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ALLIUM SATIVUM - BOON TO THE HERBAL WORLD

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ABSTRACT

From ancient time *Allium sativum* has been used as food, spice and household medicine for several common problems such as dog bites, insect stings, earaches, burns, wounds, baldness, headaches, chest colds etc. The therapeutic effect of *Allium sativum* is due to Allin, Allicin, protein, fixed oil, thiamine, ascorbic acid and minerals. This review covers the study of Pharmacognosy, pharmacchemistry, pharmacology and pharmaceutical aspects of this herb. Moreover, its valuable medicinal effects along with its economical value are being discussed.

Keywords: Garlic, pharmaceuticals, economics, medicinal uses, herbs

INTRODUCTION

Garlic (*Allium sativum*) is the earliest of cultivated foods and spices, easily identified by primitive food-seekers by their distinctive smell. The popularity of garlic in folk medicine for treatment of varied disorders such as dog bites, insect stings, earaches, burns and wounds, baldness, headaches, chest colds, respiratory ailments, asthma, pneumonia, diabetes, cardiovascular disorders and rheumatism¹ can be attributed to their pungent aroma and strong taste associated with organ sulfur compounds. Table 1 represents the scientific classification of garlic.

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Table 1 Botanical Classification of garlic

Kingdom	Plantae
Clade	Angiosperms
Clade	Monocots
Order	Asparagales
Family	Amaryllidaceae
Subfamily	Allioideae
Genus	<i>Allium</i>
Species	<i>A. sativum</i>

History of *Allium Sativum*

Garlic is native of mountainous regions to Central Asia². It reached China and then was carried to western hemisphere by Spanish and Portuguese. It has been frequently seasoned in Asia, Africa and Europe. It was known to Ancient Egyptians, and has been used throughout its history for both culinary and medicinal purposes³. Garlic is mentioned in the Bible and the Talmud. Hippocrates, Galen, Pliny the Elder, and Dioscorides all specified the use of garlic for many conditions, including parasites, respiratory problems, poor digestion and low energy. Its use in China was first mentioned in AD 510. During World War I and II, soldiers were given garlic to prevent gangrene. Early in the 20th century, it was sometimes used in the treatment of pulmonary tuberculosis or phthisis¹.

Pharmacognostic Aspects of *Allium Sativum*

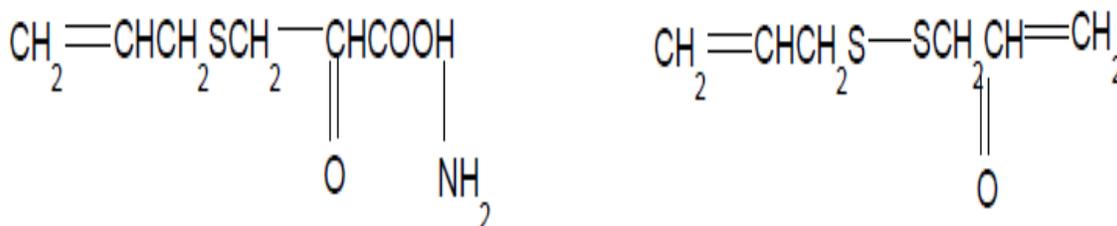
Garlic is a perennial herb that originally came from Central Asia and now it is grown throughout the world. It can grow 2 feet high or more. The part of this plant used for medicine is the compound bulb. Each bulb is made up of 4 - 20 cloves and each clove weighs about 1 gram⁴. Garlic supplements can either be made from fresh, dried; aged or garlic oil, and each may have different effects on the body.

