

## SALVADORA PERSICA IN ENDODONTICS: A SCOPING REVIEW

Sunnypriyatham Tirupathi <sup>1</sup>, Supriya Kheur <sup>2\*</sup>, Avinash Kharat <sup>3</sup>,  
Ramesh Bhonde <sup>4</sup>, Nishanth Mante <sup>5</sup> and Dharmarajan Gopalakrishnan <sup>6</sup>

<sup>1</sup> PhD Scholar, Dr. D. Y. Patil Dental College and Hospital,  
Dr. D. Y. Patil Vidyapeeth, Pimpri, Pune, Maharashtra India.

<sup>1</sup> Associate Professor, Department of Pedodontic and Preventive Dentistry,  
Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences  
(SIMATS), Saveetha University, Chennai, Tamil Nadu, India. Email: dr.priyatham@gmail.com

<sup>2</sup> Professor, Oral Pathology and Microbiology, Incharge-Regenerative Medicine Laboratory,  
Dr. D. Y. Patil Dental College and Hospital, Dr. D. Y. Patil Vidyapeeth,  
Pimpri, Pune, Maharashtra India. \*Corresponding Author Email: Supriya.kheur@dpu.edu.in

<sup>3</sup> Scientist C, Regenerative Medicine Laboratory, Dr. D. Y. Patil Dental College and  
Hospital, Dr. D. Y. Patil Vidyapeeth, Pimpri, Pune, Maharashtra India.  
Email: avinsahkharat25@gmail.com

<sup>4</sup> Scientist Emeritus, Regenerative Medicine Laboratory, Dr. D. Y. Patil Dental College and  
Hospital, Dr. D. Y. Patil Vidyapeeth, Pimpri, Pune, Maharashtra India. Email: rrbhonde@gmail.com

<sup>5</sup> Research Assistant, Regenerative Medicine Laboratory, Dr. D. Y. Patil Dental College and  
Hospital, Dr. D. Y. Patil Vidyapeeth, Pimpri, Pune, Maharashtra India.  
Email: nishantmante@gmail.com

<sup>6</sup> Professor and Head, Department of Periodontology, Dr. D. Y. Patil Dental College and  
Hospital, Dr. D. Y. Patil Vidyapeeth, Pimpri, Pune, India. Email: drgopal@dpu.edu.in

DOI: 10.5281/zenodo.11392771

### Abstract

**Background:** *Salvadora persica* is a herbal agent that is shown to have good antibacterial properties used in multitude of applications in dentistry. **Materials and Methods:** PubMed, Scopus, Web of Science, Google scholar. The search was conducted from inception to 1 march 2024. A broader search strategy was used to prevent missing articles. The search was performed using broad terminology ((*Salvadora Persica*) OR (Miswak)) AND (dental). Research gate was also consulted and cross references were also consulted on this topic to extract all the available literature. Invitro, in-vivo, ex-vivo, studies are included for the data synthesis. Exclusion criteria is narrative and systematic reviews. **Results:** A total of 517 titles were screened rigorously by three independent evaluators and after duplicate exclusion, removal of irrelevant titles, 25 articles were included for full text analysis out of which 12 qualified for final data synthesis. **Conclusion:** *Salvadora perisca* has properties such as anti-quorum and antibacterial properties against *E.fecalis* so can be a potential agent to be used in endodontic practice.

**Keywords:** Miswak, Sewak, *Salvadora Persica*, Endodontics.

### INTRODUCTION

Endodontics is a clinical branch of dentistry that specializes in the prevention, diagnosis, and treatment of dental pulp pathosis. Endodontic therapy's major goal is to maintain pulp vitality, save injured or necrotic teeth, and replace damaged teeth while also protecting the health of the root canal system's as well as peri radicular tissues. (1) Endodontic therapy involves various procedures, with the most common being the root canal procedure. For success of Root canal therapy, the chemo mechanical cleaning and shaping along with complete disinfection of the root canals of the teeth are essential. (2). In Traditional root canal therapy, only cleaning and shaping is carried out which effectively remove infections from dentinal tubules, still 9.6-47.6% of the root canal remains untreated post-instrumentation. (3), (4) Root canal system suffers from polymicrobial infection. Microorganisms can persist in root canals

