

Antihyperlipidemic And Thrombolytic Potential Of Medicinal Plants: Implications For Cardiovascular Prevention

Ghube D. D.^{1*}, Tangade K. M.², Tathe P. R.³

¹*Department of Pharmacology, Samarth College of Pharmacy, Deulgaon raja, Maharashtra India
ORCID ID: 0009-0001-8012-0736*

²*Department of Pharmacology, Samarth College of Pharmacy, Deulgaon raja, Maharashtra India
ORCID ID: 0009-0003-3691-463X*

³*Department of Pharmacology, Samarth College of Pharmacy, Deulgaon raja, Maharashtra India
ORCID ID 0000-0003-2163-2974*

ABSTRACT

Hyperlipidemia and thrombosis are key pathological drivers of cardiovascular disease, hypertension, and atherosclerotic progression. Although statins and synthetic thrombolytic agents constitute first-line therapeutic options, their prolonged use is often constrained by adverse reactions, economic burden, and bleeding complications. These limitations have intensified interest in plant-derived interventions as safer and preventive alternatives.

This narrative review systematically examines medicinal plants exhibiting antihyperlipidemic and thrombolytic activity, with particular emphasis on mechanistic pathways relevant to cardiovascular prevention. Findings from in vitro experiments, animal studies, and limited clinical investigations suggest that phytoconstituents such as flavonoids, polyphenols, saponins, and omega-3 fatty acids modulate lipid homeostasis through inhibition of cholesterol biosynthesis, enhanced bile acid elimination, regulation of lipid-metabolizing enzymes, and protection against oxidative modification of LDL.

Additionally, several plant species demonstrate fibrinolytic potential by facilitating plasminogen activation, promoting fibrin breakdown, inhibiting platelet aggregation, and attenuating pro-coagulant signaling. In vitro assessment of a polyherbal formulation containing *Allium cepa* and *Linum usitatissimum* revealed significant clot-lysis activity relative to negative controls, indicating synergistic thrombolytic effects.

Collectively, medicinal plants may serve as valuable adjuncts in cardiovascular risk reduction; however, rigorous clinical trials, extract standardization, and pharmacokinetic characterization are required before their incorporation into evidence-based cardiovascular prevention frameworks.

Keywords: Hyperlipidemia; Thrombosis; Cardiovascular prevention; Medicinal plants; Hypertension risk.

How to cite this article: Ghube DD, Tangade KM, Tathe PR. Antihyperlipidemic and thrombolytic potential of medicinal plants: implications for cardiovascular prevention. *Int J Drug Deliv Technol.* 2026;16(7s): 846-855; DOI: 10.25258/ijddt.16.7s.90

Source of support: Nil

Conflict of interest: None

INTRODUCTION

Thrombosis involves the formation of blood clots in vessels, obstructing flow and risking severe issues like heart attacks, strokes, or pulmonary embolisms. Risk factors include poor diet, oxidative stress, and inflammation. Modern medicine increasingly focuses on preventive natural strategies, such as incorporating functional foods into diets.(1). Currently, hyperlipidemia is mostly treated with statins, which decrease cholesterol by inhibiting the enzyme HMG-CoA reductase in the liver. Statins are beneficial, but long-term treatment can induce muscle discomfort, liver difficulties, digestive troubles, and, in some cases, neurological symptoms. Because of these negative effects, there is a growing

interest in safer, natural ,plant-based alternatives. Sesame seeds, which have been used in traditional medicine for ages, including Ayurveda and Chinese medicine, have been proven in tests to have substantial antioxidant, anti-inflammatory, liver-protective, and cholesterol-lowering qualities.(2) A significant risk factor for cardiovascular diseases (CVDs), which cause approximately one-third of deaths globally and are predicted to overtake all other causes of mortality and disability, is hyperlipidemia. It involves lower HDL levels and higher plasma lipid levels, including cholesterol, triglycerides, and lipoproteins, including LDL and VLDL. Hypertriglyceridemia and hypercholesterolemia are two conditions that greatly

