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Review Paper

Herbal Anticoagulants: A Comprehensive Review

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ABSTRACT

Indian traditional medicine has used herbs that thin the blood for a long time, such as Ayurveda, Siddha, and Unani, where they are frequently advised to promote circulatory health and lower the risk of thrombotic events. These medicinal plants' anticoagulant and antiplatelet qualities are attributed to a variety of bioactive phytochemicals, including flavonoids, coumarins, alkaloids, terpenoids, polyphenols, and sulfur-containing compounds. According to scientific research, a variety of Indian herbs have anti-inflammatory and antioxidant properties that can improve vascular function, enhance fibrinolysis, inhibit clotting factor activation, and modify platelet aggregation. *Allium sativum*, *Curcuma longa*, *Zingiber officinale*, *Ocimum sanctum*, *Terminalia* species, *Phyllanthus emblica*, and *Azadirachta indica* are among the major blood-thinning herbs that have been used traditionally throughout India and are updated and thoroughly reviewed in this review. Evaluation of these herbs' mechanisms of action—such as suppression of thromboxane A₂ synthesis, inhibition of cyclooxygenase pathways, prolongation of coagulation times (PT/aPTT), and modulation of endothelial function—is given particular attention. Important contributions from Indian researchers who have used in vitro, in vivo, and a few clinical studies to experimentally validate these plants' antithrombotic potential are also highlighted in the review. Although these herbs have a lot of potential as natural supplements or substitutes for synthetic anticoagulants, their safety, interactions with other drugs, and standardization need to be carefully considered. The need for additional clinical trials to determine exact dosage, efficacy, and long-term safety is highlighted by the mounting body of scientific

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evidence. By bridging the gap between traditional knowledge and contemporary pharmacological understanding, this review hopes to lay the groundwork for further investigation and therapeutic exploration.

INTRODUCTION

Blood thinners, also known as anticoagulants, are drugs that stop and treat blood clots. These drugs don't actually "thin" the blood, as many people think. Instead, they help keep blood vessels from forming clots, which keeps blood flowing smoothly. Blood clots, which are made up of red blood cells, platelets, fibrin, and other proteins, can be dangerous when they form in arteries, veins, or the heart. This can lead to serious problems like heart attacks, strokes, and blockages in the blood vessels¹. Blood thinners can't get rid of clots that are already there, but they can stop them from getting bigger and lower the risk of heart problems overall. So, treating blood clots quickly is important to avoid life-threatening situations². Thrombosis and irregular clot formation are pivotal in the advancement of cardiovascular diseases. Traditional pharmacotherapy employs agents like warfarin and aspirin to mitigate thrombotic risk. However, growing scientific interest has turned to natural substances with antithrombotic properties because they may work better and have fewer side effects. Studies show that bioactive compounds from plants, such as sulfur compounds, phenolics, and flavonoids, may change how platelets stick together and how blood clots. Herbs like garlic (*Allium sativum*), ginger (*Zingiber officinale*), and turmeric (*Curcuma longa*) have shown significant effects on platelet activity and clotting parameters in vitro, in animal studies, and in limited clinical trials³.

2. Mechanisms of Blood Thinning: The process of clotting has two parts: primary hemostasis, which makes a weak platelet plug, and secondary hemostasis, which strengthens it with

fibrin. During primary hemostasis, vasoconstriction happens first, and this is caused by endothelin-1 from damaged endothelium. When collagen and von Willebrand factor (vWF) are exposed, platelets stick to each other through Gp Ib-IX receptors. When platelets stick together, they become active, change shape, and release granules like ADP, serotonin, and PAF. ADP attaches to the P2Y1 and P2Y12 receptors, which makes them even more active and causes Gp IIb/IIIa to be expressed. When platelets are activated, they make Thromboxane A₂ (TXA₂), which makes vasoconstriction and aggregation stronger. In platelet aggregation, fibrinogen connects Gp IIb/IIIa receptors to make a weak platelet plug. Secondary hemostasis activates clotting factors through both intrinsic and extrinsic pathways, which all meet at Factor X. The prothrombinase complex is made up of Xa and Factor Va. It changes prothrombin into thrombin. Fibrinogen is changed into fibrin by thrombin, and Factor XIIIa links fibrin together to make a stable clot.⁴

3. Indian Herbs and Their Antithrombotic Potential:

3.1 Allium sativum (Garlic): Grown worldwide, garlic (*Allium sativum*, Family: Amaryllidaceae) is a flavoring herb. Numerous bioactive substances, including polysaccharides, phenolic compounds, saponins, and organosulfur compounds, are found in garlic. One of the pharmacological characteristics of garlic is its anticoagulant effect.⁵ Garlic can lower blood pressure and blood sugar, improve fibrinolytic activity, prevent platelet aggregation, and balance plasma lipids, according to a review of numerous studies. According to the findings of Hiyasat B et al. 2009 garlic may help prevent and manage cardiovascular diseases. The antiplatelet and anticoagulant properties of garlic have been thoroughly investigated.⁶ Allicin and thiosulfinates are examples of organosulfur



