



Antibacterial Activity Of *Azadirachta Indica* (Neem)

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Abstract

Azadirachta indica (a. Juss), also known as the neem tree, has been used for millennia as a traditional remedy for a multitude of human ailments. also recognized around the world as a broad-spectrum pesticide and fertilizer, neem has applications in agriculture and beyond. currently, the extensive antimicrobial activities of a. ancient people have utilized the neem tree, *Azadirachta indica* (a. Juss), as a traditional medicine for a wide range of human illnesses for millennia. neem is a widely acknowledged broad-spectrum insecticide and fertilizer with uses in agriculture and other fields. studies in the domains of dentistry, food safety, bacteriology, mycology, virology, and parasitology are now investigating the broad range of antibacterial properties of a. indica. this article provides an overview of some of the most recent research on the aforementioned study issues, highlighting neem's promise as a hitherto unexplored source of innovative treatments. furthermore, the ability of neem extracts and chemicals to combat organisms that develop biofilms and are resistant to drugs, two major categories of infections for which there is currently no effective treatment. neem has grown to be a valuable plant in the globe, holding the key to thousands or even hundreds of thousands of problems. *Azadirachta indica*, commonly known as mi, is a well-known, quickly growing evergreen tree that grows throughout the world, primarily in america, africa, and india. chinese, ayurvedic, and unani treatments have been using it extensively for many years, especially in asian countries, to cure and prevent illnesses. the neem plant has biological chemicals in its many portions that have antibacterial, antiviral, and antifungal properties. it affects several biological systems without causing any negative effects, making it regarded as a safe therapeutic herb. the neem tree yields certain active substances that have biological properties. the fruit, seed, bark, roots, leaves, flowers, and seeds all have biological properties.

Keyword

Antibacterial activity, phytochemicals , tredational ,Medicine , biofilm registance Therapeutic herb

introduction

plants have always served as a source of inspiration for new pharmacological molecules, as well as for medications produced from plants that have significantly improved human health wellbeing. while more powerful medications have largely superseded many pharmaceuticals derived from trees, trees continue to provide some medication compounds, even those that are synthetic. [1] medicinal plants have long been used to treat a variety of illnesses, including diabetes, malaria, and anemia [2], but there is still no much to learn about the potential of higher plants as a source of novel medications [3]. a methodical examination of them could lead to the discovery of new, useful substances [4]. neem (*azadirachta indica*), also known as “india lilac” or “margosa,” is a member of the tribe melieae, the family meliaceae, and the subfamily meloideae. neem is one of the most adaptable and diverse tropical trees, possessing enormous potential. it has the most beneficial non-wood items. more than any other tree species (leaves, bark, blossoms, fruits, seed, gum, oil, and neem cake). india has long practiced ayurvedic treatment using various components of the neem tree. folk medicine has utilized neem oil, as well as extracts from its bark and leaves, for therapeutic purposes. regulate respiratory conditions, intestinal helminthiasis, constipation, leprosy, and as a general facilitator of health. 5 it is possible to manage several skin infections with neem oil. leaves, roots, bark, fruit and flowers together treat skin ulcers, burning, itching, biliary disorders, and blood morbidity. feelings as well as phthisis 6. in regions with rainfall between 450 and 1200 mm, the tree develops organically. nonetheless, it has been effectively implemented in regions with rainfall as low as 150 to 250 millimeters. neem can grow as high as 1500 meters. it is able to expand effectively throughout a broad temperature range of 0 °c to 49 °c. in rwanda, it flourishes in hot climates such as bugesera and kibungo. thus, we’ll be utilizing samples of neem from one of these locations, to ascertain the antibacterial efficaciousness of plant extracts from *azadirachta indica* against some particular microorganisms that result in various illnesses and infections on the a person. in traditional medicine, plants are used to treat a variety of illnesses, including those found in rwanda. however, a few significant medicinal herbs in rwanda are scarcely utilized or have not yet been launched, which makes the rwandan traditional medicine is inadequate and has to be improved. in light of the majority of morbidity and mortality records in medicine called bacterial illnesses since the majority of germs the resistance of pathogens to antibiotics has evolved. their resistance to medicines increases mortality and the length of stay in the hospital, therefore the research and the identification of this unusual tree in opposition to certain microorganisms pathogens, because to their microbiological activity, will be advantageous as suppliers of antibacterial agents. the main goal of our research on neem (*azadirachta indica*) was to determine its efficacy against certain bacteria that cause disease particularly those that cause intestinal infections and disorders like *escherichia coli* and *staphylococcus aureus*. worldwide, neem has been characterized in a variety of ways, sounding like a cure for a wide range of illnesses. it is uncommon among commonly used plants in rwanda for medicinal purposes; in fact, we chose to focus our research on this tree in order to highlight the effectiveness of neem (*azadirachta indica*), which is also a component of rwandan traditional medicine. additionally, this study advanced our scientific understanding of the antibacterial properties of therapeutic herbs. people will be aware of this tree’s efficacy if it is discovered to be particularly beneficial following this investigation, as it has been shown to be crucial in treating health issues. the fact that medicinal herbs are typically less expensive than pharmaceuticals explains why neem is used so widely over the world. when a result, when more people in rwanda become aware of it, their interest in it will grow, and even research institutes will be inspired to learn more. our study’s main goal was to find out how effective neem (*azadirachta indica*) leaf and bark extracts were against *escherichia coli* and *staphylococcus aureus* germs. conversely, our particular goals were to ascertain if neem has any antibacterial properties against *s. aureus* and *e. coli*. 7