contribute to atherosclerosis, which is strongly associated with ischemic heart disease (IHD) and high death rates. Atherosclerosis is a condition in which cholesterol is in artery walls, resulting in a number of vascular disorders and constricted arteries. Additionally, oxidative stress and free radical generation are increased by hyperlipidemia, leading to detrimental alterations in LDL that facilitate the onset and advancement of atherosclerosis and CVDs. (3). Herbal plants, as these owe significant quantity of phytochemicals including proteins, glycosaponins, alkaloids, tannins polyphenols and flavonoids, are used to treat a number of ailments in human (2,4). The cure of many diseases such as cancer, hypoglycemia, osteoporosis, cardiovascular diseases, central nervous systems disorders and obesity is dependent on such phytochemical constituents present in medicinal plants (5). *Nigella sativa* has demonstrated promising thrombolytic and anticoagulant activities through *in vitro* studies. Its active compounds, particularly thymoquinone, show potential in promoting fibrinolysis and inhibiting platelet aggregation, which could enhance clot dissolution and prevent thrombus formation. These properties position *Nigella sativa* as a potential natural alternative to conventional thrombolytic and anticoagulant therapies. (2) The review is divided into three sections: plants that reduce blood lipids, plants that dissolve blood clots, and plants that have both effects. It covers a variety of research approaches, including laboratory testing (such as enzyme inhibition and clot-lysis assays), animal studies (such as high-fat diet-induced hyperlipidemia models in rats), and human clinical trials. Across numerous evaluated papers, comparable biological pathways are described. These include blocking HMG-CoA reductase to reduce cholesterol formation, boosting cholesterol elimination by bile acid excretion, preserving tissues with antioxidant activity, and breaking down blood clots with fibrinolytic activities. The review incorporates findings from several sources, with references referenced throughout to support these mechanisms and action. (6)

RATIONALE OF REVIEW

Cardiovascular disorders are the leading cause of sickness and mortality globally, owing to illnesses such as excessive blood lipid levels (hyperlipidemia) and blood clot formation (thrombosis). Although synthetic

medications are widely used to treat these conditions, they frequently have negative side effects such as liver damage and muscle toxicity. As a result, there is an increasing demand for safer and more cost-effective treatment choices. A thorough examination of medicinal plants with lipid-lowering and clot-dissolving capabilities emphasizes the promise of herbal medicines as natural alternatives. These plants may offer efficient cardiovascular protection with fewer side effects and a lower toxicity.

❖ Antihyperlipidemic Activity Overview:

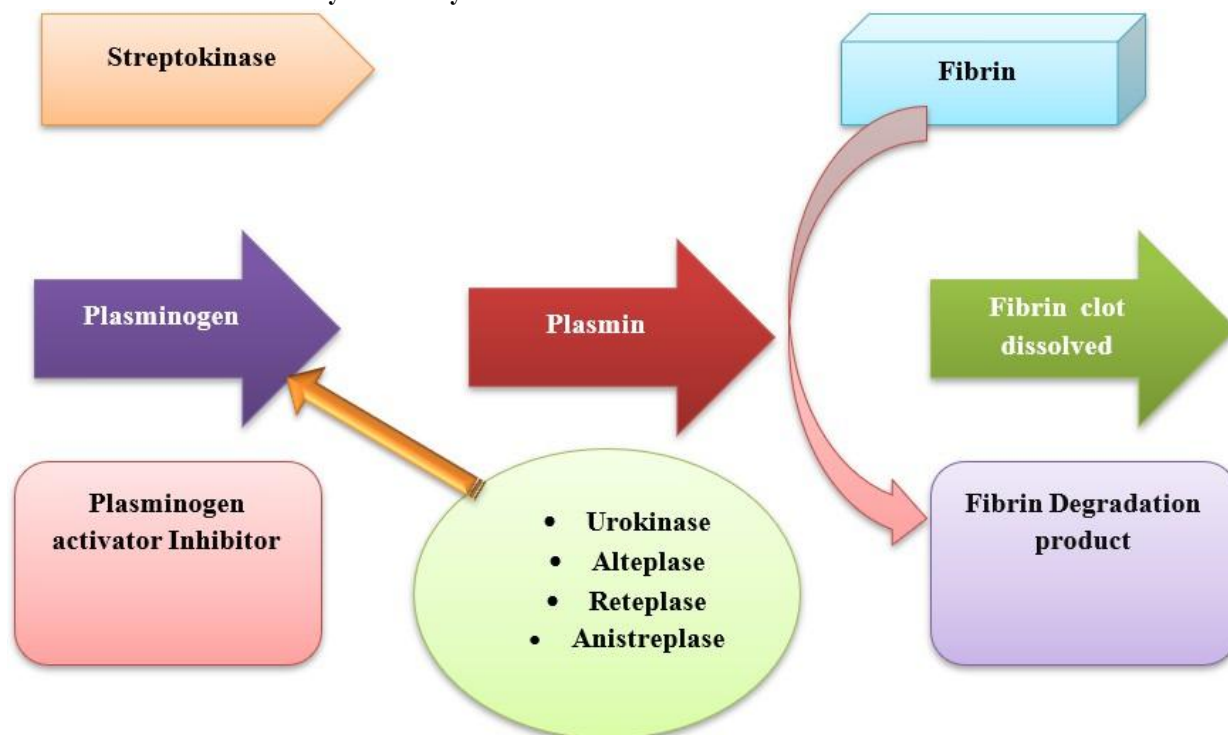
Hyperlipidemia is a lipid metabolic illness characterized by elevated blood lipid and lipoprotein levels, including total cholesterol, triglycerides, LDL, VLDL, and, in certain cases, HDL. (7) These anomalies increase the risk of significant cardiovascular issues such as atherosclerosis, heart attacks, strokes, myocardial infarctions, and pancreatitis. Hyperlipidemia can be intrinsic (genetic) or secondary to conditions such as diabetes, hypothyroidism, or renal dysfunction. Unhealthy lifestyle choices, particularly high-fat, saturated-fat, cholesterol-containing meals, and extra calories, play a significant role. (8)

