World Journal of Pharmaceutical Science and Research

www.wjpsronline.com

Review Article

ISSN: 2583-6579
SJIF Impact Factor: 6.916
Year - 2026
Volume: 5; Issue: 11
Page: 455-466

A REVIEW ON THE THERAPEUTIC POTENTIAL OF NIGELLA SATIVA: PHYTOCHEMISTRY, PHARMACOLOGICAL ACTIVITIES AND FUTURE PERSPECTIVE

Prof. Dr. Sanjay K. Bais[1], Varsha S. Mali*[2]

[1]Principal and Professor, Fabtech College Of Pharmacy, Sangola.

[2]Student, Fabtech College of Pharmacy, Sangola.

Article Received: 20 September 2026 | | ***Article Revised: 11 October 2026*** | | ***Article Accepted: 01 November 2026***

***Corresponding Author: Varsha S. Mali**
Student, Fabtech College of Pharmacy, Sangola.
DOI: https://doi.org/10.5281/zenodo.23945825

How to cite this Article: Prof. Dr. Sanjay K. Bais, Varsha S. Mali (2026) A REVIEW ON THE THERAPEUTIC POTENTIAL OF NIGELLA SATIVA: PHYTOCHEMISTRY, PHARMACOLOGICAL ACTIVITIES AND FUTURE PERSPECTIVE. World Journal of Pharmaceutical Science and Research, 5(11), 455-466.

Copyright © 2026 Varsha S. Mali | World Journal of Pharmaceutical Science and Research.
This work is licensed under creative Commons Attribution-NonCommercial 4.0 International license (CC BY-NC 4.0).

ABSTRACT

Nigella sativa L. (black seed or black cumin) is an annual herb of the family Ranunculaceae that has been used for many centuries in Unani, Ayurvedic and other traditional systems of medicine. Its seeds contain fixed oil, proteins, alkaloids, saponins and a small amount of volatile oil, and thymoquinone is the most widely studied active compound. This review gathers information from open-access articles on the phytochemistry and pharmacological activities of N. sativa. Laboratory and animal studies describe antioxidant, anti-inflammatory, anticancer, antidiabetic, antimicrobial, neuroprotective, cardiovascular, hepatoprotective and respiratory effects. Several small human trials support some of these effects, but the results are not uniform and many trials are small. The poor water solubility and low oral bioavailability of thymoquinone are major hurdles, and nanoformulations are being developed to overcome them. In summary, N. sativa is a promising source of lead compounds, but larger and better-designed clinical trials and standardised products are needed before firm clinical recommendations can be made.

KEYWORDS: Nigella sativa, black seed, thymoquinone, phytochemistry, pharmacological activities, future perspectives.

INTRODUCTION

Plants have been a major source of medicines for thousands of years, and many modern drugs have their origin in natural products.[1,2] Among medicinal plants, Nigella sativa has gained special attention because of its long history of

use and its wide range of reported biological activities.[1,2] The seeds are commonly called black seed, black cumin or kalonji, and in traditional medicine they are known by names such as Habat-ul-Sauda.[1]

Over the last few decades, many laboratory, animal and clinical studies have investigated the seed, its oil and its main constituent, thymoquinone.[3] These studies describe antioxidant, anti-inflammatory, anticancer, antidiabetic, antimicrobial, immunomodulatory, hepatoprotective, nephroprotective and neuroprotective properties.[3] Because so many reports exist, a short and clear summary is useful for students and researchers.[3]

The aim of this review is to present, in simple words, the botany and traditional uses of N. sativa, its main chemical constituents, its pharmacological activities supported by preclinical and clinical evidence, its safety, and the future directions of research.[1–3]

BOTANICAL DESCRIPTION AND TRADITIONAL USES

Nigella sativa belongs to the family Ranunculaceae, and it is an annual flowering plant native to southern Europe, North Africa and south-west Asia.[2] The plant has green, finely divided, linear leaves and produces small black seeds.[2] The genus Nigella contains several species; N. sativa is the best known, while N. damascena is mainly grown as an ornamental plant.[2]

The seeds have been used as a spice and food flavouring, for example in breads, and also as a natural medicine in many regions of the world.[1] Traditional uses include the treatment of bronchitis, asthma, diarrhoea, rheumatism and skin disorders.[1] Anticancer and antiproliferative uses have been described in the Unani, Ayurvedic and Chinese systems of medicine.[4] An early scientific study also reported that a mixture containing N. sativa had activity against Dalton's lymphoma ascites cells in animals.[5]

