# Nutritional benefits of Garlic

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*Is the 10-minute garlic rule a myth ?*

# Contents

# 1 What is garlic ?

Garlic is a plant widely used in everyday cooking, with a culinary and medical history (more than 5000 years ago at least). Its main use is spicing up a meal or being straight up a cheat code to give some flavor to a dull, boring and sad meal, such as a homemade student pasta plate (with some extra virgin olive oil, yummy...).

Garlic is the subject of various studies in the functional food industry thanks to its exceptional bioactive constituents and functional ingredients that contribute to its medicinal properties [35].
Garlic is composed of allicin, DAS (diallyl sulfide), DADS (diallyl disulfide) and DATS (diallyl trisulphide), which have been the subject of extensive scientific investigation due to their notable therapeutic effects [35]. Let's call the latter trio "**DDD**".
SAC (S-allylcysteine) is a bioactive compound that has a lot of health benefits. SAC is generated during the breakdown of allicin during aging or processing [35]. It has been showed that black garlic has 6 times more SAC than fresh garlic. [35]

# 2 Nutritional contents and health benefits of garlic

## 2.1 Vitamin B6

### 2.1.1 Vitamin B6 in general

Garlic contains Vitamin B6 [35], which is shown to have positive effects for brain development, mental health and mood [26], and keeping the nervous system and immune system healthy. Seizures, migraine, chronic pain and depression have been linked to vitamin B6 deficiency. [26]

### 2.1.2 Vitamin B6 and Homocysteine

Homocysteine is an amino acid in the blood that helps create proteins [1] [32]. Some vitamins, including Vitamin B6, break down homocysteine to generate other chemicals your body needs [1]. If there is not enough of these vitamins, then the breakdown does not happen enough.
Thus, high homocysteine (also called "hyperhomocystenaemia") levels can lead to issues such as feeling dizzy, muscle weakness, sore tongue, fatigue, skin color change, heart attack, stroke [1], inducing Alzheimer's and other forms of dementia [26].

## 2.2 Vitamin C

Vitamin C is mostly known to be present in citrus fruits, like oranges or lemon. Vitamin C deficiency is often associated with the scurvy disease (AKA "Scorbut", the one that pirates had).
Garlic contains Vitamin C [35], a powerful antioxidant that can help in scavenging free radicals*.
Vitamin C also assists the intestines in iron absorption.

## 2.3 Manganese

Manganese (Mn) is an essential nutrient : the body needs it but cannot produce it on its own, thus it must be consumed, but is toxic in excess [20]. It is widely accessible (milk, legumes, rice, nuts, whole grains, seafood, seeds, chocolate, tea, leafy green vegetables, spices, pineapple etc. [20]) so it's kinda hard to have a manganese deficiency. Adult humans absorb approximately 3–5% of ingested Mn.
Manganese plays a role in macronutrient metabolism, bone formation, reproduction, immune function, regulation of blood sugar [20], neurotransimitter synthesis and scavenging free radicals [16].
Garlic contains a wide amount of manganese.

## 2.4 Allicin

### 2.4.1 Allicin as a garlic component

Allicin is a defensive component that gives garlic its taste and smell. Allicin decomposes in the stomach after raw garlic is consumed [35] releasing multiple components associated with the smell of garlic. Allicin is known for its antimicrobial, anti-inflammatory, and antioxidant properties [35]
Allicin is responsible for the distinctive odor of garlic, contributes to several of its therapeutic effects,

and is recognized as the bioactive compound that has attracted considerable scientific attention due to its powerful bioactivity [35]. As a result of its inherent instabilities, allicin undergoes rapid conversion into DDD [35].

### 2.4.2 The 10-minute garlic rule

The 10-minute garlic rule states that in order for allicin to be produced after chopping, slicing or crushing garlic, you have to wait 10 minutes before cooking your garlic. Now, is there evidence to back it up or is it a urban legend ?

Garlic cloves are odor-free until crushed [15]. From the American Institute of Cancer Research [2], allowing your freshly chopped garlic to sit for 10 minutes gives time for allicin to develop from a protein called "allin" and a heat-sensitive enzyme called "alliinase" (yes there are two consecutive "i") .
Several studies on the influence of heating on the anti-cancer properties of garlic [34] [33] [3] showed that heating garlic for just 60 seconds in the microwave or 45 minutes in an oven removed these anticancer properties. However, letting the garlic sit for 10 minutes after chopping prevented the total loss of the sought anticancer properties.

If alliinase is deactivated or destroyed due to heat, then allicin cannot form and you lose the nutritional benefits of allicin.