❖ Thrombolytic Activity Overview:

Fermented soy products and black soybean extracts have demonstrated significant antithrombotic effects through inhibition of platelet aggregation and enhancement of fibrinolysis (9,10).

Thrombus-related disorders, such as heart attack and stroke, occur when blood clots block blood vessels, resulting in serious consequences or death. Streptokinase, urokinase, tPA (alteplase), and newer medicines such as tenecteplase and reteplase are routinely used thrombolytic medications for the removal of blood clots. Although these medications are beneficial, they do not always reduce mortality and are associated with side effects, particularly when used long-term. With the rising incidence of cardiac disease in India, including among young people, there is an increasing demand for safer thrombolytic therapy. Plant-based thrombolytic medicines are viewed favorably since they may be less toxic and have fewer adverse effects. As a result, current research focuses on finding effective and safer herbal thrombolytic medicines. (11)

Mechanism of Thrombolytic Activity:



➤ **Risk of Thrombolysis:**

Thrombolysis, which helps dissolve blood clots and increase blood flow without surgery, is not suitable for everyone. It can raise the risk of significant bleeding, thus doctors avoid giving it to those who are already predisposed to bleeding.

- Heavy bleeding
- Haemorrhagic stroke
- Kidney impairment
- Taking anticoagulants and blood thinners
- Elevated blood pressure

➤ **SIGNS AND SYMPTOMS OF HYPERLIPIDEMIA:**

- Discomfort or pain in chest
- Pain in abdomen
- Enlargement of Spleen
- Liver Enlargement and swelling
- Heart attack / myocardial infraction

➤ **CAUSES OF HYPERLIPIDEMIA:**

- Pregnancy
- Kidney impairment
- Genetics
- High intake of dietary carbohydrate
- Hypercortisolism
- Estrogen therapy
- Hypothyroidism

➤ **List of Herbal Plants used in Thrombolytic and antihyperlipidemic Activity:**

Sr. No	Plant	Parts of Plant	Extract	Active Chemical Constituents	MOA	Effective Dose	LD50
1	<i>Nigella sativa</i> (Black Cumin)	Seeds	Methanolic	Thymoquinone	Fibrinolytic; antioxidant; inhibits HMG-CoA reductase; plasminogen activation	200–500 mg/kg (oral)	Most >2000 mg/kg (safe)