Correct identification of the seed is important.[3] The seeds of N. damascena contain a compound called damascenine, and its absence in a seed sample is used to show that the sample is not contaminated with this species.[3]

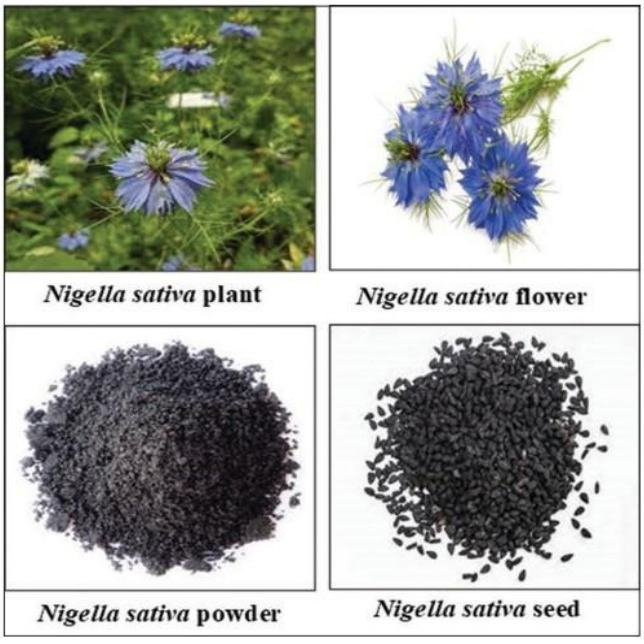


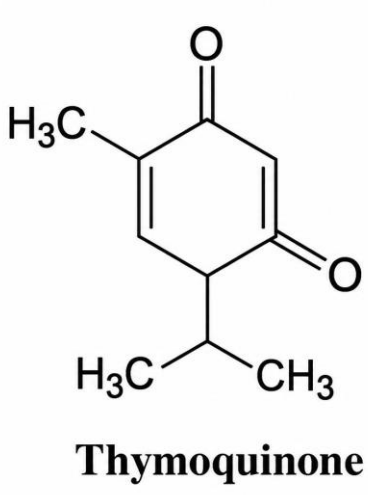
Fig. 1: Nigella sativa plant, flower and seeds.

TAXONOMIC CLASSIFICATION OF NIGELLA SATIVA

Rank	Classification
Kingdom	Plantae
Subkingdom	Tracheobionta
Superdivision	Spermatophyta
Phylum	Magnoliophyta
Class	Magnoliopsida
Order	Ranunculales
Family	Ranunculaceae
Genus	*Nigella*
Species	*N. sativa* L.

PHYTOCHEMISTRY

The pharmacological effects of N. sativa are linked to its many chemical constituents.[3,8] The subsections below describe the main groups of compounds.[3,8]



Thymoquinone

Fig. 2: Chemical structure of thymoquinone.

PROXIMATE COMPOSITION OF THE SEEDS

The seeds are a nutritious material.[1] One review reports that they contain about 26.7% protein, 28.5% fat, 24.9% carbohydrate, 8.4% crude fibre and 4.8% total ash.[1] The seeds also contain vitamins and minerals, and the exact values differ with variety, place of growth and method of analysis.[1,10] Because the composition changes with growing conditions and extraction method, standardisation of seed material is important for reproducible research.[3,10]

QUINONES AND VOLATILE OIL

Thymoquinone (2-isopropyl-5-methylbenzo-1,4-quinone, molecular formula C10H12O2) is the most abundant quinone and is considered the main active principle of the volatile oil[1]. Other compounds in the volatile fraction include p-cymene, carvacrol, thymol and related terpenes.[6] Reported amounts differ widely.[6] In one analysed oil, p-cymene (37.3%), thymoquinone (13.7%) and carvacrol (11.77%) were the leading compounds[6]. The seed is reported to contain 36 to 38% oil and only 0.4 to 0.45% volatile oil.[7] In a dichloromethane seed extract used in a clinical study, thymoquinone formed about 50% of the extract.[3] An early study isolated thymohydroquinone from the volatile oil as an antimicrobial principle.[27] Thymoquinone has attracted interest as a multi-target molecule, and its pharmacological properties and formulation challenges have been reviewed in detail.[8]

ALKALOIDS

The seeds contain alkaloids such as nigellicine and nigellidine.[2] Isoquinoline and indazole alkaloids and the dolabellane-type diterpene alkaloids called nigellamines have also been isolated from the seeds.[3] Compared with thymoquinone, the pharmacology of the alkaloids is much less explored.[3] One recent review points out that several identified molecules, including alkaloids, are still not studied enough.[3]

