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The Use of Black Cumin as a Root Canal Treatment Sealer

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ABSTRAK

Keberhasilan perawatan saluran akar sangat bergantung pada penggunaan *sealer* yang mampu menutup saluran secara rapat sekaligus membasmi mikroorganisme patogen di tubulus dentin. Sayangnya, *sealer* konvensional seperti *epoxy resin*, *Zinc Oxide Eugenol* (ZOE), dan *Mineral Trioxide Aggregate* (MTA) masih memiliki kekurangan dalam hal toksisitas, risiko iritasi, serta efektivitas antimikroba yang terbatas. Sebagai alternatif, jintan hitam (*Nigella sativa*) mulai diteliti karena kandungan senyawa bioaktifnya seperti *thymoquinone*, flavonoid, dan tanin yang kaya akan sifat antibakteri, antiinflamasi, dan antijamur. Tinjauan pustaka ini mengeksplorasi potensi jintan hitam sebagai bahan aktif dalam *sealer* endodontik melalui metode studi literatur dari berbagai jurnal ilmiah. Hasil kajian menunjukkan bahwa ekstrak jintan hitam, khususnya komponen *thymoquinone*, efektif menghambat bakteri penyebab infeksi persisten seperti *Enterococcus faecalis* dan *Staphylococcus aureus*, serta jamur *Candida albicans*. Selain itu, sifat antiinflamasi dan antioksidannya turut mendukung pemulihan jaringan periapikal. Meski potensi biologisnya menjanjikan, riset yang ada saat ini masih terbatas pada uji *in vitro*. Penelitian lebih lanjut mengenai karakteristik fisik seperti kelarutan, adhesivitas, dan kemampuan penutupan hermetis masih sangat diperlukan sebelum jintan hitam dapat resmi dikembangkan sebagai bahan tambahan *sealer* masa depan.

ABSTRACT

The success of root canal treatment depends heavily on the use of a sealer that can tightly seal the canal while eliminating pathogenic microorganisms in the dentinal tubules. Unfortunately, conventional sealers such as epoxy resin, Zinc Oxide Eugenol (ZOE), and Mineral Trioxide Aggregate (MTA) still have shortcomings in terms of toxicity, risk of irritation, and limited antimicrobial effectiveness. Alternatively, black cumin (Nigella sativa) is beginning to be studied for its bioactive compounds such as thymoquinone, flavonoids, and tannins, which are rich in antibacterial, anti-inflammatory, and antifungal properties. This literature review explores the potential of black cumin as an active ingredient in endodontic sealers through a literature review method from various scientific journals. The results of the study indicate that black cumin extract, particularly the thymoquinone component, is effective in inhibiting bacteria that cause persistent infections such as Enterococcus faecalis and Staphylococcus aureus, as well as the fungus Candida albicans. In addition, its anti-inflammatory and antioxidant properties also support periapical tissue recovery. Despite its promising biological potential, current research is limited to in vitro tests. Further research into physical characteristics such as solubility, adhesiveness, and hermetic sealing properties is needed before black cumin can be officially developed as a future sealer additive.

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1. INTRODUCTION

Root canal treatment is an endodontic procedure that aims to remove infected pulp tissue, clean the root canal system, eliminate pathogenic microorganisms, and tightly seal the canal space to prevent reinfection. The success of this treatment is strongly influenced by the ability of filling materials and sealers to suppress the growth of residual microbes that remain inside dentinal tubules and complex root canal branches that are difficult to reach with mechanical instruments. Bacteria such as Enterococcus faecalis and Staphylococcus aureus are frequently associated with root canal treatment failure because they can survive in extreme environments and form biofilms that are difficult to eliminate [5]. Persistent intraradicular infection is recognized as one of the main causes of root canal treatment failure. *Enterococcus faecalis* has been reported to be present in approximately 24–77% of teeth with persistent root canal infections because of its ability to survive under harsh environmental conditions, penetrate dentinal tubules, form biofilms, and resist antimicrobial treatment [3]. Root canal sealers currently used in dentistry are generally based on epoxy resin, Zinc Oxide Eugenol (ZOE), and Mineral Trioxide Aggregate (MTA). Although these materials have been widely applied in clinical practice, several disadvantages are still reported, including the risk of tissue toxicity, periapical irritation, tooth discoloration, and antibacterial activity that is not always effective against resistant endodontic bacteria. This condition has encouraged the development of research on natural materials that are safer, biocompatible, and possess beneficial biological activity to support successful root canal treatment [8]. One natural material that has recently attracted attention in dentistry is black cumin (Nigella sativa). This plant is known to contain various active compounds such as thymoquinone, tannins, alkaloids, flavonoids, phenolics, saponins, and terpenoids, which possess antibacterial, anti-inflammatory, antioxidant, anti-biofilm, and antifungal activities. Thymoquinone is considered the main active component because of its strong ability to inhibit the growth of bacteria associated with root canal infections and reduce inflammatory processes in tissues surrounding the tooth apex [9]. The selection of *Nigella sativa* as a candidate material for root canal sealers is based on its broad spectrum of biological activities, particularly its antimicrobial and antibiofilm effects against resistant endodontic pathogens, as well as its anti-inflammatory and antioxidant properties that may support periapical tissue healing following treatment [2].

