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STUDY ON THE USE OF ACTIVE BIOLOGICAL SUBSTANCES IN ENDODONTIC IRRIGATION

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ABSTRACT

Aim of the study Sodium hypochlorite is widely used in endodontics due to its strong antimicrobial and tissue-dissolving properties, but its cytotoxicity and risk of extrusion raise safety concerns. These limitations have sparked interest in biologically active, plant-based alternatives that may offer safer and more biocompatible irrigation solutions. **Materials and methods**: A structured questionnaire was distributed online to 100 participants, with 50 valid responses analysed. The survey assessed clinical experience, preferred irrigation solutions, incidence of complications, and attitudes toward phytotherapeutic alternatives. **Results** Sodium hypochlorite was the primary irrigant for 82% of respondents, while 40% reported irrigation-related accidents, mainly involving NaOCl. Although only 14% had used biological irrigants, 96% expressed willingness to adopt them in future practice. EDTA was the preferred agent for smear layer removal (88%), and a growing interest in natural compounds was observed across all experience levels. **Conclusions** There is strong professional interest in integrating biologically active irrigants into clinical practice. While sodium hypochlorite remains dominant, the demand for safer, non-toxic alternatives supports continued research and development of standardized bio-irrigant formulations The abstract of the paper is to be written here. It contains the main ideas and original contributions and conclusions of the authors' research. It will be structured as shown here. This is a model.

Key words: endodontics; sodium hypochlorite; bio-irrigants; EDTA; plant-based irrigants; herbal alternatives;

INTRODUCTION

Endodontics has undergone significant evolution since its inception, transitioning from rudimentary methods to sophisticated techniques aimed at preserving natural dentition. A pivotal aspect of root canal therapy is the effective disinfection of the root canal system, which is often complicated by the intricate anatomy and the presence of resilient microbial biofilms.

Traditionally, chemical irrigants such as sodium hypochlorite (NaOCl) and chlorhexidine (CHX) have been employed to achieve microbial control within the canal system. NaOCl is renowned for its potent antimicrobial properties and its ability to dissolve organic tissue; however, its high cytotoxicity and potential to cause tissue irritation pose significant clinical concerns. Moreover, inadvertent extrusion beyond the apex can lead to severe complications, including pain and swelling [1].

CHX, on the other hand, offers broad-spectrum antimicrobial activity with lower cytotoxicity compared to NaOCl. Its substantivity allows for prolonged antimicrobial effects; however, it lacks tissue-dissolving capabilities and can form precipitates when mixed with NaOCl, potentially obstructing dentinal tubules [2].

The limitations associated with

conventional irrigants have spurred interest in alternative solutions that are both effective and biocompatible. In this context, natural plant-based extracts have emerged as promising candidates. Herbal irrigants such as those derived from Azadirachta indica (neem), Triphala, Aloe vera, and Curcuma longa (turmeric) have demonstrated antimicrobial efficacy against common endodontic pathogens like Enterococcus faecalis and Candida albicans, while exhibiting lower toxicity profiles [3,4].

Furthermore, these natural substances often possess anti-inflammatory and antioxidant properties, which may contribute to improved healing outcomes. For instance, Triphala, an Ayurvedic formulation, has shown comparable antibacterial activity to NaOCl in vitro, suggesting its potential as an effective irrigant [5].

The integration of herbal irrigants into endodontic practice aligns with the growing emphasis on holistic and patient-friendly treatment modalities. However, despite encouraging preliminary findings, there remains a need for comprehensive studies to evaluate the efficacy and safety of these natural alternatives in clinical settings.

This study aims to assess the antimicrobial effectiveness and biocompatibility of selected active biological substances derived from plants when used as endodontic irrigants. By comparing their performance to conventional agents, the research seeks to explore the viability of incorporating these natural compounds into routine endodontic therapy. strongly recommend this template to be used for writing the article.

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MATHERIALS AND METHODS

To highlight the most recent findings regarding the use of phytotherapy in dental medicine—specifically in endodontic irrigation procedures—and to evaluate practitioners' openness toward using such alternative treatments, as well as to observe current trends in irrigation solutions, the following questionnaire was proposed as part of this study.

The questionnaire includes multiple questions related to the professional environment, level of experience, frequency of endodontic procedures, the irrigation solutions used during such procedures, and the incidence of adverse events and complications encountered in patients.

The final section of the questionnaire targets practitioners' knowledge of natural irrigation solutions, their use in current practice, their interest in such products, as well as their willingness to adopt and use them in the future.

The online questionnaire was distributed in the form of a link to a sample of 100 individuals, of whom 50 responded. The data were recorded, entered into a table, and interpreted as percentages (Table 1).

