ACTA Traditional Medicine

Original Research Article
ISSN 2583-7532
Journal homepage: traditionalmedicine.actabotanica.org

Nigella sativa in Traditional and Modern Medicine: Pharmacological Evidence and Future Prospects

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Citation: Sunaiba Manzar, Zainab Zaki, Farha, and Moiz Alam (2026). *Nigella sativa* in Traditional and Modern Medicine: Pharmacological Evidence and Future Prospects. ***Acta Traditional Medicine.***
DOI: https://doi.org/10.51470/ATM.2026.5.1.01

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Received 05 October 2025 | Revised 07 November 2025 | Accepted 06 December 2025 | Available Online January 04 2026

ABSTRACT

Over the past two decades, the global use of medicinal plants as complementary and adjuvant therapies has increased significantly for the management of various diseases. Nigella sativa, commonly known as kalonji, black cumin, or Roman coriander, is among the most extensively studied evidence-based medicinal herbs. It belongs to the family Ranunculaceae and is an annual flowering plant characterized by bluish-white flowers and small, black, flattened, oblong seeds resembling onion seeds. Synonyms include Nigella indica and Nigella truncata, and the plant is widely cultivated in India, the Middle East, and Mediterranean regions, thriving in both cold dry and warm humid climates. The seeds, fruits, and seed oil of N. sativa are extensively used in both culinary and medicinal applications. Numerous pharmacological properties have been documented, including antihypertensive, diuretic, antidiarrheal, analgesic, antimicrobial, immunomodulatory, antioxidant, hepatoprotective, and gastroprotective effects. In the United States, N. sativa is classified as Generally Recognized as Safe (GRAS) by the Food and Drug Administration for consumption. Phytochemical analyses reveal the presence of fixed oils, proteins, alkaloids, saponins, and essential oils, with thymoquinone identified as the principal bioactive compound responsible for many therapeutic actions. This review aims to highlight the medicinal significance of Nigella sativa, promote greater scientific interest in herbal therapeutics, and encourage further exploration of its potential in disease prevention and treatment.

Keywords: *Thymoquinone, kalonji, anti-inflammatory, and immunomodulatory.*

Introduction

Over the past two decades, there has been a growing global interest in alternative and traditional systems of medicine, as many individuals increasingly seek natural therapeutic options alongside or in place of conventional allopathic treatments, particularly for chronic diseases [1-5]. Traditional medical systems such as Unani, Ayurveda, and Siddha continue to play a significant role in healthcare due to their holistic approach and long history of medicinal plant use [6-9]. The genus *Nigella* comprises approximately 20 species of annual herbs, among which *Nigella sativa* is the most widely recognized and therapeutically important. Historical medical scholars, including Dioscorides and Hippocrates, documented its medicinal value, referring to it as "Melanthion," while in traditional Arabic medicine it is commonly known as "Habbatul Sauda." *Nigella sativa*, commonly known as kalonji or black cumin, belongs to the family Ranunculaceae, also known as the buttercup family. In Unani medicine, each medicinal substance is characterized by a specific temperament (mizaj). *Nigella sativa* is generally classified as having a hot and dry temperament in the second or third degree. The plant is widely valued for both culinary and medicinal purposes and holds a prominent place in traditional healing practices, including Tibb-e-Nabawi, where its regular use is recommended for maintaining health [10-13]. The Middle East and Mediterranean regions are traditionally known for its cultivation, although its use has now spread globally. In recent years, particularly during global health challenges such as the COVID-19 pandemic, attention has once again turned toward medicinal plants with immunomodulatory and antimicrobial properties.

Nigella sativa has attracted scientific interest due to reported pharmacological effects, including antiviral, antibacterial, anti-inflammatory, immunomodulatory, and antiallergic activities [14-16]. This review aims to highlight the therapeutic significance of *Nigella sativa*, emphasizing its pharmacological potential and reaffirming the importance of traditional medicinal systems as valuable resources for modern healthcare and preventive medicine.

Taxonomy of Nigella sativa

Taxonomic Rank	Classification
Kingdom	Plantae
Subkingdom	Tracheobionta (Vascular plants)
Superdivision	Spermatophyta (Seed plants)
Division/Phylum	Magnoliophyta (Flowering plants)
Class	Magnoliopsida (Dicotyledons)
Order	Ranunculales
Family	Ranunculaceae
Genus	*Nigella*
Species	*Nigella sativa* L.

Etymology and Vernacular Names of *Nigella sativa*

The genus name *Nigella* is derived from the Latin word *niger*, meaning "black," referring to the characteristic black color of the seeds. The species name *sativa* originates from a Latin botanical adjective meaning "cultivated," indicating that the plant is widely grown for culinary and medicinal purposes [17].