SAPONINS AND OTHER COMPOUNDS

Alpha-hederin is a water-soluble pentacyclic triterpene saponin present in the seeds, and it is regarded as a possible anticancer agent.[1,9] The seeds also contain other constituents, such as flavonoid glycosides, phenolic compounds, sterols and tocopherols, as summarised in recent reviews.[3,9] The combined presence of many compounds is one reason why whole seed extracts and oil sometimes show effects that differ from those of pure thymoquinone.[3]

FIXED OIL AND FATTY ACIDS

The fixed oil is rich in unsaturated fatty acids, mainly linoleic and oleic acids.[10] Gas chromatography–mass spectrometry (GC-MS) studies of seed extracts and oils show a variety of fatty acids, terpenes and other compounds, and the profile depends on the solvent and the extraction method used.[10] These fatty acids contribute to the nutritional value of the oil and may also play a role in its anti-inflammatory and metabolic effects, although their exact role needs further study.[10]

PHARMACOLOGICAL ACTIVITIES

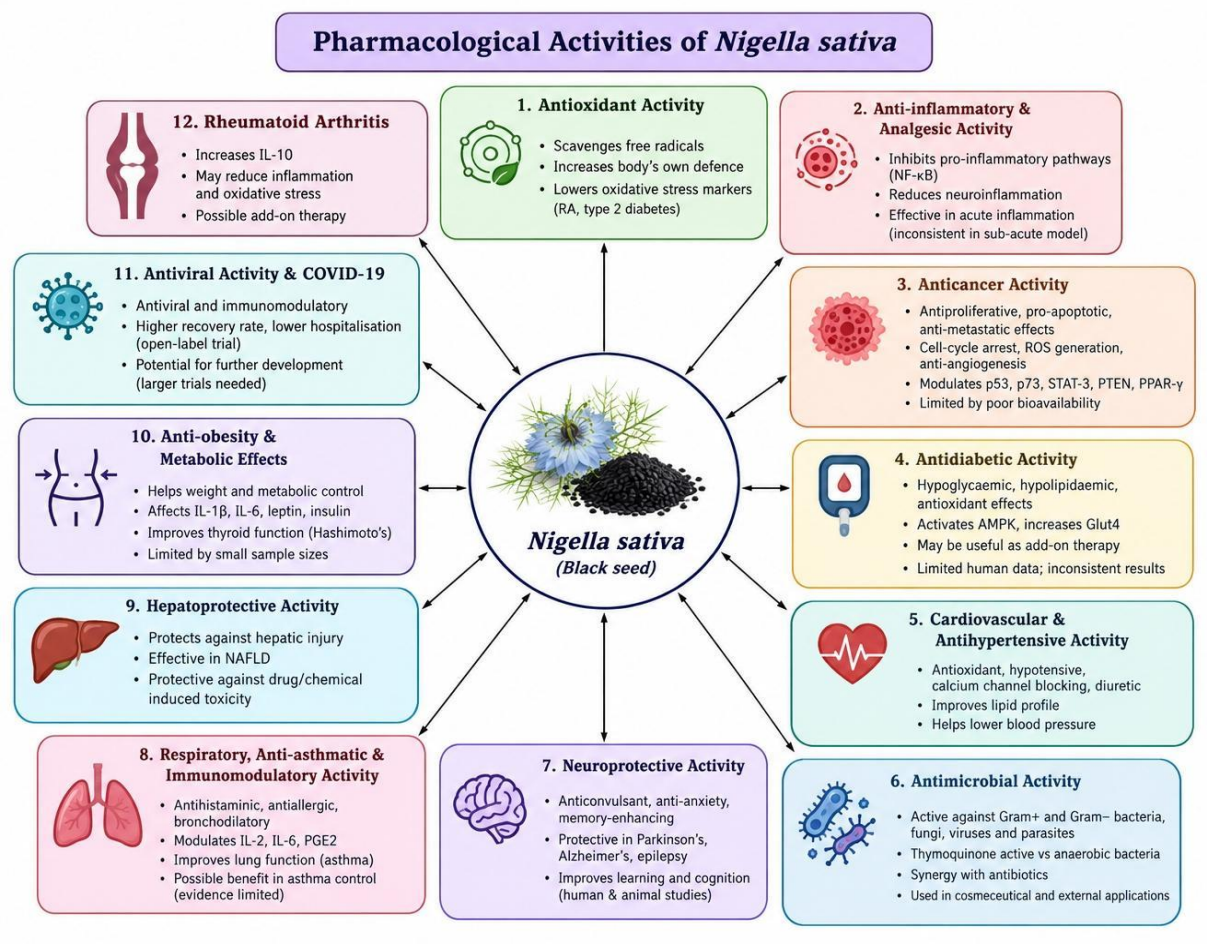


Fig. 3: Pharmacological activities of Nigella sativa.

