophylls during photo-oxidation. Its leaves being good source of β-carotene serve as a precursor of vitamin A. In coriander, β-carotene content, 160 µg/100 g is present whereas total carotenoid content is 1010 µg/100 g [25]. Its foliage is used in various types of foods especially in diets of people facing vitamin A deficiency. Green foliage contains anthocyanin [26]. Anthocyanins are bioactive flavonoid compounds that prevent body from various chronic diseases. Anthocyanin in foliage acts as antioxidants, which are very useful in improvement of nutritional value as well as maintenance of health and wellbeing [27].The various nutrients present in coriander leaf and seeds are shown in Table 2. The characteristic aromatic flavor of its seeds comes from many fatty acids and essential volatile oils. According to [28], cholesterol content of its seeds is nil. Its seeds are considered as an important source of vitamins, minerals and lipids. Among minerals, potassium is present in high amount (1267 mg/100 g) followed by calcium (709 mg/100 g), phosphorus (409 mg/100 g), magnesium (330 mg /100g), sodium (35 mg/100 g), zinc (4.70 mg/100 g). The folate content in coriander seed is 200 µg/100 g (fresh weight) [29]. Among the various constituents, vitamin C content is present in ample amount (21 mg/100 g). The different vitamins, minerals and phyto-chemicals content in leaf is shown in Table 2.

Coriander contains high amount of essential oils that are very important for growth and for proper functioning of brain. The main essential fatty acids present in coriander include linoleic and linolenic acids. Linoleic acids belong to PUFA (polyunsaturated fatty acid) group. Dietary supplementation of coriander seed greatly affects the lipid composition of carcass by decreasing saturated fatty acid (SFA) contents (palmitic and stearic acids) and by increasing monounsaturated and polyunsaturated fatty acid (MUFA and PUFA) [30]. This plant is a potential source of lipids (rich in petroselinic acid) and an essential oil (high in linalool) isolated from the seeds and the aerial parts [31]. The high content of fats and protein in the fruits make distillation residues suitable for animal feed. Coriander fruits yield 5 to 7% of ash, 13% resin, astringent principle, malic acid and alkaloids. Coriander oil contains coriandrol, jireniol and vebriniol [32].

Table2: Nutrient composition of coriander leaf and seeds as per USDA (National Nutrition Data base, 2013).

Nutrient	Amount (per 100g)	
	Coriander leaf	Coriander seed
Water	7.30 g	8.86 g
energy	279 kcal	298 kcal
Protein	21.93 g	12.37 g
Total lipid (fat)	4.78 g	17.77 g
Carbohydrate, by difference	52.10 g	54.99 g
Fiber, total dietary	10.40 g	41.9 g
Calcium, Ca	1246 mg	709 mg
Iron, Fe	42.46 mg	16.32 mg
Magnesium, Mg	694 mg	330 mg

Phosphorus, P	481 mg	409 mg
Potassium, K	4466 mg	1267 mg
Sodium, Na	211 mg	35 mg
Zinc, Zn	4.72 mg	4.70 mg
Vitamin C, total ascorbic acid	566.7 mg	21.0 mg
Thiamin	1.252 mg	0.239 mg
Riboflavin	1.500 mg	0.290 mg
Niacin	10.707 mg	2.130 mg
Vitamin B-12	0.00 µg	0.00 µg
Vitamin A, RAe	293 µg	0.00 µg
Vitamin A, IU	5850 IU	0 IU
Vitamin D (D2 + D3)	0.00 µg	0.0 µg
Vitamin D	0 IU	0 IU
Fatty acids, total saturated	0.115 g	0.990 g
Fatty acids, total monounsaturated	2.232 g	13.580 g
Fatty acids, total polyunsaturated	0.328 g	1.750 g
Cholesterol	0.00 mg	0 mg

