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a phytotherapist's perspective

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Major Oral Applications of Whole Garlic & Standardised Garlic Extract

Key Points at a Glance

Applications

- circulatory stimulant and antiseptic; historically documented use for plague, cholera, dysentery
- clinically demonstrated to:
  - modestly reduce total cholesterol, mainly by reducing triglycerides
  - reduce blood pressure
  - decrease aortic stiffness in those over 50 years
  - reduce plaque, intima-media thickness and the atherogenicity of serum in patients with atherosclerosis
  - increase peripheral blood flow
  - inhibit platelet aggregation and blood fibrinogen
  - increase activity of antioxidant enzymes
  - protect against genetic damage, reduce formation of N-nitroso compounds
  - reduce the incidence of acute viral respiratory infections
  - reduce incidence of infection in burn wounds
  - possibly improve bowel flora (conflicting results)
  - show some antifungal activity
  - provide benefit in giardiasis and worm infestation (small studies)
  - improve immune function in healthy volunteers
  - reduce the severity of hepatopulmonary syndrome
  - reduce lead toxicity
  - provide benefit in osteoarthritis (preliminary, adjunctive treatment) and rheumatoid arthritis

- epidemiological studies show protection for some types of cancer
- possibly improve liver enzymes in alcoholic liver damage (preliminary results)
- constituents found to support phase I/II enzyme activity (experimental models), which adds weight to a chemopreventive activity for Garlic

Constituents & Quality

- many products with varying constituents
- fresh and carefully dried Garlic cloves contains organic sulfur compounds, especially alliin
- under certain conditions alliin converts to the active allicin
- poor manufacture of tablets may result in little or no release of allicin in the intestine
- allicin release can be measured and is the most reliable guide to quality of dried Garlic products
- variation in some clinical results may be due to inadequate allicin release

Safety

Garlic has antiplatelet activity and ingestion needs to be stopped prior to surgery. The effect is likely to be dose dependent and combination with antiplatelet drugs should be monitored.

Traditional Use

Garlic has been used in western herbal medicine as a diaphoretic, expectorant, antiseptic (particularly for the respiratory system), anthelmintic and diuretic. Its major indications include chronic bronchitis, respiratory catarrh, recurrent colds, influenza, whooping cough and asthma.[1,2] It is also described as a 'stimulant',[1] probably meaning circulatory stimulant, as according to traditional European naturopathy, Garlic is an agent that increases perfusion,[3] and Garlic is used traditionally in France in the treatment of circulatory disorders.[4] Writing in the 1st century AD, Dioscorides noted that Garlic "clears the arteries and open[s] the mouths of the veins".[5]

The anti-infective property of Garlic was well known throughout history. Paracelsus (1493-1541) prescribed it as an antidote for plague.[6] It is said to have protected people from the infection during the Great Plague of London in 1665, the 1721 epidemic in Marseilles and the outbreak in 18th century London.[6,7] Garlic was used as a remedy in 1848 when a cholera epidemic broke out in Bulgaria.[8] Soldiers whose diet included Garlic suffered less frequently from dysentery than their World War I comrades who did not eat Garlic.[6] Garlic was also used for this purpose during World War II by the countries of Eastern Europe.[7] Dr Albert Schweitzer (1875-1965) used Garlic to treat amoebic dysentery, typhus, cholera and intestinal worms.[6,9,10]

Constituents & Products

The main compounds in Garlic cloves are the organic sulfur compounds. Of these, the most important is alliin. When a Garlic clove is crushed, or when dried Garlic powder gets wet, the odourless alliin is broken down by the enzyme alliinase. Alliin is converted to allicin (an odorous compound). Allicin is relatively unstable and other constituents are produced, such as ajoenes, vinyldithiins and polysulfides. The sulfur-containing constituents are responsible for the characteristic smell of Garlic.[11,12]

A number of Garlic products are available commercially: dried Garlic powder, aged Garlic extract, steam-distilled Garlic oil, other solvent-extracted Garlic oils, Garlic oil macerate. The composition of these products, and therefore their therapeutic activity, varies. Aged Garlic extracts do not contain allicin.[11]