Pharmacology of *Allium Sativum*

Researchers once thought that a chemical called allicin was responsible for garlic's benefits as well as its distinctive smell. But there are other chemicals in garlic, including some sulfur-containing compounds⁶, which may help lower cholesterol, fight heart disease, and help prevent cancers. The garlic bulb contains 0.2-0.3% volatile oils allin (S-allyl-L-cysteine sulfoxide), ajoenes (E-Z-methylajoene, dimethylajoene and E-Z-ajoene), 16.8% of dry weight proteins, vitamins, amino acids and lipids etc in Table 2. The bulb also contains the mixture of aliphatic mono and polysulphides including allicin and diallyldisulphide oxide. Recent studies on fresh homogenized garlic extract suggested the presence of prostaglandins A₂ and F₁⁴. Figure 1 represents the chemical structure of the basic components of garlic.

Table 2 Nutritional value per 100 g (3.5 oz) of Raw Garlic⁵

Energy	623 kJ (149 kcal)
Carbohydrates	33.06 g
Sugars	1.00g
Dietary fiber	2.1 g
Fat	0.5 g
Protein	6.39 g
beta-carotene	5 µg (0%)
Thiamine (Vit. B ₁)	0.2 mg (17%)
Riboflavin (Vit. B ₂)	0.11 mg (9%)
Niacin (Vit. B ₃)	0.7 mg (5%)
Pantothenic acid (B ₅)	0.596 mg (12%)
Vitamin B ₆	1.235 mg (95%)
Folate (Vit. B ₉)	3 µg (1%)
Vitamin C	31.2 mg (38%)
Calcium	181 mg (18%)
Iron	1.7 mg (13%)
Magnesium	25 mg (7%)
Phosphorus	153 mg (22%)
Potassium	401 mg (9%)
Sodium	17 mg (1%)
Zinc	1.16 mg (12%)
Manganese	1.672 mg
Selenium	14.2 µg

**Figure 1 Chemical structure of a) Allin b) Allicin****Pharmacological Aspects of *Allium Sativum***

Garlic is rich in antioxidants, which help destroy free radicals (particles that can damage cell membranes and DNA) and thereby may contribute to the aging process as well as the development of a number of conditions, including heart disease and cancer. Antioxidants neutralize free radicals and may reduce or even help prevent some of the damage they cause over time. Garlic is available in many different forms in the market and might prove useful. Garlic supplements are made from whole fresh garlic, dried or freeze-dried garlic, garlic oil and aged garlic extracts⁷⁻⁸. Not all types of garlic contain the same amount of active ingredients. Hence use of standardized garlic products becomes very essential to get maximum benefits. The

recommended dose of garlic and its derivatives are still under consideration, but the adult dose is specified in Table 3.

Table 3 Specified Adult Dose of Garlic and its Derivatives

Categories	Dose	Specification
Whole garlic	2 - 4 grams per day	As a food supplement
Clove Oil	0.03 - 0.12 mL, 3 times daily	-----
Fluid extract	4 mL, daily	1:1 w/v
Tincture	20 mL, daily	1:5 w/v
Aged garlic extract	600 - 1,200 mg, daily in divided doses	-----
Tablets of freeze-dried garlic	200 mg, 2 tablets 3 times daily	Products found standardized to contain 10 - 12 mg/Gm alliin and 4,000 mcg of total alliin potential (TAP) Or Standardized to contain 1.3% alliin or 0.6% alliin

Pharmaceutical Aspects of *Allium Sativum*

The best garlic powder tablets were equally as active as fresh cloves. However, steam-distilled oils were 35% as active and oil-macerates only 12% as active in comparison to fresh clove⁹⁻¹¹. The European Scientific Cooperative on Phytotherapy suggested the daily 6-10 mg of alliin (or 3-5 mg of alliin), which can be found in one clove of fresh garlic or in 500-1000 mg of garlic powder¹². There is variation of about 30–40 fold in the quantities of various garlic constituents in different products. According to research from the Center for Science in the Public Interest, the “best buy” in terms of getting the most alliin for one’s money (other than eating fresh, raw garlic) comes from buying garlic powder off the spice cabinet and putting 1/3 tsp into a gelatin capsule oneself. Some of the multi-ingredient preparations containing garlic are summarized in Table 4

Economical Aspects of *Allium Sativum*

Garlic is grown globally, but China is by far the largest producer of garlic, with approximately 10.5 million tonnes (23 billion pounds) grown annually, accounting for over 77% of world output. India (4.1%) and South Korea (2%) followed by Egypt and Russia (1.6%) which are tied up in fourth place and the United States (where garlic is grown in every state except for Alaska) in sixth place (1.4%)¹³. This leaves 12.3% of global garlic production in countries that each produces less than 2% of global output (Figure 2).