Table 1. Endodontic Irrigation Questionnaire

No.	Question	Response Options
1	What is your level of experience in the field?	- Final-year dental student- Practicing dentist < 5 years- Practicing dentist > 5 years
2	Your gender:	- Male- Female
3	The environment	- Rural- Urban

No.	Question	Response Options
	in which you practice:	
4	How frequently do you perform endodontic procedures?	- Often- Occasionally- Rarely
5	Which irrigation solution do you primarily use during endodontic procedures?	- Sodium hypochlorite- Hydrogen peroxide- Chlorhexidine
6	Which solution do you primarily use to remove the smear layer?	- EDTA- Citric acid- Other acids/chelating agents
7	Have you encountered extrusion of irrigation solution into periapical tissues?	- Yes, with NaOCl- Yes, with another substance- No
8	Have any patients experienced adverse reactions to irrigation solutions?	- Yes- No
9	If yes, please specify the adverse reactions observed:	- Open text field
10	Are you interested	- Yes- No
	in using alternatives such as bio-irrigants?	
11	Have you heard about the use of biological irrigants in endodontics?	- Yes- No
12	Have you used bio-irrigant solutions in your current practice?	- Yes- No
13	Would you be willing to use bio-irrigant solutions in your current practice?	- Yes- No
14	On a scale from 1 to 5, how willing are you to use plant-based extracts considering their non-toxicity and biocompatibility?	- 1- 2- 3- 4- 5

RESULTS AND DISCUSSIONS

1. Gender Distribution

Out of 50 respondents, 84% were female (n = 42) and 16% male (n = 8), indicating a predominantly female sample population. This aligns with current demographic trends in dental education and early-career practitioners (Figure 1).

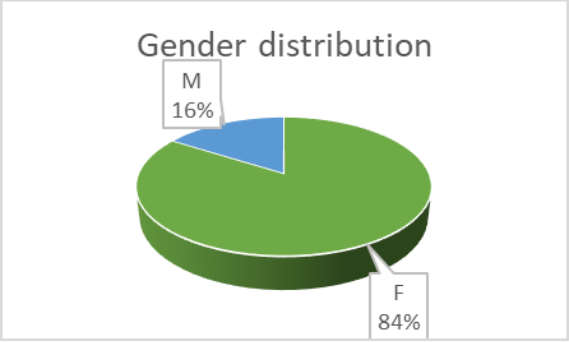

Figure 1. Gender distribution

2. Irrigation Solutions Used

Across all levels of experience, sodium hypochlorite (NaOCl) remains the most commonly used irrigant in endodontic procedures.

Among final-year students, 88% reported using NaOCl, followed by hydrogen peroxide/chloramine and chlorhexidine.

Dentists with less than 5 years of experience showed a similar trend, with 60% preferring NaOCl.

Among those with over 5 years of experience, nearly 80% reported using NaOCl, with limited use of chlorhexidine (5%).

This reflects strong adherence to conventional protocols despite known risks of tissue toxicity (Figure 2).

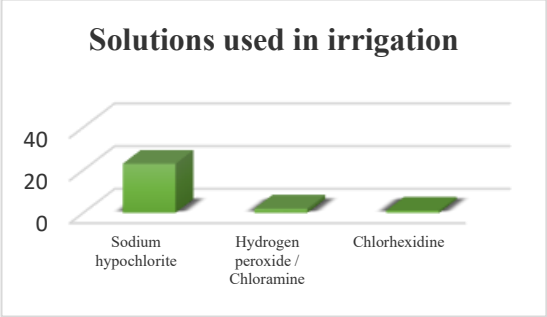

Figure 2. Irrigation Solutions Used

3. Incidence of Sodium Hypochlorite Extrusion

Sodium hypochlorite extrusion into periapical tissues was reported at varying levels:

31% of students encountered at least one such event, with NaOCl involved in 23% of the cases.

Among early-career dentists (<5 years), 60% reported incidents involving NaOCl.

For experienced dentists (>5 years), 37% confirmed similar occurrences.

These findings underline the persistent risk of NaOCl accidents across all levels of practice, especially among newer practitioners (Figure 3).

