

The Cosmetological Potential of *Nelumbo Nucifera* Gaertn : A Systematic Review

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ARTICLE INFO

Article History:

Accepted : 01 March 2025

Published: 16 March 2025

Publication Issue :

Volume 12, Issue 2

March-April-2025

Page Number :

257-268

ABSTRACT

Nelumbo nucifera Gaertn., commonly known as the lotus, has been revered across various cultures for centuries due to its diverse applications. This systematic review aims to elucidate the cosmetologic potential of *Nelumbo nucifera* by examining its phytochemical composition and associated bioactivities which have been reported individually and from Lotus to be of potent use in cosmetology and cosmeceutics. The plant is rich in a variety of biochemicals, including triterpenoids, flavonoids, alkaloids, and polyphenols, which contribute to its extensive use in cosmetic and cosmeceutical products. These compounds exhibit significant range of activities such as skin whitening, antioxidant, anti-inflammatory, and anti-aging properties, making the lotus a valuable ingredient in skincare formulations.

The review synthesizes current research findings to provide a scientific rationale for the traditional and contemporary uses of *Nelumbo nucifera* in cosmetology. It highlights the plant's efficacy in promoting skin hydration, offering UV protection, and serving as a natural preservative. Additionally, the review explores potential new applications by providing plausible reasoning for its already reported traditional applications.

By systematically analysing the existing literature, this review not only underscores the current applications of *Nelumbo nucifera* but also identifies promising avenues for future research. The findings suggest that the lotus holds significant potential for innovation in the cosmetic industry, driven by its rich phytochemical profile and multifaceted bioactivities. This comprehensive review thus provides a foundation for further exploration and utilization of *Nelumbo nucifera* in cosmetology, paving the way for new, effective, and natural cosmetic solutions.

Keywords : *Nelumbo Nucifera*, Lotus, Cosmetology

INTRODUCTION

The investigation on safer plant-based medicine and cosmetology-oriented resources has led scientist to explore even crucial ecosystems such as the aquatic ecosystems. Among the various aquatic plants, lotus, due to its myriad uses has been at the forefront of the scientific and cultural explorations [1]. *Nelumbo nucifera* Gaertn is a well-known plant with both traditional and modern Pharmaceutical, Pharmacological, Nutraceutical and Cosmetological applications. Virtually all parts of this plant such as the leaf flower seeds rice zone and even stamens are abundantly used for their medicinal and cosmetic abilities [2]

Numerous plants have been reported for their cosmeceutical potency as herbal alternatives are observed to be significantly safer than their synthetic counterparts [1]. The demand for products and extracts of natural origins has increased exponentially in recent years [3]. Among these numerous plants, Lotus stands out significantly due to the breadth of research through ages on the plant [4]. For instance, the significance of Lotus has been reported in numerous civilizations across history including the Indian subcontinent. In Egyptian iconography and in Vedic Literature, both the ceremonial, utilitarian and medicinal properties of Lotus seeds, pods and flowers have been well documented. [5]. The plant is also a focal point of aquatic flora and fauna studies to evaluate a wide range of ecological and economic advantages [6].

Lotus has been reported to be more used as a traditional medicine in comparison to its modern usage. It has been scientifically documented for its usage as a anti-inflammatory, antimicrobial, anti-cancer, anthelmintic, hepatoprotective agent. The list of reported studies on Lotus are numerous to say the least [7]. Thus, the current review article focusses on the role of lotus in cosmeceuticals and its cosmetology applications.

PLANT DISTRIBUTION

Lotus belonging to the genus *Nelumbo*, and is the only extant genera of perennial, aquatic plants belonging to the family *Nelumbonaceae*. Two species of *Nelumbo*, namely *N. lutea* and *N. nucifera* make up the family [8]. *Nelumbo lutea*, also called as the yellow lotus is native to specifically North America whereas, *Nelumbo nucifera* with its numerous forms and varieties is distributed throughout Asia, South East Asia, Indian Peninsular Region and Australia as per India Biodiversity Portal report of 2024. The plant is commonly called as Kamal or Padma in various regional languages of India and holds significant religious and cultural importance.