N. sativa seed, oil and thymoquinone have been tested in many experimental models.[3,8]

ANTIOXIDANT ACTIVITY

Oxidative stress is involved in many chronic diseases.[8] Extracts, oil and thymoquinone of N. sativa show antioxidant effects in laboratory experiments.[8] Thymoquinone is regarded as a strong antioxidant, and it can also increase the body's own defence system.[11] In human studies, supplementation with N. sativa lowered markers of oxidative stress in patients with rheumatoid arthritis and improved glycaemic control and oxidative status in type 2 diabetes.[12,13] In addition, protective effects against food toxins and chemical toxicities have been explained mainly through reduction of oxidative stress and support of antioxidant enzymes.[14,15]

ANTI-INFLAMMATORY AND ANALGESIC ACTIVITY

Seed oil and thymoquinone have been used in traditional medicine for inflammatory conditions.[1,16] Thymoquinone has been described as an inhibitor of pro-inflammatory pathways.[11] It also reduced neuroinflammation caused by lipopolysaccharide through interference with NF-κB signalling in microglial cells.[7] The evidence from animals is not always consistent.[16] In one rat study, N. sativa oil was effective in acute (carrageenan-induced) inflammation but did not show an anti-inflammatory effect in the sub-acute model, and the authors described the results as inconsistent.[16] This shows that dose, preparation and experimental model can change the result.[16]

ANTICANCER ACTIVITY

Anticancer activity is one of the most studied properties of N. sativa.[4,9] Seed extracts, thymoquinone and alpha-hederin have shown antiproliferative, pro-apoptotic and anti-metastatic effects against cancer cells of the liver, colon, breast, kidney, cervix, lung, ovary, pancreas, prostate and skin.[9] Reported mechanisms include cell-cycle arrest, apoptosis, generation of reactive oxygen species, anti-angiogenesis, control of the Akt pathway, and modulation of p53, p73, STAT-3, PTEN and PPAR-γ along with caspase activation[4,11]. Increased natural killer cell cytotoxic activity and the iNOS pathway have also been described.[17] Thymoquinone signalling in colorectal cancer has been reviewed separately.[18] Most of this evidence comes from cell and animal experiments.[9,17] The poor bioavailability of thymoquinone limits its clinical use, and nanoparticle systems and analogues are being developed to improve its anticancer effect.[19]

