LE Magazine January 2000

REPORT

GARLIC
THE BOUNTIFUL BULB

by Carmia Borek, Ph.D.

Can a clove of garlic a day keep the doctor away? Can an odor-free supplement be as good or even better? Garlic has been an important part of life for centuries, across cultures and millennia. In fact, no other single food has had as many applications as this pungent plant. Garlic has been used to spice food, protect against vampires and witches, prepare soldiers for war, cure colds, heal infections, and treat ailments ranging from heart disease to cancer and even the plague.

Today, after close to 6000 years of folklore, scientific research shows that garlic is an amazing resource of phytochemicals (botanicals) whose wide range of actions can benefit health. Studies show that garlic protects against infection and inflammation, lowers the risk of heart disease, and has anticancer and antiaging effects. Scientific studies also show that garlic does not have to be eaten raw or fresh to be effective. The potent odor of garlic may not be necessary for its health benefits. Research shows that aged, deodorized garlic extract sometimes works even better than fresh garlic without causing digestive disorders and "garlic breath" that may haunt the fresh garlic eater.

A history of garlic

Long before humans began keeping written records, garlic, found in the wild, was cultivated for human use. Though the exact geographic origin of garlic is not known, modern botanists think it came from Central Asia, some say Siberia. The plant, with its pungent flavored bulb, was transported West and East by migrating tribes, becoming native to Mediterranean regions of Europe, Asia and Africa as well as China and other countries in the Far East.

Garlic-Allium sativum-is a hardy perennial plant that belongs to the lily family, as do onions, leeks, shallots and chives. However, garlic contains a number of organosulfur substances with medicinal properties that are unique to garlic. The history of garlic stretches far back, to a time when people who foraged in the fields for food and healing herbs came across garlic and cultivated it for their use. Remnants of garlic have been found in cave dwellings that are over 10,000 years old. Egyptian tombs, dating back to close to 5700 years ago, were found to contain sketches of garlic and clay sculptures of the bulb. The ancient Egyptian text Codex Ebers details formulas with garlic as remedies for heart problems, headaches, tumors and other ailments.

Chinese writings dating from 2700 B.C. describe garlic for treating many ailments and for enhancing vigor. In India, Ayurvedic medicine recommends garlic to boost energy and treat colds and fatigue.

In modern times garlic has become popular as a healing herb in some Asian and European countries. In certain parts of China people eat about 20 grams of garlic a day, approximately 8 medium size cloves. In Germany, most adults take a daily garlic supplement to promote health. In the United States the use of garlic preparations as supplements has been rapidly escalating in recent years.

The chemistry of garlic is complex, with over 100 different compounds that contribute to its effects. The most important and unique feature is its high content of organosulfur substances. Garlic contains at least four times more sulfur than other high sulfur vegetables-onion, broccoli and cauliflower.

Water soluble sulfur compounds

From a medicinal point of view, the most important organosulfur substances are water soluble S-allyl compounds, including S-allyl cysteine and other sulfur amino acids that are increased by aging garlic extract. Stable, odorless and safe, with high antioxidant

activity, S-allyl cysteine easily gets into the circulatory system from the gut (highly bioavailable), with an absorption of close to 90%. S-allyl cysteine has been shown to slightly reduce blood cholesterol levels, protect cells from toxic chemicals, prevent cancer in laboratory animals and stop the growth of prostate cancer cells and breast cancer cells, in culture. Its high antioxidant activity provides it with the potential to fight oxidant-related damage that leads to heart disease, cancer and aging.

Oil-soluble sulfur compounds

Whole garlic cloves contain very small amount of oil-soluble sulfur compounds. However, once the cloves are cut or macerated, oil-soluble sulfur compounds are produced through enzymatic reactions. Upon crushing or chopping garlic, alliin-a sulfur containing compound that is found in the whole clove-is converted by the enzyme alliinase to a volatile compound called allicin, the substance that gives garlic its pungent odor and flavor. Allicin is highly unstable and decomposes into oil-soluble substances that include diallyl sulfide, diallyl disulfide and other volatile sulfur compounds.