Much of the garlic production in the United States is centered in Gilroy, California, which calls itself the "garlic capital of the world"¹⁴ Figure 3 represents the world market share of different countries along with top ten garlic producers in the world economics.

Table 4 Market Preparations of Garlic

Name of Pharmaceutical Preperation	
Allium Plus	Horse Radish and Garlic Tablets
Antifect	Keli-Med
Arterase	Kincare
Asgoviscum N	Kreislauf-Kapseln
Asgoviscum Forte	Prexene
Bleib Junger	Procold
Brewers Yeast with Garlic	Proesten
Cold-Eeze	Protol
Discmigon	Proyeast
Dynamol	Silybum Complex
Echinacea ACE Plus Zinc	Omegacelle
Esten	Vitalyt
Garlic and Horseradish + C Complex	Gelovitall
Garlic and Horseradish Complex 1000	Ginkovit
Gartech	Hanoartin

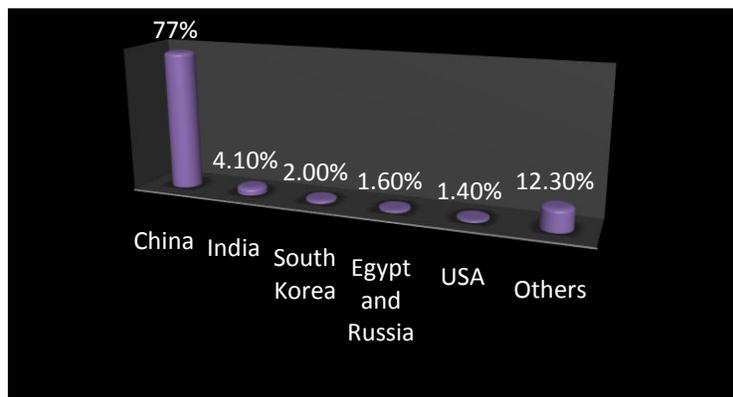


Figure 2 Global garlic productions in world

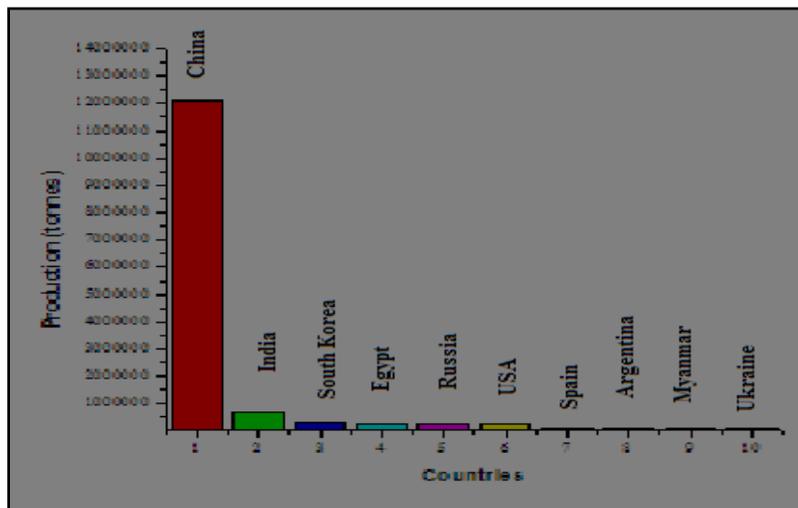


Figure 3 Top 10 Garlic producing countries

In the world market, there are many national and international firms engaged in the production and trading of garlic and products derived from garlic. This is supplied in both raw as well as processed forms and hence proves economically beneficial as it provides working opportunities to greater section of population all over the world. Table 5 enlisted the selected list of companies associated with production and supply of garlic and garlic based products¹⁵.