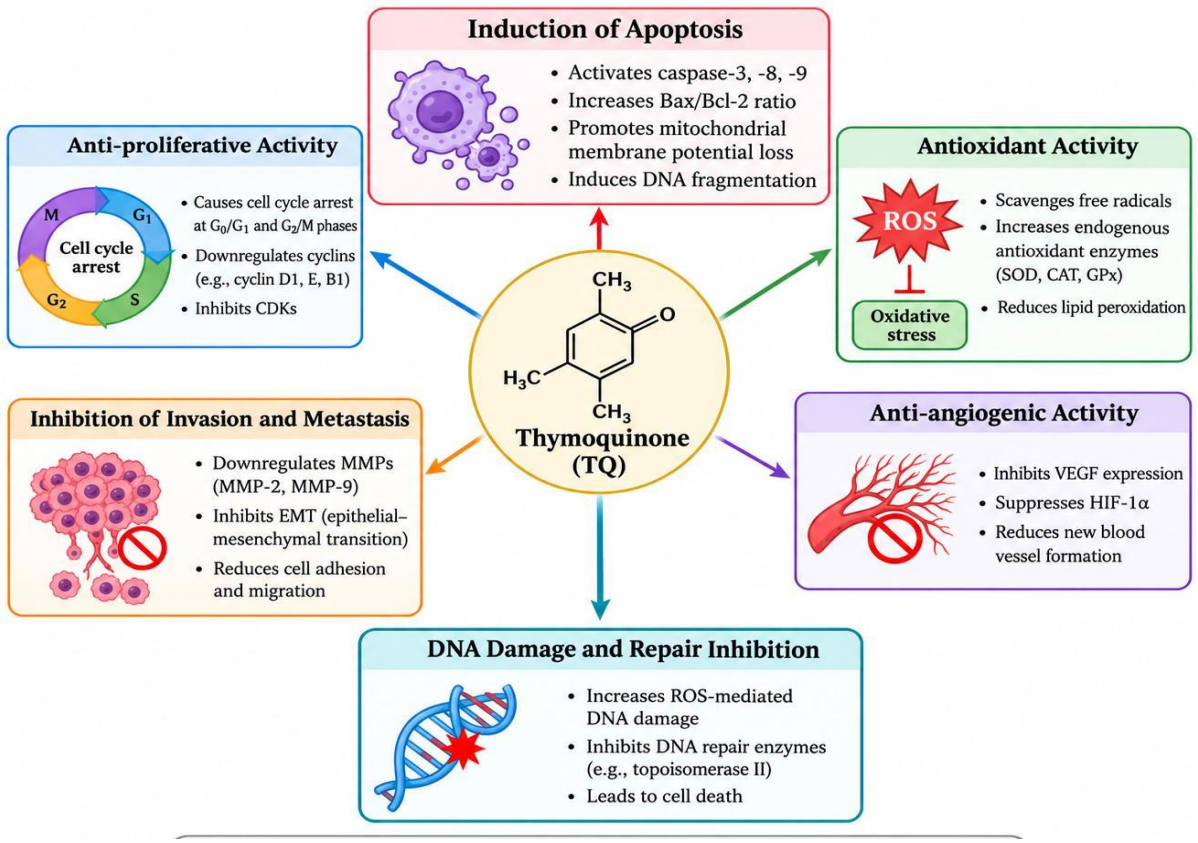


Fig. 4: Proposed anticancer mechanisms of thymoquinone.

ANTIDIABETIC ACTIVITY

N. sativa is traditionally used for diabetes.[20,22] In experimental animals, an aqueous seed extract showed antihyperglycaemic, antihyperlipidaemic and antioxidant effects at safe doses.[20] Another study found that the in vivo antidiabetic activity is linked with activation of the AMPK pathway and increased Glut4 content in muscle.[21] Human data are encouraging but limited.[22] A systematic review concluded that N. sativa may be useful as an add-on to oral antidiabetic drugs.[22] A placebo-controlled trial reported improved glycaemic control and reduced oxidative stress in type 2 diabetes,[13] and a meta-analysis of randomised trials reported improvement in cardiometabolic indicators in prediabetes and type 2 diabetes.[23] However, a small trial in healthy volunteers (1 g seed powder per day for 4 weeks) did not change insulin secretion.[3]

CARDIOVASCULAR AND ANTIHYPERTENSIVE ACTIVITY

N. sativa and its constituents show antioxidant, hypotensive, calcium channel blocking and diuretic properties that may help to lower blood pressure.[24] A review of the pharmacotherapy of hypertension noted dose-dependent reductions in systolic and diastolic pressure in people with mild hypertension who took seed extract.[25] Lipid effects have also been studied.[3] In a randomised trial in menopausal women, seed powder improved the lipid profile compared with placebo over two months.[3] In patients with Hashimoto's thyroiditis, powdered seeds were reported to improve serum lipids and the atherogenic index.[26]

ANTIMICROBIAL ACTIVITY

Extracts and thymoquinone have a broad antimicrobial range that includes Gram-positive and Gram-negative bacteria, fungi, viruses and parasites.[27,28] An early study showed that thymohydroquinone from the volatile oil was active against Gram-positive bacteria and yeasts.[27] Thymoquinone was active against anaerobic bacteria, although it was weaker than metronidazole.[29] Extracts and purified thymoquinone inhibited Bacillus species in a study that also quantified thymoquinone by HPLC.[30] Thymoquinone also showed synergy with standard antibiotics against multi-drug-resistant isolates.[31] Seed extracts and oil have also been applied in cosmeceutical and external use for skin conditions.[28]

NEUROPROTECTIVE ACTIVITY

Thymoquinone protects brain cells from oxidative stress and inflammation.[6,7] Reviews describe anticonvulsant, anti-anxiety and memory-enhancing effects, and possible use in epilepsy, Parkinson's disease and Alzheimer's disease.[6,7] In a rat model of Alzheimer's disease induced by amyloid beta, thymoquinone (5 and 10 mg/kg) improved learning function.[32] It also protected human stem-cell-derived cholinergic neurons from amyloid-beta toxicity.[33] The molecular pathways involved in Alzheimer's disease have been reviewed.[34] In healthy volunteers, a capsule dose of 500 mg twice daily for 9 weeks was reported to improve memory, attention and cognition.[7]