Research conducted by Veronica, Thangavelu, Nikhita, and Susila demonstrated that Nigella sativa water extract was able to inhibit the growth of Enterococcus faecalis and Streptococcus mutans, producing inhibition zones nearly comparable to sodium hypochlorite (NaOCl), the standard endodontic irrigation material. These findings indicate that black cumin possesses strong antimicrobial activity against bacteria related to root canal infections and has the potential to be developed as an additional active ingredient in endodontic sealer systems [13]. A study by Makmun, Surdam, and Gunawan showed that black cumin extract had high effectiveness against Staphylococcus aureus, with the largest inhibition zone observed at 100% concentration measuring 24 mm. This research demonstrated that black cumin possesses significant antibacterial activity against gram-positive bacteria commonly found in oral infections and root canal tissues. These findings provide scientific support for the potential use of Nigella sativa as an antimicrobial additive in root canal sealer materials [10]. Research conducted by

Ernawati, Wedagama, Astuti, and Fatmasari revealed that black cumin extract was able to inhibit the growth of Staphylococcus aureus in vitro at various concentrations. The study explained that active compounds such as tannins, alkaloids, saponins, and terpenoids work by damaging bacterial cell functions, thereby suppressing microbial growth. In endodontics, this biological activity is highly desirable because sealers function not only as canal-filling materials but also as agents capable of eliminating residual microorganisms within the root canal system [7].

A study by Nizzuan A.H. *et al*. demonstrated that thymoquinone derived from Nigella sativa exhibited a Minimum Inhibitory Concentration (MIC) value of 1.6 µg/mL and a Minimum Bactericidal Concentration (MBC) value of 3.12 µg/mL against Enterococcus faecalis. The study further showed that thymoquinone performed better than calcium hydroxide at certain concentrations. In addition, the compound was able to reduce biofilm formation and inhibit bacterial adhesion to dentin surfaces. These findings are highly significant because bacterial biofilms are considered one of the major causes of root canal treatment failure [11]. In addition to its antibacterial properties, black cumin is known to possess anti-inflammatory and antioxidant effects on periapical tissues. Research by Ernawati, Ma'ruf, Wedagama, and Riany demonstrated that administration of black cumin extract gel in Wistar rats with apical periodontitis reduced malondialdehyde (MDA) levels, which serve as markers of oxidative stress and tissue damage. These findings indicate that Nigella sativa not only has the potential to suppress microorganisms but may also help maintain the condition of tissues surrounding the tooth apex after treatment [6]. Black cumin is not only active against bacteria but also possesses antifungal activity against Candida albicans. A study by Chotimah, Amiruddin, Febriany, and Gustiawati demonstrated that increasing concentrations of black cumin extract resulted in stronger inhibitory effects against Candida albicans. This antifungal property provides additional value for the development of endodontic materials because fungal infections are occasionally associated with persistent root canal treatment failures [4].

Although many studies have demonstrated promising biological effects, the application of black cumin as a definitive root canal sealer has not yet been implemented clinically. Most studies are still limited to in vitro investigations focusing on antibacterial, anti-biofilm, antioxidant, and anti-inflammatory activities. Until now, physical material properties such as flowability, low solubility, adhesion strength, material stability, and hermetic sealing ability have not been fully evaluated to meet commercial sealer standards [2]. A study conducted by Alamoudi, Alamoudi, and Alamoudi explained that thymoquinone possesses strong antimicrobial activity and is safe for both organic and inorganic tissues within the root canal system. However, the research found that the chelating ability and tissue-dissolving capacity of thymoquinone remain limited, meaning that the material cannot yet function independently as a complete root canal cleaning system. Therefore, Nigella sativa is more appropriately viewed as a candidate active additive in modern sealer formulations that still require carrier matrices and further physical property evaluations [2]. Based on the findings above, black cumin demonstrates strong potential to be developed as an active additive in root canal treatment sealers because it possesses antibacterial, anti-biofilm, anti-inflammatory, antioxidant, and antifungal activities. Nevertheless, further studies regarding formulation, stability, and physical material characteristics are still necessary so that Nigella sativa can be developed into a safe, effective endodontic sealer material that fulfills clinical dentistry standards.

