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CORIANDRUM SATIVUM- REVIEW OF ADVANCES IN PHYTOPHARMACOLOGY

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ABSTRACT

Coriandrum Sativum family Umbelliferae is highly reputed ayurvedic medicinal tree commonly known as the Dhanya. It is a glabrous, aromatic, herbaceous annual plant, small sized tree growing throughout India, Italy, Netherlands, Central and Eastern Europe, China and Bangladesh. Essential oil, flavonoids, fatty acids, and sterols have been isolated from different parts of *C. sativum*. The different parts of this plant contain monoterpenes, α-pinene, limpnene, γ-terpinene, p-cymene, borneol, citronellol, camphor, geraniol, coriandrin, dihydrocoriandrin, coriandrons A-E, flavonoids and essential oils. Various parts of this plant such as seed, leaves, flower and fruit, possess antioxidant activity, anti-diabetic activity, anti-mutagenic activity, anti-helmintic activity, sedative-hypnotic activity, anticonvulsant activity , diuretic activity, cholesterol lowering activity, protective role against lead toxicity, antifungal activity, anti-feeding activity, anticancer activity, anxiolytic activity, hepatoprotective activity, anti-protozoal activity, anti-ulcer activity, post-coital anti-fertility activity, heavy metal detoxification. Various phytopharmacological evaluations have been reported in this literature for the important potential of the *Coriandrum sativum*.

INTRODUCTION: Dhaniya consist of dried ripe fruit of *Coriandrum Sativum* Linn Umbeliferae [1]; a slender, glabrous, branched, cultivated all over India, giving characteristic aroma when rubbed. It is annual herb originating from the Mediterranean [2]. The whole plant and especially the unripe fruit, is characterized by a strong disagreeable odour, wherever the name coriander (from the Greek k'opis, a bug) [3]. All part of the plants is edible but the fresh leaves and the dried seeds are the most common parts used in cooking. In India it is chiefly found in Madhya Pradesh, Tamil Nadu, Karnataka, Rajasthan, Andhra Pradesh and Bihar.

In the Indian traditional medicine, a coriander is used in disorders of digestive, respiratory and urinary system, as it has diaphoretic, diuretic, carminative and stimulant. In Iranian traditional medicine, coriander has been indicated for a number of medical problems such as dyspeptic complaints, loss of appetite, convulsion and insomnia [4, 5, 6, 7, 8].

Coriander has been reported to exhibit several pharmacological effects such as antioxidant activity [16, 17], anti-diabetic activity [20], anti-mutagenic activity [21], anthelmentic activity [22], sedative-hypnotic activity [23], anticonvulsant activity [24], diuretic activity [25], cholesterol lowering activity [26], protective role against lead toxicity [27], antifungal activity [28], anti-feeding activity [30], anticancer activity [31], anxiolytic activity [32], hepatoprotective activity [33], anti-protozoal activity [34], anti-ulcer activity [37], post-coital anti-fertility activity [38], heavy metal detoxification [39].

Ayurvedic Description: Table 1

TABLE 1: DESCRIBE AYURVEDIC DESCRIPTION OF *CORIANDER SATIVUM* [11, 12, 13]

Botanical name	*Coriandrum sativam* Linn.
Sanskrit name	Dhanika, Dhaniya, Vitunnaka, Kusutumbum
Synonyms	Dhana, Havija, Malli
Properties	
Rasa	Madhur, Tikta, Kashaya
Guna	Laghu, Snigdha
Virya	Ushna
Vipaka	Madhur
Doshaghnata	Tridoshahar, Snigdha
Karma (Actions)	Ushna=vatashaman; kashaya, tikta, madhur=pittashaman; tikta, katu and ushna=kapashman. Green coriander bieng cold is pittashmak.
Therapeutic uses	External: Local swelling and pains; Headache caused by pitta; burning sensation;lymphadenopathy; stomatitis; conjuctivitis; haemostatic;headache; in nasal drops. Internal: CNS-Tonic for majjadhatu; vertigo; syncope; memory loss. Digestive system: anti dyseptic, appeptizer, digestive, astringent, liver stimulant, anthelmentic. CVS: Bleeding disorders. Respiratory sysem: Cough, dyspnoe (as kaphaghana). Urinary system: diuretic; useful in prameha caused by pitta.