RESPIRATORY, ANTI-ASTHMATIC AND IMMUNOMODULATORY ACTIVITY

The seeds have long been used for cough, bronchitis and asthma.[1,35] Reviews describe antihistaminic, antiallergic, bronchodilatory and immunomodulatory effects.[35] In human cells, different N. sativa preparations changed the release of IL-2, IL-6 and PGE2, which are inflammatory mediators important in asthma.[35] In a randomised trial of patients with partly controlled asthma, supplementation along with regular inhaled therapy improved some lung function and inflammation measures.[36] A meta-analysis suggested a possible added benefit for asthma control, but it also stated that the current evidence is not enough for routine clinical use.[37]

HEPATOPROTECTIVE ACTIVITY

Seed extracts and thymoquinone have shown hepatoprotective activity in many animal models.[8] A systematic review of in vivo studies summarised the protective effects of thymoquinone against hepatic injury.[38] In people with non-alcoholic fatty liver disease, clinical trials of N. sativa supplementation have been reviewed systematically.[39] Protective effects against drug-induced and chemical-induced organ toxicity, including liver toxicity, have been collected in a separate review.[15]

ANTI-OBESITY AND METABOLIC EFFECTS

Obesity and its complications are major health problems, and N. sativa has been studied as a possible aid for weight and metabolic control.[40,41] A crossover trial in overweight and obese women examined the effect of black seed on IL-1β, IL-6, leptin and insulin parameters.[42] Trials in patients with Hashimoto's thyroiditis also looked at thyroid function and body measurements after supplementation.[43] The overall evidence is promising but is still limited by small sample sizes and differences in doses and preparations.[41]

ANTIVIRAL ACTIVITY AND COVID-19

Because N. sativa has antiviral and immunomodulatory properties, it was proposed as an add-on treatment for COVID-19.[44,45] In an open-label randomised trial in adults with mild disease, N. sativa oil was linked with a higher chance of recovery and a lower chance of hospitalisation.[44] However, the authors stated that larger double-blind trials are needed.[44] A review of anti-COVID-19 constituents, clinical trials and patents concluded that the literature supports its potential, and it predicted further development of such products.[45]

RHEUMATOID ARTHRITIS

Rheumatoid arthritis is a long-term autoimmune disease with pain and joint damage.[12] In a randomised, double-blind, placebo-controlled trial, 42 patients took two capsules (500 mg each) of N. sativa oil every day for 8 weeks.[12] The authors found a rise in serum IL-10 and suggested that the oil may reduce inflammation and oxidative stress and could be a useful add-on therapy.[12]

CLINICAL EVIDENCE

Human studies have examined N. sativa in diabetes, lipid disorders, hypertension, asthma, rheumatoid arthritis, thyroid disease, fatty liver and COVID-19. Many of these studies were small and short, and they used different products and doses, so the results cannot be compared easily. Positive results have been reported for the lipid profile in menopausal women, for glycaemic control in type 2 diabetes, for inflammatory markers in rheumatoid arthritis and for recovery in mild COVID-19. Other trials did not show benefit; for example, there was no change in insulin secretion in healthy volunteers. Meta-analytic evidence in asthma is still considered insufficient for routine use.

SAFETY AND TOXICITY

N. sativa seed and its preparations are generally considered to have low toxicity.[2,3] A narrative review reported that aqueous, methanol and chloroform extracts at doses up to 6 g/kg did not produce toxicity in animal sub-acute studies, while the LD50 of the fixed oil varied depending on route and species.[2,20] Long-term use of the fixed oil at 2 mL/kg in rats caused slight toxicity, and the authors advise more detailed studies for a firm conclusion.[2]

In clinical use, no serious adverse effects were found in most trials.[3] Mild effects such as nausea, bloating and a burning sensation were reported with the oil in functional dyspepsia.[3] Epigastric pain and low blood sugar were seen in some patients treated for hepatitis C.[3] Because the plant can lower blood sugar and blood pressure, people taking antidiabetic or antihypertensive drugs should use it only under medical advice.[3,22,25] Thymoquinone itself may have more toxicity than the whole seed in some studies, which is another reason why the dose and preparation must be carefully controlled.[3,8]

BIOAVAILABILITY AND NANO-FORMULATIONS

The main limitation in developing thymoquinone as a drug is its poor aqueous solubility, instability and low oral bioavailability.[46] To solve this problem, scientists have prepared several nanocarriers.[46,47] Chitosan-modified polymeric nanoparticles improved the oral bioavailability of thymoquinone by about 3.5 times in animals compared with a plain suspension.[47] A self-nanoemulsifying drug delivery system (SNEDDS) gave about four-fold higher bioavailability.[46] Polymeric nanoparticles for cancer therapy gave a modest 1.3-fold increase in a pilot study in mice.[19] These results are promising, but most of them are preclinical, and human data on such formulations are still lacking.[46,47]

FUTURE PERSPECTIVES

Standardisation: Seed products differ greatly in thymoquinone content, so standard extracts with known marker compounds are required.

