

# Garlic



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*Allium sativum* L.

Text by Armando González Stuart, Ph.D. 2005

**Common name in Spanish:** Ajo.

**Botanical family:** Liliaceae [Alliaceae].

**Medicinal parts:** Principally, the bulbs (cloves) and the oil (Grunewald, 2004).

## History

Garlic is probably one of the earliest known medicinal plants. (Lewis and Elvin-Lewis, 2003; Castleman, 2001; Starek, 2001). Its bulbs (cloves) had been used as a cure-all in ancient Egypt and are mentioned in the Ebers Papyrus, one of the earliest treatises on medicinal plants (Wichtl, 2004). In the Ayurvedic medical texts of ancient India, garlic was recommended against leprosy (Castleman, 2001). Garlic is still popular as a cure all among the traditional healing traditions of Mexico (Adame and Adame, 2000; Martínez, 1989), as well as a health supplement in the United States (Blumenthal, 2003).

## Active Principles

- Sulfur containing compounds. Alliin, is converted to the anti-microbially active allicin, when the bulb is cut or bruised. Ajoene, which is a secondary degradation product of alliin, is presumably the most active compound responsible for the anti-thrombotic activity of garlic (Wichtl, 2004; Berthold et al., 1998).
- The fresh bulb contains alliin, alicin and volatile oils. When the garlic clove is crushed, the odorless compound alliin is converted to allicin, via the enzyme allinase. Allicin gives garlic its characteristic pungent smell (Williamson, 2003).
- Vitamins and minerals (Bravo, 2003; Gruenwald, 2004).

- Trace elements: selenium and germanium. (Skidmore-Roth, 2003; Barnes et al., 2002; Castleman, 2001; Allman and Cupp, 2000; Bruneton, 1999).

### **Applications in Herbal Therapy**

- Antilipidemic: Garlic purportedly lowers circulating triglycerides (McCann, 2003) (Skidmore – Roth, 2003), and cholesterol (Wichtl, 2004; Chetty et al., 2003; Gavagan, 2002; Caron and White, 2001; Kannar et al., 2001; Spigelsky and Jones, 2001; Yeh and Liu, 2001; Ismail et al., 1999; Steiner et al., 1996), although certain garlic preparations were not effective in the treatment of hypercholesterolemia in children (McCrindle et al., 2002). Alliin, one of its sulfur containing compounds, apparently has an inhibitory effect upon key enzymes involved in cholesterol biosynthesis, such as HMG Co A reductase (Schulz et al., 2004).
- A meta analysis of selected clinical trials employing garlic preparations showed significant reduction on total serum cholesterol levels in human subjects (Warshafsky et al., 1993).
- As a potential treatment against atherosclerosis (Kwon et al., 2003; Campbell et al., 2001; Koscielni et al., 1999; Orekhov and Grunwald, 1997; Orekhov et al., 1995; Kieseletter et al., 1991; Mirhadi et al., 1991), although some research suggests effects are negligible (Berthold and Supper, 1998; Kleijnen et al., 1989).
- Antiseptic, antifungal and antimicrobial, both internally as well as externally. Some of garlic's constituents possess broad-spectrum antibiotic effects. ( Davis et al., 2003; McCann, 2003; Zhou, 2003; Castleman, 2001; Starek 2001; Schulz et al., 2004; Ankri and Mirelman, 1999).
- As prophylactic treatment against the common cold (Harborne and Baxter, 2001; Josling, 2001).
- Raw and cooked garlic, as well as other preparations, are sometimes used to treat various vaginal infections (Van Kessel et al., 2003; Genet, 1995), although raw garlic applied as a vaginal suppository can be potentially irritating to mucous membranes (see safety / precautions section below).
- Against gastrointestinal parasites of humans and animals (Zenner et al., 2003; Martins et al., 2002; Sretter et al., 1999; Nok et al., 1996; Lun et al., 1994; Perez et al., 1994; Soffar and Mokhtar, 1991), albeit with variable results.
- For the treatment of ulcers caused by *Helicobacter pylori* ( Canizares et al., 2002; McNulty et al., 2001; Sivam, 2001; O'Gara et al., 2000; Jonkers et al., 1999; Chung et al., 1998; You et al., 1998; Sivam et al., 1997), although no conclusive evidence exists of its effectiveness at this time (Salih and Abasiyanik, 2001).

