



Garlic research results based on published literature  
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## Garlic Has Many Health Benefits

A 20-year review of clinical trials on the health benefits of garlic collects information that informs the functional foodie how to eat well to increase health and well-being. Garlic is considered a spice, and as such, contains therapeutic properties shown to aid in the prevention of acute and chronic disease. Some of these properties are bioactive compounds which include organic sulfides, saponins, phenolic compounds and polysaccharides.

Garlic is considered a functional spice in that it contains nutritional constituents, phytochemicals and fiber. High levels of potassium, phosphorus, zinc and sulfur are found in garlic, along with lesser amounts of selenium, calcium, magnesium, manganese and iron. The main bioactive components include polyphenols, flavonoids, flavanols and tannins. The sulfur containing compounds in garlic are known as alliin, allicin and ajoene, among others. Garlic also contains various enzymes, along with phellandrene, citral, linalool and geraniol. Chopping or crushing garlic cloves before consuming them increases the bioavailability of the compounds.

A variety of clinical trials were conducted and summarized to show the various levels of efficacy in prevention and lowered risk of many chronic illnesses, including cancer, cardiovascular disease, diabetes, bone disease and skin conditions (including warts!). Garlic has anti-oxidant capacity, anti-inflammatory properties (decreases inflammatory markers such as cytokine activity) and lipid lowering effects. Aged garlic extract in dietary supplements are shown to improve immune system function, decrease severity of cold and flu symptoms, reduce obesity-induced inflammation and increase healthy microbial activity in the gut.

Ansary J, Forbes-Hernández TY, Gil E, Cianciosi D, Zhang J, Elexpuru-Zabaleta M, et al. Potential health benefit of garlic based on human intervention studies: a brief overview. *Antioxidants* **2020**, *9*, 619; doi:10.3390/antiox9070619.

## Garlic is a Functional Food

Have you heard of functional foods? These are foods that function as having long-term health benefits, and garlic is one of the top three, according to a consumer study. The taxonomic family of garlic is *Alliaceae*, and its members include all kinds of onions, leeks, shallots and scallions. Garlic has been used for centuries in health and medicinal applications all the way back to 2700 BC. In current epidemiological studies, garlic is used as an antioxidant, antimicrobial, therapeutic and preventative.

What makes garlic so special? The active component of garlic is called allicin (diallyl thiosulfinate). Allicin is activated when its precursor, the alliin enzyme, is released by rupturing a piece of fresh garlic by crushing, cutting or chewing it. Once the allicin is released, it goes to work in the body to produce its functional health benefits. The problem is, most people do not eat garlic freshly cut, crushed or chewed, instead relying on garlic powders and the like in preparation of meals.

Some methods of cooking maintain the allicin content better, such as steaming and boiling. Some methods further reduce the allicin content, such as sautéing and stir-frying. Try taking a clove of garlic with the skin intact, gently smashing it by pressing it with the flat of a chef's knife, then let it sit for 15-20 minutes for the allicin to activate. Remove skin and stem end, then mince and mix with your recipe minutes before serving.

Jensen, K.; Goto, K.; Giampaoli, J.; Holland, J. Factors associated with consumer knowledge of garlic health properties, garlic preparation knowledge and garlic intake. *Californian J Health Promotion* **2021**, *19*, 1: 44-53.

## Aged Garlic Extract Defends Against Alcohol

First, the bad news. Ethanol is the intoxicating element of alcoholic beverages, and is converted into the toxic compound acetaldehyde in the body as it metabolizes the drink. Acetaldehyde is highly toxic, and causes both acute and chronic damage. Some of the acute reactions, or immediate effects of drinking alcohol caused by acetaldehyde metabolism are facial flushing, headache, increased heart rate and increased respiration. Some of the chronic reactions, or those diseases caused over time and length of alcohol consumption are alcoholic liver disease, cardiomyopathy, atherosclerosis and various cancers.