with complex shapes, leading to reinfection, which is why cleaning and shaping alone may not be sufficient. (5) The modern approach to root canal preparation involves removing microbes, their byproducts, and pulp remnants, in addition to cleaning, shaping, and disinfecting. (2) Use of various chemical agents such as Irrigants, Intracanal medicaments, and antibiotics pastes came into light to enhance disinfection and reduce chances for reinfection. (4) Common chemicals used in endodontic treatment include sodium hypochlorite (NaOCl), chlorhexidine, ethylenediaminetetraacetic acid (EDTA), and calcium hydroxide. These substances have strong antibacterial properties and are used for a variety of tasks in the cleansing and disinfection of the root canal system. All of them, meanwhile, are linked to potentially hazardous side effects and unpleasant adverse reactions. Due to the rise of resistance in pathogenic microbes to antibiotics and other medicines, experts are exploring new products and treatment options for oral disorders. Also in 1987, the World Health Organization (WHO) suggested using natural products like herbs and plant extracts to alleviate the side effects of conventional endodontic materials. (6) We are using such herbs and natural products since centuries for oral hygiene purpose. It is important that instead of various hazardous chemicals we can explore use of these materials in field of dentistry specially in endodontics. Herbal medicine, once considered peripheral to medicine, can act as an alternative treatment for various diseases, including oral disease. Herbal extracts offer several benefits when it comes to endodontics: they are inexpensive, readily available, have a longer shelf life, are less toxic, do not harbor microbe resistance, are better accepted by patients, and are renewable. (7) The growing interest in them is due to the abundance of chemically and biologically unscreened plants and the long history of traditional medicine due to their ease of use and natural safety. All these unexplored plants have the potential to provide new and effective treatments for a wide range of health conditions. In general, better patient outcomes and lower treatment costs can result from using herbal extracts in dentistry along with endodontic procedures. (8) *Salvadora persica* is one of the herbs which is unexplored in terms of dentistry. *Salvadora persica*, also known as miswak, is a small tree or shrub with many branches that grows in desert areas of India and belongs to the *Salvadora* family. In conventional medicine, it is frequently used to treat piles, rheumatism, scurvy, cough, and other illnesses. (9) The pharmacological and mechanical actions of miswak contribute to its positive effects on dental health and oral hygiene. It can be used to produce astringent, carminative, diuretic, antiplaque, analgesic, anticonvulsant, antibacterial, antimycotic, cytotoxic, and antifertility effects. Due to chemical elements of the plant, such as silica, trimethylamine, tannins, benzyl-isothiocyanate, saponins, and minor amounts of resin. *S. persica* miswak, a plant has been found to have antimicrobial effects on various microorganisms, including *Candida albicans*, *Streptococcus* sp., *Staphylococcus aureus*, *Enterococcus faecalis*, and more. Research in endodontics highlights the versatile uses of *S. persica* for intracanal medicine, smear layer removal, and root canal irrigation. It has been demonstrated that this natural substitute possesses antibacterial qualities, which makes it a useful choice for preserving dental health throughout endodontic treatments. (4) *Salvadora persica* has been reported to be used as mouthwash effectively reducing the plaque and gingival scores. (10)

Many studies are conducted to evaluate the effects of *Salvadora persica* in Endodontics. So, the aim of this study was to evaluate effective use of *Salvadora persica*'s in endodontic therapies. This scoping review aims to evaluate the effects of *Salvadora persica* in endodontics.