- Against venomous stings from insects and other arthropods (Martínez, 1989), as well as an insect repellent (Stejnberg and Berglund, 2000).
- As a preventive against stomach, colon and other types of cancers, due to possible immune enhancing and antitumorigenic effects of its sulfur containing compounds (Li et al., 2004; Thomson and Ali, 2003; Dong et al., 2001; Kyo et al., 2001; Gail et al., 1998; Craig, 1997; Romano et al., 1997; Witte et al., 1996; Steinmetz et al., 1994; Maurya and Singh, 1991; You et al., 1989).
- By acting on certain forms of Cytochrome P450 and some of its detoxifying activities, allyl sulfides may inhibit the metabolism of certain chemical carcinogens, such as nitrosamines, for example, although some researchers state that garlic's potential anticancer effects may be due to its content of the trace mineral selenium (Ip and Lisk, 1995).
- Garlic has also been shown to have antioxidant properties, which could have a protective nature against gastrointestinal neoplasias. (McCann, 2003; Skidmore-Roth, 2003; Williamson, 2003; Borek, 2001; Lam and Riggs, 2001; Schulz et al., 2004; Imai et al., 1994).
- Ajoene, a constituent of garlic, may have an application in the treatment of acute myeloid leukaemia (AML). This compound was shown to inhibit proliferation and induce apoptosis of several human leukaemia CD34-negative cells including HL-60, U937, HEL and OCIM-1 (Hassan, 2004).
- To treat hypertension and reduce the risk of other cardiovascular diseases (Duke et al., 2003; Gardner et al., 2003; McCann, 2003; Skidmore-Roth, 2003; Banerjee and Maulik, 2002; Morihara et al., 2002; Matsuura, 2001; Rahman, 2001; Zhang et al., 2001; Garcia-Gómez and Sánchez-Muñiz, 2000; Qidway et al., 2000; Rahman and Billington, 2000; Ide and Lau, 1999; Blumenthal, 1998; Bordia et al., 1998; Ziaei et al., 1998; Breithaupt-Grogler et al., 1997).
- Garlic possesses a mild diuretic action (Williamson, 2003; Neuman, 2002; Pantoja et al., 2000).
- Against blood clots (antiplatelet action) due in part to the compounds alliin and ajoene, which have fibrinolytic activity. Ajoene inhibits thromboxane synthesis through the inhibition of the cyclo-oxygenase and lipoxygenase enzymes (Schulz et al., 2004; Duke et al., 2003; Bruneton, 1999; Rendu et al., 1989).
- For the treatment of hepatopulmonary syndrome (Abrams and Fallon, 1998).
- Against heavy metal poisoning (Skidmore-Roth, 2003; Schulz et al., 2001).

- Due to its hypoglycemic and antioxidant properties, garlic may be useful as coadjuvant therapy in the treatment of type 2 diabetes and some of its physiological complications (Anwar and Meki, 2003; Baluchnejadmojarad and Roghani, 2003; Ou et al., 2003; Williamson, 2003; Ryan et al. 2001; Patumaraj et al., 2000; Kasuga et al., 1999; Sheela et al., 1995; Sheela and Augusti, 2002; Swanston-Flatt et al., 1990), although more clinical studies in humans are needed in order to fully assess its efficacy (Morelli and Zoorob, 2000). Allicin, garlic's active ingredient, competes with insulin for hepatic insulin-activating sites (Ottariano, 1999).
- Aged garlic extract possesses antioxidant properties (Banerjee et al., 2003; Dillon et al., 2003; Ichikawa et al., 2002; Borek, 2001), which could be useful in the treatment of sickle-cell anemia (Takasu et al., 2002; Ohnishi and Ohnishi, 2001; Ohnishi et al., 2001).
- Garlic compounds may also have neuroprotectant effects (Ito et al., 2003; Peng et al., 2002), as well as a protective effect against the effects of certain anti tumor drugs (Horie et al., 2001).
- Research in Thailand showed that treatment with an enteric garlic-coated Thai garlic extract additional to dietary advice did not produce any significant changes in lipid levels in subjects with hypercholesterolemia (Satitvipawee et al., 2003).
- Researchers in Russia have found that dietary supplement containing garlic may be effective in the management of chronic atrophic gastritis, a precursor of stomach cancer; as well as to relieve the symptoms of benign breast disease (Bersaplov, et al., 2004<sup>1, 2</sup>).