## 2.5 Selenium

Selenium is a mineral and an essential nutrient : the body needs it but does not produce it on its own, thus selenium must be consumed.
Selenium is an antioxidant, which means it prevents cell damage from free radicals* that cause oxidative stress*.
Selenium also plays an important role in the synthesis of proteins called "Selenoproteins" (the name of the nutrient is literally in the protein). Selenoproteins are a crucial factor in the creation in DNA. Plus, the thyroid (the organ which controls the speed of your metabolism, i.e. the speed at which your body transforms food into energy, by releasing certain hormones [38]) is the organ with the most selenoproteins. They can also help in preventing atherosclerosis*, neurodegeneration, viral infections and promoting healthy embryonic nervous system and immune system [38].

Other functions of selenium include protection of the effects of heavy metals in the body [38], testosterone synthesis and normal development of spermatozoa for men [38], miscarriage risk reduction for women [38]
Fortunately, garlic comes with selenium [35] [38].

## 2.6 Flavonids

Flavonoids are various compounds found naturally in many fruits and vegetables.
Garlic contains several flavonoids, with many benefits for our health : quercetin, kaempferol and apigenin [35].

### 2.6.1 Quercetin

Quercetin is a phytochemical with antioxidant and neuroprotective activity. It was observed to normalize carbohydrate (les glucides) metabolism by inhibiting (= slowing down) glucose absorption from the gastrointestinal tract, regulating insulin secretion and improving insulin sensitivity in tissues.
Quercetin is also found in matcha.

### 2.6.2 Kaempferol

Decrease in breast cancer, bone cancer and cervical cancer has been linked to the consumption of veggies and fruits, and the corresponding chemoprotective effect has been associated with the presence of several active molecules, such as kaempferol [21].

Kaempferol has antimicrobial, anti-inflammatory, antioxidant, antitumor, cardioprotective, neuroprotective, antidiabetic activities, anti-osteoporotic, anxiolytic (i.e. good against anxiety disorders) and analgesic (i.e. decreases/relieves pain) properties [25], and is being applied in cancer chemotherapy. Kaempferol-rich food has been linked to a decrease in the risk of developing skin cancer, liver cancer and colon cancer [21].

Kaempferol has been reported to help with apoptosis (the normal and planned death of cells), angiogenesis (new blood vessels form from pre-exising vessels), inflammation, and metastasis (cancer spreads out to another location). Significantly, kaempferol inhibits cancer cell growth and angiogenesis and induces cancer cell apoptosis [17].

Kaempferol can be found for instance in beans, broccoli, cabbage, chia seeds, chives, cumin, endive, fennel, tomatoes, strawberries, grapes, apples, and of course garlic [21] [25].

#### 2.6.3 Apigenin

Apigenin is a common dietary flavonoid that is abundantly present in many fruits, vegetables and Chinese medicinal herbs [37].

Apigenin has anti-inflammatory, anti-toxicant, anti-cancer [14], antioxidant, antibacterial, antiviral activities and blood pressure reduction properties [37]. Clinical trial studies suggested that apigenin is a potent therapeutic agent to overcome diseases such as rheumatoid arthritis*, autoimmune disorders, Parkinson's disease, Alzheimer's disease, AIDS, and various type of cancers like prostate cancer or liver cancer [14].

Apigenin is found in garlic, parsley, onions, celery, thyme, spinach, basil, oranges, etc.

### 2.7 Cholesterol reduction

Numerous studies suggest that garlic lowers total cholesterol concentrations by approximately 10% [4]. SAC efficiently lowered cholesterol production by up to 55% [35][24] and DDD can also do it depending on their concentration [24].

### 2.8 Diabetes risk reduction

Consumption of garlic and its supplements reduces the risk of diabetes [35].

### 2.9 Immune system boost

DDD and allicin inhibit the growth of bacteria [35][15], viruses [15], fungi [35][15], parasites (Entamoeba histolytica in the big intestines with 100 000 people infected and there is no vaccine, and Giardia lamblia which can lead to diarrhea or vomitting) [15] and has anti-aging properties [35].

### 2.10 Blood pressure regulation (anti-hypertensive)

Several factors, such as blood pressure, contribute to the development of atherosclerosis* [28] or lead to an heart attack or a stroke (World Health Organization).
Garlic's SAC and DADS can induce a reduction of blood pressure [35] by 5-7% [4].
Allicin can also contribute to reducing blood pressure by limiting the production of an hormone that increases blood pressure [5][27] (the hormone is called "angiotensin II")

### 2.11 Free radicals scavenging

Allicin acts as an antioxidant that neutralizes free radicals* [35].

### 2.12 Anti-inflammatory properties

Allicin and DDD show anti-inflammatory effects by inhibiting mediators of inflammation* [35].

### 2.13 Anti-cancer

Consumption of garlic may decrease the risk of cancer [35] such as stomach cancer, colon cancer [36] and breast cancer [40]. For stomach cancer, a study found out that people who consumed 20 g of garlic a day had 13 times less chance to die from stomach cancer compared to people who only consumed 1 g of garlic per day [19][39].
For colon cancer, a study on 40 000 women in the Iowa Women's Health Study showed a reduced risk of colon cancer for those who consumed garlic more than once a week [19].