## MATERIALS AND METHODS

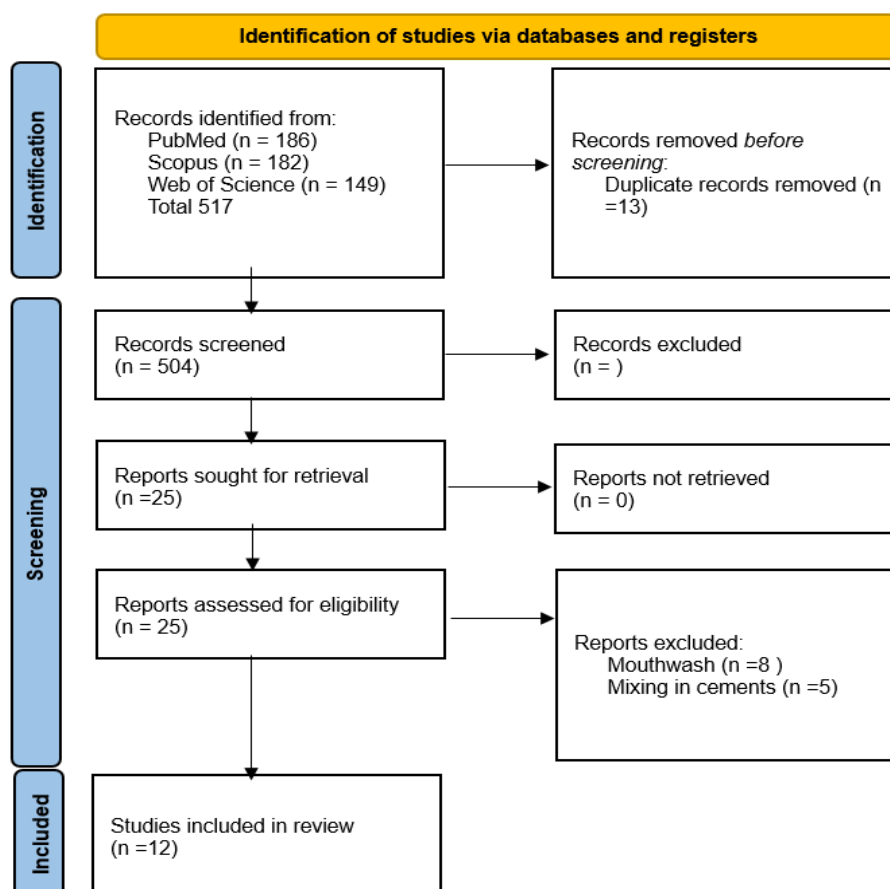
Search strategy is depicted in Table-1 (**Table-1: Search strategy**). Electronic searches were performed in the databases: PubMed, Scopus, Web of Science, Google scholar. The search was conducted from inception to 1 march 2024. A broader search strategy was used to prevent missing articles. The search was performed using broad terminology ((*Salvadora Persica*) OR (Miswak)) AND (dental). Research gate was also consulted and cross references were also consulted on this topic to extract all the available literature. Invitro, in-vivo, ex-vivo, studies are included for the data synthesis. Exclusion criteria is narrative and systematic reviews.

**Table 1: Search Strategy**

Search terms	PubMed	(( <i>Salvadora Persica</i> ) OR (Miswak)) AND (dental)
Search Dates	Inception to 1 March 2024. Last search was performed on 1 March 2024.	
Selection criteria	Inclusion	Clinical studies, Case reports, In-Vitro Studies, Ex-Vivo studies.
	Exclusion	Narrative and systematic reviews

## RESULTS

Extensive literature search was carried out using pre-defined search strategy was carried out. A total of 517 titles were screened rigorously by three independent evaluators and after duplicate exclusion, removal of irrelevant titles, 25 articles were included for full text analysis out of which 12 qualified for final data synthesis. Figure-1: PRISMA flow chart 12 articles were included for final data synthesis. The characteristics of included studies are presented in Table-2.



