

MEDICINAL AND DENTAL APPLICATIONS OF NIGELLA SATIVA: A COMPREHENSIVE REVIEW

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ABSTRACT

Nigella sativa L., commonly referred to as black seed or black cumin, is a medicinal plant with longstanding use in traditional system of medicine. In recent decades, scientific investigation has substantiated many of its traditional claims, attributing its therapeutic potential primarily to the bioactive compound thymoquinone. Experimental and clinical evidence suggests that *Nigella sativa* possesses antioxidant, anti-inflammatory, antimicrobial, immunomodulatory, metabolic regulatory, and tissue-repair properties. Emerging studies further indicate its potential application in oral health, particularly in the management of dental caries, gingivitis, periodontitis, and oral mucosal lesions. This review critically evaluates the current literature on the systemic and dental applications of *Nigella sativa*, emphasizing mechanistic insights, clinical relevance, safety considerations, and research limitations. While available findings are promising, further well-designed randomized controlled trials are necessary to establish standardized therapeutic protocols.

KEYWORDS: *Nigella sativa*, thymoquinone, black seed, periodontal therapy, phytotherapy, oral health.

INTRODUCTION

Herbal Medicine continues to play a significant role in global healthcare systems. Among medicinal plants receiving considerable scientific attention is *Nigella sativa* L., a member of the Ranunculaceae family (1,16). Traditionally used across the Middle East, North Africa, and South Asia, the seeds of *N. sativa* have been employed in the treatment of respiratory disorders, gastrointestinal disturbances, metabolic conditions, and inflammatory diseases (2,4,20).

Modern pharmacological research has increasingly focused on validating these traditional uses. The principal bioactive compound, thymoquinone (TQ), has been identified as the major contributor to its biological activity (3). Advances in phytochemical and molecular research from 2020 to 2025 have expanded understanding of its therapeutic potential, particularly in inflammatory modulation and antimicrobial activity (8–12). Moreover, interest in integrating herbal agents into dental practice has stimulated research on *N. sativa* as a potential adjunct in periodontal and cariology management. This review aims to analyse the current evidence regarding the medicinal and dental applications of *N. sativa*, while highlighting gaps that must be addressed before routine clinical implementation.

2. Phytochemistry and Mechanisms of Action

2.1 Phytochemical Constituents

The seeds of *Nigella sativa* contain a diverse array of bioactive components, including fixed oils (30–40%), volatile oils (0.4–2.5%), alkaloids, saponins, proteins, and essential fatty acids (1,6). Thymoquinone represents the most extensively studied constituent, accompanied by thymohydroquinone, dithymoquinone, thymol, nigellidine, nigellicine, and α -hederin (2,3).

Recent analytical investigations confirm that these compounds act synergistically to produce antioxidant and antimicrobial effects (10,12). The presence of polyunsaturated fatty acids such as linoleic acid further contributes to its metabolic and cardioprotective actions (6).

2.2 Molecular and Cellular Mechanisms

The pharmacodynamic actions of *N. sativa* are multifactorial:

- **Antioxidant mechanisms:** Scavenging reactive oxygen species and enhancing endogenous antioxidant enzymes such as superoxide dismutase and catalase (10).

- **Anti-inflammatory effects:** Downregulation of NF- κ B signalling pathways and suppression of pro-inflammatory cytokines including TNF- α and IL-6 (3,10).
 - **Antimicrobial activity:** Disruption of microbial cell membranes and inhibition of biofilm formation (8,12).
 - **Immunomodulation:** Regulation of T-cell responses and macrophage activation (2).
 - **Tissue regeneration:** Enhancement of collagen synthesis and growth factor signalling pathways (13).
- These mechanisms collectively underpin its broad therapeutic profile.

3. Systemic Medicinal Applications

3.1 Anti-Inflammatory and Antioxidant Effects

Chronic inflammation and oxidative stress are implicated in numerous systemic disorders. Experimental models demonstrate that thymoquinone attenuates inflammatory mediator production and reduces oxidative damage (3,4,10). Recent reviews (2024–2025) further confirm its capacity to decrease circulating inflammatory biomarkers and improve antioxidant status (10).

These properties suggest potential benefits in inflammatory diseases such as rheumatoid arthritis, asthma, and inflammatory bowel disease. However, while preclinical findings are strong, large-scale human trials remain limited.