2	<i>Vigna unguiculata</i> (Cowpea)	Seeds	Methanolic	Flavonoids	Plasminogen activation; increases prothrombin time; lipid modulation	10 mg/mL (in vitro)	Most >2000 mg/kg (safe)
3	<i>Linum usitatissimum</i> (Flaxseed)	Seeds	Hydroalcoholic	Omega-3 (ALA)	Antiplatelet; inhibits lipid absorption; modulates lipid metabolism genes	500–1000 mg/kg (animal)	Most >2000 mg/kg (safe)
4	<i>Sesamum indicum</i> (Sesame)	Seeds	Ethanolic	Sesamin	Inhibits lipid oxidation; modulates lipid enzymes; antioxidant	200–400 mg/kg	Most >5000 mg/kg (safe)
5	<i>Carthamus tinctorius</i> (Safflower)	Seeds	Ethanolic	Linoleic acid	Inhibits lipase; antioxidant; antiplatelet/thrombolytic	500–1000 mg/kg	Most >4000 mg/kg (safe)
6	<i>Trigonella foenum-graecum</i> (Fenugreek)	Seeds	Ethanolic	Diosgenin	Inhibits cholesterol absorption; binds bile acids; HMG-CoA inhibition	200–500 mg/kg (oral)	Most >5000 mg/kg (safe)
7	<i>Glycine max</i> (Soybean)	Seeds	Methanolic	phytosterols	Isoflavones modulate lipids; antiplatelet	500–1000 mg/kg	Most >5000 mg/kg (safe)
8	<i>Ficus carica</i> (Fig)	Seeds	Methanolic	Flavonoids	Inhibits pancreatic lipase; antioxidant; antiplatelet	500 mg/kg	Most >2000 mg/kg (safe)
9	<i>Cucumis melo</i> (Melon)	Seeds	Ethanolic	Unsaturated fats	Antioxidant; lipid modulation	500 mg/kg	>2000
10	<i>Syzygium cumini</i> (Jamun)	Seeds	Methanolic	Anthocyanins	Inhibits HMG-CoA; lowers liver lipid synthesis	200–400 mg/kg	>2000
11	<i>Vernonia anthelmintica</i>	Seeds	Methanolic	Flavonoids	Antioxidant; lipid reduction	500 mg/kg	Most >2000 mg/kg

							(safe)
12	<i>Pithecellobium dulce</i>	Seeds	Ethanollic	Saponins	Antioxidant; lipid modulation	500 mg/kg	Most >2000 mg/kg (safe)
13	<i>Spondias purpurea</i>	Seeds	Methanolic	Polyphenols	Antioxidant; lipid-lowering	500 mg/kg	Most >2000 mg/kg (safe)
14	<i>Opuntia dillenii</i>	Seeds	Ethanollic	Phenolics	Phenolic-mediated lipid reduction	500 mg/kg	Most >2000 mg/kg (safe)
15	<i>Ziziphus lotus</i>	Seeds	Aqueous	Flavonoids	Flavonoid-rich antioxidant; lipid-lowering	500 mg/kg	Most >2000 mg/kg (safe)
16	<i>Foeniculum vulgare</i> (Fennel)	Seeds	Ethanollic	fatty acids	Antioxidant; lipid modulation	500 mg/kg	Most >2000 mg/kg (safe)
17	<i>Ocimum tenuiflorum</i> (Tulsi)	Seeds	Ethanollic	Eugenol	Antioxidant; thrombolytic via clot lysis	500 mg/kg	Most >2000 mg/kg (safe)
18	<i>Cassia occidentalis</i>	Seeds	Methanolic	Antraquinones	Antioxidant; lipid-lowering	500 mg/kg	Most >2000 mg/kg (safe)
19	<i>Salacia chinensis</i>	Seeds/R oot	Ethanollic	Triterpenoids	Inhibits lipid absorption	500 mg/kg	Most >5000 mg/kg (safe)

20	<i>Allium sativum</i> (Garlic)	Seeds/Bulb	Ethanollic	Allicin	Inhibits oxidation; reduces LDL oxidation; fibrinolytic	200–500 mg/kg	Most >5000 mg/kg (safe)
21	<i>Brassica nigra</i> (Black Mustard)	Seeds	Methanolic	Glucosinolates	Fibrinolytic	500 mg/kg	Most >2000 mg/kg (safe)
22	<i>Cyamopsis tetragonoloba</i> (Guar)	Seeds	Aqueous	Galactomannan	Sulfated galactomannan aids clot prevention	500 mg/kg	Most >2000 mg/kg (safe)
23	<i>Terminalia bellerica</i>	Seeds	Methanolic	Tannins	Antioxidant; antithrombotic	500 mg/kg	Most >2000 mg/kg (safe)
24	<i>Moringa oleifera</i>	Seeds	Methanolic	Flavonoids	Antioxidant; inhibits lipid catabolism	200–400 mg/kg	Most >5000 mg/kg (safe)
25	<i>Piper nigrum</i> (Black Pepper)	Seeds	Methanolic	Piperine	Antioxidant; excites hepatic LPL	200–400 mg/kg	Most >5000 mg/kg (safe)
26	<i>Tamarindus indica</i> (Tamarind)	Seeds	Ethanollic	Polyphenols	Fibrinolytic; antioxidant	500 mg/kg	Most >2000 mg/kg (safe)
27	<i>Curcuma longa</i> (Turmeric)	Seeds/Rhizome	Ethanollic	Curcuminoids	Inhibits HMG-CoA; reduces cholesterogenesis	300–500 mg/kg	Most >5000 mg/kg (safe)
28	<i>Zingiber officinale</i> (Ginger)	Seeds/Rhizome	Ethanollic	Gingerol	Reduces lipid peroxidation; modulates enzymes	200 mg/kg	Most >5000 mg/kg (safe)
29	<i>Carum carvi</i>	Seeds	Aqueous	Saponins	Increases LCAT;	60 mg/kg	Most

