



A Review on Therapeutic Importance of *Allium Sativum* (Garlic)

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ABSTRACT

Medicinal plants have been used from ancient time for human health care. Garlic (*Allium sativum*) belong to *Alliaceae* family, and it has tremendous pharmacological effects due to its biological constituent organosulfur compounds such as allicin, diallyl disulphide, S-allylcysteine and diallyl disulphide. Apart from organosulfur *Allium* species is rich in sugar protein, fat, calcium, potassium, phosphorus, sulphur, iodine fiber and silicon. Garlic is an aromatic herbaceous plant that is consumed worldwide as food and traditional remedy for various diseases [1]. The pharmacological aspects of the genus *Allium L.* have been clinically evaluated since long due its typical flavour and ethnomedical importance. It possesses high nutritive value. It has been reported to possess several biological properties such as anticarcinogenic, antioxidant, antidiabetic, renoprotective, antiatherosclerosis, antibacterial, antifungal, antiviral, antihypertensive, anthelmintic, platelet effect, antiinflammatory, fibrinolytic, indigestion and anaemia. The review examines various therapeutic uses of *A. sativum*.

Key words: *Allium sativum*, Allicin, Pharmacological activity, Organosulfur.

INTRODUCTION

Medicinal plants could be a potential alternative for synthetic drugs. Most of the marketed drugs, especially antibiotics shown unwanted symptoms and emergence of resistant pathogenic microorganisms, toxic effect related to these drugs, and withdrawal issues restricting their use in many countries, therefore more attention has been given to herbal products. Garlic is the second most widely used *Allium* next to onion widely cultivated throughout the world as spice, additives and as medicinal plant. Some of the earliest references of this medicinal plant were found in approximately 5000 years ago. *Allium* species and their active components are reported to reduce the risk of diabetes and cardiovascular diseases, protect against infections by activating the immune system and have antimicrobial, antifungal, anti-aging as well as anti-cancer properties which confirmed by epidemiological data from human clinical studies. Garlic has been used for cooking purposes as a spice that can flavour foods during the cooking process. As well, it possesses therapeutic purposes including the treatment of lung disorders, whooping cough, stomach disorders, cold, earache, and assists in preventing cardiovascular disease [2]

But it is fact that garlic have occupied special place for their medicinal value for centuries in the Middle East and Southeast Asia, Europe and America. There is an attempt has been made in this review to cover the nutritional value and pharmacological and therapeutic uses of garlic reported by the recent studies for garlic.

Botanical description

Garlic is a bulbous plant, 30 to 40 cm of height alternating long and very narrow leaves; from the center of the leaves the floral pendulum arises from 40 to 50 cm of height, hairless and hollow; flowers contained in terminal umbels. Its flower has whitish petals turning to violaceous. Fruits in ovoid capsule form. The bulb or head of garlic is generally of white colour and it is divided into parts called cloves of garlic that are wrapped by a whitish tunic that is sometimes blushed and similar to the membrane that covers the whole bulb.

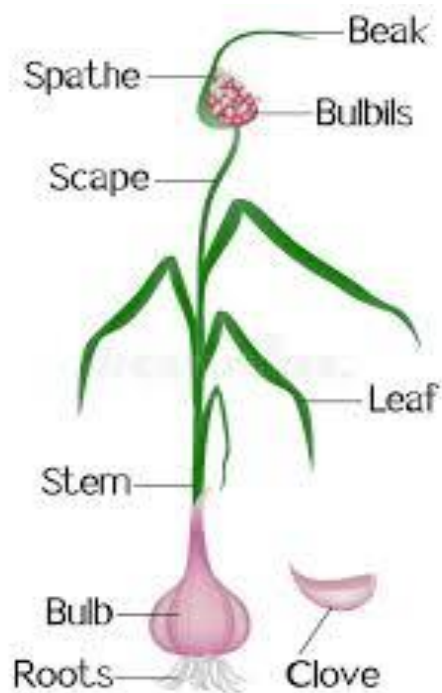


Figure 1: Illustration of garlic

Botanical classification

Kingdom : Plantae
 Division : Mangnoliophyta
 Class : Liliopsida
 Order : Asperagues
 Family : Amaryllidaceous
 Subfamily: Allioideae
 Tribe : Allieae
 Gender : Allium
 Species : Allium sativum