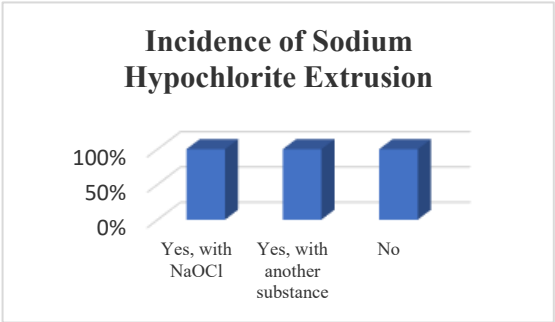

Figure 3. Incidence of Sodium Hypochlorite Extrusion

4. Attitudes Toward Biological Irrigants

Despite limited current use, respondents across all groups showed strong interest in plant-based or biologically active irrigation alternatives:

96% of students indicated a willingness to use bio-irrigants in future practice.

Among dentists with <5 years of experience, 100% expressed interest, although none had used such solutions yet.

95% of experienced dentists were open to adopting bio-irrigants, with nearly half having heard of them and about 25% having used them.

On a Likert scale from 1 to 5, the majority rated 4 or 5, showing high acceptance and perceived value in bio-compatible, non-toxic irrigants. results of some experiments are presented in Table 2.

Table 2. Responses of dental practitioners with less than 5 years' experience regarding Bio-Irrigants

Question	Yes	No
Interested in using biological alternatives to conventional irrigants?	5	0
Heard about the use of biological irrigants in endodontic practice?	0	5
Have used biological irrigants in	0	5

Question	Yes	No
current clinical practice?		
Willing to use biological irrigants in current clinical practice?	5	0

The predominance of female respondents (84%) is consistent with national statistics, which report that 66.16% of Romanian dental professionals were women in 2020 [6]. Most students practice in clinical environments, making their responses current, though limited by institutional constraints such as predefined materials.

A significant disparity in healthcare access persists between urban and rural areas, as confirmed by the fact that only 10% of participants practice in rural settings, aligning with national data showing 88.3% of dentists work in urban areas [6].

Sodium hypochlorite (NaOCl) remains the most widely used irrigant across all respondent categories, with 82% selecting it as their primary agent. Despite its broad antimicrobial activity and tissue dissolution capacity, NaOCl is associated with cytotoxic risks and potential for periapical extrusion. In our study, 40% of respondents reported at least one irrigation-related accident, with NaOCl involved in 32% of these cases.

Alternatives like chlorhexidine and hydrogen peroxide are less frequently used. Chlorhexidine is commonly reserved for final irrigation steps due to its substantivity but lacks tissue-dissolving properties. EDTA remains the preferred chelating agent for smear layer removal, used by 88% of respondents. Although citric acid offers a viable alternative, it is less frequently employed, possibly due to its lower concentration in practice.

Interestingly, 94% of respondents expressed interest in using plant-based or biologically active irrigants. While 34% were aware of such alternatives, only 14% had used them in practice. However, a substantial 96% reported willingness to implement these solutions in the future. This suggests a trend toward more biocompatible, non-toxic, and patient-friendly options.

Current literature supports this shift. Baicalein extracted from Scutellaria baicalensis promotes mineralization and angiogenesis in human pulp cells [7], while genipin from Gardenia shows strong odontogenic potential [8]. Citrus essential oils such as lemon and grapefruit exhibit effective gutta-percha dissolution capacity [9]. Noni (Morinda citrifolia) contains antibacterial compounds that rival conventional irrigants in both safety and efficacy [10].

Furthermore, numerous botanicals—including sage, chamomile, tea tree, rosemary, thyme, and aloe vera—have demonstrated antimicrobial properties against S. mutans, C. albicans, and periodontal pathogens [11]. Additional studies indicate promising outcomes in using herbal formulations in root canal irrigation and pulp therapy [12,13].

Recent contributions [14,15] support these trends, demonstrating the antimicrobial effects of Epilobium parviflorum extracts, as well as the clinical impact of marine-derived formulations and biomarker-based assessments of oral healing.

While the benefits of phytotherapy in dentistry are increasingly documented, further investigations are needed to assess optimal dosages, long-term efficacy, and interactions with conventional agents. Overall, this study underscores a strong professional interest in

shifting toward safer, biologically based irrigation protocols in endodontic treatment.

CONCLUSIONS

1. Sodium hypochlorite remains the predominant endodontic irrigant among dental professionals due to its high efficacy, despite its potential for adverse effects such as cytotoxicity and periapical extrusion. The incidence of irrigation accidents, especially involving NaOCl, highlights the need for safer alternatives.
2. There is a significant professional interest in plant-based and biologically active irrigants, with 96% of respondents expressing willingness to incorporate them into practice. This reflects a broader trend toward biocompatible and patient-friendly materials in endodontic treatment.
3. Phytotherapeutic agents show strong potential as endodontic irrigants, supported by both current literature and practitioner openness. However, further clinical studies are needed to validate their effectiveness, establish safety profiles, and standardize their application in practice.

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