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RESEARCH ARTICLE

IS GARLIC A BOON TO HUMAN HEALTH? – A COMPREHENSIVE REVIEW

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ABSTRACT

Garlic is one of the edible plants and is common ingredient available in the kitchen. Garlic (*Allium sativum*) is one of the most extensively researched medicinal plants and its typical odor and antibacterial activity depends on allicin produced by enzymatic activity of allinase (acysteine sulfoxide lyase) on alliin after crushing or cutting garlic clove. Today, both scientific and herbalist tradition support the fact that garlic, in its various forms can provide extraordinary health benefits. Unquestionably, it can significantly reduce the risk of cardiovascular disease and certain kinds of cancer. Taking garlic in certain dosages can help protect human cells from oxidation, free radicals and certain types of radiation. Garlic is an effective immune system. Booster and has anti-bacterial, anti-viral and anti-fungal properties. PubMed, Google scholar, Ebscohost databases were searched for publications from 1982 to the present (2013) using terms such as garlic, medicinal plant, traditional plant. Here, in this review, we discuss the constituents, properties, medicinal uses, dental application, advantages and disadvantages of garlic.

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INTRODUCTION

Human infections caused by Gram-positive bacterial pathogens are increasingly difficult to treat, predominantly due to emergence of drug resistant bacterial strains. One such Gram-positive bacterial organism is *Streptococcus mutans* causing dental caries in humans (Hamada and Slade, 1980) Extensive efforts have been made to find an active agent against dental caries. However *Streptococcus mutans* was found to be resistant to many of the antibacterial agent's viz., Penicillin, Amoxicillin, Cefuroxin, Tetracycline and Erythromycin (Bhattacharya *et al*., 2003). In addition they may lead to side effects including gastrointestinal problems (Craig, 1998) Conventional drugs usually provide effective antibiotic therapy for bacterial infections; however, there is an increasing problem of antibiotic resistance and a continuing need for new solutions (Fani *et al*., 2007). These drawbacks justify further research and development of natural antimicrobial agents that are effective and safe for the host. It has been well documented that traditional medicinal plants confer considerable antibacterial activity against various microorganisms (Jonathan *et al*., 2000) Chlorhexidine to date has proven to be the most effective anti-plaque agent, and a range of commercial products are available to the public (Jenkins *et al*., 1989).

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A large number of bacterial species have become resistant to antibacterial drugs (Chadwick and Goode, 1997; Walsh, 2000). Traditional plants and natural phytochemicals can treat bacterial infections and are considered as good alternatives to synthetic chemicals. Numerous traditional medicinal plants have been evaluated for their potential application in the prevention or treatment of oral diseases. Garlic is one of the most extensively investigated medicinal plants since ancient times. With its high trace mineral content and enzymes, sulfur containing compounds, garlic has shown anti-viral, anti-bacterial, anti-fungal and antioxidant abilities. (Prabu *et al*., 2006) Garlic (*Allium sativum*) has always been known to play an important role in the field of medicine throughout the history of mankind. Garlic extract has been shown to have a wide spectrum inhibitory effect on the growth of various gram-positive and gram-negative bacteria and is also active against multi-drug resistant organisms such as Pseudomonas aeruginosa, Klebsiella pneumonia, and Mycobacterium tuberculosis. (Fani *et al*., 2007; Weber *et al*., 1992) Garlic is known to act as an antibiotic, and no resistance to it has been reported (El Astal, 2004) Garlic (*Allium sativum*) is one of the most extensively researched medicinal plants and its typical odor and antibacterial activity depends on allicin produced by enzymatic activity of allinase (a cysteine sulfoxide lyase) on alliin after crushing or cutting garlic clove. (Ross *et al*., 2001; Ellmore and Feldberg, 1994) The purpose of this paper is to identify a common and cheap herbal remedy for the prevention

and treatment of sore-throat, mouth sore and dental caries, especially in a developing nation.

MATERIALS AND METHODS

The literature for the present review was obtained from the following sources:

- Published articles
- Unpublished literature
- Online manuals and books
- Thesis

Use of search engine to retrieve the concerned literature

The search for the literature concerning garlic and its health benefits was identified by searching the biomedical databases for primary research material. The databases were searched for publications from 1982 to the present 2013.