Non-sulfur compounds

Non-sulfur compounds in garlic and in the aged extract include proteins, carbohydrates (sugars, fructans, pectins), saponins, that are steroid substances recently shown to have antibacterial and antifungal actions, flavonoids, such as allixin, that are important antioxidants. Garlic contains low amounts of vitamins and minerals including selenium. The organosulfur compounds are mostly responsible for garlic's medicinal qualities, but their cooperative action with other components that are present in garlic enhances its health benefits.

Modern medicine

Over the last two decades the growing use of botanicals in complementary and alternative medicine has resulted in a burst in garlic research. Modern scientific methods are being used to investigate the actions of garlic and its components in protecting against aging and disease. At a recent scientific conference, scientists confirmed what traditional healers found out through trial and error: garlic can help prevent modern ailments and disorders.

The two and a half day international conference took place in November, 1998, in Newport Beach California and focussed on "Recent Advances on the Nutritional Benefits Accompanying the Use of Garlic as a Supplement". Organized by the National Cancer Institute and Pennsylvania State University, the conference gathered close to 200 researches and health professionals from 12 countries. Scientists presented work on the health benefits of garlic and garlic supplements and it became clear from studies reported at the conference that deodorized aged garlic extract was more effective than fresh garlic in large part because of the unique water soluble organosulfur compounds that have a wide scope of action and are highly bioavailable.

Antioxidant effects

Just as oxidized iron in a car turns to rust, so do free radicals oxidize and damage DNA, lipids and proteins in the body, triggering disease and accelerating aging. Free radicals are made in cells in normal metabolism and during infection and inflammation. They increase in the body by exposure to sunlight, X-rays, smoking, smog and other pollutants. Cells fight oxidants by antioxidant enzymes and small molecules, which are produced internally and by antioxidant vitamins, minerals and phytochemicals that are obtained from food.

Garlic is rich in antioxidants phytochemicals that include organosulfur compounds and flavonoids, capable of scavenging free radicals. Garlic also contains selenium, which is required for the antioxidant enzyme glutathione peroxidase. Though we do not know the mechanisms of all the garlic components, many of its disease preventive, anti-inflammatory and anti-aging effects are due to the antioxidant actions of garlic and garlic preparations that contain stable organosulfur compounds.

Research shows that among garlic preparations, aged garlic extract has the highest antioxidant potential, compared to fresh garlic and some commercial preparations. Aged garlic extract and in other experiments some forms of garlic powder have been shown to boost cell glutathione, which scavenges free radicals and helps maintain a healthy immune system and enzymes that convert free radicals to water and destroy toxic peroxides.

Reducing the risk of heart disease and stroke

In the past 15 years, garlic supplementation studies have concentrated on the bulb's effects in reducing blood cholesterol and triglycerides (the form in which fat is transported in the blood). All studies did not agree with one another, given differences in the kind of garlic preparation, quality of standardization, doses and periods of treatment. But most findings showed that garlic slightly lowered blood cholesterol, LDL cholesterol and triglycerides with a consistent lowering of blood lipids seen in studies that used aged garlic extract as the supplement. For example, while a University of Oxford study showed that garlic powder, given to patients at 900 mg a day for six months, had no protective effects and did not lower cholesterol levels, a study at East Carolina University

found that aged garlic extract given at 2.4-4.8 gm a day, for six months, lowered cholesterol by 5-7%, and reduced LDL, triglycerides and blood pressure in men with high cholesterol.

Preventing lipid oxidation, protecting blood vessels, anti-platelet action

Oxidation of LDL cholesterol by free radicals accelerates atherosclerosis. The oxidized LDL injures cells that line the blood vessels, increasing the chance of plaque forming cholesterol deposits in the vessel wall. Aged garlic extract, its components S-allyl cysteine and the flavonoid allixin, have been shown to protect LDL from oxidation and prevent cell injury in the blood vessels. Oil soluble organosulfur components of garlic also show an ability to protect LDL from oxidation.

Garlic has anti-clotting effects that reduce plaque formation in blood vessels and clots that cause heart disease and stroke. Garlic prevents clumping of blood platelets to each other (aggregation) and their sticking to blood vessels (adhesion). When patients were given 2.4-4.8 grams of aged garlic extract daily for six months, the aged extract that contains stable organosulfur compounds prevented clotting and adhesion of blood platelets and reduced blood pressure.