	(Caraway)				binds saponins to cholesterol		>2000 mg/kg (safe)
30	<i>Hibiscus cannabinus</i> (Kenaf)	Seeds	Methanolic	Anthocyanins	Antioxidant; ameliorates hyperlipidemia	400 mg/kg	Most >2000 mg/kg (safe)

1. *Nigella sativa* (Black Cumin):

Nigella sativa (black cumin) is a medicinal plant whose seeds contain active chemicals such as thymoquinone. Water-based seed extracts have been shown in laboratory testing to effectively dissolve blood clots, with up to 90% clot disintegration compared to typical medications such as streptokinase. These effects are assessed utilizing in vitro human blood clot models. The clot-dissolving function is hypothesized to work by modulating key clotting proteins (thrombin, fibrin, and plasmin), as well as by antioxidant actions that reduce oxidative stress and clot formation. However, information from human clinical investigations remains sparse. (2)

2. *Vigna unguiculata* (Cowpea):

Vigna unguiculata (cowpea or black-eyed pea) is a popular food crop in Africa, India, China, and other countries. The seeds and leaves are widely utilized and include nutrients and bioactive chemicals such as flavonoids, alkaloids, phenols, amino acids, and phytic acid. Cowpea contains essential vitamins such as vitamin A, C, B-complex and minerals such as iron, zinc, potassium, magnesium, calcium, and selenium. Cowpea, which has been traditionally used in medicine, has a number of health-promoting properties, particularly thrombolytic (clot-dissolving) and anti-sickling actions. It also has anti-diabetic, hypolipidemic, antioxidant, antibacterial, antifungal, antiviral, and anthelmintic activities. These medical effects are mostly due to the rich phytochemical and nutritional makeup of the seeds and leaves. (12)

3. *Linum usitatissimum* (Flaxseed):

Flaxseed (*Linum usitatissimum*) is rich in α -linolenic acid, fibre, and phytosterols, which together help lower total and LDL cholesterol and protect against atherosclerosis, though it has little effect on lipoprotein(a). Its cardiovascular benefits are linked to improved lipid profiles and modulation of inflammation and endothelial function. Clinical studies suggest flaxseed can reduce certain inflammatory markers like CRP and IL-6, but results are not always consistent. Overall, flaxseed is a promising dietary aid for managing dyslipidaemia, though more uniform clinical evidence is needed. (13)

4. *Sesamum indicum* (Sesame):

Natural and herbal foods are preferred because they are safer and have fewer side effects. Sesame seeds, widely used in Asian diets, are rich in oil and valuable bioactive compounds like sesamin and sesamol. These compounds help lower blood lipids, reduce oxidative stress and inflammation, and support heart health. By improving lipid balance and protecting against oxidative damage, sesame seeds may help prevent atherosclerosis and related cardiovascular diseases. (14)

5. *Carthamus tinctorius* (Safflower):

Carthamus tinctorius (safflower) is a drought-tolerant, A yearly growing plant resembling a thistle from the Asteraceae family, domesticated over 4,000 years ago in Southern Asia. Once used mainly for natural dyes, it is now cultivated primarily as an oilseed crop. Its deep taproot helps it grow in hot, dry, rain-fed areas, and its seeds produce a nutritious oil which is a rich source of polyunsaturated fatty acids, especially linoleic acid. (15,16)

6. *Glycine max* (Soybean):

Soybean (*Glycine max*) is rich in natural compounds that are good for heart health. Research shows that soybeans especially black soybeans and fermented foods like tempeh—can help with blood clot control and lowering blood fats. For thrombolytic activity, black soybeans reduce platelet clumping and clot formation, while fermented soy products produce enzymes that can break down clots. This may help lower the risk of thrombosis. For antilipidemic activity, soybean proteins and antioxidants help reduce cholesterol and triglycerides by improving fat metabolism and protecting against oxidative damage. Overall, soybeans show promising benefits for controlling clots and high lipid levels. Most evidence comes from lab and animal studies, so more human studies are needed, but soy-based foods may support cardiovascular health. (17)