Chemical composition of the essential oil of coriander

The extraction of essential oil from coriander seeds and leaves was carried out through hydrodistillation [33].The yield of coriander seed essential oil varied from 0.03–2.6 %, depending on the species, growing region and climatic conditions. The accumulation and chemical composition of essential oil in plants were determined by different factors like environmental [34], genetic [35], ontogenetic [36] as well as cultivation. The fresh coriander herb, containing essential oil [37], fatty acids [38], flavonoids [39], carotenoids [40] as well as coumarin compounds [41]. The aroma of the coriander fruit and herb is completely different, the aliphatic aldehydes (mainly C10–C16 aldehydes), having unpleasant odour, are the main components of the volatile oil from the fresh herb [42], linalool and other oxidized monoterpenes as well as monoterpene hydrocarbons predominate in the oil distilled from the fruit [41]. The compounds present in seeds and leaves were found to vary significantly (Table 3).The composition of coriander seed essential oil was found to vary with place of production. The chemical composition of coriander revealed that the linalool was 72.3 and 77.7 %, while α-pinene was 5.9 and 4.4 %, γ-terpinene 4.7 and 5.6 %, camphor 4.6 and 2.4 %, limonene 2.0 and 0.9 %, in Argentinean and european coriander, respectively [43]. The essential oil from New Zealand contained linalool, α-pinene, γ-terpinene, camphor and limonene in the concentration of 65.8, 6.8, 6.1, 5.1, and 2.7 %, respectively [44]. In Russian coriander seed essential oil, linalool constitutes about 68.0 % of oil [45]. Hence, we can conclude that linalool was the main compound in the coriander seed essential oil.

Table3: Percentage composition variation in seeds and leaves of coriander Seeds.

Seeds			Leaves	
No	**Compounds**	**Areas (%)**	**Compounds**	**Areas (%)**
1	Linalool	55.49	(e)-2-Decanal	32.23
2	γ-terpinene	7.47	Linalool	13.97
3	α-pinene	7.14	(e)-2-Dodecenal	7.51
4	Camphor	5.59	(e)-2-Tetradecenal	6.56
5	Decanal	4.69	2-Decen-1-ol	5.45
6	Geranyl acetate	4.24	(e)-2-undecenal	4.31
7	Limonene	3.10	Dodecanal	4.07
8	Geraniol	2.23	(e)-2-Tridecanal	3.00
9	Camphene	1.78	(e)-2-Hexadecenal	2.94
10	D-Limonene	1.36	Pentadecenal	2.47
11	Myrcene	0.98	Undecanal	2.43
12	p-Cymene	0.90	1-Decanol	2.18
13	α-terpinol	0.81	α-pinene	1.90
14	Decanol	0.81	Decanal	1.73

CORIANDER IN TRADITIONAL MEDICINE

All parts of this herb are in use as a flavoring agent (culinary purposes) and/or as traditional
remedies for the treatment of different ailments in the folk medicine on different civilizations
[46] especially in digestive disorders. The fruits of this herb are very popular as a spice

in Mediterranean countries [47]. Hippocrates (460–377 BC) used coriander in ancient Greek
Medicines. Decoction and tincture of powdered fruits of C. sativum alone or in combinations with other herbals are recommended for dyspeptic complaints, loss of appetite, convulsion, insomnia, and anxiety. Coriander essential oil has also a long history in traditional medicine. The
essential oil was found to improve blood glucose control and promise as an antihyperglycemic
(antidiabetic) agent [48]. On the other hand, the aqueous extract of coriander fruits is used in
traditional Moroccan medicine in the treatment of diabetes and dyslipidemia besides to treat
a variety of disorders [49] including Saudi Arabia and Jordan [47]. In addition, Moroccan and
Palestinian pharmacopeias have been mentioned the usages of coriander as a traditional diuretic
and treat urinary infections. The plant is also used to cure diseases like digestive tract disorders, respiratory tract disorders, urinary tract infections [50]. In Iranian traditional medicine, coriander fruits have a long history of use as an anxiolytic and a sedative in insomnia. The fruits were widely used internally as a carminative, digestive, spasmolytic, and galactagogic as usual. Moreover, it is also known as an anti-inflammatory agent in Iranian traditional medicine, still in herbal formulations, might be beneficial in human inflammatory bowel diseases [51]. Coriander is highly reputed Ayurvedic medicinal plant commonly known as "Dhanya" in India [50]. Usage of coriander leaves is not clear on diabetes as suggested on Persian folklore medicine, but Ayurvedic medicine also recommends the regular use of a decoction of coriander fruits (seeds) and mentioned about effects in the treatment of arthritis and other inflammatory disorders [47]. Anyway, it is the
main ingredient in curry powder in Indian food; the fresh green leaf is dominated in Thai and
Vietnamese foods. Moreover, the roots of coriander have been used in Asian cuisine for intense
flavor [47]. Moreover, in some regions of India, the plant has been used traditionally for its "antiinflammatory" principals; besides, the fruits are used to treat spermatorrhea, leucorrhea, and
rheumatic fever [52].