### 2.14 Anti-hepatotoxic (Liver preservation)

Antihepatotoxic is the ability of a substance to reduce or prevent damage to the liver. This long word comes from "hepatic" which means "related to the liver" (example : hepatic disorder = liver disease). SAC, present in garlic, has antihepatotoxic properties [35].

### 2.15 Mortality risk reduction

A 2019 chinese study on more than 27 000 old people [31] associates an habitual consumption of garlic with a lower all-cause mortality risk, which can advocate for a better longevity when consuming garlic.

### 2.16 Neurotrophic properties

SAC has neurotrophic properties [35], which means it helps in the growth, survival and function of neurons.

### 2.17 Heavy metals (lead) detoxification

A study [23] on 117 car battery workers which are consistently exposed to lead (le plomb) showed that garlic can be recommended to treat mild to moderate lead poisoning.

### 2.18 Bone health preservation

A clinical trial [13] on menopausal women showed that garlic can reduce oxidative stress, the latter may lead to osteoporosis*, which is one of the most prevalent metabolic diseases at higher ages [13].

## 3 Aged garlic extract (AGE)

AGE is garlic slices soaked in ethanol for up to 20 months. The majority of irritating taste and odor is eliminated and the antioxidant profile in the resulting AGE changes [30].
A study [29] on 120 healthy people for 90 days showed that the AGE group reduced cold and flu severity, with a reduction in the number of symptoms, the number of days participants were "functionning suboptimally", and the number of work/school days missed. These results suggest that AGE supplementation may enhance immune cell function and may be partly responsible for the reduced severity of colds and flu reported. The results also suggest that the immune system functions well with AGE supplementation, perhaps with less accompanying inflammation.

### 3.1 Alzheimer's prevention

AGE can help in preventing Alzheimer's disease [30].

### 3.2 Parkinson's prevention

AGE can help in preventing Parkinson's disease [30].

### 3.3 Huntington's disease prevention

Huntington's disease causes nerve cells in the brain to decay over time. The disease affects a person's movements, thinking ability and mental health.
AGE can help in preventing Huntington's disease [30].

### 3.4 Brain ischemia prevention

Cerebral ischemia, also called "brain ischemia", is a condition where there isn't enough blood flow to the brain to meet the metabolic demand.
AGE can exhert neuroprotective effects on cerebral ischemia [30].

## 4 Conclusion

Garlic has been shown to have a wide variety of health benefits. It can be a nice addition to every meal to spice up the flavor, and if you do add garlic, it is recommended to slice/chop/whatever it 10 minutes before cooking it to extract as much health benefits as possible.

# 5 Glossary

**Atherosclerosis**

An atheroma (or plaque) is a fatty material composed of cholesterol, proteins, calcium, inflamatory cells and other substances that builds up in the arteries, which means atheroma clogs your artery. The disease associated with that is called **atherosclerosis**.
Atheroma grows over time and can result in coronary artery disease (the main individual cause of death and morbidity in industrialized countries [18]), peripheral artery disease (condition in which narrowed arteries reduce blood flow to the arms or legs), heart attack or stroke [6].

**Free radicals**

Free radicals are unstable molecules that can damage the DNA inside cells if they build up. They may play a role in a range of diseases and the visible signs of aging [7].

**Inflammation**

Inflammatory response is part and parcel of many diseases. It may lead to the production of excessive amounts of substances promoting the production of reactive oxygen species, which can damage cell structures and lead to long-term disruption in the functioning of the body as a whole, as well as playing signalling functions promoting inflammation [22].

**Osteoporosis**

Osteoporosis silently weakens your bones, which can make you more likely to experience a bone fracture [8] : it causes your bones to become weak and brittle [9] . This condition occurs when the production of new bone is not keeping up with the loss of old bone [9].

**Oxidative stress**

Oxidative stress is an imbalance of free radicals (Reactive Oxygen Species*) and antioxidants in the body that leads to cell damage. It plays a role in many conditions like cancer, Alzheimer's disease and heart disease. It can also make your body "feel older" than it is. Foods rich in antioxidants can reduce oxidative stress, whereas toxic molecules (such as the ones found in cigarette smoke or pollution) can cause oxidative stress [10]

**Reactive Oxygen Species**

Reactive oxygen species (ROS) are created during stressful situations : environmental pollution, cigarette smoke, improper diet, chronic psychological stress, very intense and prolonged physical exertion, UV radiations from the sun etc.
Consequences include illnesses such as diabetes, atherosclerosis, neoplastic disease (abnormal mass of tissue that forms when cells grow and divide more than they should or do not die when they should [11]), neurodegenerative diseases or the aging of the organism [22].

**Rheumatoid arthritis**

Rheumatoid arthritis happens when the immune system attacks its own body's tissues by mistake. It is a chronic condition that causes pain, swelling and irritation (i.e. inflammation) in the joints. But it also can damage other parts of the body like the skin, eyes, lungs, heart and blood vessels [12].

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