Anti-bacterial and anti-fungal properties of garlic extract (*Allium sativum*): A review

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ABSTRACT

Garlic (*Allium sativum*) contains various biologically active components that play significant role in treatment of bacterial and fungal infections. It contains sulfur compounds like allicin, ajoene, allylmethyltrisulfide, diallyltrisulfide, diallyldisulphide and others which exhibit various biological properties like antimicrobial, anticancer, antioxidant, immunomodulatory, anti-inflammatory, hypoglycemic and cardiovascular effects. The objective of the current review was to relate various literatures and assess the anti-microbial potential of garlic extract. The antimicrobial potency of garlic can be maximized by increasing the concentration of the extract. Garlic extract of 100% concentration showed a maximum zone of inhibition against both gram-positive and gram-negative bacteria.

Keywords: Antimicrobial activity, Bacteria, Fungi, Garlic extract

INTRODUCTION

Medicinal plants have been used as traditional treatments for numerous human diseases [1]. In rural areas of the developing countries, they continue to be used as the primary source of medicine [2]. A wide range of microorganisms including bacteria, fungi, protozoa and viruses have been shown to be sensitive to crushed garlic preparations [3-4]. Garlic antimicrobial activities have been recognized for centuries being many of its therapeutic properties first mentioned in 1500 BC in an Egyptian recipe named *Papirus ebers.* Currently, it is used in folk medicine for the treatment of many diseases [5].

Microbial infections are the major cause of morbidity and mortality in the developed and developing country, although a number of antimicrobial agents are available for the treatment and management of infectious diseases [6]. Historically, garlic has been used for centuries worldwide by various societies to combat infectious disease. Garlic can be provided in the form of capsules and powders, as dietary supplements, and thus differ from conventional foods or food ingredients [7].

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Garlic (*Allium sativum* L.) exhibit a broad antibiotic activity against both gram negative and gram positive bacteria including species of *Escherichia, Salmonella, Staphylococcus, Streptococcus, Klebsiella, Proteus, Bacillus, Clostridium, Helicobacter pylori* [8-10]. One of the most potent and active component in garlic is the Sulphur compound called allicin which is a chemical compound produced when garlic is chopped, chewed or bruised. It is a powerful antibiotic and an agent that helps the body to inhibit the growth and development of pathogenic microbes [11].

ANTI-BACTERIAL EFFECTS OF GARLIC EXTRACT (*Alliums sativum*)

Garlic (*Allium sativum*) has antibacterial, antifungal and antiviral properties. Aqueous, ethanol and chloroform extracts of garlic inhibited the growth of the pathogenic bacteria, though with varying degrees of susceptibility [9, 12].

Disease causing gram positive *bacteria S. mutans* were sensitive to garlic extract. The diameter of non-growth zone increased as the concentration of garlic extract increase. Similarly, *Lactobacillus acidophilus* was sensitive to different concentrations of garlic extract on blood agar medium. Again the diameter of inhibition zone increased as the concentration of garlic extract increased [13]. Garlic extract tested on *Bacillus subtilis, Staphylococcus aureus*, *Escherichia coli* and *Salmonella typhi* showed zone of inhibition 29mm, 26mm, 31mm and 25mm respectively. The inhibition zone with streptomycin antibiotics was found to be 35mm, 33mm, 29mm and 31mm respectively [14].

The antibacterial effect of garlic extract was highest against skin pathogenic bacteria *S. aureus* with diameter zones of inhibition ranging from 4.40 – 3.80 cm followed by *S. epidermidis* ranging from 4.13 - 3.57cm, and then *Strep. pyogenes* with zones of inhibition ranging from 3.40 – 2.67cm. The least inhibition zones recorded about 2.32 – 1.55 cm were observed in *P. aeruginosa* [15]. Fresh domestic and imported garlic extract are known to play bacteriostatic activity against the methicillin-resistant *Staphylococcus aureus* (MRSA) with 31mm inhibition zone [16]. The most sensitive bacteria to garlic extract have been determined as *S. aureus* of the 26 mm diameter zone of inhibition, followed by *S. enteritidis* and *B. cereus* was the most resistant bacteria against garlic extract [17]. Garlic extract can be utilized for the development of broad spectrum antibiotics as it has wide spectrum antibacterial activity [18].

Garlic collected from Tamil Nadu town showed a better zone of inhibition in both gram negative and gram positive bacterial isolates but maximum diameter was obtained in *Staphylococcus aureus* and *Vibrio cholerae* 30mm, followed by ß hemolytic streptococcus and *Escherichia coli* 26mm [19]. Garlic extract of 100% concentration showed a maximum zone of inhibition against *B. subtilis* and *Proteus mirabilis* bacteria. This indicates that garlic

extract has the potential of a broad spectrum of activity against both gram-positive and gram-negative bacteria [20].

