Pharmacological Potential of *Nigella Sativa* in Metabolic, Inflammatory, and Neurological Disorders: A Comprehensive Review from an Unani Perspective

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ABSTRACT

Nigella sativa (NS) is a plant extensively used for its therapeutic properties. NS is also termed as Kalonji, Black seed, or black cumin. In Unani medicine, it has properties of *Muhallil-i-waram* (anti-inflammatory), *Mudirr-i-Bawl* (diuretic), *Mufattiḥ-i-Sudad* (deobstruent), and *Muqawwī-i-Aʿṣāb* (nervine tonic). It has been used for inflammatory, metabolic, respiratory, and neurological disorders. This review aims to provide a detailed description of *Kalonji* (NS) in the Unani System of Medicine and to critically evaluate the pharmacological potential of *Nigella sativa* in metabolic, inflammatory, neurological, and respiratory diseases, especially from an Unani perspective. We performed a literature search using various keywords such as *Nigella sativa* from the year 2020 to 2026 with the help of PubMed and Google Scholar databases for different therapeutic activities of this plant, focusing on antidiabetic, thymoquinone, anti-inflammatory, antioxidant, and neuroprotective properties, etc. It has a significant potential role to modulate neuronal functions, glycaemic control, inflammatory pathways, and oxidative stress based on experimental as well as clinical findings. Despite this current potential for therapeutic efficacy, the evidence today is largely from preclinical studies, and large-scale standardized clinical trials are lacking. More research is warranted to determine safety, efficacy, dosage standardization, and chronic therapeutic use of integrative medicine.

Keywords: Kalonji, *Nigella sativa*, Thymoquinone, Unani medicine, Anti-inflammatory, Type 2 Diabetes Mellitus.

Abbreviations

NS – *Nigella sativa*; TQ – Thymoquinone; FBG – Fasting Blood Glucose; FBS – Fasting Blood Sugar; HbA1c – Glycated Haemoglobin; LDL-C – Low-Density Lipoprotein Cholesterol; TG – Triglycerides; BMI – Body Mass Index; RCT – Randomized Controlled Trial; HOMA-IR – Homeostatic Model Assessment for Insulin Resistance; hs-CRP – High-sensitivity C-reactive Protein; MDA – Malondialdehyde; TAC – Total Antioxidant Capacity; SOD – Superoxide Dismutase; TNF-α – Tumour Necrosis Factor-alpha; and FEV1 – Forced Expiratory Volume in One Second. **Aβ** – Amyloid-beta, **AD** – Alzheimer's Disease, **CAT** – Catalase, **GABA** – Gamma-Aminobutyric Acid, **GSH**–Reduced Glutathione, **NF-κB** – Nuclear Factor Kappa B, **Nrf2** – Nuclear Factor Erythroid 2-Related Factor 2,

ROS – Reactive Oxygen Species.

INTRODUCTION

Nigella sativa (N.S) is an annual herbaceous plant from the Ranunculaceae family (1). *Kalonji* or Black cumin is the black seeds of this plant. In Arabic, it is known as '*Kamoon e Aswad*', '*Shoniz'*, and '*Habbatus Sauda'*. It is an annual herb with a wide range of medicinal uses, in addition to its commercial significance as a spice-producing plant. It has an aromatic odor and taste. It is one of the common drugs used in Unani medicine and *Tibbe-Nabwi* (Prophet's Medicine) throughout the world. Prophet Muhammad once stated that the black seed has a cure for every illness except death (2). N. sativa seeds are used in the treatment of diseases such as asthma, bronchitis, inflammatory diseases, and antifungal. The medicinal properties of N. sativa are due to its ability to prevent cellular damage caused by oxidative stress. The word Nigella originates from the Latin word 'Niger', meaning black, and sativa originates from the Latin botanical adjective meaning cultivated (3). In Islamic literature, our beloved Prophet Muhammad recommended it for many ailments due to its healing properties; hence, it is advised to use it regularly. It has different names such as *seeds of blessing*, *black cumin, black seed, Al-Habba Al-Sauda, Al- Habba Al-Barakah, Siyah daneh,* and *Kalonji* (4)

Table 1: Taxonomic classification of *Nigella sativa*

TAXONOMICAL RANK	**TAXON**
Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Ranunculates
Family	Ranunculaceae
Genus	Nigella
Species	*Nigella sativa*
Common name	Black cumin

METHODOLOGY

Electronic databases such as PubMed, Google Scholar, and relevant Unani literature were searched for literature related to Nigella sativa and its pharmacological activities. The papers were taken from 2020 to 2026. The keywords used in the search were: N. sativa, phytochemistry, "Nigella sativa", "Kalonji", thymoquinone, anti-inflammatory, antidiabetic, metabolic disorders, respiratory diseases, neuroprotective, and oxidative stress. Boolean operators (AND, OR) were used to narrow down the search strategy.

