



An Overview of *Allium sativum*

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Abstract

Garlic is probably one of the earliest known medicinal plants, which used from ancient time to cure different disease conditions in human. Garlic's principal medicinal uses are to lower blood pressure and cholesterol, fight infections, and prevent cancer. The active constituents are sulfur-containing compounds that are rapidly absorbed and metabolized. Numerous studies suggest that garlic lowers total cholesterol concentrations by approximately 10%, favorably altering HDL/LDL ratios. Literature survey support garlic's effectiveness as a mild antihypertensive, lowering blood pressure by 5-7%. Garlic inhibits platelet aggregation and enhances fibrinolytic activity, reducing clots on damaged endothelium. Another important use of garlic is as antidiabetic. Garlic controls the blood sugar level by different types of mechanisms. In vitro studies and animal data suggest that garlic may help to prevent some solid tumors. Therefore garlic is also effective in the cancer prevention. There are no studies evaluating its effectiveness in treating children or pregnant or nursing women. The other proposed uses of garlic include the hepatoprotective, antihelmentics, anti-inflammatory, antioxidant, antifungal and wound healing.

Keywords: *Allium sativum*, Garlic, Anti-inflammatory Effect.

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1. Introduction

Allium sativum (Garlic) is a bulb-shaped plant with a powerful aroma and pungent taste that has been used as a flavoring agent, condiment, and for medicinal purposes for over 5,000 years. Its medicinal uses are mentioned in the world's oldest surviving medical text, the Ebers Papyrus. Garlic powder, extracts, and oils have been employed in folk medicine for various disorders by the Egyptians, Chinese, Greeks, Indians, Koreans, and Romans [1]. Garlic contains high levels of phosphorus, potassium, sulfur, and zinc; moderate levels of selenium, vitamins A and C; and low levels of calcium, magnesium, sodium, iron, manganese, and B-complex vitamins. In addition, many compounds have been identified and isolated from garlic extracts including 33 sulfur compounds and 17 amino acids which include alanine, arginine, aspartic acid, asparagine, histidine, leucine, methionine, phenylalanine, proline, serine, threonine, tryptophan, and valine [2].

2. Bioactive Composition of *Allium Sativum*

Garlic has a variety of bioactive compounds, including organosulfur compounds, saponins, phenolic compounds, and polysaccharides. The major active components of garlic are its organosulfur compounds, such as diallyl thiosulfonate (allicin), diallyl sulfide (DAS), diallyl disulfide (DADS), diallyl trisulfide (DATS), E/Z-ajoene, S-

allyl-cysteine (SAC), and S-allyl-cysteine sulfoxide (alliin). Moreover, garlic contained more than 20 phenolic compounds, with higher contents than many common vegetables. The main phenolic compound was β -resorcylic acid, followed by pyrogallol, gallic acid, rutin, protocatechuic acid, as well as quercetin [3]. This suggests that dietary supplementation with antioxidant plant extracts such as garlic extract (GE) may be more beneficial than supplementation with singular pure antioxidants in reducing the development and progression of multi-risk factor diseases such as atherosclerosis [4]. Garlic has been identified as a rich source of antioxidant flavonoids these include apigenin, myricetin, and quercetin. The potent antioxidant activity of a garlic preparation such as GE may in part be attributed to the presence of a plethora of different antioxidants with differing sites and mechanisms of action, which may act alone or in concert with each other. This has been exemplified by lycopene, which synergistically inhibits low-density lipoprotein oxidation [5].

3. Mechanism of Action of Garlic

Several mechanisms of action have been proposed. These include:

- Antioxidant activity: garlic preparations exhibit radical scavenging activity and decrease lipid peroxidation, which is relevant in light of the observation that tumor

promotion may involve oxygen radicals. These effects of garlic may play a role in the cardiovascular, antineoplastic, and cognitive effects of garlic. Garlic has a significant impact on the nuclear factor erythroid 2-related factor (Nrf2) pathway, which is crucial for cellular defense against oxidative stress and inflammation. This activation enhances the expression of antioxidant enzymes, helping to neutralize reactive oxygen species and reduce oxidative stress [6].

