



The Effect of *Nigella sativa* on Infections and Inflammation: A Narrative Review with Focus on *Helicobacter pylori*

Nawfal R. Hussein ✉ 

Department of Biomedical Sciences, College of Medicine, University of Zakho, Zakho Independent Administration, Kurdistan Region, Iraq

Halat S. Majed

Center for Diabetes and Endocrine, Azadi Teaching Hospital, Duhok, Kurdistan Region, Iraq

Rasheed Hussein Ahmed

Department of Psychology, College of Arts, University of Salahaddin, Kurdistan Region, Iraq

Ali Abdi

Department of Medicine, College of Medicine, University of Duhok, Duhok, Kurdistan Region, Iraq

Abstract

Nigella sativa, known as black seed, is traditionally utilized in Middle Eastern and Asian medicine for millennia as a therapeutic herb. Preclinical and clinical research have shown that thymoquinone, its active ingredient, has immunomodulatory, antioxidant, anti-inflammatory, and antibacterial effects. The aim of this narrative review is to highlight present knowledge on the function of *Nigella sativa* in treating infections, especially *Helicobacter pylori*, and its regulatory effects on inflammatory processes. To emphasize the therapeutic potential of *Nigella sativa* as an adjuvant in infectious and inflammatory illnesses, the review gathers results from systematic reviews, in vitro and in vivo research, and clinical trials.

More Information

How to cite this article: Hussein NR, Majed HS, Ahmed RH, Abdi A. The Effect of *Nigella sativa* on Infections and Inflammation: A Narrative Review with Focus on *Helicobacter Pylori*. Eur J Med Health Res, 2025;3(3):130-4.

DOI: 10.59324/ejmhr.2025.3(3).19

Keywords:

Nigella sativa,
thymoquinone,
H. pylori,
antimicrobial,
inflammation.



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Introduction

Nigella sativa is known for its therapeutic effects in ancient systems of medicine—including Unani, Ayurveda, and Islamic medicine and it is often called as black seed. Historically, it has been used for a wide range of diseases including respiratory and gastrointestinal disorders to immune system support. Recent advances in pharmacognosy and phytotherapy have shown that its bioactive components, especially thymoquinone (TQ), have several pharmacological effects including antimicrobial, antioxidant, anti-inflammatory, and immunomodulatory [1, 2]. It was previously suggested that *Nigella sativa* is effective against different bacterial strains, including drug resistant *Helicobacter pylori* and multiple-drug resistant *Staphylococcus aureus* [3, 4]. Such an effect is achieved via different mechanisms including the disruption of microbial membranes and interference

with metabolic pathways. Additionally, the TQ-rich essential oil has exhibited both bactericidal and fungicidal properties [4]. Furthermore, *Nigella sativa* was shown to possess antiviral activities through immunological modulation and reduction of oxidative stress [5].

Moreover, *Nigella sativa* showed immune modulatory effects in both healthy people and those with inflammatory diseases such as T-helper cell activity elevation and higher anti-inflammatory cytokines (e.g., IL-10) [6, 7]. Such effects imply a possible role for *Nigella sativa* in infection management and in lowering tissue damage caused by inflammation-driven processes. Particularly in settings where antibiotic resistance or chronic inflammation present major treatment obstacles, the wide therapeutic range of *Nigella sativa* keeps attracting attention as a

supplementary or integrative agent in contemporary medicine.

Chemical Composition and Bioactivity

Thymoquinone is the primary bioactive component in *Nigella sativa* which accounts for approximately 30-48% of its essential oil. Additional components include p-cymene, carvacrol, thymol, α -pinene, and nigellone, such substances possess antibacterial properties through various mechanisms such as disrupting bacterial membranes, inhibiting efflux pumps, and inducing oxidative stress in microbial cells [8, 9]. Additionally, thymoquinone exhibits anti-inflammatory effects by affecting nuclear factor kappa B (NF- κ B), cyclooxygenase-2 (COX-2), and pro-inflammatory cytokines [1].

Antimicrobial Activities of *Nigella Sativa*

Antibacterial activity

There is alarming rise in antibiotic-resistant bacteria, particularly in countries such as Iraq where the resistance rates rank among the highest globally [10, 11]. Such a rise underscores the urgent need for the development of new antimicrobial medications. Treatments with antibiotics are becoming less effective, prompting the exploration of alternative therapies, such as natural compounds with proven antibacterial properties. It is worth mentioning that extensive studies on both Gram-positive and Gram-negative bacteria have confirmed the antibacterial efficacy of *Nigella sativa*. It has been shown that black seed oil and its derivatives exhibit significant efficacy against *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Salmonella typhi* [4]. The minimum inhibitory concentration (MIC) of *Nigella sativa* oil is 0.5 mg/mL against *S. aureus*, including methicillin-resistant strains (MRSA), suggesting its potential use in addressing antibiotic resistance [12].