Botanical Description [12, 13, 14, 15]:

Leaves: A small herb having many branches and sub-branches. New leaves are oval but aerial leaves are elongated.

Flowers: white, having slightly brinjal like shades.

Fruit: round, divided into 2 parts.

Seed: The herb bears flowers and seeds at the end of winter.

Phytochemicals: The general chemical composition present in coriander fruits are described in **Table 2**. Green coriander contains 84% water.

TABLE 2: DESCRIBES CHEMICAL COMPOSITION OF *CORIANDER SATIVUM* [9]

Component Content	Percentage (%)
Water	11.37
Crude protein	11.49
Fat	19.15
Crude fibre	28.43
Starch	10.53
Pentosans	10.29
Sugar	1.92
Mineral constituents	4.98
Essential oil	0.84

Seeds contain up to 1.8% volatile oil according to origin (BP standard not less than 0.3%). Major active constituents of *Coriandrum sativum* is essential oils and fatty oil. The essential oil content of the weight of ripe and dried fruits of coriander varies between 0.03 and 2.6%, and the content of fatty oil varies between 9.9 and 27.7% 1% the major component of which is S-(+)-linalool (60-70%) other minor active constituents in essential oil are monoterpenes hydrocarbons viz. α-pinene, limpnene, γ- terpinene, p-cymene, borneol, citronellol, camphor, geraniol and geraniol acetate, heterocyclic components like pyrazine, pyridine, thiazole, furan and tetrahudrofuran derivatives, isocoumarins, coriandrin, dihydrocoriandrin, coriandrons A-E, flavonoids, pthlides, neochidilide, digustilide phenolic acids and sterols. The composition of the essential oil & fatty oil are described in **Table 3 and 4** respectively [9, 10].

TABLE 3: DESCRIBE COMPOSITION OF ESSENTIAL OIL IN RIPE FRUITS OF *CORIANDER SATIVUM* [9]

Main components	% of Total Essential oil	Minor components (all with less than 2%)
Linalool	67.7	β- pinene
α- pinene	10.5	Camphene
γ- terpine	9.0	Myrcene
Geranylacetate	4.0	Limonene
Camphor	3.0	p-cymol
Graniol	1.9	Dipentene
		α- terpinene
		n-decylaldehyde
		Borenol

TABLE 4: DESCRIBE COMPOSTION OF FATTY ACID IN RIPE FRUITS OF *CORIANDER SATIVUM* [9]

Main components	% of all fatty acids	Minor component
Petroselinic acid	68.8	Stearic acid
Linoleic acid	16.6	Vaccenic acid
Oleic acid	7.5	Myristic acid
Palmitic acid	3.8	

Pharmacological Studies:

Antioxidant Activity: An aqueous coriander extract obtained through a sequential extraction process identify the phenolic compounds responsible for its antioxidant activity. When considered with the recognized antioxidant ability of phenolic acids, suggest that they are principal components responsible for the antioxidant activity of the aqueous coriander extract. This study is designed to examine the fruit essential oil composition, the total phenolic amounts and the antioxidant activities in methanolic extracts of *Coriandrum sativum*.

Five fractions (b-carotene, b-cryptoxanthin epoxide, lutein-5, 6-epoxide, violaxanthin and neoxanthin) were isolated from a coriander ether extract using column chromatography and identified according to their chromatographic and spectral characteristics. Extracts of different polarity from leaves and seeds of coriander and coriander oil were investigated for their antioxidant activity coriander to food will increase the antioxidant content and may have potential as a natural antioxidant and thus inhibit unwanted oxidation processes. Extracts from both leaves and seeds showed a concentration-dependent DPPH scavenging activity respectively [16, 17].