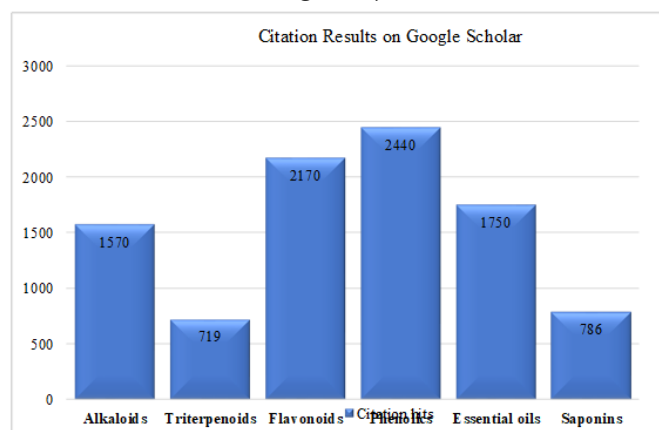


In the natural environment, lotuses commonly grow in shallow ponds, on the banks of slow-moving streams, reservoirs and swampy wetlands regions. The plant fertile soils including, silty loam, and marginally acidic waters. Lotus grows well in temperate and tropical conditions with good amount of sunlight and constant supply of water [9] [10].

Morphologically, lotus is a aquatic herb with adventitious roots, simple, solitary, stipulated and petiolate large leaves. Leaves are globous and glaucous on both surfaces with prominent veins on the undersurface. Flowers are solitary, on long peduncles and emerge above the water surface. A variety of colors has been reported in the species with prominent sepals, petals and stamens [India Biodiversity portal, 2024]. Biologically, lotus has been reported to possess certain unique features that distinguish it from other plant species including hydrophytes. These features include the ultra-hydrophobicity in leaves, unusual seed longevity, and floral thermoregulation [11]. Lotus seeds have been reported to show germination ability even after 1300 years in a report from China [12]. These the above aspects also make this plant a promising candidate for nutraceutical and cosmeceutical purposes [11].

TRENDS IN PHYTOCHEMICAL LITERATURE

Various plant parts of Lotus, especially the roots, seeds and stamens are reported to supply vital nutrients and possess potent bioactive components which make it invaluable for its use in various schools of traditional medicine [13]. Numerous plants parts such as the plant leaf, leaf stalk, flower buds, petals, thalamus, stamens, even pistil parts, seeds, seed coats, stem, roots etc. have been reported to be used in various schools of traditional medicine of the world in the management of numerous ailments including poisoning, leprosy, inflammation, skin diseases and disorders of the neurological system [13].



Significant amount of plant studies on the various parts of the plant reveals that, the whole plant is rich in triterpenoids, alkaloids, lipids, flavonoids, and vitamins [14] [15] [13]. Literature review on the plant done using google scholar engine presents that since 2023 itself, i.e., in the last two years, there have been 9435 articles pertaining to various major phytochemical groups. The detailed data has been represented in the figure 1.1.

It can be observed that, most prominent work has been in evaluation of flavonoids and phenolics. Both these secondary metabolites are well established to be useful in cosmetic applications and cosmeceutical properties.

COSMETOLOGICALLY IMPORTANT CHEMICAL CONSTITUENTS

Various parts of the plant have been reported to possess numerous bioactive agents. The flower petals are reported to content cosmetologically important phytochemicals like Myricetin, quercetin, astragalin, kaempferol, beta-sitosterol to name a few [16] [7]. The rhizomes are reported to contain maslinic acid, betulin and lupeol etc. which have been individually reported to possess wound healing and antimicrobial activity [17]. An elaborate list of the potent phytoconstituents present in the plant has been provided in table 1.1.

