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Review Article

Potential of *Coriandrum sativum* in management of diabetes and hyperlipidemia: a comprehensive review of pharmacological evidence and mechanisms

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ABSTRACT

Diabetes mellitus, obesity, and hyperlipidaemia are interconnected metabolic disorders with rising prevalence worldwide, posing significant public health challenges. These conditions often coexist, forming a metabolic syndrome characterized by elevated glucose levels, excess body fat, and abnormal lipid profiles, leading to severe complications such as cardiovascular diseases and organ dysfunction. *Coriandrum sativum* (coriander), a culinary herb with a long history of medicinal use in traditional systems like Ayurveda, has shown promising therapeutic potential in managing these metabolic disorders. Rich in bioactive compounds such as flavonoids, polyphenols, and essential oils, coriander exhibits antidiabetic and antihyperlipidemic activities. Its efficacy has been demonstrated in various experimental models of diabetes and Hyperlipidemia, with significant reductions in blood glucose levels, lipid parameters, and oxidative stress markers. The mechanisms underlying these effects include stimulation insulin secretion, inhibition of α-glucosidase activity, modulation of lipid metabolism, and antioxidant activity. This review comprehensively evaluates the pharmacological actions and mechanisms of coriander, including its seed and leaf extracts, essential oils, and dietary incorporation, in mitigating hyperglycaemia, dyslipidaemia, and obesity-associated complications. By integrating traditional knowledge with modern scientific evidence, this article highlights the therapeutic potential of *Coriandrum sativum* as a natural remedy for addressing the escalating burden of metabolic disorders.

Keywords: *Coriandrum sativum*, Antidiabetic, Hypolipidemic, Seed, Leaves, Essential oil

INTRODUCTION

Diabetes mellitus is a metabolic disease characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. Chronic hyperglycemia is associated with long-term damage, dysfunction, and failure of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels.[1] Type 2 diabetes is the most common, which occurs when the body becomes resistant to insulin or does not make enough insulin. About 830 million people worldwide have diabetes, the majority living in low-and middle-income countries.[2] Type 2 diabetes mellitus (T2DM) is a public healthcare problem and one of the most frequent diseases worldwide, especially in older patients.[3] In India, an estimated 77 million people above the age of 18 years are suffering from diabetes (type 2), and nearly 25 million are prediabetics (at a higher risk of developing diabetes in the near future).[4] The international diabetes federation (IDF) estimates the number of people with diabetes in India to be 134 million by 2045.[5]

Obesity is a chronic complex disease defined by excessive fat deposits that can impair health.[6] Obesity, particularly when associated with increased abdominal and intra-abdominal fat distribution and increased intrahepatic and intramuscular triglyceride content, is a major risk factor for prediabetes and type 2 diabetes because it causes both

insulin resistance and β-cell dysfunction.[7] The accumulation of an excessive amount of body fat can cause type 2 diabetes, and the risk of type 2 diabetes increases linearly with an increase in body mass index. Accordingly, the worldwide increase in the prevalence of obesity has led to a concomitant increase in the prevalence of type 2 diabetes.[8] Obesity can lead to an increased risk of type 2 diabetes and heart disease; it can affect bone health and reproduction, and it increases the risk of certain cancers. In 2022, 2.5 billion adults aged 18 years and older were overweight, including over 890 million adults who were living with obesity. The worldwide prevalence of obesity more than doubled between 1990 and 2022.[9]

Diabetes mellitus, obesity, and hyperlipidemia are connected metabolic disorders that have reached epidemic proportions worldwide. Together, these disorders form a metabolic syndrome that poses a substantial public health challenge, necessitating innovative therapeutic approaches.

