Protection against *Helicobacter pylori* and Other Bacterial Infections by Garlic

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ABSTRACT Louis Pasteur was the first to describe the antibacterial effect of onion and garlic juices. Historically, garlic has been used worldwide to fight bacterial infections. Allium vegetables, particularly garlic (*Allium sativum* L.) exhibit a broad antibiotic spectrum against both gram-positive and gram-negative bacteria. Noteworthy results published include the following: 1) raw juice of garlic was found to be effective against many common pathogenic bacteria-intestinal bacteria, which are responsible for diarrhea in humans and animals; 2) garlic is effective even against those strains that have become resistant to antibiotics; 3) the combination of garlic with antibiotics leads to partial or total synergism; 4) complete lack of resistance has been observed repeatedly; 5) even toxin production by microorganisms is prevented by garlic. Helicobacter pylori (*H. pylori*) is a bacterium implicated in the etiology of stomach cancer and ulcers. The incidence of stomach cancer is lower in populations with a high intake of allium vegetables. We have demonstrated in vitro that *H. pylori* is susceptible to garlic extract at a fairly moderate concentration. Even some antibiotic-resistant *H. pylori* strains are susceptible to garlic. Clinical trials are necessary to explore the possibility of using garlic as a low-cost remedy for eradicating *H. pylori*.

KEY WORDS: garlic • Allium • antibacterial activity • *Helicobacter pylori*
Garlic is renowned for its antibacterial properties and has been reviewed by Reuter et al. (1996). Garlic has been reported to inhibit Aerobacter, Aeromonas, Bacillus, Citrella, Citrobacter, Clostrium, enterobacter, Escherichia, Klebsiella, Lactobacillus, Leuconostoc, Micrococcus, Mycobacterium, Proteus, Providencia, Pseudomonas, Salmonella, Serratia, Shigella, Staphylococcus, Streptococcus and Vibrio. Noteworthy among the reported findings are the following: 1) Garlic exhibits a broad antibiotic spectrum against gram-positive and gram-negative bacteria (Kabelik and Hejtmankova-Uhrova 1968). 2) Enterotoxic coli strains and other pathogenic intestinal bacteria, which are responsible for diarrhea in humans and animals, are more easily inhibited by garlic than the normal intestinal flora (Caldwell and Danzer 1988, Kumar and Sharma 1982, Rees 1993). 3) Garlic is active even against organisms that have become resistant to antibiotics (Jezewa et al. 1966). 4) The combination of garlic extracts with antibiotics leads to partial or total synergism (Didry et al. 1992). 5) A garlic oil preparation showed good antituberculosis activity in guinea pigs with a intraperitoneal dose of 0.5 mg/kg (Jain 1993). 6) Complete lack of resistance of bacteria to garlic has been found (Dankert et al. 1979, Singh and Shukla 1984). 7) As a result of the bactericidal activity of garlic, toxin production by the bacteria is also prevented (Dewitt et al. 1979, Sanick 1975).

Garlic and Helicobacter pylori. Gastric cancer is the major cancer in the developing world and one of the top two worldwide. Helicobacter pylori is a bacterium implicated in the etiology of stomach cancer (Fuchs and Mayer 1995). The incidence of stomach cancer is lower in individuals with a high intake of allium vegetables in developed and developing (high risk) countries (Steinmetz and Potter 1991a and 1991b). Because allium vegetables, particularly garlic, have antibiotic activity, we investigated the antimicrobial activity of garlic against H. pylori (Sivam et al. 1997). An aqueous extract of a known variety of garlic (Oswego white) was used. The extract was standardized for thiosulfinate concentration. The minimum inhibitory concentration was found to be 40 \( \mu \text{g/mL} \). At this concentration, the control organism Staphylococcus aureus was not inhibited by the garlic extract. Thus H. pylori is more susceptible to garlic extract. Cellini et al. (1996) reported a similar study. They tested 16 clinical isolates of H. pylori and showed 90% inhibition of the isolates with aqueous garlic extract at 5 mg/mL. The concentration used in that study is the total weight of garlic per milliliter. However, calculations show that the minimum inhibitory concentrations reported in the two studies are comparable. It is plausible that the sensitivity of H. pylori to garlic extract at such a low concentration may be related to the reported lower risk of stomach cancer in those with a high allium vegetable intake. The inhibitory concentration of garlic reported in the two studies above is achievable in the stomach by consuming a medium size clove of garlic or equivalent amount of garlic supplements. Thus, this finding may identify a strategy for low-cost intervention for stomach cancer, with few side effects, in populations at high risk, particularly in the case of high resistance to antibiotics.

Mechanism of action. Thiosulfinates play an important role in the antibiotic activity of garlic. Hughes and Lawson (1991) showed that the antimicrobial activity of garlic is completely abolished when the thiosulfinates (e.g., allicin) are removed from the extract. Also, upon reduction of allicin to diallyl disulfide, the antibacterial activity is greatly reduced (Reuter et al. 1996). Feldberg et al. (1988) showed that allicin exhibits its antimicrobial activity mainly by immediate and total inhibition of RNA synthesis, although DNA and protein syntheses are also partially inhibited, suggesting that RNA is the primary target of allicin action. The structural differences of the bacterial strains may also play a role in the bacterial susceptibility to garlic constituents (Tynecka and Gos 1975). The cell membrane of Escherichia coli contains 20% lipid, whereas that of Staphylococcus aureus contains only 2% lipid (Salton 1964). The lipid content of the membranes will have an effect on the permeability of allicin and other garlic constituents. On the basis of this hypothesis, it is interesting to recall the difference in susceptibility we observed between gram-negative H. pylori (40 \( \mu \text{g/mL} \)) and gram-positive Staphylococcus aureus (>160 \( \mu \text{g/mL} \)) to garlic extract (Sivam et al. 1997).

Summary

The antibacterial activity of garlic is well documented. This knowledge could be utilized in two different areas.

Antibiotics. Microbial drug resistance is a difficult problem. As medicinal chemists advance in their search for new bacterial targets to attack, bacteria relentlessly evolve; as a result, a large number of bacterial species have become resistant to antibacterial drugs (Garau 1994, Gould 1994, Sanders and Sanders 1992). Thus there is a need to develop alternate strategies. Because garlic is known to act synergistically with antibiotics, and resistance has not been reported for garlic, more dose-response preclinical studies and eventually clinical studies should be done to assess the use of an antibiotic/garlic combination for bacteria that are difficult to eradicate. Antibiotic resistance is a problem in the case of H. pylori as well (Graham 1998). Because H. pylori is a worldwide problem and the cost of eradicating it using standard antibiotic regimen is also high, this bacterium is another candidate for clinical trials using garlic either alone or in combination with a less expensive antibiotic regimen.

Food preservation. Garlic inhibits the growth of microorganisms as well as toxin production. More research must be done to assess the value of garlic as an alternative to chemical food preservatives, especially in foods in which the garlic flavor would be an added bonus. There is also potential use for garlic by itself or in combination with other herbs and spices to extend the shelf life of raw meat products.

LITERATURE CITED


L. (garlic), Allium ampeloprasum (elephant garlic), and Allium cepa (onion), garlic compounds and commercial garlic supplement products. Phytother. Res. 5: 154–158.