2. METHOD

This study used a literature review method by collecting, reading, comparing, and analyzing various scientific sources discussing the application of black cumin (*Nigella sativa*) in root canal treatment. Literature searches were conducted through several electronic databases, including PubMed, Google Scholar, ScienceDirect, and Scopus. The search process utilized combinations of the keywords "Nigella sativa", "black cumin", "thymoquinone", "root canal treatment", "endodontic sealer",

"Enterococcus faecalis", "antibacterial activity", "anti-biofilm", "antifungal activity", and "endodontics".

The inclusion criteria were: (1) original research articles and review articles published between 2020 and 2026; (2) articles written in English or Indonesian; (3) studies evaluating the antibacterial, anti-inflammatory, antioxidant, anti-biofilm, or antifungal properties of *Nigella sativa* and its active compounds; and (4) studies relevant to endodontic infections, root canal treatment, or root canal sealer materials. The exclusion criteria included duplicate publications, articles without full-text access, studies unrelated to dentistry or endodontics, and articles with insufficient methodological information.

A total of 56 articles were initially identified through database searching. After removing duplicate records and screening titles and abstracts for relevance, 26 articles were selected for full-text assessment. Following the application of the inclusion and exclusion criteria, 13 articles were included in the final review and used in the discussion.

The research data were obtained from national and international scientific journals, research articles, and academic publications discussing the antibacterial, anti-inflammatory, antioxidant, anti-biofilm, and antifungal activities of black cumin against microorganisms responsible for endodontic infections [13]. Data analysis was conducted by examining research findings related to the potential of black cumin as an additional material in root canal treatment sealers. The discussion focused on its antimicrobial activity against endodontic pathogenic bacteria, anti-inflammatory effects on periapical tissues, antifungal activity, and the potential development of thymoquinone as an active compound in modern endodontic materials [10].

3. RESULT AND DISCUSSION

The selected studies demonstrated that *Nigella sativa* possesses antibacterial, antibiofilm, anti-inflammatory, antioxidant, and antifungal properties that may support its application in endodontic treatment.

Table 1. Summary of Studies on the Potential of Nigella sativa in Endodontics

Author	Year	Study Design	Tested Microorganism	Main Findings
Makmun et al.	2020	In vitro	Staphylococcus aureus	100% black cumin extract produced the largest inhibition zone (24 mm).
Ernawati et al.	2023	In vitro	Staphylococcus aureus	Black cumin extract inhibited bacterial growth at various concentrations.
Chotimah et al.	2023	In vitro	Candida albicans	Antifungal activity increased with increasing extract concentration.
Kurnia et al.	2024	Phytochemical and antibiofilm study	Oral biofilm bacteria	Demonstrated antibiofilm activity through flavonoids, phenolics, and thymoquinone.

Ernawati et al.	2024	In vivo	Apical periodontitis model	Reduced MDA levels and oxidative stress in periapical tissues.
Veronica et al.	2025	In vitro	Enterococcus faecalis, Streptococcus mutans	Antibacterial activity comparable to sodium hypochlorite.
El Ghazzawy et al.	2025	In vitro	Enterococcus faecalis	Reduction of bacterial growth up to 99.89%.
Nizzuan et al.	2026	Experimental study	Enterococcus faecalis	Thymoquinone showed MIC 1.6 µg/mL and MBC 3.12 µg/mL with antibiofilm effects.