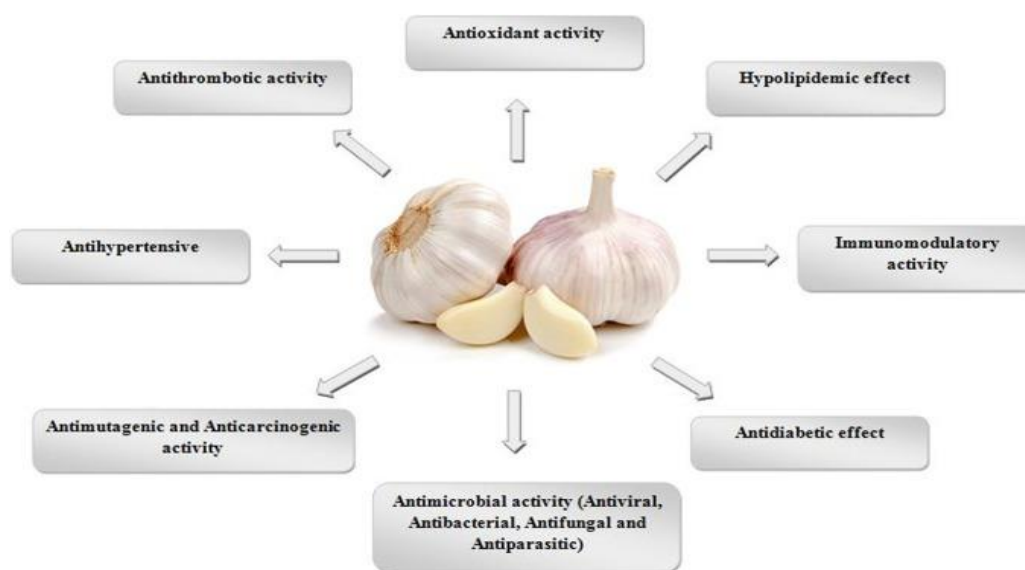
Table 1: Summary of nutritive value of garlic

Substance	Amount found/100g	Substance	Amount found/100g
Water (Moisture)	58.58%	Vitamin B6	1.235 mg
Energy	623 kJ (149 kcal)	Folate (Vitamin. B9)	3 µg
Carbohydrates	33.06 g	Vitamin C	31.2 mg
Sugars	1.00g	Calcium	181 mg
Dietary fiber	2.1 g	Iron	1.7 mg
Fat	0.5g	Magnesium	25 mg
Protein	6.39g	Phosphorus	153 mg
Beta-carotene	5 µg	Potassium	401 mg
Thiamine (Vitamin B1)	0.2 mg	Sodium	17 mg
Riboflavin (Vitamin. B2)	0.11 mg	Zinc	1.16 mg
Niacin (Vitamin. B3)	0.7 mg	Manganese	1.672 mg
Pantothenic acid (Vitamin B5)	0.596 mg	Selenium	14.2 µg

Table 2: Recommended daily doses in humans

S. No.	Form of garlic	Doses (daily)
1.	Fresh garlic:	4g approx. 1 clove (4–12 mg of alliin or 2– 5 mg of Allicin)
2.	Dehydrated Garlic powder	600–1200 mg in divided doses
3.	Fresh air-dried bulb	2–5 g
4.	Tincture	(1:5 in 45% alcohols): 2–4 ml three times daily ³²
5.	Garlic oil	2–5 ml
6.	Dried bulb	2–4 g three times daily

Pharmacological activities

**Figure: 2**

Antihypertensive activity

Garlic has probably been most popularized as a complementary therapy for blood pressure control. The mechanism of antihypertensive activity of garlic is due to its prostaglandin-like effects, which decrease peripheral vascular resistance. The gamma-glutamyl cysteines are the compounds in garlic that may lower blood pressure, as indicated by their ability to inhibit angiotensin-converting enzyme in *in vitro* [2]. Garlic modulates the production and function of both endothelia derived relaxing and constricting factors and this may contribute to its protective effect against hypoxic pulmonary vasoconstriction. Garlic elicits nitric oxide-dependent relaxation in pulmonary arteries (Palani *et al.*, 2014).

