

Assessment of the potential of *Allium sativum* oil as a new medicament for non-vital pulpotomy of primary teeth

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Abstract

Objective: The objective of this study was to compare the clinical and radiographic effects of *Allium sativum* oil and formocresol in nonvital pulpotomy in primary teeth. **Materials and Methods:** Twenty children ranging in age from 4 to 8 years were included in the study. In every one of those children, pulpotomy was indicated for the primary molars. Pulpotomy procedure was performed and the radicular pulp tissue of one molar was capped with *A. sativum* oil in a cotton pellet while the other molar was capped with formocresol. The teeth were evaluated clinically and radiographically before and after 6 months using standard clinical and radiographic criteria. Statistically, these results revealed significant difference between the radiographic findings of nonvital pulpotomy in primary molars with the two medicaments. Statistical analysis was performed using independent *t*-test and paired *t*-test at the significance level of $\alpha = 0.05$. **Results:** *A. sativum* oil has potent antibacterial properties that enable it to combat intracanal microbes in the infected pulp of primary molars. Better results were obtained when *A. sativum* oil was used. **Conclusion:** *A. sativum* oil had more powerful effects than formocresol on the infected pulp of primary nonvital molars.

Key words: *Allium sativum*, formocresol, pulpotomy

INTRODUCTION

Dental caries is one of the most common chronic diseases affecting millions of people.^[1] Caries activity usually causes tooth decay or cavities and can even lead to the loss of afflicted teeth, which is particularly harmful to children's growth and development. The World Health Organization (WHO) reported that 60–90% of school children experience caries globally.^[2] Preservation of the remaining vital portion of curiously exposed pulpal tissue in primary teeth,

where the demand is to keep a functioning tooth in site, was one of the most frequent problems in pediatric dentistry.^[3] To solve this problem, pulpotomy therapy was introduced, developed, and classified according to treatment objectives.^[4] Pulpotomy is amputation of the coronal portion of the affected or infected dental pulp and treatment of the remaining vital radicular pulp tissue surface for preserving the vitality and function of all or part of the remaining radicular portion of the pulp.^[5] Furthermore, it is an accepted procedure for treating both primary and permanent teeth with

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carious pulp exposures. Several materials have been used for capping the radicular pulp after pulpotomy. These include formocresol, glutaraldehyde,^[6] ferric sulfate, collagen material, and mineral trioxide aggregate.^[7] However, none of them have met the same degree of effectiveness and success rate as formocresol. Possible hazards of formocresol^[8] such as cytotoxicity, carcinogenicity, immunologic, biochemical, mutagenic, and teratogenic changes in the host have been reported.^[9] Moreover, it produced enamel defects in the permanent successors.^[10] A systemic uptake of formocresol has been found from pulpotomized teeth.^[11] The tissue changes have been found to occur in various internal organs, particularly in kidney and liver, and the quantity of circulating formocresol was found to increase with the number of teeth treated.^[12] Hence, increased utilization of indigenous plant medicines in developing countries became a policy of WHO in the 1970s.^[13]

In this regard, a demand for natural medicament to replace formocresol as a pulp dressing material became imperative. Historically, garlic has been used around the world to treat many conditions, including hypertension and infections. Currently, garlic is used for reducing the cholesterol levels and cardiovascular risk, as well as for its antineoplastic and antimicrobial properties.^[14]

Allium sativum is one of the most extensively researched medicinal plants and its antibacterial activity depends on allicin produced by the enzymatic activity of allinase (a cysteine sulfoxide lyase). Allicin and other thiosulfonates are believed to be responsible for the range of therapeutic effects reported for garlic; there is extensive literature on the antibacterial effects of fresh garlic extract.^[15] Garlic extract has been reported to inhibit growth of various gram-positive and gram-negative bacteria.^[16]

A. sativum extract has been known to have inhibitory activity on various pathogenic bacteria, viruses, and fungi. The inhibitory activity of garlic extract on multidrug-resistant (MDR) strains of *Streptococcus mutans* isolated from human carious teeth has been reported.^[17] Interest in medicinal plants has burgeoned due to the increased efficacy of new plant-derived drugs and the growing interest in natural products. Because of the concerns about the side effects of conventional medicine, the use of natural products as an alternative to conventional treatment in healing and treatment of various diseases has been on the rise in the last few decades.^[18]

Aim of the study

The aim of this study was to compare the clinical and radiographic effects of *A. sativum* oil with those of

formocresol in mortal pulpotomy in primary teeth.