3.1 Black Cumin (Nigella sativa) in Root Canal Treatment

3.1.1 Definition and Potential of Black Cumin in Endodontics

Black cumin (Nigella sativa) has increasingly been studied in the field of dentistry, especially in root canal treatment or endodontics. The application of this material is still limited to laboratory research and has not yet been widely used as a primary sealer in clinical practice. Existing studies more commonly evaluate black cumin as an irrigation material, intracanal sterilization agent, and medicament because it possesses antibacterial, anti-inflammatory, and antifungal activities against microorganisms that cause root canal infections [8]. Root canal treatment requires materials capable of cleaning the canal space from bacteria, reducing inflammation, and maintaining the health of tissues surrounding the tooth root. Active compounds found in black cumin, such as thymoquinone, tannins, alkaloids, flavonoids, phenolics, and terpenoids, are known to possess biological properties that support these needs. Thymoquinone is the most frequently discussed compound because it exhibits strong antibacterial activity against Enterococcus faecalis and Staphylococcus aureus, which are commonly associated with persistent endodontic infections [9]. A study by Veronica *et al*. demonstrated that Nigella sativa water extract was able to inhibit the growth of Enterococcus faecalis and Streptococcus mutans, producing inhibition zones nearly comparable to sodium hypochlorite (NaOCl). These findings indicate that black cumin has promising antibacterial activity against root canal bacteria and may be considered as an additional active material in modern root canal treatment systems [13]. According to information published by UNAIR News, black cumin is considered to have strong potential in oral health because of its antibacterial, analgesic, and anti-inflammatory properties. This material has even begun to be investigated as a gutta-percha softener and intracanal sterilization aid because it can suppress the growth of resistant bacteria within the root canal system (Airlangga, 2024).

3.1.2 The Role of Thymoquinone as the Main Active Compound

Thymoquinone is the principal active compound in black cumin that is most frequently studied in endodontics. This compound is known to possess antibacterial, anti-inflammatory, antioxidant, and antifungal activities. In root canal treatment, these properties are highly valuable because bacteria located within dentinal tubules are difficult to eliminate through conventional mechanical preparation alone [2]. A study by Alamoudi *et al*. demonstrated that thymoquinone has strong antimicrobial activity against endodontic pathogens and does not damage organic or inorganic tissues within the root canal system. These findings indicate that thymoquinone has good biological safety when in contact with dental tissues and periapical tissues. However, the study found that its chelating ability and tissue-

dissolving capacity remain limited, meaning that this material cannot yet function independently as a complete root canal cleaning agent [2]. Research conducted by Nizzuan A.H. *et al*. showed that thymoquinone exhibited a Minimum Inhibitory Concentration (MIC) value of 1.6 µg/mL and a Minimum Bactericidal Concentration (MBC) value of 3.12 µg/mL against Enterococcus faecalis. These values indicate that thymoquinone is capable of killing resistant bacteria at low concentrations. The study even demonstrated that the antimicrobial activity of thymoquinone was superior to calcium hydroxide at certain concentrations [11]. The mechanism of action of thymoquinone occurs through disruption of microbial cell membranes, inhibition of ATP formation, and reduction of bacterial adhesion within biofilms. In root canal infections, bacterial biofilms are considered a major cause of treatment failure because microorganisms can survive deep within dentinal tubules. Therefore, the ability of thymoquinone to inhibit biofilm formation provides strong additional value for its development as an additive in root canal sealers [11].

3.1.3 Antibacterial Activity of Black Cumin in Root Canals

1. Activity against Enterococcus faecalis and Staphylococcus aureus

Enterococcus faecalis and Staphylococcus aureus are two microorganisms frequently found in root canal infections and endodontic treatment failure cases. Both bacteria are capable of surviving in extreme environments and are difficult to eliminate using conventional antiseptic agents. Therefore, an ideal sealer material should possess strong antibacterial activity against these microorganisms [5]. A study by Makmun, Surdam, and Gunawan demonstrated that black cumin extract exhibited significant inhibitory activity against the growth of Staphylococcus aureus. The research used the disc diffusion method on Mueller Hinton Agar media and showed that the 100% concentration produced the largest inhibition zone with an average diameter of 24 mm. These findings indicate that black cumin possesses high antibacterial activity and has potential for development as an additive in herbal-based root canal sealer formulations [10]. Research conducted by Ernawati, Yudistian, and Putri demonstrated that increasing concentrations of black cumin extract resulted in larger inhibition zones against Staphylococcus aureus. A 50% concentration produced an inhibition zone of 9.87 mm, a 75% concentration produced 14.24 mm, and a 100% concentration reached 17.19 mm. The study explained that thymoquinone and thymohydroquinone work by inhibiting bacterial protein synthesis, thereby preventing microbial reproduction (Ernawati, Yudistian, & Putri, 2024). A study by El Ghazzawy *et al*. demonstrated that Nigella sativa was able to reduce Enterococcus faecalis by up to 99.89%. These results were even higher than several other herbal materials such as ginger and resin gum. This study is highly relevant to the development of root canal sealers because Enterococcus faecalis is the bacterium most frequently able to survive after endodontic treatment has been completed [5].

