Coriandrum sativum Linn.-- Review

Padmaa M Paarakh*

* Department of Pharmacognosy, The Oxford College of Pharmacy, Bangalore 560 078, Karnataka, India

Summary

Coriandrum sativum Linn (Dhanyaka; Apiaceae) is a widely used medicinal plant throughout India and popular in various Indigenous System of Medicine like Ayurveda, and Siddha. In the Traditional System of Medicine, the fruits are used as astringent, aromatic, anthelmintic, emollient, anti-inflammatory, stomachic, carminative, antibilious, digestive, appetizer, constipating, diuretic, antipyretic, stimulant, aphrodisiac, refrigerant, tonic, expectorant, anodyne, dyspepsia etc. The present review is therefore an effort to give a detailed literature on pharmacognosy, phytochemistry and pharmacological activities of *Coriandrum sativum*.

Key words: *Coriandrum sativum*, dhanyaka, pharmacognosy, phytochemistry, pharmacological activities, review.

Correspondence Author
Dr. Padmaa M Paarakh
Department of Pharmacognosy
The Oxford College of Pharmacy
J P Nagar, I.Phase
Bangalore 560 078
padmaparas@hotmail.com
Mobile: 09880681532

Introduction

Coriandrum sativum Linn is an aromatic herbaceous annual herb distributed and cultivated all over India[1, 2]. In the traditional system of medicine, the fruits are used as astringent, aromatic, anthelmintic, emollient, anti-inflammatory, stomachic, carminative, antibilious, digestive, appetizer, constipating, diuretic, antipyretic, stimulant, aphrodisiac, refrigerant, tonic, expectorant, anodyne, dyspepsia[3] etc. The aim of present review is to highlight the traditional uses, pharmacognostical, phytochemical and pharmacological investigation carried out on the plant so that more pharmacological studies could be conducted to investigate the unexploited potential.

Plant Profile

Coriandrum sativum Linn (Apiaceae) commonly known as Dhanyaka, is an aromatic herb, is extensively grown in India. It is cultivated in all states and is an important subsidiary crop in black cotton soils of Deccan, South India and North India[4,5,6].

Taxonomical/ Scientific Classification[7]

Kingdom: Plantae

Subkingdom: Angiosperm

Division: Eudicot

Class: Asterid

Order: Apiales

Family: Apiaceae

Genus: *Coriandrum*

Species: *sativum*

Classical Names[7]
Dhanyaka, Dhanaka, Dhana, Kunati, Chhattra, Dhaneya, Kustumburu, Kotimira.

Botanical Description
Annual herb about 30-90 cm tall. Leaves: pinnately or ternately decompound, lower ones long petioled and upper ones short petioled. Flower: small, white or pinkish purple in compound terminal umbels. Fruit: yellowish brown globose, 4-5 mm in diameter, ribbed, separating into two halves. Seeds: compressed[8,9,10,11].

Climate, Soil and Propagation
It is generally cultivated on black soil and rich silt loam, seeds are grown in cold season and in Western region in monsoon. Germination starts after 10 to 25 days after sowing the fruits halves and the plant is ready for harvest within 3-4 months time[12,13]. The *in vitro* developed coriander flowers on SH medium using different concentration of NAA and GA_3 were of high genetic purity[14,15].

Pharmacognostical Studies

Macroscopical Characteristics

Fruit: They are small subglobose, glabrous, schizocarp, about 5 mm in diameter, splitting into two hemispherical mericarps. Each mericarp has 5 wavy, rather inconspicuous, primary ridges alternating with 4 more prominent secondary ridges. Seed is convexo-concave, about thrice as broad as thick; odor: aromatic; taste: spicy[16,17].

Microscopical and Powder Characteristics

Transverse section of fruit shows pericarp with outer epidermis having slightly thickened wall with stomata and prisms of calcium oxalate. Outer layer of mesocarp is parenchymatous with inner cells in wavy longitudinal rows. Middle layer of mesocarp is sclerenchymatous forming thick layer of fusiform, pitted cells, layers often crossing at right angles with definite longitudinal strands in the secondary ridges. Inner cells of mesocarp are large, hexagonal with thin lignified walls. Inner epidermis of very narrow thin-walled cells with slightly sinuous anticlinal wall showing paraquetry arrangement; two or rarely more normal vittae occurring on commissural side of each mesocarp containing volatile oil. Endosperm is composed of thick walled cellulosic parenchyma containing fixed oil, numerous aleurone grains, and micro-rosettes of calcium oxalate. Carpophore consists of fibers surrounded by spiral vessels[18,19].