Coriandrum sativum, commonly known as coriander, is a widely used culinary herb that has been recognized for its medicinal properties in Ayurveda and other traditional medicine systems. It is rich in bioactive compounds such as flavonoids, polyphenols, and essential oils *C sativum* belongs to the Apiaceae (Umbelliferae) family, which is herbaceous and grows annually *C sativum* is known as "coriander" or "Chinese parsley" in English, "kusthumbari" or "dhanya" in Sanskrit; "dhane" in Bengali.[10]

In recent years, there has been a resurgence of interest in traditional medicine systems, such as Ayurveda, for managing these metabolic disorders. Ayurveda emphasizes a holistic approach to health and disease. The use of natural remedies, particularly those derived from plants, is gaining popularity due to their perceived safety, efficacy, and ability to target multiple pathways involved in disease progression. There is vivid description of *Coriandrum sativum* often as Dhanyaka in Ayurveda classics. The dried ripe fruits of the plant are used for the medicinal purposes.

According to Ayurveda, it is Katu (pungent), Madhura (Sweet), tikta (bitter), Kashaya (astringent) in taste, is Madhura in Vipaka and ushna (hot) in Virya (potency). It is Dipana (appetizer), Pachana (helps in digestion), Tridoshant (pacifies all the three vitiated Doshas), Mutrala (diuretic), Chakshushya (beneficial for eyes), Hridya (beneficial for heart). According to Ayurveda scriptures, it is mainly indicated in therapeutics for the management of various disease conditions such as Jvara (fever), Trishna (thirst), Chardi (Vomiting), Daha (Burning sensation), Ajirna (indigestion), Atisara (diarrhoea), Shwasa (Asthma), Kasa (bronchitis/cough), Karshya (general debility), krimi (worm infestation/helminthiasis) etc.[11] *Coriandrum sativum* is one of the ingredient in some of the Ayurveda formulations such as Chandraprabha Vati, Shukramatrika Vati, Dadimadya Ghrita, Brihat Dadimadya Ghrita, Prameha mihira taila indicated for the management of Prameha (Diabetes mellitus/metabolic disorders).[12] Traditionally, coriander is used in Morocco and China to treat diabetes.[13] Different pharmacological studies have demonstrated its potential antidiabetic and antihyperlipidemic activities, making it a promising candidate for managing metabolic disorders.

This review aims to comprehensively evaluate the antidiabetic and antihyperlipidemic properties of *Coriandrum sativum* seeds, leaves essential oil and bioactive component, with a focus on its pharmacological action/mechanisms. By bridging traditional knowledge with modern scientific evidence, this article seeks to highlight the therapeutic potential of this versatile herb in addressing the growing burden of metabolic disorders.

Effect of coriander on the experimental models of diabetes

The methanolic extract of *Coriandrum sativum* leaves was screened for antidiabetic activity in alloxan-induced diabetic mice. The extract at doses of 200 mg/ kg body weight and 400 mg/ kg body weight has shown a significant reduction in elevated glucose levels in rats upon 21 days of administration.[14] The ethanolic extract of leaves of *Coriandrum sativum* upon consecutive administration at a dose of 400 mg/kg showed a significant reduction in the elevated glucose levels of male Swiss mice rendered experimentally diabetic by alloxan injection.[15]

In a study conducted by Sinaga et al., 2019, a significant antihyperglycemic effect was observed in alloxan-induced diabetic rats upon administration of ethanolic extract of *Coriandrum sativum* leaves for a consecutive period of 15 days.[16] Significant decreases in the elevated blood glucose levels were observed in the alloxan-induced diabetic upon oral administration of 500 mg/ kg B W of methanolic extract of *Coriandrum sativum* seeds for a period of 30 days.[17]

The effect of the Aqueous extract of *Coriandrum sativum* seeds in reducing elevated blood glucose was evaluated in rats rendered diabetic by streptozotocin injection. The test extract at a dose of 40 mg/kg body weight significantly reduced the glucose level and mean Hb A1C upon 28 days of consecutive administration.[18] The essential oil from *Coriandrum sativum* was tested for its activity in the streptozotocin-diabetic rats and administration of the essential oil consecutively for 21 days at dose of 40 mg. kg body weight has significantly reduced the elevated glucose levels.[19]