Antiviral and antifungal activities

Nigella sativa showed antifungal activity against many dermatophytes, *Aspergillus niger*, and *Candida albicans*. Thymoquinone impairs the integrity of fungal cell walls and interferes with ergosterol synthesis [13]. Previous studies showed antiviral properties, suggesting that *Nigella sativa* extracts might prevent the entrance and multiplication of viruses such as HCV, CMV, and some coronaviruses in laboratory environments [5]. A preliminary investigation on HCV patients found that *Nigella sativa* supplementation, when paired with usual therapy, resulted in better normalization of liver enzyme levels and better viral clearance [14].

Helicobacter Pylori and *Nigella Sativa*: Mechanisms and Efficacy

Helicobacter pylori infection is highly prevalent in Iraq [15, 16]. Such an infection contributing significantly to the burden of gastritis and related gastrointestinal diseases. Addressing this infection is critical, especially given the high rates of antibiotic resistance reported in the region [17, 18]. Without treatment, the persistence of *H. pylori* may lead to serious complications such as peptic ulcers and gastric cancer, highlighting the urgent need for optimized eradication therapies. In this context, investigating alternative therapeutic alternatives such as *Nigella sativa* is becoming more vital to improve treatment efficacy and address resistance issues

Human clinical trials

Several studies investigated the use of *Nigella sativa* in the treatment of *Helicobacter pylori* infections. The combination of omeprazole and *Nigella sativa* seed powder (2 g/day) reached an *H. pylori* eradication rate of 66.7% in a randomized trial including 88 patients with *H. pylori*-positive non-ulcer dyspepsia. Such results were statistically comparable to the standard triple therapy rate of 82.6% [3]. Lower and larger dosages (1 g and 3 g) were both shown to be less effective—about 48%, indicating an appropriate dosing range. All groups showed improvement in dyspepsia symptoms, and no major side effects were noted, proving good tolerance. In another clinical trial conducted in Iran, 46 subjects were allocated to have either a placebo or *Nigella sativa* (2 g/day) for 8 weeks, along with a 2-week course of triple antibiotic treatment. Patients in the *Nigella sativa* group showed significantly greater rates of eradication and reported improvements in their appetite and body weight [19]. There were no major side effects recorded for the black seed, which was well tolerated.

In a pilot study conducted in Iran recruiting 14 people investigating a traditional combination of black seed and honey. Using the urea breath test, 57.1% (8 of 14) of individuals tested negative for *H. pylori* after a two-week treatment period [20]. Symptoms of dyspepsia became better as well and no major side effects were recorded.

Furthermore, a double-blind trial in 2015 looking at how a mix of honey and black seed oil (given at a dose of 5 mL per day) affected people with functional dyspepsia [21]. The group getting therapy demonstrated notably better dyspepsia symptom scores and a better *H. pylori* eradication success rate than the placebo group after 8 weeks. The only reported adverse effects were modest nausea and



bloating, which were similar to those seen with the placebo.

Another study recruited 60 children diagnosed with *H. pylori* infection and treatment was given though combining black seed oil with the conventional triple therapy [22]. Such a combination showed an additive benefit and raised the eradication from 30% for those without *Nigella sativa* to 75%. The oil showed no major negative effects and was determined to be well tolerated.

Research involving people taken together indicates that *N. sativa*, particularly when combined with PPIs or antibiotics, can enhance the eradication rates of *H. pylori*, lower dyspeptic symptoms, and is usually safe and well tolerated (Table 1).

Animal studies

Few in vivo studies investigated the antibacterial and gastroprotective properties of *Nigella sativa*. Studies conducted on rats showed that black seed extract greatly lowered stomach lesions in a model of ethanol-induced ulcers, suggesting mucosal protection [23]. In another study on *H. pylori*-infected mice revealed that *Nigella sativa* extract therapy lowered bacterial load and stomach inflammation [24]. Although studies are

limited in animal, these findings imply that *Nigella sativa* could have a general preventive impact against stomach harm brought on by *H. pylori*.