The powder microscopy of fruit powder shows epidermal cells of pericarp with prisms of calcium oxalate, masses of sclerenchymatous cells, large tubular hexagonal sclerenchymatous cells of endocarp, thick walled polygonal parenchymatous cells of endosperm containing fixed oil, aleurone grains and micro-rosettes of calcium oxalate[20].

Physical constants of the fruit[21] are given in the Table No.1

Table No.1: Physical constants of fruits

Part of plant	Foreign organic matter % w/w	Total ash % w/w	Acid insoluble ash % w/w	Alcohol soluble extractive % w/w	Water soluble extractive % w/w
Fruit	2	6	1.5	10	19

Important Marketed Formulations[2,22]

Dhanyapachaka kvatha churna, Dhanyakadi hima, Changeri ghrita, Dhanyagokshuranka ghrita, Jeerakadi modaka, Nagaradi kvatha, Bhaskara lavan churna and Guduchyadigana kvatha churna.

Doses[2]

Fruit powder: 3-5 gm.

Cold infusion: 50 –100 ml.

Oil: 1-3 drops.

Traditional Uses **[3,22,23,24]**

Plant parts used: whole plant, fruit.

Fruit: Aromatic, astringent, emollient, anti-inflammatory, anthelmintic, stomachic, carminative, antibilious, digestive, appetizer, constipating, diuretic, antipyretic, stimulant, aphrodisiac, refrigerant, tonic, expectorant, anodyne, useful in burning sensation, cough, bronchitis, sore throat, common catarrh, vomiting, dyspepsia, anorexia, colic, flatulence, diarrhea, dysentery, chronic conjunctivitis, headache, epitasis, erysipelas, strangury, dropsy, chronic ulcers, carbuncles, scrofula, helminthiasis, hemorrhoids, intermittent fever, hyper dyspepsia, gout, rheumatism and giddiness.

Seed oil: Flatulent colic, rheumatism, neuralgia.

Leaves: Aromatic, astringent, analgesic, carminative, antibilious, anti-inflammatory, styptic, useful in halitosis, throat disorder, epistaxis, bleeding from gums, chronic conjunctivitis,erythema, hiccough, inflammation, suppuration, hemorrhoids, jaundice and odontalgia.

Ayurvedic Properties[2]
Rasa: Katu, Tikta
Guna: Laghu, Snigdha
Veerya: Ushna
Vipaka: Madhura
Doshaghnata: Tridoshashamaka
Rogaghnata: Shirahshoola, Shotha, Visarpa, Gandamala, Mukhapaka, Kantharoga, Raktapitta, Nasagataraktasrava, Nterabhishyanda, Bhrama, Aruchi, Chhardi, Gulma, Arsha, Krimi, Kasa, Shwasa.
Karma: Deepana, Rochana, Shothahara, Shoolahara, Mastishkabalya, Trishnanigrahana, Pachana, Grahi, Hridya, Sheetaprashamana.

Phytochemical Studies
Very little phytochemical work has been carried out with the plant *Coriandrum sativum*. The structures of the compound isolated from the plant are given as Fig No. 1.

Seed: β-sitosterol, D-mannitol,flavonoid glycoside[25], chlorogenic acid, caffeic acid, rutin, umbelliferone, scopoletin[26], coriandrinonediol[27], palmitic, petroselinic, oleic, linolenic acid, lauric, myristic, myristoleic, palmitoleic acids[29], quercetin-3-O-caffeyl glycoside, kaempferol-3-glucoside, octadecenoic acid[30].

Seed oil: α-pinene, limonene, β-phellandrene, 1, 8-cineole, linalool, borneol, β-caryophyllene, citronellol, geraniol, thymol, linalyl acetate, geranyl acetate, caryophyllene oxide, elemol, methyl heptenone[26], petroselinic acid[29].