figure 1



chemistry of neem compounds

neem contains naturally occurring chemicals called limonoids or triterpenes. neem continues to yield new discoveries of limonoids. it is commonly known that nimbin, salannin, meliantriol, and azadirachtin (naik and others, 2014). the nimbin, the bitter component, has an aldehyde, an ester, a lactone, a methoxy, and an acetoxy collective. nimbidin has sulfur in it.

bark

the bark releases a clear, brilliant amber-colored gum that accumulates in tiny rips or pieces. it has a bitter taste to it. a “margosine” alkaloid. leaves bitter principles as well. however in little amounts that are far more soluble in water. this material is the resin’s hydrate. 10% of seeds up to 31% of a bitter yellow fixed oil with a pronounced disagreeable smell bitter flavor. lauric acid makes only a small portion of the volatile fatty acids found in the bark, which are primarily stearic and oleic acids. nimbin produced from trunk bark is 0.4%, 0.001 nimbinin, and 0.04% have discovered that flowers contain a flavonoid. nimbicetin is the same as kaempferol. throughout the desiccated bark, the same harsh elements found in the seed oil and in the the fruit’s pericarp contained the bitter compound bakayanin.

oil of neem

nimbidin and 0.02% of essential oil. terpenoids tetracyclic and the stem bark has yielded its derivatives. tricyclic diterpenoids in addition to).

flowers

researchers sulfur, a very bitter, yellowish compound extracted from the alcoholic extract of neem oil, is present in 0.427% of the oil. is believed to consist of fatty acids, resins, glucosides, and alkaloids.

seeds

meliacins found in the seeds include gedunin, 7-desacetylgedunin, desace-tylnimbin and azedarachtin. the seed oil mainly contains nimbidin, nimbin and nimbinin, which also occur in the stem bark (ara et al., 1989). 8

toddy

the sap, or toddy, comprises gums, glucose, and colors are important

microscopy of neem

azadirachta indica is a tree in the mahogany family *meliaceae*, also referred to as neem, margosa, nimtree, or indian lilac. it belongs to the genus *azadirachta* and is one of the two species. although it is native to the indian subcontinent and some regions of southeast asia, it has been naturalized and is grown in tropical and subtropical regions all over the world. the oil extracted from neem leaves and fruits. hindustani term nim comes from the sanskrit word nimb

neem or mungesa is a botanical cousin of mallogany. it belongs to the family *meliaceae*. the latinized name of neem *azadirachta indica* – is derived from the persian

synonyms of *azadirachata indica*

azadirachta indica var. *minor* valetton

azadirachta indica var. *siamensis* valetton

azadirachta indica subsp. *vartakii* kothari, londhe & n.p. singh

melia azadirachta l.

melia indica (a. juss.) brandis

azadirachta indica (commonly known as neem, nimtree and indian lilac) is a tree in the mahogany family of *meliaceae*.