7. *Ficus Carica* (Fig):

Obesity is a common health problem and is often associated with high levels of blood lipids and lipoproteins, known as hyperlipidemia and hyperlipoproteinemia. In these conditions, cholesterol, triglycerides, and other lipid fractions increase in the blood due to disturbed lipid metabolism. Elevated lipid

levels are one of major risk factor for cardiovascular diseases, including cerebral, coronary, and peripheral artery disorders, which are leading causes of death worldwide. If left untreated, hyperlipidemia can lead to atherosclerosis and coronary heart disease. The first line of management involves lifestyle changes such as healthy diet, avoiding alcohol and tobacco, reducing simple carbohydrates and excess salt intake, and improving overall lifestyle habits. (1,18)

8. *Cucumis melo* (Melon):

Extracts of *Cucumis melo* (melon), especially from the fruit peel, seeds, and wild types like *C. melo* var. *agrestis*, show clear lipid-lowering effects in animal studies. In models of high-fat diet, hyperlipidemia, and diabetes, these extracts reduce overall cholesterol, triglyceride levels, and LDL cholesterol while raising HDL cholesterol. These benefits are mainly due to biologically active compounds viz., polyphenols, flavonoids, unsaturated fatty acids, and plant sterols. Methanolic peel extracts also helps to remove excessive cholesterol by increasing fecal excretion of bile acids and sterols, contributing to their antihyperlipidemic action. (16)

9. *Syzygium cumini* (Jamun):

Syzygium cumini (Jamun) is a tropical medicinal tree that is widely used in Ayurveda to treat diabetes, inflammation, and cardiac problems. Its fruits, seeds, leaves, and bark contain valuable natural substances such as polyphenols, flavonoids, anthocyanins, and tannins. Jamun contains substances that decrease blood cholesterol and triglycerides, increase fat metabolism, and protect against lipid illnesses such as dyslipidemia and atherosclerosis. Studies, primarily in diabetic animals and humans, have shown that its lipid-lowering action is due to reduced fat formation in the body, significant antioxidant activity, and improved blood sugar and metabolism management (19)

10. *Vernonia anthelmintica*:

Vernonia anthelmintica has no known thrombolytic, antithrombotic, or anticoagulant action in scientific literature. Research primarily supports its antihyperlipidemic efficacy, particularly in diabetic animals, where it reduces cholesterol via inhibiting HMG-CoA reductase and improves lipid metabolism. These effects are most likely related to its antidiabetic action and phytochemicals (flavonoids, steroids, phenolics, fatty acids) with antioxidant and anti-inflammatory qualities. (20)

11. *Pithecellobium dulce*:

Hyperlipidemia refers to abnormally high blood lipid levels, which rises the risk of atherosclerosis, diabetes, and heart disease. It can be inherited or developed as a result of lifestyle factors, diseases, or drugs, and is characterized by high cholesterol and triglycerides with

low HDL. *Pithecellobium dulce* (Manila tamarind) is a Fabaceae tree found in India and other places. Aside from the tasty pods, it contains medical characteristics such as antidiabetic, antioxidant, anti-inflammatory, and antiulcer benefits. (21)

12. *Spondias purpurea*:

Spondias purpurea exhibits thrombolytic (clot-dissolving) activity, despite the fact that kindred species have similar effects. However, *S. purpurea* has excellent antihyperlipidemic capabilities, with seed and bark extracts lowering cholesterol and triglycerides, increasing glucose control, and lowering oxidative stress in experimental mice. These findings suggest potential benefits in dyslipidemia and metabolic diseases, however its clot-dissolving action is unproven. (22)

13. *Piper nigrum* (Black Pepper):

Black pepper demonstrates promising thrombolytic and antihyperlipidemic effects. Its extracts help dissolve blood clots by indirectly activating plasminogen, an enzyme that breaks down fibrin clots. Laboratory studies show that methanolic extracts of black pepper can cause significant clot breakdown nearly comparable to streptokinase while staying safe at lower doses and not disrupting normal blood coagulation. Computational studies back up this result, demonstrating that active chemicals like piperolactam D interact significantly with tissue plasminogen activator (tPA), promoting fibrin breakdown. (20)

14. *Tamarindus indica* (Tamarind):

The antihyperlipidemic effect is principally caused by pancreatic lipase inhibition, decreased intestinal fat absorption, regulation of lipogenic genes (SREBP-1c and fatty acid synthase), and potent antioxidant activity. In high-fat diet models, these processes work together to lower total cholesterol, LDL, and triglycerides while boosting HDL. (23) The thrombolytic action of tamarind, particularly from seeds and bark, is mild and primarily observed in vitro. This action is most likely due to polyphenol-mediated fibrinolysis support or clot formation inhibition, while being weaker than traditional thrombolytic medicines and lacking direct plasminogen activation.