Randomized controlled trials, systematic reviews, meta-analyses, and clinical and experimental studies published in English were included that assessed the therapeutic effect of Nigella sativa in metabolic, inflammatory, respiratory, and neurological disorders. Articles which lack completed data, duplicated publications, non-English articles, conference abstracts, or non-peer-reviewed sources were excluded.

Relevant studies were screened using title, abstract, and full-text evaluation, and the latest and scientifically relevant studies were included from 2020 to 2026. The recent studies on this topic from 2020 to 2026 (RCTs, systematic reviews, meta-analyses, and umbrella reviews) are included in this review. The literature was critically analyzed to condense the pharmacological potentials and clinical significance of Nigella sativa, as seen from modern scientific and Unani viewpoints.

Plant Description:

Habitat and Distribution:

The plant is widely distributed in different areas of the world. It is mostly found in southern Europe, North Africa, and Southeast Asia, and cultivated in various countries in the world, such as the Middle East, the Mediterranean region, Turkey, Saudi Arabia, India, Pakistan, South Europe, Syria, Lebanon, Israel, and Bangladesh (5). It is mainly found in India and Pakistan. *N. sativa* is cultivated in the winter, the same as wheat. In India, it is specially grown in Punjab, Himachal Pradesh, the Gangetic plains, Bihar, Assam, and Maharashtra (6).

Botanical Description:

Nigella sativa (figure 1) is a little prostrate annual herb. The herb is about 44 cm to 60 cm long. It is a green-coloured plant with finely divided linear leaves, up to 3 cm long. They are opposite in pairs on either side of the stem. The flower is pale blue and white in colour with 5-10 petals. It grows terminally on its branches. The fruits are found in the form of inflated capsules. The capsules are further divided into 3-7 united follicles. Seeds are trigonous and black in color. *N. sativa* reproduces with itself and forms a fruit capsule that consists of many white trigonal seeds when the fruit capsule matures. The fruit opens up automatically, and the seeds within are exposed to the air, becoming black; it is also known as black seeds. Seeds are triangular in shape, black in color, and possess a pungent smell. It contains a considerable quantity of oil (7,8).

Figure 1:

Unani Description:

Parts Used (Hissa Mustamela):

Dried fruit and Seeds of *Nigella sativa* L (9).

Mizaj (Temperament):

Hot^{2} and dry^{2} (9,10)

Hot^{3} and dry^{3} (11,12)

Actions (Af'al):

Kasire Riyah (Carminative) (11), Mohallil-e-Auram (Anti-inflammatory) (11,13), Musakkine Auja (Analgesic) (9,11,13), Mudirre Baul (Diuretic) (11,13), Mudirre Haiz (Emmenagogue) (9–11,13), Mufrize Laban

(Galactogogue) (9,11), Mukhrij-e-Balgham/Munaffise Balgham (Expectorant) (10,13). It acts as a diuretic, an antiseptic, an emmenagogue, and a galactogogue.

Therapeutic uses:

Nafakhe shikam (flatulence), *zaufe meda* (weakness of stomach), *nazla wa zukam* (cold and coryza), as inkebab sual (cough), *zeequn nafas* (asthma), Powdered seeds externally applied to boils. It is also useful in skin infections, puerperal fevers and loss of appetite (9,14–17).

***Muzir* (Adverse effects):**

It causes *Khunaaq* (diphtheria). It causes *Dauran-e-Sar* (Giddiness). It is toxic for the lungs and kidneys. It should be avoided during pregnancy (9,15).

***Musleh* (Correctives):**

Kateera, Sirka, Samagh-e- Arbi, Sard Ashiya, Banslochan, Kasni, Tukhm- Kheyar, Kasni, or Khurfa ka Pani (9,15).