**Figure 1: PRISMA Flow Chart**

**Table 2: Characteristics of included studies**

S. No	Author-year	Type of study	Suggested Use	Intervention	Comparison	Test model	Objectives evaluated	Antibacterial property	Smear layer removal/Bio-Film	Biocompatibility	Root Dentine related parameters	Conclusion
1	Sharma et al 2023.(11)	Ex-vivo study	Irrigant	Salvadora Persica extract	5.25% Hypo+ 2% Chlorhexidine group, 2% Chlorhexidine alone, saline	Not mentioned clearly	Disk Diffusion Test and Colony Forming unit assay.	The results of disk diffusion method showed that the zone of inhibition for 2% chlorhexidine gluconate was 29 mm for Gram negative anaerobic bacteria and 22 mm for <i>E. faecalis</i> , and the zone of inhibition for Salvadora Persica extract was 8 mm for Gram negative anaerobic bacteria and 10 mm for <i>E. faecalis</i> . Gram negative anaerobic bacteria on the culture plates treated with Salvadora Persica extract had 6.41 CFU/mL, and <i>E. faecalis</i> had 5.21 CFU/mL. Gram negative anaerobic bacteria on the culture plates treated with normal saline had a CFU/mL of 6.77, and <i>E. faecalis</i> had a CFU/mL of 5.77. The antibacterial activity of Salvadora Persica extract was lower than that of other irrigants.				The antibacterial effectiveness of the combination of 5.25% NaOCl and 2% Chlorhexidine gluconate was found to be higher than, 2% Chlorhexidine gluconate, Salvadora Persica extract
2	Aljarbou et al 2022. (12)	In-Vitro	Irrigant	10 mg/ml of ethanolic Salvadora persica	1% Sodium Hypochlorite.		Antimicrobial investigations used Crystal violet assay and live/dead® BacLight™ assay on <i>Pseudomonas aeruginosa</i> and <i>E. faecalis</i> biofilms followed by			AlamarBlue® cell viability testing on human gingival fibroblast cells.		Ethanolic Salvadora persica root extract demonstrated cytotoxic and antimicrobial effects that were significantly weaker than NaOCl exposure.

							confocal laser scanning microscopy (CLSM) imaging. Antimicrobial activity was observed for both irrigation solutions, but NaOCl has significantly stronger antimicrobial effects in the live/dead® assay. NaOCl could reduce the bacterial viability for both species more than <i>Salvadora persica</i> extract in the Crystal violet assay. There were limited effects of <i>Salvadora persica</i> extract on <i>Pseudomonas aeruginosa</i> ; these effects were confirmed on CLSM images.		The <i>Salvadora persica</i> root extract was cytotoxic to gingival fibroblasts but significantly weaker than NaOCl at its highest concentration.		These variations in effects might introduce the herbal extract as an alternative irrigant especially for regenerative endodontic treatments that require great care for cellular components.
3	Abdeltawab et al 2022.(13)	Ex-vivo & In-vitro	Intracanal medication	<i>Salvadora persica</i> extract	Meta paste		Biocompatibility and antibacterial properties  % RCC (Percentage reduction in colony count) of <i>E. fecalis</i> was evaluated at 1,3 and 7 <sup>th</sup> day.  At 1 and 3 <sup>rd</sup> day the greatest amount of % RCC of <i>E. fecalis</i> was there in <i>Salvadora persica</i> extract group  At 7 <sup>th</sup> day there was no significant difference in % RCC of <i>E. fecalis</i> in <i>Salvadora persica</i> and Meta-paste group.		Gingival fibroblastic MTT assay was carried out. Meta paste showed slight cytotoxicity at 1 and 3 days, whereas <i>S. persica</i> showed moderate cytotoxicity		

										. At 7 days, neither material was cytotoxic		
4	Ahmed et al 2021.(14)	In-Vitro	Irrigant	Salvadora persica extract	Green tea extract, Chamomile extract, Naocl	Zone of Inhibition – Disk Diffusion method		Naocl and Green tea extract were better than Salvadora persica extract.				
5	Rosli et al 2021.(15)	In-vitro	-	150 mg/ml alcoholic extract of Salvadora persica  Freeze drying method of extraction	Sodium Hypochlorite.		Antibacterial properties against <i>E. faecalis</i>	150 mg/ml alcoholic extract of Salvadora persica is comparable to Sodium hypochlorite in inhibition of <i>E. faecalis</i>				
6	Ayoub et al 2021.(16)	Ex-vivo	Intracanal medication	Salvadora Persica Petroleum extract	Calcium Hydroxide positive control and saline negative control.	Forty-five single-rooted Mandibular premolars were infected with that of <i>E. faecalis</i> suspension. Colony-forming units (CFU) were counted before the medicaments' application (CFU-1) and after seven days of their applications (CFU-2)	MIC, MBC, CFU	The results showed a significant difference between CFU-1 and CFU-2 in both Salvadora persica ( $P \leq 0.006$ ) or Calcium hydroxide group Ca (OH) <sub>2</sub> ( $P \leq 0.011$ ).  The MIC of Salvadora persica and Ca (OH) <sub>2</sub> were measured to be 3.5 and 4.2 mg/ml, respectively.			Salvadora Persica can efficiently eradicate <i>E. faecalis</i> from the root canal system by many antimicrobial components. It could be used as a good alternative to calcium hydroxide in endodontic therapy	
7	Phillip et al 2021.(17)	In-vivo study	Irrigant	Salvadora Persica extract	2.5% Sodium hypochlorite, Cashew leaves,	100 root segments without any defects were selected	Dentin microhardness was measured with a vickers indenter, and the				Microhardness and flexural strength values of	Salvadora persica as a root canal irrigant do not affect the microhardness

