

Recent developments in Neem (*Azadirachta indica* – A. Juss) derived antimicrobial constituents for control of human and plant diseases – a review

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ABSTRACT

Neem has immense biocontrol potential against a large number of pathogens causing various diseases in human beings and plants. The plant has maximum useful value in its leaves, bark, flowers and fruits than any other tree species. These values include antiallergic, antidermatic, antifeedent, antifungal and anti-inflammatory properties. Due to the vast activities of neem, it has become extremely valuable in making our ecosystem a green treasure. Neem leaves have been demonstrated to exhibit immuno-modulatory, anti-inflammatory, antiulcer, antimalarial properties. Neem tree plant parts contain a promising pest control substance which has found effective use against economically important agricultural pests. Neem plant products are easy to process by village level industries on the micro scale level and use by resource poor farmers in crop protection resulting thereby in income generation. This plant also has antioxidant properties and free radical scavenging potential in its different extracted solvents. The present review highlights the properties of neem against the pathogens of living organisms for environmental protection.

KEY WORDS

antiallergic, antidermatic, antifeedent, antifungal, anti-inflammatory activity, *Azadirachta indica*, bacterial pathogens, neem, secondary metabolites

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INTRODUCTION

India is known as the botanical garden of the world because it grows a large number of medicinal plants. These plants show a synergistic effect in our ecosystem and are useful for human beings [1] and plants besides being environmentally friendly. However, the responses of these plants to adverse environmental conditions result in a wide spectrum of changes in their biochemical profile resulting thereby in the production of a large number of secondary metabolites. These secondary metabolites have pharmacophoric and medicinal properties which are characterized as phenols, terpenes, alkaloids and hence have use against human and plant pathogens besides their use in many antimutagenic and anticancerous studies. This review has been written with an objective to highlight the antimicrobial constituents of neem and their use in controlling human pathogens (*Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Salmonella typhimurium*, *Bacillus pumilus*) and plants (*Pythium*, *Rhizoctonia*, *Fusarium*, *Sclerotinia*, *Dematophora*).

Neem in daily life

A. indica from as early as the Vedic times has been aptly referred to as 'Sarvaroga Nivarini' in the *Charaka Samhita*. It has held the interest of phytochemists all over the world for its rich source of alkaloids and terpenoids. Medicinal plants are used these days in different *rasayans* that have different medicinal properties against microbes causing human diseases. Neem is one of such medicinal plants and belongs to the Meliaceae family. *Azadirachta indica* is found in various regions of world like India, America and Africa. The present review article has been written to provide information related to its biological activities like antiallergic, antidermatic, antibacterial, antifungal and anti inflammatory. Neem plant parts like roots, bark, leaves, flowers, seed and fruit possess biological activities against human and plant pathogens. Girish [2] reported neem as arista – a name derived from Sanskrit which is considered the reliever of sickness hence called *Sarbaro garibarini*. Neem is also used as a spermicidal and mouth wash. Oil that is extracted from neem leaves, seed and bark has a wide spectrum of antibacterial activity against gram positive and gram negative microorganisms like *Mycobacterium tuberculosis* and some Streptomycin resistant strains. In Himachal Pradesh, the neem plant is grown in low hills. Shah et al. [3] reported that this medicinal plant has a chemical moiety which is a source of molecules that after chemical manipulation can be used as a source of drugs. Certain bacteria possess resistance to many medicines which are used to combat human

diseases and therefore neem can overcome such a resistance problem. All these products relate to a shift towards herbal sources keeping in view their use as an effective alternative to fight infectious diseases [4].

Neem in combating diseases

A. indica is indigenous to Southern Asia [5]. Neem is used as a biological compound for combating human and plant diseases. Phytochemical screening of *A. indica* was determined by the following method given by Trease and Evans [6]. The chemicals in neem were analysed and found as alkaloids, tannins, phenolics, glycosides, saponins, flavonoids, steroids, phlobatannins and triterpenes. Hugo and Russell [7] performed studies related to minimum inhibitory concentration using bacteria strains like *Pseudomonas aeruginosa*, *Klebsiella ozane*, *Staphylococcus aureus* and *Escherichia coli*. Silver et al. [8] undertook antimicrobial susceptibility testing and found in their studies that *P. aeruginosa* showed the highest zone of inhibition followed by *S. aureus* and then by *E. coli*. Neem extract contains the chemical *Azadirachtin* which is effective against pests besides a deformatory effect on viruses, mites, fungal pathogens, plant parasite nematodes, bacteria, mollusks and protozoan parasites such as coccidian species. *Azadirachtin*, which is one active ingredient of neem, is extracted from neem seed kernels. The activity of *azadirachtin* is affected by a number of factors viz., humidity, sunlight, storage, pH and method of extraction. Khan et al. [9] reported the beneficial role of neem cake when applied to soil. It releases beneficial chemicals upon decomposition and inhibits many diseases of fruit, vegetable, ornamental and spice crops. Mankau [10], Alam et al. [27], Jayarajan et al. [11] reported that the application of neem oil has been beneficial in combating fungal pathogens like *Fusarium oxysporum*, *Rhizoctonia solani* and *Macrophomina phaseolina* causing various diseases in plants as well as the tungro virus of rice seedlings [12].

