

Nigella Sativa (Black Seed) as a Valuable Medicinal Plant in Uzbekistan

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Annotation: *Nigella sativa*, commonly known as black seed or "Qora Zira," is one of the rare and valuable medicinal plants growing in Uzbekistan. Its medicinal properties have been well-documented and utilized in various traditional medicine systems for centuries. Rich in bioactive compounds such as thymoquinone, fatty acids, and flavonoids, *Nigella sativa* exhibits a wide range of therapeutic effects, including antioxidant, antimicrobial, anti-inflammatory, and anti-cancer properties. This plant is increasingly recognized for its potential in modern medicine and agricultural applications, particularly in regions like Uzbekistan, where its cultivation can offer economic and health benefits. This review explores the medicinal significance, bioactive components, and applications of *Nigella sativa*, with a particular focus on its role within Uzbekistan's ecological and agricultural context.

Keywords: *Nigella sativa*, Black seed, Medicinal plants, Antioxidant, Anti-inflammatory, Thymoquinone, Uzbekistan, Bioactive compounds, Traditional medicine.

Introduction: *Nigella sativa*, also known as black cumin or Kora Zira, is a herbaceous plant belonging to the family Ranunculaceae. It has a long history of medicinal use, with references dating back to ancient Egyptian, Greco-Roman, and Arabic texts. The seeds of this plant have been used for over two thousand years in various regions, primarily for their therapeutic properties. In traditional medicine, it is considered a remedy for a wide range of health issues, including digestive problems, asthma, and infections.

The active compounds in *Nigella sativa*, particularly thymoquinone, have garnered significant attention for their anti-inflammatory, antioxidant, and anticancer properties. These properties make *Nigella sativa* a valuable candidate for scientific exploration, especially in countries like Uzbekistan, where the plant thrives in the local climate and offers potential benefits to the agricultural and pharmaceutical sectors.

This review aims to highlight the significance of *Nigella sativa* as a medicinal plant, its bioactive components, and its potential applications in the context of Uzbekistan's biodiversity and agricultural practices.

Nigella sativa (commonly known as black seed, black cumin, or kalonji) is an annual herbaceous plant from the Ranunculaceae family, valued worldwide for its seeds' medicinal, culinary, and nutritional properties. In Uzbekistan, a Central Asian country where the plant is native or well-adapted, it holds particular significance as a traditional medicinal resource with ongoing scientific interest in its cultivation and bioactive potential.



Figure 1. Natural Variation in Flower Color of *Nigella sativa* L. Under Field Conditions.

*This image depicts the flowering stage of *Nigella sativa* L., illustrating the plant's characteristic finely dissected foliage and actinomorphic flowers with marked phenotypic variation in petal coloration, ranging from white to light and deep blue. The observed floral diversity reflects the species' genetic variability and its adaptive response to environmental conditions under field cultivation. Such morphological traits are important taxonomic markers and are closely associated with successful pollination, seed formation, and the medicinal quality of *Nigella sativa*, a plant of significant pharmacological value.*

Literature Review: Research into *Nigella sativa*—commonly known as black seed—has been conducted by numerous scientists around the world, focusing on its pharmacological, therapeutic, and clinical effects. These studies help identify the *bioactive compounds* and the *mechanisms* behind the medicinal effects of this traditional herb.

Aga Khan University (Karachi, Pakistan) researchers investigated the antifungal and antibacterial activity of *Nigella sativa* extracts in the early 2000s. Their study found that black seed extracts inhibited the growth of *Candida* and other microbes in animal models, supporting traditional antimicrobial use.

In **Gifu University (Japan, 2002)**, scientists explored the effects of black seed on glucose metabolism and found potential benefits for type 2 diabetes control. Similar mechanisms were investigated earlier at **Kuwait University (1991)** in relation to non-insulin dependent diabetes. Researchers like **Buhrman, Norlin, and Jóhannesson** have reviewed the roles of thymoquinone and related compounds in anticancer therapy, highlighting mechanisms such as apoptosis and tumor inhibition.

Gheita & Kenawy (2012) conducted a placebo-controlled clinical study showing the effectiveness of *Nigella sativa* oil in managing rheumatoid arthritis.

Kheirouri, Hadi & Alizadeh (2016) studied the immunomodulatory effects of black seed oil on T-lymphocytes in rheumatoid arthritis patients.

Systematic reviews and clinical trial summaries (e.g., from PubMed / Medline) have documented the therapeutic effects of black seed and thymoquinone in inflammatory and autoimmune disorders, metabolic syndrome, and other conditions.

