

Allium sativum (Garlic)

Subjects: **Materials Science, Biomaterials**

Contributor: Murugan Sesha Subramanian , Giri Nandagopal MS , Syafinaz Amin Nordin , Karuppiah Thilakavathy , Narcisse Joseph

Garlic (*Allium sativum*) is an ancient civilised plant, originated from the Asian continent between the Mediterranean and China over 600 years ago. Humans use garlic as a medicinal herb in food as well as to relieve from pain and physical and emotional stress. Currently, people are looking for alternative natural medicine.

Allium Sativum (Garlic)

1. Introduction

People consume a capsule of garlic worldwide as it has an antimicrobial effect and can also cure high cholesterol, thrombosis, hyperlipidaemia and Alzheimer's diseases. Moreover, in India it is used as a galactagogue to enhance lactation in humans. It contains antioxidants that help to destroy the free radicals. Many people use crushed garlic mixed with coconut oil to prevent hair loss and it can promote the regeneration of hair growth. Garlic has been consumed in multiple aspects, as cooked or raw. Garlic has been included in food dishes, which include soups, chutney, salads, fish, and meat curry. The plants of allium have powerful antioxidants, sulphur and phenolic compounds, which serve as the most attractive quality in the food industry. The chemical compounds in garlic have proven its beneficial effects against various diseases including infections, snake bites, hypertension, blood fibrinolytic activity and hyperlipidaemia. Many clinical studies revealed the post effectiveness of garlic towards lowering the cholesterol formation rate, inhibition of enzymes affecting lipid synthesis and angiotensin-converting enzymes. Garlic minimizes the parameters like the low-density lipoprotein (LDL) oxidation rate and reduces the platelet aggregation resulting in decreased blood pressure as it controls the cardiac arrest of a heart patient [1]. The black fresh garlic can raise the immune response with reduced side effects under high temperatures and humidity. Black garlic (BG) was widely used against the treatment of diabetes through the proliferation of monocytes and granulocytes and reduces lymphocytes production rates. BG has the potential beneficial effects on allergic disorders [2]. For many years it is used to treat the diseases like the common cold, illnesses, chronic respiratory diseases, sexually transmitted diseases, wound infection, malaria, cough, mental illness, lung tuberculosis, kidney diseases, liver diseases, asthma, chronic respiratory diseases, and cardiovascular diseases [3]. It has the ability to kill parasites, bacteria, and fungi as well as to protect the liver. Diallyl trisulfide (DATS) from garlic has unique medicinal therapeutic uses, as it inhibits the proliferation of cancerous cell growth through apoptosis and cell cycle arrest [4]. It provides cardiovascular protection, which lowers the cholesterol and blood pressure level. It gives protection against atherosclerosis and helps to decrease the levels of serum glucose, triglycerides, and uric acid as well as insulin resistance and reduces cytokine levels [5].

2. Biological Activities of Sulfur Compounds from Allium sativum

Garlic is one of the important components in people's diet and used as herbal medicine over thousands of years [6] [7]. Ancient literature reveals the importance of garlic to its health benefit towards health maintenance and treatment of diseases like heart diseases, tumours and infections ([Figure 1](#)).

Figure 1. Biological activities of sulfur compounds from *A. sativum* L.

2.1. Effects on Cardiovascular Diseases

Garlic has the therapeutic potential to reduce the LDL oxidation rate and reduce the platelet aggregation results in decreasing the blood pressure. Garlic is the most common spice, which solves many health disorders as it contains many bioactive compounds including polysaccharides, saponins, and organic sulphides [8]. The sulphur content in alliums has a defence role mechanism [9]. Recent in vitro investigation revealed that water-soluble organosulfur compounds of S-allyl cysteine (SAC), and diallyl-di-sulphide (DADS) which are present in garlic extract and garlic oil respectively, are the intense inhibitors of cholesterol synthesis. The clinical uses of garlic and its component extract on cardiovascular diseases have been widely studied [10][11][12]. The water-soluble and insoluble sulphur compounds in garlic exhibits beneficial effects in cardiac abnormalities, especially for the treatment of hypercholesterolaemia and prevention of arteriosclerosis through antioxidant ability. A continuous investigation is being carried out to identify the other potent bioactive constituents in garlic. Phenolic compounds have emerged as minor but potent compounds, which are responsible for its antioxidant activity. Many studies were carried out to determine the hypercholesterolaemic action.

