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Evaluation of atherogenic risk indices and vascular changes following *Coriandrum sativum* L. Root extract treatment in hyperlipidemic rabbits

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Hyperlipidemia is a foremost global health concern. It contributes significantly to cardiovascular diseases and atherosclerosis. Imbalances in the cholesterol pool lead to dyslipidemia, which further intensifies vascular pathology. Natural plant-based therapies are gaining attention as safer alternatives to conventional lipid-lowering drugs. The root of *Coriandrum sativum* remains underexplored for its potential antiatherosclerotic effect. Present study investigated the effect of *Coriandrum sativum* L. root extract on cholesterol-induced hyperlipidemia in rabbits, with particular focus on atherogenic indices and vascular planimetry. Hyperlipdemia was caused through oral dose of cholesterol powder (500mg/kg.b.wt./day) and high-fat diet, followed by 45 days of treatment with either 70% ethanol root extract of *C. sativum* (Gr.III) or Atorvastatin (Gr.IV). Serum lipid profiles, liver and kidney function tests, and other biochemical markers were measured. Atherogenic indices (AI, CRI-I, II & AC) were calculated, and aortic sections were analyzed planimetrically. Treatment with the root extract improved lipid profiles, lowered atherogenic indices, and sustained biochemical markers within normal ranges. Planimetric analysis showed a noticeable reduction in plaque formation compared to the standard drug. These results indicate that *C. sativum* root extract has significant antihyperlipidemic and anti-atherosclerotic properties, emphasizing its potential as a natural therapeutic agent for regulating dyslipidemia and precluding atherosclerosis.

Keywords: Hyperlipidemia, Cardiovascular diseases, atherosclerosis, Herbal extract, vascular planimetry, vascular remodeling

Hypercholesterolemia is a metabolic condition characterized by an imbalance in total cholesterol homeostasis, specifically an elevated concentration of total cholesterol in the body, which predisposes the onset of several other ailments, including atherosclerotic diseases, coronary heart diseases, stroke, fatty liver, Alzheimer's, dementia, pancreatitis, and hepatitis[1]. A strong pathophysiological association between high cholesterol concentration and cardiovascular diseases has been well established[2]. Hypercholesterolemia is a major health burden causing reduced life expectancy and the onset of various metabolic disorders even in developing countries[3]. Alarmingly, epidemiological studies in India indicate an increasing trend of occurrence of high total cholesterol levels among the younger population[4].

Although lipid-lowering diet and pharmacological interventions such as statins, fibrates and niacin are effective in managing dyslipidemia, but their long term use is often associated with adverse effects including pancreatic and hepatic dysfunction, neuropathy, myalgia, myositis, and rhabdomyolysis[5]. In contrast, the complementary and alternative herbal medicinal treatments have shown significantly promising results in the treatment of hyperlipidemia and thus Ayurvedic medicines are gaining momentum with the perspective of safety and efficacy[6].

One such important plant that has been illustrated in Ayurvedic documentations is *Coriandrum sativum* (Family: Apiaceae)[7]. The plant has been pervasively used as a culinary spice and widely cultivated as flavoring agent in seasoning and confectionary products for its distinctive fragrance and flavor[8]. The herb has also been reported to exhibit diverse pharmacological activities including anti-inflammatory, antibacterial, antifungal, antioxidant, anticancer, hepatoprotective, cardioprotective attributes[9,10]. Phytochemical analysis suggests, it is a rich source of various phytochemicals and secondary metabolites such as linalool, vanillic acid, alkaloids, tannins, saponins, dodecanal, polyphenols, tacols, carotenoids, terpenes, and flavonoids, etc[11,12].

While the leaves and seeds of *Coriandrum sativum* have been extensively investigated, the root remains relatively underexplored despite its potential to harbor biologically active compounds. Therefore, the present

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study was aimed to evaluate the anti-atherogenic potential of ethanol extract of *Coriandrum sativum* root in the amelioration of dyslipidemia and atherosclerosis. Additionally, the exploration of relatively underutilized plant parts such as roots may provide novel therapeutic opportunities.

Materials and Methods

Extraction of plant material

The plant material (*Coriandrum sativum* L.) were collected from the local market and subsequently authenticated by the Botanical Survey of India, Jodhpur regional center, assigned reference number (भा.व.स./शु.अ.क्षे.के./A.12012/Tech./2026-27(Pl.ID)/77) has been used for identification in the present study. 70% Ethanol extract was prepared with the use of soxhlet apparatus for 24 hours. The extract was treated under low pressure and temperature, and then distilled to remove excess of ethanol from the extract. After complete removal of ethanol from the extract, it was dried to obtain the dark green colored sticky extract. The extract was stored in desiccation for future use in experiments.