Better clinical trials: Large, double-blind, placebo-controlled, long-term trials with fixed doses are needed to confirm the benefits in diabetes, hypertension, asthma, arthritis and fatty liver.

Mechanism studies: The exact molecular targets of thymoquinone and of less-studied compounds, such as alkaloids, need clearer investigation.

Drug delivery: Nano-formulations such as lipid carriers and polymeric particles should move from animal studies to human pharmacokinetic studies.

Safety and interactions: Long-term toxicity data and studies on interactions with antidiabetic, antihypertensive and anticoagulant drugs are needed.

Combination therapy and analogues: Combining thymoquinone with standard drugs and developing improved analogues could increase efficacy and reduce side effects.

CONCLUSION

Nigella sativa is a traditional medicinal plant with a rich chemistry, and thymoquinone, alkaloids, saponins and unsaturated fatty acids are its important constituents. Preclinical studies show a wide range of pharmacological effects, and several small human trials give encouraging results. However, its therapeutic potential is still not fully proven because of differences in plant material, dose and study design, the limited bioavailability of thymoquinone, and the lack of large clinical trials. With standardised preparations, improved formulations and well-designed clinical research, N. sativa may become a useful complementary or lead source for new drugs.

LIST OF ABBREVIATIONS

NF-κB	Nuclear factor kappa B
IL	Interleukin
PGE2	Prostaglandin E2
iNOS	Inducible nitric oxide synthase
Akt	Protein kinase B
AMPK	AMP-activated protein kinase
Glut4	Glucose transporter type 4
GC-MS	Gas chromatography–mass spectrometry
HPLC	High-performance liquid chromatography
SNEDDS	Self-nanoemulsifying drug delivery system
COVID-19	Coronavirus disease 2019
LD50	Median lethal dose

REFERENCES

1. A review on therapeutic potential of Nigella sativa: A miracle herb. Asian Pac J Trop Biomed, 2013.
2. Ziaee T, Moharreri N, Hosseinzadeh H. Review of pharmacological and toxicological effects of Nigella sativa and its active constituents. J Med Plants, 2012; 11(42): 16-42.
3. Nigella sativa: A Comprehensive Review of Its Therapeutic Potential, Pharmacological Properties, and Clinical Applications.
4. Review on the Potential Therapeutic Roles of Nigella sativa in the Treatment of Patients with Cancer: Involvement of Apoptosis. J Pharmacopuncture, 2017.
5. Salomi MJ, Panikkar KR, Kesavan M, Donata K, Rajagopalan K. Anti-cancer activity of Nigella sativa. Anc Sci Life, 1989; 8(3-4): 262-6.
6. The Protective Effects of Nigella sativa and Its Constituents on Induced Neurotoxicity.
7. Thymoquinone: Review of Its Potential in the Treatment of Neurological Diseases. Pharmaceuticals (Basel), 2022; 15(4): 408.
8. Thymoquinone: an emerging natural drug with a wide range of medical applications. Iran J Basic Med Sci, 2014; 17(12): 950-7.
9. Nutritional Value and Preventive Role of Nigella sativa L. and Its Main Component Thymoquinone in Cancer: An Evidenced-Based Review of Preclinical and Clinical Studies. Molecules, 2021; 26(8): 2108.
10. Phytochemical characterization and antimicrobial activity of Nigella sativa seeds. PLoS One.
11. Anticancer Activities of Nigella Sativa (Black Cumin).
12. Hadi V, Kheirouri S, Alizadeh M, Khabbazi A, Hosseini H. Effects of Nigella sativa oil extract on inflammatory cytokine response and oxidative stress status in patients with rheumatoid arthritis: a randomized, double-blind, placebo-controlled clinical trial. Avicenna J Phytomed, 2016; 6(1): 34-43.
13. Nigella sativa Improves Glycemic Control and Ameliorates Oxidative Stress in Patients with Type 2 Diabetes Mellitus: Placebo Controlled Participant Blinded Clinical Trial. PLoS One. 2015.
14. Nigella sativa and its Derivatives as Food Toxicity Protectant Agents.
15. Black Seed (Nigella Sativa) and its Constituent Thymoquinone as an Antidote or a Protective Agent Against Natural or Chemical Toxicities.
16. Nigella Sativa's Anti-Inflammatory and Antioxidative Effects in Experimental Inflammation. Antioxidants (Basel), 2020; 9(10): 921.
17. Recent advances on the anti-cancer properties of Nigella sativa, a widely used food additive.
18. Molecular Mechanisms and Signaling Pathways Underlying the Therapeutic Potential of Thymoquinone Against Colorectal Cancer.
19. Development of a Thymoquinone Polymeric Anticancer Nanomedicine through Optimization of Polymer Molecular Weight and Nanoparticle Architecture.
20. In Vivo Subacute Toxicity and Antidiabetic Effect of Aqueous Extract of Nigella sativa.
21. The In Vivo Antidiabetic Activity of Nigella sativa Is Mediated through Activation of the AMPK Pathway and Increased Muscle Glut4 Content.
22. Effects of Nigella Sativa on Type-2 Diabetes Mellitus: A Systematic Review.
23. Nigella sativa supplementation improves cardiometabolic indicators in population with prediabetes and type 2 diabetes mellitus: A systematic review and meta-analysis of randomized controlled trials.