The human genome has 19 genes identified that work to metabolize acetaldehyde after alcohol consumption. The two most effective of these genes relevant to detoxification are aldehyde dehydrogenases 1A1 and 2, or ALDH1A1 and ALDH2. Therefore, it becomes very important to induce, or bring about, the activation of these genes to prevent acetaldehyde toxicity. The expression of our alcohol detox genes may be inhibited under stressed conditions, or high intake of alcoholic beverages. (Current CDC guidelines for alcohol intake are two drinks per day for men, and one drink per day for women, on those days that alcohol is consumed—not necessarily every day!)

Now, for the good news. Garlic has been applied to maintain health and treat disease throughout history. Some of the ways garlic has been prepared for consumption in health maintenance are garlic powder, garlic oil, and commercial extracts. One of these extracted preparations is called aged garlic extract, or AGE. These are commonly found in dietary supplements all over the retail environment. AGE is made by slicing garlic cloves and storing them in a water-ethanol solution until the volatile components are converted into stable compounds. In this study, mice were given AGE to see if it helped

decrease toxicity from acetaldehyde, and it did just that. The researchers concluded that AGE prevented alcohol induced hepatotoxicity (liver damage) in mice, so human research studies are needed to confirm the same action in humans.

Kitakaze T, Inoue M, Ashida H. Aged garlic extract prevents alcohol-induced cytotoxicity through the induction of aldehyde dehydrogenase 2 in the liver of mice. *Mol Nutr Food Res* **2023**, *67*, 2200627.

## **Stinking Rose**

Garlic has long been used in a variety of ways for health benefits, including cardiovascular, immunity, infection and oxidative stress. It is available in powder, oil and aged garlic extract (AGE) supplements, which have been prepared in a lengthy process over 20 months' time and renders it odorless as well as richer in antioxidants. The active constituents of garlic are allicin and organic sulfur compounds. Some of the marketing claims for AGE and other garlic infused dietary supplements include fighting free radicals, reduction of cold and flu symptoms, reduction of upper respiratory tract infections, supporting immunity, inhibition of blood platelet formation, lowering of blood pressure and lowering of blood lipids. There is evidence in the research for garlic's efficacy; however, a variety of preparations have been used across a variety of methods in studies, and some preparations have varying levels of quality, therefore, not one single brand of AGE can be conclusively recommended.

Garlic is safe to use generally speaking (some allergic reactions have been reported, which may happen with almost any food). Some folks may experience gas and bloating from eating fresh garlic in their food or too much culinary garlic powder, but this reaction is from microbial activity promoting healthy gut bacteria, not from any harmful process. If you are sensitive to eating garlic, or don't like the taste or how it makes your breath smell, AGE supplements are the best bet. A final caution is to check with your health care professional before taking supplements or eating too much garlic if you are taking certain prescription drugs, or if you are having surgery within a week, because of the anti-coagulant activity on the blood.

Martini N. Garlic. *J Prim Health Care* **2014**, *6*, 4: 337-338.

## **Garlic and Osteoporosis**

Osteoporosis is a bone disease of progressive bone mass loss and deterioration with increased fragility associated with imbalanced bone formation and resorption closely related to diet. Osteoporotic fractures (OPF) occur mostly amongst postmenopausal elderly women concurrent with decreased bone healing capacity. Interest remains high for dietary remedies in the face of unsatisfactory results, side effects, related complications and high costs of conventional medical treatments.

The study presented here was devised to examine how taurine and garlic dietary supplements have been used in the recent past to help with OPF. Some of the ways taurine has been used include attenuation of hypertension, congestive heart failure, diabetes, convulsion, obesity, cancer and to promote bone and skin health. Garlic has a long list of beneficial applications through the years, including its role as an antibacterial, antiviral, antifungal, antioxidant, anti-inflammatory, antithrombotic (coagulation/platelets), anti-cholesterol, antidiabetic, antineoplastic (cancer), anti-obesity, antiaging,

antiapoptotic (cell death), immunomodulatory, cardioprotective, radioprotective and hepatoprotective (liver).