Vernacular Names

Nigella sativa is known by different names across regions and traditional medicinal systems:

- **Unani:** Kalonji, Shoniz

- **Arabic:** Kamoon-e-Aswad, Shoniz, Habbatussauda, Shonizgam
- **English:** Small fennel, Black cumin
- **Hindi:** Kalonji, Kalazeera, Mugrela, Kalajeera
- **Persian:** Siyah Dana, Shoniz, Siyahdaru, Shonoz, Siyahbiranj
- **Urdu:** Kalonji
- **Sanskrit:** Upakunchika, Kalajaji, Karavi, Kunchi, Kunchika, Krishna Jiraka
- **United States (Common usage):** Black caraway seed
- **Bengali:** Kalajira
- **Indonesian:** Jinten Hitam

Morphological Description

Nigella sativa is an annual, herbaceous, flowering plant that grows erect and typically attains a height of 30–60 cm at maturity [18-19].

Plant: The plant is slender, erect, and highly branched, with delicate foliage giving it a feathery appearance.

Flower: The flowers are solitary and borne terminally on long peduncles. Young flowers appear pale green, gradually turning light blue and later becoming pale bluish-white upon maturation. The involucre is absent. The flower consists of five petaloid sepals, while true petals are absent. Numerous stamens surround five partially united carpels, and the flowers are hermaphroditic in nature.

Leaves: Leaves are compound and finely divided into 2–3 pinnatisect linear-lanceolate segments. They appear greyish-green and have a fine, feathery texture that contributes to the plant's delicate appearance.

Fruit: The fruit is an inflated capsule formed by the fusion of 3–7 united follicles, each containing numerous seeds.

Seed: Seeds are small, trigonous, black, and rugulose in texture, resembling onion seeds in appearance. They measure approximately 0.2 cm in length and 0.1 cm in width.

Therapeutic Potential of *Nigella sativa*

Medicinal plants have long been valued for their multiple therapeutic properties, and *Nigella sativa* (black cumin) is among the most widely recognized for its health benefits. Traditional literature and prophetic medicine emphasize its healing potential. According to a well-known narration reported by Abu Huraira, Prophet Muhammad (SAW) stated that black seed contains a remedy for every disease except death. Historically, this seed has been referred to as *Shoonez* in traditional medicine texts. The majority of pharmacological effects of *Nigella sativa* are attributed to its principal bioactive compound, thymoquinone, which exhibits diverse biological activities [20-21]. The renowned physician Avicenna also mentioned black seed in *The Canon of Medicine*, stating that it helps stimulate body energy and assists recovery from fatigue and weakness. Modern scientific studies have increasingly validated many of these traditional claims, demonstrating the plant's broad therapeutic potential.

Major Pharmacological Actions

Anti-inflammatory Activity (Mohlil-e-Auram)

Nigella sativa exhibits significant anti-inflammatory and analgesic properties. Experimental studies have demonstrated that aqueous extracts of the seeds reduce inflammatory responses and alleviate pain [22]. Clinical investigations, including double-blind trials in patients with allergic rhinitis, have shown that *Nigella sativa* preparations help reduce nasal itching, rhinorrhea, congestion, and turbinate hypertrophy, suggesting its effectiveness in managing inflammatory respiratory conditions.

Immunomodulatory Effect

The volatile oil extracted from *Nigella sativa* seeds has shown immunomodulatory and cytotoxic effects in experimental animal studies. In traditional medicine systems, both the seeds and their oil are widely used as general health tonics to strengthen the immune system and prevent disease. *In vitro* studies further demonstrate that *Nigella sativa* influences immune responses by enhancing macrophage activity, stimulating splenocyte proliferation, and improving natural killer (NK) cell activity, thereby supporting antitumor immune responses [23-24]. These findings suggest that black cumin plays an important role in immune regulation and disease resistance.

Additional Pharmacological Properties of *Nigella sativa*

Neuroprotective Activity

Thymoquinone, the principal bioactive compound of *Nigella sativa*, has demonstrated neuroprotective effects in experimental studies [25]. In animal models of transient forebrain ischemia, thymoquinone significantly reduced neuronal damage in the hippocampus, suggesting its potential role in protecting brain tissue from ischemic injury and neurodegenerative conditions.

Nephroprotective Activity

Thymoquinone has also shown protective effects against drug-induced kidney damage. Studies indicate that it reduces nephrotoxicity caused by gentamicin administration, likely through antioxidant and anti-inflammatory mechanisms that help preserve renal function [26].

Gastroprotective Activity

Nigella sativa exhibits gastroprotective effects by influencing gastric secretions and mucosal defense mechanisms. Experimental studies report increased mucosal histamine levels along with modulation of gastric acid secretion and enhancement of antioxidant defenses such as glutathione levels, thereby protecting the gastric mucosa against ulceration and injury [27].