2.2. Effects on Atherosclerosis and Lipid Metabolism

The therapeutic benefits of garlic are well known for its lipid-lowering and antiatherogenic impacts [13][14]. DAS and DATS are the most abundant sulphur-containing volatile compounds, which are accountable for its antiatherogenic activity, mainly present inside the sleek part of the garlic. Among these constituents, allicin in the clove region is

another compound that plays a crucial role in antiatherosclerotic action as well as a cancer preventive agent. Moreover, it induces the macrophages that will degrade the LDL uptake, and it can modify the lipoprotein and reduces the lipid content in the blood vessels to stop the intracellular lipid aggregation [15]. A previous study exhibited that garlic reduces the atherogenic properties of cholesterol [4][16]. EGP (egg yolk-enhanced garlic powder) with copper enhances LDL oxidation in a dose-dependent manner and is used to prevent atherosclerosis [17]. The water-soluble and insoluble sulphur components present inside the garlic presents a typical adverse effect in every cardiac defect remarkably for the treatment of hypercholesterolaemia and inhibition with respect to arteriosclerosis by antioxidant ability, induction and inhibition of numerous metabolic enzymes as well via chelating activity.

2.3. Effects on Hypertension

People are using garlic as a remedy treatment to control blood pressure, worldwide. Approximately 29% of people use garlic to control their blood pressure to about 10 mmHg systolic and 8 mmHg diastolic as identical to normal blood pressure medication [18]. Hydrogen sulphide content from the garlic helps relax the blood vessels by inhibiting the angiotensin II protein [19][20]. Endothelial nitric oxide and vascular gasotransmitter hydrogen sulphide were enhanced by garlic-derived polysulfides, which induce smooth muscle cell relaxation, vasodilation and blood pressure reduction. Various dietary and genetic factors control the effectiveness of the hydrogen sulfide and nitric oxide signalling pathways that contribute to the development of hypertension. Sulfur deficiency also is part of the aetiology of hypertension and can be treated with organosulfur compounds derived from garlic. Previous studies reported that SAC from aged garlic (AG) extract acts as an antihypertensive and renoprotective agent. Day by day treatment with 600 mg of Allicor (garlic powder tablets) has proven to decrease both systolic and diastolic blood pressure. Younis, F., et al., had shown that S-allyl-mercapto-captopril (CPSSA), a conjugate of captopril with allicin, was effective in attenuating systolic and diastolic blood pressures as well as reducing blood glucose levels [21].

2.4. Effects on Platelets and Fibrinolytic Activity

Many medicinal plants like Allium sativum have various therapeutic uses including antimicrobial effect as well as fibrinolytic activities and they would effectively prevent cardiovascular diseases [22]. Garlic beneficially reduces platelet adhesion or aggregation, a potential hazard factor for cardiovascular diseases. Allicin and ajeones are pronounced to have antithrombotic activity [23]. Blood clotting is inhibited by using the garlic, which enhances the fibrinolysis action. The diallyl disulphide and diallyl trisulphide of the garlic has antiplatelet adhesion property [24]. The L-methionine from the aged garlic extract that was used as the dietary supplement by healthy individuals may be beneficial in protection against cardiovascular disease through inhibition of platelet aggregation [25]. Certain biochemical factors support and encourage the platelet aggregation together with Thromboxane A, collagen, arachidonate, adenosine diphosphate (ADP) and epinephrine. The saline and alcoholic onion extractives perfectly prohibit the aggregatory action from ADP and arachidonic acid but not thrombin in platelet-rich plasma. It has been reported that collagen, ADP, and epinephrine of platelet aggregation factors were inhibited by the consumption of garlic [26]. Catecholamines present in platelets somewhat idle against the secondary phase of ADP-induced platelet aggregation and the continuing use of garlic may suppress catecholamines involved in the thrombotic activity.

2.5. Effects on Cancer

Garlic and its compounds are attractive therapeutic agent that can serve as an efficient anticancer agent against various cancer. Eating 10 g or more garlic in a day may significantly reduce the risk of prostate, colon, and stomach cancer. Further clinical research on garlic compounds would shed a lead-on cancer therapy.

2.6. Effects on Immunomodulatory Response

Garlic and its compounds are the crucial immunomodulators that can stimulate the immune system against various diseases. Garlic extract (allicin and DAS) were reported to reduce inflammatory bowel disease by suppressing cytokine production. The garlic extract at low concentration was shown to inhibit the production of proinflammatory cytokine (interleukin-2), and at higher concentration induces the production anti-inflammatory cytokine (interleukin-10) and seized the production of other proinflammatory cytokines such as TNF- α , IL-1 α , IL-6, IL-8, IL2, and IFNy. Thus, the inhibition of proinflammatory and induction of anti-inflammatory cytokines production led to the suppression of inflammatory bowel disease [27]. A different study has been proclaimed that garlic extract could stimulate the immune response against the Leishmania major infection. The mechanisms behind it were defined as that the compounds might activate the nitric oxide synthase (NOS). The NOS activation ultimately leads to the stimulation of the phagocytic activity of macrophage against Leishmania and eliminates it from the body [28].