***Badal* (Substitutes):**

Anisoon (9,10,12), Gond Zaitoon, Tukhme Rashad, Ajwain Khurasani (9), Soye ke Beej (Seeds of Soya) (12)

Dosage (Miqdar-i-Khuraq):

1-2grams (10,13)**.**

Important formulations:

Majoon-e-Kalkalanaj, Majoon-e-Fanjnosh, Majoon-e-Kundur, Majoon-e-Fotnaji (15,16)

Chemical constituents:

The seeds of Nigella sativa (Black Cumin) contain a complex profile of more than 100 bioactive compounds, categorized into volatile oils, fixed oils, and other secondary metabolites. Numerous studies have examined the chemical composition of N. sativa, and it has been found that its medicinal value is mainly due to the presence of its quinone constituent, thymoquinone (TQ). TQ is the main constituent of the volatile oil and exhibits several pharmacological actions, including antibacterial, antioxidant, fungicidal, hepatoprotective, anti-inflammatory, and anticancer. Other components found in N. sativa include p-cymene, carvacrol, thymohydroquinone (THQ), dihydrothymoquinone (DHTQ), α-thujene, thymol, t-anethole, β-pinene, α-pinene, and γ-terpinene. The chemical constituents of N. sativa have been tabulated (Table 2). Phytoconstituents and their pharmacological activities are listed in Table 3.

Table 2: Chemical constituents of *N. Sativa*.

Group	Sub groups	Active constituents	References
Fixed oil	Unsaturated fatty acids	Oleic acid, linoleic acid, dihomolinoleic acid	Naz, 2011 (6)
	Saturated fatty acids	Palmitic acid, stearic acid	Naz, 2011 (6)
Terpenes	Aliphatic	Thymoquinone, p-cymene, dithymoquinone, thymohydroquinone, Carvacrol, carvone, limonene, 4-terpineol, citronellol, anethol.	Ghosheh et al., 1999; Naz, 2011 (6)
Alkaloids	Isoquinoline alkaloids	Nigellicimine, Nigellicimine N-oxide	Naz, 2011 (6)

	Pyrazole alkaloids	Nigellidine, nigellicine	Naz, 2011 (6)
Coumarins	Hydroxy coumarin	7-hydroxy-coumarin	Tembhurne et al., 2014 (18)
	Methoxy coumarin	6-methoxy-coumarin	Tembhurne et al., 2014 (18)
	Oxy coumarin	7-oxy-coumarin	Tembhurne et al, 2014 (18)
Saponins	Steroidal	Alpha hedrin	(Randhawa and Al-Ghamdi, 2002)
	Triterpenes	Steryl glucosides, Acetylsteryl-glucoside	(Randhawa and Al-Ghamdi, 2002)
Flavonoids	Flavonoidal pigment	Quercetin	(Merfort et al., 1997)
	Flavonoidal glycoside	Kaempferol 3-glucosyl galactosyl glucoside, quercetin 3-galactosyl glucoside, trigillin quercetin3-glucoside	(Merfort et al., 1997; Rajkapoor et al., 2002 (19))
Phenolics	Acidic phenolics	Vanillic acid, hydroxybenzoic acid, syringicacid, p-cumaric acids	(Bourgou et al., 2008; Mariod et al., 2009) (8)
Amino acids	Essential amino acids	Valine, phenylalanine, lysine, leucine, isoleucine, histidine, threonine, methionine, tryptophan.	(Babayan et al., 1978) (8)
Metals and trace elements		Iron, calcium, zinc, potassium, and phosphorus.	(Al-Gaby, 1998) (8)

Table 3: Nigella sativa phytoconstituent with pharmacological activities.

Phytoconstituent	**Pharmacological Activity**	**References**
Thymoquinone	Anti-inflammatory, antidiabetic, neuroprotective	(8,20)
Thymohydroquinone	Antioxidant	(21)
p-Cymene	Antioxidant	(22)
Carvacrol	Anti-inflammatory	(23)
Quercetin	Antioxidant, anti-inflammatory	(24)
Nigellidine	Antioxidant, anti-inflammatory, Neuroprotective	(25)
α-Hederin	Immunomodulatory	(26)

Pharmacological Studies of *Nigella sativa:*

Recent studies between 2020 and 2026 demonstrate that *Nigella sativa* shows a promising therapeutic effect in metabolic, inflammatory, respiratory disorders, and neurodegenerative disorders. All these studies are listed in Tables 4 and 5.