3.2 Antimicrobial Properties

The antimicrobial spectrum of *N. sativa* encompasses Gram-positive and Gram-negative bacteria, fungi, and certain viruses (8,12). Essential oil fractions demonstrate inhibitory activity against multidrug-resistant bacterial strains (12). Mechanistically, thymoquinone disrupts microbial cell wall integrity and interferes with enzymatic pathways essential for pathogen survival (8).

Given the global rise of antimicrobial resistance, phytotherapeutic agents such as *N. sativa* warrant further investigation as adjunctive or alternative therapies.

3.3 Metabolic and Cardiovascular Effects

Emerging evidence suggests that *N. sativa* may influence glucose metabolism and lipid profiles. Clinical studies report improvements in fasting blood glucose and reductions in total cholesterol and LDL levels (5). These metabolic effects may be mediated by enhanced insulin sensitivity and antioxidant protection of pancreatic β -cells (2).

Additionally, cardioprotective properties have been attributed to its anti-inflammatory and lipid-modulating effects (6). Nonetheless, standardized dosage regimens and long-term cardiovascular outcome data are still required.

3.4 Anticancer Potential

Preclinical research indicates that thymoquinone may induce apoptosis, inhibit angiogenesis, and modulate tumour-related signalling pathways (3). Although these findings are encouraging, translation into clinical oncology remains preliminary. Human trials evaluating efficacy and safety in cancer patients are sparse and require further development.

4. Dental Applications

Interest in plant-based therapeutics in dentistry has increased due to concerns regarding antimicrobial resistance and adverse effects of synthetic agents. *Nigella sativa* has demonstrated promising potential in several domains of oral health.

4.1 Anticariogenic Activity

Dental caries is primarily associated with biofilm-forming bacteria such as *Streptococcus mutans*. In vitro investigations demonstrate that *N. sativa* extracts inhibit cariogenic bacterial growth and biofilm formation (9). The essential oil's ability to interfere with bacterial adhesion suggests potential use in preventive oral care products such as mouthwashes and dentifrices (8).

However, clinical trials evaluating long-term caries prevention in human populations are limited.

4.2 Gingivitis and Periodontal Therapy

Periodontal diseases are characterized by microbial dysbiosis and exaggerated host inflammatory responses. Research indicates that *N. sativa* may address both components.

Clinical comparisons of herbal mouthwashes containing *N. sativa* with chlorhexidine have shown comparable improvements in gingival index and plaque reduction (5). Animal and in vivo studies further demonstrate decreased expression of inflammatory mediators such as TNF- α and matrix metalloproteinases following application of *N. sativa*-based formulations (7).

Additionally, essential oil preparations have exhibited antibacterial effects against key periodontal pathogens including *Porphyromonas gingivalis* and *Aggregatibacter actinomycetemcomitans* without cytotoxic effects on human gingival fibroblasts (8). These findings suggest potential utility as an adjunct to scaling and root planing.

Despite promising laboratory evidence, robust multicentre randomized controlled trials in periodontal patients are necessary.

4.3 Endodontic Applications

Persistent endodontic infections often involve resistant microorganisms such as *Enterococcus faecalis*. The antimicrobial action of thymoquinone against resistant strains suggests possible use as an intracanal medicament or irrigant adjunct (8). Nevertheless, further evaluation of its efficacy within complex root canal systems and its interaction with standard irrigants is required.

4.4 Oral Mucosal Lesions and Wound Healing

The antioxidant and anti-inflammatory properties of *N. sativa* may support oral mucosal healing. Studies report enhanced tissue repair and reduced inflammatory infiltration following topical application (13). Although most data derive from dermatological models, these mechanisms may have relevance in oral ulceration, mucositis, and post-surgical healing.

5. Safety and Toxicological Considerations

Available evidence suggests that *N. sativa* is generally safe at therapeutic doses (1,2). Reported adverse effects are typically mild and include gastrointestinal discomfort. Experimental toxicology studies indicate low systemic toxicity, though extremely high doses may induce hepatic or renal stress.

For dental applications, essential oil preparations have not demonstrated cytotoxicity to gingival fibroblasts in vitro (8). Nevertheless, standardized formulations and dosage guidelines are essential before widespread clinical use.

6. Limitations of Current Evidence

- Despite increasing research output, several limitations persist:
- Many studies are preclinical or laboratory-based.
- Sample sizes in human trials are often small.
- Standardization of extracts and dosing regimens is lacking.
- Long-term safety data are insufficient.
- Comparative effectiveness with established therapies requires further study.
- Addressing these gaps will strengthen the evidence base for clinical integration.