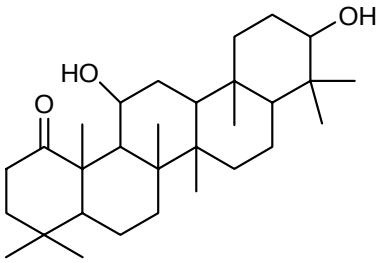
Whole plant: β-sitosterol, triacontane, triacontanol, tricosanol, psoralen, angelicin, coriandrinol, β-sitosterol glucoside[26], butyl phthalides-neoenidilide, Z-ligustilide[27], coriandrin, dihydrocoriandrin[28], coriandrone A, coriandrone B[29], coriandrone C to E[22].

Leaves: Nonane, C9-16 alkenals, C7-17 alkanals, C10-12 primary alkenols, alkanols[29], oxalic acid, vitamin C, carotene, calcium[22].

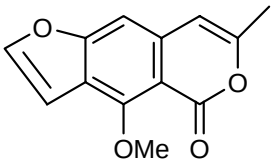
Fruit: Gnaphaloside A, gnaphaloside B, quercetin, isorhamnetin, rutin, luteolin[28].

Essential oil: Linalol, furfural, geraniol[27,31].

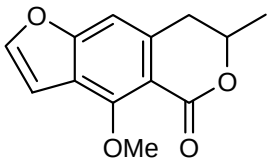
FIG No.1: STRUCTURE OF COMPOUND ISOLATED FROM Coriandrum sativum



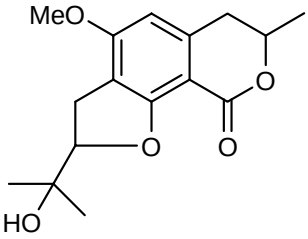
Coriandrinonediol



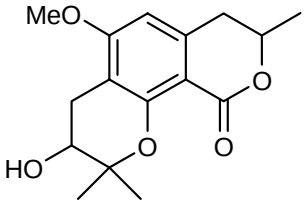
Coriandrin



Dihydrocoriandrin



Coriandrone A



Coriandrone B

Pharmacological Studies

Antioxidant activity

Antioxidative activity of ethanol extract of *C.sativum* fruits showed that it has free radical scavenging activity against DPPH radical[32]. The antioxidant activity of the aqueous extracts of *C.sativum* was investigated in comparison with the known antioxidant ascorbic acid in *in vitro* studies. The amount of aqueous extract of *C.sativum* fruits and ascorbic acid needed for 50% scavenging of superoxide radicals was found to be 370 µg and 260 µg. The amount needed for 50% inhibition of lipid peroxide was 4500 µg (coriander) and 5000 µg (ascorbic acid). The quantity needed for 50% inhibition of hydroxyl radicals was 1250 µg (coriander) and 4500 µg (ascorbic acid).The present study revealed strong antioxidant activity of the *C.sativum* extract that was superior to known antioxidant ascorbic acid and indicate their intake may be beneficial as food additives[33]. The antiperoxidative effect of *C.sativum* was studied in rats administered high fat diet. Significant decrease in the levels of lipid peroxides, free fatty acids and glutathione was observed when compared to control group whereas the activity of antioxidant enzymes showed increase[34]. *C.sativum* crude seed oils were extracted with n-hexane and the oils were further fractionated into neutral lipids (NL), glycolipids (GL), and phospholipids (PL). Crude oils and their fractions were investigated for their radical scavenging activity (RSA) toward the stable galvinoxyl radical by electron spin resonance (ESR) spectrometry and toward 1, 1-diphenyl-2-picrylhydrazyl (DPPH) radical by spectrophotometric method. Coriander seed oil and its fractions exhibited the strongest RSA suggesting potent antioxidant activity[35].

Cardiovascular activity

C.sativum crude extract caused atropine sensitive stimulatory effect in isolated guinea pig ileum. In rabbit jejunum, it evoked a similar contractile response but in presence of atropine, it exhibited relaxation against both spontaneous and high K induced contractions as well as shifted the Ca^{2+} concentration response curve to right, similar to verapamil. *C.sativum* caused fall in arterial blood pressure of anaesthetized animal and produced vasodilatation against phenylephrine and K^{+} induced contraction in rabbit aorta, and cardio-depressant effect in guinea pig atria. These results indicate that coriander fruit exhibit gut stimulatory, inhibitory and hypotensive effect being mediated through cholinergic and Ca^{2+} antagonist[36].

