

Ethnopharmacological insight and therapeutic potential of *Nymphaea alba*: A Comprehensive Review of Its Therapeutic Applications

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Abstract

Nymphaea alba L., widely recognized as Neelofar in Unani medicine, is a perennial aquatic plant renowned for its extensive therapeutic applications in traditional healing systems and its emerging significance in modern pharmacological research. This comprehensive review synthesizes the ethnobotanical, phytochemical, pharmacological, and clinical dimensions of *Nymphaea alba*, integrating classical Unani texts with contemporary scientific evidence to highlight its multifaceted medicinal potential. In Unani medicine, Neelofar is classified as having Barid (cold), Ratab (moist), and Musakkin (sedative) properties, making it a cornerstone for managing conditions such as reproductive disorders, neurological imbalances, inflammatory diseases, and metabolic disorders like diabetes. The pharmacological potential of the plant is attributed to its diverse array of bioactive constituents, including alkaloids (such as nupharine and nymphaeine), flavonoids (e.g., quercetin, kaempferol), phenolic acids (e.g., gallic acid, ellagic acid), and steroidal compounds (such as nymphayol). These compounds contribute to a wide spectrum of therapeutic activities, including antioxidant, antidiabetic, analgesic, anxiolytic, anticancer, antimicrobial, antifertility, and anti-urolithiatic effects. Clinical studies, particularly in ovulation induction, demonstrate its efficacy with ovulatory rates comparable to conventional treatments, underscoring its potential as a safe and effective therapeutic agent. Additionally, its ecological role as a bioindicator for environmental metals enhances its interdisciplinary relevance. This review compiles an extensive reference list to serve as a robust resource for researchers and practitioners, bridging traditional Unani wisdom with modern scientific validation, and identifying critical gaps for future research to fully harness Neelofar's therapeutic and ecological potential.

Keywords: Unani medicine, Traditional healing, Alkaloids, Antidiabetic, Ovulation induction, *Nymphaea alba*, UV-blocking activity, Sedative Effects.

Introduction

Nymphaea alba L., also known as the European White-Water Lily and referred to as Neelofar in Unani medicine, is an aquatic perennial plant recognized for its therapeutic value in both traditional and modern healthcare systems. A member of the Nymphaeaceae family, this hydrophyte naturally grows in calm freshwater environments such as ponds, lakes, and slow-flowing rivers throughout Europe, North Africa, and parts of Asia. Its ability to adapt to various aquatic habitats contributes to its widespread availability and utilization in medicinal and ecological contexts. Within the Unani medical framework—an ancient system based on Greco-Arabic medical philosophy—*Nymphaea alba* is characterized by a Barid (cold) and Ratab (moist) temperament. This classification is rooted in the humoral theory, which emphasizes maintaining a balance among the

body's four essential fluids: Dam (blood), Balgham (phlegm), Safra (yellow bile), and Sauda (black bile). The plant is traditionally employed to correct imbalances associated with excess heat and dryness, thereby supporting overall health and well-being[1][2]. Neelofar is utilized in the Unani system in multiple dosage forms, including powders, syrups (Sharbat-e-Neelofar), electuaries (Majoon-e-Neelofar), decoctions, and topical applications like poultices. These preparations are traditionally prescribed for a range of health conditions such as insomnia, anxiety, anovulatory infertility, diabetes, urinary tract issues, and inflammatory disorders. Its therapeutic efficacy is attributed to its ability to alleviate imbalances caused by excessive Hararat (heat) and Yabusat(dryness), thereby restoring humoral equilibrium in the body.[3][4].

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The broad therapeutic potential of *Nymphaea alba* is largely due to its diverse phytochemical profile, which encompasses alkaloids, flavonoids, phenolic acids, glycosides, tannins, and steroidal constituents, as recognized in both classical literature and contemporary research [5][6]. These naturally occurring compounds form the basis for its wide range of pharmacological effects, including antioxidant, antidiabetic, analgesic, anxiolytic, anticancer, antimicrobial, and antifertility properties—many of which support its traditional usage within Unani medicine. Emerging clinical investigations, especially those examining its utility in stimulating ovulation, have yielded encouraging results. These findings indicate comparable efficacy to standard therapies like clomiphene citrate, suggesting *Nymphaea alba* as a potentially safer and effective therapeutic option [7]. In addition to its medicinal applications, the plant plays a valuable role in aquatic ecosystems by limiting algal proliferation and acting as a bioindicator for environmental heavy metals, underscoring its importance across both medical and ecological disciplines [8] [9].

