

## Phytogetic ingredients in the spotlight:

### Garlic, the ‘voodoo bulb’ – love it or hate it

„Garlic garlic, it's a remedy we crave! “says a line of the chorus from the musical *Dance of the Vampires* - probably some of you might know. In this case, the garlic serves to protect against the bloodthirsty undead. Entertaining and – who knows – perhaps with a spark of truth. By the way, where does the vampire's aversion to garlic come from? A legitimate question, we try to answer later on.

Garlic (*Allium sativum*) has to offer so much more than just keeping away undesired vampires, and it is definitely more than only a worldwide used spice plant. Throughout history, garlic has been known as **herbal medicine for the prevention and treatment of a variety of diseases**. Though – one by one, let's go back in history a little bit and have a closer look at this bulbous plant, belonging to the family of *Amaryllidaceae*.

**Garlic originated in Central Asia** and was already widespread in ancient times. At that time, opinions about garlic already differed widely due to its intense smell: In Rome it was rather frowned upon by the upper class, whereas among the Egyptians it was considered sacred. Its **strong smell** made garlic an important plant even in superstition, hence it was used to ward off demons, evil spirits and vampires.



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Besides its „**defence characteristics**“, throughout history, garlic always found its role to human (and animals) soundness. For instance, Hildegard von Bingen treated jaundice with garlic, the Greek doctor Dioskurides described garlic as a **medicinal plant with a positive effect on digestion and as a remedy against poisoning**. Above, garlic was also used in ancient times to treat skin diseases and colds. In the Middle Ages, it was used to fight the plague. A very versatile, remarkable spice, therefore, worth describing it in more detail below.

## Characteristics

Garlic is a **perennial herbaceous plant**. It has a small bulb, which consists of five to twenty daughter bulbs, the so-called garlic cloves. It is a precious spice plant used in the kitchen as well as a medical plant with an important role in naturopathy.

### Quickly read:

- **Scientific Name:** Allium sativum
- **Family:** Amaryllis family (Amaryllidaceae)
- **Growth height:** up to 90 cm
- **Colour of flowers:** white, pink to purple
- **Collection time:** summer or autumn
- **Occurrence:** originally from Central Asia, today worldwide
- **Habitats:** sunny, humus-rich, nutrient-rich, deep soils
- **Used parts of plants:** tubers



## Effective Ingredients

Following numerous scientific studies, garlic has regained fame today. Though it is to say, that so far, not all ingredients have been analyzed down to the last detail. However, related to garlic, there is always talk of the valuable secondary plant substances, sulfides. But it's not only these sulfides, garlic owes its good reputation to, **the list of precious ingredients is long**. Let's have an outline on the considerable compounds of this superfood:

Despite other lily plants, such as onions and leeks, which are also important sources of sulfides, the majority of scientific studies have been carried out on garlic sulfides. No doubt, garlic serves as excellent source for many important active substances, but it is the **sulfur compounds** that are seen as its spotlight nutrients regarding overall health benefits. Here we are talking about **sulfur-containing amino acids and peptides** (i.e. cysteine, glutathione), **thiosulfinates** (i.e. allicin), **sulfoxides** (i.e. alliin), **sulfides**, **diallyl sulfides** and **polysulfides** (i.e. diallyl disulfide, diallyl trisulfide), **vinylidithiin** (i.e. 1,2-vinylidithiin) and **ajoenes** (i.e. E-ajoene). **Ajoene** is a product of the decomposition of allicin and is said to cause the **antithrombotic properties** of garlic. It is an extremely effective ingredient of garlic, but only develops when the garlic is heated. **Alliin and allicin**, probably the two most important ingredients of garlic, are created by a chemical process during growth. In a study, **high antibacterial activity** of freshly