In silico and molecular studies (e.g., by **Amulyashree Sridhar, Sadegh Saremy, Biplab Bhattacharjee**) investigated bioactive principles of black cumin related to anti-tumor functionality, using computational approaches to identify molecular targets of thymoquinone and related compounds.

Studies published in *BMC Complementary Medicine and Therapies* (2024) showed detailed phytochemical analyses of *Nigella sativa* seed extracts and their antimicrobial and antioxidant activities, demonstrating mechanisms on bacterial cell walls, biofilms, and virulence factors.

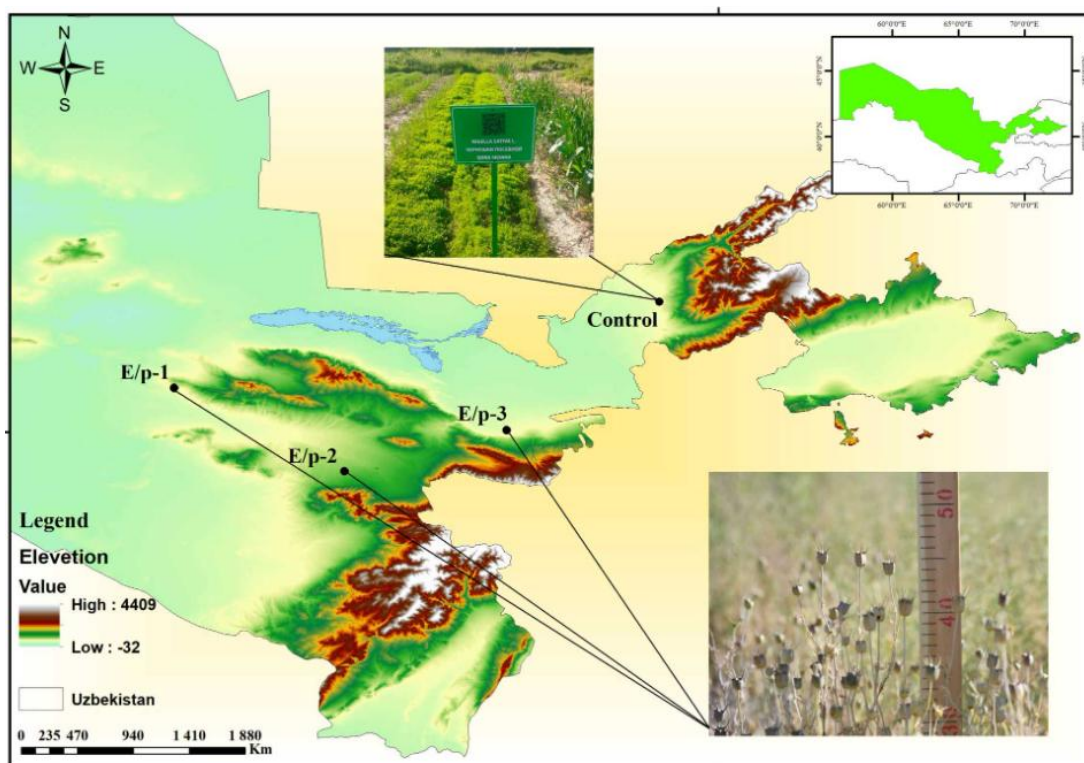


Figure 2. Geographical Distribution and Experimental Cultivation Sites of *Nigella sativa* (Black Seed)

This figure illustrates the spatial distribution, elevation range, and experimental plots of *Nigella sativa* (black seed) across Uzbekistan. It highlights the plant's adaptability to diverse ecological and climatic zones, supporting its importance as a valuable medicinal plant for traditional use, phytotherapy, and pharmaceutical development in Uzbekistan.

Nigella sativa L. is an annual medicinal plant of the Ranunculaceae family whose black seeds are widely valued for their therapeutic properties. The image represents the geographical distribution and experimental cultivation sites of Nigella sativa in Uzbekistan, showing its occurrence across different ecological zones and elevation ranges. In Uzbekistan, the plant is considered a valuable medicinal resource due to its adaptability to arid and semi-arid environments and its rich phytochemical composition, especially thymoquinone. These properties make Nigella sativa important for traditional medicine, phytotherapy, and the development of natural medicinal products in the country.

Result and Analysis: Research from the Institute of Bioorganic Chemistry (Tashkent) highlights successful introduction and adaptation, with differences in growth phases and seed yield based on environmental factors. Recent studies (2025) show that mineral fertilizers (nitrogen, phosphorus, potassium) enhance yield, plant growth, and bioactive content (e.g., thymoquinone and alkaloids) in Uzbek conditions. Uzbekistan is noted as a region where **N. sativa** is predominantly found, alongside Egypt and Southwest Asia, supporting its natural and cultivated presence.