3. Conclusions

Herbs are nature's endowments to us. The usage of garlic in cultural and traditional settings had a wide range of medicinal value, which may differ from concepts accepted in current western medicine. Though garlic consumption is highly beneficial, long-term and large trials are necessary to evaluate the serious adverse effects it may pose. Consumption of raw garlic directly causes the sensation of burning in the mouth and throat or stomach, heartburn, diarrhoea, nausea and vomiting. Consumption of garlic products may cause the reddening of the gastric mucous layer and also has a chance of having hyphaemia leading to permanent vision loss. Sometimes it might increase the risk of bleeding including nosebleeds and bleeding gums. In some individuals, consumption of excess garlic may also cause GERD (gastroesophageal reflux disease) and loss of appetite. Overdose of garlic may lead to kidney haematoma and had a chance of getting an autoimmune disorder of pemphigus. The safe dose of garlic consumption should be tested particularly in pregnant or breastfeeding women and also in young children. During the second and third trimesters of pregnancy, it is advisable to take a moderate level of garlic cloves to lower blood pressure and maintain good development of the baby, however consuming large quantities of garlic during pregnancy may lead to some adverse effect such as blood thinning and miscarriage. The U.S Food and Drug Administration, certified garlic as "generally recognized as safe" (GRAS) for consuming garlic as a flavouring agent as well as food including during lactation. Some reports stated that working with garlic could cause side effects like asthma and possible allergic reactions. may lead to miscarriages. However, it is advisable to consult the well-trained practitioner for using the herbal supplements.

References

1. Banerjee, S.K.; Maulik, S.K. Effect of garlic on cardiovascular disorders: A review. *Nutr. J.* 2002, 1, 1–14.
2. Zahid Ashraf, M.; Hussain, M.E.; Fahim, M. Antiatherosclerotic effects of dietary supplementations of garlic and turmeric: Restoration of endothelial function in rats. *Life Sci.* 2005, 77, 837–857.
3. Chan, J.Y.Y.; Yuen, A.C.Y.; Chan, R.Y.K.; Chan, S.W. A review of the cardiovascular benefits and antioxidant properties of allicin. *Phyther. Res.* 2013, 27, 637–646.
4. Kearney, P.M.; Whelton, M.; Reynolds, K.; Muntner, P.; Whelton, P.K.; He, J. Global burden of hypertension: Analysis of worldwide data. *Lancet* 2005, 365, 217–223.
5. Gonen, A.; Harats, D.; Rabinkov, A.; Miron, T.; Mirelman, D.; Wilchek, M.; Weiner, L.; Ulman, E.; Levkovitz, H.; Ben-Shushan, D.; et al. The antiatherogenic effect of allicin: Possible mode of action. *Pathobiology* 2006, 72, 325–334.
6. Mikaili, P.; Maadirad, S.; Moloudizargari, M.; Aghajanshakeri, S.; Sarahroodi, S. Therapeutic uses and pharmacological properties of garlic, shallot, and their biologically active compounds. *Iran J. Basic Med. Sci.* 2013, 16, 1031–1048.
7. Gebhardt, R. Multiple inhibitory effects of garlic extracts on cholesterol biosynthesis in hepatocytes. *Lipids* 1993, 28, 613–619.
8. Lee, H.S.; Lim, W.C.; Lee, S.J.; Lee, S.H.; Lee, J.H.; Cho, H.Y. Antiobesity effect of garlic extract fermented by *Lactobacillus plantarum* BL2 in diet-induced obese mice. *J. Med. Food* 2016, 19, 823–829.
9. Nwachukwu, I.D.; Slusarenko, A.J.; Gruhlke, M.C.H. Sulfur and sulfur compounds in plant defence. *Nat. Prod. Commun.* 2012, 7, 395–400.
10. Rietz, B.; Isensee, H.; Strobach, H.; Makdassi, S.; Jacob, R. Cardioprotective actions of wild garlic (*Allium ursinum*) in ischemia and reperfusion. *Mol. Cell. Biochem.* 1993, 119, 143–150.
11. Kendler, B.S. Garlic (*Allium sativum*) and onion (*Allium cepa*): A review of their relationship to cardiovascular disease. *Prev. Med.* 1987, 16, 670–685.
12. Koscielny, J.; Klüßendorf, D.; Latza, R.; Schmitt, R.; Radtke, H.; Siegel, G.; Kiesewetter, H. The antiatherosclerotic effect of *Allium sativum*. *Atherosclerosis* 1999, 144, 237–249.
13. Schwartz, C.J.; Valente, A.J.; Sprague, E.A. A modern view of atherosclerosis. *Am. J. Cardiol.* 1993, 71.
14. Obenin, I.A.; Myasoedova, V.A.; Iltchuk, M.I.; Zhang, D.W.; Orekhov, A.N. Therapeutic effects of garlic in cardiovascular atherosclerotic disease. *Chin J. Nat. Med.* 2019, 17, 721–728.

