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**Literature Review**

# Anti-microbial efficacy of garlic (*Allium Sativum L.*) extract as a root canal irrigant in endodontic treatment

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## *ABSTRACT*

***Background:*** *Herbal medications are an effective alternative in dental endodontic treatment due to their antimicrobial, anti-inflammatory, and biocompatibility properties and thus they are more biocompatible and less cytotoxic. The antibacterial, antifungal, and antiviral properties of garlic (Allium sativum L.) support broad-spectrum activity against gram-positive and gram-negative organisms and effectiveness against multidrug-resistant organisms that are essential as endodontic materials.* ***Purpose:*** *The purpose of this literature review is to analyze how the antimicrobial efficacy of garlic (Allium sativum L.) extract can be used as a root canal irrigant in endodontic treatment.* ***Review:*** *The development of pulp and periapical disease involves high-intensity bacterial activity that proliferates and produces toxic side products such as organic acids. When crushed or minced, garlic releases allicin compounds through the enzymatic action of alliinase (cysteine sulfoxide lyase) on alliin. Allicin, organosulfur compounds, and antioxidant compounds in garlic extract can exert antimicrobial role by inhibiting the synthesis of pathogenic microorganisms, fighting the resulting infection, and working synergistically with other antimicrobial agents to increase the effectiveness of treatment against antibiotic-resistant bacterial infections. In comparison to other antimicrobial agents, a number of studies have shown that there is no significant difference between garlic extract and sodium hypochlorite (NaOCl) in exerting bactericidal effects against pathogenic bacteria. Other studies have also shown that garlic extract has good dentin penetration properties as well as ideal flow and wetting capabilities.* ***Conclusion:*** *Garlic (Allium sativum L.) extract has good antimicrobial efficacy, dentin penetration, as well as ideal properties of root canal irrigation in endodontic treatment.*

***Keywords:*** *Allium sativum L.; antimicrobial; bactericidal; root canal; endodontic*

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## INTRODUCTION

The success rate of endodontic treatment is influenced by various factors, starting from cavitary access preparation, and biomechanical preparation followed by three-dimensional obturation of the root canal system. The main goal of endodontic treatment is to achieve root canal disinfection to prevent reinfection. The use of chemical substances as well as mechanical instruments to aid in the disinfection and removal of necrotic tissue from the root canal space has become an important part of endodontic treatment. The ideal endodontic irrigator should have the ability to dissolve pulp tissue, and collagen, remove biofilm, and remove the smear layer. It should not be toxic or carcinogenic to the peripheral tissue cells of the tooth, should not impair the sealer's ability, should not irritate the periapical tissues, and should be readily available.[1]

Sodium hypochlorite (NaOCl) has long been the gold standard and has proven effective in disinfecting root canals and dissolving residual pulp tissue.[2] It is a highly effective antimicrobial agent but is known to have several disadvantages such as bad taste, cytotoxicity, and potential irritation to periapical tissues, especially at high concentrations. These undesirable effects of irrigants are the reason for the increasing use of alternative irrigants in recent years.[3]

Herbal treatments are an effective alternative in dental endodontic treatment due to their high antimicrobial, anti-inflammatory, and biocompatibility properties and thus have more biocompatible and less cytotoxic manifestations.[4] Garlic has been used as a food or medicine with anti-infective properties for many years. Numerous experimental and clinical studies have shown that garlic extracts have antibacterial, antifungal, antiviral, antioxidant, anti-inflammatory, and immunomodulatory effects. Previous in-vitro studies have revealed that garlic extract has antibacterial and antifungal properties as an endodontic irrigant. It has been proven that garlic as a nutrient has


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no genotoxicity and mutagenicity and does not cause cytotoxicity of human gingival fibroblasts.[5]

## METHODS

The type of research used is the literature review, and the research design used is a narrative review. The literature review is compiled by searching and selecting journal publications based on literature criteria, which will then be extracted and discussed further. The information used was secondary data. Secondary data was obtained through primary data, namely data derived from previous studies, both in the form of research results, published articles, and review articles. Secondary data were obtained by searching for published articles in online databases, such as PubMed, Science Direct, Google Scholar, and Research Gate.