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Anti-diabetic activity:

Several experimental and clinical studies have researched the antidiabetic activity of Nigella sativa. N. sativa oil in a randomized controlled clinical study by Hadi et al. (2021) significantly lowered FBS, total cholesterol, LDL-C and waist circumference. In this research Nigella sativa oil enhanced glycaemic control, serum lipid profile, blood pressure and body weight of persons with T2D (27). Likewise, following systematic reviews and meta-analyses additionally verified its antidiabetic activity through reductions in fasting blood glucose, postprandial blood glucose, HbA1c and insulin resistance indicators. Randomized controlled trials indicated significant improvement in FBS, HbA1c, Lipid markers and BMI among patients of Type 2 DM.

Anti-inflammatory activity:

The main component responsible for the anti-inflammatory activity of Nigella sativa is thymoquinone which controls various signaling processes of inflammation. In experimental studies, thymoquinone was shown to inhibit the activation of NF-κB, thereby limiting the production of pro-inflammatory cytokines such as TNF-α, IL-1β and IL-6. It also decreases the level of malondialdehyde (MDA) and enhances the level of endogenous antioxidant enzymes such as superoxide dismutase (SOD) and catalase (CAT) thus lowering oxidative stress. Nigella sativa provides cellular protection, tissue regeneration, and improved disease outcome in various inflammatory and chronic diseases by simultaneously regulating inflammatory mediators and oxidative stress markers.

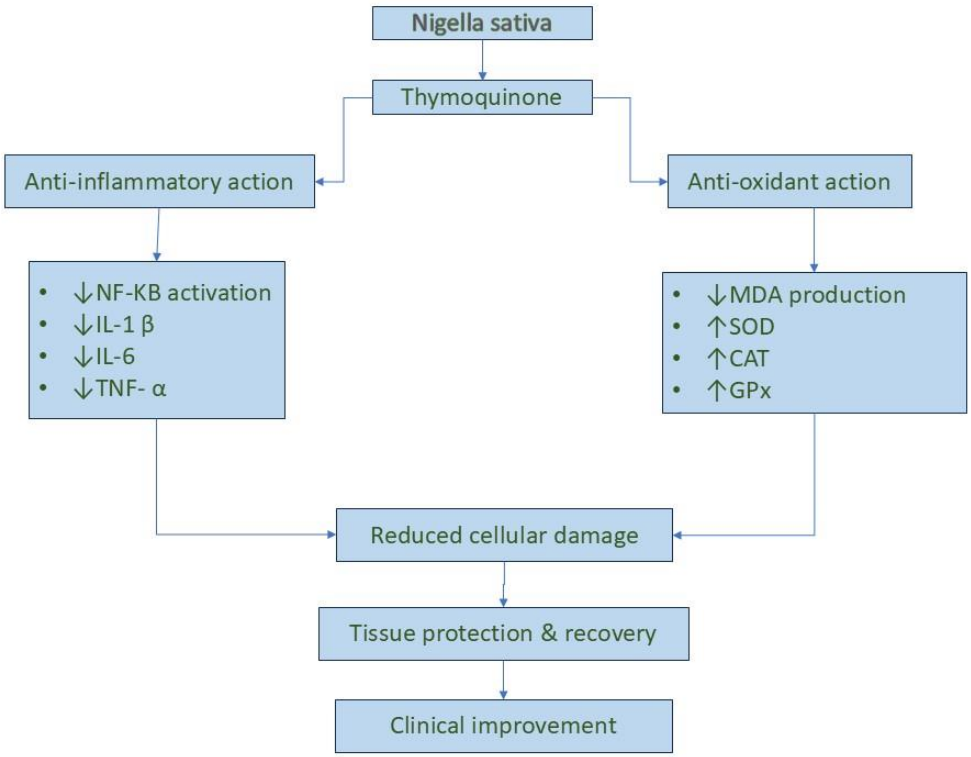

Figure 2: Thymoquinone and its anti-inflammatory and antioxidant actions.

Studies conducted very recently also demonstrated the anti-inflammatory and antioxidant properties of Nigella sativa. An article by Amirtaheri Afshar et al. (28) Nigella sativa oil was a more potent agent at decreasing the inflammatory and oxidative stress markers (hs-CRP and MDA) in knee OA patients, while it significantly improved total antioxidant capacity (2023). Likewise, the pooled evidence of Lan and Xia (2025) umbrella systematic review supported its effects on chronic diseases in terms of anti-inflammatory-mediated outcome reductions in CRP, TNF-α, and oxidative stress biomarkers through general assessment (29). Thymoquinone, the most bioactive compound of Nigella sativa, contributes to antioxidant and anti-inflammatory activity. It is largely believed to be related to the pharmacological activity of Nigella sativa by inhibiting oxidative stress pathways and suppressing pro-inflammatory cytokines and NF-κB signaling.