Comparison of the available studies indicates that the antibacterial activity of *Nigella sativa* varies according to the tested microorganism, concentration, and formulation used. Studies conducted by Makmun et al. (2020) and Ernawati et al. (2024) demonstrated concentration-dependent inhibition against *Staphylococcus aureus*, whereas Veronica et al. (2025) and El Ghazzawy et al. (2025) reported strong activity against *Enterococcus faecalis*, a pathogen more closely associated with persistent endodontic infections. Furthermore, Nizzuan et al. (2026) demonstrated that thymoquinone exhibited low MIC and MBC values and was able to inhibit biofilm formation, suggesting that the purified active compound may provide stronger antimicrobial effects than crude extracts. These findings collectively indicate that *Nigella sativa* has broad-spectrum antimicrobial potential, although differences in extraction methods, concentrations, and experimental designs may influence the reported outcomes.

b. Anti-Biofilm and Antifungal Activity

Biofilm is a collection of bacteria attached to dentin surfaces and protected by a special matrix layer. In root canals, biofilms are very difficult to eliminate and are often the main cause of recurrent infections. Therefore, materials capable of inhibiting biofilm formation are highly valuable in

endodontics [9]. A study by Kurnia *et al*. explained that black cumin seeds contain flavonoids, phenolics, alkaloids, and thymoquinone, which possess anti-biofilm properties. These compounds are able to inhibit bacterial colony formation and reduce microbial adhesion to tooth surfaces. The study demonstrated that Nigella sativa does not only function as a conventional antibacterial agent but is also capable of suppressing biofilm formation, which is a major source of chronic infection [9]. In addition to its antibacterial activity, black cumin is known to possess antifungal effects against Candida albicans. This fungus is sometimes found in failed root canal treatment cases and may worsen infections. A study by Chotimah, Amiruddin, Febriany, and Gustiawati demonstrated that black cumin extract was able to inhibit the growth of Candida albicans, and the inhibition zone increased along with higher extract concentrations [4]. This antifungal activity provides additional value to black cumin because an ideal sealer material is expected to protect the root canal system from various types of microorganisms, not only bacteria. The anti-biofilm and antifungal properties of black cumin provide opportunities for the development of natural sealer materials with broader activity compared to certain synthetic materials (Chotimah *et al*., 2023).

3.1.4 Potential of Black Cumin as a Root Canal Sealer

1. Biological Advantages and Biocompatibility

An ideal root canal sealer should not only be capable of tightly sealing the canal space but should also be safe for body tissues. Many synthetic materials carry risks of toxicity and irritation to periapical tissues. For this reason, natural materials such as black cumin are increasingly considered safer alternative options [8]. A study by Ernawati, Wedagama, Astuti, and Fatmasari explained that black cumin extract possesses strong antibacterial activity against Staphylococcus aureus because it contains tannins, terpenoids, saponins, and alkaloids. These compounds can assist in eliminating microorganisms that remain in difficult-to-clean areas of the root canal system. The study suggested that black cumin extract could be applied as an active additive in sealer formulations to support long-term sterilization within the root canal [7]. Another study by Ernawati *et al*. demonstrated that black cumin extract possesses antioxidant and anti-inflammatory properties in cases of apical periodontitis. The reduction of malondialdehyde (MDA) levels in experimental animals indicated that black cumin was able to reduce oxidative stress and help maintain the stability of tissues surrounding the root apex after treatment [6]. These anti-inflammatory properties are highly desirable in sealer materials because periapical tissues frequently experience irritation after endodontic procedures. If a sealer material can help calm tissues surrounding the apex, the success rate of root canal treatment may improve. This makes black cumin an attractive candidate for development as a biological additive in future sealer systems (Ernawati *et al*., 2024).

b. Challenges in Development as a Definitive Sealer

Although black cumin possesses promising biological activity, it has not yet been applied as a definitive sealer in clinical dental practice. At present, root canal filling materials used globally are still dominated by epoxy resin, Zinc Oxide Eugenol (ZOE), and Mineral Trioxide Aggregate (MTA) because these materials possess physical properties that already meet international standards [8]. Root canal sealers must possess good flowability, low solubility, strong adhesion, long-term stability, and the ability to hermetically seal the root canal system. Existing studies still focus mainly on the biological activity of black cumin and have not fully evaluated its physical material properties. Therefore, the development of black cumin as a complete sealer material still requires extensive further investigation [13]. A study by Putri *et al*. demonstrated that the dosage form strongly affects the release of active compounds from black cumin. A 50% black cumin solution showed better antibacterial activity than the oil emulsion form. These findings indicate that material formulation greatly influences the effectiveness of thymoquinone release on dentin surfaces and root canal walls [12]. Although black cumin has not yet fulfilled the requirements to function as a standalone sealer material, it still possesses

strong potential as an active additive in modern sealer systems. The antibacterial, anti-inflammatory, antioxidant, anti-biofilm, and antifungal activities of Nigella sativa provide a strong scientific foundation for the future development of herbal-based endodontic materials [11].

