INTRODUCTION

The evergreen tree *Azadirachta indica*, most popularly known as neem. Because of its therapeutic characteristics, it has been utilized by Indians for centuries to cure a wide range of conditions. Leaves, bark, fruit, flowers, oil, and gum from the neem tree are all listed in the aforementioned medical folklore for their purported ability to treat various diseases and ailments. The review explores most recent work that has been done on neem extracts. While it is natural that starting materials and extraction procedures can vary widely, we will provide a brief summary of few of the most relevant bioactive chemicals frequently present in many extracts. We also stress that much of the current work is still experimental, which should always be taken into account when trying to create safer goods for people to consume. The plant also has the potential to mitigate heavy metal pollution and develop a model for predicting soil remediation using neem leaves. Neem’s inhibitory activity on papain-like protease of SARS-CoV-2 is also explored. Overall, neem’s therapeutic potential is significant and its potential in healthcare and environmental remediation is highlighted.

Keywords: *Azadirachta indica*, Therapeutic properties, Pharmacological perspectives.


Source of support: Nil.

Conflict of interest: None

ABSTRACT

This review explains the therapeutic prospective of *Azadirachta indica* (Neem), a traditional medicinal tree in India, Southeast Asia, and Africa. Neem extracts have been found to have various therapeutic properties, including antimicrobial, antifungal, hepatoprotective, antiulcer, antifertility, and antinoceceptive properties. Recent research has shown neem’s potential as an antiviral agent, cancer treatment, and a source of antibiotic compounds. Neem oil nano hydrogel shows significant antimicrobial activity against various pathogens. The plant also has the potential to mitigate heavy metal pollution and develop a model for predicting soil remediation using neem leaves. Neem’s inhibitory activity on papain-like protease of SARS-CoV-2 is also explored. Overall, neem’s therapeutic potential is significant and its potential in healthcare and environmental remediation is highlighted.

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REVIEW ARTICLE

Exploring the Therapeutic Potential of *Azadirachta indica* (Neem): Recent Advances and Applications

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INTRODUCTION

The evergreen tree *Azadirachta indica*, most popularly known as neem. Because of its therapeutic characteristics, it has been utilized by Indians for centuries to cure a wide range of conditions. Leaves, bark, fruit, flowers, oil, and gum from the neem tree are all listed in the aforementioned medical folklore for their purported ability to treat various diseases and ailments. The review explores most recent work that has been done on neem extracts. While it is natural that starting materials and extraction procedures can vary widely, we will provide a brief summary of few of the most relevant bioactive chemicals frequently present in many extracts. We also stress that much of the current work is still experimental, which should always be taken into account when trying to create safer goods for people to consume. We searched academic databases (like PUBMED, Science Direct, and Elsevier) and commercial search engines (like Google, Google Patents, and Patenscope) to compile the information used in this literature review.

The usage of neem has led to its transformation into a “wonder tree” of Western medicine. It has usage in alternative medication for anything from inflammation and infection to fever, skin illness, and tooth decay. Acne, psoriasis, and eczema are just few of the epidermal dysfunctions that it helps. Additionally, neem leaves have been shown to have characteristics against hyperglycemia, viruses, mutagenesis, inflammation, malaria, and carcinogenesis. In addition to its antimicrobial, antifungal, hepatoprotective, antiulcer, antifertility, and antinoceceptive properties, neem also has a number of other useful properties.

Neem twigs can be used to eliminate bad breath, reduce tooth pain, and clean and polish teeth. The bark of the neem tree can kill microorganisms and prevent sweating. Some of the phytochemicals are potent in their ability to kill microorganisms. Azadirachtin, a component of neem, is effective against bacteria. Neem-based moisturizers have also been utilized in the past.

Recent Advances in *A. indica*

Recent (within the last three to four years) neem research is discussed. A worldwide healthcare crisis has resulted from the SARS-CoV-2 epidemic, with symptomatic therapy being the mainstay of care. The rising mortality toll necessitates the use of targeted antivirals, yet the Food and Drug Administration (FDA) only permits emergency use of remdesivir. To find small chemical inhibitors of the membrane and envelope proteins of SARS-CoV-2, scientists used docking and simulation techniques. Common chemicals were discovered to have a high affinity for binding to these proteins, indicating that they may be able to block viral assembly.