Experimental animals

New Zealand white rabbits (weighing 1.0-1.25 kg.) were obtained from a certified breeding facility. Animals were acclimatized for ten days prior to experimentation and housed in clean metallic wire-mash cages under controlled laboratory conditions (12-hr light-dark cycle, 20-25 ºC temperature, and 40-50% relative humidity). They were provided with standard pellet diet supplemented with fresh green vegetables and drinking water *ad libitum*. All experimental procedures were conducted in accordance with ethical guidelines and were approved by the Institutional Animal Ethical Committee (IAEC, Reg No.: 1646/GO/Re/12/CPCSEA).

Experimentation

Induction of hyperlipidemia

Hyperlipidemia was induced in rabbits by administration of high fat diet; the HFD consisted of 15%protein, 60%carbohydrates, 15%fat, 3% sugar, 4% salt, 1%vitamin and 2% fibers[13]. Additionally, cholesterol powder was administrated at a dose of 500 mg/kg.body-weight/day, dissolved in 5 ml. of coconut oil for 15 consecutive days[14].

Standard Drug Treatment

Atorvastatin (Atorlip-10, Cipla) was used as a standard hypolipidemic drug. It was administrated orally at the dose of 0.25mg/kg.body weight/day dissolved in 5 ml of distilled water.

Plant Extract Administration

The 70% ethanol extract of *Coriandrum sativum* root was administered orally at a dose of 500mg/kg body weight, suspended in 5ml of distilled water. The dose was selected based on results from LD_{50} test and available literature.

Experimental design

The experiment was designed as a curative model. Hyperlipidemia was induced for initial 15 days, after which animals were randomly divided in four groups (n= 5). Then the treatment was initiated. The treatment was continued for remaining 45 days, thus the total experimental period lasted for 60 days.

Group - I: Untreated control.

Group- II: Hyperlipidemic control.

Group- III: Hyperlipidemic + 70%EtOH of Coriander root treatment.

Group- IV: Hyperlipidemic + Atorvastatin (Atorlip-10) treatment.

Blood collection and serum preparation

At the end of experimental period, over night fasted animals were sacrificed under prolonged anesthesia. Blood was collected by direct cardiac puncture and centrifuged at 3000 rpm for 15 minutes to separate serum, which was stored at -20ºC until further analysis.

Biochemical analysis and atherogenic indices

Serum biochemical parameters, including total cholesterol (TC), triglycerides (TG), Low-density lipoprotein (LDL), High- density lipoprotein (HDL)and total lipid levels were measured using a biochem Auto-analyser Rx-50 (Microlab Instrument) with commercial diagnostic kits (Siemens Healthcare Diagnostics, USA)[15]. Several atherogenic risk indices were calculated. These include Castelli's Risk Index-I (CRI-I; TC/HDL-C) and Castelli's Risk Index –II (CRI-II; LDL-C/HDL-C)[16] which are usually recognized as marker of lipid-related risk. Furthermore the Atherogenic Coefficient (AC; TC-HDL-C/HDL-C) and non HDL-Cholesterol (TC-HDL-C) were also calculated to provide a comprehensive assessment of the atherogenic lipoprotein burden. The Athergenic index of Plasma (AIP; log [TG/HDL-C])[17] was also evaluated as it is considered as a strong predictor of cardiovascular disease risk burden.

Safety evaluation was performed by assessing standard biochemical markers including liver and

kidney function parameters using commercial assay kits[18].

Histological study

After the autopsy aorta was excised and processed for histological examination. Tissues were fixed in formalin, trimmed into small pieces and subjected to graded alcohol dehydration before paraffin embedding. Paraffin blocks were sectioned at 5µm thickness using a microtome. Sections were stained with Harris hematoxylin and eosin (H&E) stain and observed for histopathological changes under a light microscope.

Planimetric analysis of the histological sections of aorta was performed to quantify tissue architecture and lesion areas manually using a calibrated ocular micrometer fitted in a light microscope. Lesion areas were measured in five non-overlapping fields per section, and mean values were calculated for statistical evaluation.