Search terms employed to retrieve the relevant literature

In order to ensure that relevant studies were not missed, the search terms remained broad. The following search terms were employed to retrieve the literature using the search engine:

- Garlic and its health benefits.
- Garlic and oral benefits.
- Antimicrobial activity of garlic.
- Garlic in oral and systemic health
- Allium Sativum and its health benefits
- Medicinal plant and its benefits
- Medicinal plants and its importance
- Medicinal plant and herbs
- Medicinal plant and its uses
- Traditional medicinal plants.

The literature with these search terms anywhere in the title or abstract was considered. Language restricted to English only. Studies were eligible for consideration in this review if: focus of the study was garlic and its health benefits, which include general benefits and oral benefits.

Segregation of the literature

The literature retrieved was then organized as per the following specifications:

- Primary and secondary sources
- Literature from India, from other developing countries and literature from developed countries
- Literature focusing garlic, its general benefits and oral benefits
- Literature focusing on antimicrobial action of garlic.

The entire literature reviewed in the present manuscript was in English and the authors did not come across any published literature in a language other than English. The literature from these sources was thoroughly scrutinized by the authors and relevant information from these sources was considered for discussion under different sections of this paper.

The Results of the Search are Summarized in Table 1

The total literature retrieved and /or collected, the segregation of literature into various specifications and the number of articles considered for discussion in the present review is summarized in Table 1.

Figure 1. Methodology employed in search of relevant literature

Methodology employed in present review
Use of search engine to retrieve the concerned literature
Search term employed
Garlic and its health benefits
Allium Sativum and its health benefits
Garlic and oral benefits.
Antimicrobial activity of garlic.
Garlic in oral and systemic health
Medicinal plant and its benefits
Medicinal plants and its importance
Medicinal plant and herbs
Medicinal plant and its uses
Traditional medicinal plants
Segregation of the literature
Primary and secondary sources
Literature from India, from other developing countries and literature from developed countries
Literature focusing garlic, its general benefits and oral benefits.
Literature focusing on antimicrobial action of garlic.
Through scrutiny of the retrieved literature and inclusion of relevant information for discussion under various sections of manuscript

Table 1. Summary of the search results

Total material retrieved and / or collected	54
Primary sources	49
Secondary sources	11
Garlic in general health	34
Garlic in oral health	16
Comparison of garlic and chlorhexidine	6

History

Garlic is of central Asian origin, but widely recognized and used as a valuable spice and remedy for various ailments. (Ankri and Mirelman, 1999) Garlic was found in Egyptian pyramids and ancient Greek temples. There are Biblical references to garlic. Ancient medical text from Egypt (Papyrus Ebers), Greece, Rome, China and India each prescribe medical applications for garlic. It was administered to provide strength and increase work capacity for labours in the building of the pyramids. Hippocrates and Plinius gave a long list of scenarios in which it was considered beneficial. Garlic was given to the original Olympic athletes in Greece, as perhaps one of the earliest "performance enhancing" agents. (Catalina Hogea, 2007) The Greeks utilized its laxative properties, and the Chinese prescribed it for high blood pressure. Vikings and Phoenicians alike extolled the virtues of garlic and used it both for flavoring foods and treating disease. Garlic is a hardy, perennial bulb which is native to the Mediterranean regions of Africa and Europe. (Harini *et al*., 2013) Along with onions, leeks, chives and shallots, garlic is a member of the lily family. The botanical name for garlic, *allium sativum* may have been derived from the celtic word *all* which refers to "pungent." The