24. Leong XF, Mustafa MR, Jaarin K. Nigella sativa and its protective role in oxidative stress and hypertension. Evid Based Complement Alternat Med, 2013.
25. Nigella Sativa (Black Seeds), A Potential Herb for the Pharmacotherapeutic Management of Hypertension: A Review.
26. Powdered black cumin seeds strongly improves serum lipids, atherogenic index of plasma and modulates anthropometric features in patients with Hashimoto's thyroiditis.
27. Black cumin (Nigella sativa) and its constituent (thymoquinone): a review on antimicrobial effects. Iran J Basic Med Sci, 2015.
28. Antimicrobial Properties and Therapeutic Potential of Bioactive Compounds in Nigella sativa: A Review.
29. An active principle of Nigella sativa L., thymoquinone, showing significant antimicrobial activity against anaerobic bacteria, 2016 Nov 21; 6(1): 97-101.
30. HPLC Quantification of Thymoquinone Extracted from Nigella sativa L. (Ranunculaceae) Seeds and Antibacterial Activity of Its Extracts against Bacillus Species.
31. Synergistic efficacies of thymoquinone and standard antibiotics against multi-drug resistant isolates. Saudi Med J., 42(2): 196.
32. Thymoquinone recovers learning function in a rat model of Alzheimer's disease.
33. Neuroprotective efficacy of thymoquinone against amyloid beta-induced neurotoxicity in human induced pluripotent stem cell-derived cholinergic neurons.
34. Molecular signaling pathway targeted therapeutic potential of thymoquinone in Alzheimer's disease. Heliyon.
35. Clinical and experimental effects of Nigella sativa and its constituents on respiratory and allergic disorders. Avicenna J Phytomed, 2019.
36. Effect of Nigella sativa supplementation on lung function and inflammatory mediators in partly controlled asthma: a randomized controlled trial. Ann Saudi Med.
37. The efficacy of Nigella sativa supplementation for asthma control: a meta-analysis of randomized controlled studies.
38. Plants and Surgery: The Protective Effects of Thymoquinone on Hepatic Injury—A Systematic Review of In Vivo Studies.
39. Nigella sativa supplementation and non-alcoholic fatty liver disease: A systematic review of clinical trials.
40. A Review of the Potential Health Benefits of Nigella sativa on Obesity and Its Associated Complications.
41. Is Nigella sativa an Effective Bodyweight Lowering Agent and a Mitigator of Obesity Risk? Vasc Health Risk Manag.
42. A crossover randomized controlled trial examining the effects of black seed (Nigella sativa) supplementation on IL-1β, IL-6 and leptin, and insulin parameters in overweight and obese women.
43. The effects of Nigella sativa on thyroid function, serum Vascular Endothelial Growth Factor (VEGF) – 1, Nesfatin-1 and anthropometric features in patients with Hashimoto's thyroiditis: a randomized controlled trial.
44. Nigella sativa for the treatment of COVID-19: An open-label randomized controlled clinical trial. Complement Ther Med, 2021.
45. Nigella sativa L. and COVID-19: A Glance at The Anti-COVID-19 Chemical Constituents, Clinical Trials, Inventions, and Patent Literature.

46. Self-nanoemulsifying drug delivery system (SNEDDS) mediated improved oral bioavailability of thymoquinone: optimization, characterization, pharmacokinetic, and hepatotoxicity studies.
47. Thymoquinone-entrapped chitosan-modified nanoparticles: formulation optimization to preclinical bioavailability assessments. Drug Deliv.