Statistical analysis

All biochemical parameters were expressed as the mean ± standard error of the mean (SEM). Data were analyzed using One-way analysis of variance (ANOVA) followed by Tukey's multiple comparison tests. GraphPad Prism-7 was used for data analysis and graphical representations were created using MS Excel-2007. A *P*-value of <0.05 was considered statistically significant.

Results

Lipid profile

High cholesterol diet administration for 15 days resulted in a significant elevation of serum cholesterol (TC), triglycerides (TG), high-density lipoprotein (HDL), low-density lipoprotein (LDL-C), very low-density lipoprotein (VLDL) and total lipid in hyperlipidemic control rabbits compared to the control group ($P \leq 0.05$). Administration of 70% EtOH of *Coriandrum sativum* root extract (500mg/ kg.b.wt/day) for 45 days appreciably attenuated hyperlipidemia by lowering down the total cholesterol by (TC) 88.58%, LDL-C by 91.54%, VLDL by 75.1%, triglycerides by 75.16% and total lipid by 81.46%. These results were comparable to the standard drug treated group.

Following the observed improvements in the serum lipid profile the atherogenic risk of the experimental group was further assessed using calculated indices. The treated group exhibited marked normalization in key atherogenic markers, both Castelli's risk indices-I & II were reduced in the treated group compared with hyperlipidemic control group ($P \leq 0.001$), indicating a favorable shift in cholesterol homeostasis. A considerable increase in the atherogenic coefficient and non HDL-C was observed after induction of hyperlipidaemia, relative to the untreated control group ($P \leq 0.001$) in hyperlipidemic group. Both plant extract and atorvastatin treatment were associated with a marked decline in the atherogenic coefficient and non HDL cholesterol, suggesting restoration towards normal value ($P \leq 0.001$) in comparison with hyperlipidemic group (Table 1).

Like wise the Atherogenic Index of Plasma was lowered reflecting improvement in triglyceride- HDL equilibrium. Moreover derived ratio such as, the protective HDL/LDL ratio increased appreciably in coriander root extract (70%EtOH) treated animals. The extent of improvement in most indices was comparable with that observed in the standard statin- treated group (Fig. 1).

Table 1 — Lipid profile of hyperlipidemic rabbits following treatment with 70% ethanol extract of coriander root.

Group Name	Untreated control (Gr.I)	Hyperlipidemic control (Gr.II)	Coriander Root (Gr.III)	Statin (Gr.IV)
CHOLESTEROL (mg/dL)	79.8 ±8.63	990.08 ±60.16^{c}	113.02±7.6^{b,g}	115.35 ±7.3^{b,g}
HDL-C (mg/dL)	27.3 ±2.01	112.9 ±11.16^{c}	30.6±2.27^{d,g}	27.05 ±2.97^{d,g}
LDL-C (mg/dlL)	16.11 ±1.36	817.6 ±71.16^{c}	69.1 ±1.12^{c,g}	67.61 ±2.8^{c,g}
VLDL (mg/dL)	19.46 ±1.67	59.44 ±4.76^{c}	14.8 ±2.02^{a,f}	20.69 ±2.51^{d,f}
TRIGLYCERIDES (mg/dL)	80.16 ±6.01	299.22 ±25.12^{c}	74.3 ±12.01^{b,g}	103.45 ±13.79^{b,g}
Non HDL-C	52.5 ±2.05	877.18±5.24^{c}	82.42 ±2.89^{b,g}	88.3 ±1.92^{c,f}
HDL/LDL	1.69 ±0.2	0.138 ±0.87^{c}	0.44 ±0.16^{c,h}	0.40 ±0.1^{d,h}
Total Lipid (mg/dL)	323.71 ±30.16	2379.8 ±210.16^{c}	393.14 ±40.79^{d,g}	431.37 ±41.12^{d,g}

Values are expressed as mean±SEM (n=5). Group II to IV were compared with Group I, where $P \leq 0.05$=a, $P \leq 0.01$=b, $P \leq 0.001$=c and non significant =d. Group III and IV were compared with Group II, where $P \leq 0.05$=e, $P \leq 0.01$=f, $P \leq 0.001$=g and non significant =h. SEM: Standard error of the mean.

Serum biochemical markers

Hyperlipidemic control rabbits demonstrated marked deviation in serum biochemical markers, including liver function test (ALT,AST,ALP) and renal functional test (Urea, Creatinine), in comparison with control group. This indicated hepatic and metabolic alterations due to high lipid concentration. On the other hand, treatment with 70% ethanol extract of Coriander root exhibited significant normalization in these biochemical parameters, which was comparable with normal control and standard drug treated groups (Table 2). However these values displayed minor deviation from standard human physiological ranges, they remained within a near normal range for rabbits.