Cardioprotective activity

Epidemiologic studies show that the cardiovascular diseases are associated with multiple factors such as raised serum total cholesterol, increased LDL, increased platelet aggregation, hypertension and smoking. *In-vitro* studies have confirmed the ability of some plants of *Allium* species to reduce these parameters. The screening of methanolic extract of *Allium* species (*A. ampeloprasum*, *A. hirtifolium*, *A. haemanthoides*, *A. vavilovi*, *A. atroviolaceum*, *A. jesdianum* and *A. shelkovnikovii*) showed that the maximum effect of anti-platelet aggregation was related to *A. atroviolaceum* (Lorigooinia *et al.*, 2015) [3]

Antihyperlipidemic

Dyslipidaemia is a known to be the main cause of myocardial infraction and cardiovascular diseases and it is defined by high levels of triglyceride (TG), LDL, total cholesterol and low HDL level. Interestingly, various evidence encourages the significant and crucial role of garlic preparation and its phytochemical in treating hypercholesterolemia by preventing the cholesterol biosynthesis in the liver as well as inhibiting low-density lipoproteins (LDL and HDL) oxidation [3]. Moreover, garlic reduces the cholesterol level either by stimulating the acidic and neutral steroids excretion or by reducing the cholesterogenic and lipogenic effects of fatty acid synthase, 3-hydroxy-3-methyl-glutaryl-CoA reductase, malic, and glucose-6-phosphate dehydrogenase in hepatocytes. Garlic was found to have an important effect on dyslipidaemia by significantly decreased serum TC, TG and LDL levels and moderately

elevated HDL cholesterol. Various experimental and clinical trials were performed in animals and humans using various garlic preparations and they exhibited disputable results [4].

Antioxidant

Garlic is rich in antioxidants which help to destroy the free radicals and particles that damage cell membrane and DNA which slows down the aging process. Garlic has complex chemical properties which have apparently opposite biological effects and play role in the antioxidants properties [5]. Aged garlic extract and other active constituents of the garlic showed scavenging effect on Chain-breaking effect induced by hydrophilic radical initiator and scavenging assay of superoxide anion radical. The two pivotal organ sulphur compounds S-allylcysteine and S-allylmercaptocysteine in aged garlic showed scavenging activity in both chemiluminescence and 1-1-diphenyl-2-picrylhydrazyl. Studies shown that the garlic compounds tested have different patterns of antioxidant activity in terms of scavenging of superoxide and hydroxyl radical and preventing peroxidation of microsomal membranes.

Antithrombotic

Garlic extracts and several garlic constituents demonstrated significant antithrombotic actions both in vitro and in vivo. Allicin and adenosine are the most potent antiplatelet constituents of garlic. A study suggested that odorless garlic not only activates fibrinolytic action by accelerating (tissue-type plasminogen activator) t-PA-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 [6]. A study mentioned that aqueous extract of garlic inhibits platelet aggregation induced by several aggregation agents, including arachidonate in a dose-dependent manner. Another survey indicated that garlic extracts act through inhibition of the ADP (adenosine diphosphate) pathway. Their mechanisms of action are comparable to that of the clinically used drug clopidogrel [6].

Anticancer

Cancer is one of the most prevalent and the heinous disease in the world which is claiming life. Garlic which is daily used as condiment in every kitchen can cure cancer who would have ever thought it. Many research enthusiasts have found that garlic directly inhibit proliferation of a variety of cancer cell lines derived from colon, lung, leukaemia, skin, breast, and prostate cancers. Garlic together with vitamin E and C reduced the incidence of precancerous gastric lesion in a large population in China [7]. A study from China indicated an inverse relationship in mortality between stomach cancer and garlic consumption, providing the first evidence of garlic's anticancer potential. Similarly, other studies like a lower risk of colon cancer for American consumers of garlic were reported in the Iowa Woman's Health Study. The modes of action of garlic is by inhibiting of tumour growth, exhibit radical scavenging, induction of apoptosis, stimulation of the immune response which is the virtue of organosulphur compounds. Fresh garlic extract inhibits the carcinogen DMBA (7,12-dimethylbenzene(a)anthracene); garlic oil inhibits the carcinogen DMBA, PMA (phorbol-myristate-acetate); fresh garlic powder inhibits the carcinogen DEN (diethyl nitrosamine) and diallyl sulphide (DAS) inhibits the carcinogens DMH (1,2-dimethylhydrazine), NMBA (N-nitroso methylbenzylamine), BP (benzo[a]pyrene) and DMBA (7,12- dimethylbenz(a)anthracene). DMBA (7,12- dimethylbenz(a)anthracene). It is studied that garlic loses its health properties on heating and therefore, it is advice to take garlic raw or consume its extract or essential oil or garlic macerate [8,9]