Inclusion criteria: Research publications that discuss the antimicrobial effectiveness of garlic extract as root canal irrigation; Research publications that discuss the comparison between root canal irrigation using garlic extract and irrigation materials in general; Research publications published in the period 2013-2023; Research publications registered in PubMed, Science Direct, Google Scholar, and ResearchGate. Exclusion criteria: Research publications published before 2013; Research publications that were not available in full-text format.

The article search used Boolean operators, namely AND/OR/NOT. The search was conducted online and accessed the PubMed, Science Direct, Google Scholar, and ResearchGate databases using the keywords "Garlic Extract as a Root Canal Irrigant" and "Anti-Microbial Efficacy of Garlic Extract in Endodontic Treatment." The article search specialized in journal articles in English and Indonesian. The expected result of this research literature review is that garlic extract has antimicrobial properties and can be used as a non-toxic, bactericidal, and antibiotic-resistant root canal irrigant.

## RESULTS

### Properties of Garlic Extract and its Potential as Dental Root Canal Irrigation

Garlic (*Allium sativum L.*) has high medicinal value and is used to cure various human diseases. It has anti-inflammatory, rheumatologic, ulcer-inhibiting, anticholinergic, analgesic, antimicrobial, antistress, antidiabetic, anticancer, liver protection, anthelmintic, antioxidant, antifungal, and wound-healing properties.[6] The main active component of garlic is alicin which destroys the cell walls and cell membranes of bacterial root canals. Alicin can prevent spore germination and hyphal growth. Concentrated garlic extract (95%) contains 34% alicin, 44% total thiosulfinate, and 20% vinyldithiins which are believed to be responsible for antimicrobial activity.[7]

The alicin extract from garlic has antimicrobial and therapeutic effects, indicating its potential for use as a root canal irrigator. There are several in vitro studies that have confirmed the antimicrobial action of garlic on microorganisms, such as Enterococcus faecalis and Candida albicans, that inhabit the root canal system.[8] One of the important properties of sodium hypochlorite (NaOCl) as a potent root canal irrigator is its ability to penetrate into the dentinal tubules. Several studies have been conducted to examine and analyze the dentin penetration ability of various concentrations of sodium hypochlorite (NaOCl). Studies proved that 6% sodium hypochlorite (NaOCl) showed the highest dentin penetration. In a study conducted by Birring, Viloria, and Nunez (2015), it was seen that 70% GE concentration showed good dentin penetration similar to 5.25% sodium hypochlorite (NaOCl).[2] In a study conducted by Mehta et al (2020), it was found that garlic showed substantial antibacterial action without any side effects on patients, so it can be considered an endodontic irrigator.[8]

In a study conducted by Ghoddusi et al (2021) it was found that 2.5% sodium hypochlorite and garlic extract as intracanal irrigation significantly reduced the number of intra-canal bacteria in infected root canals and further research is still needed to consider garlic as an alternative in root canal treatment. Therefore, it can be concluded that this study shows that garlic extract has potential as a root canal irrigator due to the antibacterial properties and biocompatibility of garlic extract itself. However, further research is needed to determine its effectiveness and safety in different clinical situations.[5]

### Comparison of Antimicrobial Efficacy of Garlic Extract with Commonly Used Endodontic Materials

#### Garlic (*Allium sativum L.)*

Garlic is a perennial herbaceous plant that forms layered bulbs. This plant grows in clumps and stands upright to a height of 30-75 cm. The stem that appears above the ground is a pseudo stem consisting of leaf midribs. While the actual stem is in the soil. From the base of the stem grow many small fibrous roots with a length of less than 10 cm. The roots that grow on the main stem are the rumen, which also functions as a sucker for food.[9]

Garlic have 33 sulfur components, some enzymes, 17 amino acids, and many minerals, for example selenium. Garlic has a larger sulfur component compared to other Allium species. It is this sulfur component that gives garlic its characteristic odor and various medicinal effects. A very important sulfur compound of garlic is alicin. When garlic bulbs are crushed or cut, they activate the enzyme allinase which metabolizes allin into alicin. Alicin not only has antibacterial effects but also anti-parasitic and antiviral effect.[9]

The odor produced by garlic can be considered a drawback of using extracts of thesubstance in endodontic treatment. Garlic has a pungent odor that is unpleasant for both patients and dental professionals. However, this can be overcome by using garlic in combination with