MATERIALS AND METHODS

A total of 20 children with age ranging from 4 to 8 years were selected from the outpatient clinic of Pediatric Dentistry Department, Faculty of Dental Medicine, AlAzhar University. Every one of those children had a pair of nonvital primary molars (upper or lower second primary molars).

Ethics of the study

- Caregiver's approval was taken
- Approval of Faculty of Oral and Dental Medicine, Al-Azhar University, Egypt (under number 327/2013) was obtained.

Inclusion criteria

- Patient's and parental cooperation
- Absence of any systemic disease which would contraindicate pulp therapy
- No previous history of antibiotic therapy for at least 2 weeks
- Presence of clinical signs or symptoms suggesting a non-vital tooth, such as localized swelling, suppurating sinus, tenderness on percussion, or slight mobility
- Possibility for establishing a final restoration of the tooth.

Radiographic criteria

- No pathological external or internal root resorption
- No periodical radiolucency
- No calcific pulp degeneration.

Technique

A rubber dam was used to isolate the designated molar. Cavity outline was established with a sterile, #330, high-speed, pear-shaped carbide bur with air/water spray. Caries was removed with a slow-speed, sterile, round, steel bur. Access to pulp chamber could be detected with a probe. The roof of the pulp chamber was removed with a sterile, non-end cutting, slow-speed bur. Removal of the coronal pulp tissue was achieved with a sterile, low-speed carbide round bur No. 6 and/or sharp, large spoon excavator.

The pulp stumps of molars in the right side were dressed with a cotton pellet damped with *A. sativum*

oil [Captin Company (CAPpharm) registration No. 952/94, Cairo, Egypt] and in the left side with a cotton pellet damped with formocresol (Petrópolis-RJ-Industria Brasileira, Dentsply, Latin America) for 1 week. Then, temporary filling was added. After 1 week, the temporary filling and cotton pellet were removed and the pulp stumps of molars treated with *A. sativum* oil were dressed with zinc oxide–*A. sativum* oil paste, while those of teeth treated with formocresol were dressed with a thick paste prepared by mixing zinc oxide powder with one drop of eugenol. Then, a layer of intermediate restorative material zinc phosphate cement had been placed over the dressing materials. After that, the molars were restored with suitable final restoration and then with stainless steel crowns. The molars were clinically and radiographically evaluated after 6 months using standard clinical and radiographic criteria.

Clinical evaluation

History of pain related to the treated molars

- Sensitivity to percussion
- Teeth mobility
- Signs of erythema, swelling, and the presence of fistulous tract in the surrounding gingival tissues and mucosa.

Radiographic evaluation

Periapical radiographs were taken for all treated molars (ultra-speed Kodak Periapical films, size 0 or 1 film). All radiographs taken during the follow-up period were screened for their diagnostic quality prior to being included in radiographic evaluation. Acceptable radiographs should have non-distorted images of the treated molars and the osseous structures immediately adjacent to the roots. Radiographs that did not meet these criteria were excluded from the evaluation.

During radiographic evaluation, the following were determined:

- Presence or absence (or reduction in size) of furcation or periapical radiolucency
- Presence or absence of pathologic internal or external root resorption
- Presence or absence of widening in the periodontal membrane.

Statistical analysis was done between the clinical and radiographic effects of *A. sativum* oil and those of

formocresol in non-vital pulpotomy in primary teeth using *t*test and the level of significance was taken as $P \leq 0.05$.