It is important to note that various garlic products may differ widely in their biochemical composition, and hence, may possess different pharmacological properties, depending upon the method of processing or preparation. This accounts for the accompanying differences in efficacy (Barrett, 2004; Duke et al., 2003; McKenna et al., 2002; Amagase et al., 2001; Kasuga et al., 2001; Munday et al., 1999). According to some reviewers, not all the clinical trials employing garlic for therapeutic purposes have an adequate methodological quality (Alder et al., 2003).

**Table 1. Selected Clinical Studies Employing Garlic\***

<b>Reference</b>	<b>Plant / Plant product</b>	<b>Purpose of study</b>	<b>Number of subjects</b>	<b>Results</b>
Andrianova et al., 2004	Garlic powder tablets (Allicor®)	Evaluation of hypocholesterolemic action of long-acting garlic powder tablets	Not available	Effective

<sup>1</sup> Bespalov et al., 2004	Karinat® dietary supplement containing beta-carotene, alpha-tocopherol, ascorbic acid and garlic	To evaluate the effectiveness of a dietary supplement in the treatment of chronic multifocal atrophic gastritis	34	Effective
<sup>2</sup> Bespalov et al., 2004	Karinat® dietary supplement containing beta-carotene, alpha-tocopherol, ascorbic acid and garlic	To test the efficiency of a dietary supplement in reducing symptoms in patients with benign breast disease	33	Effective
Li et al., 2004	Allitridum	To examine allitridum and selenium as gastric cancer preventives	2,526	Effective
Turner et al., 2004	Garlic powder tablets	To test the effect of dried garlic powder on blood lipids, blood pressure and arterial stiffness in normal volunteers	75	Not effective
Satitvipawee et al., 2003	Thai standardized garlic extract tablets	To assess the effects of an enteric-coated garlic extract tablet on serum lipid levels in patients with hypercholesterolemia	136	Not effective
Andrianova et al., 2002	Garlic powder tablets (Allicor® and Kwai®)	Comparison between 2 garlic products in reducing high blood pressure	85	Allicor® was more effective than Kwai® in reducing blood pressure
Andrianova et al., 2001	Garlic powder tablets (Allicor®)	Evaluation of the effects of garlic powder on fibrinolysis and hemostasis in patients with chronic cerebrovascular diseases	29	Effective
Josling, 2001	Allicin-	Prevention of	146	Effective

	containing garlic supplement	common cold		
Kannar et al., 2001	Enteric-coated garlic tablets	Treatment of hypercholesterolemia	46	Moderately effective
Steiner and Li, 2001	Garlic capsules (Kyolic® aged garlic)	Effects on platelet aggregation in healthy women	34	Aged garlic powder selectively inhibited platelet aggregation and adhesion
Zhang et al, 2001	Steam-distilled garlic oil capsules	Effects of garlic oil upon coronary heart disease risk factors in trained male runners	28	Not statistically significant (larger population study required to reach a conclusion)
Rozenfeld et al., 2000	Garlic capsules (Kyolic® aged garlic)	Evaluation of potential bleeding of combined warfarin and garlic treatment	8	Garlic did not worsen side effects of warfarin
Byrne et al., 1999	Garlic powder tablets (Kwai®)	Effects of garlic supplementation on the resistance of low density lipoprotein (LDL) to oxidation	31	Not effective
Koscielni et al., 1999	Garlic powder (Kwai®)	Reduction of arterial plaque in advanced atherosclerotic plaque patients	152	Effective
Berthold et al., 1998	Garlic oil (Tegra ®)	Treatment of hypercholesterolemia	25	Not effective
Isaacsohn et al., 1998	Garlic powder tablets (Kwai® and Sapec®)	Effects of garlic on high blood lipid levels	50	Not effective
McCrindle et al., 1998	Garlic powder (Kwai®)	Treatment of high blood cholesterol levels in children	30	Not effective
Neil et al., 1996	Dried garlic tablets	Treatment of moderate hyperlipidemia	115	Less effective compared to results from previous meta-analyses