Protection against brain injury by ischemia

If blood circulation to the brain is decreased due to atherosclerosis or a poor heart condition-risks that increase with age-the brain is deprived of oxygen (ischemic hypoxia). When the brain is enriched again with oxygen (reperfusion), free radicals are produced, causing brain injury that accelerates aging and diseases such as Alzheimer's disease. Antioxidants protect against such damage and garlic preparations rich in water soluble antioxidants show a protective effect. Experiments in rats show that aged garlic extract and water soluble S-allyl cysteine, prevented brain injury by ischemia and reperfusion. In contrast, oil soluble garlic compounds allyl sulfide and allyl disulfide, tested in the same way, did not protect the brain.

Enhanced immune functions

The immune system consists of many types of cells and protective substances that fight infections, the common cold and help battle life threatening diseases, such as cancer. A strong immune system can defend against bacteria, viruses and fungal diseases. When immunity is severely damaged, as in the case of AIDS, the body cannot fight off invading infectious organisms. Immunity can be compromised by many factors, by a poor diet, stress, environmental pollution, disease and aging. Fortunately, science has identified dietary substances that help stimulate the immune system, and garlic is among them.

Human studies confirm immune stimulation by garlic. Subjects receiving aged garlic extract at 1800 mg a day for three weeks showed a 155.5% increase in natural killer immune cell activity that kills invaders and cancer cells. Other subjects receiving large amounts of fresh garlic of 35g a day, equivalent to 10 cloves, showed an increase of 139.9%. In six weeks, patients with AIDS receiving aged garlic extract showed an enhancement of natural killer cells from a seriously low level to a normal level.

In another human study, subjects were given garlic powder for three months. Blood samples tested for white cell activity, showed an increased capacity of the immune cells to engulf the E. coli bacteria. Garlic and garlic preparations increase the activity of immune cells, including macrophages, that kill infectious invaders.

Recent studies show that garlic powdered extract contains substances that kill Heliobacter pylori, a virulent organism that grows in the stomach and is thought to be associated with stomach ulcers and stomach cancer. Since 122 patients out of 145 people infected with H. pylori showed resistance to antibiotic treatment, treatment with garlic supplementation may be an essential approach.

Anti-cancer effects

Normal cells become malignant through stages, in a complex process that takes many years, thus enhancing cancer risk with age. Mutations in DNA by free radicals or by binding of chemical carcinogens trigger a loss in growth regulation, causing cells to replicate in an uncontrolled way and result in a cancer.

The anti-cancer effects of garlic have been recognized since ancient times, mostly in the form of therapeutic effects. New scientific methods enable us to confirm that garlic helps prevent cancer and stop cancer cell growth.

Epidemiological studies

The anti-cancer effects of garlic-rich diets have been shown in over 12 epidemiological studies in China, Italy and the United States. Diets high in garlic lowered the risk of stomach and colon cancer. Among the earliest documented evidence were studies in China that showed a marked decrease in stomach cancer in residents of the Gangshang province whose daily consumption was 20 g or more. Cancer rate was thirteen times lower compared to people in another province who consumed 1g a day. Studies in

Italy showed a 50% reduction in stomach cancer in people who's daily diet was high in vegetables and contained large amounts of garlic. The protective effects of garlic against colon cancer were shown in a striking finding in the Iowa Womens' study, in which 41.837 women, aged 55-69, ate one or more servings of garlic a week, over five years. Garlic eaters showed a 35% lower risk of colon cancer, compared with women on diets that did not include garlic.

Experimental studies

The antioxidant effects that prevent DNA damage and cancer-causing mutations are essential to the cancer preventive effects of garlic and its components. In addition, aged garlic extract, and lipid soluble organosulfur compounds that are also found in garlic powder, prevent the binding of DNA and chemical carcinogens. They also increase the disposal of the carcinogens in animals, ridding the body of the cancer causing agents.

Other animal studies show that aged garlic extract protects against early and late stages of cancer development in the colon, mammary glands, skin, stomach and esophagus. Among the compounds in the garlic extract showing prevention of tumor promotion is allixin, a flavonoid that also prevents the formation of prostaglandins, hormone-like substances that are active in enhancing inflammation, platelet aggregation and tumor growth.