- Effect on drug metabolizing enzymes: induction of phase II detoxification enzymes, including glutathione transferases, quinone reductase, epoxide hydrolase, and glucuronosyl transferase that inactivate toxic substances and facilitate their excretion [7].
- Tumor growth inhibition: Garlic has been extensively studied for its potential anti-cancer properties, including its ability to inhibit tumor growth in various carcinoma cell lines. Research has shown that garlic-derived compounds such as allicin, diallyl sulfide, and diallyl disulfide possess anti-proliferative and pro-apoptotic effects on cancer cells. In the case of prostate carcinoma cells, several studies have demonstrated the tumor growth inhibitory effects of garlic compounds [8].
- Effective stimulation of the immune response: Organosulfur compounds stimulate the proliferation of lymphocytes and macrophage phagocytosis, induce the infiltration of macrophages and lymphocytes in transplanted tumors, induce splenic hypertrophy, stimulate the release of interleukin-2 (IL-2), tumor necrosis factor- α (TNF- α) and interferon- γ , enhance natural killer cell, killer cell and lymphokine-activated killer cell activity [7].

4. Therapeutic Effects of Garlic

Garlic (*Allium sativum*) has acquired a reputation in different traditions as a prophylactic as well as therapeutic medicinal plant. Garlic has played important dietary and medicinal roles throughout history [9].

1- Cardiovascular Effects of Garlic

Garlic has been widely recognized as an agent for the prevention and treatment of cardiovascular diseases. Studies support that garlic consumption has significant effects on lowering blood pressure, prevention of atherosclerosis, reduction of serum cholesterol and triglyceride, inhibition of platelet aggregation, and increasing fibrinolytic activity. Garlic can also protect the heart. It has been shown to increase Na^+/K^+ -ATPase protein levels and reduce cardiac hypertrophy and remodeling induced by isoproterenol in rats [3]. A statistical study showed that individuals whose blood pressure is on the lower side are more likely to consume more garlic in their diets. In addition, garlic is effective in the treatment of mean systolic blood pressure. In one study the GE caused a decrease in blood pressure and bradycardia. Another study showed that GE prevents oxidative stress, systolic blood pressure, and vascular remodeling in rats with metabolic syndrome [9]. In vivo and in vitro studies have shown that prophylactic administration of GE inhibits lipid peroxidation and prevents depletion in glutathione through its compounds which leads to functional recovery. Numerous in vitro and in vivo studies show that garlic compounds possess anti-atherosclerotic activity. Possible mechanisms for lipid lowering and anti-

atherogenic effects of garlic include inhibition of the hepatic activities of lipogenic and cholesterologenic enzymes that are thought to be the origin of dyslipidemias, increased excretion of cholesterol, and suppression of LDL (low-density lipoprotein) cholesterol oxidation [10]. Garlic not only activates fibrinolytic action by accelerating tissue-type plasminogen activator mediated plasminogen activation but also suppresses the coagulation system by down-regulating thrombin formation, suggesting a beneficial role in preventing pathological thrombus formation in such cardiovascular disorders. Garlic extract works as an antithrombotic act through inhibition of the adenosine diphosphate pathway. Their mechanisms of action are comparable to that of the clinically used antiplatelet drug named clopidogrel [11].

2- Lipid-Lowering Effect of Garlic

Several clinical trials using various garlic preparations have shown lipid-lowering effects. In the late 1970s, several studies were conducted in which raw garlic (5-10 gram/day) was given orally for 2-3 months to healthy subjects and patients with ischemic heart disease. Studies demonstrated significant reductions in blood cholesterol and triglyceride levels after garlic ingestion [12].