The effect of administration of coriander seeds on the metabolism of lipids was studied in rats fed with high fat diet and added cholesterol. The levels of total cholesterol, triglycerides, β-hydroxy, β-methyl glutaryl CoA reductase, plasma lecithin cholesterol acyl transferase activity were significantly increased. The level of LDL, VLDL cholesterol was decreased and HDL cholesterol levels were increased. The increased activity of plasma LCAT enhanced degradation of cholesterol to fecal bile acids and neutral sterols appeared to account for its hypocholesterolemic effect[37]. In the biphasic model of triton-induced hyperlipidemia, *C. sativum* at a dose of 1g/kg body weight reduced cholesterol and triglycerides levels in both synthesis and excretory phases in rats, and the results were comparable with that of Liponil, a commercially available herbal hypolipidemic drug. The results suggest that coriander decreases the uptake and enhances the breakdown of lipids which can be used as household herbal remedy with preventive and curative effect against hyperlipidemia[38].

The effect of the administration of *C.sativum* on the metabolism of lipids was studied in rats fed a high fat diet with added cholesterol. The spice had a significant hypolipidemic action. The levels of total cholesterol and triglycerides decreased significantly in the tissues of the animals of the experimental group which received coriander seeds. Significant increases in beta-hydroxy, beta-methyl glutaryl CoA reductase and plasma lecithin cholesterol acyl transferase activity were noted in the experimental group. The level of LDL + VLDL cholesterol decreased while that of HDL cholesterol increased in the experimental group compared to the control group. The increased activity of plasma LCAT, enhanced hepatic bile acid synthesis and the increased degradation of cholesterol to fecal bile acids and neutral sterols appeared to account for its hypocholesterolemic effect[39].

To assess the lipolysis and absorption *in vivo* of triacylglycerols containing petroselinoyl, diets containing 120 g seed oil triacylglycerols of *C.sativum* per kg diet at a level of 72 g 18:1(n-12) moieties/100 g oil were fed to a group of weaned male Wistar rats without restriction for a period of 10 wk. For comparison, groups of rats were fed similar isocaloric diets containing plant oil triacylglycerols with various levels of oleoyl [18:1(n-9)] moieties, e.g., high oleic sunflower seed oil [75 g 18:1(n-9)/100 g oil], olive oil [(66 g 18:1(n-9)/100 g oil], medium oleic rapeseed oil [54 g 18:1(n-9)/100 g oil] and conventional high linoleic sunflower seed oil [25 g 18:1(n-9)/100 g oil]. All diets were supplemented with 20 g corn oil/kg diet. Consumption of coriander oil, compared with the other oils, led to significantly greater liver weights. No significant differences were observed among the groups fed various levels of oleic acid in body weight, the weights of heart, liver, kidneys, spleen or testes, lipid content of heart, or total cholesterol, HDL cholesterol and triacylglycerol concentrations of blood plasma. Ingestion of coriander oil led to incorporation of 18:1(n-12) into heart, liver and blood lipids and to a significant reduction in the concentration of arachidonic acid in the lipids of heart, liver and blood with a concomitant increase in the concentration of linoleic acid compared with results for the other groups[40].

Antidiuretic activity

C.sativum crude extract at doses of 1- 10 mg/ml produced diuresis in rats[36].In another study, the acute diuretic activity of continuous intravenous infusion of an aqueous extract of the seed of *C.sativum* in rats was evaluated. Crude extract of *C.sativum* increase diuresis, excretion of electrolytes and glomerular filtration rate in a dose –dependent manner in comparison of furosemide suggesting diuretic activity of the plant[41].

Hepatoprotective activity

Pretreatment of rats with 100 and 200 mg/Kg dose of *C.sativum* extract significantly lowered SGOT, SGPT and TBARS levels; with increase in SOD, CAT and GPx emzymes levels when compared to CCL_4 treated rats. The activity of leaf extract at the dose of 200 mg/Kg was comparable with that of standard drug Silymarin suggesting that the extract protect liver from oxidative stress induced by CCL_4[42].