Unani Description and Ethnobotanical Uses

In the Unani system of medicine, *Nymphaea alba*—commonly referred to as *Neelofar*—is regarded as a significant medicinal plant, primarily due to its *Barid* (cold) and *Ratab* (moist) temperament, which corresponds with the humoral concept of maintaining equilibrium among the four bodily fluids: *Dam* (blood), *Balgham* (phlegm), *Safra* (yellow bile), and *Sauda* (black bile) [1]. Its therapeutic actions include cooling, astringent, sedative, and rubefacient effects. These properties support its traditional classification as a *Muqawwi-e-Bah* (aphrodisiac), *Mudirr-e-Baul* (diuretic), *Musakkin* (sedative), and *Musakkin-e-Alam* (analgesic). As such, it is utilized in the treatment of reproductive health issues, neurological conditions like anxiety and insomnia, urinary disorders, diabetes (*Ziabetus*), and inflammatory conditions, including dermatological inflammations [2] [3] [7] [19]. Its rhizomes, flowers, seeds, and leaves are used in powders, syrups (*Sharbat Neelofar*), electuaries (*Majoon-e-Neelofar*), decoctions, and poultices for boils, while its starch-rich rhizomes and seeds are processed into flour or boiled for nutritional purposes, serving both medicinal and dietary roles [20] [5].

Temperament (*Mizaj*): Cold (*Barid*) and Moist (*Ratab*) in the second degree, making it suitable for balancing hot and dry conditions in the body [3] [21].

Part Used: Rhizomes, flowers, seeds, and leaves, with rhizomes and flowers being the most commonly used in Unani formulations [22].

Therapeutical Uses:

Muhilil e awram (Anti-inflammatory): *Neelofar* contains bioactive compounds like tannins and flavonoids that reduce inflammation in the respiratory tract [23].

In Unani medicine, it is used to soothe irritated airways in conditions such as bronchitis and asthma (*Zeeq-un-NafasSho'abi*), providing relief from symptoms like swelling and discomfort in the lungs [3].

Mukhrijbalgham (Mucolytic and Expectorant): The astringent and resolvent properties of *Neelofar* aid in clearing mucus from the respiratory system [24]. It is commonly included in Unani formulations like *Sharbat-e-Neelofar* to alleviate cough and chest congestion, particularly in conditions like chronic bronchitis and pleurisy (*Zat-ul-Janb*) [25].

Neelofar is combined with herbs like *Unnab* and *Banafsha* in Unani syrups and decoctions to treat cough and respiratory irritation [25]. Its flowers, known for their cooling and narcotic effects, are particularly valued for easing symptoms like chest tightness and persistent cough [24].

Munawwim (Sedative) and Musakkin-e-a'asab (Calming Effects): *Neelofar's* sedative action helps calm the respiratory system, reducing bronchial spasms that cause breathing difficulties [26]. Its alkaloids contribute to relaxing bronchial muscles, making it effective for managing asthma symptoms and improving airflow [27]. It is also prescribed for insomnia, anxiety, and restlessness due to its sedative (*Munawwim*) and analgesic (*Musakkin-e-A'asab*) properties, often used in decoctions or pastes to calm the nervous system [3].

Mubarrid(Cooling): Its cold temperament makes it effective for fever, liver inflammation, and burning sensations. It is used in *Nutool* (irrigation) with cooling herbs like *Khatmi* (*Althaea officinalis*) and *Banafsha* (*Viola odorata*) for tremors and inflammatory conditions [21].

Muqawwiqalb (Cardioprotective and Cardiac Tonic): The flowers act as a cardiac tonic, used for palpitations and cardiac weakness [22].

Mudir e Bol (diuretics): Seeds and rhizomes serve as diuretics, treating urinary tract inflammations, kidney stones, and burning micturition [28].

Muqawwi Bah (Aphrodisiac and Reproductive Health): Noted for its aphrodisiac properties, *Neelofar* is used in formulations to enhance sexual health and treat seminal weakness [3].

Qabiz for Dermatological Uses: Applied externally as a paste (*Zimad*), it treats skin inflammations, burns, and eruptions due to its cooling and astringent (*Qabiz*) effects [29].

Preparations in Unani:

Joshanda (Decoctions): Used for fever and insomnia.

Zimad (Paste): Applied externally for skin inflammations.

Nutool(Irrigation): Combined with other cooling herbs for tremors and inflammation.

Sufoof (Powders and Confections): Incorporated in formulations for cardiac and urogenital health [22].