it grows in tropical and semi tropical regions and is widely found in burma, india and pakistan. this is a very fast growing, ever green tree which reaches the height of 15 to 20 meters.

kingdom 8 plantae

division: magnoliophyt

class : magnoliopsida

• order : sapindales 9

taxonomical classification

kingdom: plantae

subkingdom: tracheobionta

division: magnoliophyta

class: eudicot

subclass: rosidae

order: sapindales

family: meliaceae

genus: azadirachta

species: a. indicathe seeds contain gedunin and other meliacins. zedarachtin, 7-desacetylgedunin, and desacetylnimbin.the the primary components of seed oil are nimbidin, nimbin, and nimbinin, whichadditionally transpire in stembark (area et al., 1989)



macroscopic properties

morphological of bark (macroscopy)

the outer bark consists of a thick hard “woody” outer rind exfoliating in large pieces comparatively thin corky inner portion. and entire portion is fairly externally dark brown, thick with oblique fun peripheral region purplish red, mid tangentially lamellated in transvers separates into thin papery fibrous .

colour, odour and taste

bark varies much in thickness according to age and parts of tree from where it is take, external surface rough, fissured and rusty grey, laminated inner surface yellowish and foliaceous, fracture, and fibrous.

odour : characteristic

taste: bitter

macroscopy of leaf

they are imparipinnate, alternate, exstipulate, 3-6 cm long on long slender petioles; leaflets 7-17; alternate or opposite, very shortly stalked, 1-1.5 cm long.