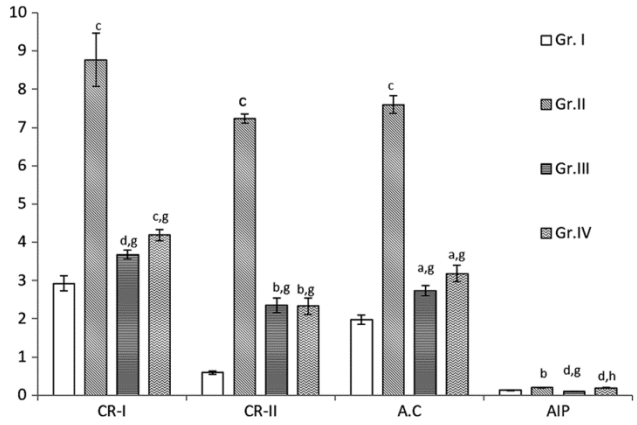

Fig. 1 — Comparative effect of coriander root extract (70% EtOH) and standard drug Atorvastatin on atherogenic indices on hyperlipidemic rabbots. Values are expressed as Mean±SEM (n=5). Group II-IV were compared with Group I ($P \leq 0.05$ = a, $P \leq 0.01$ = b, $P \leq 0.001$ = c, ns = d) Group III and IV were compared with Group II ($P \leq 0.05$ = e, $P \leq 0.01$ = f, $P \leq 0.001$ = g, ns = h). Gr.I Untreated control, Gr. II: Hyperlipidemic control, Gr. III:70% EtOH of Coriander root treated, Gr. IV: Standard drug Atorvastatin treated.

Planimetric evaluation

Planimetric assessment of the arterial wall revealed significant alterations across the experimental groups. The total wall area was significantly increased in hyperlipidemic control rabbits, in comparison with normal control once ($P \leq 0.001$). Whereas treatment with coriander root extract (70% EtOH) and standard drug atorvastatin markedly reduced the increased total wall area. Lumen area was significantly decreased in hyperlipidemic control group, in comparison with normal control group. While both coriander root extract (70% EtOH) and atorvastatin treated groups demonstrated appreciably increased lumen dimension, in comparison with hyperlipidemic control group ($P \leq 0.001$). Intimal thickness showed no significant alterations across all experimental groups compared to normal control group, and similarly no significant difference were observed when compared with hyperlipidemic control rabbits. Plaque size was markedly elevated in all experimental groups relative to normal control group, while both coriander root extract (70%EtOH) and atorvastatin treatments significantly reduced plaque dimensions ($P \leq 0.001$). Media thickness showed moderate, non significant alterations across groups; similarly adventitia thickness remained largely unaltered between the experimental groups (Table 3).

Hyperlipidemic control rabbits exhibited significant increase in % stenosis and plaque burden compared to normal control group ($P \leq 0.001$), indicating extensive arterial lesion formation. Treatment with coriander root extract (70%EtOH) and

Table 2 — Serum biochemistry profile of hyper-lipidemic rabbits treated with 70% EtOH of coriander root extract.

Biochemical parameters	Group I: Untreated control	Group II: Hyper-lipidaemic control	Group III: coriander root extract	Group- IV: Atrovastatin
Blood sugar (mg/dL)	89.5 ±8.76	118.4 ±15.12^{a}	91.24 ±8.6^{d,f}	102.6 ±10.14^{d,h}
Blood urea (mg/dL)	46.05 ±3.66	82.3 ±8.76^{b}	40.04 ±6.36^{d,g}	51.9 ±4.33^{d,f}
Creatinin (mg/dL)	0.81 ±0.07	1.25 ±0.16^{a}	0.89 ±0.06^{d,f}	1 ±0.18^{d,h}
Uric acid (mg/dL)	3.7 ±0.3	2.05 ±0.21^{b}	3.1 ±0.46^{d,g}	5.02 ±0.36^{b,g}
SGOT (U/L)	74.9 ±7.5	163.35 ±5.16^{a}	95.4 ±8.1^{a,g}	88.75 ±8.23^{b,f}
SGPT (U/L)	71.5 ±7.5	175 ±8.12^{d}	93.55 ±7.9^{a,f}	152.35 ±14.21^{b,f}
Bilirubin total (mg/dL)	1.06 ±0.01	0.63 ±0.06^{c}	0.6 ±0.04^{d,e}	0.72 ±0.06^{c,h}
Alkaline phosphatase (U/L)	130.1 ±15.12	235.1 ±21.3^{b}	111.45 ±10.76^{d,g}	158.35 ±14.1^{d,f}
Albumin (mg/dL)	2.9±0.3	3.23±0.41^{a}	2.820.±0.36^{d,e}	3.54±0.19^{b,e}
Globulin (mg/dL)	3.05±0.27	2.4±0.16^{b}	2.9±0.11^{d,f}	2.9±0.23^{a,f}
Total protein (g/dL)	6.8 ±0.35	5.21 ±0.43^{b}	5.32 ±0.36^{d,e}	5.44 ±0.49^{b,h}