- Stamens

The stamens have been reported to be rich in alkaloids and flavonoids. One potent chemical reported to be present in the stamens is Arbutin which has been shown to possess the skin whitening properties [14]. Other potent cosmetologically important biomolecules like Gallic acid and Tannic acid have also been reported to be present in the flowers and leaves of lotus. Tannic acid is reported to possess anti-photoaging properties and the chemical also promotes skin regeneration whereas gallic acid is a testified antioxidant molecule with anti-melanogenic properties [18] [19]. Another potent molecule Isoliensinine is also reported to be present in Lotus.

Isoliensinine has been reported scientifically to be useful in prevention of hair-greying related to stress [20] [21]. Isorhamnetic acid has also been reported from lotus flowers. This molecule has been reported to possess photoprotective properties as it shows potential application in UV protection aspects of skin care [22].

- Seeds

Seeds of *Nelumbo* genus are also reported to be rich especially in alkaloids and many more bioactive markers of cosmetological use. The seeds are reported to be rich in Ferulic acid and P-coumaric acid content which are individually report to be used in the treatment of hyperpigmentation [23] [24]. The literature also reports the presence of 3-Indolacetic acid in the seeds which has been reported to possess photosensitizer properties [25].

Some highly specific cosmetologically potent bioactives reported from lotus include lotusine which has been reported to possess anti-wrinkle properties [26], neferine has been reported to possess anti-wrinkle properties as well as anti-sagging properties [27]. Also, the plant possesses nuciferine, a compound that can reduce hyperpigmentation [28]. Nuciferine has also been reported to be present in the flowers and flower buds of lotus [28].

- Petals

The petals of *Nelumbo nucifera* have also been reported to possess various Cosmetological applications due to the presence of phytochemicals like Gallic acid which has been reported to be a potent anti-melanogenic by Kim et al, 2007 [18]. Further, Tannic acid, a anti-photoaging and skin-regeneration agent along with quercetin and rutin which is

reported to possess antiaging properties have also been reported from the petals of *Nelumbo* [19], [29], [30].

- Leaves

The leaves of *Nelumbo nucifera* have also been reported specifically to possess phytochemicals with Cosmetological applications. Icariside B2 is reported from the leaves which is noted to prevent graying of hair. Similarly, the antioxidant and antifungal phytoconstituent, Anonaine is also found to be present in the leaves [28]. Other potent phytoconstituents reported from the leaves of lotus include, Cis-N-Feruloyltyramine and Lotusine, bioactive markers with anti-wrinkle properties [26], Neferine, another potent chemical with anti-aging properties, anti-wrinkle and anti-sagging properties is also reported to be present in Lotus leaves [27].

Other cosmetologically important phytochemicals present in the leaves of lotus include Catechin, Hyperoside, Isorhamnetine, Kaempferol, Luteolin, Rutin, etc. [31] [29] [30]. Taxifolin, a specific bioactive marker with skin viscoelasticity properties, B-Sitostenone, a phytochemical with anti-melanogenic properties, Tarteric acid, a antioxidant with anti-acne, anti-wrinkle and exfoliant properties has also been reported from the leaves of this plant [32].

- Rhizome

Even the rhizome of *N.nucifera* has been reported to possess bioactives of cosmetological applications. Rhizomes are reported to be rich in betasitosterol, betulin and also Alpha amyryn which is useful in reduction of Hyperpigmentation [33], [34], [35]. Other potent chemicals like palmitic acid, linoleic acid and Octadecatrienoic acid has also been reported to be present in the rhizome of this plant [36], [37], [38]

Table 1.1 - A summary of the potent bioactives present in the plant

Plant parts	Phytochemical compounds	References
Stamens	Arbutin, Gallic acid, Tannic acid, Anonaine, Dehydroemerine, Dehydronuciferine, Demethylcoclaurine, isoliensinine, Liensinine, Liriodenine, N-	[39], [18], [19], [21], [40], [22], [31]