The supplementation of the diet with *Coriandrum sativum* seed powder at 10% level and administration for a period of 90 days has shown significant decrease in fasting glucose levels in male Sprague Dawley rats fed on high cholesterol diet.[20] The effect of intraperitoneal administration of hydroalcoholic extract of *Coriandrum sativum* seeds was investigated on streptozotocin-induced diabetes in male Wistar rats. The test extract at the dose of 100, 200 and 250 mg/kg body weight has shown significant

decrease in fasting serum glucose levels as compared to control group.[21] Administration of methanolic extract of *Coriandrum sativum* seeds at a dose of 100 mg/kg body weight and 200 mg/kg body weight for a period of 14 days has shown a significant decrease in the blood glucose levels in the streptozotocin-induced diabetic Wistar rats.[22]

The effect of co-administration of coriander oil along with dexamethasone on the development of insulin resistance was studied in male Wistar rats. The essential oil at the dose of 1 ml /kg body weight significantly reversed the development of dexamethasone Insulin resistance in rats, as shown by a reduction in fasting glucose level, serum insulin, and HOMA-IR as compared to the rats that receive dexamethasone alone. The essential oil also reversed the elevation of glucose levels consequent to exogenous oral glucose administration.[23]

Effect of coriander on the experimental models of hyperlipidemia

The effect of the incorporation of coriander seeds into the diet on lipid metabolism was studied in female Wistar rats fed with a high-fat diet. The intake of feed containing 10% of coriander seed powder upon 75 days has significantly reduced the levels of serum cholesterol, triglyceride, LDL, and VLDL and significant increased HDL levels as compared to the control group.[24]

The methanolic extract of *Coriandrum sativum* leaves at doses of 200 mg/ kg body weight and 400 mg/ kg body weight has shown significant reduction in triglycerides, LDL, and VLDL in the experimental diabetic rats as compared to untreated diabetic rats.[14] The hypolipidemic and hypoglycaemic effects of aqueous extract of seeds extract were evaluated in normal rats and obese-hyperglycaemic-hyperlipidaemic (OHH) rats. Upon 30 days of consecutive administration at dose of 20 mg/kg, the extract showed significant reduction in total cholesterol, triglycerides, serum glucose, atherosclerotic index and improvement in the cardioprotective index.[25]

The effect of the inclusion of *Coriandrum sativum* seeds powder in the diet on the lipid profile of experimental diabetic male Sprague Dawley rats was studied. The incorporation of coriander seed powder at a 10% level in feed for a period of 28 days has revealed a significant reduction in blood glucose levels, total cholesterol, and triglycerides as compared to the disease control group, whereas a significant increase was observed with respect to HDL.[26]

The ethanolic extract of *Coriandrum sativum* seeds showed significant hypolipidemic activity in alloxan-induced diabetic rats and the daily oral administration at the dose of 250 mg/kg body weight for a period of 28 days showed significant reduction in the serum triglycerides, cholesterol, LDL, VLDL and increase in HDL as compared to those in disease control group.[27] The effect of administration of Coriander seed powder at dose of 1 g/kg was in male Wistar rats rendered hyperlipidaemic administration of Triton. A decrease in the cholesterol levels and triglycerides was observed in the synthesis phase (initial 24 hours) where the coriander powder was administered immediately after triton administration, A Decrease in the cholesterol levels and triglycerides was also observed in the synthesis phase (24-48 hours) wherein the coriander powder was administered 22 hours after triton administration.[28]

The hydroalcoholic extract of seeds of *Coriandrum sativum* was screened for its effects on lipid profile in male rats fed on a high-fat diet. Oral administration of the extract at dose of 150 mg and 300 mg/ kg body weight for 42 consecutive days has significantly reduced the total cholesterol, LDL and VLDL levels in rats as compared to non-treated group fed only on high fat diet.[29]