For the purposes of this study, garlic is a known antiosteoporotic, mainly due to it being a phytoestrogen (plant-based estrogen). Although the research was done with the use of lab rats, the results showed that an aqueous garlic extract (AGE) dietary supplement, along with taurine dietary supplement (a semi-essential amino acid), together were conclusive in positively affecting postmenopausal hip fractures. Basically, these two supplements can improve the healing process of OPF as “detected by multimodal quantitative evaluations” which include “biochemical, histological, micro-CT, and scintigraphic parameters” as methods used in this determination. These findings suggest the need for controlled clinical trials to determine the effects on human individuals.

Misirlioğlu M, Bingöl I, Genc C, Akbulut A, Ocak M, Diker NY, et al. Investigation of taurine and aqueous garlic extract diet supplementation effect on the healing of rat osteoporotic fractures. *Turk J Med Sci* **2023**, *53*, 29-39.

## **Black Garlic and Polysaccharides**

Garlic has been used for thousands of years in culinary and medicinal applications. It possesses many biological activities, such as anticancer, antimicrobial, antidiabetic and antioxidant. Black garlic is the ferment of fresh garlic made by heat treatment, and is generally thought to be more effective than fresh in some applications. Some of the properties of black garlic include antioxidant, anticarcinogenic and anti-hepatopathic (liver disease). The purpose of this study was to find out if the fermentation process actually made for stronger antioxidant activity in black garlic over fresh.

In previous studies, fructans, a type of carbohydrate found in many foods, were thought to be decreased after fermentation, which may be less irritable in the gut for some sensitive people. Further, organosulfuric compounds increased after fermentation, leading previous research to indicate that black garlic might have higher antioxidant activity compared to the fresh version. However, it is the polysaccharide content that is the main component of garlic's effects on enhancing the immune system, so it was important for researchers to find out if fermentation would increase polysaccharide activity even further.

After the study, the results revealed that fresh garlic polysaccharides actually did promote immune function, while the polysaccharide content in black garlic did not. Polysaccharides are only one of the many health components of garlic. Further research is needed, because even though polysaccharide activity remains higher with fresh garlic, there are still other benefits of the fermented product, black garlic, that could have health enhancing benefits.

Li M, Yan Y-X, Yu Q-T, Deng Y, Wu D-T, Wang Y, et al. Comparison of immunomodulatory effects of fresh garlic and black garlic polysaccharides on RAW 264.7 macrophages. *J Food Sci* **2017**, *82*, 3: 765-771.

## **Obesity, Inflammation, and Garlic—Oh My!**

Obesity is a heavy social burden, and with rising statistics on the percentage of overweight people who are also obese, the situation is concerning. Excessive body fat creates health problems such as hypertension, diabetes, cardiovascular events and even some cancers. Further obesity causes oxidative stress, a sort of 'rusting' from the inside of the body, leading to chronic inflammation, which in turn increases the risk of high blood pressure. This and other cardiovascular events are associated with a higher level of C-reactive protein and proinflammatory cytokines. A painful result of all of this is arterial stiffness.

The first and best course of action for most people is to modify lifestyle factors by creating good dietary habits, including the moderate use of a common functional food—garlic, of course! Garlic's health properties are many, such as anti-thrombotic and anti-inflammatory, the most important of which aid better outcomes for obesity. These properties come from organic polysulfides, causing reactions in the body such as vaso-relaxation as well as modulating the production of nitric oxide, which in turn lowers blood pressure. Garlic's lipid lowering effects inhibit certain enzymes that cause or create excess cholesterol.

In a 2014 study, researchers sought to explore the effects of garlic extract on arterial stiffness and endothelial function, or the lining of the arteries. Eighty-eight patients aged 25-60 in a random double-blind study were given Garlicin® (two capsules at breakfast) for three months. Dietary intake and activity levels were kept stable throughout the trial. At the end of the study, results showed reduced body weight and BMI, lowered endothelial markers, reduced lipids and increased antioxidant status. Background research on garlic extract also listed garlic's antiplatelet, fibrinolytic and antithrombotic activity, along with increased brachial artery flow. The main takeaway? Garlic extract supplementation decreases chronic inflammation in obese people. (Be sure to carefully select products for quality and efficacy and discuss with your health care professional before embarking on a course of dietary supplementation of any kind.)