Compound formulations of Neelofar: Sharbat Neelofar, Majoon Supari Paak, ArqMurakkabMusaffiKhoon, MajoonDabeedul Ward.

Taxonomy and Geographic Distribution

Nymphaea alba is classified within the following taxonomic hierarchy:

Taxonomic Rank	Classification
Kingdom	Plantae
Division	Angiosperms
Order	Nymphaeales
Family	Nymphaeaceae
Genus	Nymphaea
Species	alba

Vernacular Names

Nymphaea alba is known by various names across different languages, reflecting its cultural and medicinal significance:

- **Urdu/Unani:** Neelofar [2]
- **Arabic:** Nilufar [1]
- **Persian:** Nilupar [10]
- **Hindi:** Kumudini, Kanwal [5]
- **Bengali:** Shapla [11]
- **Tamil:** Alli [12]
- **Telugu:** Kaluva
- **Kannada:** Tavare
- **Malayalam:** Ambal
- **English:** European White Water Lily [9].

Cultivation: *Nymphaea alba*, widely known as the white water lily, is a perennial aquatic species cultivated for its ornamental beauty, therapeutic applications, and ecological significance. It flourishes in still or slow-moving shallow waters and depends on particular environmental conditions for optimal development.

Habitat Requirements:*Nymphaea alba* thrives in calm aquatic environments such as ponds, lakes, and marshes, ideally at water depths ranging from 30 to 150 cm. It grows best under full sun to partial shade, needing a minimum of six hours of direct sunlight each day. The optimal water pH for its growth lies between 6.0 and 7.5, favoring slightly acidic to neutral conditions. Well adapted to temperate regions, this species can withstand cold climates, with its rhizomes remaining viable even in frozen substrates during winter. As such, it is well suited for cultivation in USDA hardiness zones 4-10 [13] [14].

Soil and Substrate: The plant requires nutrient-rich, muddy, or silty substrates. A loamy soil mixed with clay is ideal for anchoring rhizomes. In artificial ponds, a heavy clay-loam mix in submerged containers is recommended to support growth and prevent nutrient leaching [14].

Climate and Distribution: Native to Europe, North Africa, and parts of Asia, including a notable presence in India's Bengal, Orissa, and Kashmir regions, *Nymphaea alba* grows at elevations up to 1500 m [9]. It thrives in neutral to alkaline waters of ponds, lakes, and slow-moving rivers at depths of 0.5–5.5 m over muddy or silty substrates [8]. Its ecological role includes reducing algal growth by shading water bodies, making it valuable for both medicinal and environmental applications, as well as Unani formulations across diverse regions [5][10].

Macroscopic Characters:

Rhizome: Thick, creeping, and tuberous, 5–20 cm long, dark brown to black externally, white internally when cut (Fig. 1), with numerous rootlets and a rough surface bearing scars of old leaves and roots (Fig. 2) [15].

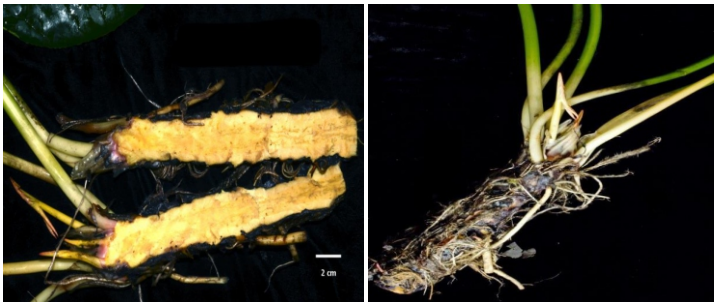


Fig.1: Longitudinal section (L.S.) of Fig.2: Rhizome of Nymphaeaalba.

Nymphaeaalba rhizome

Leaves: The leaves are floating and nearly circular in shape, measuring approximately 10–30 cm in diameter, and feature a pronounced basal sinus. Their upper surface is dark green, smooth, and coated with a waxy layer (Fig. 3), while the underside displays a purplish to reddish hue. The petioles are elongated, submerged, and notably flexible, allowing the leaves to adapt to water movement [13].