prepared garlic clove was observed, and soon attributed to an oxygenated sulfur compound<sup>1</sup>. They called it allicin and it was soon found out, that allicin had a precursor, alliin<sup>2</sup>. **Alliin**, probably the genuine mother substance of garlic, a sulfoxide and derivative of the amino acid cysteine, is converted into allicin when fresh garlic is chopped or crushed<sup>3</sup>. Alliin itself has no bactericidal action. A specific enzyme, **alliinase**, converts alliin into allicin (diallyl thiosulfinate), a potent **bactericidal substance**. But the generated allicin is rather unstable and spontaneously transforms into a series of other sulfur-containing compounds such as di- and trisulfides (in water), or ajoene and vinyldithiin (in oil). It is these sulfur-containing compounds that are responsible for the typical smell of garlic and some of which have been investigated for their **cancer preventive activity**<sup>4,5,6</sup>. Above, most of the other health-promoting effects of garlic (i.e. **anti-oxidant, antimicrobial, antithrombotic, immunostimulant**) are attributed to this big diversity of bio actives.

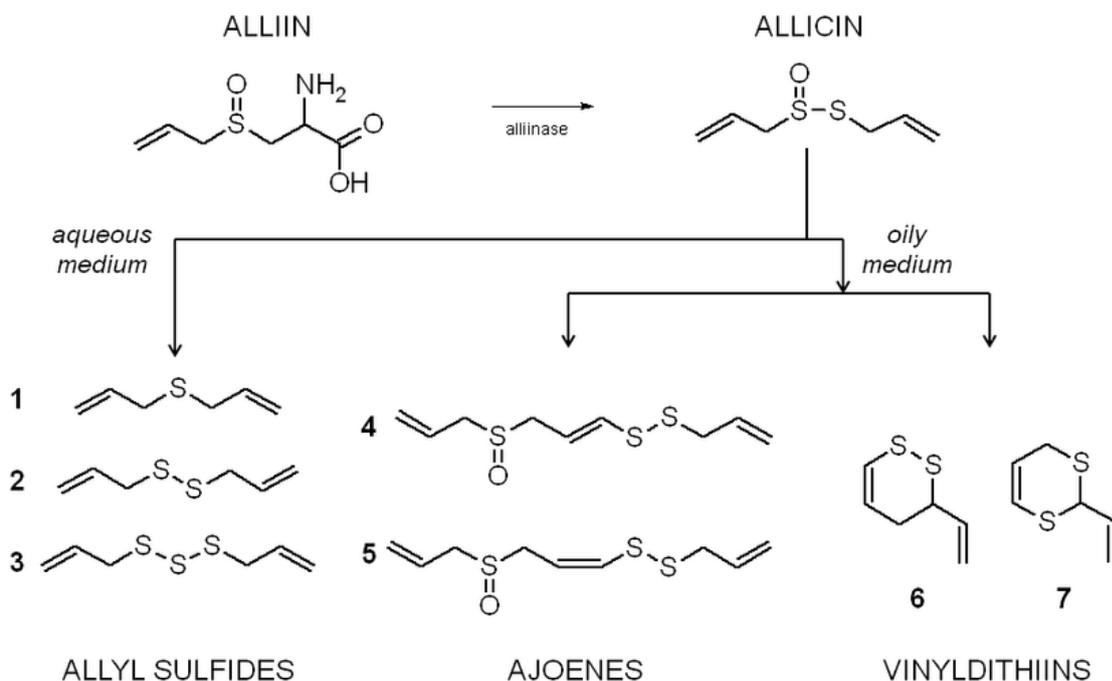


Figure 1: *Alliin* is the substrate of the enzyme *alliinase* and *allicin* the reaction product. Allicin quickly turns into various groups of molecules according to the conditions and medium<sup>7</sup>.

The healthy leek plant also contains various **vitamins** (vitamin A, B1, B3, B5, B6, C, E, H), **minerals** and **trace elements** (i.e. potassium, copper, molybdenum, selenium, iodine, germanium). Though in order to absorb a significant amount of these substances via garlic, you have to consume a fairly large quantity of this spice plant. It is easier to meet this need with certain types of vegetables. Other with the **scordines**, that seem to suppress the accumulation of small blood cells (thrombocytes), which leads to hemodilution, thus having a positive effect on circulation and may **help to protect against atherosclerosis**. Similar with **adenosine**, one of the four so-called nucleic acids, having an extremely positive effect on blood pressure and general

blood circulation in the body. Also, **flavonoids** are present in garlic and with their **blood pressure lowering characteristics**, do a positive contribution to various therapeutic successes of garlic treatment.