Table 5 Selected list of companies associated garlic and garlic based products

Countries	Manufacturers/ Traders/ Suppliers
India	Denree world incorporation, Satikuwar Exports Private Limited, Gemini Trading Co., Sai International Trading Company,
Malaysia	Ebony wonder sdn. Bhd.
Vietnam	Viemts joint stock company, vietgo joint stock company
South Korea	K.Y.Cdigital nomad co ltd
Japan	Toyo suppli co ltd, Green Tex Co Ltd, Kaburagien Co Ltd
Pakistan	khurshed trading co. (private) limited
Thailand	Nine and king co., ltd.
Australia	Vvrs Australia pty ltd, Sumabe Holdings Pty Ltd., Vitaimpex
New Zealand	New Zealand health food co ltd, fresh fruits co ltd, deep blue health new zealand ltd
Northern Mariana Islands	Guangxi Linshifubang trade co., ltd
United Kingdom	Kolli international trading limited, rav industries ltd
Spain	Easyfish S.L., basic allium S.L.
Turkey	Manu agro supplies, Arkil Alp Trades
Netherlands	bloemimex BV, Victoria Mondial
Cyprus	Al Ali traders
France	Maison Aux Mille Saveurs
Germany	Nwenzak S.kayap investment (nski)
Switzerland	phytolites gmbh
Portugal	Sousa Antunes
Egypt	Arkanza international trade, lashein for import, export & commercial agencies, anb for manufacturing, packaging and exporting agricultural and food products
United Arab Emirates	Al-hikma fzco, Al-Nooran General Trading Llc
Yemen	Alkirshi for trading co., Okaz Trading & Marketing

Medicinal Perspectives of *Allium Sativum*

The product feasibility and its rationalized utilization are the two basic ideas behind the development of any formulation. The pharmaceutical product is considered as a boon if its therapeutic effects overcome its economic and other adverse effects. The greater multifunctional approach of any pharmaceutical preparation provides selection opportunities and diversification.

Antilipemic (cholesterol lowering)

Over 35 human studies have evaluated garlic's lipid lowering effects¹⁶. Case series and controlled trials in healthy adults given garlic supplements along with cholesterol rich diets suggest that garlic can reduce mean serum cholesterol levels and increase fibrinolytic¹⁷⁻¹⁸. In a single blind, placebo-controlled crossover study, 40 hypercholesterolemic adults were assigned to either placebo for one month or fish oil (1800 mg of eicosapentanoic acid [EPA] + 1200 mg of docosahexanoic acid [DHA]) with garlic powder (1200 mg) capsules daily for one month. Supplementation with garlic resulted in an 11% decrease in cholesterol, a 34% decrease in triglycerides, and a 10% decrease in low-density lipoprotein (LDL) levels, as well as a 19% decrease in cholesterol/high-density lipoprotein (HDL) risk¹⁹.

Anti-atherosclerotic

In hypercholesterolemic rabbits, garlic supplements significantly reduced the aortic lesions and lipid content of existing fatty plaques²⁰. In cell cultures, aqueous solutions of dried garlic powder containing allicin and ajoene significantly inhibited the proliferative activity of smooth muscle cells from atherosclerotic aortic plaques²¹⁻²².