Values are expressed as mean±SEM (n=5). Group II to IV were compared with Group I, where p≤0.05=a, p≤0.01=b, p≤0.001=c and non significant =d. Group III and IV were compared with Group II, where $P \leq 0.05$=e, $P \leq 0.01$=f, $P \leq 0.001$=g and non significant =h. SEM: Standard error of the mean

Table 3 — Planimetric evaluation of vascular parameters of hyperlipidemic rabbits treated with 70% EtOH of coriander root extract.

Group name	Total wall area	Lumen	Intima	Plaque	Media	Adventitia
	----------% of Total Area----------					
Untreated control (Gr.I)	50.13 ±3.01	47.12 ±1.01	14.1 ±0.3	Nil	27.1 ±0.1	10.12 ±1.01
Hyperlipidemic control (Gr.II)	83.01 ±0.61^{c}	14.01 ±0.46^{c}	9.16 ±0.3^{d}	42.01 ±2.01^{c}	25.25 ±0.6^{d}	11.01 ±1.26^{d}
Coriander Root (Gr.III)	61.46 ±5.09^{a,f}	38.99 ±3.01^{a,g}	10.13 ±0.63^{d,h}	13.12 ±0.79^{c,g}	29.23 ±1.96^{d,h}	9.01 ±1.06^{d,h}
Statin (Gr.IV)	49.16 ±1.76^{a,g}	51.76 ±2.66^{d,g}	12.01 ±0.41^{d,h}	6.12 ±0.13^{c,g}	20.12 ±1.62^{d,h}	10.16 ±1.02^{d,h}

Values are expressed as mean±SEM (n=5). Group II to IV were compared with Group I, where $P \leq 0.05$=a, $P \leq 0.01$=b, $P \leq 0.001$=c and non significant =d. Group III and IV were compared with Group II, where $P \leq 0.05$=e, $P \leq 0.01$=f, $P \leq 0.001$=g and non significant =h. SEM: Standard error of the mean

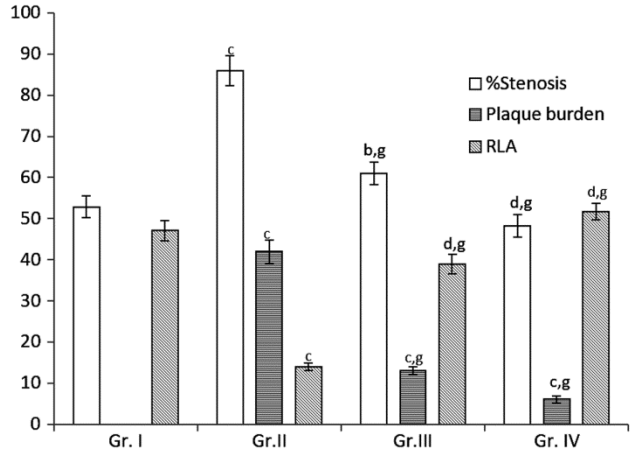

Fig. 2 — Comparative effect of Coriander root extract (70% EtOH) and standard drug on Planimetric parameters: % Stenosis, Plaque Burden and RLP, in hyperlipidemic rabbits. Values are expressed as Mean±SEM (n=5). Group II-IV were compared with Group I ($P \leq 0.05$ = a, $P \leq 0.01$ = b, $P \leq 0.001$ = c, ns = d) Group III and IV were compared with Group II ($P \leq 0.05$ = e, $P \leq 0.01$ = f, $P \leq 0.001$ = g, ns = h). Gr.I Untreated control, Gr. II: Hyperlipidemic control, Gr. III:70% EtOH of Coriander root treated, Gr. IV: Standard drug Atorvastatin treated.

atorvastatin significantly reduced % stenosis and plaque accumulation, in comparison with hyperlipidemic untreated control group ($P \leq 0.001$). Relative lumen area (RLA) showed marked decrease in hyperlipidemic control group compared to normal control group, where as treatment with coriander root extract (70%EtOH) and atorvastatin significantly restored RLA towards normal condition ($P \leq 0.001$) (Fig. 2).