Antidiabetic Activity: After a single oral dose of CS-extract (20 mg/kg) in sub-chronic administration of an aqueous extract of coriander seeds in OHH-Meriones shawi rats normalized glycemia and decreased the elevated IR (insulin resistant), levels of insulin, total cholesterol, LDL-cholesterol and TG, without a significant effect on BW (body weight), and plasma urea and creatinine. Our results also imply that regular consumption of coriander seeds (which are relatively non-toxic) could decrease hyperglycemia as well as prevent or reduce cardiovascular complications caused by dyslipidemia/hyperlipidemia in pathologies such as pre-diabetes, T2DM, and the metabolic syndrome [18].

Anti-microbial Activity: Aqueous infusions and aqueous decoctions of coriander against 186 bacterial isolates belonging to 10 different genera of G +ve bacterial population and 2 isolates of Candida albicans isolated from urine specimens [19]. The essential oil from leaves of *Coriandrum sativum L.* (Apiaceae), obtained by hydro-distillation was analysed. The major constituents were 2E-decenal (15.9%), decanal (14.3%), 2E-decen-1-ol (14.2%) and n-decanol (13.6%). Other constituents present in fairly good amounts are 2E-tridecen-1-al (6.75%), 2E-dodecenal (6.23%), dodecanal (4.36%), undecanol (3.37%), and undecanal (3.23%). The oil was screened for antimicrobial activity against both Gram positive (*Staphylococcus aureus, Bacillus* spp.) and Gram negative (*Escherichia coli, Salmonella typhi, Klebsiella pneumonia, Proteus mirabilis, Pseudomonas aeruginosae*) bacteria and a pathogenic fungus, *Candida albicans* [20].

Anti Mutagenic Activity: The 4- nitro-o-phenylenediamine (NOP) is a well-known direct-acting mutagen whose mutagenic potential can be enhanced by plant metabolism; m-phenylenediamine (m-PDA) is converted to mutagenic products detected by the *Salmonella typhimurium* TA98 strain, and 2-aminofluorene (2-AF) is the plant-activated promutagen most extensively studied. Plant cells activate both 2- AF and m-PDA into potent mutagens producing DNA frame shift mutations. *Coriandrum sativum* is a common plant included in the Mexican diet, usually consumed uncooked.

The antimutagenic activity of coriander juice against the mutagenic activity of 4-nitro o-phenylenediamine, m-phenylenediamine and 2-aminofluorene was investigated using the Ames reversion mutagenicity assay (his − to his+) with the *S. typhimurium* TA98 strain as indicator organism. The plant cell/microbe coincubation assay was used as the activating system for aromatic transformation and plant extract interaction. Aqueous crude coriander juice significantly decreased the mutagenicity of metabolized aromatic amines (AA) in the following order: 2-AF (92.43%) > m-PDA (87.14%) > NOP (83.21%) [21].

Anthelmintic Activity: *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. The hydro-alcoholic extract showed better in vitro activity against adult parasites than the aqueous one [22].

Sedative Hypnotic Activity: *Coriandrum sativum L*. has been recommended for relief of insomnia in Iranian traditional medicine. To determine sedative & hypnotic activity Aqueous and hydroalcoholic extract & essential oil administer to rat. The result 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 [23].

Anticonvulsant activity: The anti-convulsant effects of aqueous and ethanolic extracts of coriander sativum seeds were studied by in two anti-convlusant evaluation test, namely the pentylenetetrazole (PTZ) and the maximal electroshock tests. Aqueous and ethenolic 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 [24].

Diuretric: 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. 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 [25].

Cholesterol lowering Activity: Coriander seeds incorporated into diet and the effect of the administration of coriander seeds on the metabolism of lipids was studied in rats fed with high fat diet and added cholesterol. The seeds had a significant hypolipidemic action. In the experimental group of rats (tissue) the level of total cholesterol and triglycerides increased significantly. There was significant increase in b-hydroxy, b-methyl glutaryl CoA reductase and plasma lecithin cholesterol acyl transferase activity was noted in the experimental group. The level of low density lipoprotein (LDL) and very low density lipoprotein (VLDL) cholesterol decreased while that of high density lipoprotein (HDL) cholesterol increased in the experimental group compared to the control group. The increased activity of plasma LCAT, enhanced degradation of cholesterol to fecal bile acids and neutral sterols appeared to account for its hypocholesterolemic effect [26].