Synergistic activity with common antidiabetics

The aqueous extract of *Coriandrum sativum* seeds was screened for its synergistic activity with conventional antidiabetics in Sprague Dawley rats which were rendered diabetic by intraperitoneal injection of streptozotocin. Administration of 400 mg /kg of the test extract with Metformin (100 mg/ kg body weight) for a period of 21 days has shown significant decrease in blood glucose levels with elevation of pharmacokinetic parameters like Cmax and Tmax.[30]

Effect on diabetic associated complications

The petroleum ether extract of *Coriandrum sativum* seeds was screened for its effect on diabetic nephropathy in rats with streptozotocin- Nicotinamide-induced type 2 diabetes. The elevated levels of serum creatinine, blood urea nitrogen, urea, uric acid, and albuminuria indicative of kidney damage were found to be reduced upon treatment with the extract for a period of 45 days.[31]

Yibru et al, have studied the effect of oral administration of ethanol extract of *Coriandrum sativum* seeds on the renal parameters in a streptozotocin-induced diabetic mice model. The test extract at doses of 300 mg/kg, 4000 mg/kg and 500 mg/kg was found to significantly reduce the serum.[32]

Administration of Coriander seed extract at a dose of 150 mg/kg for a period of six weeks coupled with aerobic exercise showed beneficial effects on tissue liver damage with a significant reduction in elevated serum levels of serum glucose, AST, ALT, and ALP in male Wistar rats.[33] The effect of the inclusion of *Coriandrum sativum* seeds powder at a 10% level in the diet has shown improvement in liver function with a significant reduction in AST, ALT, uric acid, urea, and creatinine levels in the alloxan-induced diabetic male Sprague Dawley rats upon 28 days of consecutive administration.[26] The *Coriandrum sativum* hydroalcoholic extract was found to attenuate indices of diabetic peripheral neuropathy in streptozotocin-induced

experimental diabetes in male Wistar rats. Administration of the test extracts for 30 days at doses of 100 mg/ kg body weight and 200 mg/ kg body weight has shown increased pain threshold in animals screened by behavioural tests such as Randall Sellito paw pressure test, Van Frey hair test, Tail immersion test and hot plate test.[34]

DISCUSSION

The review of the literature has revealed the significant antidiabetic and hypolipidemic activities of Coriandrum sativum. The antidiabetic activity was evident in the experimental diabetes animal models by the reduction in the elevated serum glucose levels upon administration as different extracts of leaves and seeds or as dietary supplements in the form of powder. The inhibition of the activity of α-glucosidase enzyme, which plays a major role in the breakdown of monosaccharides in the intestine and its absorption, might be one of the mechanisms of action of Coriandrum sativum.[15]

The phytochemical investigation of the extract of *Coriandrum sativum* has shown the presence of flavonoids, alkaloids, saponins, tannins, glycosides, and steroids. Saponins prevent beta cell damage and increases insulin sensitivity. Alkaloids assist in establishing hypoglycemia via their stimulatory effect on the hypothalamus, resulting in reduced gluconeogenesis. The chelating effect of tannins shrinks the small intestinal epithelial membranes and reduces the absorption of sugar from the gut.[16] Flavonoids contribute to hypoglycaemia through mechanisms such as increased glucose uptake by peripheral tissue, stimulation of insulin release, and regulation of enzymes that play a role in carbohydrate metabolism.[35] Saponins aid in the regeneration of pancreatic beta cells, and the resultant increase in insulin secretion will regulate the glucose levels.[36]

The beneficial effect of *Coriandrum sativum* in the pathological complications of diabetes is attributed to its hepatoprotective activity by virtue of its antioxidant activity. It increases the levels of SOD, catalase, GPX, GST and glutathione reductase which exert their protective effect by defense against reactive oxygen species (ROS) and free radical scavenging.[17] The hypoglycaemic activity observed in response to the use of essential oil of *Coriandrum sativum* may be attributed to its major ingredients such as linalool which stimulates beta cells and increase insulin secretion and activation of insulin receptors. The other major ingredients are terpenes geranyl acetate and gamma. Terpinene, which possess antioxidant activities and decrease the oxidative stress commonly observed in diabetic conditions by reducing free oxygen radicals.[19]