Histology of aorta

Histological analysis of the aortic section which was stained with hematoxylin and eosin (H&E) depicted normal vascular histoarchitecture in the untreated control group, characterized by an intact endothelium, well defined tunica media and uniformly arranged elastic lamellae, without any plaque deposition. In contrast, the hyperlipidemic control group demonstrated marked disruption of the endothelial lining, degeneration of elastic fibers and evident thickening of the tunica intima, indicating plaque development. On the other hand treatment with coriander root extract (70% EtOH) and atorvastatin profoundly restored the vascular morphology, demonstrating reorganization of elastic lamellae, reduction in intimal thickening and near normal endothelial continuity. These findings were comparable to those observed in untreated control group (Fig. 3).

Discussion

The notion that dietary cholesterol contributes to hypercholesterolemia and elevates cardiovascular disease (CVD) risk has long been recognized in experimental and clinical research. Among various determinants of atherosclerosis and its associated complications, diet remains a critical factor[19]. Serum cholesterol levels are directly modulated by the lipid composition of the diet in various animal models[20]. In the present study, oral administration of cholesterol powder (500/kg body weight) along with high fat diet induced hyperlipidemia in experimental rabbits. These findings are consistent with earlier reports demonstrating that dietary cholesterol supplementation markedly elevates serum cholesterol concentrations[21,22]. *Coriandrum sativum* is a good reservoir of various bioactive compounds including linalool, geraniol, linoleic acid, vanillic acid and decanol[23].

The presence of these constituents underlies the diverse pharmacological properties reported for various parts of the herb, such as cardio protective[24], antimicrobial, anti-diabetic, antioxidant, anti-mitogenic, anti-inflammatory[25], antiepileptic, antidepressant, anxiolytic, antihypertensive, diuretic and anti-dyslipidemic activities[26]. Despite this pharmacological profile, the root of the plant has been relatively less explored compared to its leaves and seeds. Therefore the present study was undertaken to evaluate the hypolipidemic and vascular protective effects of *C. sativum* root. In the present study, 70% ethanol

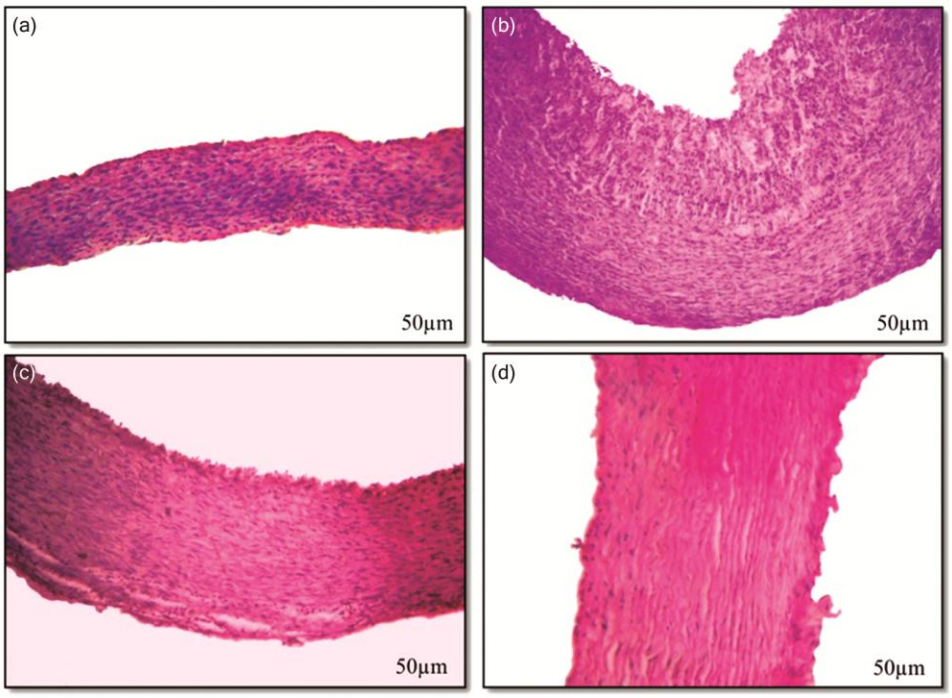

Fig. 3 — Histological micrographs of aortic sections stained with H&E (100X) (a) Untreated control — normal vascular morphology; (b) Hyperlipidemic control group — intimal thickening and elastic fiber disruption; (c) Coriander root extract treated group — marked restoration of vessel wall integrity and reduction in intimal thickening, (d) Standard drug- Atorvastatin treated group— nearly normal vascular architecture. Scale bar = 50 µm.