Steiner et al., 1996	Kyolic ® AGE capsules	Reduction of high blood cholesterol levels in men	41	Moderately effective
Yeh et al., 1995	Kyolic ® AGE capsules	Reduction of high blood cholesterol levels	34	Effective
Simons et al., 1995	Garlic powder (Kwai®)	Reduction of mild to moderate blood cholesterol levels	28	Not effective
Steiner and Lin, 1994	Kyolic ® AGE capsules	Reduction of high blood cholesterol levels in men	45	Moderately effective only on LDL
Jain et al., 1993	Garlic powder tablets	Reduction of serum lipid levels	42	Effective
Kiesewetter et al., 1993	Garlic powder tablets (Kwai®)	Treatment of stage 2 intermittent claudication	80	Effective
Kiesewetter et al., 1993	Garlic powder tablets	Effects of garlic on platelet aggregation in patients with risk of juvenile ischaemic attack.	60	Effective
Phelps and Harris, 1993	Garlic powder (Kwai®)	Retardation of lipoprotein oxidation	10	Effective
Grunwald et al., 1992	Garlic powder (Kwai®)	Reduction of high blood cholesterol levels	48	Effective
Rotzsch et al., 1992	Garlic powder (Kwai®)	High blood triglycerides after ingestion of meal with butter	24	Effective
Auer et al., 1990	Garlic powder (Kwai®)	Reduction of moderately high blood pressure	47	Effective
Mader et al., 1990	Garlic powder tablets (Kwai® and Sapec®)	Reduction of high blood lipid levels	261	Effective
Vorberg and Schneider, 1990	Garlic powder	Reduction of hypercholesterolemia	40	Effective

**\*Additional information about clinical trials and the products tested is available in the following publications:** Barrett, M. *Handbook of Clinically Tested Herbal Remedies 2* Vols. New York: Haworth Herbal Press; 2004, Blumenthal, M. *ABC's Clinical Guide to Herbs*. New York: Thieme; 2003, Bratman S, Girman A. *Handbook of Herbal, Supplements and Their Therapeutic Uses*. St. Louis: Mosby; 2003, Bascom A. *Incorporating Herbal Medicine into Clinical Practice*. Philadelphia: F. A. Davis; 2002,

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### Safety/Precautions

- Garlic in small amounts applied as a food condiment does not usually pose any important risk, aside for rare specific allergic reactions in hypersensitive people (Bielory, 2004; Pires et al., 2002; Rance and Dutau, 2002).
- Do not ingest in large amounts for at least 2 weeks before surgery. Garlic's antiplatelet factors may interfere with normal blood clotting and may increase bleeding time. Avoid ingesting garlic in therapeutic amounts during post surgical care, to allow for proper tissue cicatrisation. (McCann, 2003; Skidmore-Roth, 2003; Ang-Lee et al., 2001).
- Do not use in large amounts in persons with bleeding disorders, such as hemophilic patients, for example (McCann, 2003).
- Do not use medicinally in patients with bleeding ulcers or gastritis, due to potential gastric irritation (Skidmore-Roth, 2003; Hoshino et al., 2002).
- Do not apply raw garlic cloves or garlic preparations (such as poultices, for example) directly to the skin for any extended period of time, as this may cause a severe burn (especially avoid doing so in small children). Contact dermatitis can occur in hypersensitive people. (Baruchin et al., 2001; Allman and Cupp, 2000; Bruneton, 1999; Lee and Lam, 1991; Mitchell and Rook, 1979).
- Use with caution in diabetic patients (garlic may lower blood glucose levels) (McCann, 2003; Skidmore-Roth 2001).
- Do not use in large amounts in patients with thyroid dysfunction, as garlic's active constituents may theoretically interfere with iodine metabolism (Skidmore-Roth, 2003).
- Do not use ingest in large amounts during pregnancy, as this may theoretically induce labor (Barnes et al., 2002; Brinker, 2001), although no clinical evidence in humans seems to support this (McKenna et al., 2002; Blumenthal, 1998).