edible portion of the garlic plant grows underground and consists of a cloved bulb. During the Bubonic Plague years in Europe, garlic was used to boost immunity against the infectious organism responsible for so many deaths. (Harini *et al*., 2013) During the eighteenth century, Russians utilized garlic to treat influenza. Eventually, garlic would become known as "Russian penicillin." American colonists regarded garlic for its ability to kill parasites. In the nineteenth century, Louis Pasteur finally proved scientifically that garlic contains antibiotic properties. His discovery led to the initiation of hundreds of studies which have substantiated his findings. Garlic can effectively kill bacteria, fungi, viruses and parasites. In the late nineteenth century, garlic was routinely used by physicians as an effective treatment for typhus, cholera and whooping cough. It was highly recommended by medical Practitioners and considered as staple treatment for infection. Albert Schweitzer used garlic for treating amebic dysentery in Africa. Early in this century, tuberculosis was treated with garlic and it was also used as an antibiotic/antiseptic for wounds during World War II. American and European doctors alike noted a remarkable high cure rate in tuberculosis patients treated with garlic. Septic poisoning and gangrene, which can so quickly develop in battlefield wounds were prevented to a significant degree by using garlic. Herbalists have always considered garlic as an effective treatment and preventative agent against colds, flu and other infectious diseases. The present focus on garlic as a medicinal agent promises to support the notion that garlic should be utilized by medical practitioners much more than it currently is. Recently, medical research has focused on garlic's potential value in treating cardiovascular disorders and as an anti-cancer agent. This renewed interest in garlic has contributed to the development of the "Designer Foods Program" which is sponsored by the National Cancer Institute. This agency investigates foods that may be effective cancer preventatives. Garlic is one of those foods which may have profound cancer prevention potential (Harini *et al*., 2013; Nature's Amazing Nutritional and Medicinal Wonder Food, 1995).

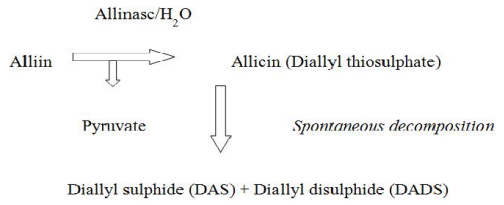
Food Value of Garlic (Kumar *et al*., 2010)

An analysis of garlic shows it to contain high percentage of minerals and vitamins. It also Contains traces of iodine, sulphur and chlorine. (Values per 100 gm's edible portion)

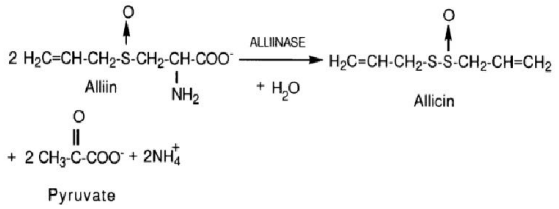
Food Value	Minerals and Vitamins
Moisture - 62.0%	Calcium - 30 mg
Protein - 6.3%	Phosphorus - 310 mg
Fat - 0.1%	Iron - 1.3 mg
Fibre - 0.8%	Vitamin C - 13 mg
Minerals - 1.0%	Small amount of Vitamin B Complex
Carbohydrates - 29.8%	

Mechanism

Broadly the mechanisms of action of garlic in oral health care are: its role as a strong antioxidant, antibacterial, antiseptic and immune - modulatory effect. (Amagase *et al*., 2001) Inhibition of certain thiol-containing enzymes in the microorganisms by the rapid reaction of thiosulfinates with thiol groups was assumed to be the main mechanism involved in the antibiotic effect. (Ankri and Mirelman, 1999) Allicin also specifically inhibits other bacterial enzymes such as the acetyl-CoA-forming system, consisting of acetate kinase and phosphotransacetyl-CoA synthetase. (Ankri and Mirelman, 1999) Chemical analyses of garlic cloves have shown the presence of sulphur-containing compounds. The beneficial antimicrobial effects of garlic are attributed to these sulphur based compounds, the significant ones being allicin and the products of its breakdown namely diallyl sulphide (DAS) and diallyl disulfides (DADS) (Bakri and Douglas, 2005; Masaadeh *et al*., 2006; Tripathi, 2009). The reactive allicin molecules so produced have a very short half-life, as they react with many of the surrounding proteins, including the allinase enzyme, making it into a quasi-suicidal enzyme (Ankri and Mirelman, 1999). The biological activity of allicin extracted from fresh garlic is ascribed to (a) its function as an antioxidant, (b) its ability to attach the sulphur (SH) groups in enzymes, proteins and modify their activities, thereby inhibiting the sulfhydryl enzymes and (c) its ability to rapidly penetrate into cells through the cell membranes (Ankri and Mirelman, 1999). The active component of garlic extract, allicin partially inhibits DNA and protein synthesis, and entirely inhibitsRNA synthesis. (Harini *et al*., 2013) Allium sativum L. Liliaceae or simply garlic contains various biologically active constituents, like alliin, alliinase, allicin, S-allycystein, diallylsulphide and allymethyltrisulphide. Alliin is an amino acid, which is converted into allicin by alline-lyase catalyses when the bulbs are crushed. Allicin is the precursor of sulphur-containing compounds, which are responsible for the flavour, odour and pharmacological properties. Once exposed to air, allicin is further converted into diallyldisulphide, which has antibacterial effects and the reduction by cysteine will disrupt the disulphide bond in microbial proteins. (Groppo *et al*., 2007)