The concentration (100 mg/ml) of garlic extract had the highest inhibitory effect about (36mm) inhibition zone for *S. aureus* and about (33mm) inhibition zone for *E. faecalis*. The zone of inhibition was increased with increasing the concentration of garlic extracts. The lowest concentrations (5 and10 mg/ml) inhibited the bacteria weakly [21]. Another report also indicated that the effectiveness of 50% garlic extract against *S. aureus* is more (10 mm zone of inhibition) when compared to (ampicillin) antibiotic at 50% concentration (6 mm zone of inhibition). Similarly 50% of garlic extract against *Pseudomonas aeruginosa* showed better zone of inhibition (9 mm) compared to 50% of antibiotic (ciprofloxacin) (7mm) zone of inhibition. But 20% of both garlic extract and antibiotics showed no result against *Pseudomonas aeruginosa* [22]. The alcoholic extract of garlic against *Staphylococcus aureus* showed that the zone of inhibition was 9 mm recorded for the concentration of 10 mg/ml and 23 mm for the concentration 100 mg/ml. The concentrations 10-20 mg/ml were rather low active in preventing the growth of *S. aureus*, the concentrations 40-60 mg/ml were moderate active, while the concentrations 80-100mg/ml was highly active [23].

ANTIFUNGAL EFFECTS OF GARLIC EXTRACT (*Allium sativum*)

The slow pace of newer antibiotic development coupled with the availability of fewer antifungal agents with fungicidal actions centered on inhibition of ergosterol synthesis has provided the need to explore nature in search of phytotherapeutic agents with novel targets and mode of actions [24]. It was revealed from the study of [25], the aqueous and ethanol diluted garlic extracts showed complete inhibition (100%) of *Botrytis cinerea* at the higher concentrations (80% and 60%) respectively. At a concentration of 80%, the aqueous and ethanol diluted extracts inhibited *Penicillium expansum* by 96.21% and 99.21% respectively. Ethanol diluted extracts seemed to be more effective against *Neofabraea alba* with 80% extract showing 79.63% inhibition. [26], also reported that the ethanolic extract of garlic tested against *A. flavus*, *A. niger* and *C. herbarum* showed inhibition diameter of (3.766cm, 4.750cm and 1.883cm) respectively after seven-day incubation on PDA. With inorganic water base extraction medium garlic extract had inhibition diameter growth (0.934cm) on *A. flavus,* (0.884cm) on *A. niger* and (5.750cm) on *C. herbarum* at day seven of incubation.

A report of [27], indicated that the mean zone of inhibition of *Candida albicans* was found to be 28.0±1.0 mm with aqueous garlic extract and 27.5±0.5 mm with clotrimazole. This result indicated that that garlic juice has an equal or a better effect against *Candida albicans* compared with a commercial antifungal drug. The aqueous garlic extract exhibit higher zone of inhibition against *Aspergillus niger* was reported to be 41.0±4.0 mm and 22.5±1.5 mm with

clotrimazole. Both aqueous and methanolic extracts of *A. sativum* exhibited antifungal activities against almost all the tested *Candida albican* [28]. Petroleum ether and aqueous extracts of garlic were found to inhibit the growth of the standard organism of *Candida albicans* and *Aspergillus niger* and the clinical isolates of *A. flavus*, *Curvularia lunata, Microsporum audouinii, Trichophyton soudanense* and *Trichophyton mentagrophytes* at a concentation of 10mg/ml [29].

Antidermatophytic activity of aqueous extract of garlic tested on dermatophytic fungi showed that zones of inhibition against *Trichophyton mentagrophytes* was (18.00 mm), *Trichophyton rubrum,* (18.33 mm), *Microsporum gypseum* (16.53mm), *Trichophyton verrucosum* (15.67mm) *and Epidermophyton floccosum* (6.00mm). Inhibition zone of Nystatin used as control for cultures at a concentration of 1mg/ml varies between 25-31 mm [30]. The extract of garlic at highest concentration proved highly to be effective in reducing the spore germination of *Alternaria alternata* and *Rhizopus stolonifera* [31].

CONCLUSION

Garlic extracts exhibit broad spectrum antibiotics against both gram positive and gram negative bacteria and fungi. The anti-bacterial and anti-mycotic activity of garlic was increased with increasing the concentration of garlic extract. Garlic extract enhances the antibacterial activity and protect individual from bacteria invasion. Thus, consuming of garlic may be utilizing as an economic way for patients or hospital workers and have been proposed as novel treatments of bacterial infectious diseases also to reduce the problem of multi-drug resistant pathogenic bacteria.

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CONFLICT OF INTEREST

The author declares no conflict of interest.

AUTHORS' CONTRIBUTIONS

This review paper was carried out by the author. The author search related literature and compare the findings of various scholars. Wrote the protocol and the first draft of the manuscript. Finally the author read and approved the final manuscript.

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