Antidiabetic activity

In the present study, an ethanol extract of the seeds was investigated for effects on insulin release from the pancreatic beta cells in streptozotocin induced diabetic rats. The results showed that the administration of the ethanol extract at doses of 200 and 250 mg/Kg, i.p., exhibited a significant reduction in serum glucose and significantly increase the activity of the beta cells in comparison with the diabetic control rats[43].

In the present study, coriander incorporated into the diet (62.5 g/kg) and drinking water (2.5 g/l, prepared by 15 min decoction) reduced hyperglycemia of streptozotocin-diabetic mice. An aqueous extract of coriander (1 mg/ml) increased 2-deoxyglucose transport (1.6-fold), glucose oxidation (1.4-fold) and incorporation of glucose into glycogen (1.7-fold) of isolated murine abdominal muscle comparable with 10(-8) M-insulin. In acute 20 min tests, 0.25-10 mg/ml aqueous extract of coriander evoked a stepwise 1.3-5.7-fold stimulation of insulin secretion from a clonal B-cell line. This effect was abolished by 0.5 mM-diazoxide and prior exposure to extract did not alter subsequent stimulation of insulin secretion by 10 mM-L-alanine, thereby negating an effect due to detrimental cell damage. The effect of extract was potentiated by 16.7 mM-glucose and 10 mM-L-alanine but not by 1 mM-3-isobutyl-1-methylxanthine. Insulin secretion by hyperpolarized B-cells (16.7 mM-glucose, 25 mM-KCl) was further enhanced by the presence of extract. Sequential extraction with solvents revealed insulin-releasing activity in hexane and water fractions indicating a possible cumulative effect of more than one extract constituent suggesting the presence of antihyperglycaemic, insulin-releasing and insulin-like activity in *C.sativum*[44]. The effects on glucose homeostasis of seed of *C.sativum* used as traditional treatments for diabetes mellitus was evaluated in normal and streptozotocin diabetic mice. It was supplied in the diet (6.25% by weight). Food and fluid intake, body weight gain, plasma glucose and insulin concentrations in normal mice were not altered by 12 days of treatment with any of the plants. After administration of streptozotocin (200 mg/kg i.p.) on day 12, treatment with coriander reduced the level of hyperglycemia and a reduced rate of body weight loss suggesting that coriander can retard the development of streptozotocin diabetes in mice[45].

Anthelmintic activity

In vitro anthelmintic activities of crude aqueous and hydro alcoholic extracts of the seeds of *C.sativum* were investigated on the egg and adult nematode parasite *Haemonchus contortus*.

Both extract of *C.sativum* inhibited hatching of eggs completely at a concentration less than 0.5 mg/ml. ED_{50} of aqueous extract of *C.sativum* was 0.12 mg/ml while that of hydro alcoholic extract was 0.18 mg/ml[46]. *In vivo* experiment in sheep, faecal egg count reduction was significant in group treated with *C.sativum* and albendazole. Total worm count reduction was observed in the extract treated group suggesting its anthelmintic activity[46].

Antispasmodic activity

The effectiveness of Carmint (Melissa *officinalis, Mentha spicata* and *Coriandrum sativum*) on abdominal pain/discomfort and bloating in irritable bowel syndrome patients was evaluated. The severity and frequency of abdominal pain/discomfort were significantly lower in the Carmint group than that of placebo group suggesting antispasmodic activity[47].

The polyherbal formulation contained four different drugs viz., Bilwa (*Aegle marmeloes*), Dhanyak (*Coriandrum sativum*), Musta (*Cyperus rotundus*) and Vala (*Vetiveria zinzanioids*) were tried on two different experimental animal models of inflammatory bowel disease, which are acetic acid-induced colitis in mice and indomethacin-induced enter colitis in rats. The formulation showed significant inhibitory activity against inflammatory bowel disease induced in these experimental animal models which was comparable with the standard drug prednisolone suggesting its efficacy against inflammatory bowel diseases[47].