Antihypertensive

In a meta-analysis of seven placebo-controlled clinical trials using KwaiÒ garlic powder supplementation, three showed a significant reduction in systolic blood pressure (SBP) and four in diastolic blood pressure (DBP). The overall pooled mean difference in the change in SBP was 5-7% greater in the subjects who were treated with garlic than in those treated with placebo. The corresponding reduction in DBP in the garlic-treated subjects was slightly smaller²³⁻²⁴. In one of these studies, the onset of garlic's hypotensive action was within five hours after administration of a single dose of 2400 mg of dried garlic; the effect lasted more than 14 hours²⁵. In a prospective, four-year clinical trial of atherosclerotic adults, standardized garlic powder supplementation (900 mg daily) lowered blood pressure by 7% ($P < 0.05$)²⁶. Garlic extracts reduce blood pressure in rats and dogs²⁷⁻³⁰. In rabbits, intravenous administration of garlic extracts elicited a dose-dependent diuretic-natriuretic response and a gradual decrease in heart rate, but not in arterial blood pressure³¹.

Antimicrobial

Allicin has antimicrobial effects *in vitro* against many viruses, bacteria, fungi and parasites, although powdered and oil preparations of garlic have not been shown significant antimicrobial activity³². Garlic and its sulfur constituents demonstrated antiviral activity against *Coxsackie*

virus spp, Herpes Simplex Virus types 1 & 2, Influenza B, Parainfluenza Virus type 3, Vaccinia Virus, Vesicular Stomatitis Virus, Human Immunodeficiency Virus type 1 and Human Rhinovirus type 2. Garlic extract exhibited a dose dependent inhibitory effect against human cytomegalovirus in tissue cultures³³. Garlic supplements provided synergistic protection with influenza vaccine against influenza infections in mice³⁴⁻³⁵. Crude garlic extracts exhibited activity against both gram negative (*E. coli, Proteus spp, Salmonella, Serratia, Citrobacter, Enterobacter, and Pseudomonas*). Allicin exerted antibacterial activity against *Salmonella typhimurium*, primarily by interfering with RNA synthesis³⁶. Aged garlic extracts demonstrated dose-dependent antimicrobial activity against three different reference strains of *H. pylori* at concentrations of 2-5 mg per mL; however, heat treatment of the extracts reduced the inhibitory or bactericidal activity against *H. pylori*³⁷⁻³⁸. Garlic also exhibited synergistic effects against *H. pylori* when given along with a proton pump-inhibitor (omeprazole)³⁹⁻⁴⁰. Allicin demonstrated fungicidal activity against numerous yeast and fungi, including *Candida albicans, Cryptococcus, Trichophyton, Histoplasma capsulatum* and *Cryptococcus neoformans*⁴¹⁻⁴⁶. Diallyl trisulfide had antifungal activity against *C. neoformans*; it had synergistic fungicidal effects when administered with amphotericin B⁴⁷. Its *in vitro* activity against yeast has led some herbalists and naturopaths to recommend garlic as a treatment for vaginal and systemic yeast infections⁴⁸. Allicin also exhibits antiparasitic activity against major human intestinal parasites such as *Entamoeba histolytica, Ascaris lumbricoides* and *Giardia lamblia*⁴⁹⁻⁵⁰.

Spasmolytic and Hepatoprotectant

Garlic administration prior to exposure to hepatotoxins (such as carbon tetrachloride, galactosamine and doxorubicin) provided protection against histologic and biochemical evidence of damage⁵¹⁻⁵³. In toads and rats, pretreatment with garlic protected against aflatoxin- and chemically induced liver tumors⁵⁴⁻⁵⁵. Aged garlic and garlic's diallyl sulfur compounds protected against acute chemically induced hepatotoxicity in rats⁵⁶⁻⁵⁷. A patient with severe hepatopulmonary syndrome who failed somatostatin therapy and declined liver transplantation showed signs of improvement over 18 months of continuous self medication of powdered garlic⁵⁸. Although garlic has been used to calm gastrointestinal spasms, there are no studies evaluating this effect.

Hypoglycemic Although several animal studies suggest that high doses of garlic can lower elevated blood sugars⁵⁹⁻⁶¹, there are no human studies suggesting that garlic has antidiabetic properties or hypoglycemic effects⁶².