Generation of allicin from a garlic clove



The sulphur compounds are known to have an inhibitory effect on *Streptococcus mutans (S. mutans)* harbored in the dental plaque, whose acidogenicity leads to demineralization of the teeth and dental caries (Masaadeh *et al*., 2006). This antimicrobial action could be applied in the prevention of dental caries. *In vitro* studies have shown that garlic extract has an inhibitory effect on periodontopathic and cariogenic bacteria (Masaadeh *et al*., 2006; Chen *et al*., 2009). Thus the extracts of garlic may be used to break the chain of caries aetiology, by affecting the host factors and the microbial flora. Garlic extracts stimulate the flow of saliva and facilitates the

clearance of the substrates from the mouth (Groppo *et al*., 2007). It reduces the *S. mutans* counts, their acid production and prevents the demineralization of tooth structure (Chen *et al*., 2009).

Therapeutic applications in dentistry

This potent anti- inflammatory, antioxidant, antibacterial effect and immunomdulatory effect of garlic suggest that it has a therapeutic potential in different oral diseases.

General Benefits [Jonkers *et al*., 1999; Durak *et al*., 2002; Nishino, 1990; Imai, 1994; Kock and Lawson, 1996; Fareed *et al*., 2007; Rahman, 2001; Reinhart *et al*., 2008; Bordia, 1996; Harin *et al*., 2013; Sudarshan *et al*., 2012; Bordia, 1978; Kumar *et al*., 2010]	Oral benefits [Harini *et al*., 2013; Sudarshan *et al*., 2012; Ureghe *et al*., 2010; Chavana and Nagesh, 2010]
Prevent heart disease, Intestinal disorders, Antithrombotic agent, Respiratory infections, Influenza, cold, cough, Bronchitis, Triglyceride levels, Asthma, Deafness, Leprosy, Chronic lead poisoning, Bladder problems, and ear aches, Reduce nasal congestion, Skin diseases, Healing properties, Wounds, Symptoms of aging, Atherosclerosis, In high blood pressure, Anti oxidant effect, Lower the cholesterol level, Flatulence, Worms, Warts, It was used as an antiseptic to prevent gas gangrene, Successfully used in aids patients to treat *cryptosporidium* infections, Garlic has been reported to reduce blood lipids and to have anticancer effects, Gastrointestinal problems, Boost the body's immune system, Regulate blood sugar levels.	Prevent dental caries, Gingivitis, Periodontitis Mouth sore Oral cancer Aphthous ulcer Kaposi sarcoma Sore throat Used as mouthwash, sub gingival irrigant and as a component in local drug delivery system.