apex : ovate-lanceolate, attenuate

base : unequal

colour: smooth and dark green

odour: typical

taste: bitter

the importance of *Azadirachta indica* (neem) as a medicinal plant

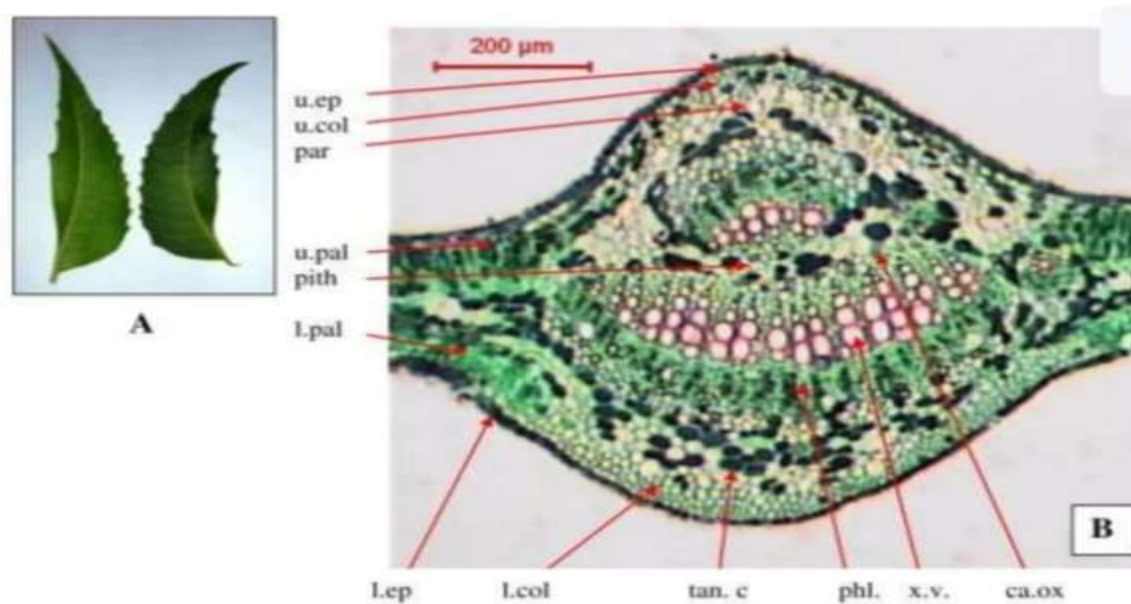


figure 2

biological activity of neem



the neem tree, or *azadirachta indica* (a. juss), is a tropical evergreen tree indigenous to the indian subcontinent (noorul aneesa, 2016). **10** millennia, neem is known for having a variety of advantageous features, such as ones used in agriculture for pest management and in conventional treatment for a number of common human illnesses when *indica* was first introduced to the world, it sparked curiosity since it could be used in farming as a non-toxic agent to manage infections. gregory d. andrews, 1992)[15]. as it happens, among the most plentiful *azadirachtin*, one of the substances in neem plants, is an growing prevalence of biopesticide (chaudhary et al., 2017;(2017) **11** pasquoto-stigliani et al.; 2021) **12**. kilani-morakchi et al. that being said, traditional indian medicine has long employed various neem tree parts for their purported antipyretic, antacid, antiparasitic, antibacterial, and antiviral properties. medication for oral health, contraception, antidermatitis, anticancer, anti-inflammatory, antioxidant, and other qualities that are both protective and therapeutic in govindachari (1992), alzohairi (2016) **13,14**. nearly all of a. *indica*'s components, including the stem, bark, roots, gum, foliage, fruits, flowers, and seeds) have being applied as home cures for medical conditions in people. in addition, twigs of neem are chewed by millions of people worldwide. teeth brushing sticks (brahmachari, 2004; gupta et al., 2017) **15,16**. the neem tree has drawn interest from contemporary researchers studying infectious diseases and medicine as a possible source in addition to the uses of a. *indica*, for novel antimicrobials in addition to the uses of a. *indica*, the neem tree has recently drawn interest from academics studying infectious diseases and modern medicine as a possible source of novel antimicrobials. within the specialties of dermatology, dentistry, cancer, and among others, endocrinology; for summaries of some of these specific subjects, refer to (patel et al., 2016; lakshmi et al., 2015; in 2021, **17** aumeeruddy and mahomoodally; iman et al.; patil the sections that follow in this review aim to give a summary of the most current research supporting the use of neem extracts and phytochemicals as antimicrobial substances. specifically, the potential for neem and products related to neem to target infections resistant to first-line antibiotics, oral health-related microorganisms, and/or may create hard-to-get rid of biofilms, fungal infections that pose a threat to food supplies and viruses that have significant highlights the effects on human health. investigate these the global demand for neem products supports areas it ranges from traditional medical procedures to an abundance of several articles showcasing a. *indica* as a plant with contemporary pharmacological characteristics in addition to the activities listed here, we would like to direct the reader to the expert review by saleem et al. (2018), **18** which covers the most recent data in favor of neem as a remedy for particular human ailments as well as the known mechanisms of action of neem components; in this review, the unique protective properties of a. *indica* and associated clinical trials are extensively reported several neem components have yielded the isolation of over 150 chemicals. the compounds fall into two main categories: isoprenoids (chatterjee and pakrashi, 1991) **19** which include triterpenoids and dipterpenoids, which contain protomeliacins, limonoids, azadirone and its derivatives, gedunin and its derivatives, vilasinin type of compounds, and c-secomeliacins like nimbin, salanin, and azadirachtin; and non-isoprenoids, which include proteins, carbohydrates, sulphurous compounds, polyphenolics like flavonoids and their glycosides, dihydrochalcone, coumarin and tannins, among other things. with multiple biological activities, *indica* contains several tetranortriterpenes, such as nimbin, nimbinin, nimbidinin, isolated compounds include nimbolide and nimbidic acid (siddiqui, 1942; schumacher et al., 2011; naik et al., 2014) **20,21,22** further, in their 2002 review, biswas et **23**, examined the biological activities several neem chemicals, their pharmacological properties, and their the clinical research, neem extracts, and potential therapeutic uses of neem and an assessment of their safety further, neem also possess compound act as anti-inflammatory, antiarthritic, antipyretic, hypoglycemic, etc. joshi, et al. 2010; saleem, et al. 2018. **24,25**. a *indica* seed kernel oil contained nimbidin, a primary crude bitter component that exhibited a number of biological actions. from this basic idea, some nimbidic acid, nimbin, nimbinin, nimbidinin, nimbolide, and other tetranortriterpenes have been isolated **26,27**. in rats, formalin-induced acute paw edema and carrageenin-induced acute paw oedema are both significantly dose-dependently anti-inflammatory properties of nimbidin and sodium nimbidate. **28,29** there have also been reports of antipyretic activity. as well as verified in **30**. nimbidin given orally had a notable hypoglycemic impact