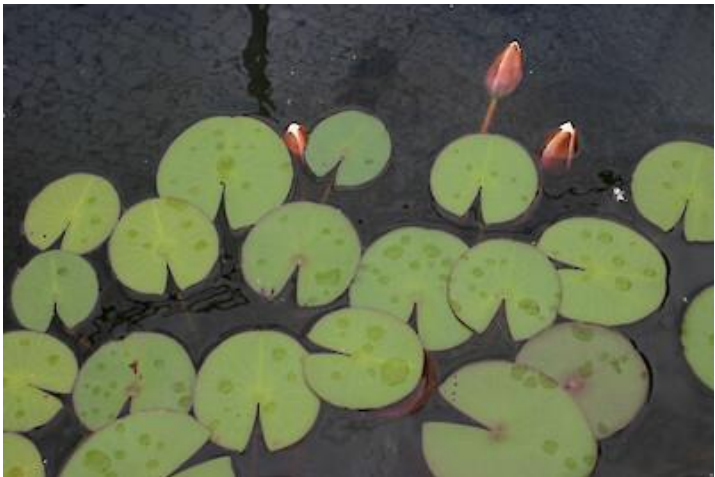


Fig.3: Leaves of Nymphaea Alba

Flowers: Large (7–15 cm in diameter), solitary, white, and fragrant, with 4 sepals and numerous spirally arranged petals (Fig. 4). Flowers float on the water surface and bloom during the day [16].



Fig.4. Flower of *Nymphaea Alba*

Seeds: Small, ovoid, 1–2 mm, enclosed in a spongy aril aiding flotation and dispersal (Fig. 5) [13].



Fig.5: Seeds of *Nymphaea Alba* fruit

Fruit: A spongy berry, ripening underwater, containing numerous seeds (Fig. 6) [15].



Fig.6: Spongy berry-like Fruit of *Nymphaea Alba*.

Microscopic Characters

Rhizome:

- **Epidermis:** Single-layered with thick-walled cells.
- **Cortex:** Large, loosely arranged parenchymatous cells with air spaces (aerenchyma) for buoyancy, containing starch grains and calcium oxalate crystals (raphides).
- **Vascular Bundles:** The vascular bundles are scattered and collateral in arrangement, comprising xylem elements (tracheids and vessels) along with phloem components (sieve tubes and companion cells) [17].

Leaf

- **Epidermis:** Upper epidermis is waxy, lacking stomata; lower epidermis has numerous stomata. Trichomes are absent.
- **Mesophyll:** Spongy parenchyma with large air spaces, lacking a palisade layer.
- **Vascular Tissue:** Veins embedded in mesophyll with small vascular bundles [18].

Flower

Petals and sepals consist of thin-walled parenchymatous cells with pigments (anthocyanins in sepals) (Fig. 7). Anthers contain pollen grains with spiny exine [17].



Fig.7: Transverse section of *Nymphaea Alba* flower.

Useful components: Alkaloids, glycosides, resin, tannins

Phytochemical Composition:

Table 1: Phytochemical Constituents of *Nymphaea alba*

Phytochemical Constituents	Plant Part	Key Compounds	Reported Activities	References
Alkaloids, Flavonoids, Phenolic acids, Glycosides, Tannins, Steroidal compounds	Whole Plant / General	Alkaloids: Nupharine, Nymphaeine. Flavonoids: Quercetin, Kaempferol, Apigenin Phenolic Acids: Gallic acid, Ellagic acid Steroidal: Nymphayol	General therapeutic efficacy; antioxidant, anti-inflammatory, and diverse pharmacological properties	[5][30]
Flavonoid aglycones, Glycosides, Cardiac glycosides	Flowers	Quercetin, Quercetin-3- β -xyloside, Nymphalin	Antioxidant, anti-inflammatory, cardiac benefits	[31][6]
Phenolic Compounds	Rhizomes	Pentagalloyl glucose, Gallic acid	Antioxidant activity; aligns with Unani “cooling” properties	[5][32]
Essential fatty acids, Inorganic elements	Seeds	Copper, Sulphate	Nutritional support, mineral supplementation	[6][33]
Polyphenols	Whole Plant (Polyphenolic Profile)	Rutin, p-Coumaric acid, Caffeic acid (among 27 identified)	Supports pharmacological versatility in Unani medicine	[5][34]

These constituents underpin its Unani applications for balancing humors and treating conditions associated with heat and dryness Table 1 [2].

Pharmacological Properties

Modern research has validated the pharmacological activities of *Nymphaea alba*, many of which corroborate its traditional Unani uses. The following sections provide a detailed analysis, integrating Unani perspectives and additional references from primary studies.