Cytotoxicity activity

Cytotoxicity activity of essential oil of *C.sativum* was observed in the diploid yeast strain D7 (*Saccharomyces cerevisiae*), with the cells being more sensitive in exponential than in stationary growth phase[49]. The capacity of essential oil [EO] of *C.sativum* to induce nuclear DNA damage-responsive genes was tested using suitable Lac-Z fusion strains for RNR3 and RAD51, which are genes involved in DNA metabolism and DNA repair, respectively. At equitoxic doses, EO demonstrated significant gene induction, approximately the same as that caused by hydrogen peroxide, but much lower than that caused by methyl methanesulfonate (MMS). EO affects mitochondrial structure and function and can stimulate the transcriptional expression of DNA damage-responsive genes. The induction of mitochondrial damage by EO appears to be closely linked to overall cellular cytotoxicity and appears to mask the occurrence of nuclear genetic events. EO-induced cytotoxicity involves oxidative stress, as is evident from the protection observed in the presence of ROS inhibitors such as glutathione, catalase or the iron-chelating agent deferoxamine[49].

Larvicidal activity

Larvicidal activity of acetone and petroleum ether extracts of four plants *Murraya koenigii, Coriandrum sativum, Ferula asafoetida, Trigonella foenum graceum* [25-900 ppm] and synthetic larvicides Fenthion and Temephos [0.01-7.5 ppm] used alone and in combination was carried out against *A. aegypti* larvae. The synergistic study was carried out by using 0.05 ppm of Temephos and Fenthion with 25ppm of *M. koenigii, F. asafetida, T. foenum graceum* and 100 ppm of *C. sativum*. All the plants showed potential synergistic activity although showed comparatively poor larvicidal activity when tested individually[50]. The larvicidal properties of 34 plant extracts were tested against *Aedes fluviatilis* larvae, at 100, 10 and 1 ppm concentrations; 26.6% of the extracts enhanced larval mortality at 100 ppm (*Anacardium occidentale, Agave americana, Allium sativum, Coriandrum sativum, Nerium oleander, Spatodea campanulata, Tibouchina scrobiculata and Vernonia salzmanni*)[51].

Anxiolytic activity
The anxiolytic effect of aqueous extract of *C.sativum* (10, 25, 50, 100 mg/kg, i.p.) was examined in male albino mice using elevated plus-maze as an animal model of anxiety. The effects of the extract on spontaneous activity and neuromuscular coordination were assessed using Animex Activity Meter and rotarod, respectively. In the elevated plus-maze, aqueous extract at 100 mg/kg showed an anxiolytic effect by increasing the time spent on open arms and the percentage of open arm entries, compared to control group. Aqueous extract at 50, 100 and 500 mg/kg significantly reduced spontaneous activity and neuromuscular coordination, compared to control group suggesting that the aqueous extract of *C.sativum* seed has anxiolytic effect and may have potential sedative and muscle relaxant effects[52].

Antibacterial activity
Essential oil extracted from the fruit of *C.sativum* was assayed *in vitro* for antibacterial activity to *Escherichia coli* and *Bacillus megaterium*, and 27 phytopathogenic bacterial species and two mycopathogenic ones responsible for cultivated mushroom diseases. A significant antibacterial activity, as determined with the agar diffusion method, was shown by *C. sativum* essential oil[53].
Aliphatic (2E)-alkenals and alkanals characterized from the fresh leaves of *C. sativum* were found to possess bactericidal activity against *Salmonella choleraesuis*. (2E)-Dodecenal (C (12)) was the most effective against this food-borne bacterium with the minimum bactericidal concentration (MBC) of 6.25 µg/ml (34 µM), followed by (2E)-undecenal (C (11)) with an MBC of 12.5 µg/ml (74 µM) suggesting its bactericidal activity[54].

Anticancer activity
The biochemical effect of coriander seeds on lipid parameters in 1, 2-dimethyl hydrazine (DMH) induced colon cancer in rats were studied. The study shows that the concentrations of cholesterol and cholesterol to phospholipids ratio decreased while the level of phospholipids increased significantly in the DMH control group compared to the spice 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 suggesting that coriander plays a protective role against the deleterious effects in lipid metabolism in experimental colon cancer[55].
Methanol extracts of 36 samples of 21 Umbelliferae plants were screened for polyacetylenic compounds using the ELISA for panaxytriol, and their antiproliferative activity was checked by MTT assay using the tumor cell lines MK-1, HeLa and B16F10. The presence of antiproliferative polyacetylenes was suggested in *Angelica acutiloba* (fruit), *Anethum graveolens* (root), *Bupleurum rotundifolium* (fruit), *Carum carvi* (fruit and root), *Coriandrum sativum* (fruit), *Cryptotaenia japonica* (leaf), *Glehnia littoralis* (fruit), *Heracleum moellendorffii* (root) and *Torilis japonica* (fruit)[56].