Recently, **garlicin** and **allistatin** have gained increased interest, as natural ‘antibiotics’ that occur in plants belonging to the *Allium* group. **Garlicin** seems to be effective against *E. coli.*, whereas **allistatin** may have an impact on *S. aureus*. In contrast to the chemical club, these substances also **promote a healthy intestinal microbiota**. As the intestinal microbiota is important for a strong immune system, one reaches into the other. This already brings us to our last, important ingredient of the popular bulb: **enzymes**. Above many other enzymes of garlic, **lysozyme** is of great importance, as it cleans cell walls, especially of gram-positive bacteria, and it may possibly act as **mediator of the antitumor functions of macrophages**<sup>8</sup>.

## Fields of application

Over the last decade, garlic has been investigated extensively for health benefits, as evident from many peer-reviewed scientific publications. Accordingly, garlic is considered as a plant with **antibiotic, anticancer, antioxidant, immunomodulatory, anti-inflammatory, hypoglycemic and cardiovascular-protecting effects**<sup>9,10,11</sup>.

Studies with birds and livestock reported that powdered garlic in a dose range on 0.25 to 0.50% **improves growth and feed conversion ratio**<sup>12,13</sup>.



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## Antimicrobial activity

The antimicrobial qualities of crushed garlic, mainly arising from **organosulfur compounds**, have been known for many years<sup>14</sup>. However, also **phenolic compounds** have demonstrated to contribute to antimicrobial properties<sup>15,16</sup>.

In particular allicin and its sulfur compounds have **germicidal properties** in that they can act against all kinds of pathogenic microorganisms and parasites, without killing beneficial intestinal bacteria. Though at this point, it is fair to say that some investigations showed that certain strains of **bifidobacteria** were more susceptible to garlic’s antibacterial activity than others<sup>17</sup>. Reported modes of action of garlic against pathogens is mostly based on modifications to secondary structure proteins, fatty acids and phospholipids in the cell membrane as well as nucleic acids. These changes may prevent exposed bifidobacteria from colonizing the intestines thus preventing them to fully exploit their beneficial potential.

Indeed, an approach, that should not be underestimated, as the intestinal microbiota makes up the largest part of the immune system, and therefore should be strengthened best possible. An intact intestinal environment also enables **better absorption and utilization of nutrients**, i.e. more building blocks reach the cells. This is mainly desired and applied in many sectors of livestock production, where improved nutrient availability benefits the entire organism and therefore **enhances animals' performance**.

### Anti-oxidant activity

Garlic is also said to be able to inhibit cell damage thanks to its anti-oxidant secondary plant substances. Anti-oxidants inactivate **reactive oxygen species (ROS)** in the organism, the excessive presence of which leads to **oxidative stress** associated with ageing and the development of a number of diseases. ROS naturally occur as byproduct of oxygen metabolism and as such they carry important roles (i.e. cell signaling, homeostasis). Environmental stress (i.e. heat stress and weaning) may lead to a laps of ROS levels, making them increase dramatically. For its protection, the organism, respectively the cells, confront the ROS or other toxic free radicals with anti-oxidant defense mechanisms. Plant derived **phytochemicals**, including garlic, provide additional **protection against damage caused by oxidation processes**.

**Protein oxidation, DNA damage and lipid peroxidation** count among the consequences of high-grade oxidative stress and are regarded as contributory causes to the ageing process. The latter, lipid peroxidation, ultimately leads to cells having to use more energy to stabilize their membrane potential. Upon **low-density lipoproteins (LDL, lipoproteins that transport lipids in the blood)** it comes to oxidative modifications that lead to **atherosclerosis** via the formation of foam cells. These foam cells are 'transformed macrophages', characterized by a massive accumulation of lipid droplets in the cytoplasm, which is seen as key process in the development of atherosclerosis. When foam cells become apoptotic, they release extracellular lipid droplets in the layer of endothelial cells coating the blood and lymph vessels.