Protective role against Lead Toxicity: Oxidative stress was induced in mice by a daily dose of lead nitrate (40 mg/kg body weight by oral gavages) for seven days. From day eight, after lead nitrate treatment, experimental animals received an oral dose of coriander extracts (aqueous extract - 300 mg/kg body weight and 600 mg/kg body weight; ethanolic extract - 250 mg/kg body weight and 500 mg/kg body weight) daily. The effect of these treatments in influencing the lead induced changes on hepatic and renal oxidative stress and biochemical changes along with histopathological alterations in soft tissues was studied. The data showed significant increase in liver and kidney LPO levels in animals treated with lead nitrate while the effect was attenuated by the plant extracts. Also, lead caused a significant decrease in antioxidant enzyme activity and this effect was reversed in groups treated with plant extract. Treatment with coriander significantly reduced the adverse effects related to most of biochemical parameters altered in animals treated with lead, related to hepatic and renal oxidative stress [27].

Antifungal activity and potential synergism with Amphotericin B: Present study was to evaluate the antifungal activity of coriander essential oil according to classical bacteriological techniques, as well as with flow cytometry. The effect of the essential oil upon germ tube formation, seen as an important virulence

factor, and potential synergism with amphotericin B were also studied. Coriander essential oil has a fungicidal activity against the *Candida* strains tested with MLC values equal to the MIC value and ranging from 0.05 to 0.4% v/v. Also, concentrations bellow the MIC value caused a marked reduction in the percentage of germ tube formation for *C. albicans* strains. A synergetic effect between coriander oil and amphotericin B was also obtained for *C. albicans* strains, while for *C. tropicalis* strain only an additive effect was observed. This study describes the antifungal activity of coriander essential oil on *Candida* spp., which could be useful in designing new formulations for candidosis treatment [28].

Aroma characterization of Coriander: Essential oil content of coriander samples ranged from 0.18 to 0.39%. The GC–MS analysis revealed presence of 30 compounds in coriander oil and around 98% of the compounds were identified in all the samples. Linalool which has floral and pleasant odour notes was the major compound (56.71–75.14%) in the essential oil, but the variation in the linalool content did not significantly affect the pleasantness of samples as perceived by the panelists. Higher *α*-pinene content of S7 and S8 could be related to the higher turpentine note. Sweet and rose-like odour notes of S1 could be due to occurrence of higher levels of geranyl acetate and lemonol. The odour profiling depicted the overall odour perceived, while the GC–O represented the odour notes of specific volatile compounds of coriander. Principal component analysis showed that samples S7 and S8 loaded with *α*- pinene, myrcene and undecanal [29].

Antifeedant Activity: Antifeedant activity against the field slug *Deroceras reticulatum* by using an electrophysiological recording assay, the olfactory sensory epithelium of the posterior tentacle of the slug was exposed to volatile components of the plant extracts presented in an airstream, and any subsequent activity of the olfactory nerve was recorded. A feeding bioassay was used to measure any change in consumption when extracts were added to a standard food. Statistical analysis of data obtained from both electrophysiological traces and the feeding bioassays identified extracts of *Coriandrum sativum* and it is most neuroactive as well as the most antifeedant [30].

Anti-Cancer: 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 phospholipid ratio decreased while the level of phospholipid 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. Thus, coriander plays a protective role against the deleterious effects in lipid metabolism in experimental colon cancer. This effect can be explained as one of the possible mechanisms by which coriander can inhibit colon tumorogenesis [31].

Anti-Anxiety Activity: *Coriandrum sativum* L. has been recommended for relief of anxiety and insomnia in Iranian folk medicine. The anxiolytic effect of aqueous extract (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. These results suggest that the aqueous extract of *Coriandrum sativum* seed has anxiolytic effect and may have potential sedative and muscle relaxant effects [32].