RESULTS

Clinical findings

The clinical findings of the primary molars after 6 months of treating with *A. sativum* oil were as follows. Of the 20 non-vital pulpotomies, 2 cases complained of pain. Tenderness to percussion was not present. There was no tooth presenting with a draining sinus, gingival inflammation, and increased mobility.

The clinical findings of primary molars after 6 months of treatment with formocresol were as follows. Only two teeth exhibited a draining sinus, gingival inflammation, and mobility. Four cases had pain and tenderness to percussion. These findings were considered as a treatment failure case. For this reason, subtotal pulpectomy was performed for them. Comparisons between the clinical findings of vital pulpotomy in primary molars treated with *A. sativum* oil and formocresol are presented in Table 1 and Figure 1.

Statistically, these results revealed the differences between the clinical findings of non-vital pulpotomy in primary molars treated with either *A. sativum* oil or formocresol throughout the study interval.

Radiographic findings

The radiographic outcomes of primary molars after 6 months of treatment with *A. sativum* oil Figure 2. Among the 20 non-vital pulpotomies, 8 had widening in the periodontal membrane space and 8 showed periapical radiolucency throughout the follow-up

Table 1: Comparison between the effects of *A. sativum* oil and formocresol on the clinical findings of non-vital primary teeth after 6 months

Clinical findings	<i>A. sativa</i>		Formocresol	
	Count	Percentage	Count	Percentage
Postoperative pain	2	10	4	20
Tenderness to percussion	0	-	4	20
Gingival inflammation	0	-	2	10
Draining sinus	0	-	2	10
Increased mobility	0	-	2	10

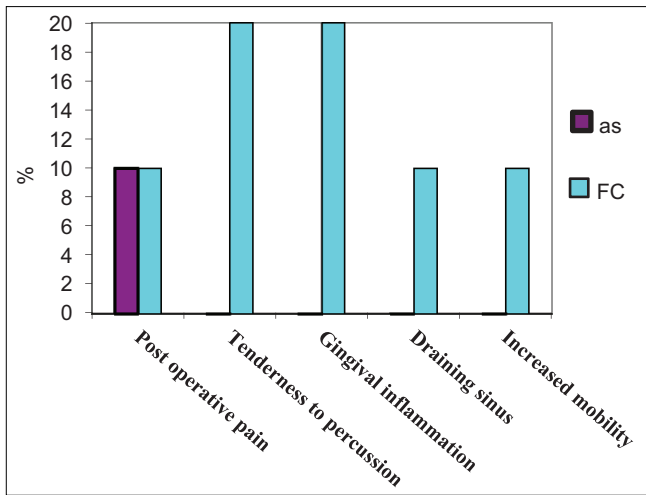


Figure 1: A histogram showing a comparison between the effects of *A. sativum* oil (AS) and formocresol (FC) on the clinical findings at 6 months postoperatively

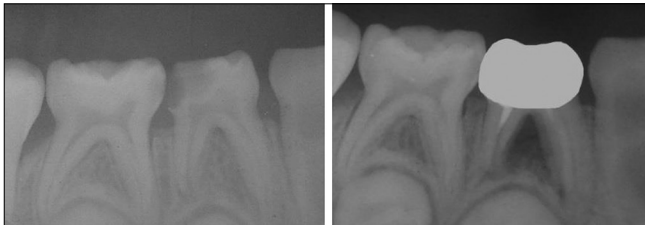


Figure 3: Radiographic features of the teeth treated with formocresol. (a) preoperative radiograph (b) Primary molars showed no changes at 6 months postoperatively

period. Four cases exhibited furcation radiolucency. None of the treated molars exhibited root resorption.

The radiographic outcomes of teeth after 6 months of treatment with formocresol are given in Figure 3. Of the 20 non-vital pulpotomies, 12 showed radiographic changes. Widening in the periodontal membrane space, periapical radiolucency was present in 12 cases. However, 8 showed furcation. None of treated molars exhibited root resorption.