Cancer therapy

In ancient times, garlic was used to treat cancer of the uterus. Experimental studies with human cells in culture support garlic action in blocking tumor growth. Work at Sloan Kettering Memorial Medical Center showed that the water soluble S-allyl cysteine and S-allyl mercaptocysteine, which are high in aged garlic extract, stop the growth of human prostate cancer and breast cancer cells in culture. Other recent studies at Pennsylvania State University showed that the oil soluble diallyl sulfide prevented the growth of human colon cancer cells. These studies offer hope for adjuvant therapy with garlic compounds.

Preventing heart and liver toxicity in cancer therapy

Cardiotoxicity and liver toxicity caused by anti-cancer agents that produce free radicals is a concern in cancer therapy. Doxorubicin, which is used in treating breast cancer, ovarian carcinoma and other tumors, damages the heart muscle and leads to in-heart failure. Methotrexate and 5-fluorouracilused, which are used in treating a variety of cancers, produce liver toxicity. Aged garlic extract and the organosulfur compounds polysulfides protect mice and heart cells in vitro from Doxorubicin toxicity and liver cells against the toxic effects of methotraxate and 5-fluorouracil. These protective effects of the garlic supplement may have applications in the clinic, reducing the risk of toxicity in patients receiving anti-cancer treatment.

Anti-aging, cognitive function enhancement and life extension

The history of garlic tells us of its uses to promote well being. Recent studies on mice show that garlic may have important effects on brain function and in increasing life span. The research showed that aged garlic extract and its key sulfur compound, S-allyl cysteine, enhanced learning ability in mice that are genetically prone to early aging. Nerve cells exposed to these compounds showed an unusual ability to grow and branch, which may be associated with the enhanced memory function by the garlic compounds. Aged garlic extract prevented degeneration in the frontal lobe of the brain, improved memory retention and extended the life span of the animals.

Conclusions

Garlic contains a wide range of substances, including antioxidants, which are enhanced by aging garlic extract and act together to help prevent atherosclerosis, heart disease, stroke, cancer and aging, as well as boost immunity and help increase memory and life span. Garlic and garlic supplements as well as garlic components, notably stable organosulfur compounds, have been shown to influence cancer by several mechanisms: prevent mutations, prevent the binding of carcinogens to DNA, increase the destruction of carcinogens by producing enzymes that do the job, prevent later stages in cancer, enhance immunity and stop the growth for some human cancer cells. Garlic antioxidants are highest in the aged garlic supplement compared to fresh garlic and other commercial preparations. The antioxidants protect against toxic effects of free radicals from radiation, including sunlight, environmental pollutants and some anti-cancer drugs, and help fight cancer, heart disease, loss of memory and aging.

The conference on "Recent Advances on the Nutritional Benefits Accompanying the Use of Garlic as a Supplement" concluded that garlic research has come a long way in confirming the health benefits of garlic. However, there is work ahead to define other benefits and establish the most effective doses that will provide each person with the benefits against diseases and aging.

Garlic supplementation in our daily diet may be one of the best options to prevent aging and disease and therefore extend life. Those who wish to eat a clove of garlic a day and do not suffer adverse reactions can do so. Various garlic products on the market offer an alternative but require careful viewing of the manufacturer's standardization of the product and of the bioavailability of the

compounds in the supplement. Those who want to increase their daily dose of garlic but avoid garlic breath can turn to regular use of aged garlic extract, a deodorized standardized, highly bioavailable supplement, whose benefits are well researched.

Anti-Atherosclerotic Effects of Garlic

Back to the Magazine Forum

REPORT

Anti-Atherosclerotic Effects of GARLIC

Continued from Garlic The Bountiful Bulb

Garlic protection against atherosclerosis and heart disease can be partly ascribed to some of its known multiple functions in reducing risk factors: lowering blood cholesterol and other lipids, anticoagulation effects and antioxidant actions. Subjects with moderately high blood cholesterol given aged garlic extract supplement, in a double blind crossover study (Am J Clin Nut 1996;64:866-870), showed after six months a decrease in total cholesterol and harmful LDL and a lowering of blood pressure, as compared to placebo.

