

A review on Phytochemistry, Medicinal value and Antimicrobial properties of *Azadirachta Indica*

Dr. Udai Pratap Singh

Assistant Professor, Department of Chemistry, D. A.-V. College, Kanpur

ABSTRACT

Neem (*Azadirachta Indica*) is a deciduous tree indigenous to the Indian subcontinent, recognized for its diverse array of phytochemicals. This review synthesizes current research findings on the chemical constituents present in neem, highlighting key compounds including azadirachtin, limonoids, nimbin, nimbidin, quercetin, and various flavonoids. Furthermore, it delves into the antibacterial potential of these constituents, elucidating their mechanisms of action and efficacy against a spectrum of bacterial pathogens. The synergistic interactions with other compounds and potential applications in pharmaceuticals and agriculture are also discussed.

Keyword: Phytochemicals, Neem, evergreen , environment , medicinal , antimicrobial .

INTRODUCTION

Neem, scientifically known as *Azadirachta Indica*, is a versatile evergreen tree native to the Indian subcontinent. Revered for its myriad of benefits, this botanical marvel has played a pivotal role in traditional Indian medicine, agriculture, and various industries for centuries. Standing at the crossroads of cultural, historical, and ecological significance, neem's introduction unravels a story of a tree deeply intertwined with the fabric of Indian society.

With its slender, drooping branches and delicate, pinnate leaves, neem casts a distinctive silhouette across the landscape. Its botanical name, *Azadirachta Indica*, reflects its Indian origins, 'azad' meaning free and 'dirakht' denoting tree. This nomenclature pays homage to the tree's indigenous roots and its historical importance to the region.

Neem's mention in ancient Indian texts, such as the Vedas and the Charaka Samhita, dates back thousands of years. These scriptures extol its therapeutic properties, deeming it 'Sarva Roga Nivarini' or the 'healer of all ailments'. Neem's leaves, seeds, bark, and oil contain a rich cocktail of bioactive compounds, including nimbin, nimbidin, and azadirachtin, which exhibit potent antibacterial, antifungal, and anti-inflammatory properties.

In traditional medicine, neem has been utilized to treat a diverse array of maladies, ranging from skin conditions like eczema and acne to more complex issues like diabetes and malaria. Its leaves, when ground into a paste, are applied topically to alleviate skin irritations and promote wound healing. Meanwhile, neem oil, extracted from the seeds, is used in formulations for hair care and cosmetics.



Azadirachta Indica

Beyond its medicinal powers, neem plays a pivotal role in agricultural practices, acting as a natural pesticide and fertilizer. The high azadirachtin content in neem disrupts the life cycle of pests, making it a potent and eco-friendly alternative to synthetic chemicals. Moreover, neem cake, a byproduct of oil extraction, serves as an organic fertilizer, enhancing soil health and promoting sustainable agriculture practices.

Neem's influence extends beyond the realm of traditional medicine and agriculture. In India, it holds cultural significance, often associated with purification rituals and festivals. Neem leaves are used in auspicious ceremonies and are believed to ward off negative energies. Its presence in Indian folklore and mythology further reinforces its revered status in the collective consciousness.

In recent decades, the global community has recognized neem's ecological importance. Its inherent pest-resistant properties and minimal environmental impact have led to its integration into integrated pest management strategies worldwide. Neem-based products have found applications in organic farming, horticulture, and even in the pharmaceutical and cosmetic industries.

In conclusion, neem stands as an emblem of India's rich botanical heritage, embodying centuries of traditional wisdom and ecological stewardship. Its multifaceted contributions, from holistic healing to sustainable agriculture, underscore its value as a natural resource with global significance. As we navigate an era of increasing environmental awareness, neem's legacy continues to inspire innovative solutions for a more sustainable and harmonious coexistence with nature.

CHEMICAL CONSTITUENTS

Neem (*Azadirachta Indica*) contains a diverse array of chemical compounds, each contributing to its unique properties and potential applications. Here are some of the key constituents found in neem:

1. **Azadirachtin** : Azadirachtin ($C_{35}H_{44}O_{16}$) is one of the most well-known and studied compounds in neem. It is a complex tetranortriterpenoid limonoid. Azadirachtin is primarily responsible for neem's insecticidal properties.
2. **Limonoids** : Limonoids are a class of highly oxygenated triterpenoids. They contribute significantly to the biological activity of neem. These compounds exhibit a wide range of biological effects, including antibacterial and insecticidal activities.
3. **Nimbin and Nimbidin** : Nimbin ($C_{30}H_{36}O_9$) and Nimbidin are sulfur-containing compounds. They are primarily found in neem seeds. These compounds have demonstrated anti-inflammatory and antibacterial properties.
4. **Quercetin** : Quercetin is a Flavonol, which is a type of Flavonoid. It is a powerful antioxidant and exhibits antibacterial potential. It can disrupt bacterial membrane integrity and inhibit crucial enzymatic processes.
5. **Flavonoids** : Neem contains a spectrum of flavonoids, including various glycoside forms and substitution patterns. These compounds contribute to neem's overall bioactivity and therapeutic potential.