Comparisons between the radiographic findings associated with the two medicaments in non-vital pulpotomy performed in primary molars are presented in Table 2 and Figure 4. Statistically, these results revealed significant difference between the radiographic findings of vital pulpotomy in primary molars with the two medicaments.

DISCUSSION

Pulpotomy means removal of the coronal portion of the affected dental pulp and treatment of the remaining radicular pulp tissue. Furthermore, it is an accepted



Figure 2: Radiographic features of the teeth treated with *A. sativum*. (a) preoperative radiograph (b) Primary molar showed no changes at 6 months postoperatively

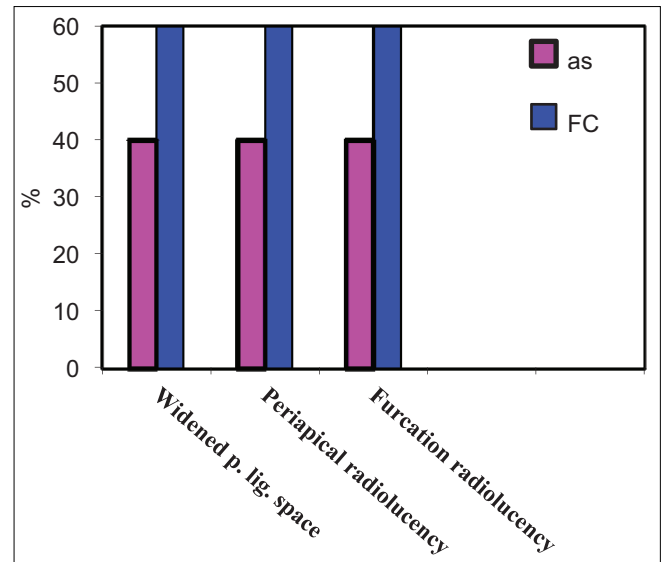


Figure 4: A histogram showing comparison between the effects of *A. sativum* oil and formocresol on the radiographic findings at 6 months postoperatively

Table 2: Comparison between the effects of *A. sativum* oil and formocresol on the radiographic findings of non-vital primary teeth after 6 months

Radiographic findings	<i>A. sativa</i>		Formocresol	
	Count	Percentage	Count	Percentage
Widened periodontal ligament space	8	40	12	60
Periapical radiolucency	8	40	12	60
Furcation radiolucency	4	20	8	40

procedure for treating both primary and permanent teeth with carious pulp exposures. Pulpotomy has become the dominating pulp therapy for deciduous dentition because of the complicated anatomy of the root canals in the primary teeth, the proximity of the permanent tooth germ, and the difficulties in finding a root canal filling material compatible with physiological root resorption.^[19] So, pulpotomy is indicated for teeth with deep carious lesion with no history swelling, presence of fistula, or tooth mobility;

primary teeth with vital pulp exposure as a result of carious process; absence of radiographic evidence for internal or external root resorption or radiolucency in the furcation area; no more than one-third of physiological root resorption; and possibility for further tooth restoration. Pulpotomy is not suitable for teeth when there is perforation of the floor of pulp chamber, internal or external root resorption, and inability to isolate the tooth.^[20]

A number of studies on this alternative therapeutic system as well as its use for several purposes have been reported. It serves as a therapeutic alternative, safer choice, or in some cases, the only effective treatment. People in separate cultures and places are known to have used the same plants for similar medical problems.^[18]

Nigella sativa oil (NS) extracted from black seed was used in pulpotomies for dogs. This study conducted a histopathological comparison of Formocresol and NS pulpotomies in dogs. Specimens in NS groups showed mild to moderate vasodilatation, continuous odontoblastic layer, and few samples showed scattered inflammatory cell infiltration.^[21]

In spite of the large number of pharmacological studies carried out worldwide on *A. sativa*,^[22] scrutiny of the published articles showed that there is a need to investigate its application in dental practice. Therefore, this study was the first to find out the effect of *A. sativa* in treatment of pulpal affected primary teeth.