	Methylasimilobine, N-Methylcoclaurine, N-Methylisococlaurine, N-Norarmepavine, Nornuciferine, Reserpine, Rosmerin, Hirustrine, Isorhamnetin, Kaempferol, Myricetine, Nelumboroside A, Nelumboroside B, Quercetin, Rutin etc.	
Seeds	Ferulic acid, Coumaric acid, Protocatechuic acid, p-Hydroxybenzoic acid, 3-Indoleacetic acid, Anisic acid, Coclaurine, Dauricine, Isoliensinine, Liensinine, Lotusine, Neferine, Nuciferine, Isoschaftoside	[24], [23], [41], [42], [25], [43], [21], [26], [27], [28], [44]
Flower bud	Asimilobine, d,l-Armeapavine, Dehydronuciferine, Lysicamine, N-Methylasimilobine, N-Nornuciferine, Nuciferine, Nuciferine N-oxides.	[26], [27], [28]
Petals	Gallic acid, Tannic acid Reserpine, Quercetin, rutin	[18], [29], [30], [19]
Leaves	Annuionone D, Byzantionoside A, Icariside B2, Nelumnucifoside A, Vomifoliol, Nelumnucifoside B, Asimilobine, Caaverine, Nuciferine, Roemerine, N-Feruloyltyramine, d,l-Armeapavine; Dehydronuciferine, Liensinine, Liriodenine; Lotusine, Lysicamine, Catechin, Epitaxifolin, Hyperoside, Hirsutrin, Isorhamnetin, Kaempferol, Luteolin; Quercetin, Rutin, Taxifolin, B-Sitostenone, 10-Eicosanol, A range of Isophytol, Octadecanoic acid, Tartaric acid	[28], [26], [27], [31], [29], [30]
Receptacles	Hirsutrin, Kaempferol, Myricetin 3-O-galactoside, Myricetin 3-O-glucuronide, Myricetin 3-O-glucoside, Quercetin 3-O-glucuronide, Syringetin	[31], [29], [30]
Rhizome	Beta-Sitosterol, Betulinic acid, alpha-Amyrin, Linoleic acid, 9E,12E,15E-Octadecatrienoic acid;	[33], [34], [35], [36], [37], [38]
Plumule	4'-Methyl-N-methylcoclaurine; Armeapavine, Higenamine, O-Nornuciferine, Roemerin Hyperoside, Hirsutrin, Luteolin	[25], [39], [43]

TRADITIONAL COSMETOLOGICAL APPLICATIONS

Lotus governs significant traditional and spiritualistic significance in India. Due to these aspects of its sociocultural involvement, lotus has been utilized in a range of traditional treatment regimens including cosmetological applications. With reference to its traditional pharmacological uses, Lotus has been used in various cultures of the world for the treatment of sunstroke, diarrhoea, dysentery, blood vomiting, uterine bleeding and female reproductive disorders. It has also been used traditionally for the treatment of fever, hypertension, treatment of infections, haematuria etc [45] [46] [47].

With respect to its cosmetological applications, lotus flowers have been traditionally considered as a symbol of beauty and used for skin whitening, anti-wrinkle, anti-aging effects prominently [48]. It has also been used for overall improvement of skin condition [45]. The leaves are especially used in the treatment of Leprosy and other skin conditions [15].

Lotus liquor made from the blossoms and leaves has been reported to possess prominent antioxidant and rejuvenating properties and hence used traditionally for its stress relieving and skin rejuvenating properties [14]. Lotus leaves and blossoms, due to their antimicrobial properties have also been used traditionally as anti-acne treatments. Due to its cooling properties, it has been reported to be calming and relaxing on the skin [48]. Further, the petals are also used for evening out skin tone, reduce discoloration etc.

In the Ayurvedic manuscripts, Kamal i.e., Lotus has been reported to be used in various ayurvedic formulation preparations such as Aravindasava, Catura Kaval Ghrita, Guchiyadi Modaka. Modern nutraceutical and cosmeceutical industry employ *Nelumbo nucifera* in a wide range of products.