in rabbits who were 31 noteworthy antiulcer benefit was noted in the prevention of acetylsalicylic acid, indomethacin, stress, or gastric induction caused by serotonin lesions in addition to duodenal ulcers brought on by histamine or 32,33. additionally, nimbidin can inhibit basal acid in addition to carbachol- and histamine-stimulated gastric acid and by obstructing h2, it might have antihistamine effects. receptors, functioning as an antiulcer agent in the process34. . the action of nimbidin and nimbin (1) on sperm was documented as early as 1959 in both humans and rodents (refs 35,36).nimbidin also shown antifungal action by preventing tinea rubrum30 from growing.37

antibacterial activity of neem

common uses for neem include pharmaceuticals and medicine. neem's stem and bark have strong antibacterial properties against *Serratia* species, *Klebsiella*, and *Streptococcus*.38 neem methanolic extracts are antibacterial against *Vibrio cholera*, while chloroform extracts are effective against *Escherichia coli*, *Bacillus subtilis*, *Faecalis enterococcus* and *Faecalis streptococcus*.]39neem oil extraction exhibits potent antibacterial properties against both gram positive and gram negative bacteria, including forms of *Mycobacterium tb* that are resistant to streptomycin. according to Mahmood et al. (2013), 40 is antibacterial activity in neem crude extraction when it comes to treating ear and ocular infections. methanol with petroleum ether the most effective treatment for *Candida albicans* is extract. results of this investigation included an assessment of the antibacterial activity of neem and guava samples against 21 types of food-borne pathogens. suggested that the chemicals in neem and guava extracts hold antimicrobial qualities that can be advantageous to withstand food infections and breakdown microbes.thirteen another study was conducted. evaluated to determine the fruit, bark, seed, and leaf's antibacterial properties. 41 neem (*Azadirachta indica*) extracts on microorganisms obtained from adult's mouth and experiments showed that compounds from leaves and bark had antimicrobial activity directed against every examined bacterium.42 additionally, fruit and seed extract exhibited higher concentrations of antibacterial activity. only.leaf, bark, and seed oils provide a wide spectrum of antibacterial activity against *Mycobacterium* and other gram positive and gram negative bacteria that have mechanisms resistant to streptomycin. different *tb* strains.15 "e phytoconstituents such as saponins, alkaloids, and utilized were tannins, crude glycosides, sterols, and flavonoids (figure 1). for sterile activity against *Corynebacterium* and *Escherichia coli* strains *Staphylococcus aureus* and *bovis*.16a wide spectrum of antibacterial action is exhibited by oil extracted from leaves, bark, and seeds against gram positive and gram negative bacteria that include *Mycobacterium* and streptomycin-resistant mechanisms43. different *tb* strains.15 "e phytoconstituents such as saponins, alkaloids, and in figure 1, steroids, tannins, crude glycosides, and flavonoids were utilized. for sterile activity against *Corynebacterium* and *Escherichia coli* strains *Staphylococcus aureus* and *bovis*.44when neem extracts are exposed to bacteria, their susceptibility as contrast to a specific antimicrobial. neem methanol extract has been strong antimicrobial action directed against *Bacillus subtilis* (28 mm).45, neem oil has been shown to be effective against a variety of bacteria, including *Mycobacterium tb*, *Bacillus pumilus*, *Staphylococcus aureus*, and *Pseudomonas salmonella typhi*, *Salmonella vulgaris*, *Escherichia coli*, and *Klebsiella pneumoniae* *Streptococcus salivarius*, *Enterococcus faecalis*, and *Streptococcus dysenteriae* the bacteria *Streptococcus mitis* and *Streptococcus mutans*.46 indigo *Azadirachta* the most antibacterial activity is seen in leaf extracts, which confirms the strength of bioactive chemicals and demonstrated the neem plant's use in significant upkeep of health.47khan et al. (1997) looked into the purified neem's antibacterial properties. *Azadirachta indica* bark extract was tested against *Streptococcus sobrinus*. " bark extracts, both aqueous and acetonic, were investigated on agar plates by strains of *Streptococcus sobrinus*.48asthana et al. (2006) investigated the antibacterial activity of neem bark isolates of the *Cyanobacterium fischerella* spp. neem (*Azadirachta indica*) bark extract in methanolic form starts to work against *Salmonella typhi*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Mycobacterium tuberculosis*, and *Escherichia coli*. a slightly modified version of the disk diffusion Kirby-Bauer