The issue of manufacture is important when considering dried Garlic powder products.[6,13]
- Garlic needs to be dried carefully to preserve the alliin and allinase.
- Because stomach acid can degrade alliinase (thus reducing the production of allicin from alliin), Garlic powder products should be enterically coated. Enteric coating is acid resistant. When enterically coated, the tablet survives intact and enters the intestine.
- If the tablet is correctly coated and able to break down in the non-acidic environment of the small intestine within a specified time limit, the enzymatic reaction can occur: allicin is produced and can be absorbed in the large intestine.
- The tablet, if incorrectly coated and/or affected by other factors leading to slow disintegration, may not produce allicin.
- Other factors may affect the amount of allicin released e.g. whether tablets are consumed with or without food, the protein content of the meal.
- Allicin release from Garlic tablets can be measured under simulated gastrointestinal conditions (a calibrated laboratory test method).

Pharmacological Activity

Garlic has a wide range of pharmacological activities, most of which are described in the Clinical Studies section. This includes the effect on antioxidant enzymes and a potentially chemopreventive effect. Experimental studies indicate that metabolites of Garlic inhibit phase I metabolism (potentially inhibiting activation of certain carcinogens) and enhance phase II detoxification by inducing enzymes such as glutathione S-transferase, quinone reductase and epoxide hydrolase. Diallyl sulfide, diallyl disulfide and diallyl trisulfide are formed in the body from allicin and other thiosulfinates.[14] Most of the studies found induction of phase II enzymes in the liver, although an increase in activity has also been observed in other tissues including stomach and intestine. Although most studies used very high doses of these sulfides, in one study, significant effects on enzyme activity were observed at dose levels similar to that which could be obtained from high dietary intake of Garlic in humans.[15]

Clinical Studies

The clinical research findings are restricted to that of fresh Garlic and Garlic powder. Many of the trials used products standardised for allicin content although the allicin release was not measured or is unknown.

In 2001 allicin release of the most frequently trialled brand of standardised Garlic tablet was tested for batches dating from 1989 to 1997. Older batches (before 1993) released significantly more allicin than product made later (after 1993). The negative results found in later trials may have been influenced by the inadequate release of allicin.[16]

Blood Lipids

An analysis of randomised, double-blind, placebo-controlled trials to November 2007 found that Garlic had an impact on blood lipids. The meta-analysis included 29 trials that evaluated a range of products. Subgroup analysis found the effect on total cholesterol was greater for one brand (the most common) of standardised Garlic extract (15 trials): a reduction of 0.30 mmol/L (11.6 mg/dL). The dosage that produced this effect was not given. For these trials diet modification occurred in 6 trials. The **modest effect on total cholesterol** was due mostly to reduction in triglycerides, without substantial effect on low-density lipoprotein (LDL) or high-density lipoprotein (HDL) cholesterol. Considering trials of all products, studies lasting greater than 12 weeks tended to have greater effects than those of shorter duration, and the hypocholesterolaemic effect of Garlic was greater when dietary control was not used.[17]
- One of the trials used an enteric-coated Garlic powder validated for allicin release (providing 9.6 mg/day). Treatment over 12 weeks caused a significant reduction in LDL-cholesterol and total cholesterol in mild to moderate hypercholesterolaemic patients on a low fat diet. These results were also significantly different from placebo. LDL-cholesterol decreased by 6.6% (0.44 mmol/L (17.0 mg/dL)).[18]

Several randomised, double-blind, placebo-controlled trials have been published since this meta-analysis.
- Slow-release, standardised Garlic tablets significantly decreased serum total cholesterol from baseline after 8 and 12 weeks in men with mild hypercholesterolaemia. The difference was significantly different from the placebo group at 12 weeks. Levels of low-density and high-density cholesterol also improved. The Garlic tablet is said to be standardised for allicin (providing 7.8 mg/day).