extract of *C. sativum* root exhibited marked hypolipidemic activity, restoring serum cholesterol, HDL-C, LDL-C VLDL and total lipid levels towards normal. These results align with previous reports demonstrating that coriander seed oil improves plasma lipid profiles and exerts hypocholesterolemic effects in cholesterol-rich diet fed rats[27] and also with Das *et al.* who observed significant lipid-lowering effects of *C. sativum* in diabetic dyslipidemic rats[28]. The atherogenic risk of plasma is regarded as robust marker of cardiovascular risk predispostion[29]. Although studies directly evaluating the effect of *Coriandrum sativum* on atherogenic indices are scarce, the present study demonstrated significant improvement in CR-I, II, AIP and AC. Comparable effects have been reported with other hypolipidemic plant extracts, highlighting similar mechanistic pathways involving lipid regulation and antioxidant modulation. For instance, *Cuminum cyminum* seed extract exhibited HMG-CoA reductase inhibition and normalize atherogenic risk indices[30], while polyphenols such as myricetin and quercetin showed hypocholesterolemic efficacy in cholesterol fed rabbits[31], Feugreek- supplemented camel milk improved lipid profiles and atherogenic indices in wistar rat models[32] and aqueous seed extracts of *Syzygium aromaticum* demonstrated appreciable antilipidemic effects reflected by atherogenic risk indices in wistar rats[33]. These collective findings support the present observations and underscore the potential of *C. sativum* as a natural hypolipidemic agent. Moreover studies suggest that diabetes mellitus and atherosclerosis are closely interconnected metabolic conditions, where metabolic dysregulation such as hyperglycemia and dyslipidemia lead to endothelial dysfunction[34]. In present study, 70% EtOH of *Coriandrum sativum* root considerably reduced serum glucose levels towards normal, demonstrating notable hypoglycemic activity of the plant. These results are consistent with previous reports showing that Coriander seed supplementation improved glycemic indices in type- 2 diabetic patients[35], and that Coriander root extracts exhibit alpha- glucosidase inhibitory activity alongside antioxidant effects[36].

In the present study, normalization of urea, creatinine, and uric acid levels towards control group indicates that *Coriandrum sativum* root extract exerts a protective influence on renal function under toxic stress. Comparable nephroprotective response has

been reported for other plant parts of *C. sativum*. Kajal and Singh (2019) demonstrated that the seed extract attenuated diabetic nephropathy and improved renal histoarchitecture in wistar rats[37]. Similarly Kumar and co-workers reported that administration of Coriandrum sativum seed extract to experimental rats significantly restored histoarchetecture of renal tissue and improved renal cellular integrity[38]. A recent review by Anaeigoudari (2024) further emphasized the antioxidant and nephropretective potential of *C.sativum*[39]. Additionally Shalaby et al. reported that *Coriandrum sativum* aqueous seed extract significantly improved renal bio-chemical parameters in carbendazim- induced nephrotoxicity, indicating its nephroprotective potential[40]. In the present study, hepatic biochemical parameters, including SGOT, SGPT, ALP, Albumin, globulin and, total protein, remained comparable to control values, indicating that *C. sativum* root extract did not exert any hepatotoxic effect. These findings are consistent with previous reports demonstrating hepatoprotective potential of various plant parts of Coriander. Sorial and Adly[41] observed normalization of liver function parameters in streptozotocin- induced diabetic rats following administration of Coriander aqueous extract. Similarly, Sfar et al.[42] reported hepatoprotection against cadmium- induced toxicity with Coriander seed polysaccharides, while comparative studies on Coriander and Garlic extract also confirmed systemic organ safety[43]. Moreover Planimetric analysis of the aortic sections in 70% EtOH treated group revealed marked preservation of vascular integrity with reduced intimal thickening and plaque burden when compared to hyperlipidemic controls. The architecture of the aortic wall exhibited normal elastic lamellae and intact endothelial lining, suggesting significant vascular protection. These findings indicate that *C.sativum* root extract effectively mitigates atherosclerotic progression and improves vessel morphology. Similar vascular benefits of *C. sativum* have been attributed to its endothelium dependent vasorelaxant properties mediated via reduction of oxidative stress and arsenic-induced vascular injury in experimental rats[44]. Moreover, the comprehensive review by Pathak *et al*. (2022) corroborates its cardio-protective and anti-atherogenic potential through anti oxidant, lipid modulatory and endothelial- stabilizing actions[45]. The observed reduction in aortic plaque area and restoration of luminal architecture in the present study, therefore, may be ascribed to the synergistic effects of improved endothelial function and attenuation of oxidative and lipid mediated vascular injury induced by *C. sativum* root constituents.