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According to a study<sup>18</sup>, **aged garlic extract inhibits lipid peroxidation** and modification of LDL, thereby protecting endothelial cells from the injury caused by oxidized molecules. Other studies<sup>19</sup> showed that garlic (raw and boiled) improved plasma lipid metabolism and plasma anti-oxidant activity in rats. Dietary garlic effectively reduced oxidative stress, which was shown by **increased anti-oxidant activity** and decreased

blood lipids of rats. In both, *in vivo* and *in vitro* trials, boiled garlic, respectively its extract, turned out to be strong anti-oxidant. This was explained by enhanced lipid and anti-oxidant metabolic indices in the rat serum.

Above, garlic and its components can improve endogenous cellular anti-oxidant defenses: **Glutathione** (GSH) is present in almost every cell and is formed in the liver from glutamic acid, glycine and cysteine. It serves as substrate for **glutathione peroxidase** (GPX) and in its reduced form, it is able to **mitigate free radicals**. Therefore, it supports the immune system like hardly any other element in the body. Specific enzymes like **superoxide dismutase** (SOD), which dismutates reactive superoxides and **catalase** (CAT), which destroys toxic peroxides also count among the important anti-oxidant defense mechanisms of cells. Bovine cell culture studies showed aged garlic extracts being able to protect endothelial cells from ROS by generating increased levels of SOD, CAT and GPX<sup>20</sup>.

### Antihypertensive activity

Though still further studies are required on the detailed mode of action of **antihypertensive effects of garlic**, respectively allicin, some studies suggest a possible positive effect on hypertension in organism<sup>21,22</sup>.

Treatments with S-1-propenylcysteine (S1PC, a key constituent of aged garlic extract) showed decreasing effects on the systolic blood pressure in hypertensive rats<sup>22</sup>.

### Immunostimulant activity

Next to these benefits, that have already been proclaimed for many years to some extent, *Allium sativum*, respectively its derivatives, is also taking center stage regarding **immunostimulant activities**, as they show the ability for **balancing the homeostasis of the immune system**<sup>23</sup>. However, to date, the responsible plant components being able to support the immune stimulation are not yet known in detail.

A study<sup>24</sup> suggested the plant mechanisms being responsible for an **improved gut ecosystem**, enhancing the function of the immune system in chickens. Others consider the **anti-oxidant characteristics of plants as a weapon against environmental stressors** and **support of the immune function in its role to combat certain diseases**.

It seems as if garlics' anti-inflammatory and immunomodulatory characteristics base on two main mechanisms: the **modulation of cytokine profiles** and **direct stimulation of immune cells**<sup>23</sup>.



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### And finally, ...

...quite versatile in use, our voodoo bulb. Well, at this point we still owe you the solution of the myth that garlic helps against vampires:

The allegedly great aversion of vampires to garlic stems from a theory that vampires have an extremely sensitive nose. And since garlic is rather odor-intensive, vampires avoid it like the plague. Another thesis says vampires have porphyria, an illness, which is characterized by insufficient hemoglobin (responsible for the red color of the blood) production and thus, making the skin pale and sensitive to light. The enzyme P450 is responsible for the degradation of hemoglobin. Garlic contains large quantities of this enzyme, which is the reason for its blood diluting characteristics. That's why garlic seems harmful for an already blood-damaged vampire, hence showing the deterrent effect on the undead. Granted, perhaps not that essential to know, but the much more important is our message to you as follows:

Of course, we at Delacon don't believe in fairy tales and vampires, but we do **strongly believe in the power of mother nature** and its **plant universe**. A universe, in which garlic already represents a bright star regarding research and development of phytogetic feed additives. And we even go one step further, we prove the beneficial effects of natural derived substances in animal nutrition and thereby **replace believe by knowledge** – this is what distinguishes us as market leader in **phytoGENICS**.

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