Specific actions associated with garlic (Nature's Amazing Nutritional and Medicinal Wonder Food, 1995)

Antioxidant	Protects cells against damage by free radicals found in environmental pollutants including heavy metals. Garlic contains the highest level of the antioxidant selenium, which affords excellent cellular protection.
Anti-toxic	Can be considered a radiation antidote in that it stimulates cellular detoxification.
Anti-cancer	Blocks the ability of carcinogens to mutate healthy cells into malignant ones. In some cases, Garlic can even inhibit the early proliferation of cancerous cells.
Decongestant	Helps to rid the respiratory tract of mucus.
Artery Cleanser	Significantly lowers blood levels of triglycerides which have been associated with an increased risk of heart attack.
Anti-atherosclerotic	Promotes the regression of fatty deposits in blood vessels, a major cause of atherosclerosis, and can even help reverse arterial blockages caused by the collection of plaque.
Antibiotic	Works as an immune system stimulant which helps the body fight bacterial, viral and fungal infections. Enhancing immune defenses may also help the body rid itself of cancerous invaders.
Anticoagulant	Reduces the tendency of the blood to clot and helps to dissolve existing clots. Both of these actions are very significant in reducing the risk of heart attack and stroke.
Tonic	Garlic has a positive effect on the heart, stomach, lungs and spleen.
Anti-infection	Externally, garlic can be used as a drawing poultice.
Antiparasitic	Garlic has traditionally been used in enemas to rid the colon of intestinal parasites.
Blood Purifier	Helps to stimulate the lymphatic system to more efficiently get rid of waste material.
Glucose Control	Garlic has been found to be useful in controlling glucose tolerance and is beneficial for both hypo and hyperglycemia. Anyone with diabetes can benefit from garlic as well.
Swelling	Garlic suppositories have been used to shrink hemorrhoids.
Anti - inflammatory	The anti-inflammatory action of garlic makes it a valuable treatment for arthritis. Garlic reduces joint swelling and inflammation
Antihypertensive	Garlic has been recognized by the Japanese Food and Drug Administration as an official treatment for high blood pressure.

Advantages and adverse effect of Garlic

Advantage	Adverse effect (Kumar *et al*., 2010; Groppo *et al*., 2007; Lee *et al*., 2011)
Easily obtainable, Minimum side effect Effective Less expensive Acceptable to all	Halitosis, Nausea, Unpleasant taste, Gastric irritation Diarrhea Burning of the mouth, throat, and stomach Increased bacterial biofilm formation on orthodontics wire Lightheadedness; and eczema or a rash. Garlic has been associated with decreased platelet aggregation and bleeding events. Poor bioavailability.

Garlic produced a significant reduction in the inflammatory infiltrate and potentially inhibited innate immune response associated with periodontal diseases thus suggesting a therapeutic potential in this chronic inflammatory condition. Garlic can be used as a mouth wash, sub gingival irrigant and as a component in local drug delivery system. It has a great role in the treatment of periodontal diseases. (Harini *et al*., 2013)