In the United States, coriander has recently been studied for its cholesterol-lowering effects
[52]. Moreover, in some parts of europe, coriander has traditionally been referred to as
an "antidiabetic" plant [52, 53]. In Pakistan, the whole plant part is used for the treatment
of flatulence, dysentery, diarrhea, cough, stomach complaints, ja undice, and vomiting. In
Turkey, it is noted that the fruit infusions are useful in indigestion and as an appetizer [47].
However, in history, it is mentioned that coriander has an aphrodisiac effect as many other
spices [53]. In traditional medicine, the usual dose of fruit powder is from 1-5 g, three times per day. This translates to a 43–71 mg/kg dose for a 70 kg individual [54]. Most of the traditional usages of the coriander have been supported by scientific data as mentioned in the text. This point is very important that the plant has been integrated between traditional and scientific usages.

PHARMACOLOGICAL EFFECTS

Coriander fruits and its oil have been used for many diseases [55] such as for the
treatment of rheumatism, gastrointestinal upsets, insomnia, flatulence, and joint pain in
humans [56]. Moreover, coriander has a positive influence on lipid profile in plasma of rats
[57]. The fruits of the plant are famous for carminative, diuretic effects and used in the treatment of cold, fever, nausea, and stomach disorders [52]. The fruit extract has been found as a strong analgesic agent than dexamethasone [58]. Laribi et al. discussed with all aspects regarding the pharmacological effects of coriander in a review [47]. In this manner, the most frequent effects of coriander will be debated in an order.

Diuretric effects

The aqueous extract of coriander seed possesses diuretic and saluretic activity, thus, validating the use of coriander as a diuretic plant in Moroccan pharmacopoeia aqueous extract of coriander seed was administered by continuous intravenous infusion (120 min) at two doses (40 and 100 mg/kg) to anesthetized Wistar rats. Furosemide (10 mg/kg), a standard diuretic was used as the reference drug. Excretion of water and electrolytes (sodium, potassium and chloride) in urine was measured, and glomerular filtration rate (equal to creatinine clearance) was determined. The crude aqueous extract of coriander seeds increased diuresis, excretion of electrolytes, and glomerular filtration rate in a dose-dependent way; furosemide was more potent as a diuretic and saluretic. The mechanism of action of the plant extract appears to be similar to that of furosemide [59].

Anticancer effects

The biochemical effect of coriander fruits on lipid parameters in 1, 2-dimethylhydrazine
induced colon cancer has been studied in rats. The concentrations of cholesterol and cholesterol to phospholipid ratio declined while the level of phospholipid increased significantly in
1, 2-dimethylhydrazine control group compared to the coriander administered group. Fecal
dry weight, fecal neutral sterols, and bile acids showed a sharp increase in the coriander-fed
group compared with the DMH-administered group. Thus, it seems that the coriander plays a
protective role in the lipid metabolism of colon cancer [60]. Although there are not many studies on the anticancer effect of coriander, there are some studies based on antioxidant effect.