Patients were placed on a low fat diet prior to receiving treatment.[19]

- Slow-release, standardised Garlic powder tablets significantly decreased serum low-density cholesterol from baseline after 12 months in patients with coronary heart disease and hypercholesterolaemia. The difference was significantly different from the placebo group at the end of treatment.[20]
- Slow-release, standardised Garlic powder tablets significantly **decreased serum triglycerides** from baseline after 3 and 4 weeks in type 2 diabetics. Other lipids were unchanged. Lipid levels were unchanged in the placebo group. All participants were placed on a standard diet for diabetics.[21]

A small, randomised trial conducted in Iran found a greater reduction in serum triglycerides and total cholesterol in hyperlipidaemic patients treated over 8 weeks with standardised Garlic tablets than in those treated with the drug clofibrate.[22] A randomised trial conducted in Germany in the early 1990s found similar efficacy for Garlic compared to bezafibrate in patients with hyperlipidaemia, treated for 12 weeks and adhering to a low fat diet.[23]

Lipid Peroxidation

Mixed results have been found in clinical studies for the effect of Garlic on lipid peroxidation (as measured by plasma malonaldehyde and LDL lag time). The most specific test (F_2-isoprostanes) has not been conducted using raw Garlic or standardised powder.[24-32] The most reliable assessment, which measured levels of antibodies to oxidised LDL found no effect in moderately hypercholesterolaemic patients (randomised, placebo-controlled trial; standardised Garlic powder).[26] (*See also the preeclampsia study in Blood Pressure section*. Uncontrolled lipid peroxidation may be an aetiological factor in the condition.)

Blood Pressure

A systematic review of randomised, double-blind trials conducted to the end of June 2008 found that Garlic **reduced systolic blood pressure** (SBP) by 16.3 mm Hg and diastolic by 9.3 mm Hg compared with placebo in patients with elevated systolic blood pressure (greater than 140 mm Hg). However, use of Garlic did not reduce blood pressure in patients with normal systolic blood pressure. This meta-analysis was quite rigorous as it only included trials that reported blood pressure endpoints and baseline SBP.[33] The three trials involving hypertensive patients used the same Garlic product (water extracted). Dosage ranged from 600 to 900 mg/day of Garlic dried extract, made from 1.8 to 2.7 g/day of fresh Garlic, and standardised for alliin content, although the allicin release is not known.

Administration of Garlic powder tablet during the third trimester of pregnancy reduced the occurrence of hypertension but did not prevent preeclampsia. The Iranian trial was randomised, single-blind, placebo-controlled in design with the tablets said to provide 2 mg/day of allicin.[34]

Arterial Stiffness

Garlic was found to decrease the **age-related increases** in aortic stiffness (measured by a significant decrease in pulse wave velocity and elastic vascular resistance) in healthy volunteers (50–80 years) compared to controls. Regular intake of standardised Garlic powder tablets was defined as more than 2 years, although the average was 7.1 years.[35] An effect was not however observed in a randomised, double-blind, placebo-controlled trial, in which Garlic powder tablets were administered for 12 weeks to healthy volunteers aged 40–60 years. The daily dose of alliin was estimated at 10.8 mg by chemical analysis (corresponding to about three cloves),[36] although allicin release was not determined.

Atherosclerosis

Two hundred and six men (40–74 years old), asymptomatic but with carotid atherosclerosis, were randomised to receive slow-release, standardised Garlic powder tablet or placebo in a double-blind trial. The rate of progression of carotid atherosclerosis was measured as the increase in carotid intima-media thickness (IMT) of the far wall of left and right common carotid arteries, using ultrasonography. They were treated for 2 years with examination every 6 months. A significant difference in IMT changes between the groups was observed at 12 months. A decrease in **intima-media thickness** of 0.022 mm per year occurred in the Garlic-treated group compared to an increase in IMT of 0.014 mm per year in the placebo group (p < 0.05).[37,38]

Treatment with standardised Garlic powder tablets over a 4-year period significantly reduced the increase in atherosclerotic plaque volume by 6–18%. In some cases there was a **slight regression of plaque**. The randomised, double-blind, placebo-controlled trial involved 152 patients with advanced atherosclerotic plaques and at least one atherosclerosis risk factor. Plaque volumes in the carotid and femoral arteries were measured by ultrasound.[39]

A double-blind, placebo controlled trial in 1996 involving coronary artery disease patients demonstrated that treatment with standardised Garlic powder tablets reduced the **atherogenicity of serum** and LDL isolated from blood, using *ex vivo* assays. The atherogenicity of serum obtained from patients taking placebo remained unchanged.[40]

Blood Flow, Peripheral Arterial Disease

Several studies have shown that Garlic increases **blood flow to the periphery** in healthy volunteers and patients.[3,41-45] Several of these were single-dose studies. In the other trials:

- circulation to the skin increased (placebo-controlled trial; standardised Garlic powder tablet, for 4 weeks);[42]
- blood flow through the calf muscle increased (small, controlled trial; enteric-coated standardised Garlic powder tablet, 1.8 mg/day of allicin for 7 days);[45]
- vasomotor function was unchanged in patients with systemic sclerosis (randomised, double-blind, placebo-controlled trial; standardised Garlic powder tablet, for 7 days).[3]

An increase in walking distance (46 m) was observed in the fifth week of treatment with Garlic tablets (enteric-coated, standardised powder) in patients with peripheral arterial occlusive disease (stage IIa Fontaine). The placebo group increased their walking distance by 31 m. Both groups received physical therapy twice a week.[46] The change from baseline was significant, but the difference between the two groups was not.[46,47]

Antiplatelet & Antithrombotic Activity

Risk factors for cardiovascular disease include decreased fibrinolysis, decreased blood clotting time and increased platelet aggregation. The effect of Garlic in a range of patients is outlined in Table 1.

A decrease in fibrinogen concentration and/or an increase in fibrinolytic activity **decrease clotting**. Reducing platelet aggregation may be of benefit in conditions where there is impaired blood flow or perfusion such as systemic sclerosis. Several methods were used to measure fibrinolytic activity, which may have affected the consistency of results. Euglobulin clot lysis time (a test of fibrinolytic activity) is influenced by circadian variations, and this needs to be taken into consideration. An effect was not observed in preeclampsia. (In this condition it was thought that oxidative stress may affect platelet aggregation and clotting.)

In addition to having a beneficial effect on disordered function, Garlic may also affect platelet function in the normal or healthy state. The majority of clinical studies indicate an antiplatelet effect for Garlic in healthy volunteers. Excluding single dose or very high doses, Garlic:

- inhibited platelet aggregation (8 g/day, fresh Garlic providing 35 mg/day of allicin from 88 mg/day of alliin; no effect for boiled Garlic);[48]
- inhibited platelet aggregation, increased tissue plasminogen activator activity, but produced no change in total euglobulin fibrinolytic activity (standardised Garlic powder tablets);[49]

- reduced serum thromboxane B2 – indicative of inhibition of platelet aggregation *in vivo* (one fresh clove: about 3 g/day);[50]
- had no effect on platelet function, including platelet aggregation (4.2 g/day, fresh Garlic).[51]
- increased fibrinolytic activity and clotting time (10 g/day, fresh Garlic);[52]
- increased fibrinolytic activity, but had no effect on whole blood coagulation time (5 g/day, fresh Garlic).[53]

There are case reports of increased bleeding with high Garlic intake,[54-57] and increased international normalised ratio and clotting times when taken with warfarin (Garlic oil, Garlic tablets; dosage undefined).[58] A clinical trial with healthy volunteers found no effect for Garlic (enteric-coated standardised tablets equivalent to 4 g/day of fresh Garlic) taken with warfarin.[59]

Cancer & Antimutagenic Activity

A substantial body of epidemiological data to November 2007 has not found sufficient evidence of a chemopreventive effect for dietary intake of Garlic. More rigorous studies are required.[60,61]

- Considering the most rigorous studies and excluding those that assessed supplements: three studies reported a decrease in colon cancer risk with Garlic intake, while another four studies found no association.[61]
- One small study, of high methodological quality found that intake of Garlic **reduced the risk** of oesophageal, larynx, oral, ovary and renal cell cancer.[61]
- Intake of Garlic has not been found to reduce risk of breast, prostate, lung, endometrial or gastric cancer.[61]

In epidemiological research published since this review, dietary intake of Garlic:

- had a protective effect for intake of Garlic on the risk of endometrial cancer;[62]
- had a protective effect on the risk of prostate cancer;[63]
- was inversely associated with the occurrence of colorectal polyps.[64]

A small clinical study concluded that consumption of raw Garlic may **protect against genetic damage** induced by exposure to polycyclic aromatic hydrocarbons. The addition of raw Garlic to participant's diet (3 g/day in salad for 8 days) reduced the level of benzo[a]pyrene-DNA adducts in peripheral blood lymphocytes treated *ex vivo* with benzo[a]pyrene. (A reduction, albeit smaller, was also observed during the period in which the salad was consumed without the Garlic.)[65]