Szulińska M, Kręgielska-Narożna M, Świątek J, Styś P, Kuźnar-Kamińska B, Jakubowski H, et al. Garlic extract favorably modifies markers of endothelial function in obese patients—randomized double blind placebo-controlled nutritional intervention. *Biomed Pharmacother* **2018**, *102*, 792-797.

## **Aged Garlic Extract and Hypertension**

Aged Garlic Extract, or AGE, is a dietary supplement most notably manufactured by Wakunaga in a product called Kyolic. Researchers decided to put this popular product to the test in conjunction with high blood pressure (HPB) reduction. Since about 40% of deaths worldwide are related to cardiovascular issues, including HBP, many patients seek out complementary medicine alternatives such as dietary and lifestyle change, including supplementing their diets with garlic pills. These supplements have been studied in clinical settings before for their BP-lowering effects, but AGE has been shown to be the most effective of the various forms of garlic, such as powder, oil, raw, and cooked.

The active component of AGE is *S*-allylcysteine (SAC), which may be isolated then standardized so that the same effective dose may be measured. AGE has also been determined as safer than other forms of garlic, as it may be taken with other medications without undo bleeding. Other properties of garlic

stimulate nitrogen oxide and hydrogen sulfide which block angiotensin II and promote vasodilation. In this particular study, a formulation of Kyolic garlic supplement contained 480 mg of AGE along with 1.2 mg of SAC. Different groups of participants were given 1, 2, or 4 capsules daily of Kyolic or a placebo.

What did they find out from the results? Some participants taking 4 capsules reported gastro-intestinal distress, such as gas and bloating, and some participants taking only 1 capsule or a placebo had no significant effects on their HBP readings. It seems the 2 capsule per day regimen was the most tolerated and effective. As the research was done with participants who had uncontrolled HBP, clinicians found that the Kyolic supplement demonstrated enough efficacy to be a meaningful adjunct along with physician-recommended medication in older populations.

Ried K, Frank OR, Stocks NP. Aged garlic extract reduces blood pressure in hypertensives: a dose-response trial. *Eur J Clin Nutr* **2013**, *67*, 64-70.

## **Garlic, Immunity and Inflammation**

The immune system function and inflammation go hand in hand. When pathogens enter the body, the immune system is in surveillance mode and can eliminate pathogens before we get symptoms or even know that we are sick. However, when the body gets bombarded with pathogens, the immune system kicks in and responds with the activation of immune cells, which secrete cytokines to kill the pathogens, resulting in inflammation, the normal product of the immune response. However, chronic inflammation happens when the body is unable to resolve the inflammation, or “prolonged activation of immunity” which can cause many chronic disease states such as metabolic syndrome, high blood pressure, atherosclerosis, diabetes and arthritis. This chronic state of being inflamed causes tissue damage, which causes the immune system to be activated, and ends up in a vicious cycle as the immune system and inflammation spiral on and on. The best state is for the immune system to work in surveillance mode, where it may easily take care of invading pathogens before they become a cytokine storm.

Enter garlic, which has long been known for centuries as a benefit to health, but more recently in human history, garlic has been aged and extracted into a dietary supplement known as AGE, or aged garlic extract. It's made by growing garlic organically, then slicing and soaking it in a water and ethanol solution to extract the active components, and finally aged up to 20 months. Lectins are also present in AGE, such as fructo-oligosaccharides (FOS), and these lectins interact with pathogen recognition by the immune system. Further, AGE supports the immune system's pathogen recognition system, thus they may be eliminated before they cause inflammatory trouble. Thus, AGE has antioxidant properties against neurodegeneration, cardiotoxicity and diabetic complications.

To confirm these actions of AGE dietary supplementation, researchers designed a randomized, double-blind, placebo-controlled, parallel intervention study with two groups of 60 participants taking AGE capsules for 90 days. They found that immune cells had better proliferation than the placebo group, as AGE works by increasing surveillance and response activity of the immune system, resolving inflammation by encouraging immune cell death once their job is done. AGE did not necessarily prevent illness, but it did reduce severity of symptoms. Supplementation with AGE, therefore, may decrease overall inflammation according the results of this study.

Percival SS. Aged garlic extract modifies human immunity. *J Nutr* **2023**, *146(Suppl)*, 433S-436S.