The extract of the neem utilized for the treatment and prevention of cancer, is being studied for its anti-inflammatory
Therapeutic Potential of Azadirachta indica

properties. Human leukemia cells had their NF-B activity, vitality, and 1B kinase activity suppressed by the extract. Improved knowledge of the mechanisms of A. indica influences on pro-inflammatory cell signaling and apoptosis outcomes.13

Silver nanoparticles (AI-AgNPs) with a high yield and crystalline structure were synthesized using the leaves. Disc diffusion studies showed that the compound was effective at killing various bacteria. A viscos hydrogel with improved antibacterial characteristics was created by loading nanoparticles onto a biocompatible-biodegradable polymer (PF127). Hydrogel application improved the healing of wounds in mice without causing any harm to the skin. An easy green method for synthesizing AI-AgNPs with improved antimicrobial and free-radical scavenging activity is presented in the study.14

This study analyses the utilization of non-edible plant-based oil of A. indica, ethanol, and diesel fuels in IC engines. To evaluate the performance of A. indica oil and diesel, three blends were developed: D80B20, B80E20, and D60B20E20. Brake thermal efficiency (BTE) was shown to be higher using various fuels, and exhaust emissions were found to be lower when compared to pure diesel. It is suggested that the biodiesel blends be used in IC engines as a replacement fuel.15

This research shows a nano hydrogel derived from A. indica oil as a potential new source of antibacterial chemicals. Inhibition ranged from 50.23 to 82.57% when compared to diclofenac sodium, the gold standard.16

Nosocomial Acinetobacter baumannii is an antibiotic-resistant human infection. A. baumannii’s biofilm development is a major virulence factor since it is mediated by the csgA gene. This could be a unique infection-control target. To determine whether or not essential bio-compounds from A. indica have anti-biofilm activity against ESBL-generating strains of A. baumannii, in-vitro and in-silico investigations were conducted.17

The research describes an environmentally benign technique for creating AgNPs from silver nitrate and A. indica leaf extract. It was observed that 1 mM AgNO3, 60 mg/mL, 30 minutes, and 85°C produced the best results. Minimum inhibitory concentration studies showed that 15.6 g/mL of AgNPs was effective against both Escherichia coli and Staphylococcus aureus. The biomedical sector may benefit from this green and cheap technique.18

The nanoparticles were measured and found to be spherical with a diameter between 19.27 and 22.15 nm. The anti-inflammatory and anti-diabetic effects of the nanoparticles were moderately comparable to those of established therapies.19

Air, water, and land pollution, especially from heavy metals, have increased worldwide as a result of industrialization and population development. A. indica was tested to see if its powder might be used as a natural adsorbent to get rid of copper ions in water. The maximum percentage of copper removal was attained under optimized circumstances. According to these results, A. indica could be a good biomass to use in order to remove copper ions.20

Total petroleum hydrocarbon (TPH) degradation was tracked using the model while microorganisms were present in the reactor. Soil treated with 100 g of room-dried A. indica leaves showed the greatest remediation, with data showing a considerable reduction in polluting agents. The model was effectively utilized to predict TPH remediation behavior, enabling for monitoring of contaminated soil remediation.21

Research has been reported that looked into whether or not neem extracts have any effect on the new coronavirus SARS-CoV-2’s papain-like protease (PLpro). All of the substances investigated showed respectable inhibitory action in molecular docking and molecular dynamics simulations, with desacytiledunin (DCG) demonstrating the highest binding affinity.22

The research demonstrates the green manufacturing of copper oxide nanoparticles (CuO NPs) utilizing A. indica flower extract. Crystalline, round, and chemically unadulterated NPs were discovered. Different concentrations were also used to examine their cytotoxicity towards H9c2 cardiomyocyte cells during treatment. The results may help lessen the prevalence of organ failure and death overall.23

In the study reported, the antioxidant and anticancer activities of A. indica gum polysaccharide were isolated and purified. The carboxymethylated polysaccharide was utilised to create curcumin nanocarriers, which demonstrated potent cytotoxicity against MCF7 cancer cell lines despite lacking antibacterial activity.24

The research explores the prospective of leaves for phenol adsorption in refineries and chemical industries. The study found that neem leaves can effectively remove 97.5% of phenol when the pH, dose, time, concentration, and temperature are controlled. The adsorption mechanism was supported by various models, and the adsorption process was non-random, exothermic, and spontaneous. The study recommends safe disposal of the adsorbent through incineration.25

CONCLUSION

A. indica (Neem) has therapeutic potential in traditional medicine, offering health benefits like addressing epidermal dysfunctions and viral infections. It has been integrated into modern Western medicine for treating inflammatory diseases and cancer. Neem’s antimicrobial properties make it useful for wound healing and infections. Its eco-friendly applications include silver nanoparticle synthesis and heavy metal removal. Neem’s antiviral potential is promising, particularly in inhibiting the SARS-CoV-2 protease. Its anti-inflammatory properties make it a potential candidate for cancer treatment. Neem’s potential extends to biomedical applications. This work gives recent work done on A. indica, which is very helpful for further research.

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