					mango leaves extract, saline.	which were obtained from splitting permanent maxillary canines were divided into five groups of 20 each	flexural strength test was done using a universal testing machine				root dentine in <i>Salvadora Persica</i> group did not decrease significantly as opposed to sodium hypochlorite group where there was significant reduction of Microhardness and flexural strength values.	and flexural strength of root dentine.
8	Gupta et al 2020. (18)	In-Vitro	Irrigant	12.5% <i>Salvadora persica</i> extract	5% NaOCl 20% <i>Thymus vulgaris</i> 10% <i>Acacia nilotica</i> 10% <i>Calendula arvensis</i> .	Zone of Inhibition – Disk Diffusion method		Naocl had the greatest zones of inhibition, there was no significant difference in zones of inhibition of herbal agents.				
9	Al-Sabawi et al 2020.(19)	Ex-Vivo	Intracanal medication	2%, 4%, and 8% <i>Salvadora Persica</i>	<i>Ficus carica</i> latex [FX], <i>F. carica</i> leaves [FL], olive leaves, 2% Chlorhexidine.	Zone of Inhibition – Disk Diffusion method		Ethanollic extracts of 8% FL, 8% OL, and 8% SP roots were effective for the elimination of <i>E. faecalis</i> .				
10	Balto et al 2015. (20)	In-vitro study	Irrigant	1 mg/ml ethanolic extract of <i>Salvadora persica</i>	17 %ethylene diaminetetraacetic acid (EDTA) and Bio Pure MTAD	40 extracted primary tooth were divided into three groups (15- <i>Salvadora persica</i> , 15- BioPure MTAD AND 10-EDTA)	The presence or absence of smear layer at the coronal and middle portion of each canal were examined under a scanning electron microscope (SEM)		MTAD and EDTA were significantly more effective in smear layer removal than <i>S. persica</i> solution at the middle third of the canal wall			At the middle third 17% EDTA and MTAD were more effective than <i>Salvadora Persica</i> extract for biofilm removal .

11	Balto et al 2012.(21)	In-vitro study	Irrigant	1 mg/ml and 5 mg/ml ethanolic extract of <i>Salvadora persica</i>	17 %ethylene diaminetetraacetic acid (EDTA)	Sixty extracted, single-rooted human teeth were cleaned, shaped, and divided into four groups.	The presence or absence of smear layer at the coronal and middle portion of each canal were examined under a scanning electron microscope (SEM)		A significant difference in smear layer removal between groups 1 and 2 at the coronal and middle thirds of the canal was observed, and no significant difference was seen between group 2 and the positive control at the coronal third. At the apical third, both concentrations of <i>S. persica</i> had similar effects and were less effective than the positive control in removing the smear layer.			
12	Shingare and Chaugule 2011. (22)	In-vivo study	Irrigant	12.5% alcoholic extract of <i>Salvadora persica</i>	3% sodium hypochlorite, 11% alcoholic extract of propolis and, 0.9% saline.	40 children with infected primary molars requiring pulpectomy were divided into 4 groups.	The pre- and post-irrigation samples using sterile paper points. Samples were cultured on tryptose soya agar at a temperature of 37°C for 24-48 hours. The colonies were counted with a digital colony counter	The differences in pre- and post- irrigation values were calculated for each group, the greatest difference being seen in Hypo group (95.549%) followed by <i>Salvadora persica</i> group (89.794%), Propolis (34.735%) and saline (28.087%).				<i>Salvadora Persica</i> as an irrigant is as effective as hypo for reducing the bacterial load in infected primary molars.