Several pharmacological therapies are widely employed to manage dyslipidemia and reduce cardiovascular risk factors, including statins, fibrates, niacin, and β-blockers. Among these, statins are considered the most effective and commonly prescribed medications, acting through direct inhibition of the key regulatory enzyme HMG-Co A reductase in the mevalonate pathway. This inhibition suppresses endogenous cholesterol biosynthesis and effectively lowers down circulating lipid levels[46]. However, despite their efficacy, long term statin therapy is often associated with adverse effects such as myopathy, rhabdomyolysis, and hepatic dysfunctions[5]. These limitations highlight the urgent need for alternative therapeutic strategies that are safe, non-toxic, cost-effective, and derived from natural sources. Among various herbal candidates, *Coriandrum sativum* (Coriander) root extract emerges as a promising alternative owing to its rich phytochemical composition and minimal toxicity profile. In the present study, the standard drug atorvastatin significantly reduced serum lipid concentrations and atherogenic indices, effects that were found to be comparable with those observed in the *Coriandrum sativum* root extract-treated group. Moreover, the Planimetric parameters of both treatment groups demonstrated similar vascular protection. Collectively, these findings establish C.sativum root extract as potential and safer herbal substitute for conventional statin therapy.

The hypolipidemic and vascular protective effects of *Coriandrm sativum* root extract are likely mediated through multiple complementary mechanisms. Although, detailed phytochemical characterization of the root is limited. It is suggested that roots may contain some bioactive attributes such as polyphenols, flavonoids and terpinoid compound, which could contribute to the observed pharmacological effects. These phytochemicals may inhibit the HMG-CoA reductase enzyme activity, thus reducing endogenous cholesterol biosynthesis.

In addition, the extract exhibit antioxidant potential may be due to the presence of linalool. Linalool has been reported to enhance catalase activity in diabetic rat model without directly affecting blood glucose level[47]. Coriander has also been reported to possess free radical scavenging properties[48], protective effects

against oxidative stress induced mitochondrial/ lysosomal damage in human lymphocytes[49]. Furthermore, Goswami et al. (2025) demonstrated that linalool modulates oxidative stress and inflammatory pathways, which may contribute to the vascular protection observed in the present study[50].

The anti inflammatory potential of the extract may further suppress pro-inflammatory cytokines, thereby improving endothelial integrity and function, thus preventing atherogenic remodeling. The observed improvements in lipid profile including reduction in LDL and Triglycerides with concomitant increase in HDL, support restoration of systemic lipid homeostasis. Collectively these mechanisms may underlie the improved planimetric and histomorphometric parameters observed in the present study, providing mechanistic bases for the hypolipidemic and vascular protective effects of *C. sativum* root extract.

Taken together, these findings suggest that *Coriandrum sativum* exert hypolipidemic, anti-inflammatory and lipid modulating mechanism.

Conclusion

Collectively, these findings suggest that *Coriandrum sativum* root extract may serve as potential herbal alternative for the management of hyperlipidemia. The extract exhibit significant hypolipidemic effect along with improvements in atherogenic risk indices, thereby contributing to enhanced vascular integrity and reduced cardiovascular risk in cholesterol fed hyperlipidemic rabbits.

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Conflicts of Interest

The authors declare no conflict of interest.

Limitation of the study

The present study did not include assessment of hepatic lipid profile, which could provide additional insight into lipid accumulation and its correlation with observed effects. Additionally, phytochemical assessments of the extract and toxicity evaluation following standard OECD guidelines were not performed, which could further support the mechanistic and safety aspects of the study.

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