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other ingredients such as lemon or lime to mask the odor. Therefore, although the smell of garlic may be detrimental, it can be minimized by using it in conjunction with other ingredients.[10]

**Sodium Hypochlorite (NaOCl)**

Sodium hypochlorite (NaOCl) is an irrigation agent that is often used as a root canal disinfection solution. The usual concentration used as irrigation material is between 0.5%-5.25%. This material has the advantage of being able to dissolve vital and necrotic tissue, has broad-spectrum antibacterial power, has lubrication ability, and is relatively cheap and easy to obtain. However, sodium hypochlorite (NaOCl) irrigation solution has disadvantages, namely that it is toxic when used in high concentrations and is unable to clean the smear layer in the tooth root canal.[11]

Sodium hypochlorite (NaOCl) has a deproteinizing effect that can convert insoluble proteins into soluble polypeptides and amino acids that it can cause a significant decrease in attachment strength.[12]

The following is a table comparing the antimicrobial efficacy of sodium hypochlorite (NaOCl) and garlic extracts as root canal irrigation materials (Table 1 and 2). Sodium hypochlorite (NaOCl) and garlic (Table 1) are effective antimicrobial agents with comparable capabilities.

The respective advantages and disadvantages of sodium hypochlorite (NaOCl) and garlic are shown in Table 2. Based on the comparison shown, both are considered good endodontic irrigants, but sodium hypochlorite (NaOCl) can be toxic and garlic has an unpleasant odor.

## DISCUSSION

**Clinical Application of Garlic Extract as Dental Root Canal Irrigation**

Research conducted by Elheeny (2019) shows the clinical application of Garlic extract with the following mechanism: A total of 100 g of garlic cloves were cleaned, peeled, and dried.[15] Ethanol with a concentration of 70% was added with a duration of 60 seconds. The garlic cloves were then placed in a laminar airflow chamber to evaporate the remaining ethanol. Using a sterile mortar and pestle, the garlic cloves were aseptically homogenized and filtered through double-layer paper. The fully concentrated extraction yield was diluted to 25% concentration with distilled water.[14-16]

Another way of extracting has been conveyed through research conducted by Ghoddusi et al (2021) in a way: 200 g of clean and peeled garlic cloves were crushed and mixed with 200 ml of distilled water.[5] The mixture was filtered through double filter paper and centrifuged for 10 minutes at 5000 rpm to precipitate the garlic particles. The extracted liquid was used at different concentrations to determine the MIC (minimum inhibitory concentration) and MBC (minimum bactericidal concentration) of the garlic extract. A sterile syringe filter (0.22 μ) was used to sterilize the extract[5].

The appropriate contact time to achieve maximum antimicrobial efficacy of garlic extract in the root canal is 5 minutes.[1] Several studies have shown that the antimicrobial efficacy of 2.5% sodium hypochlorite (NaOCl) with a

**Table 1.** Comparison of antimicrobial efficacy of sodium hypochlorite (NaOCl) and garlic extracts

| Irrigation Material | Antimicrobial Efficacy |
|---|---|
| Sodium Hypochlorite (NaOCl) | Widely used and effective due to its tissue dissolving and antimicrobial properties.[13] |
| Garlic (*Allium sativum L.*) | An antimicrobial that is comparable to sodium hypochlorite (NaOCl) against pathogenic bacteria, even some strains that are resistant to antibiotics. Has the ability to remove inorganic tissue and has good antibacterial capacity, with lower side effects.[14] |

**Table 2.** Advantages and disadvantages of sodium hypochlorite (NaOCl) compared to garlic

| Material | Advantages | Disadvantages |
|---|---|---|
| Sodium Hypochlorite (NaOCl) | Sodium hypochlorite (NaoCl) can dissolve vital and necrotic tissue, has broad spectrum antibacterial power, has lubricating ability and is easily obtained.[11] | It is toxic when used in high concentrations and is unable to clean the smear layer in the root canal.[11] |
| Garlic (*Allium sativum L.*) | Garlic can activate the enzyme allinase which metabolizes allin into alicin. Allisin not only has antibacterial effects but also antiparasitic and antiviral effects.[10] | It has a pungent odor that is unpleasant for patients and dental professionals.[12] |