susceptibility method was used to measure antimicrobial activity. Neem (*azadirachta indica*) is an antibacterial agent that can be used against pathogenic bacteria found in plants, according to barua et al. (1999). Four harmful bacteria were treated with aqua-neem, which was made from neem kernels (*azadirachta indica*) (*pseudomonas fluorescens*, *aeromonas hydrophila*, *escherichia coli* and *mycobacteria* spp.) For the effectiveness of neem against all studied bacteria, including *p. fluorescens*, *a. hydrophila*, and *mycobacteria* spp. the findings indicated that it is more sensitive to aquaneem (*azadiracht*).

importance of *azadirachta indica*

indeed, a tropical evergreen tree native to the indian subcontinent, *azadirachta indica* (a. juss) is one of the most abundant substances identified within the neem tree (noorul aneesa, 2016)⁵². for thousands of years, neem has been known for its wide array of beneficial characteristics, including those in agriculture for pest control and in traditional medicine for several common human maladies. the ability of a. *indica* to act as a non-toxic infection-control agent in farming initially sparked interest around the globe (govindachari, 1992)⁵³. in fact, *azadirachtin*, one of the most prevalent substances present in neem plants, is a biopesticide that is becoming more and more popular (chaudhary et al., 2017; pasquoto-stigliani et al., 2017; kilani-morakchi et al., 2021)^{54,55}. however, due to their purported antipyretic, antacid, antiparasitic, antibacterial, antiviral, antidiabetic, contraceptive, antidermatitic, anticancer, anti-inflammatory, antioxidant, antifungal, dental, and other healing and protective properties, various parts of the neem tree have been used for millennia in traditional indian medicine (govindachari, 1992; alzohairy, 2016)^{56,57}. nearly all of a. *indica*'s parts, including the stem, bark, roots, leaves, gum, seeds, fruits, flowers, and so on, have been utilized as common home cures for ailments in people. furthermore, millions of people utilize neem twig chewing sticks for dental hygiene throughout the world (brahmachari, 2004; gupta et al., 2017)⁵⁸. in addition to a. *indica*'s applications in the fields of oncology, dentistry, dermatology, and endocrinology, among others, the neem tree has garnered attention from researchers in modern medicine and infectious disease as a potential source for new antimicrobials; for reviews on some of these specific topics, see (lakshmi et al., 2015; patel et al., 2016; aumeeruddy and mahomoodally, 2021; iman et al., 2021; patil et al., 2021; singh et al., 2021; yarmohammadi et al. 2021)^{59,60,61,62,63,64,65}. the review's following parts aim to give a summary of the most recent research supporting the use of phytochemicals and neem extracts as antibacterial agents. particularly noted are the potential uses of neem and neem-related products against pathogens resistant to first-line antibiotics, bacterial species that damage oral health and/or form hard-to-remove biofilms, fungal infections that pose a threat to food sources, and viral infections that significantly affect human health. the global interest in neem products, which dates back to ancient therapeutic traditions and a plethora of papers highlighting a. *indica* as a plant with contemporary pharmacological qualities, supports research in these disciplines. in addition to the activities we have highlighted here, we would like to direct the reader to the expert review by saleem et al. (2018), ⁶⁷ which covers the latest research on neem's efficacy in treating particular human ailments as well as the known mechanisms of action of neem components. the review goes into great detail about the unique protective properties of a. *indica* as well as related clinical trials.

conclusion

one of the greatest harmless biological sources for the creation of modern medications is neem. because neem extracts have a wide range of benefits that go beyond traditional medicinal folklore, we may now use neem extracts as modern medical adjuvants on humans, animals, and plants by knowing its potential thanks to scientific and technological advancements (gogati, s.s.). a sustainable development can investigate the economic and therapeutic applications of this “kalpavriksha” given its great significance. working to maximize the therapeutic potential of this plant to fight illnesses is necessary, given the importance of the neem tree in the field of ethnomedicinal science. the development of contemporary medications must come after in-depth studies on the pharmacotherapeutics, toxicity, mechanism of action, bioactivity, and other related features of the chemical components of neem extract. there’s still a lot of room for improvement in this subject. of this amazing plant.

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