Antimicrobial Activity (Dafa-e-Taffun)

Seeds of *Nigella sativa* possess broad antimicrobial activity against various pathogenic microorganisms, supporting its traditional use in managing infections.

Antifungal Activity

Aqueous seed extracts have demonstrated antifungal activity in in vivo studies, indicating potential usefulness in controlling fungal infections.

Other Pharmacological Actions

In addition to the above effects, *Nigella sativa* exhibits several other therapeutic properties, including:

- Antioxidant activity
- Carminative effect (Kasir-e-Riyah)
- Analgesic action (Musakkin-e-Auja)
- Diuretic effect (Muddire-Baul)
- Emmenagogue action (Muddire-Haiz)
- Galactagogue effect (Mufriz-e-Laban)
- Expectorant action (Mukhrij-e-Balgham)
- Abortifacient activity (Mukhrij-e-Janeen)

- Antidiabetic effect (Dafa-e-Ziyabeetus)

These diverse pharmacological activities contribute to the wide therapeutic applications of the plant in traditional medicine.

Therapeutic Uses (Istemaal)

In Unani and traditional medicine systems, *Nigella sativa* is commonly used in the management of several clinical conditions, including:

- Urinary retention (Ehtebas-e-Baul)
- Amenorrhea (Ehtebas-e-Haiz)
- Agalactorrhea (Qillat-e-Laban)
- Common cold and coryza (Nazla wa Zukam)
- Asthma and respiratory disorders (Zeeq-un-Nafas/Dama)
- Skin infections (Jildi Amraz)
- Hemorrhoids (Bawaseer)
- Jaundice (Yarqan)
- Memory disorders and dementia (Nisyan)
- Flatulence and gastric discomfort (Nafakh-e-Shikam)
- Gastric pain (Dard-e-Shikam)
- Paralysis (Falij)

Chemical Composition

Nigella sativa seeds contain a complex mixture of bioactive compounds responsible for their medicinal properties. The major active component is thymoquinone, constituting approximately 30–48% of the volatile oil and responsible for many pharmacological actions, including anti-allergic and antiasthmatic effects. Other important constituents include thymohydroquinone, dithymoquinone, thymol, longifolene, and various essential oil components. The seeds also contain alkaloids belonging to isoquinoline and pyrazole groups [28-29]. Chemically, the seeds contain approximately 1.5% volatile oil and 37.5% fixed oil, with the volatile oil contributing significantly to therapeutic activity. Additional compounds include alpha-hederin, pentacyclic triterpenes, and saponins, many of which exhibit anticancer properties. *Nigella sativa* seeds provide essential minerals such as calcium, magnesium, iron, zinc, and selenium, contributing to their nutritional and therapeutic value [31-33].

Adverse Effects (Muzir Asrat)

Although generally considered safe when used appropriately, excessive consumption or improper use may lead to certain adverse effects, including:

- Khunaq (diphtheria-like throat irritation)
- Dauran-e-sir (giddiness or dizziness)

Correctives (Musleh)

In Unani medicine, the following substances are recommended to minimize adverse effects:

- Kateera (*Cochlospermum religiosum* gum)
- Sirka (vinegar)
- Banslochan (bamboo silica) [34]

Substitutes (Badal)

In situations where *Nigella sativa* is unavailable, the following substitutes may be used:

- Anisoon (anise seed)
- Soya ke beej (dill seeds)

Dosage (Miqdar)

The commonly recommended dosage of *Nigella sativa* seeds is: 1–2 grams per day, depending on therapeutic indication and patient condition [35].

Formulations (Murakkab)

Nigella sativa is an ingredient in several classical Unani compound formulations, including:

- Majoon-e-Fanjnosh
- Majoon-e-Fotnaji
- Majoon-e-Kundur [36]

Conclusion

Nigella sativa (black cumin or kalonji) is a medicinally important plant with a long history of use in traditional systems such as Unani, Ayurveda, and other indigenous medical practices. Modern scientific investigations increasingly support many of its traditional claims, demonstrating a wide range of pharmacological activities including anti-inflammatory, antioxidant, antimicrobial, immunomodulatory, neuroprotective, hepatoprotective, nephroprotective, and gastroprotective effects. These therapeutic actions are largely attributed to its major bioactive constituent, thymoquinone, along with several other phytochemicals present in the seeds, *Nigella sativa* also provides nutritional benefits through its essential oils, fatty acids, and mineral content. Its broad spectrum of biological activities suggests promising applications in the prevention and management of various chronic and infectious diseases. However, despite extensive preclinical and emerging clinical evidence, further well-designed clinical trials are needed to establish standardized dosage, long-term safety, and therapeutic efficacy, *Nigella sativa* represents a valuable medicinal and nutritional resource, and continued scientific exploration may help integrate this traditional remedy into evidence-based modern healthcare practices.

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