compounds that interfere with thromboxane production and prevent platelet aggregation brought on by ADP and other agonists.⁷ Garlic supplementation decreased platelet aggregation in a number of human trials, according to a systematic evaluation of randomized controlled trials; however, outcomes differ depending on preparation and dosage.⁸ In lab tests, garlic extracts also prevented platelet aggregation at physiologically significant levels. *A. sativum* bulbs contain hundreds of phytochemicals, including sulfur-containing compounds (Table 1) such as ajoenes (E-ajoene, Z-ajoene), thiosulfates (allicin), vinylthiols (2-vinyl-(4H)-1,3-dithiol, 3-vinyl-(4H)-1,2-dithiol), sulphides (diallyl disulfide), and vinylthiols⁹ Alliin, the main cysteine sulfoxide, is changed into allicin by the enzyme allinase once the garlic has been cut and the parenchyma has been dissolved. Allicin, S-methyl cysteine-sulfoxide (MCSO), and S-propyl cysteine-sulfoxide (PCSO) are the main odoriferous substances found in freshly ground garlic homogenates. The enzyme Allinase, which is produced by PCSO, can react with the mixture of MCSO, PCSO, and alliin to produce allyl methane thiosulfates, methyl methanethiosulfonate, and additional corresponding thiosulfates (R-S-S-R₀), where R and R₀ are allyl, propyl, and methyl groups. Temperature and water content affect fifty metabolites.²(Zakira Chaudhary and colleagues,2022).

Mateen AA et al. (2011) found that when garlic was administered in single or repeated doses, platelet aggregation was significantly inhibited after 2 hours, while cilostazol showed a significant inhibition at all three time points, with the greatest inhibition occurring at 4 hours. There was no discernible difference in the antiplatelet activity of the individual medications after seven days of coadministration of garlic and cilostazol in single and multiple doses.¹⁰

3.2 *Zingiber officinale* (ginger): The bioactive substances in ginger (gingerols, shogaols) have been demonstrated to increase bleeding time by preventing platelet aggregation and acting as antagonists of thromboxane production. Ginger should be used with caution in clinical settings since it may interact with anticoagulant medications.¹¹

3.3 *Curcuma longa* (Turmeric): In high-dose in vitro experiments, curcumin and related curcuminoids demonstrate antiplatelet action by decreasing platelet aggregation. Ar-turmerone is one of the components that considerably reduces platelet reactions to collagen and arachidonic acid.¹²

According to Manikandan et al. (2004), curcumin's anticoagulant action has been demonstrated to prolong blood clotting periods, as demonstrated by analyses of prothrombin time, thrombin time, and activated partial thromboplastin time when compared to a control blood sample. Additionally, curcumin and its derivative, bisdemethoxycurcumin, inhibited thrombin and activated factor X activities and dramatically extended activated partial thromboplastin time and prothrombin time¹³

3.4 *Terminalia chebula* and *Terminalia bellirica*: By extending clotting, PT, and APTT tests, *Terminalia chebula* and *Terminalia bellirica* demonstrated strong anticoagulant effects in a study that screened 120 extracts from Indian medicinal plants.

3.5 Pomegranate (*Punica granatum*): In vitro clotting tests revealed anticoagulant activity in extracts from pomegranate peel, which was associated with a high phenolic content and interaction with coagulation factors.¹⁴

3.6 *Cinnamomum cassia* (cinnamon): The phenolic components of cinnamon have been shown to exert minor antiplatelet effects by inhibiting platelet activation and aggregation.



3.7. Ginkgo biloba as blood thinner: Ginkgo biloba is known to thin and enhance blood flow. Ginkgo can help with tinnitus in a variety of ways, particularly in the small capillaries of the brain, eyes, and ears. One of the compounds in ginkgo is ginkgo toxin. Ginkgo leaves also contain minor amounts of the toxin, but the highest concentrations are found in the nuts. Despite having a similar molecular makeup, it has been found to hinder vitamin B6 action.² The chemical components of Camellia sinensis include polyphenols, alkoids, polysaccharides, amino acids, vitamins, catechin, caffeine, epigallocatechin, gallate, and gallic acid. The plant belongs to the Theaceae family. C counteracts the anticoagulant effects of warfarin. sinensis Individuals who get high levels of C. sinensis have bleeding and a decrease in the effects of warfarin. Drinking green tea may help avoid the anticoagulant effects of warfarin because it contains vitamin K.¹⁶

3.8. VITAMIN E: This fat-soluble vitamin contributes to blood thinning but is best recognized for its antioxidant qualities. By disrupting the mechanisms that result in the formation of blood clots, it functions as a natural anticoagulant. Inhibiting platelet aggregation, which helps stop blood cells (platelets) from grouping together to form clots, is one of its main functions. The primary chemical components are tocopherols (saturated side chain: α , β , γ , δ) and tocotrienols (unsaturated side chain: α , β , γ , δ)¹⁷

4. Ethnobotanical: Context in India: Herbs like garlic, ginger, turmeric, and other botanicals have long been used in Ayurvedic writings for cardiovascular health. These uses are frequently referred to as "blood purification," which is similar to how antithrombotic benefits are currently understood. Scientific research into the pharmacodynamic activities of these herbs is

supported by their empirical application for circulation improvement.¹⁵

5. Safety, Interactions, and Clinical Considerations: Although herbal anticoagulants often have less severe adverse effects than pharmaceutical treatments, they may interact with anticoagulant or antiplatelet drugs. Herbs like garlic, ginger, ginkgo, and turmeric have been shown in studies to enhance the effects of aspirin and warfarin, raising the risk of bleeding.¹⁸

CONCLUSION

Several Indian plants, including garlic, ginger, turmeric, and Terminalia species, have been shown to have antiplatelet and anticoagulant properties by science. Larger clinical trials are required to ascertain safe dosages and usable formulations, even though in vitro and some in vivo evidence are encouraging. Research that combines conventional wisdom with contemporary pharmacology may increase the range of treatments available for thrombotic conditions.

CONCLUSION:

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