## **Growing Garlic**

The many benefits of garlic are affected by the various pre- and post-harvest methods employed in the growing cycle. As we know, garlic is valued for its many culinary and medicinal properties, which vary in different formulations such as raw, cooked, powder, oil or extracts. Sulfur-containing compounds are responsible for garlic's distinct flavor, the most prevalent are alliin, allicin, alixin and others. These flavor compounds lend healthful benefits such as anticancer, antidiabetic, anti-inflammatory, antimicrobial, antioxidant, cardioprotective and immunomodulatory activities. Garlic is also rich in vitamins, particularly B-complex and C, along with flavonoids, minerals and phytonutrients. Further, these volatile components are activated during the growing cycle to ward off pests with their strong effects. Garlic is a multi-faceted and fascinating vegetable!

All of these properties of garlic are affected by various growing conditions and cultivation practices. In pre-harvest activities, genotype is the first consideration. The selection of a particular cultivar may result in an increase in total phenolics. Different colors also affect nutrition: vitamin C and total fractionated oil are higher in purple varieties, and total phenolic compounds and flavonoid content are higher in white garlic. Growing conditions can affect some factors, such as caffeic, coumaric and vanillic acids, but not on others, such as total phenolics. Irrigation is not a significant factor overall, but fertilization is important as garlic needs nitrogen for best enhancement of qualities. Sulfur amendments increase garlic's sulfuric compounds. Harvesting garlic later in the season allows for the compounds to travel from the leaves into the bulbs, where they are most frequently utilized for culinary or medicinal purposes.

In post-harvest, it is important to consider processing in order to maintain quality. In traditional societies, harvested garlic bulbs were soaked in various solvents: alcohol, wine, milk, vinegar. Today, blanching is used in both the food and pharmaceutical industries. However, blanching decreases sulfides and anti-oxidants. The longer garlic is cooked, the more "good stuff" is lost. The best method for cooking is to crush the garlic and wait a few minutes for the active components to establish, then stir-fry quickly over high heat with other vegetables. Boiling and frying garlic are the most detrimental to its efficaciousness.

Martins N, Petropoulos S, Ferreira ICFR. Chemical composition and bioactive compounds of garlic (*Allium sativum* L.) as affected by pre- and post-harvest conditions: a review. *Food Chem* **2016**, *211*, 41-50.

## **Garlic and Cancer**

The allium family includes garlic, onions, shallots, chives and leeks. They all have healthful properties and should be included in a balanced diet to prevent chronic disease. Garlic and onions are native to Central Asia, and have a 4,000-year use for culinary and health benefits. Historically, an ancient Egyptian text cites 22 applications for garlic, Hippocrates suggested garlic as a laxative and diuretic, and Aristophanes and Galen promoted its use for treating uterine cancer. Today, as dietary habits are becoming increasingly emphasized in the prevention of disease, garlic has been especially studied for its long history. In fact, 30%-40% of cancers could be prevented with appropriate food, nutrition, physical activity and body weight maintenance.

Of all the alliums, garlic is richest in minerals overall, especially selenium, important in cancer prevention. Other bioactive compounds of garlic include flavonoids, oligosaccharides and arginine; however, it is best known for its sulfur-containing components, which give garlic and the alliums their distinctive pungent flavor and aroma. Crushing fresh garlic releases the enzyme alliinase, but temperature, pH, time and processing can all affect the activity of these bioactive compounds. The various processes are used to mitigate the strong taste and odor of garlic, yet it is this same pungency that delivers the goods we need for health.

Some of the types of cancers studied in association with garlic's cancer preventive action are stomach, colorectal, esophageal, prostate, oral, larynx, renal, breast and ovarian. Results have been varied, with the strongest evidence for prevention of gastrointestinal cancers. Sulfuric compounds in garlic alter biologic behavior of tumors and their precancerous cells, and suppress cell proliferation. Other mechanisms of garlic towards cancer are their antifungal action, and substantial evidence also shows garlic extract to inhibit Gram-negative and -positive bacteria, as well as *H. pylori*, which may be a precursor to stomach cancer. Garlic may also be useful in suppressing inflammation and enhancing immunity. As research continues in this area, enjoy your garlic and other alliums to your heart's content!