The hypoglycaemic activity of *Coriandrum sativum* might be due to decreased gluconeogenesis and increased glycogenesis, resulting in elevated hepatic glycogen.[20] The hypoglycaemic activity of *Coriandrum sativum* may also be due to increase in the release of Insulin from pancreas due to increase in number of active beta cells.[21] The insulin resistance is associated with decreased expression of GLUT4, a major glucose transporter in adipose tissue and skeletal muscles. Linalool, a major component of coriander essential oil might be involved in the restoration of its expression and improvement in peripheral glucose uptake.[23] The administration of coriander as a powder or in the extract has been shown to exert influence on the metabolism of lipids as documented by various experimental studies. The transport of cholesterol from extrahepatic tissues to the liver for its excretion is believed to be mediated by HDL and plasma LCAT. Dietary incorporation of coriander powder exerts a hypocholesterolaemia effect by enhancing the levels of plasma LCAT and high-density lipoprotein (HDL).[24]

The hypolipidemic action of the coriander might be attributed to the enhanced degradation of cholesterol to faecal bile acids and neutral sterols and inhibition of 3-hydroxy-3 methylglutaryl coenzyme A reductase, a key enzyme of cholesterol biosynthesis.[25] Elevated levels of plasma troponin 1 and Plasma PK-MB are usually associated with an increase in total cholesterol, triacylglycerol, reduced HDL and increased LDL and the administration of extracts of *Coriandrum sativum* has shown decrease in the levels of troponin and Plasma CK-MB indicative of their hypolipidemic activity.[29]

The nerve fibre damage observed in diabetic complications is mediated through oxidative damage as a result of a decrease in antioxidant enzymes (Catalase, SOD, and GSH) and resulting in an increase of free radicals/ reactive oxygen species. An increase in the levels of antioxidant enzymes might be one of the possible mechanisms by which *Coriandrum sativum* will facilitate in combating diabetic peripheral neuropathy. Peripheral neuropathy in diabetes is also mediated through the excessive production of cytokines like TNF- alpha, which causes neuronal hyper-excitability. The beneficial effects of *Coriandrum sativum* administration might be due to a reduction in the production of TNF-α owing to its flavonoid content.[34]

The nephroprotective activity of the *Coriandrum sativum* may be attributed to its anti-oxidant activity owing to high flavonoid and alkaloid contents.[32] The nephroprotective activity of *Coriandrum sativum* may also be due to its linalool and ascorbic acid contents, which reduce lipid peroxidation and combat oxidative damage.[31] The high contents of phenolics and flavonoids also contribute to hepatoprotective activity by virtue of their antioxidant properties.[29]

CONCLUSION

The comprehensive review highlights the significant therapeutic potential of *Coriandrum sativum* (coriander) in managing diabetes mellitus, obesity, and hyperlipidemia-three interconnected metabolic disorders that collectively pose a global health burden. The antidiabetic and hypolipidemic properties of coriander, demonstrated in

various experimental studies, underline its role as a promising natural remedy. The bioactive compounds in coriander, including flavonoids, polyphenols, and essential oils, contribute to its efficacy by enhancing insulin secretion, regulating glucose uptake, modulating lipid metabolism, and exerting antioxidant effects.

Coriander also addresses complications associated with metabolic disorders, such as oxidative stress, insulin resistance, and organ damage, by leveraging its hepatoprotective and anti-inflammatory activities. Additionally, its safety profile and cost-effectiveness offer a compelling alternative or adjunct to conventional therapies.

By integrating traditional medicinal wisdom with modern pharmacological evidence, coriander emerges as a valuable dietary and therapeutic intervention to mitigate the rising prevalence of metabolic disorders. However, further clinical studies are essential to confirm its efficacy and elucidate its mechanisms in humans, paving the way for its broader application in public health management.

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