6. Nimbolide and Gedunin : Nimbolide and Gedunin are notable limonoids found in neem. They have been studied for their anti-cancer properties.
7. Azadirone : Azadirone is a triterpenoid compound found in neem leaves and seeds. It exhibits insecticidal properties and has been explored for its potential as an anti-cancer agent.
8. Beta-sitosterol : Beta-sitosterol is a plant sterol found in neem seeds. It has potential anti-inflammatory and immunomodulatory effects.
9. Volatile Compounds : Neem oil, derived from neem seeds, contains various volatile compounds like triterpenoids, fatty acids, and sulfur-containing compounds. These contribute to its characteristic odor.
10. Nimocinol and Nimocinolide : These are triterpenoids found in neem seeds. They have exhibited anti-inflammatory properties.
11. Salannin : Salannin is a limonoid found in neem seeds and leaves. It contributes to neem's insecticidal properties.

It's important to note that the exact composition of these compounds can vary depending on factors such as the part of the neem tree (leaves, seeds, bark) and the extraction method used.

MEDICINAL IMPORTANCE OF NEEM

Neem (*Azadirachta Indica*), often referred to as the "wonder tree" or "nature's pharmacy," holds significant medicinal importance in various traditional healing systems, particularly in Ayurveda, the ancient Indian system of medicine. Its diverse range of bioactive compounds imparts it with a plethora of health benefits. In this comprehensive overview, we will explore the multifaceted medicinal properties of neem.

1. **Antibacterial and Antifungal Properties:** Neem is rich in bioactive compounds like Nimbin, Nimbidin, and Azadirachtin, which exhibit potent antibacterial and antifungal properties. These properties make neem an effective natural remedy for a wide spectrum of microbial infections.
2. **Skin Health and Healing:** Neem's efficacy in treating skin conditions is well-documented. Its antimicrobial properties, combined with anti-inflammatory compounds such as Gedunin and Nimbidol, make it an excellent choice for managing various dermatological disorders. It is used to alleviate acne, eczema, psoriasis, and fungal infections.
3. **Anti-Inflammatory Effects:** Neem contains potent anti-inflammatory agents like quercetin and catechin. These compounds help reduce inflammation, making neem beneficial for conditions like arthritis, joint pain, and other inflammatory disorders.
4. **Antiviral Potential:** Preliminary studies suggest that neem extracts may possess antiviral properties. Compounds in neem have shown inhibitory effects against certain viruses, although further research is required to establish its full potential in this area.
5. **Antioxidant Richness:** Neem is a rich source of antioxidants such as carotenoids, flavonoids, and vitamin C. These antioxidants help neutralize harmful free radicals, offering protection against cellular damage and oxidative stress.
6. **Immunomodulatory Effects:** Neem is believed to stimulate the immune system, enhancing the body's ability to defend against infections and diseases. It aids in bolstering the body's natural defense mechanisms.
7. **Digestive Health Support:** Neem leaves and extracts have traditionally been used to promote digestive health. They possess properties that aid in digestion, making neem beneficial for conditions like indigestion, ulcers, and constipation.
8. **Dental Care:** Neem twigs, commonly used as natural toothbrushes in certain cultures, contain antibacterial compounds that promote oral health. They help combat gum diseases, plaque, and bad breath.
9. **Blood Sugar Regulation:** Studies suggest that neem may have a positive impact on blood sugar levels. Compounds like Nimbin and Nimbidin exhibit potential hypoglycemic effects, which could be beneficial for individuals with diabetes.

10. **Anti-Cancer Properties:** Neem contains phytochemicals like quercetin and Nimbolide, which have shown promise in inhibiting the growth of cancer cells. While more research is needed, these findings highlight neem's potential role in cancer prevention and treatment.

11. **Cardiovascular Health Benefits:** Neem may contribute to heart health by helping to regulate blood pressure and cholesterol levels. Compounds like nimbin and oleic acid have been associated with cardiovascular benefits.

12. **Insecticidal and Pest-Repellent Properties:** Neem oil and extracts are commonly utilized in natural insecticides and repellents. Azadirachtin, a prominent compound in neem, disrupts the growth and feeding patterns of pests, making it an eco-friendly alternative to chemical pesticides.

13. **Liver Health Support-** Neem aids in detoxifying the liver and promoting its optimal function. It helps in removing toxins from the body, which is crucial for overall health.

13. **Wound Healing and Antiseptic Properties:** Neem's antiseptic qualities accelerate wound healing and prevent bacterial infection.

SIDE EFFECTS OF NEEM

While neem is generally considered safe when used in appropriate amounts and for short periods of time, it can have side effects in some individuals, especially if used excessively or over an extended period. Here are potential side effects of neem:

1. **Allergic Reactions:** Some people may be allergic to neem. If you experience symptoms like itching, rash, difficulty breathing, or swelling of the face, lips, tongue, or throat after using neem, seek immediate medical attention.