Nicastro HL, Ross SA, Milner JA. Garlic and onions: their cancer prevention properties. *Cancer Prev Res* 2015, 8(3), 181-189.

## **Garlic: The Science in Review**

A recent review of the scientific literature on garlic studies summarizes the many attributes, actions and applications of the various forms of garlic studied over the years. First, the list of garlic's bioactive compounds is long, and this is just a sampling: organic sulfides, polysaccharides, saponins, phenolic compounds, allicin, alliin, diallyl sulfide/disulfide/trisulfide, ajoene and S-allyl-cysteine. Next, another long list of how these compounds play out and may assist us in health: anti-oxidant, anti-inflammatory, antibacterial, antifungal, immunomodulatory, cardiovascular protective, anticancer, hepatoprotective, digestive system protective, anti-diabetic, anti-obesity, neuroprotective and renal protective. Finally, these two lists indicate the possible applications of garlic for functional foods, or nutraceuticals, as well as dietary supplements.

Some of the various forms of garlic used in applications are fresh, powder, oil, aged garlic extract (AGE), black garlic and purple garlic. Some of the compounds in these many varieties have greater potency when cooked, for example, as opposed to some compounds that are emphasized when garlic is eaten raw. Black garlic is a processed form found in supplements, along with AGE which has been well-researched on its own right, and purple garlic is a variety grown which has been found to have more bioactive compounds than its white variety. Overall, some compounds, like the phenols, are higher in garlic than in many other common vegetables.

The actions of garlic are many; they reduce severity of colds and flu, protect against various alimentary canal cancers among others, reduce proliferation of cancer cells while enhancing activity of anti-cancer drugs such as tamoxifen, protects the liver and is highly anti-microbial. For example, the Rosato and Caposele varieties from Italy are effective against *Penicillium expansum*, *Aspergillus versicolor* and *Penicillium citrinum*. AGE is effective against *Burkholderia cepacia*, and raw garlic for *Helicobacter pylori*. Garlic oil is effective against a number of "bad" bacteria, including *Staphylococcus aureus*,



*Escherichia coli*, *Bacillus subtilis*, *Penicillium fumiculosum* and *Candida albicans*. Much more clinical trials are needed to explore and examine the effects of all the various forms of garlic, how they are processed and their proper dosages in determining better recommendations for human health promotion.

Shang A, Cao S-Y, Xu X-Y, Gan R-Y, Tang G-Y, Corke H, et al. Bioactive compounds and biological functions of garlic (*Allium sativum* L.). *Foods* **2019**, *8*, 246.

## **Special Chinese Garlic and Colitis**

Inflammatory bowel disease (IBD) is a chronic gastro-intestinal condition characterized by reduced appetite, abnormal pain, diarrhea and rectal bleeding. Two IBDs in particular, Crohn's and ulcerative colitis (UC), have a complex pathogenesis based on genetics, dietary patterns and/or the environment. Current conventional medical treatments include the use of steroids, immunomodulators, antibodies and amino-salicylates all with limited efficacy along with various adverse effects. Enter polysaccharide-rich garlic, with all its unique anti-inflammatory properties, to the rescue!

Polysaccharides are pre-biotics found in garlic in other foods, meaning they provide the food that "good bacteria" in the gut thrive on. The properties of polysaccharides are anti-inflammation, antioxidation and immunomodulation. They relieve colitis by reducing levels of inflammatory factors and improving the microbiome. Garlic polysaccharides other properties include antitumor, anticoagulation, liver protection and microbiome balance.

The Ministry of Health in China lists garlic as a medicinal edible. From Jinxiang County, "home of the Chinese garlic," comes Jinxiang garlic, the most abundant in polysaccharides. Researchers conducted a study involving colitis-induced mice to see if anti-inflammatory factors of this unique garlic variety improved the condition of the colon and the intestinal microbiome. A water extract of Jinxiang garlic was used in the trials. Results showed definite benefits in alleviating induced colitis by improving mucosal lining of the intestines, blocking proinflammatory cytokines and modulating gut microbiota. Further studies on this and other varieties of garlic are warranted to alleviate chronic gut conditions suffered by humans all over the world.