Antioxidant Properties

Ethanollic rhizome extracts of *Nymphaea alba* exhibit robust antioxidant activity, with IC50 values of 63.9 μ g/ml (DPPH assay), 9.21 μ g/ml (nitric oxide scavenging), and 79.56 μ g/ml (superoxide radical scavenging) [5]. These effects are attributed to tannins and phenolic compounds, which neutralize reactive oxygen species, reducing oxidative stress [35][36]. In Unani medicine, *Neelofar's* cooling (*Barid*) properties are used to counteract excessive heat (*Hararat*), aligning with its antioxidant capacity [2]. A study in Wistar rats demonstrated that *Nymphaea alba* mitigates potassium bromate-induced renal oxidative stress, reducing lipid peroxidation and enhancing antioxidant enzyme activity [37][38][39]. This supports its Unani use for conditions involving humoral imbalances caused by oxidative stress [3].

Antidiabetic Effects

In Unani medicine, *Neelofar* is employed to manage diabetes (*Ziabetes*) by restoring humoral balance and reducing excessive heat [2][40]. Scientific investigations have confirmed that nymphayol, a steroidal constituent isolated from the flowers, promotes insulin secretion and supports the regeneration of pancreatic β -cells in streptozotocin-induced diabetic rat models [30]. This effect is associated with improved glucose metabolism, demonstrated by a significant reduction in blood glucose levels and enhanced β -cell recovery. [41][42]. These findings support *Neelofar's* traditional use in Unani formulations for diabetes management[4].

Analgesic Effects

Ethanollic extract of the rhizome at a dose of 600 mg/kg exhibits notable analgesic effects in murine models, showing

superior efficacy compared to standard drugs in both acetic acid-induced writhing and formalin-induced pain tests by significantly decreasing licking responses[5]. This aligns with *Neelofar's* Unani classification as a *Musakkin-e-Alam* (pain reliever) for conditions like headaches and joint pain [2][43]. The analgesic effects are likely mediated by flavonoids and phenolic compounds, which inhibit prostaglandin synthesis and modulate pain pathways [44][45].

Anxiolytic and Sedative Effects

In Unani medicine, the *Musakkin* (sedative) effects of *Neelofar* are traditionally employed in the management of insomnia and anxiety [2][1]. Experimental studies show that ethanollic extracts of its rhizome enhance diazepam-induced sleep and significantly reduce head-dipping behavior in the hole-board test, demonstrating effects comparable to diazepam [46]. Additionally, in the elevated plus maze model, the extract increases the time spent in open arms, suggesting pronounced anxiolytic activity. These effects are likely attributed to the presence of flavonoids, which are believed to modulate GABAergic pathways [47][48].These findings support *Neelofar's* use in Unani formulations like *Sharbat Neelofar* for calming the nervous system [10].

Anticarcinogenic Effects

Nymphaea alba has shown chemopreventive potential in studies involving Wistar rats, where it mitigated renal carcinogenesis by reducing oxidative stress and suppressing the hyperproliferative effects induced by potassium bromate [37]. The presence of flavonoids and phenolic compounds contributes to its antitumor activity, primarily through free radical scavenging and regulation of key cellular signaling pathways [49][50]. In the Unani system, *Neelofar* is traditionally valued for its *Barid* (cooling) temperament, which is believed to counteract abnormal tissue growth, thus aligning with its observed anticancer effects[2][3].

Antimicrobial Effects

Methanolic extracts derived from the flowers and rhizomes of *Nymphaea alba* have demonstrated antibacterial properties against *Escherichia coli*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus*, with minimum inhibitory concentrations (MICs) ranging from 0.25 to 2 mg/ml [6].

The activity is attributed to flavonoids and phenolic acids, which disrupt bacterial cell membranes [51][52]. This aligns with Unani's use of *Neelofar* to purify the body of morbid matter (*Madda-e-Fasida*) [2][53].

Antifertility and Contraceptive Effects

Neelofar is a key Unani herb for reproductive health, used in contraceptive formulations and ovulation inducers [2][10]. A clinical study confirmed its efficacy in ovulation induction, achieving ovulatory rates of 70%, 75.3%, and 76.8% over three cycles in women with anovulatory infertility, comparable to clomiphene citrate [7]. The mechanism may involve hormonal modulation, supporting its Unani classification as a *Muqawwi-e-Bah* [7][54].

Anti-solar Effects

The ethyl acetate extract exhibits UV-blocking activity due to its flavonoid content, with measurable sun protection factor (SPF) values [20]. In Unani, *Neelofar's* cooling properties are used externally for skin protection, supporting its application in dermatological conditions [2][3].