CONCLUSION

Hyperlipidemia is a serious condition characterized by abnormally high levels of lipids in the bloodstream, which contribute to the onset and progression of various cardiovascular diseases (CVDs). Although the association between hyperlipidemia and cardiovascular disorders is well established, elevated blood cholesterol remains widespread and continues to be a major factor in the development of coronary conditions. This study shows that the ethanolic extract of *Fagonia arabica* has promise anti-hyperlipidemic activity in vivo and appears to be safe, with no acute toxicity reported at the tested

levels. Although these first findings are intriguing, more in-depth research is required to thoroughly assess its lipid-lowering benefits and impact on metabolic parameters. Future study should involve long-term tests in various animal models, followed by clinical trials in people, to confirm its therapeutic potential. Overall, this study provides a foundation for further research into the antihyperlipidemic effects and underlying processes of *Fagonia arabica* ethanolic extract. An increasing amount of research reveals that many medicinal plants have powerful antihyperlipidemic and thrombolytic properties, offering them viable natural solutions for the management and control of cardiovascular disease. Numerous plants have strong clot-dissolving, antiplatelet, and anticoagulant characteristics similar to conventional thrombolytic drugs. These effects are mostly due to bioactive phytochemicals with antioxidant and anti-atherosclerotic properties. Compared to synthetic medications, herbal remedies are often safer, less expensive, and more widely available. However, additional *in vivo* investigations, clinical trials, and standardization of active compounds are required to show therapeutic efficacy and promote their development as reliable phytopharmaceuticals for cardiovascular health.

REFERENCES

- Ashorobi D, Ameer MA, Fernandez R. Thrombosis. In: *StatPearls* [Internet]. Treasure Island (FL): StatPearls Publishing; 2024.
- Amandeep, Sharma M, Kumar V. Enlightening food application and mega health benefits of *Sesamum indicum*. *Int J Curr Microbiol Appl Sci*. 2019;8(1):2224–2232.
- Adams R, Gianturco M. The alkaloids of *Crotalaria juncea*. *J Am Chem Soc*. 1956;78:1919–1921.
- Bhatnagar D, Soran H, Durrington PN. Hypercholesterolaemia and its management. *BMJ*. 2008;337:a993. doi:10.1136/bmj.a993
- Shattat GF. Hyperlipidemia: types, treatments and new drug targets. *Biomed Pharmacol J*. 2014;7(2):339–346.
- Kelly JP, Kaufman DW, Kelley K, Rosenberg L, Anderson TE, Mitchell AA. Recent trends in use of herbal and other natural products. *Arch Intern Med*. 2005;165(3):281–286.
- Babar ZUM, Jaswir I, Maifiah MHM, Ismail S, Raus RA, Tareq AM, et al. Thrombolytic and cytotoxic effects of *Nigella sativa* seeds. *Int J Halal Res*. 2020;2(2):70–77.
- Boland A, Dundar Y, Bagust A, Haycox A, Hill R, Mujica-Mota R, et al. Early thrombolysis for acute myocardial infarction. *Health Technol Assess*. 2003;7:1–75.
- Dalibalta S, Majdalawieh AF, Manjikian H. Health benefits of sesamin on cardiovascular disease and its associated risk factors. *Saudi Pharm J*. 2020;28(10):1276–1289.
- Gebauer SK, Psota TL, Harris WS, Kris-Etherton PM. n-3 fatty acid dietary recommendations and cardiovascular benefits. *Am J Clin Nutr*. 2006;83:1526S–1535S.
- Desu BSR, Saileela CH. Antihyperlipidemic activity of methanolic extract of *Rhinacanthus nasutus*. *Int J Res Pharm Chem*. 2013;3(3):708–711.
- Dalwadi PD, Patani PV. Antihyperlipidemic activity of *Tephrosia purpurea*. *Int J Pharmacol Res*. 2014;4(4):186–193.
- Kim K, et al. Black soybean extract attenuates thrombosis through inhibition of collagen-induced platelet activation. *J Nutr Biochem*. 2011;22(10):964–971.
- Weng Y, Yao J, Sparks S, Wang KY. Nattokinase: an oral antithrombotic agent for cardiovascular disease prevention. *Int J Mol Sci*. 2017;18(3):523.
- Ayyanar M, Subash-Babu P. *Syzygium cumini* (L.) Skeels: phytochemical constituents and traditional uses. *Asian Pac J Trop Biomed*. 2012;2(3):240–246.
- Babu PS, Srinivasan K. Hypolipidemic action of curcumin in streptozotocin-induced diabetic rats. *Mol Cell Biochem*. 1997;169:175–181.
- Bae CS, Park CH, Cho HJ, Han HJ, Kang SS, Choi SH, et al. Therapeutic effects of safflower seed powder on osteoporosis. *Korean J Electron Microsc*. 2002;32:285–290.
- Bejarano A, Ramirez-Bahena MH, Velázquez E, Peix A. *Vigna unguiculata* nodulation by *Bradyrhizobium*. *Syst Appl Microbiol*. 2014;37(7):533–540.
- Bidkar JS, Ghanwat DD, Bhujbal MD, Dama GY. Anti-hyperlipidemic activity of *Cucumis melo* peel extracts. *J Complement Integr Med*. 2012;9(1):20.
- Emon NU, Alam S, Rudra S, Riya SR, Paul A, Hossen SMM, et al. Thrombolytic profiling of *Piper nigrum*. *Food Sci Nutr*. 2021;9(2):833–846.
- Fatima SS, Rajasekhar MD, Kumar KV, et al. Antihyperlipidemic activity of *Vernonia anthelmintica*. *Food Chem Toxicol*. 2010;48(2):495–501.
- Hadijah H, Ayub MY, Zaridah H, Normah A. Hypolipidemic activity of *Morinda citrifolia*. *J Agric Food Sci*. 2008;36(1):77–85.
- Hirwaikar A, Khan S, Kamariya YH, Patel BD, Gajera FP. Medicinal plants for post-menopausal osteoporosis. *Open Bone J*. 2010;2:1–13.
- Kanakavalli K, Thillaivanan S, Parthiban P, Vijayalakshmi G, Sudha M, Sutha J. Antihyperlipidemic herbs in Siddha medicine. *Int J Pharm Sci*. 2014;4:541–545.

