# FermaPro® Black Garlic

## A Complete Antioxidant for Cardiovascular and Immune Health

Presented by
RFI Ingredients
Blauvelt, NY

Fermented food ingredients are one of the hottest new trends in dietary supplements and functional foods. In addition to the unique flavors that result from fermentation, fermented food ingredients can provide numerous nutritional and health benefits. Many regular foods become even healthier when fermented due to improvement in bioavailability of nutrients and phytochemicals, elimination of anti-nutrients, or the increased production or creation of phytonutrients found in the raw material.

FermaPro® Black Garlic is an example of how fermentation can increase the levels of a key phytochemical as well as create new ones. Prized in many Asian cuisines for its unique flavor and health benefits, black garlic is the result of aging regular garlic under mild heat resulting in natural enzymatic fermentation. This fermentation turns the color from white to black and changes the flavor from pungent to sweet and savory. In addition, the fermentation reactions improve garlic's immune-enhancing activity and antioxidant potency — doubling the oxygen radical absorption capacity value of regular garlic. The most abundant antioxidant compound found in black garlic is S-Allyl-Cysteine (SAC). During the aging process, unstable compounds of fresh garlic including alliin are converted into stable compounds including SAC, a water-soluble compound with potent antioxidant activity. Unique new antioxidant compounds have also been identified in black garlic, such as tetrahydro-betacarbolines, which are structurally similar to flavonoids.

The use of garlic for medicinal purposes dates back more than 5000 years. Garlic's known cardiovascular effects are the most studied and promoted benefits, but its proven therapeutic properties also include its positive effect on immune system and plasma lipid regulation. The health-promoting effects of garlic are derived from sulfur-containing compounds such as allicin and S-allyl cysteine (SAC). Allicin, however, is very unstable under heat and is extremely pungent, which limits its potential as a dietary supplement. The aging/fermentation of black garlic, on the other hand, increases the levels of the stable compound SAC and changes the flavor profile from the overpowering flavor and odor of raw garlic to a sweet, umami flavor.

This white paper reviews the current science pertaining to black garlic and its active compound SAC, with particular attention to its antioxidant activity and human clinical trials.

# Antioxidant Activity

The protective activities of SAC have been well studied and have been shown to be associated with the prevention or amelioration of oxidative stress, including the prevention of oxidation of lipids and proteins. While the mechanism of most antioxidant compounds is the quenching of specific free radicals (direct antioxidant effect), the antioxidant properties of black garlic and SACs include a direct antioxidant effect on all biologically-relevant free radicals as well as numerous "indirect" antioxidant mechanisms, making it truly a "Complete Antioxidant." In fact, aged black garlic showed stronger antioxidant activity in vitro and in vivo than raw garlic due to the safe, stable, bioavailable and beneficial compounds during the natural aging process.[1,2] A recent comprehensive review of SAC and black garlic's antioxidant activity describes the many mechanisms.[3]

## Free Radical Scavenging Activity

There are many types of free radicals, but those of most concern in biological systems are derived from oxygen, and known collectively as reactive oxygen species (ROS). SAC contains a thiol group responsible for its antioxidant capacity because this nucleophile can easily donate its proton to an electrophilic species, thereby neutralizing them or making them less reactive. SAC has been shown to scavenge reactive oxygen species, including superoxide anions,[4,5,6,7] hydrogen peroxide,5,6[,8,9,10] hydroxyl radicals,4,5[,11,12] peroxynitrate anions,4[,13] hypochlorous acid6 and singlet oxygen.6 Black garlic also contains additional antioxidant compounds such as S-allylmercaptocysteine, and tetrahydro-betacarbolines.3

## Activation of Endogenous Antioxidant Enzymes and Nrf2

In vitro and animal models have shown that SAC increases the activity of endogenous antioxidant enzymes such as glutathione peroxidase,[14,15] NAD(P)H:quinone oxidoreductase[15] and superoxide dismutase (SOD).[16,17,18] In addition, SAC has also been shown to activate the nuclear factor erythroid 2-related factor (Nrf2),3[,17] a transcription factor that functions as the key controller of the redox homeostatic gene regulatory network. Under oxidative stresses, the Nrf2 signaling pathway is activated to enhance the expression of a multitude of antioxidant and phase II enzymes that restore redox homeostasis.[19]

## Inhibition of Pro-oxidant Enzymes

SAC has also been shown to inhibit a number of pro-oxidant enzymes, as an imbalance of these enzymes can increase oxidative stress. Nitric oxide synthase (NOS) is a family of pro-oxidant enzymes that catalyze the conversion of L-arginine to L-citrulline to produce nitric oxide (NO). While nitric oxide is an important signaling molecule for a number of physiological responses, increased levels of NO are also associated with oxidative stress and disease by causing damage to proteins, lipids and DNA either directly or after reaction with superoxide. Black garlic and SAC have been shown to help regulate NOS enzymes, which can help prevent oxidative stress resulting from imbalanced NO levels.4[,20,21,22] SAC and black garlic have also been shown to inhibit other pro-oxidant enzymes, whose over-activation is related to different patho-physiological events, including xanthine oxidase,[23] NADPH oxidase[24] and COX-2.[25]

## Chelation of Metal Ions

Iron and copper ions are involved in the generation of reactive oxygen species and increased levels have been shown to cause oxidative stress, with particular potential on neurodegeneration and LDL oxidation. Black garlic and SAC have been shown to possess chelating properties for both iron and copper.[26]

# Cardiovascular Health

Garlic and its preparations have been widely recognized for supporting cardiovascular health. In vitro and animal studies have provided evidence that black garlic may also protect the cardiovascular system by maintaining healthy cholesterol levels and blood pressure as well as reducing platelet aggregation and vascular calcification.3[,27,28,29,30] The following human studies have supported the use of black garlic for cardiovascular health:

- LDL cholesterol isolated from subjects receiving 2.4 g of black garlic daily for 7 days were reported to be more resistant to oxidation than LDL isolated from subjects receiving no supplementation.[31]
- In a double-blind, parallel randomized placebo-controlled trial involving 50 patients, daily supplementation with 960 mg black garlic (providing 2.4 mg SAC) daily for 12 weeks resulted in reduced systolic blood pressure compared with controls.[32]
- A 12-week, double-blind, randomized placebo-controlled dose–response trial reported a reduction of mean systolic blood pressure in subjects supplemented with 480 or 960 mg black garlic (containing 1.2/2.4mg of SAC) compared to placebo.[33]
- In a randomized, placebo-controlled, cross-over design, 2.4 grams/day of black garlic supplementation improved endothelial function. Brachial artery flow mediated endothelium-dependent dilation (FMD) was shown to increase from the baseline. FMD is the most widely used, non-invasive test for assessing endothelial function. Normal functions of endothelial cells include mediation of coagulation, platelet adhesion and immune function, while endothelial dysfunction is associated with a number of cardiovascular conditions. These data suggest that short-term treatment with black garlic may improve impaired endothelial function.[34]

# Conclusion

Based on the large body of scientific evidence, FermaPro® Black Garlic can be used to support cardiovascular and immune health. FermaPro® Black Garlic is standardized to SAC content, allowing the dosage (800-1600 mg) to match clinical trials in order to make the following claims:

- Provides antioxidant support better than raw garlic
- Helps maintain healthy cholesterol levels and blood pressure already in normal range
- Supports improved immune function by increasing NK cell activity and immunostimulatory activities.



For a real-time list of available ingredients, go to: RFIingredients.com
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