Shao X, Sun C, Tang X, Zhang X, Han D, Liang S, et al. Anti-inflammatory and intestinal microbiota modulation properties of Jinxiang garlic (*Allium sativum* L.) polysaccharides toward dextran sodium sulfate-induced colitis. *J Agric Food Chem* **2020**, *68*, 12295-12309.

## **Fino de Chinchón Garlic from Spain**

The timeline of garlic begins about 10,000 years ago when it was first cultivated in Central Asia, which encompasses the Stans (Russian states) and Western China. From that region, it spread to China and India in the East, and Northern Europe and the Mediterranean in the West. In 1944, the first bio-active components of garlic were discovered, and today, garlic is one of the top 20 most cultivated vegetables. In the European Union, Spain grows the most garlic: enter the Fino de Chinchón (FC) variety, named after the village of Chinchón, close to Madrid.

Intensive agriculture has largely replaced landraces, or local, traditional varieties of crops. But more recently, there has been consumer demand for heirloom, sustainable varieties of various foods. In this spirit, researchers set out to examine the qualities of FC garlic, along with another Spanish cultivar called Spanish purple (MP), against a number of common white and non-indigenous varieties. The tests were carried out in Spain's public research organization, the IMIDRA, to determine FC's importance as a cultivar worthy to be propagated for consumer choice.

Garlic extracts were made of the various cultivars in order to compare various qualities, such as anti-oxidant and free-radical scavenging capabilities, pungency (an indication of sulfur-containing compounds), surface color and texture. Both FC and MP garlic varieties had higher anti-oxidants than the common foreign varieties and FC had the highest pungency overall. There are other important factors to consider in landrace, traditional cultivation of foods: gene mutation and migration, recombination, cross cultivation, soil, climate, ecology of growing region and cultivation techniques. Overall, researchers concluded that "FC garlic deserves to be promoted and considered as a potential vegetable crop species for further research." Studies like these show the importance of heirloom varieties in the consumer catalog of choice for overall human and planetary health.

Ruiz-Aceituno L, Lázaro A. Physicochemical and textural properties of a Spanish traditional garlic (*Allium sativum* L.) variety: characterizing distinctive properties of "Fino de Chinchón" garlic. *Eur Food Res Technol* **2021**, *247*, 2399-2408.

## **Garlic and Viruses**

Many viruses have threatened human health recently, such as SARS in 2003, MARS in the Mid-East in 2012, Ebola in West Africa in 2014 and of course, COVID-19 worldwide in 2020. Prevention of viral disease stymies current treatment because it emerges and spreads rapidly and has drug-resistance, adapting quickly to treatments as strains mutate. Even though some success has emerged in medical prevention and treatment in lieu of a fast-changing environment; e.g., with herpes simplex, HIV and hepatitis B, many look to applications of functional food in order to bolster their immune systems to deal with the onslaught.

The action of plant-based medicines towards viral infection is known as immunomodulatory; i.e., enhancement of the immune system. Enter garlic: long cultivated and used for both food and medicinal purposes, it is currently grown in China, India, South Korea, Egypt and the USA. As recent as 1720, garlic was used in Marseille as effective against the plague. Today, it is used mostly to alleviate symptoms of colds and flu. The organo-sulfuric compounds are the main active feature of garlic that gives it its smell as well as efficaciousness in breaking up pathogenic activity. Other compounds include lectins, fructans (polysaccharides) and ajoenes, the latter being especially effective against tumor cells.

Other immunomodulatory actions of garlic include inhibiting viral replication, reducing viral load and blocking cell surface receptors so viruses cannot attach themselves to human cells. In dengue fever, garlic reduces inflammation, one study showed. Another revealed that there was a reduced instance of infection by air-borne viruses by sniffing powdered garlic extract (a special formulation—don't try this at home!). Aged garlic extract (AGE) supplements tested in another study resulted in modulated inflammation in obese people. The best course of action today is to eat garlic in moderation regularly in your meals to help overall immunity thrive.