## DISCUSSION

**Intracanal medicament:** In-vitro study by Abdeltawab et al 2022.(13) and Ex-vivo studies by Ayoub et al 2021 (16) and Al-Sabawi et al 2020.(19) have recommended usage of *Salvadora Persica* as an intracanal medicament. The study by Abdeltawab et al 2022.(13) compared the usage of *salvadora persica* with meta-paste as an intracanal medicament and percentage reduction in colony count % RCC of *E. faecalis* was evaluated on the first, third and seventh day. At first and third day the greatest amount of % RCC of *E. faecalis* was there in *Salvadora persica* extract group. At seventh day there was no significant difference in % RCC of *E. faecalis* in *Salvadora persica* and Meta-paste group. The ex-vivo study by Ayoub et al 2021(3) has compared the usage of *salvadora persica* with calcium hydroxide as an intracanal medicament. Forty-five single-rooted Mandibular premolars were infected with that of *E. faecalis* suspension. Colony-forming units (CFU) were counted before the medicaments application (CFU-1) and after seven days of their applications (CFU-2) The results showed a significant difference between CFU-1 and CFU-2 in both *Salvadora persica* ( $P \leq 0.006$ ) or Calcium hydroxide group  $\text{Ca}(\text{OH})_2$  ( $P \leq 0.011$ ). The MIC of *Salvadora persica* and  $\text{Ca}(\text{OH})_2$  were measured to be 3.5 and 4.2 mg/ml, respectively. *Salvadora Persica* can efficiently eradicate *E. faecalis* from the root canal system by many antimicrobial components. It could be used as a good alternative to calcium hydroxide in endodontic therapy. (3) Al-Sabawi et al 2020 (12) in their ex-vivo study utilized different concentrations (2,4, and 8%) of herbal agents *Ficus carica* latex, leaves, olive leaves, 2% Chlorhexidine as an intracanal medicament. The results of this current study reported that Ethanolic extracts of 8% *Salvadora persica* is effective and comparable to other herbal agents for the elimination of *E. faecalis*.(19)

**Endodontic Irrigation:** In-vitro studies by Aljarbou et al 2022 (12), Ahmed et al 2021 (14), Phillip et al 2021 (17) Gupta et al 2020 (18) Balto et al 2015 (20) and Ex-vivo study by Sharma et al 2023 (11), In-vivo study by Shingare and Chaugule 2011(22) have evaluated the usage of *salvadora persica* as endodontic irrigant. Ex-Vivo study by Sharma et al 2023 (11), have compared *salvadora persica* extract as an intra-canal irrigant and it was compared with 5.25% Hypo+ 2% Chlorhexidine group, 2% Chlorhexidine alone, saline. 5.25% Hypo+ 2% Chlorhexidine group had the best antibacterial property against *E. faecalis* than *salvadora persica*. (11) In-vitro studies by Aljarbou et al 2022 (12) have compared 10 mg/ml of ethanolic *Salvadora persica* to that of 1% Sodium Hypochlorite as an endodontic irrigant and reported that both *salvadora persica* and hypo were effective on *E. faecalis* although hypo solution was more effective. (12) Similar results were reported in the invitro study by Ahmed et al 2021.(14), Gupta et al 2020.(18) where hypo was more effective than *Salvadora Persica* in reducing microbial load of *E. faecalis*. (14)

**Smear layer removal:** Balto et al has evaluated smear layer removal capacity of EDTA, MTAD in comparison to *salvadora persica* and reported that MTAD and EDTA have better smear layer removal capacity in middle and apical third of root canal.(20,21)

**Dentine properties:** The study by Phillip et al 2021(17) have evaluated and compared the mechanical properties of dentine after using sodium hypochlorite and *salvadora persica*, and reported that *Salvadora persica* as a root canal Irrigant do not affect the microhardness and flexural strength of root dentine whereas sodium hypochlorite has significantly reduced the microhardness and flexural strength. (17)