Antidiabetic activity

The prevalence of diabetes for all age-groups worldwide was estimated to be 2.8% in 2000 and 4.4% in 2030. The total number of people with diabetes is projected to rise from 171 million in 2000 to 366 million in 2030 [9]. The presence of allicin, DAS, DADS have anti-diabetic properties, garlic has significant hypoglycemic action and this effect is thought due to increased hepatic metabolism and/or increased release of insulin and insulin sparing effect. Streptozotocin induce diabetic rats were studied and promising results were derived. On administration of garlic extract to diabetic rats' significant decline in serum glucose was noted along with total cholesterol and triglycerides [10].

Antiinflammatory activity

Garlic extracts and its related phytochemicals have been reported to possess anti-inflammatory activity. A study reported that the garlic extracts remarkably impaired the liver inflammation and damage caused by *Eimeria papillate* infection. The anti-inflammatory activity of garlic is caused by inhibiting the emigration of neutrophilic granulocytes into epithelia. Aged black garlic (ABG) exhibited potent antioxidant activities and these activities may be responsible for its anti-inflammatory activity [11].

Anti-Alzheimer's Disease Activity

Alzheimer's disease is the main cause of dementia in the elderly with neurodegenerative and cerebrovascular disorders. Acetylcholinesterase is the main enzyme that converts the acetylcholine in the nervous system to acetate and choline. Acetylcholine depletion in the central nervous system has been involved in the pathophysiology noticed in alzheimers, therefore, donepezil was effective in the management/prevention of alzheimers. Surprisingly, oil from garlic bulbs suppressed acetylcholinesterase activity of cerebral cortex synaptosome and exhibits antioxidant properties, thus, inhibiting acetylcholinesterase activity in vitro as well as their ability to scavenge diphenyl-1-picrylhydrazyl(DPPH) free radical that are used to evaluate the compound's ability to act as hydrogen donors or free radical scavengers and to assess the antioxidant activity of food and reduce Fe³⁺ to Fe²⁺ could be suggested as the possible mechanism of action for their neuroprotective potential [12].

Effect on Obesity

Obesity is the most common health problems that may lead to many ailments like hypertension, dyslipidemia, cardiovascular disorders, and metabolic syndrome. Garlic extracts have been reported for their activity in reducing body weight, adipose tissue mass and improved plasma lipid profiles in mice

with high-fat diet-induced obesity and these effects mediated by the downregulation of multiple genes expression that is included in adipogenesis along with upregulation of the mitochondrial inner membrane proteins expression [13]. Moreover, Lee et al. [13] revealed that the antiobesity effect of garlic extracts attributed to stimulation of AMP-activated protein kinase (AMPK) as well as increased thermogenesis and decreased multiple genes expression that is included in adipogenesis.

Antibacterial

Allicin and other sulfur compounds are thought to be the major compounds responsible for the antimicrobial effect of garlic. Garlic is effective against a number of gram-negative, gram-positive, and acid-fast bacteria, including *Staphylococcus*, *Salmonella*, *Vibrio*, *Mycobacteria*, and *Proteus* species [14]. Aqueous, ethanol and chloroform extracts of garlic inhibited the growth of the pathogenic bacteria, though with varying degrees of susceptibility. The gram-positive *Staphylococcus aureus* was more susceptible to the toxic effects of garlic than its gram-negative counterparts. An in vitro study on the effects of aqueous and ethanolic extracts of garlic against specific bacteria such as *Escherichia coli* and *salmonella typhi* showed that the aqueous extract had little or no inhibition while the ethanolic extract had a higher inhibitory effect. the ethanolic extract had a higher inhibitory effect. Allicin in its pure form was found to exhibit antibacterial activity against multidrug-resistant entero toxicogenic strains of *E. coli*. [15].

Antifungal

Allicin (diallyl-dithiosulfinate), which is produced by the garlic enzyme alliinase from the alliin, has been shown to have wide-range antifungal specificity. An in vivo study showed that antibody alliinase conjugates and alliin are effective against murine pulmonary aspergillosis. One study showed that allicin from garlic has antifungal activity particularly against *Candida albicans*. in vitro study showed both intrinsic antifungal activity of allicin and its synergy with the azoles, in the treatment of candidiasis [16].