Rouf R, Uddin SJ, Sarker DK, Islam MT, Ali ES, Shilpi JA, et al. Antiviral potential of garlic (*Allium sativum*) and its organosulfur compounds: a systematic update of pre-clinical and clinical data. *Trends Food Sci Technol* **2020**, *104*, 219-234.

## **Garlic and Chronic Digestive Issues**

Garlic is an herb from the Amaryllidaceae family of botanicals and has been used as both a spice for cooking and a traditional medicine. Its bioactive compounds include phenolics, saponins, polysaccharides and organosulfur compounds, to name but a few! Garlic's "countless" pharmaceutical properties include anti-inflammatory, antioxidant, anti-atherosclerotic, anticancer, immunomodulatory, antidiabetic, anti-obesity, neuroprotective and digestive system protective. All of these properties are affected by genetic varieties of the plant as well as agronomic factors. Processing, including cooking and preparation methods, also result in variability of efficacy, with raw garlic having the most potency.

Ulcerative colitis (UC) is a distressing chronic condition affecting many with such inflammatory bowel diseases (IBDs). As garlic has strong anti-inflammatory and antioxidant properties, a study was conducted to see if garlic would help to alleviate or resolve these conditions. Two garlic extracts were tested, one extracted by alcohol and one by water, in mouse trials with induced UC. The type of garlic was a Sicilian variety known as Nubia red.

The results of the study were promising. The garlic extracts showed antioxidant activity with regard to increasing antioxidant enzymes such as superoxide dismutase (SOD), catalase and glutathione. This was due to garlic's polyphenol content, especially the catechins, which reduced colonic oxidative damage while enhancing the antioxidant enzymes. These protective effects reveal that garlic has a potential role in preventing and managing UC in humans. Garlic extracts such as these may have applications in the pharmaceutical and nutraceutical industries. Of course, further research is always warranted to determine more definitive applications for treatment.

Recinella L, Gorica E, Chiavaroli A, Frascchetti C, Filippi A, Cesa S, et al. Anti-inflammatory and antioxidant effects induced by *Allium sativum* L. extracts on an ex vivo experimental model of ulcerative colitis. *Foods* **2022**, *11*, 3559.

## **Bioavailability of Various Forms of Garlic**

Clinical trials involving garlic supplements have been carried out since the 1980s, and were focused mainly on how effective they were in dealing with blood pressure and cholesterol levels. Since then, tests have been conducted for lipid-lowering, antioxidant, anti-atherosclerotic and anticancer capacity. As early as 1944, the active enzyme in garlic, allicin, showed anti-bacterial activity as well. Bioavailability of garlic happens through enzymatic formation, absorption and metabolism.

Researchers wanted to learn how much allicin was bioavailable or bioequivalent in garlic dietary supplements along with garlic as food. Garlic supplements are made by drying and pulverizing whole cloves of garlic, and culinary uses of garlic vary widely and are available in many prepared products on the grocery shelves and online. Previous studies have had mixed results in the consistency of measured

effect for positive benefits of garlic on human health. Some of the problems in determining these benefits are due to high variations in dosage, type of garlic tested and if the supplement was standardized for active ingredients; i.e., allicin.

Scientists have been working towards a standardized system to study the amount of bioavailability of various forms of garlic occur in culinary and supplementary applications. Once they found a method for determining this, they set out to test garlic supplements against food products: Mezzetta brand spicy pickled garlic, Spice World brand minced garlic, Christopher Ranch brand chopped garlic and a product from South Korea called Black Garlic brand, which is simply whole black garlic cloves. Various types of cooking were employed. Study participants consumed these various forms, and breath samples were taken to measure potency. Results showed that garlic supplements had some bioequivalence to the same number in garlic as food, except for enteric-coated supplements because of the variability in gastric emptying. Crushed raw garlic had the strongest bioavailability, followed by roasted, then boiled garlic (as for soups and stews). All we can say is...keep that garlic coming and enjoy good health!

Lawson LD, Hunsaker SM. Allicin bioavailability and bioequivalence from garlic supplements and garlic foods. *Nutrients*, **2018**, *10*, 812.