Table 1.2 – A summary of the traditional applications of Lotus

Part of Plant	Traditional use in cosmetics	Scientific Experimentation regarding the usage	References
Stamen	Anti-ageing	<i>N. nucifera</i> stamens are reported to provide anti-aging effects against three key enzymes involved in skin aging; tyrosinase, elastase, and collagenase, using both computational and experimental methods. Kae-3-Rob, a significant flavonoid from stamen, has been reported to be the functional molecule for promising collagenase and tyrosinase inhibitor activity.	[49]
Leaf	Tighten skin, reduce excess oil, detoxify skin	Leaf extracts have been demonstrated to decrease interleukin-6 [IL-6] concentration which is a cytokine associated with an inflammatory response. This suggests that include <i>Nelumbo nucifera</i> leaf extract in oral formulations may be an effective way to prevent or treat periodontal problems. The Extract has also been used to isolate invaluable bioactive markers which provide significance cosmetological applications.	[7]
Flower	Moisturising, anti-inflammatory, Skin brightening	The phenolic acids, flavonoids, and anthocyanidins in lotus flowers can be attributed the myriad of cosmetological applications associated with the petals. Petals are also a common ingredient of numerous traditional formulations along with the stamens of Lotus.	[49]

		The petals' extract has been scientifically proven to possess several skin-beneficial qualities that enhance the suppleness and smoothness of the skin as reported in Ayurvedic texts. Being rich in vital vitamins, such as B complex, petals naturally become perfect choice for antiaging formulations which replenishes and nourishes the skin. It also has a large amount of minerals that are good for the health of the skin and hair. A 2021 study has further revealed that lotus flowers are ideal ingredient for cosmetic applications and offers enormous benefits for the skin and hair.	
Seeds	Skin Rejuvenation, Anti-ageing, anto-oxidant	Extracts from lotus seeds have the ability to scavenge reactive nitrogen species. Additionally, the seed extract possesses nephroprotective, antihemolytic, and antioxidant qualities. The primary and most established use of lotus seed extract is as an antioxidant. Lotus seeds include several components that work as potent antioxidants and scavengers of free radicals. Applying it to the skin's or hair's surface can shield it from damaging free radicals and act as a stand-in for structural proteins. Therefore, the structural damage caused by free radicals may be prevented or even reversed. It possesses antibacterial qualities as well. It has two functions when added to a product: it can shield the skin from damage caused by microbes while also preventing the product from going bad. It creates a coating on the skin when applied, shielding it from harmful elements like the wind, dust, or bacteria.	[1], [50]
Rhizomes	Calming effects, used in masks	The Rhizome has been reported to possess potent triterpenoids such as betulinic acid which has showed strong anti-inflammatory properties against edema and erythema. Further, triterpenoids such as maslinic acid, also have been reported to have calming and hydrating effect on the skin. The anti-inflammatory properties of the Rhizome also makes them applicable in relieving irritated skin. The rhizome extract has also been reported to increase collagen synthesis and cell proliferation thus also useful in skin healing. The binding property of Rhizomatous Starch also has made it a common ingredient as an adjuvant in cosmetic tablets.	[7]

Embyos	Anti-ageing, Skin nourishment	Lotusine, a soluble alkaloid found in the embryos, has been reported to prevent UV-induced matrix metalloproteinase-1 [MMP-1] expression, which is connected to skin pigmentation and aging. Thus, the reported activity. Antioxidant activity of the embryos has also been reported to be used to shield skin cells from oxidative stress, thus explaining the used in treatment of pigmentation problems. Vitexin and Liensinine, two substances present in lotus embryos, are scientifically reported to be potent anti-aging agents. Embryo extracts are also proven to be useful in treatment of sensitive skin issues due to their calming properties on the skin. They have the soothing effect of lessening redness and irritation following exposure to environmental stimuli.	[26]
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COSMETIC APPLICATIONS OF NELUMBO NUCIFERA

Nelumbo nucifera, the Indian lotus, is a treasure trove of natural compounds with remarkable cosmetic benefits. Its anti-aging properties stem from its ability to inhibit key enzymes like tyrosinase, elastase, and collagenase, which contribute to the formation of wrinkles and age spots. By hindering these enzymes, Nelumbo nucifera helps reduce the appearance of fine lines, wrinkles, and age spots, promoting a more youthful complexion.