**Bio-Compatibility and Cytotoxicity:** the studies by Aljarbou et al 2022, (12) and Abdeltawab et al 2022 (13) have both reported that salvadora persica has lower cytotoxicity as opposed to sodium hypochlorite.(12)(13)

**Anti-Quorum sensing:** In *E. faecalis*, quorum sensing plays an important role in regulating various virulence phenotypes, including biofilm formation, toxin production, and antibiotic resistance. Understanding this cell communication system can aid in the development of new strategies for controlling infections caused by *E. faecalis*, such as interfering with quorum sensing signals to prevent the expression of virulence genes. Anti-quorum sensing ability of salvadora persica for *E. faecalis* has been demonstrated in the studies by Razei et al 2012 and Kadhim et al 2022. (23,24)

**Limitations of the current review and directions for future research:** Most of the studies included for the current scoping review are in-vitro and ex-vivo studies and in all the studies mostly *E. faecalis* was the only test organism that was used, most of the endodontic flora in the root canal infections are multi-species biofilms so it would be more practical to test the antibacterial efficacy on multi-species biofilms. Most of the studies the concentration of salvadora persica was not stated clearly which is a flaw in the methodology of the conducted manuscript.

## CONCLUSION

Salvadora persica has antibacterial properties that can be of value in endodontic practice, even though it has lesser potency than sodium hypochlorite, the advantageous properties are it does not reduce the micro-hardness and flexural strength of radicular dentine and has an anti-quorum ability against *E. faecalis*.

## References

- 1) Lobprise HB. Principles of endodontic therapy. Semin Vet Med Surg Small Anim. 1993 Aug;8(3):155–64.
- 2) Ayoub N, Badr N, Alghamdi S, Alzahrani A, Nassar A, Qadi R, et al. The Effectiveness of Salavadora persica (Siwak) Petroleum Ether Extract as an Intracanal Medicament used in Endodontic Therapy: An in vitro Study.
- 3) Peters OA, Schöenberger K, Laib A. Effects of four Ni–Ti preparation techniques on root canal geometry assessed by micro computed tomography. Int Endod J. 2001 Apr 21;34(3):221–30.
- 4) Abdeltawab SS, Abu Haimed TS, Bahammam HA, Arab WT, Abou Neel EA, Bahammam LA. Biocompatibility and Antibacterial Action of Salvadora persica Extract as Intracanal Medication (In Vitro and Ex Vivo Experiment). Materials. 2022 Feb 1;15(4).
- 5) Siqueira JF, Magalhães KM, Rôças IN. Bacterial Reduction in Infected Root Canals Treated With 2.5% NaOCl as an Irrigant and Calcium Hydroxide/Camphorated Paramonochlorophenol Paste as an Intracanal Dressing. J Endod. 2007 Jun;33(6):667–72.
- 6) Munirah Che Rosli, Intan Azura Shahdan, Dr Mohd Haikal Muhamad Halil. An In Vitro Study Of Antibacterial Efficacy Of Salvadora Persica (Miswak) Extract Against Enterococcus Faecalis. Malaysian Journal of Science Health & Technology. 2022 Feb 7;8(1):55–62.
- 7) Philip PM, Sindhu J, Poornima M, Naveen DN, Nirupama DN, Nainan MT. Effects of conventional and herbal irrigants on microhardness and flexural strength of root canal dentin: An in vitro study. Journal of Conservative Dentistry. 2021 Jan 1;24(1):83–7.
- 8) Aljarbou F, Almobarak A, Binrayes A, Alamri HM. Salvadora persica 's Biological Properties and Applications in Different Dental Specialties: A Narrative Review. Vol. 2022, Evidence-based Complementary and Alternative Medicine. Hindawi Limited; 2022.