Antimicrobial effects

The antimicrobial activity of the coriander has been arisen from the essential oil content.

The spice, C. sativum is one of the plants that are known to produce essential oils with antimicrobial activity [61]. The coriander seed essential oil was screened for antibacterial activity against both Gram positive (Staphylococcus aureus, Bacillus spp.) and Gram negative (escherichia coli, Salomonella typhi, Klebsiella pneumonia, Proteus mirabilis, Pseudomonas aeruginosae) bacteria and a pathogenic fungi Candida albicans [62]. The essential oil showed pronounced antibacterial activity against all of the microbes tested except for P. aeruginosae, B. cereus and enterococcus faecalis [63], which showed resistance. C. sativum showed a significant antibacterial activity against e. coli and B. megaterium bacterial species and two mycopathogenic ones responsible for cultivated diseases as determined with the agar diffusion method whereas F. vulgare var. showed a much reduced effect [64].

Sedative Hypnotic effects

Coriandrum sativum L. has been recommended for relief of insomnia in Iranian traditional medicine. To determine sedative & hypnotic activity Aqeuous and hydroalcoholic extract & essential oil administer to rat. The results of experiment shows that aqueous extract prolonged pentobarbital-induced sleeping time at 200, 400 and 600 mg/kg. Hydro-alcoholic extract at doses of 400 and 600 mg/kg increased pentobarbital- induced sleeping time compared to saline-treated group. The essential oil increased pentobarbital induced sleeping time only at 600 mg/kg. The extracts and essential oil of coriander seeds possess sedative-hypnotic activity [65].

Antioxidant effects

Addition of coriander to food increased the antioxidant content of food due to the presence of
antioxidant and anti-inflammatory compounds [66]. It was a potent natural antioxidant and inhibited unwanted oxidation processes. The coriander leaves showed stronger antioxidant activity than the seeds [67]. It was reported that the aqueous extracts of seeds exhibited antioxidant activity both in vitro and in vivo [68]. Time and dose dependent in vivo antioxidant activity of fresh coriander juice was evaluated by various methods [69]. This spice reduced lipid peroxidation by 300-600 %, increased the antioxidant enzyme activities (catalase by 57-75 %, superoxide dismutase by 57-62 %, and glutathione peroxidase by 80-83 %) and reduced liver damage [70]. Naveen and Farhath [71] observed that coriander seed extract minimized the drug induced oxidative stress and protected the system against its toxicity. The antioxidant property of coriander seed was related to the large amounts of tocopherols, carotenoids and phospholipids, which acted through different mechanisms [72].Coriander oil, could be used as free radical scavenger, preventing oxidative deterioration in foods. It showed greater activity against the radical generating activity of 1, 1-diphenyl-2-picrylhydrazyl in several essential oils [73]. The carotenoids extracts of coriander showed a high antioxidant activity with IC50 value of 14.29±1.68 µg/mL, scavenging hydroxyl radicals and reducing higher protection to DNA than by the standard gallic acid (IC50 value of 357.21±4.29 µg/mL) [74]. Antioxidant effects of this essential oil may be due to its terpene and terpenoid components.

The coriander seeds also showed scavenging activity against superoxides and hydroxyl radicals in a concentration-dependent manner. Maximum free radical-scavenging action and free radical reducing power of coriander seed extract was observed at a concentration of 50 µg GAe (gallic acid equivalent). Increased dietary intake of coriander seeds decreased the oxidative burden in Diabetes mellitus [75]. A comparative study of lipophilic and hydrophilic antioxidants was undertaken in vivo and in vitrogrown C. sativum by radical scavenging reducing power and lipid peroxidation inhibition [76]. The in vivo sample showed the highest antioxidant activity mainly due to its highest levels of hydrophilic compounds.