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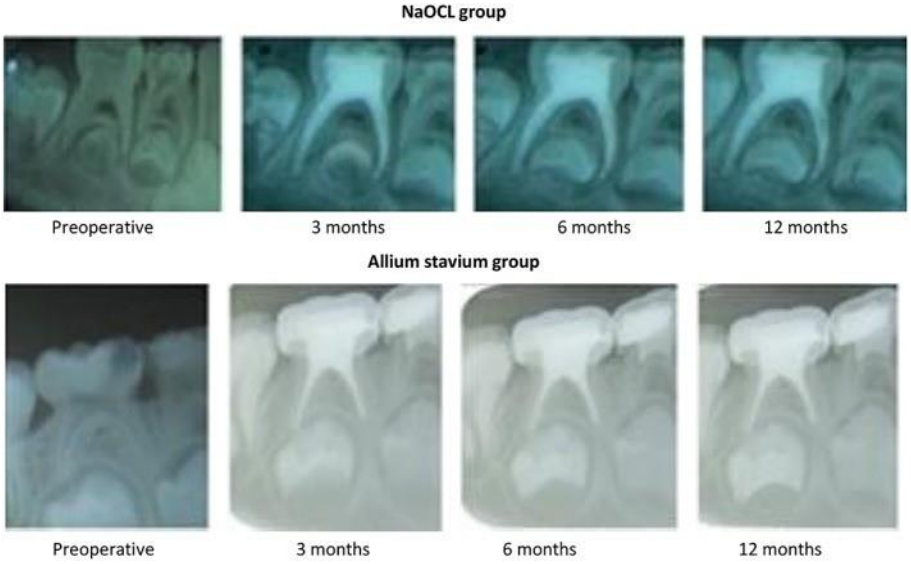


**Figure 1.** Comparison of periapical radiographs of successful pulpectomy with garlic extract and sodium hypochlorite (NaOCl) on the lower right first molar tooth[15].

contact time of 5 minutes is similar to that of 5.25% sodium hypochlorite (NaOCl) with a contact time of 30 seconds to 2 minutes.[5] This is proven by the success of pulpectomy treatment using garlic extract and sodium hypochlorite (NaOCl) irrigation materials (Figure 1).

Studies have shown that garlic extract had a clinical success rate of 80%, while sodium hypochlorite (NaOCl) irrigation showed 88.5%. Radiographic assessment showed success rates of 72.7% and 89.1% for the test and control groups, respectively. First molar teeth irrigated with garlic extract had similar success rates at 6 and 12 months, while first molar teeth irrigated with NaOCl showed 87.3% and 89.1% success.[15]

**Effectiveness and Side Effects of Using Garlic Extract as Dental Root Canal Irrigation**

The complex nature of the deciduous root canal system going through endodontic treatment allows the spread of pathogenic microbes through the lateral and accessory canals, dentinal tubules, apical ramifications, and possibly damaging the germ of the permanent replacement tooth, and consequently, these barriers make complete removal of necrotic tissue by instrumentation alone impossible.[17] Therefore, irrigation is a mechanical instrumentation refilling step during root canal preparation to create a disinfecting environment inside the root canal.[14] Another important function of intracanal irrigation is to remove the smear layer that increases dentin permeability and allows intracanal drug permeation.[15]

Herbal extracts from garlic can be used as an alternative to sodium hypochlorite (NaOCl). Garlic has therapeutic effects through its broad-spectrum antibacterial effects as well as smaller cytotoxic effects.[14,18] Various studies have shown that raw garlic extracts have bactericidal effects against many pathogenic bacteria, even some antibiotic-resistant strains.[1,3] It has been proven through previous in-vitro studies that garlic as a nutrient has no genotoxicity and mutagenicity and does not cause cytotoxicity for human gingival fibroblasts.[19]

The only problem encountered in the clinical application of garlic extracts as dental rootcanal irrigants is the pungent odor of its sulfur compounds. Although these compounds are responsible for the antimicrobial activity of garlic, they cannot be completely removed from the composition of the extract. The addition of flavoring agents to the irrigant can help make the aroma more acceptable to patients.[5]

In conclusion, garlic extract has antimicrobial effects, dentin penetration, as well as good root canal irrigation ideal properties in endodontic treatment. Further research needs to be done to analyze the utilization of garlic extract in treatments in the field of conservation as well as in other fields of dentistry.

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