Furthermore, this remarkable plant possesses potent moisturizing and hydrating properties. It effectively locks in moisture, leaving the skin feeling supple and hydrated. This makes it an ideal ingredient for a wide range of skincare products, from lightweight moisturizers to deeply hydrating masks. By improving skin hydration, Nelumbo nucifera enhances skin elasticity and helps to combat dryness, leaving the skin feeling soft, smooth, and rejuvenated.

The antibacterial and anti-inflammatory properties of Nelumbo nucifera make it a valuable asset in the fight against acne. It helps to reduce the growth of acne-causing bacteria, preventing future breakouts and

minimizing the risk of infection. Additionally, its anti-inflammatory properties soothe redness and irritation associated with acne breakouts, promoting faster healing and a clearer complexion.

Beyond skincare, Nelumbo nucifera offers significant benefits for hair health. Its antioxidant and antibacterial properties nourish the scalp, strengthen hair follicles, and reduce dandruff and itchiness. By improving scalp health, it creates an optimal environment for hair growth, promoting stronger, healthier hair.

The applications of Nelumbo nucifera in the cosmetic industry extend beyond skincare and hair care. Its antioxidant properties provide crucial protection against harmful UV radiation. By shielding the skin from the damaging effects of the sun, it helps to prevent premature aging, reduce the appearance of fine lines and wrinkles, and prevent skin discoloration. This makes it an invaluable ingredient in sunscreens and other sun protection products.

Nelumbo nucifera also finds its place in lip care products. Its moisturizing and nourishing properties hydrate and protect the delicate lip skin, leaving them soft, smooth, and supple. Lip balms and lip scrubs infused with Nelumbo nucifera provide gentle

exfoliation and long-lasting hydration, promoting healthy and beautiful lips. Finally, the anti-inflammatory and antioxidant properties of *Nelumbo nucifera* make it an ideal ingredient for face masks and face washes. These products soothe and calm irritated skin, reduce redness, and promote a healthy, glowing complexion. By incorporating *Nelumbo nucifera* into their formulations, cosmetic brands can offer consumers effective and natural solutions for a wide range of skin concerns.

In conclusion, *Nelumbo nucifera* is a versatile and potent botanical ingredient with a wide range of applications in the cosmetic industry. Its anti-aging, moisturizing, antibacterial, and antioxidant properties make it a valuable asset in skincare, hair care, and sun protection products. By harnessing the power of this remarkable plant, cosmetic brands can create innovative and effective products that deliver exceptional results and enhance the beauty and well-being of consumers.

CONCLUSION

The current review article thus focuses on the phytochemicals present in *Nelumbo nucifera*, commonly known as the lotus, and underscores its prominence in scientific research. Historically, the plant lotus has been utilized across various cultures and civilizations for diverse applications including cosmetics. This review is an attempt to provide a scientific rationale for the widespread popularity of the plant, particularly in the context of its cosmetic and cosmeceutical potential.

The extensive range of biochemicals found in *Nelumbo nucifera*, including flavonoids, alkaloids, and polyphenols, contribute significantly to its noted applications in cosmetics. These compounds exhibit various beneficial properties including but not limited antioxidant properties, anti-inflammatory activity, and anti-aging effects, which are highly valued in the cosmetic industry.

Moreover, the review further identifies additional potential applications of the lotus. For instance, its bioactive compounds can certainly be further explored for their efficacy in skin hydration, UV protection, and as natural preservatives in cosmetic formulations. Thus, the systematic analysis of existing literature highlights not only the current uses but also the future prospects of *Nelumbo nucifera* in cosmetology.

NO CONFLICT OF INTEREST

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