Antidiabetic effects

In many articles, we can find the antidiabetic effects regarding the coriander. In fact, coriander has been confirmed as an antidiabetic remedy. The studies have confirmed the antihyperglycemic
effect of coriander in streptozotocin diabetic mice. The mechani sm of action of the antihyperglycemic action of the aqueous extract of the coriander fruits is connected with stimulation of insulin secretion, enhancement of glucose uptake and metabolism by muscle. In general, the effect is generated by one or more components existed in the extract. Therefore, C. sativum is acceptable as a possible antihyperglycemic dietary supplement and can be accounted for a potential source of a new orally active agent for diabetes [77]. In another study, a single dose of coriander fruit-extract or glibenclamide suppressed hyperglycemia in obese–hyperglycemic–hyperlipidemic Meriones shawi rats. After administration, the insulin resistance significantly decreased in the rats. Interestingly, the hypoglycemic effect was lower in normal rats, its mean; the test substances reduced plasma glucose, insulin and insulin resistance, cholesterol, LDL-cholesterol, and triglyceride [78]. Moreover, it was observed that a dose of coriander fruit decrease and regulate blood sugar and dyslipidemia at typical traditional doses in the patients who have noninsulin dependent diabetes mellitus. In a study of 40 volunteers, 20 subjects took 2.5 g of ground coriander fruit twice daily for 60 days and 20 volunteers served as controls. The treatment group had a significant declining in fasting blood-sugar levels; a significant reduction in lipid peroxidation in red blood cells; and rises in serum β-carotene, vitamin A, vitamin C, vitamin e, and glutathione levels [54]. In addition, the animals in the two groups showed almost similar weight gain, and the diet consumption was similar in both groups. There is a significant decrease in fasting blood glucose level and increase in the concentration of hepatic glycogen in the rats of the experimental group. Hexokinase and phosphoglucomutase activity increased significantly in the liver of rats administered coriander fruits. The glycogen synthase activity in the liver was increased, and that of glycogen phosphorylase showed a decrease in the rats of the experimental group compared to the control group. Significant reduction in glucose-6-phosphatase activity was observed in the experimental group, whereas glucose-6-phosphate dehydrogenase activity showed a significant increase

[79]. In this frame, coriander, especially the fruits of the plant found in the receipts can be also acceptable for the treatment of hepatic fibrosis and chronic liver diseases [80].

Anthelmentic effects

In vitro anthelmintic activities of crude aqueous and hydro-alcoholic extracts of the seeds of Coriandrum Sativum (Apiaceae) were investigated on the egg and adult nematode parasite Haemonchus contortus. The aqueous extract of Coriandrum Sativum was also investigated for in vivo anthelmintic activity in sheep infected with Haemonchus contortus. Both extract types of Coriandrum Sativum inhibited hatching of eggs completely at a concentration less than 0.5 mg/ml. eD(50) of aqueous extract of Coriandrum Sativum was 0.12 mg/ml while that of hydro-alcoholic extract was 0.18 mg/ml. There was no statistically significant difference between aqueous and hydroalcoholic extracts. The hydro-alcoholic extract showed better in vitro activity against adult parasites than the aqueous one.

Metal detoxification effects

Coriander can be used as a natural cleansing agent as it has potential to remove toxic metals from body. Chemical compounds present in coriander attach to toxic metals and remove them from cells [81]. [82] Observed that this plant is very effective to remove inorganic (Hg^{2+}) and methyl mercury (CH_3Hg^{+}) from aqueous solutions. This effect was due to the binding effect of carboxylic group to mercury. These results clearly showed that sorbent can be used to remove inorganic and methyl mercury from contaminated water. [83] Found that coriander led to marked decline in oxidative stress caused by lead nitrate.