Teeth included in the present study were non-vital primary molars in which the infected coronal pulp remained and, hence, microorganisms invaded the radicular pulp resulting in irreversible pulpitis and necrosis. At this stage, the radicular pulp is unable to recover and the preferred treatment is pulpectomy.^[23] However, pulpectomy of primary molars is often impractical because of difficulty in obtaining adequate access to the root canals in small mouth openings of children, as well as the complexity of the root canals (ribbon shaped, lateral branching, and ramifications). Therefore, non-vital (mortal) pulpotomy technique is often used and preferred by clinicians.^[24]

In this study, a comparison between the clinical and radiographic outcomes of *A. sativum* oil and formocresol as pulpotomy medicaments in primary molars was successfully made.

Since formocresol is still considered the standard in primary teeth pulp therapy, it was used in the

present study as a control. Because of its hazardous effects, it produced enamel defects in the permanent successors.^[25] A systemic uptake of formocresol has been found from pulpotomized teeth; lead to tissue changes in various internal organs, particularly in kidney and liver, and in lymphatic and venous vascular flow due to uptake from the coronal pulp. This formocresol distributed apically and to the regional vascular vessels. Therefore, the local insult results in systemic distribution.^[26]

The quantity of circulating formocresol was found to increase with the number of teeth treated. It is known to have toxic, mutagenic, and carcinogenic potential. Considering these facts, the formaldehyde component of formocresol during a pulpotomy is insignificant.^[27] In this regard, a demand for medicament to replace formocresol as a pulp dressing material became imperative.

Despite the penetration of modern medicine, traditional medicine continues to be a viable health alternative for the large underprivileged sections of the world. Medicinal plants constitute a promising source of several drugs. Among the promising medicinal plants, *A. sativa* is considered to be an amazing herb with a rich historical and religious background.^[16] In spite of the fact that *A. sativa* oil was used for the first time in treatment of vital primary molars, the results were remarkable and promising, as none of the succeeded cases showed any signs or symptoms of morbidity during the entire follow-up period. Moreover, no obvious radiographic changes were noticed during the recall visits.

Results of the present study revealed that the success rate of treatment with *A. sativum* oil was 95%, while the success rate of treatment with formocresol was 80%. Indeed, these results confirm the success rate of formocresol in treatment of non-vital pulps of primary molars and it is in agreement with other studies; however, the success rate of formocresol in the present study was lower than that suggested by others. Rölling and Thylstrup, in their study, reported 100% clinical success rate with formocresol.^[28]

The promising clinical outcome of vital pulpotomy performed with *A. sativum* oil may be explained based on the following reasons. The oil was found to possess potent analgesic and anti-inflammatory properties and it is used in the folk medicine for treatment of toothache without any side effects. The analgesic effect might be due to ajoene and diallyl sulfide

which inhibit prostaglandin. The anti-inflammatory effect of *A. sativum* has been reported by several investigators.^[29] ajoene inhibits prostaglandins through the suppression of cyclooxygenase (COX) enzyme in the inflamed area and inflammatory cytokines. It also inhibits prostaglandins through suppression of 5-lipoxygenase enzyme. In addition, Allicin and ajoene (component of *A. sativum*) appear to inhibit nitric oxide (a pro inflammatory mediator) which leading to anti inflammatory effect.^[30]

In the present study, radiographic investigation revealed an improvement in both *A. sativum* oil and formocresol treated teeth at the end of the follow-up period. This finding agrees with those of other investigators.^[31] The clinical and radiographic results revealed success at the aforementioned interval. If the recall periods had been continued longer, complete resolution of these changes would have occurred. Statistical analysis revealed significant difference between the effects of both medicaments on the clinical and radiographic outcomes.

CONCLUSION

- *A. sativum*oil has potent antibacterial properties that enable it to combat intracanal microbes in the infected pulp of primary molars
- As the usage of *A. sativum* oil in the pulp treatment of vital and non-vital primary molars was promising, this will encourage dentists to use it in the future as an alternative to formocresol.

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Conflicts of interest

There are no conflicts of interest.

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