7. Future Perspectives

- Future research should prioritize:
- Large-scale randomized controlled clinical trials.
- Development of standardized pharmaceutical-grade formulations.
- Exploration of nano-delivery systems to enhance bioavailability.
- Investigation of synergistic effects with conventional dental therapies.
- Long-term safety monitoring in diverse patient populations.

Such efforts will determine whether *Nigella sativa* can transition from complementary therapy to mainstream clinical practice.

8. CONCLUSION

Nigella sativa represents a promising phytotherapeutic agent with broad systemic and dental applications. Its bioactive constituents, particularly thymoquinone, exert antioxidant, anti-inflammatory, antimicrobial, immunomodulatory, and tissue-repair effects supported by experimental and emerging clinical evidence. In dentistry, it shows potential as an adjunct in managing caries, gingivitis, periodontitis, and oral infections. However, despite encouraging findings, high-quality clinical trials and standardized treatment protocols remain necessary before routine incorporation into medical and dental practice.

REFERENCES

1. Ahmad A, Husain A, Mujeeb M, Khan SA, Najmi AK, Siddique NA, et al. A review on therapeutic potential of *Nigella sativa*: A miracle herb. *Asian Pac J Trop Biomed*. 2013;3(5):337–352.
2. Gholamnezhad Z, Havakhah S, Boskabady MH. Preclinical and clinical effects of *Nigella sativa* and its constituent, thymoquinone: A review. *J Ethnopharmacol*. 2016;190:372–386.
3. Mekhemar M, Hassan Y, Dörfer C. *Nigella sativa* and thymoquinone: A natural blessing for periodontal therapy. *Antioxidants (Basel)*. 2020;9(12):1260.
4. Woo CC, Kumar AP, Sethi G, Tan KH. Thymoquinone: Potential cure for inflammatory disorders and cancer. *Biochem Pharmacol*. 2012;83(4):443–451.
5. Ilangovan S, Rajasekar A. Evaluation of efficacy of 20% *Nigella sativa* mouthwash on gingival health: A clinical study. *J Pharm Res Int*. 2021;33(61A):354–363.
6. Ramadan MF. Nutritional value, functional properties and nutraceutical applications of black cumin (*Nigella sativa* L.): An overview. *Int J Food Sci Technol*. 2007;42(10):1208–1218.
7. Maduratna E, Sari DS, Rahayu RP, Setiawatie EM, Ernawati DS. The anti-inflammatory effect of *Nigella sativa* toothpaste on *Porphyromonas gingivalis* bacteria through decreased TNF- α , MMP-9 and PGE-2 expression in Wistar rats. *Eur J Dent*. 2024;18(3):808–814.
8. Bhavikatti SK, Zainuddin SLA, Ramli RB, Razak IA. Insights into the antioxidant, anti-inflammatory and antimicrobial potential of *Nigella sativa* essential oil against oral pathogens. *Sci Rep*. 2024;14(1):11878.
9. Kurnia D, Padilah R, Apriyanti E, Dharsono HD. Phytochemical analysis and anti-biofilm potential of black cumin (*Nigella sativa*) against dental caries pathogens. *Drug Des Devel Ther*. 2024;18:1917–1932.
10. Chatterjee G, Saha AK, Khurshid S, Roy A, Paul S. A comprehensive review of the antioxidant, antimicrobial and therapeutic efficacies of black cumin (*Nigella sativa* L.) seed oil and its major bioactive constituent thymoquinone. *J Med Food*. 2025;28(4):325–339.
11. Abbas M, Gururani MA, Ali A, Al-Sadi AM, Jan AT. Antimicrobial properties and therapeutic potential of bioactive compounds in *Nigella sativa*. *Molecules*. 2024;29(20):4914.
12. Forouzanfar F, Bazzaz BSF, Hosseinzadeh H. Black cumin (*Nigella sativa*) and its constituent (thymoquinone): A review on antimicrobial effects. *Iran J Basic Med Sci*. 2014;17(12):929–938.
13. Ahamed SR, Anwar M, Khan AA. Role of *Nigella sativa* in tissue regeneration and oral wound healing: An experimental review. *IIUM J Orofac Health Sci*. 2020;1(2):45–52.