15. Bayan, L.; Koulivand, P.H.; Gorji, A. Garlic: A review of potential therapeutic effects. *Avicenna J Phytomed.* 2014, 4, 1–14.
16. Mag, P.; Bose, S.; Laha, B.; Banerjee, S. Quantification of allicin by high performance liquid chromatography ultraviolet analysis with effect of post ultrasonic sound and microwave radiation on fresh garlic cloves. *Pharmacog. Mag.* 2014, 10.
17. Yamaji, K.; Sarker, K.P.; Abeyama, K.; Maruyama, I. Anti-atherogenic effects of an egg yolk-enriched garlic supplement. *Int. J. Food Sci. Nutr.* 2004, 55, 61–66.
18. Osamor, P.E.; Owumi, B.E. Complementary and alternative medicine in the management of hypertension in an urban Nigerian community. *BMC Complement Altern Med.* 2010, 10, 36.
19. Benavides, G.A.; Squadrito, G.L.; Mills, R.W.; Patel, H.D.; Isbell, T.S.; Patel, R.P.; Darley-Usmar, V.M.; Doeller, J.E.; Kraus, D.W. Hydrogen sulfide mediates the vasoactivity of garlic. *Proc. Natl. Acad. Sci. USA* 2007, 104, 17977–17982.
20. Banerjee, S.K.; Mukherjee, P.K.; Maulik, S.K. Garlic as an antioxidant: The good, the bad and the ugly. *Phyther. Res.* 2003, 17, 97–106.
21. Younis, F.; Mirelman, D.; Rabinkov, A.; Rosenthal, T. S-allyl-mercapto-captopril: A novel compound in the treatment of cohen-rosenthal diabetic hypertensive rats. *J. Clin. Hypertens.* 2010, 12, 451–455.
22. Ansari, F.; Soltan, M.N.; Naderi, G.; Sadegh, S.M.; Karimi, A. Original article study of garlic effect on fibrinolytic activity of the blood clot in vitro. *Iran. J. Pediatr. Hematol. Oncol.* 2011, 1, 48–52.
23. Teranishi, K.; Sc, R.; Romano, E.; Dkc, C.; Robson, S.C.; Teranishi, K.; Apitz-Castro, R.; Robson, S.C.; Romano, E.; Cooper, D.K.C. Inhibition of baboon platelet aggregation in vitro and in vivo by the garlic derivative, ajoene. *Xenotransplantation* 2003, 10, 374–379.
24. Aslani, N.; Entezari, M.H.; Askari, G.; Maghsoudi, Z.; Maracy, M.R. Effect of garlic and lemon juice mixture on lipid profile and some cardiovascular risk factors in people 30–60 years old with moderate hyperlipidaemia: A randomized clinical trial. *Int. J. Prev. Med.* 2016, 7, 95.
25. Rahman, K. Effects of garlic on platelet biochemistry and physiology. *Mol. Nutr. Food Res.* 2007, 51, 1335–1344.
26. Ackermann, R.T.; Mulrow, C.D.; Ramirez, G.; Gardner, C.D.; Morbidoni, L.; Lawrence, V.A. Garlic shows promise for improving some cardiovascular risk factors. *Arch. Intern. Med.* 2001, 161, 813–824.
27. Hodge, G.; Hodge, S.; Han, P. *Allium sativum* (garlic) suppresses leukocyte inflammatory cytokine production in vitro: Potential therapeutic use in the treatment of inflammatory bowel disease. *Cytometry* 2002, 48, 209–215.

28. Ghazanfari, T.; Hassan, Z.M.; Khamesipour, A. Enhancement of peritoneal macrophage phagocytic activity against *Leishmania* major by garlic (*Allium sativum*) treatment. *J. Ethnopharmacol.* 2006, 103, 333–337.

Retrieved from <https://encyclopedia.pub/entry/history/show/8797>