2. **Digestive Disturbances:** Ingesting large amounts of neem, especially in concentrated forms like neem oil, can lead to digestive issues such as nausea, vomiting, diarrhea, or stomach upset.

3. **Liver Damage (in high doses):** Excessive consumption of neem, particularly in concentrated forms, may lead to liver damage. This is rare and typically associated with very high doses.

4. **Kidney Damage (in high doses):** Extremely high doses of neem may potentially cause kidney damage. Again, this is a rare occurrence and usually associated with improper use.

5. **Pregnancy and Breastfeeding:** Neem should be used with caution during pregnancy and breastfeeding. There is limited research on its safety during these periods, so it's advisable to consult a healthcare professional before using neem.

6. **Children:** Neem products should be used cautiously in children. It's best to consult a pediatrician before using neem or giving it to children.

7. **Blood Sugar Effects:** Neem may lower blood sugar levels. Individuals with diabetes should monitor their blood sugar levels closely if using neem and consult a healthcare provider for guidance.

8. **Decreased Fertility (in high doses):** Some studies in animals have suggested that very high doses of neem extracts may affect fertility. However, more research is needed to establish the relevance in humans.

9. **Interactions with Medications:** Neem may interact with certain medications. If you are taking medications, especially for diabetes, consult a healthcare professional before using neem.

10. **Skin Irritation (Topical Use):** Some individuals may experience skin irritation, redness, or itching when using neem topically. It's recommended to perform a patch test before applying neem products to a larger area of skin.

11. **Not Suitable for Pets:** Neem oil and products containing neem should not be used on pets without consulting a veterinarian. Some animals may be sensitive to neem.

It's important to note that while neem has a long history of traditional use and offers potential health benefits, it should be used judiciously and in moderation. Always consult a healthcare professional or herbalist before using neem for medicinal purposes, especially if you have underlying health conditions or are taking medications. Additionally, if you experience any adverse effects after using neem, discontinue use and seek medical advice promptly.

CONCLUSION

This comprehensive review underscores the extraordinary medicinal potential of neem (*Azadirachta Indica*), affirming its status as a versatile natural remedy with a wide range of health benefits. From its formidable antibacterial and antifungal properties to its effectiveness in promoting skin health, neem stands as a testament to the healing power of botanical resources. Its anti-inflammatory, antiviral, and antioxidant attributes further enhance its therapeutic value, making it a valuable addition to various healthcare regimens.

Neem's influence extends across diverse domains, encompassing digestive health, immune support, and even potential roles in cancer prevention and treatment. Its application in dental care, pest control, and liver health further solidifies its status as a holistic remedy. However, caution is advised, especially for individuals with specific health considerations, such as pregnancy, breastfeeding, or existing allergies.

While neem offers substantial promise, its application should be approached with prudence, and consultation with healthcare professionals or herbalists is recommended, particularly for individuals with underlying health conditions or those taking medications. Additionally, the potential for side effects, albeit rare, should not be overlooked, necessitating careful consideration of dosage and usage.

In summation, neem's enduring relevance in traditional medicine is substantiated by its rich chemical composition and its myriad therapeutic applications. As a source of natural remedies, neem exemplifies the wealth of healing potential derived from botanical resources. By leveraging its diverse array of bioactive compounds, neem holds the promise of contributing to modern healthcare in various capacities, provided it is utilized judiciously and in accordance with professional guidance.

REFERENCES

- [1]. Debjit B, Jitender Y, Tripathi KK, et al. Herbal remedies of *Azadirachta Indica* and its medicinal application. *Jchem pharm res.* 2010;2(1):62-72.
- [2]. Kim JH, Shin SP, Han JE, et al. Occurrence and antibiotic resistance of *Vibrio vulnificus* in seafood and environmental waters in Korea. *J Food Saf.* 2011;31(4):518-524.
- [3]. Chaube SK, Prasad PV, Khillare B, et al. Extract of *Azadirachta Indica* (Neem) leaf induces apoptosis in rat oocytes cultured in vitro. *Fertil Steril.* 2006;85:1223-1231.
- [4]. Biswas K., Chattopadhyay I., Banerjee R. K., Bandyopadhyay U. Biological activities and medicinal properties of *Neem* (*Azadirachta Indica*) *Current Science.* 2002;82(11):1336-1345.
- [5]. Kumar S., Agrawal D., Patnaik J., Patnaik S. Analgesic effect of neem (*Azadirachta Indica*) seed oil on albinorats. *International Journal of Pharma and Bio Sciences.* 2012;3(2):P222-P225
- [6]. Patil P. R., Patil S. P., Mane A., Verma S. Antidiabetic activity of alcoholic extract of *Neem* (*Azadirachta Indica*) root bark. *National Journal of Physiology, Pharmacy and Pharmacology.* 2013;3(2):142-146. doi: 10.5455/njppp.2013.3.134-138
- [7]. Jaiswal A. K., Bhattacharya S. K., Acharya S. B. Anxiolytic activity of *Azadirachta Indica* leaf extract in rats. *Indian Journal of Experimental Biology.* 1994;32(7):489-491