Gastric activity
The stomach of pentobarbitone-anesthetized rats was perfused at 0.15 ml/min with aqueous extract of coriander (10%w/v) or acetylcholine (1 µg/ml or 10 µg/ml solutions, in 40 min blocks, twice in each experiment bracketed by saline perfusions and the acid content in the samples was estimated. Coriander increased acid secretion was 0.18 (0.03) from 0.09 (0.02). Atropine abolished the acid secretion induced by acetylcholine and significantly reduced acid induction by coriander. In experiments with aspirin-induced mucosal injury the basal acid secretion was low; coriander increased acid secretion in injured stomachs suggesting that coriander increased gastric acid secretion[57].

Antifertility activity

Effect of the aqueous extract of fresh coriander (*C. sativum*) seeds has been studied on female fertility in rats. Parameters included effects on oestrus cycle, implantation, fetal loss, abortion, teratogenicity and serum progesterone levels on days 5, 12 and 20 of the pregnancy. The extract at doses of 250 and 500 mg/kg orally produced a dose-dependent significant anti-implantation effect, but failed to produce complete infertility. Treatment of animals during day-8 to day-12 and day-12 to day-20 of the pregnancy did not produce any significant abortifacient activity. There was no significant change in the weight and length of the fetuses delivered by rats treated with the extract and no abnormalities were seen in the organs of the offspring's. The extracts produced a significant decrease in serum progesterone levels on day-5 of pregnancy which may be responsible for the anti-implantation effect observed in this study[58].

Lead deposition activity

The preventive effect of *C.sativum* (Chinese parsley) on lead deposition was investigated in male ICR mice given lead (1000 ppm) as lead acetate trihydrate in drinking water for 32 days. The lead reached its highest concentration in the femur but localized lead deposition in the femur was significantly decreased by meso-2, 3-dimercaptosuccinic acid (DMSA), a chelating agent used as a positive control to validate this experimental model. Administration of Chinese parsley also significantly decreased lead deposition in the femur and severe lead-induced injury in the kidneys. In addition, urinary excretion of delta-aminolevulinic acid (ALA) which is known to increase with lead intake was significantly decreased after administration of Chinese parsley. The MeOH extract of Chinese parsley also reduced lead-induced inhibition of delta-aminolevulinic acid dehydratase (ALAD) activity *in vitro* suggesting that Chinese parsley has suppressive activity on lead deposition, probably resulting from the chelation of lead[59].

Clinical Evaluation

Herbal preparation Dhanyapanchaka kashaya, prepared from *C.sativum, Valerian wallichii, Aegle marmelos, Cyperus rotundus* and *Zingiber officinale* has been found to be effective in dyspeptic symptoms and on free acid of hypoacidity group[60].

Gasozyme syrup (*Carica papaya, Carum copticum, Coriandrum sativum, Peucedanum graveolens, Atropa belladonna, Aegle marmelos, Piper longum* and *Embelia ribes*) was administered orally for 3 month to 40 patients of gastritis. Eight cases (20%) were completely relieved of symptoms, 16 cases showed improvement and 10 showed satisfactory improvement[61].

The classical herbal compound Shalaparnyadi churna consisting of *Desmodium gangeticum, Sida cordifolia, Aegle marmelos, Coriandrum sativum* and *Zingiber officinale* were assessed for irritable bowel syndrome at a dose of 3 g thrice daily for 1 month. The result showed positive response in all cases[62].

In the present review, the literature pertaining to botanical, pharmacognostical, phytochemical and pharmacological activities has been given comprehensively. The plant is having antidiabetic, antioxidant, antidiuretic, cardiovascular, anthelmintic, larvicidal, antibacterial, hepatoprotective, cytotoxicity and anxiolytic activities. A literature survey also pinpoints the fact that although the number of diseases for which *C.sativum* finds use as a medicine is fairly large but its therapeutic efficacy has been assessed only in few cases with few models. Therefore, it is imperative that more clinical and pharmacological studies should be conducted to investigate the unexploited potential of this plant.

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