Another study (Atherosclerosis 1999;144: 399-404) tested the effects of garlic in preventing oxidation of human LDL cholesterol. Oxidized LDL is a risk factor for plaque formation. LDL cholesterol taken from the blood of subjects who were supplemented with aged garlic extract, fresh garlic or placebo (no garlic) showed different responses to oxidation. After seven days of garlic intake, LDL particles of garlic users showed resistance to oxidation, compared to placebo. LDL from consumers of Kyolic aged garlic extract showed the highest degree of resistance to oxidation, indicating a higher antioxidant activity compared to fresh garlic.

Plaque in arteries present a risk factor for atherosclerosis and heart disease. They begin early in life by the development of fatty streaks in the smooth muscle of the arterial wall. Plaques formation increases with age and with exposure to high risk factors such as a high fat diet, high cholesterol, smoking and diabetes. Plaques in the common carotid artery double the risk of heart attacks and plaques in the femoral artery double the risk of heart disease due to insufficient blood supply.

Two studies have tested that ability of garlic supplementation to prevent and possibly reverse atherosclerotic plaques. A study on rabbits (Atherosclerosis 1997; 132: 37-42) investigated the effects of Kyolic aged garlic extract on the development of fatty streaks in arteries of rabbits fed high and low cholesterol diets. Fatty streaks are growths of fibrous fatty deposits in the smooth muscle tissue of the arteries and are markers of early atherosclerotic lesions. The study used four groups of animals. Group one received a standard diet, group two a standard diet plus odor free Kyolic, group three a standard diet supplemented with 1% cholesterol, and group four, a standard diet supplemented with 1% cholesterol plus Kyolic.

After six weeks rabbits of group three developed fatty streaks covering 70% of the surface area of the large artery studied (thoracic aorta), which was reduced to 2.5% in the Kyolic treated group four. No fatty streaks were present in groups one and two. The high cholesterol diet in group three caused cholesterol accumulation in the aorta, which was reduced by 50% in the Kyolic supplemented rabbits, in group four. Kyolic also prevented the in vitro growth of smooth muscle cells that occurs in plaque development. The effects were dose related. The higher the dose of Kyolic in the culture medium, the lesser the growth. The study also found that following injury of the carotid artery, Kyolic reduced fatty plaque formation in the intima of the carotid artery by 50%, compared to controls with high cholesterol diet and no Kyolic.

The authors of the study concluded that supplementing the diet with Kyolic aged garlic extract provides protection against the onset of atherosclerosis by reducing fatty streak development, lowering cholesterol accumulation in artery walls and preventing fatty plaques in the injured intima of arteries, in cholesterol fed animals.

Reduction in plaque development by garlic is further supported by another report (Atherosclerosis 1999;144:237-249). A double blind placebo controlled study tested the effects of 900 mg/day garlic powder, for 48 months, on plaque formation, using ultrasound examination to scan the carotid and femoral arteries. Criteria for participation in the study included the presence of atherosclerotic plaques and at least one of the established risk factors such as high blood pressure, high cholesterol, diabetes and smoking. Of the 280 patients that enrolled, 140 in the drug group (93 males and 47 females) and 140 in the placebo group (105 males and 33 females), 152 completed the 48 month treatment (62 in the garlic trial; 38 males and 23 females and 91 in the placebo group; 67 males and 24 females). The main reason for dropping out of the trial group (mostly younger females) was annoyance by the strong odor of the garlic powder. This resulted in the fact that younger women (ages 40-55) dominated in the placebo group and older women (over 55) in the garlic trial group.

The average plaque volume of all participants at the beginning of the study was 32.2 (+/- 2.3) mm2. After four years of garlic intake the calculated mean plaque volume of garlic users was 30.7 mm2 (+/- 1.6) as compared to the placebo 36.3 mm square (+/-2.4). In men the reduction in plaque volume as related to a four year effect was 12.5%. In women, where older women dominated the trial group, the increase in plaque volume with age was calculated to have decreased by 6.4% in relation to the 48 months of garlic intake. While age and gender were considered in the calculations, the response to garlic of subjects exposed to a particular risk factor was not considered possibly because of the small size of final participants in the study.

While larger clinical investigations are needed to add to the body of information, these studies show that continuous intake of garlic supplements can prevent the development of fatty streaks and atherosclerotic plaques and in some cases, may cause regression of the existing plaques.