- It has been stated that lactating women should not consume garlic in large quantity, as the sulfur containing compounds may pass from the milk to the baby and cause gastrointestinal upset, such as colic and diarrhea. (Castleman, 2001), although some studies suggest that garlic ingested by the lactating mother will actually increase feeding time and interest in nursing, presumably by the odor present in milk, by the baby. This and other studies did not report any adverse effects on the children (Hale, 2000; Mennella and Beauchamp, 1993).
- The amounts of garlic constituents transmitted through breast milk to an infant are deemed to be very small (McKenna et al., 2002). In any case, it is advisable to consult with your pediatrician if a large amount of garlic (more than 4 grams per day) is to be consumed during lactation (Blumenthal, 1998).
- Although certain herbal products containing garlic have been proven effective against otitis media in children (Sarrell et al., 2001), raw garlic oil should not be used to treat infections of the inner ear in children, as it may cause serious irritation (McCann, 2003).
- Chopped garlic and oil medicinal preparations left to stand at room temperature for many hours can serve as a growth medium for certain dangerous bacteria, such as *Clostridium botulinum*, which produces the deadly botulinum toxin (Allman and Cupp, 2000).
- Contact dermatitis may occur in sensitive individuals exposed to garlic (Moneret-Vautrin et al., 2002; Pires et al., 2002; Kanerva et al., 1996; Mitchell and Rook, 1979) and exposure to garlic dust may cause asthma and rhinitis (Jiménez-Timón et al., 2001; Añíbarro et al., 1997; Seuri et al., 1993).

### **Potential Herb/Drug Interactions**

- Do not ingest medicinal amounts of garlic concurrently with other herbs that may interfere with blood clotting, such as ginger, ginkgo or feverfew, for example (Skidmore-Roth, 2003; Brinker, 2001).
- Do not ingest garlic in large amounts along with drugs that have anticoagulant activity, such as warfarin, heparin, aspirin or protacyclin (McCann, 2003; Evans, 2000; Allman and Cupp, 2000; Argento et al., 2000; Vaes and Chyka, 2000; Brinker, 2001). Interestingly, a study involving the intake of garlic and warfarin, found no INR differences between the groups of subjects who took garlic and warfarin together, suggesting no significant interaction (Rozenfeld et al., 2000).

- Avoid using large amounts of garlic while taking acetaminophen (paracetamol) or other drugs metabolized by the enzyme CYP 450 system, as their metabolism may be reduced. (Skidmore-Roth, 2003).
- A study assessed the influence of a garlic extract on the activity of cytochrome P450 (CYP) 2D6 and 3A4 in healthy volunteers. The results indicated that garlic extracts are unlikely to alter the disposition of coadministered medications primarily dependent on the CYP2D6 (dextromethorphan) or CYP3A4 (alprazolam) pathway of metabolism. (Markowitz, et al., 2003).
- Do not take medicinal amounts of garlic concomitantly with oral antidiabetic medications or insulin, as blood glucose levels could theoretically be further decreased (McCann, 2003).
- Use medicinal amounts of garlic (more than 4 grams per day) with caution if patient is under treatment with drugs that may affect the thyroid gland (Skidmore-Roth, 2003).
- Garlic supplements may affect the pharmacokinetics and delay absorption of the protease inhibitor Saquinavir (Fortovase) (Piscitelli et al., 2002) and perhaps other anti HIV medications (Sussman, 2002). Avoid using together.
- Acute dosing of 400 mg. garlic capsules over a period of 4 days did not significantly alter the single-dose pharmacokinetics of the antiviral drug ritonavir in healthy volunteers (Gallicano et al., 2003), although the researchers mention that longer duration studies are needed to evaluate the possibility of an interaction.

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