Hepatoprotective Activity: Ethanolic extract was found to be rich in alkaloids, phenolic compounds and flavonoids, isoquercetin and quercetin. *C. sativum* signifies hepatoprotection against carbon tetrachloride (CCl4), by reducing the liver weight, activities of SGOT, SGPT, and ALP, and direct bilirubin of CCl4 intoxicated animals. Administration of *C. sativum* extract at 300 mg/kg dose resulted in disappearance of fatty deposit, ballooning degeneration and necrosis, indicating antihepatotoxic activity [33].

Anti-Protozoal Activity: Leishmaniasis is a zoonosis caused by the protozoan species *Leishmania infantum* (syn.- *L. chagasi*) and is primarily transmitted through the bite of the female *Lutzomyia longipalpis*. The in vitro effect of methanol fraction from *Coriandrum sativum* (coriander) on promastigotes and amastigotes of *L. infantum* and to analyze the toxicity against the murine monocytic cells RAW 264.7. To determine the viability of these substances on 50% parasites (IC50), we used a tetrazolium dye (MTT) colorimetric assay (bromide 3-4.5-dimethylthiazol-2-yl- 2, 5-dephenyl-tetrazolium), and on amastigotes we performed an in situ ELISA [34]. The flavonoid quercetin isolated from fruits of *C. sativum* [35] interferes with the iron metabolism in L. donovani, reducing splenic burden in golden hamsters by 75–95% [36].

Therefore, the inhibitory effect on promastigotes and amastigotes observed in fraction of *C. sativum* may be due to the presence of terpenoids and flavonoids, suggesting the action on NO production of macrophages and/or iron dependent enzymes [34].

Gastric Mucosal Protective Activity: The effect of Coriander pretreatment on gastric mucosal injuries caused by NaCl, NaOH, ethanol, indomethacin and pylorus ligation accumulated gastric acid secretionswas investigated in rats. Pretreatment at oral doses of 250 and 500 mg/kg, body weightwas found to provide a dose-dependent protection against the

(i) Ulcerogenic effects of different necrotizing agents;

(ii) Ethanol-induced histopathological lesions;

(iii) Pylorus ligated accumulation of gastric acid secretions and ethanol related decrease of Non-protein Sulfhydryl groups (NP-SH).

Results obtained on the study of gastric mucus and indomethacin induced ulcers demonstrated that the gastro protective activity of Coriander might not be mediated by gastric mucus and/or endogenous stimulation of prostaglandins. The protective effect against ethanol-induced damage of the gastric tissue might be related to the free-radical scavenging property of different antioxidant constituents (linanool, flavonoids, coumarins, catechins, terpenes and polyphenolic compounds) present in Coriander.

The inhibition of ulcers might be due to the formation of a protective layer of either one or more than one of these compounds by hydrophobic interactions [37].

Post-Coital Antifertility Activity: Effect of the aqueous extract of fresh coriander *seeds* has been studied on female fertility in rats. Parameters included effects on oestrus cycle, implantation, foetal 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, day-12 and day-20 of the pregnancy did not produce any significant abortifacient activity. There was no significant change in the weight and length of the foetuses delivered by rats treated with the extract and no abnormalities were seen in the organs of the off springs. 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 [38].

Heavy Metal Detoxification: Asorbent prepared from the plant coriander was observed to remove inorganic (Hg^{2+}) and methyl mercury (CH_3Hg^+) from aqueous solutions with good efficiency. The sorption behavior indicates the major role of carboxylic acid groups in binding the mercury. The studies suggest that the sorbent can be used for the decontamination of inorganic and methyl mercury from contaminated waters [39].

CONCLUSION: Throughout history, humans have found that some plants and herbs can be not only to enhance the flavor of foods but also to restore health. Numerous phytochemical and pharmacological studies have been conducted on different parts of *Coriander sativum*. The present literature supports the potential of *Coriander sativum* as a medicinal tree. In view of the nature of the *Coriander sativum* plant, more research can be done to investigate the undiscovered and undeveloped potential of this plant.

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