DISCUSSION

Over the years, garlic has been a part of tradition, ancient myth, and household remedies. Garlic can rightfully be called one of nature's wonders. Garlic alone can provide us with over two hundred unusual chemicals that have the capability of protecting the human body from a wide variety of diseases. (Bordia, 1978) Garlic is considered one of the most important herbal/ Ayurvedic supports for blood pressure and cholesterol reduction. Garlic also has contains germanium which is an anti cancer agent and garlic has more of it than any other herb. (Kumar *et al*., 2010) From the published research articles it is clear that raw garlic juice is effective not only against many common pathogenic bacteria but also against the strains that have become resistant to antibiotics and even the toxic metabolites of some pathogenic bacteria can be inactivated by garlic. (Kumar and Sharma, 1982; Jezowa *et al*., 1966) *Streptococcus mutans* is one of the most important oral bacteria which play a major role in dental caries, bacteremia and consequently bacterial endocarditis among predisposed patients. (Chang *et al*., 2001) However, for prevention of bacteremia and endocarditis by *S. mutans*, antibiotic administration prior to invasive dental procedures is recommended. Chlorhexidine and sodium hypochlorite are widely used as mouthwashes and irrigating agents, respectively. Chlorhexidine has been used as anticariogenic agent in Finland (Osteal *et al*., 1990); and chlorhexidine gel used twice daily for 2 weeks significantly decreased the caries rate. (Lindquist *et al*., 1989) Although this antimicrobial agent is widely used, however, immediate hypersensitivity and other side effect reactions to this agent have been reported. Chlorhexidine and sodium hypochlorite were shown to be cytotoxic to human periodontal ligament cells, inhibit protein synthesis and affect mitochondrial activity of these cells (Chang *et al*., 2001; Beaudouin *et al*., 2004). Many studies on chlorhexidine have shown that the reduction in oral micro flora on usage of the mouthwash is transient and dose related. The bacterial counts rapidly return to baseline levels within a week to a month depending on the dosage and term of use. (Tamaki *et al*., 2006; Ribeiro *et al*., 2007) Due to these factors, there is always a quest for new and improved products, emphasis being placed on natural/nature identical products. Garlic based products are the focus of such research with the recent development and availability of purified extracts for use. (Masaadeh *et al*., 2006; Groppo *et al*., 2007; Chen *et al*., 2009) Regarding a study at Hawassa University, garlic was found to have antimicrobial effects on *Staphylococcus* aureus (Deresse, 2010) Belgunith *et al.* showed that garlic extract prevented the growth of *Salmonella in vitro*. *Salmonella* is a significant pathogen in food poisoning. (Belguith *et al*., 2010) Amin *et al.* investigated in vitro antimicrobial and antifungal effects of garlic and onion extracts on 23 species of fungi and bacteria and found that the antimicrobial effect of garlic was greater than that of the onion extract (Amin and Kapadnis, 2005) Mansour Amin (2012) in-vitro study tested the efficacy of garlic juice against Streptococcus mutans, S. sanguis, S. salivarius and Lactobacillus casei, found that garlic juice is more effective than Chlorhexidine mouthwash. Masaadeh *et al.* (2006) found that different concentrations of garlic extracts inhibited several micro-organisms including those associated with caries. U. B. Owhe-Ureghe *et al*. 2010 compared the Inhibitory activity of garlic (Allium sativum Linn.) and lime (Citrus aurantifolia Linn.) on seven bacterial species (Streptococcus mutans, Lactobacillus acidophilus, Norcadia asteroides, Pseudomonas aeruginosa, Actinomyces viscosus, Staphylococcus aureus and Veillonella alcaligens) isolated from 240 extracted, carious teeth and found that that a paste made by blending garlic and lime could be used as a mouth wash in the treatment of dental caries, mouth sore, sore throat and also, be incorporated into toothpaste to prevent dental caries. (Ureghe *et al*., 2010). Similar kind of study by Fani *et al*. (2007) who tested the inhibitory activity of garlic extract on multidrug-resistant (MDR) strains of *Streptococcus mutans* isolated from human carious teeth, they found that chlorhexidine was active against MDR strains of *S. mutans* with MIC ranging from 4 to 16 µg/ml while MIC of this agent on non-MDR strains ranged from 0.25 to 1 µg/ml ($P < 0.05$) and direct *in vitro* correlation was observed between the resistance to commonly used antibiotics and chlorhexidine. And the results of this study are in accordance with Jarvinen *et al*. (1993) who have also shown chlorhexidine MIC to be ≤1 µg/ml. Sangeeta Devanand Chavan, 2010 *et al*. also compared the antibacterial effect of garlic extract with chlorhexidine (in vitro and in vivo) against Streptococcus mutans and found that 3% concentration was the minimum concentration at which zone of inhibition was observed, similar result was observed with Groppo *et al*. 2002 who observed a remarkable reduction of streptococcus mutans after gargling with 2.5% garlic mouthwash solution. Behzad houshmad *et al*. 2013 conducted a in vitro-study to assesses the antibacterial effect of different concentration of garlic extract against human dental plaque microbiota and found that all bacterial strains were inhibited by garlic and all the concentration 5%,10%,20%,100% shows the same effect. There is similar study by Elnima EI *et al*. 1983 who reported the significant effect of 10% garlic solution in decreasing levels of oral micro-organism. Shailesh Kudva *et al* (2012) that garlic is effective in minimising the fall of salivary pH after a cariogenic challenge, in a similar way to that of chlorhexidine. In short term period, within 24 hours, this acid production is countered by salivation in response to the spicy flavour of garlic and we hypothesize this may also be because of its inhibitory effect on *S. mutans* (Chen *et al*., 2009). The spicy flavour stimulates salivary flow. Stimulated saliva contains greater concentration of bicarbonate ions in addition to other substances. This increases the buffering capacity of saliva and its ability to clear the acid and substrates from the plaque thus improving the pH of saliva and increasing resistance to caries (Chen *et al*., 2009). Garlic is also proven to have antioxidant, anti-atherogenic, hypolipidemic, anti-microbial, antithrombotic and anti-hypertensive activity. The garlic extract and its purified component, allicin, have the antimicrobial activity which is of particular interest, especially the inhibitory activity on *S. mutans* (Masaadeh *et al*., 2006; Groppo *et al*., 2007; Chen *et al*., 2009).