Beyond its antimicrobial properties, the potential application of *Nigella sativa* in root canal sealer formulations should also be considered from a material science perspective. Rather than functioning as a standalone sealer, black cumin extract or thymoquinone may be incorporated as a bioactive additive into existing sealer matrices such as epoxy resin-, calcium silicate-, or bioceramic-based sealers. The incorporation of *Nigella sativa* could enhance the antimicrobial, antibiofilm, anti-inflammatory, and antioxidant properties of the sealer while maintaining the physical characteristics required for clinical use. However, further studies are needed to evaluate the effects of black cumin incorporation on critical sealer properties, including flowability, setting time, solubility, dimensional stability, adhesion strength, and sealing ability.

3.1.5 Evaluation of Nigella sativa Based on Ideal Root Canal Sealer Characteristics

An ideal root canal sealer should possess several essential properties, including adequate flowability, strong adhesion, low solubility, good biocompatibility, and effective sealing ability. These characteristics are important to ensure complete filling of the root canal system, prevent microleakage, and support long-term treatment success.

Table 2 presents a comparison between the ideal characteristics of root canal sealers and the currently available evidence regarding *Nigella sativa*.

Ideal Sealer Property	**Requirement**	**Evidence for Nigella sativa**	**Evaluation**
Flowability	Ability to flow into accessory canals, dentinal tubules, and canal irregularities	No specific studies evaluating flowability of Nigella sativa-based sealers	Not yet demonstrated
Adhesion	Strong bonding to dentin and core filling materials	No direct studies assessing adhesive strength	Not yet demonstrated
Solubility	Low solubility in tissue fluids to maintain long-term sealing	No studies evaluating solubility of Nigella sativa-containing sealers	Not yet demonstrated
Biocompatibility	Non-toxic and supportive of tissue healing	Anti-inflammatory and antioxidant effects reported; reduction of oxidative stress in periapical tissues	Potentially favorable
Sealing Ability	Prevention of microleakage and bacterial penetration	No microleakage or sealing tests currently available	Not yet demonstrated
Antibacterial Activity	Inhibition of residual microorganisms	Strong evidence against Enterococcus	Supported

Ideal Sealer Property	Requirement	Evidence for Nigella sativa	Evaluation
		faecalis and Staphylococcus aureus	
Antibiofilm Activity	Prevention of biofilm formation	Demonstrated by thymoquinone studies	Supported

Based on the available literature, *Nigella sativa* has demonstrated strong biological properties, particularly antibacterial, antibiofilm, anti-inflammatory, antioxidant, and antifungal activities. These characteristics support its potential use as a bioactive additive in root canal sealers. However, evidence regarding the physical and mechanical properties required for an ideal sealer, including flowability, adhesion, solubility, and sealing ability, remains limited. Therefore, current evidence suggests that *Nigella sativa* should be considered a promising bioactive component rather than a standalone root canal sealer. Further investigations are needed to evaluate its influence on the physicochemical properties of sealer formulations and determine whether it can fulfill international standards for endodontic sealers.

4. CONCLUSION

Based on the reviewed literature, *Nigella sativa* demonstrates promising potential as a bioactive additive in root canal sealer formulations due to its antibacterial, antibiofilm, anti-inflammatory, antioxidant, and antifungal properties. Its main active compound, thymoquinone, has shown significant activity against endodontic pathogens, particularly *Enterococcus faecalis* and *Staphylococcus aureus*, which are commonly associated with persistent root canal infections.

However, the current scientific evidence is still dominated by in vitro and experimental studies, with limited data regarding its clinical application as a root canal sealer. Furthermore, important sealer characteristics such as flowability, adhesion, solubility, sealing ability, and long-term biocompatibility have not been comprehensively evaluated. Therefore, further research is required to assess the physicochemical properties, biocompatibility, and clinical performance of *Nigella sativa*-containing sealer formulations before they can be recommended for routine clinical use in endodontic treatment.

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