Antiviral

A. sativum has been shown to have antiviral activity. In one study the virucidal activity of this plant was attributed to the following contents in this order: ajoene > allicin > allyl methyl > thiosulfinate > methyl allyl thiosulfinate. Also, Allicin, the main constituent of *A. sativum*, has a variety of antimicrobial activities both in vitro and in vivo. Among the viruses which are sensitive to garlic extracts are the human Cytomegalovirus (HCMV), influenza B virus, Herpes simplex virus type 1, Herpes simplex virus type 2, Parainfluenza virus type 3, vaccinia virus, vesicular stomatitis virus, and human Rhinovirus type 2 [17].

Anti-parasitic

An ultrastructural study showed that allicin is able to produce morphological changes in the male *Schistosoma mansoni* [18]. Another study indicated that Allicin has antiparasitic activity against *Plasmodium falciparum* and *Trypanosoma brucei*. It is also effective against some major human intestinal protozoan parasites such as *Entamoeba histolytica* and *Giardia lamblia*. *A. sativum* were shown to have anthelmintic activity against *Haemonchus contortus* from sheep. The ethanol extract was the most effective in decreasing larval count. Garlic is an ingredient of a mixture (Prepared from the extracts of coconut, onion, garlic, fig, date tree, chicory, ananas, and cistrose) tested in vivo and in vitro for its anthelmintic activity against cestodes (*Hymenolepis diminuta*, *H. microstoma*, and *Taenia taeniaeformis*) and trematodes (*Fasciola hepatica*, *Echinostoma caproni*). In all in vitro tests, the target parasites died [19].

Immunomodulatory effect

Immunomodulation is among innumerable biological activities of *A. sativum*. Aged garlic extract has been shown to have superior immunomodulatory properties over raw garlic extract [20]. This effect of garlic is attributed to the transformed organosulfur compounds. Aged garlic fructans have recently been shown to possess immunomodulatory activities in vitro. Garlic extract is concentration dependently effective on the proliferation of interleukin (IL)-2 and interferon (INF)- γ gene expression of stimulated lymphocytes. Garlic extracts reduced macrophage infection through induction of nitric oxide (NO) production In vitro [21].

Platelet Effects

Al Qattan *et al.* (2006) pointed out that garlic and its derived compound (ajoene) have proven inhibition of platelet aggregation in vitro and in animals and reduction of platelet- dependent thrombus formation [22]. Anti-platelet activity may be attributable to garlic constituents including adenosine, allicin and paraffinic polysulfides as described Srivastava and Tyagi (1995).

Sickle Cell Anemia

Sickle cell anemia is a genetic disease caused by abnormal hemoglobin. Dense cells, which have an elevated density and possess an abnormal membrane, have a tendency to adhere to blood components such as neutrophils, platelets, and endothelial cells, which line blood vessels. Ohnishi et al. (2001) found that aged garlic extract (4.0 mg/ml) could inhibit dense cell formation by 50% along with other effective nutrients like black tea extract, green tea extract, pycnogenol, α - lipoic acid, vitamin E, coenzyme Q10, and β -carotene [23].

Diuretic

Garlic acts as a diuretic which helps to get rid of body liquids. It may act as a very useful resource in case of rheumatism, gout, arthritis, hidropesia, edemas as described by Ali (1995) [24].

Fibrinolytic activity

Fibrinolytic activity has found that garlic increased fibrinolytic activity in healthy individuals as well as in acute myocardial infarction patients [24].

Hepatoprotective activity

Several studies showed that garlic can protect the liver cells from some toxic agents. Dietary inclusion of garlic powder protects rats against gentamycin-induced hepatotoxicity, improves antioxidant status, and modulates oxidative stress [25].

Conclusion

Garlic (*Allium sativum*) has been described with the various biological activities from ancient times. The plant contains biological active constituents which contributes a vital role in its nutraceutical application. it contains essential mineral, vitamins, protein and is well known to all as it's wide use as a spice or condiment continental cuisine besides to its, along with this the plant has various potential pharmacological activities against various life-threatening diseases and disorders. It must be used on daily basis for combating with diseases to live healthy and long life. The impression of this review is directed to provide a brief spectrum of garlic in medicines and culinary.

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