Patients	Trial Details	Results	Ref
peripheral arterial occlusive disease	randomised, double-blind, placebo-controlled; standardised Garlic powder tablets, 12 weeks	decreased platelet aggregation*, plasma viscosity	[46]
cerebral atherosclerosis	double-blind, placebo-controlled, crossover; standardised Garlic powder tablets, duration not known	inhibited platelet aggregation, reduced blood fibrinogen, normalised initially low fibrinolytic activity	[66]
coronary heart disease	uncontrolled; standardised Garlic powder tablets, 12 weeks	decreased blood fibrinogen	[67]
coronary artery disease and hyperlipidaemia	uncontrolled; standardised Garlic powder tablets, 4 weeks	decreased blood fibrinogen, increase in fibrinolysis, no effect on platelet aggregation, nonsignificant decrease in prothombin time	[68]
hyperlipidaemia	randomised, double-blind, placebo-controlled; dried Garlic tablet; 6 weeks	no effect on fibrinolytic activity, levels of fibrinogen or fibrin split products, prothrombin time, whole blood coagulation time	[69]
hypertension	controlled; Garlic powder (1 g/day = 4 cloves/day), 14 days	inhibited platelet aggregation	[70]
preeclampsia	randomised, single-blind, placebo-controlled; Garlic powder tablets, during third trimester	no effect on platelet aggregation	[34]
cerebrovascular risk and constantly increased spontaneous platelet aggregation	double-blind, placebo-controlled; standardised Garlic powder tablets, 4 weeks	inhibited platelet aggregation*, decreased plasma viscosity	[42,71]
chronic myeloproliferative disorders	antiplatelet agents investigated including "odourless" (undefined) Garlic prescribed to 5 patients alone or combined with clopidogrel	reduced platelet hyperactivity to normal or hypoactive	[72]
systemic sclerosis	randomised, double-blind, pilot; standardised Garlic powder tablets, 7 days	inhibited platelet aggregation	[3]
diabetes	controlled; Garlic powder (1 g/day = 4 cloves/day), 14 days	inhibited platelet aggregation	[73]

Table 1. Clinical studies of the effect of Garlic on platelet aggregation, fibrinolysis and other parameters in patients.

* These studies measured spontaneous platelet aggregation, in other studies platelet aggregation induced by agonists (aggregating agents) was measured.

In a controlled single-dose study with healthy Chinese volunteers, 5 g/day of blended fresh Garlic reduced the amount of N-nitrosoproline in urine generated from oral doses of sodium nitrate and proline.[74] This suggests that Garlic may be able to reduce the **formation of N-nitroso compounds**, which are potentially carcinogenic. (Nitrite can react with amines in the stomach to form N-nitrosamines.)

Antioxidant Enzymes

In uncontrolled trials, administration of Garlic:
- increased the activity of superoxide dismutase and glutathione peroxidase in erythrocytes; there was no effect on catalase (0.1 g/kg body weight per day, for one month; healthy volunteers);[24]
- increased the glutathione concentration in circulating erythrocytes, and produced a decreasing trend for the ratio of oxidised glutathione to total glutathione which is indicative of decreased **oxidative stress** (standardised Garlic powder tablets, 2 months; healthy volunteers);[30]
- improved antioxidant enzymes in erythrocytes of newly diagnosed diabetic patients (3.6 g/day raw Garlic, 30 days),[32] and patients with alcoholic liver disease (2.4 g/day raw Garlic, 45 days).[31]

Respiratory Infections

In a randomised, double-blind trial, slow-release standardised Garlic powder tablets reduced the incidence of **acute viral respiratory infections** in children, 1.7-fold compared to placebo and 2.4-fold compared to those treated with dibazole (immune modulating drug). The trial was conducted over 5 months.[75]

Antibacterial Activity

A randomised trial in Iran assessed the efficacy of orally administered fresh Garlic to control *Pseudomonas aeruginosa* infection in burn patients. The treatment group received two crushed Garlic cloves mixed with yoghurt with their daily lunch meal, while the control group received plain yoghurt. All patients received standard medical care for burn wounds. After the first week of hospitalisation, for those with burn sizes of less than 45% of total body surface area (TBSA), significantly fewer patients developed a **burn wound infection** in the Garlic group compared to the control group. Garlic did not reduce infections in those with a higher TBSA.[76]

Addition of fresh Garlic purée (1 g, twice a day for 3 weeks) to antibiotic drug therapy resolved a case of multidrug-resistant *Pseudomonas aeruginosa* pneumonia and bacteraemia.[77]

Standardised Garlic products have not been efficacious for the treatment of *Helicobacter pylori* infection, either given alone or in conjunction with omeprazole. These trials ran for 4 and 8 weeks.[78,79] A case-control study of a Turkish population found that Garlic intake for not less than 5 years did not affect the prevalence of *H. pylori* infection.