Cardioprotective effects

The hydro-methanolic extract of coriander fruits has been found cardioprotective potential. This effect should be attributable to its high polyphenol content in the fruits likewise. The preventive effect of coriander on cardiac damage has been investigated by isoproterenol induced cardiotoxicity model in male Wistar rats and found that the methanolic extract of the fruits prevent myocardial infarction by inhibiting myofibrillar damage on rats [84]. The coriander fruits caused a significant decrease in all cholesterol-associated lipids, while the extract reduced high-density lipoprotein (HDL) cholesterol; the extract also improved the cardioprotective indices. Coriander fruits also reduced dyslipidemia in rabbits. All blood-fat values improved significantly with the coriander diet. It means that the extracts have beneficial profits on cardioprotective effect [54].

Antiaging effects

The long chain fatty acids are potentially beneficial in antiaging products for local use, helping
to restore barrier properties of the epidermis and prevent moisture loss. Therefore, the long chain fatty acids can be considered as potential antiaging agents. Coriander fruit oil is very rich in these types of the fatty acids. The studies done as a topical treatment for a variety of skin conditions with coriander-fruit oil and as a component of herbal sunscreens seem very impressive [54]. The oil may contain ceramides of petroselinic acid as well. The extract also functions as an anti-irritant and helps to maintain skin texture and tone. A specially prepared extract from coriander fruits such as Umbelliferin® (INCI: Coriandrum sativum (coriander) extract is a trademarked product containing petroselinic acid triglycerides o btained as a nonlauric fraction from coriander fruit oil) helps in supporting skin barrier functio ns [85]. Preparations using coriander/oil as single form or in combination with the other plants can be developed i n the future and may become famous as one of the secrets of staying young for a long time.

Hepatoprotective effects

C. sativum extract protects liver from oxidative stress induced by carbon-tetrachloride (CCl_4) and thus helps in evaluation of traditional claim on this plant. Pretreatment of rats with different doses of plant extract (100 and 200mg/kg) significantly lowered serum glutamate oxaloacetate transaminase (SGOT), serum glutamate pyruvate transaminase (SGPT), and TBARS levels against CCl_4 treated rats. Hepatic enzymes like superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx) were significantly increased by treatment with plant extract, against CCl_4 treated rats. Oral administration of the leaf extract at a dose of 200mg/kg significantly reduced the toxic effects of CCl_4. The activity of leaf extract at this dose was comparable to the standard drug, silymarin [86].

Anti-convulsant effects

The anti-convulsant effects of aqueous and ethanolic extracts of coriander sativum seeds were studied in order to evaluate the fokloric use of this plant. two anti-convlusant evaluation test, namely the pentylenetetrazole (PTZ) and the maximal electroshock test, were used for assessing antiseizure effect in the pentylenetetrazole test, aqueous and ethenolix extracts prolonged onset of clonic convulsions and anti convulsant activity of high dose (5mg/kg) were similar to that of phenobarbital at a dose of 20mg/kg in the PTZ test. Both extracts in high doses decreased the duration of tonic seizures and showed a stastically significant anticonvulsant activity in the maximal electroshock test [87].

TOXICITY OF CORIANDER

Coriander fruits at a dose of 750 mg/kg caused no mortality in rats, and LD50 (lethal dose that
kills 50% of test subjects) for the oil was found 4.13 g/kg. However, high doses of coriander
fruits (500 mg/kg) inhibited implantation in female rats significantly and had a small abortifacient (but no teratogenic) effect on the rats. In the Ames test, a dried leaf extract produced a mutagenic effect [54]. By the way, coriander juice extracts were neither toxic nor mutagenic in the range of concentrations

tested (50–1000 µL/coincubation flask); the chlorophyll content in whole juice extracts was 0.0325 µg/mL [88].

CONCLUSION

Numerous phytochemical and pharmacological studies have been conducted on different parts of Coriander Sativum. This review discusses the chemical constituent, pharmacological and therapeutic effects of Coriandrum sativum. According to the wide range of pharmacological activities, Coriandrum sativum should be considered as a promising source of many drugs because of its safety and effectiveness. Moreover, the present literature supports the potential of Coriander sativum as a medicinal plant. In view of the nature of the plant, more research can be done to investigate the unexplored and unexploited potential of this plant.

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