25. Kodali G, Seru G. Antihyperlipidemic activity of *Boswellia ovalifoliolata*. *Int J Phytother Res*. 2013;3(3):11–17.
26. Lim CY, Yuen KH, Liong MT, Tan YS. Biochemical and gene expression analyses of *Tamarindus indica*. *PLoS One*. 2013;8(10):e75563.
27. Misra L, et al. Chemical constituents and bioactivity of *Withania somnifera*. *Nat Prod Commun*. 2008.
28. Muñoz-Ramírez A, et al. Antihyperlipidemic activity of *Spondias purpurea*. *Plants*. 2021;10(7):1417.
29. Nweke K. World literature on cowpea (*Vigna unguiculata*). *Ann Libr Sci Doc*. 1988;35(1):26–31.
30. Radha K, Syed M, Rao SD. Antihyperlipidemic activity of *Carica papaya* seeds. *Indo Am J Pharm Sci*. 2014;1(5):328–332.
31. Rehman AA, Riaz A, Asghar MA, Raza ML, Ahmed S, Khan K. Antiplatelet and anticoagulant effects of *Syzygium cumini*. *BMC Complement Altern Med*. 2019;19(1):236.
32. Rajani GP, Ashok P. Antioxidant and antihyperlipidemic activity of *Bauhinia variegata*. *Indian J Pharmacol*. 2009;41(5):227–232.
33. Wang LW, Cui XY, He JF, Duan S, Liu CR, Shan CB, et al. Hydroxysafflor yellow alleviates thrombosis. *Phytomedicine*. 2021;87:153579.
34. Harikumar K, Niveditha B, Reddy PK. Anti-hyperlipidemic activity of *Crotalaria juncea*. *Int J Phytopharmacol*. 2012;3(3):256–262.
35. Keane WF, Kasiske BL, O'Donnell MP. Aggressive management of hyperlipidemia in nephrotic syndrome. *Kidney Int*. 1992;41(1):134–141.
36. Grundy SM, Balady GJ, Criqui MH, Fletcher G, Greenland P, Hiratzka LF, et al. Primary prevention of coronary heart disease. *Circulation*. 1998;97(18):1876–1887.