However, Garlic consumers had a significantly lower average antibody titer than those not consuming Garlic. (Immunoglobin G titers are demonstrated to fall by 20–30% after treatment of *H. pylori* and decrease to 50% or less at 6 and 12 months.) This suggests that Garlic intake might exert an indirect inhibitory effect on the reproduction of *H. pylori* and possibly progression of the infection to peptic ulcer disease.[80]

Bowel Flora

A 1941 publication describes investigations into the effect of Garlic on intestinal flora.[81] Twenty-two patients with a history of **gastrointestinal disorders** were divided into 3 groups: control (no treatment, 10 weeks), group A (no treatment for 3 weeks, followed by 7 weeks of Garlic) and group B (no treatment for 3 weeks, followed by 4 weeks of Garlic). Dried Garlic was administered in tablet form three times daily and corresponded to an equivalent of 114 grains (just over 7 g) of fresh Garlic per day.

- All those receiving Garlic reported a marked improvement in their general condition. A beneficial effect was observed on intestinal flora, favouring an increase in the aciduric flora (bacteria that tolerate an acid environment, e.g. Lactobacillus).
- Garlic suppressed the population of *Bacillus proteus* and possibly related putrefactive bacteria, and tended to increase gram positive bacteria.
- Headaches, present in 4 patients prior to the beginning of the study were relieved following one week of Garlic treatment. Two patients who displayed mild but persistent diarrhoea prior to treatment returned to normal stools on the ninth and tenth days after initiation of Garlic.

Another study is described in this publication:[81] Garlic for the treatment of functional diarrhoea without specific intestinal lesions.

- Intestinal symptoms were usually entirely relieved and the stools became normal.
- Bacteriological examination showed that as the stools became normal and symptoms were relieved the pathogenic gram positive bacteria disappeared and the normal gram negative flora predominated.

In a more recent study, administration of dehydrated Garlic powder (3 g/day) to healthy volunteers for 90 days had no effect on faecal bacteria counts. Volunteers' diets were not controlled. There were no details provided about the quality of the Garlic product.[82]

Antifungal Activity

A small group of patients with cryptococcal meningitis in Singapore (1978–1981) were successfully treated with amphotericin B (intravenous), 5-fluorocytosine (oral) and Garlic tablets (oral).[83]

Crushed and filtered fresh Garlic was orally administered to healthy volunteers. Anticandidal and anticryptococcal activity was detected for serum at 0.5 and 1 hours after ingestion. No activity was detected in the urine at any time.[84] The dose was likely to be very high as the volunteers experienced adverse effects including burning (in the mouth, oesophagus and stomach), nausea and light headedness.

Antiprotozoal and Anthelmintic Activity

In children (3–6 years) with giardiasis, treatment with Garlic removed symptoms within 1 day. Within 3 days Garlic had removed all indication of giardiasis from stools. Clinical symptoms improved in children infected with *Hymenolepis nana* (small tapeworm) after 2 days' treatment with Garlic. Stools were **free of parasites** in all patients after the fifth day. The study was conducted in Egypt.[85]

Garlic tablets taken for 20 days were beneficial for the treatment of children infested with *Enterobius vermicularis* (threadworm).[8]

A man infected with the intestinal parasite *Necator americanus* ate raw Garlic mixed with food for 3 periods of 5 days (17.4–18.7 g/period), separated by control periods. A significant reduction in the number of larvae developing in faecal cultures made during a period of Garlic ingestion was observed.[86]

Immune Function

In elderly volunteers administration of standardised Garlic powder for three months **increased phagocytosing** peripheral granulocytes and monocytes when tested *ex vivo* for their ability to engulf bacteria (*Escherichia coli*).[87] Intake of raw Garlic (0.5 g/kg body weight per day for 3 weeks) resulted in an increase in natural killer cell activity *ex vivo* compared to baseline and to controls.[88] Consumption of fresh Garlic (2 g) increased the level of interferon-alpha in the plasma of healthy volunteers. The increase could be maintained for several days. Boiled Garlic was inactive.[89]