Anti-urolithiatic Effects

The ethanolic rhizome extract reduces bladder stone weight in ethylene glycol-induced urolithiatic rats, likely due to its diuretic (*Mudirr-e-Baul*) and antioxidant properties [55][56]. This supports its Unani use for urinary disorders [2][43].

Table 2: Therapeutic Effects and Animal Studies of *Nymphaea alba*

Therapeutic Effect	Study Details	Animal Model	Key Findings	Therapeutic Value	Limitations
Antioxidant, Anti-inflammatory, and Analgesic	[60].Journal of Ethnopharmacology, 205, 23-31 "Evaluation of anti-inflammatory and analgesic activities of <i>Nymphaea alba</i> flower extracts in rats and mice."	Rats & Mice	Ethanolic extract reduced paw edema (carrageenan-induced) and writhing (acetic acid-induced), suggesting anti-inflammatory and analgesic effects due to flavonoids and phenolic compounds.	Potential for treating inflammatory and pain-related conditions (e.g., arthritis, muscle pain).	Preclinical animal study; human efficacy requires further clinical trials.
Hepatoprotective	[61].Pharmaceutical Biology, 51(9), 1107-1114. "Hepatoprotective effects of <i>Nymphaea alba</i> against carbon tetrachloride-induced liver damage in rats."	Rats	Rhizome extract reduced liver enzymes (ALT, AST) and improved liver histopathology in CCl4-induced liver damage, attributed to polyphenols and flavonoids with antioxidant activity.	Potential use in liver disorders (e.g., drug-induced injury, hepatitis).	Limited to animal models; no human clinical trials available.
Antidiabetic and Hypolipidemic	[61]. Indian Journal of Pharmacology, 40(5), 225-229. "Hypoglycemic and hypolipidemic effects of <i>Nymphaea alba</i> in streptozotocin-induced diabetic rats."	Rats	Administration of methanolic leaf extract resulted in reduced blood glucose levels and improved lipid parameters in diabetic rat models, likely due to the presence of active compounds such as alkaloids and glycosides.	Potential in managing diabetes and lipid disorders.	Preclinical only; lacks human studies and detailed mechanism analysis.
Anxiolytic and Antidepressant	[62]. Journal of Pharmacy and Bioallied Sciences, 3(2), 279-283 "Anxiolytic effect of <i>Nymphaea alba</i> Linn. in mice as assessed by elevated plus-maze and light-dark box."	Mice	Ethanolic flower extract showed significant anxiolytic activity (comparable to diazepam), likely via GABA receptor modulation by flavonoids.	Potential in treating anxiety disorders.	Animal study only; lacks long-term safety and human efficacy data.

7. Conclusion

Nymphaea alba (*Neelofar*) is a versatile medicinal plant with significant applications in Unani medicine and modern pharmacology. Its antioxidant, antidiabetic, analgesic, anxiolytic, anticancer, antimicrobial, and antifertility properties, driven by a rich phytochemical profile, align with its Unani uses for balancing humors and treating diverse ailments. Clinical evidence supports its efficacy in ovulation induction, with potential for broader applications in diabetes, pain management, and nervous disorders. This review, backed by a comprehensive set of references, offers a solid framework for future research on *Neelofar*, integrating traditional Unani insights with contemporary scientific findings to promote its clinical relevance and therapeutic development.

Bioindicator Potential

Nymphaea alba serves as a bioindicator for environmental metals (e.g., Ba, Co, Mn, Cu), with plant concentrations correlating with environmental levels, supporting its ecological monitoring applications [9][57][58].

6. Clinical Studies

Although clinical investigations on *Nymphaea alba* remain limited, emerging evidence—especially within the context of Unani medicine—is encouraging. One notable study assessed the effectiveness of a Unani polyherbal formulation comprising *Neelofar*, *Withaniasomnifera*, *Anogeissus latifolia*, and *Barleriaprionitis* in promoting ovulation among women aged 20 to 40 years diagnosed with anovulatory infertility[7]. Administered as a 12 g powder daily for five days over three menstrual cycles, it achieved ovulatory rates of 70%, 75.3%, and 76.8%, with conception rates of 10% and 17.8% in the first and third cycles, respectively [7]. These outcomes were comparable to clomiphene citrate, with no adverse effects, highlighting *Neelofar's* potential as a safe reproductive therapy [7][59]. The study's success aligns with Unani's use of *Neelofar* as a *Muqawwi-e-Bah* for reproductive health [10][1]. Additional clinical studies are required to evaluate its therapeutic potential for other Unani indications, including its roles in managing diabetes, inducing sedation, and alleviating pain [3].

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