References:

Abdulllah T. et al. (1989). Enhancement of natural killer cell activity in AIDS with garlic. Onkologie 21:52-53

Amagase H. (1998) Intake of garlic and its components. Nutritional and Health Benefits of Garlic as a Supplement Conference, Newport Beach CA. 4 (Abstract)

Amagase, H., Schaffer, E.M.,& Milner J. (1996) Dietary components modify the ability of garlic to suppress 7, 12,-dimethyl (a anthracene induced DNA adducts. J. Nut. 126:817-824

Block, E.(1985) The chemistry of garlic and onion. Sci. Am 252: 114-119

Borek C. Maximize Your Healthspan with Antioxidants. 1995. Keats Publishing, New Canaan, Conn.

Borek, C.(1993) Molecular mechanisms in cancer induction and prevention. Environ Health Perspectives 101: 237-245

Borek, C. (1991) Free radical processes in multistage carcinogenesis. Free Rad. Res. Comm. 1991 12 745-750

Brosche T. and Platt N. Knoblauch Terapie und zelullaere immunoabweher in Alter(1994). Phytoter 15: 23-24

Freeman, F. & Kodera, Y. (1995) Garlic Chemistry: Stability of S-(2-Propenyl) 2-Propene-1-sulfinothioate (Allicin) in blood, solvents and simulated physiological fluids. J. Agr. and Food Chemistry 43:2332-2338

Ide, N. and Lau, B.H. S. (1997) Garlic compounds protect vascular endothelial cells from oxidized low density lipoprotein-induced injury. J Pharm Pharmacol. 49: 908-911

Imai, J., Ide, N., Nagae, S., Moriguchi, T.,Matsuura, H. & Itakura, Y. (1994) Antioxidants and free radical scavenge effects of aged garlic extract and its constituents. Planta Med 60: 417-420

Kojima, R., Epstein, C.J. Mizui, T., Carlson, E. & Chan, P.H. (1994) Protective effects of aged garlic extracts on doxorubicin-induced cardiotoxicity in the mouse. Nutr. Cancer 22:163-173

Lau, B.H. S. (1989) Detoxifying, radioprotective and phagocyte-enhancing effects of garlic. Int. Nutr. Rev. 9:27-31

Lawson, L.D., Ransom, D.K. & Hughs (1992) Inhibition of whole blood platelet aggregation by compounds in garlic clove extracts and commercial garlic products. Thromb Res 65: 141-156

Milner, J. A. (1996) Garlic: Its anticarcinogenic and antimutagenic properties. Nut. Rev 54: S82-S-86

Moriguchi, T., Saito, H. & Nishyama, N. (1997) Anti-aging effect of aged garlic extract in the inbred brain atrophy mouse model. Clin. and Exp. Pharmachol. and Physiol. 24: 235-242

Neil, H.A. et al. Garlic powder in the treatment of moderate hyperlipidemia: a controlled trial and meta-analysis.

Nishino, H.,Nishino,A.,Takayasu,A., Iwashima, Y.,Itakura,y., Kodera, Y., Matsuura, H.,& Fuwa, T. (1990) Antitumor-promoting activity of Allixin, a stress compound produced by garlic. The Cancer Journal. 3:20-21

Numagami, Y., sato, S., & Onishi, T. (1996) Attenuation of rat ischemic brain damage by aged garlic extracts: A possible protecting mechanism as an antioxidants. Neurochem Int. 29: 135-143

Nutritional and Health Benefits of Garlic as a Supplement Conference, Newport beach CA (1998). 1-70. Abstracts

Steiner, M. (1996) A double blind cross over study in moderately hypercholesterolemic men that compare the effect of Aged Garlic Extract and placebo administration on blood lipids and platelet function. Am. J. Clin. Nutr. 64:866-870

Steinmetz, K.A., Kushi, L.H., Bostick, R.M., Folsom A.R & Potter, J.D. (1994) Vegetables, fruit and colon cancer in the Iowa Women's Study. Am. J. Epidemiol. 139:1-5

Wei, Z. & Lau, B.H.S. (1998) Garlic inhibits free radical generation and augments antioxidant enzyme activity in vascular endothelial cells. Nutr. Res. 18: 61-70

Back to the Magazine Forum