Table 4: Clinical Trials of *Nigella sativa* (2020–2026)

Author, year	Study design	Population	Intervention and duration	Main outcomes	Clinical Significance
Hadi et al, 2021	Randomized double- blind placebo-controlled trial	Patients with Type 2 DM	*Nigella sativa* oil extract, 8 weeks	Reduced FBS, reduced HbA1c, reduced LDL, reduced TG, reduced BMI	Supports adjunct use in diabetes management (27)
Multiple authors, 2022	Systematic review of 17 clinical studies.	Type 2 DM/ Prediabetes	Various forms (seed, oil, capsules)	Improved FBG, PPBG, HbA1c, HOMA-IR	Strong evidence for antidiabetic role
Han & Shi, 2020.	Meta-analysis of RCTs	Asthma patients	*Nigella sativa* supplementation	Improved Asthma Control Test scores and FEV1.	Helpful adjunct in asthma control (30)
Saadat et al. 2021	Comprehensive clinical review	Respiratory/ allergic disorders	Various formulations	Improved asthma symptoms, bronchodilation, and anti-allergic effect	Supports traditional respiratory use (31)
Amirtaheri Afshar et al,.2023.	A parallel triple-arm double-blind randomized controlled trial	Patients with knee osteoarthritis (OA)	Oral/topical *Nigella sativa* oil, 6 weeks	Oral oil reduced hs-CRP and MDA; improved TAC and quality of life.	Confirms anti-inflammatory + antioxidant effects (28)
Lan X, 2025	umbrella meta-analysis	Adults with various chronic diseases	*Nigella sativa* supplements	Reduced CRP, TNF-α, MDA; increased TAC and SOD.	Strong pooled evidence for anti-inflammatory effects (29)
He Y et al ,. 2024	A meta-analysis of randomized controlled trials (RCTs)	Patients with allergic rhinitis	*Nigella sativa* supplementation	Improved nasal symptoms, reduced allergy burden	Useful in allergic rhinitis (32)
Karimi et al,. 2025	Systematic review and meta-analysis of RCTs	Type 2 diabetes mellitus patients	*Nigella sativa* supplementation	significantly improve FBG, HbA1c, TC, and LDL levels	Beneficial adjunct therapy for glycemic and lipid control in T2DM (33).

Neuroprotective activity:

The research summarized (table 5) has shown the therapeutic potential of Nigella sativa and its probable major bioactive component, thymoquinone for the treatment of many neurodegenerative diseases. Recent studies have revealed that thymoquinone possesses several protective properties through anti-inflammatory, antioxidant, anti-apoptotic, and mitochondrial stabilising properties. In these ways, experimental and clinical research indicated thymoquinone's protective effects on cognitive function, its ability to inhibit neuroinflammation, attenuate β-amyloid neurotoxicity, and protect neuronal cells. Furthermore, Nigella sativa has anticonvulsant effects in refractory epilepsy and has been tested to have a beneficial role in memory and learning in Alzheimer's disease

models. In the light of these results, Nigella sativa could be a possible therapeutic agent in neurodegenerative disorders, but the further trials should be done in humans with proper-designed clinical trials to prove its efficacy and safety.

Table 5: Recent studies on the Neuroprotective effects of Nigella sativa and Thymoquinone in Neurodegenerative disorders (2020-2026) :

Author and year	Neurodegenerative disorders	Study model	Intervention	Findings	Mechanism
Elibol et al. (2020)	Alzheimer's disease	Aβ1–42-induced rat model	Thymoquinone	Improved memory and learning, enhanced hippocampal neuronal survival, reduced neuronal apoptosis.	Antioxidant, anti-apoptotic, neuroprotective activity (34).
Khan et al. (2022)	Alzheimer's disease	Experimental and molecular pathway analysis.	Thymoquinone	Reduced β-amyloid toxicity, attenuated neuroinflammation, improved neuronal function	Modulation of NF-κB, Nrf2, oxidative stress and amyloidogenic pathways (35)
Sedaghat et al. 2014	Parkinson's disease	6-OHDA-induced Parkinsonian rat model	Thymoquinone	Improved motor function, protected dopaminergic neurons	Reduction of oxidative stress and neuroinflammation (36)
Akhondian et al. (2010)	Epilepsy	Clinical trial in refractory epilepsy.	Nigella sativa extract / Thymoquinone	Reduced seizure frequency and severity	Possible GABAergic modulation and antioxidant effects(37)
Ojetunde et al. (2025)	Alzheimer's disease (AD)	Experimental study in Wistar rats, 24rats divided into four groups.	*Nigella sativa* oil	Improved cognitive and spatial learning and memory, reduced acetylcholinesterase activity, increased SOD, CAT, and GSH levels, and decreased lipid peroxidation.	Modulation of Cholinergic activity, brain neurotransmitters, and oxidative stress (38).