- 9) Khatak M, Khatak S, Siddqui A, Vasudeva N, Aggarwal A, Aggarwal P. *Salvadora persica*. Vol. 4, *Pharmacognosy Reviews*. 2010. p. 209–14.
- 10) Adam FA, Mohd N, Rani H, Mohd Yusof MYP, Baharin B. A systematic review and meta-analysis on the comparative effectiveness of *Salvadora persica* - extract mouthwash with chlorhexidine gluconate in periodontal health. *J Ethnopharmacol*. 2023 Feb;302:115863.
- 11) Sharma R, Panadan JJ, Sharma M, Tanweer SA. Antimicrobial Effectiveness of Different Root Canal Irrigants on Viability of Root Canal Flora. *Journal Of Clinical And Diagnostic Research*. 2023;
- 12) Aljarbou F, Niazy AA, Lambarte RNA, Mothana RA, Binrayes A, Al-Obaida M, et al. Efficacy of *Salvadora persica* root extract as an endodontic irrigant – An in-vitro evaluation. *J Herb Med*. 2022 Jul;34:100564.
- 13) Abdeltawab SS, Abu Haimed TS, Bahammam HA, Arab WT, Abou Neel EA, Bahammam LA. Biocompatibility and Antibacterial Action of *Salvadora persica* Extract as Intracanal Medication (In Vitro and Ex Vivo Experiment). *Materials*. 2022 Feb 12;15(4):1373.
- 14) Mohammed NA, Selivany BJ. Antibacterial Efficacy of Different Herbal Based Irrigant Solutions in Deciduous Teeth. *Journal of Clinical And Diagnostic Research*. 2021;
- 15) Munirah Che Rosli, Intan Azura Shahdan, Dr Mohd Haikal Muhamad Halil. An In Vitro Study Of Antibacterial Efficacy Of *Salvadora Persica* (Miswak) Extract Against *Enterococcus Faecalis*. *Malaysian Journal of Science Health & Technology*. 2022 Feb 7;8(1):55–62.
- 16) Ayoub N, Badr N, Al-Ghamdi SS, Alzahrani A, Alsulaimani R, Nassar A, et al. GC/MS Profiling and Ex Vivo Antibacterial Activity of *Salvadora persica* (Siwak) against *Enterococcus faecalis* as Intracanal Medicament. *Evidence-Based Complementary and Alternative Medicine*. 2021 Dec 27;2021:1–8.
- 17) Philip P, Sindhu J, Poornima M, Naveen D, Nirupama D, Nainan M. Effects of conventional and herbal irrigants on microhardness and flexural strength of root canal dentin: An in vitro study. *Journal of Conservative Dentistry*. 2021;24(1):83.
- 18) Gupta D, Kamat S, Hugar S, Nanjannawar G, Kulkarni R. A comparative evaluation of the antibacterial efficacy of *Thymus vulgaris*, *Salvadora persica*, *Acacia nilotica*, *Calendula arvensis*, and 5% sodium hypochlorite against *Enterococcus faecalis*: An in-vitro study. *Journal of Conservative Dentistry*. 2020;23(1):97.
- 19) Al-Sabawi N, Al-Naimi A, Yahya E. An in vitro and in vivo antibacterial effect of different plant extracts on *Enterococcus faecalis* as intracanal medicament. *Journal of International Oral Health*. 2020;12(4):362.
- 20) Balto H, Salama F, Al-Mofareh S, Al-Yahya F. Evaluation of Different Irrigating Solutions on Smear Layer Removal of Primary Root Dentin. *J Contemp Dent Pract*. 2015 Mar;16(3):187–91.
- 21) Balto H, Ghandourah B, Al-Sulaiman H. The efficacy of *Salvadora persica* extract in the elimination of the intracanal smear layer: A SEM study. *Saudi Dent J*. 2012 Apr;24(2):71–7.
- 22) Shingare P, Chaugule V. Comparative evaluation of antimicrobial activity of miswak, propolis, sodium hypochlorite and saline as root canal irrigants by microbial culturing and quantification in chronically exposed primary teeth. *Germs*. 2012 Dec;1(1):12–21.
- 23) Rezaei A, Oyong GG, Borja VB, Inoue M, Abe T, Tamamura R, et al. Molecular Screening of Anti-quorum Sensing Capability of *Salvadora Persica* on *Enterococcus Faecalis*. *J Hard Tissue Biol*. 2011;20(2):115–24.
- 24) Kadhim E, Amin B, Amin B. Anti-Quorum Sensing Effect of *Salvadora Persica* Against *Enterococcus faecalis* (ATCC 29212). *Open Dent J*. 2022 May 31;16(1).