Antibacterial action in vitro

Several in vitro experiments validate *Nigella sativa* antibacterial action vs *H. pylori*. One study showed that an aqueous extract of *Nigella sativa* totally suppressed *H. pylori* growth within 60 minutes [25]. Such an effect was true for clinical strains as well as antibiotic-resistant isolates.

Additionally, another study found dose-dependent growth suppression of clinical *H. pylori* isolates after testing *Nigella sativa* [26]. Another study likewise found that black seed extract showed significant efficacy against all examined strains and strengthened the effects of regular antibiotics when used together [27]. Studies further show that the majority of black seed's antibacterial action is caused by thymoquinone. It was shown that such an active ingredient could cause notable *H. pylori* growth suppression and might increase the permeability of bacterial membranes, hence promoting medication synergy [4].

Table 1: Summary of Clinical Studies on Black Seed and *Helicobacter pylori*

Study	Population	Treatment	Duration	Eradication Rate	Tolerability
Salem et al. [3]	88 adults with non-ulcer dyspepsia	Omeprazole + <i>N. sativa</i> seed powder (2 g/day)	Not specified	66.7% (<i>N. sativa</i>) vs 82.6% (standard)	Good, no serious adverse effects
Alizadeh-Naini et al. [19]	46 adults	<i>N. sativa</i> (2 g/day) + quadruple antibiotics	8 weeks	87.5% (<i>N. sativa</i>) vs 54.5% (placebo)	Good, no significant adverse effects
Hashem-Dabaghian et al. [20]	14 participants	Black seed and honey mixture	2 weeks	57.1%	Mild gastrointestinal discomfort
Mohtashami et al. [21]	Adults with functional dyspepsia	Honey + black seed oil (5 mL/day)	8 weeks	Improved elimination vs placebo	Mild nausea and bloating
Hamed et al. [22]	60 children	Black seed oil (alone and with triple therapy)	Not specified	30% (black seed oil alone), 75% (with triple therapy)	Well tolerated, no significant adverse effects

Mechanisms of Action Against *H. pylori*

Nigella sativa shows various anti-*Helicobacter pylori* properties through multiple distinct mechanisms. The primary bioactive compound, thymoquinone, induces oxidative damage that results in direct bactericidal effects against *H. pylori* [4]. Additionally, the lipophilic components of black seed compromise bacterial

membrane stability, which subsequently enhances permeability and increases susceptibility to antibiotics [28]. *Nigella sativa* shows the capacity to inhibit urease activity, an enzyme critical for the survival of *H. pylori* in acidic conditions of the stomach [29]. Furthermore, extracts of *Nigella sativa* reduce the adherence of bacteria to gastric epithelial cells, thereby obstructing



colonization and the formation of biofilms [25]. Recent findings suggest that *Nigella sativa* may affect bacterial virulence by downregulating vital pathogenicity-related genes, including *cagA* and *vacA* [30]. In addition, thymoquinone mitigates inflammation in the stomach induced by *H. pylori* by inhibiting pro-inflammatory cytokines, such as TNF- α and IL-1 β , and by blocking NF- κ B signaling pathways [3].

Conclusion and Recommendations

This review highlights the importance of *Nigella sativa* as a potential natural therapeutic agent for *Helicobacter pylori* infections and inflammation-associated gastric disorders. Data from in vitro, in vivo, and human clinical studies confirm the antibacterial, anti-inflammatory, and immunomodulatory properties of thymoquinone. *Nigella sativa* has many activities against *H. pylori*, including direct bactericidal effects, disruption of bacterial membranes, decrease of urease activity, suppression of virulence factors, and mitigation of stomach inflammation. Clinical trials indicate that *N. sativa* is safe, well-tolerated, and enhances eradication rates when used as an adjuvant to standard therapy, with no major adverse effects.

The inclusion of *Nigella sativa* as a supplementary or alternative therapy requires thoughtful evaluation because of the rising worldwide concern regarding antibiotic resistance and the shortcomings of existing eradication methods. Future studies ought to emphasize extensive, multicenter randomized controlled trials to determine the best dosing strategies, treatment duration, and long-term impacts. It is highly advisable to perform studies on standardized pharmaceutical formulations of *Nigella sativa* extracts, coupled with an in-depth analysis of its molecular mechanisms, especially its influence on host immune modulation and genes related to bacterial resistance. At the same time, integrating *Nigella sativa* into alternative medical practices could offer a unique, affordable approach for treating *H. pylori*-related issues.

Conflict of Interests

Authors declare no conflict of interest.

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