3- Anti-tumor effect of garlic

Garlic was found to be the most potent food having cancer-preventive properties. Many in vitro and in vivo studies have suggested possible cancer-preventive effects of garlic preparations and their respective constituents. Garlic has been found to contain many potent bioactive compounds with anticancer properties, largely allylsulfide derivatives. Garlic has a variety of anti-tumor effects, including tumor cell growth inhibition and chemo-preventive effects. In rodents, garlic, and its constituents have been reported to inhibit the development of chemically induced tumors in the liver [13].

4- Anti-inflammatory Effect of Garlic

Garlic extracts have been shown to exert anti-inflammatory effects. Garlic treatment significantly attenuated inflammation and injury of the liver. A study indicated that thiocresonone, a sulfur compound isolated from garlic, inhibits neuroinflammation and amyloidogenesis through the inhibition of nuclear factor kappa B (NF- κ B) activity [14].

5- Immunomodulatory Effect of Garlic

Immunomodulation is among the innumerable biological activities of garlic. This effect of garlic is attributed to the transformed organosulfur compounds. GE reduced macrophage infection through the induction of nitric oxide production in vivo. A study demonstrated that immune-mediated liver damage in mice can be prevented by allicin, probably because of its immunomodulatory effects on T cells and adhesion molecules and inhibition of NF- κ B activation [15].

6- Anti-Microbial Effect of Garlic

Garlic has been used for centuries in various societies to combat infectious diseases. Garlic has been proven to be effective against a plethora of gram-positive, gram-negative, and acid-fast bacteria [16]. Garlic has been

recognized for its potential antiviral properties, with various studies indicating its ability to inhibit the replication of viruses. Weber et al. [17] demonstrated the antiviral activity of garlic extract against a range of viruses, including herpes simplex virus type 1, herpes simplex virus type 2, parainfluenza virus type 3, and human rhinovirus type. The study found that garlic extract exhibited significant antiviral effects by inhibiting viral replication at different stages of the viral life cycle. Garlic possesses potent antifungal properties that have been recognized in various studies. One study published in the Journal of Antimicrobial Chemotherapy by Ankri and Mirelman [18] investigated the antifungal activity of garlic extract against a wide range of fungal species, including *Candida albicans*, *Aspergillus niger*, *Trichophyton mentagrophytes*, and *Cryptococcus neoformans*. The study found that garlic extract exhibited significant inhibitory effects on the growth of these fungal pathogens. Additionally, allicin, a major bioactive compound found in garlic, was identified as the primary antifungal agent responsible for its activity. Another study by Lemar et al. [19] demonstrated the antifungal activity of garlic extract against *Candida* species, including *Candida albicans* and *Candida glabrata*.

5. Side Effects of Garlic

Garlic is a commonly used medicinal herb with various health benefits, but it may also have some side effects, especially when consumed in large quantities or over extended periods. Potential side effects of garlic may include stomach and bowel irritation, increased stomach acidity, bloating, and bad breath resulting from ingesting garlic [9].

6. Drug Interactions of Garlic

Garlic contains compounds, such as allicin and ajoene, which have natural anticoagulant (blood-thinning) properties. These compounds work by inhibiting platelet aggregation, the process by which blood platelets clump together to form clots. Garlic supplements, particularly in concentrated forms such as garlic oil or garlic extract, may interact with certain medications, including blood-thinning medications like warfarin (Coumadin) and antiplatelet drugs like aspirin. Garlic may enhance the effects of these medications, potentially increasing the risk of bleeding [20].

7. Toxicity of Garlic

While garlic is generally safe when consumed in food amounts, excessive intake of garlic supplements or raw garlic may lead to toxicity. In rare cases, excessive consumption of garlic may lead to more severe symptoms such as hemolytic anemia or allergic reactions. However, toxicity from dietary garlic intake is uncommon and typically occurs with extremely high doses or prolonged use [13].

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