This Akhondian et al, 2010 paper was included due to limited availability of studies evaluating the neurological effects of nigella sativa. Therefore from the available information, it is apparent that most of the neuroprotective effects of Nigella sativa have been attributed to the effect of its principle neuroactive component, thymoquinone; however, the limited number of clinical trials performed in humans is not extensive enough to be generalizable to clinical practice.

DISCUSSION

This narrative review illustrates that Nigella sativa shows promising results in the treatment of multiple metabolic, inflammatory, respiratory, and neurological disorders based on current clinical and experimental findings. In conclusion, several studies from 2020 to 2026 reported beneficial effects of Nigella sativa supplementation on glycaemic control, lipid metabolism, inflammatory biomarkers, oxidative stress, and respiratory function.

Han and Shi (2020) and Saadat et al. (2021) both showed that asthma control score, pulmonary function test, bronchodilation, and allergic symptoms improved in patients with respiratory diseases when given Nigella sativa

supplementation. Moreover, it was further confirmed by the meta-analysis performed by He et al. (2024) that it is also useful in allergic rhinitis, as it reduced the symptoms of the nose and improved the quality of life. These findings are in support of the traditional use of Nigella sativa, which is *Munafis-e-Balgham* (Expectorant) and *Muhallil-e-Waram* (Anti-inflammatory). Although evidence regarding neurological disorders remains limited in human clinical studies, experimental research suggests that *Nigella sativa* possesses neuroprotective potential due to its antioxidant and anti-inflammatory activities.

However, there are some drawbacks to be taken into account. Most of the studies that are available have small numbers of sample size, short intervention times, and different types of doses which may restrict the validity of the results. Additionally, there is no unified dosage recommendations and long-term safety studies, limiting the capacity to make a definite therapeutic recommendation. Therefore, there is a need for more large-scale multicentric RCTs and pharmacokinetic studies to substantiate the efficacy, safety, and clinical utility of Nigella sativa for evidence-based integrative medicine. The traditional Unani concepts of *Muhallil-i-Waram* (anti-inflammatory), *Muqawwi-i-Aʿṣāb* (nervine tonic), and *Mufatteh-i-Sudad* (deobstruent) are well correlated with the results of recent studies, thereby supporting the therapeutic relevance of *Nigella sativa* in modern integrative healthcare systems.

CONCLUSION

Kalonji (Nigella sativa) is a herb with therapeutic importance in the treatment of metabolic, inflammatory, respiratory, and neurological diseases. Over the past several years (2020-2026), clinical studies and meta-analyses have shown numerous antidiabetic, antioxidant, anti-inflammatory, and immunomodulatory properties, such as the reduction of fasting blood glucose, HbA1c, lipid profile, inflammatory cytokines, and oxidative stress markers. It can also be used with increasing proven benefits in asthma, allergic diseases, and neuroprotection. These pharmacological activities are thought to be due to some bioactive compounds found in the seeds and oil. In the modern scientific era, the use of N. sativa as a *Muhallil-i-Waram, Muqawwi-i-Aʿṣāb,* and *Mufatteh-i-Sudad* was confirmed by scientific studies, thus enhancing its importance in integrative medicine.

However, there are a number of disadvantages. Most available clinical studies have small sample sizes, brief intervention durations, inconsistent dosage forms and treatment protocols, reducing the generalizability of the results. Evidence from human clinical studies on neurodegenerative disorders remains limited, whereas substantial experimental evidence supports the neuroprotective potential of Nigella sativa. Nevertheless, there is plenty of experimental evidence. Long-term safety studies, larger, multicentric RCTs, and establishment of the optimal dose are necessary for clear therapeutic recommendations for this purpose. Thus, better-designed clinical trials need to be conducted to assess the effectiveness and safety of Nigella sativa in different clinical situations.

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