Summary of the key articles included in the present review

Authors	Title	Conclusion
Fani *et al*. (2007)	Inhibitory activity of garlic (Allium sativum) extract on multidrug-resistant Streptococcus mutans.	Considering *in vitro* data obtained in this study, mouthwashes or toothpaste containing optimum concentration of garlic extract could be used for prevention of dental caries.
Groppo *et al*. (2007)	Antimicrobial activity of garlic against oral streptococci.	It was concluded that the Garlic clones have antimicrobial properties in vitro against streptococci and anticariogenic properties against oral microorganism in spite of its adverse effects.
Ureghe *et al*. (2010)	Antibacterial activity of garlic and lime on isolates of extracted carious teeth.	Blending garlic and lime could be used as a mouth wash in the treatment of dental caries, mouth sore, sore throat and also, be incorporated into toothpaste to prevent dental caries. Further studies on toxicity tests are recommended.
Chavana *et al*. (2010)	Comparative Evaluation of Garlic Extract Mouthwash and Chlorhexidine Mouthwash on Salivary Streptococcus mutans Count—An In Vivo Study	Garlic extract has been shown to be effective against S. mutans, garlic extract mouth rinse might be used as an effective remedy in the prevention of dental caries.
Amin *et al*. (2012)	In Vitro Comparison of the Effects of Garlic Juice and Chlorhexidine Mouthwash on Oral Pathogens.	The efficacy of garlic juice was higher than Chlorhexidine against target bacteria and could be used as an effective mouthwash, but its side effects need to be investigated.
Kudva *et al*. (2012)	Effects of garlic extract on salivary pH: a clinical study.	Garlic is effective in minimizing the fall of salivary pH after a cariogenic challenge, in a similar way to that of chlorhexidine. But the best results were obtained when they were both combined and used, making them synergistic in their actions.
Housmand *et al*. (2013)	Antibacterial effect of different concentration of garlic extract on dental plaque bacterial.	5%,10%,20% and 100% concentration of garlic had a similar effect,so further studies seems to be indicated on the usefulness of 5% extract.

Summary/ Conclusions

In summary, the epidemiological, clinical, and laboratory data have proved that garlic contains many biologically and pharmacologically important compounds, which are beneficial to human health from cardiovascular, neoplastic, and several other diseases. Numerous studies are in progress all over the world to develop effective and odorless garlic preparations, as well as to isolate the active principles that may be therapeutically useful. Today, both scientific and herbalist tradition support the fact that garlic, in its various forms can provide extraordinary health benefits. Unquestionably, it can significantly reduce the risk of cardiovascular disease and certain kinds of cancer. Taking garlic in certain dosages can help protect human cells from oxidation, free radicals and certain types of radiation. Garlic is an effective immune system booster and has anti-bacterial, anti-viral and anti-fungal properties. Garlic promises to emerge once again, as a powerful medicinal agent which will most certainly impact 21st-century health practices. Over the years, garlic has been a part of tradition, ancient myth, and household remedies. The therapeutic properties of garlic have been known to mankind for ages. Garlic and its compounds have been found to attack multiple targets, which provide the basis for their effectiveness in many different diseases. It is easily available with less cost then medicine. Sides effects are less even though if used for longer duration. Work is in progress at the medical center for standardization and preparation of toothpaste and mouthwash containing this antimicrobial agent for prevention of dental caries. Garlic is a "wonder" food that is considered to be one of the most effective natural healing substances in the world.

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