Hematologic

Ajoene synergistically potentiated the anti-aggregatory action of prostacyclin, indomethacin and dipyridamole⁶³. Oral administration of garlic also decreased platelet aggregation⁶⁴. In another study of platelets from healthy adults who had eaten four fresh garlic cloves, there was a complete inhibition of platelet aggregation induced by 5-hydroxytryptamine⁶⁵. Histopathological examination of lung and liver tissues of animals pretreated with garlic, then treated with a lethal dose of collagen or arachidonic acid, showed a significant reduction in the damage compared to animals not pretreated with garlic⁶⁶. In case series and randomized, controlled trials in healthy adults and in those with vascular disease, garlic supplementation (600–800 mg daily) has reduced platelet aggregation and enhanced fibrinolysis, probably by interfering with thromboxane synthesis⁶⁷. In a study in 14 normotensive men, garlic supplements had no significant effect on platelet aggregation or serum thromboxane concentrations⁶⁸.

Emmenagogue/ Abortifacient

Despite garlic's widespread traditional use as an abortifacient, there are no epidemiologic studies suggesting an association between garlic intake and miscarriage. There is one *in vitro* studies showing that garlic causes uterine stimulation when applied to rat uteri, but no reports from animal or human studies suggesting that normal dietary intake of garlic is problematic for pregnant mothers or their fetuses.

Immunostimulant

Aged garlic extract significantly enhanced the cytotoxicity of human peripheral blood lymphocytes (PBL) against both natural-killer (NK)-sensitive K562 and NK-resistant M14 cell lines. This effect was enhanced synergistically by concurrent treatment with interleukin 2 (IL-2), suggesting that garlic extracts serve as efficient immunostimulant⁶⁹. Alliin significantly increased pokeweed mitogen-induced peripheral blood mononuclear cell (PBMC) proliferation, increased IL-1-beta and TNF-alpha production and enhanced the engulfing capacity of phagocytosing cells; Con-A induced cell proliferation and IL-6 production decreased following incubation with alliin, whereas PHA-induced cell proliferation, IL-2 and superoxide anion generation remained unchanged⁷⁰.

Antineoplastic

At least two anti-carcinogenic agents have been identified in garlic: diallyl sulfide and glutathione-S-transferase⁷¹. Garlic constituents, particularly allicin, are cytotoxic against HeLa and Vero cell lines at concentrations used to achieve anti-viral effects⁷². Ajoene induces

apoptosis in human promyeloleukemic cells⁷³. Pretreatment of head and neck squamous cell carcinoma cell lines with S-allyl cysteine significantly enhanced the cytotoxic effects of cisplatin, but had no cytotoxic effects when given alone⁷⁴. Numerous epidemiologic studies suggest that diets rich in garlic are associated with reduced risks of several kinds of solid tumors⁷⁵⁻⁸⁰.

Antioxidant

Whole garlic and aged garlic extract exhibit direct antioxidant effects and enhance the serum levels of two antioxidant enzymes, catalase and glutathione peroxidase⁸¹⁻⁸². In rat liver microsomes, garlic extract prevented formation of thiobarbituric-acidreactive substances in cell membranes during lipid peroxidation in a dose dependent fashion⁸³. An aqueous extract obtained from 1 mg of a garlic preparation (KwaiO) was as effective an antioxidant as 30 nmol of ascorbic acid and/or 3.6 nmol of alphatocophero⁸⁴. In a randomized, placebo-controlled cross over trial in ten volunteers who took 600 mg daily of a standardized garlic powder preparation (KwaiO tablets), garlic supplementation was associated with a significantly (34%) decreased susceptibility to lipoprotein oxidation⁸⁵.

CONCLUSION

Allium sativum proves itself as the miracle product and a boon to the herbal world. The therapeutic and non therapeutic aspects of this drug overshadow its adverse effects. Its distinctive smell can also prove beneficial. There is hardly any disease category left where this herb has not marked its appearance. Moreover, the market of this miracle product is expanding at an alarming rate. Future of *Allium sativum* depends on consumer perception of the relationship between diet and disease.

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