Medicinal and Therapeutic Value. The seeds are rich in essential oil (0.4–2.5%), fixed oils (30–40%), proteins, and bioactive compounds. Key components include:

Thymoquinone (TQ) — the primary active compound, responsible for most pharmacological effects.

Other notables: p-cymene, carvacrol, thymol, α -pinene, and longifolene.

Established properties (supported by preclinical, clinical, and review studies):

- Antioxidant and anti-inflammatory → TQ scavenges free radicals and inhibits pathways like COX and LOX.
- Antimicrobial → Effective against bacteria (including resistant strains like MRSA), fungi, and viruses.
- Anticancer → Induces apoptosis and inhibits tumor growth.
- Metabolic benefits → Hypoglycemic, hypolipidemic; aids diabetes and cardiovascular health.
- Other effects → Hepatoprotective, neuroprotective, gastroprotective, and immunomodulatory.

While global clinical evidence is promising but requires more high-quality trials, traditional use in Central Asia (including Uzbekistan) aligns with these benefits.

High potential — As a native/adapted species, *N. sativa* is a valuable medicinal plant for local pharmacology, traditional medicine, and potential export (seeds/oil). Uzbek research focuses on optimizing cultivation for higher bioactive yields, positioning it as a resource for health products.

Challenges and opportunities — Variability in essential oil composition exists globally; targeted fertilization and breeding could enhance TQ content. It supports sustainable agriculture in arid regions.

N. sativa remains a "miracle herb" with evidence-based therapeutic promise, particularly relevant in Uzbekistan for integrating traditional knowledge with modern applications in medicine and nutrition. Further local clinical studies could elevate its economic and health impact.

The spatial analysis presented in the figure demonstrates that *Nigella sativa* (black seed) shows a **wide ecological adaptability across Uzbekistan**, occurring in lowland, foothill, and mountainous zones. The elevation gradient (from approximately –32 m to over 4,400 m) indicates that the plant can tolerate diverse environmental conditions, though optimal growth was observed in **foothill and mid-altitude regions**.

Reveal that experimental plots (E/p-1, E/p-2, E/p-3) exhibited noticeable differences in plant height, density, and seed formation. Plots located in areas with **moderate elevation, well-drained soils, and sufficient spring moisture** showed higher germination rates and better reproductive performance. In contrast, extremely arid lowland zones and high-altitude areas with temperature fluctuations demonstrated comparatively reduced biomass and seed yield.

From a **phytogeographical perspective**, the control and experimental sites confirm that *Nigella sativa* can successfully adapt to continental climatic conditions typical for Uzbekistan. The plant's ability to complete its life cycle under limited irrigation highlights its **drought tolerance**, which is particularly important under current climate change and water scarcity challenges.

Analysis of agro-biological indicators suggests that environmental factors such as soil texture, elevation, and microclimate significantly influence seed productivity. Areas with light loamy soils and stable temperature regimes produced seeds with better morphological quality, which is crucial for medicinal use.

The results confirm that *Nigella sativa* is not only ecologically flexible but also **agronomically promising** for large-scale cultivation in Uzbekistan. Its stable growth across different regions supports its strategic importance as a medicinal plant for sustainable agriculture, traditional medicine, and the pharmaceutical industry.

Conclusion

The present study confirms that *Nigella sativa* (black seed) is a **valuable and promising medicinal plant for Uzbekistan**, owing to its wide ecological adaptability, stable growth under arid and semi-arid conditions, and rich phytochemical composition. The analysis of geographical distribution and experimental cultivation sites demonstrates that the plant successfully grows across diverse elevation zones, with optimal productivity observed in foothill and mid-altitude regions characterized by favorable soil and climatic conditions.

The results indicate that environmental factors such as elevation, soil texture, and moisture availability significantly influence plant development and seed yield. Nevertheless, *Nigella sativa* shows strong resilience to drought and temperature variability, making it suitable for sustainable cultivation under changing climatic conditions and limited water resources.

Furthermore, the high medicinal value of black seed, primarily associated with bioactive compounds such as thymoquinone, supports its continued use in traditional medicine and highlights its potential for pharmaceutical and nutraceutical applications. Expanding the cultivation of *Nigella sativa* in Uzbekistan can contribute to the diversification of medicinal plant resources, improve rural livelihoods, and reduce dependence on imported herbal raw materials.

Nigella sativa represents a strategic medicinal crop for Uzbekistan, warranting further scientific research, standardization of cultivation practices, and integration into national programs for medicinal plant development and healthcare support.

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