Lead Detoxification

The effect of a Garlic supplement on workers in a lead smelter endangered by chronic lead poisoning was investigated in the 1960s in Europe. The number of workers already exhibiting signs of **early lead toxicity** (such as damaged red blood cells) fell by 83% after one to three months of using a Garlic preparation. The level of porphyrin in the urine was decreased, and there was a statistically significant increase in haemoglobin and the number of erythrocytes. Of the workers who were not showing signs of early lead toxicity at the beginning of the trial, 28% of these developed signs after three months compared to only 3% in the group given Garlic.[8]

A more recent clinical trial conducted in Iran found that treatment with capsules of powdered Garlic for 4 weeks was beneficial for mild to moderate lead poisoning. From baseline levels of around 400 microg/L, Garlic **reduced blood lead levels** by 18% (p = 0.025). Those treated with the chelating drug penicillamine experienced a similar reduction (24%; p = 0.002). Clinical improvement was significant in a number of signs and symptoms including irritability, headache, decreased deep tendon reflex and systolic blood pressure after treatment with Garlic but not penicillamine. The frequency of side effects was significantly higher in the drug group. The daily dose was equivalent to 6 g of fresh Garlic and said to provide 3.6 mg of allicin.[90]

Other Activity

Clinical trials (one controlled,[91] two uncontrolled)[92,93] and several case reports[94,95] indicate that Garlic can reduce the severity of **hepatopulmonary syndrome** (a liver disease characterised by abnormalities of arterial oxygenation). Arterial oxygen pressure was increased after treatment.

Two preliminary trials have been conducted in Egypt for **knee osteoarthritis**. Both trials were randomised and 8 weeks in duration. Garlic tablets added to rehabilitation therapy resulted in significantly less pain and improved quadricep function. Garlic compared well to glucosamine in terms of reduced pain and reduced cartilage degeneration.[96,97] A small trial conducted in Russia found an improvement in 87% of rheumatoid arthritis patients who took a Garlic tablet for 4–6 weeks. In the control group receiving only conventional therapy, some parameters changed for the worse.[98]

Raw Garlic (2.4 g/day) improved liver enzymes in **alcoholic liver damage** after 45 days' treatment, although the results are difficult to assess without a placebo comparison. Patients had ceased consuming alcohol. Most strikingly, serum gamma-glutamyltransferase decreased from 226 U/L to 65 U/L.[31]

A cross-sectional study in China found that including Garlic in the diet was protective against the development of **gastric ulcer**.[99]

A conclusive result has not been found in controlled clinical trials for the effect of Garlic on blood glucose or serum insulin in type 2 diabetes.[21,100-102]

Actions

The main actions of Garlic are known from traditional use and the results of clinical studies:
- expectorant, diaphoretic,
- antibacterial, antiparasitic, anthelmintic, possibly immune supporting,
- circulatory stimulant,

- reducing cardiovascular risk factors, including a modest effect on blood lipids and blood pressure, vascular protective, antiatherosclerotic,
- antithrombotic, antiplatelet.

Experimental studies suggest that Garlic has a beneficial effect on phase I and phase II detoxification, an effect that supports an antimutagenic activity for Garlic.

Indications

- Treatment and prevention of age-related vascular changes, coronary artery disease, atherosclerosis.
- Adjunctive treatment for hyperlipidaemia and mild hypertension.
- Treatment and prevention of infections (particularly gastrointestinal and bronchial infections) and intestinal infestation.
- Support detoxification, particularly by enhancing phase II enzymes.
- May support circulation and tissue perfusion, and conditions of reduced arterial oxygenation, such as hepatopulmonary syndrome.
- Part of a protocol to improve bowel flora.
- May provide chemopreventive activity and promote the excretion of heavy metals from the body.

Cautions and Contraindications

Intake of Garlic should be discontinued 10 days prior to surgery. Garlic at doses of more than 3 g/day (fresh weight) may interact with antiplatelet medication. These cautions apply to dietary, as well as supplemental Garlic. Allergy to Garlic has been reported.

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