Neem use in biocontrol consortium

Tripathi and Tripathi [13] reported that neem extract was found most potent in reducing virus infectivity. Neem products can be mixed with the bioproducts of some species of *Trichoderma*, *Gliocladium* and *Bacillus thuringiensis* to have an effective control of various plant diseases.

Neem against bacterial pathogens

El Mahmood et al. [14] studied the antibacterial activity of *A. indica* (neem) seed extract against the bacterial pathogens causing eye and ear infections. They

reported that there are certain plants that can be used as herbal medicine and have many therapeutic values. They tested the crude extract of *A. indica* against various bacteria like *S. aureus*, *E. coli* and *S. pyogens*. These clinical microbes were obtained from patients suffering from eye and ear infections. The agar well diffusion method was adopted and the growth of these bacteria was restricted to various degrees than the control strain which was more sensitive to the toxic effect of the corresponding bacteria. Jahan et al. [15] studied the effect of neem oil on some pathogenic bacteria like *S. aureus*, *E. coli*, *S. typhi*, *P. aeruginosa* by the agar disc diffusion method and found that *S. aureus* has a minimum zone of inhibition. Thakurta et al. [16] reported in their study on the antibacterial, antisecretory and antihemorrhagic activity of *A. indica* that was used to treat cholera and diarrhea in India. Winee et al. [17] reported on the metabolic extract and acetone extract from the leaves of *A. indica* that was screened for antibacterial activity against two bacterial strains of *E. coli* and *B. subtilis*. Irshad et al. [18] reported that neem extract in acetone possessed maximum antibacterial activity when compared with other solvent extracts. Ethanolic extracts of neem leaves were screened for antibacterial properties. Ranganathans et al. [19] performed *in vitro* studies and reported on the antidermatophytic activities of *A. indica*. Rao and Rao [20] reported on the antifungal activity of gedunin that was isolated from neem leaves. Plant et al. [21] reported on a sulfurous compound from *Azadirachta* leaves that showed antifungal activity against *Trichophyton metagrophytes*. Dua et al. [22] reported on the repellent action of neem cream against mosquitoes. Pillai and Santhakumari [23] studied the effect of nimbidin on acute and chronic gastro duodenal ulcer models in experimental animals.

CONCLUSION

Zoonotic food- and waterborne pathogens are becoming resistant to antibiotics and thus is an environmental problem. Neem therefore, is one of the most promising alternatives of the 21st century for its great use in pest management, environmental protection and medicine. Neem leaf extract increases the blood platelet and white blood cell counts which work effectively against the ZIKA virus and fortifies the immune system of a patient. There is a total reversal of gum degeneration after using neem tooth paste. Scalp condition problems respond to treatment with neem shampoo and conditioner. The antibiotic principles are the defensive mechanism of these plants against different pathogens. It has a role in anti-inflammatory, antiarthritic, antipyretic, hypoglycemic, antigasteric ulcer and antitumour activities [24]. Neem may take a role as an adjuvant to the use of antibiotics or as a replacement of current antibiotics to treat opportunistic infections which are the cause of death in HIV-infected patients.

Paddy and wheat crops with neem coated urea as a source of nitrogen have produced significantly higher yields. It improves the uptake of vitamins N, P and K. The health promoting effect of neem is due to its rich source of antioxidant. Due to chemicals like nimbin, nimbidin, nimbolide and limonoids of neem plant parts, it is of significant importance in agricultural fields and horticultural sciences [25]. Quercetin and β -sitosterol, polyphenolic flavonoids are known to have antibacterial and antifungal activities. *Staphylococcus aureus* and *Pseudomonas aeruginosa* are sensitive to neem plant extract. *Candida albicans* was inhibited more often by neem plant extract [26,27,28].

REFERENCES

- Serrone P.D., Toniolo C., Nicoletti M. Neem (*Azadirachta indica* A. Juss) oil to tackle enteropathogenic *Escherichia coli*. BioMed Research International 2015; ID 343610, 10pp. (<http://dx.doi.org/10.1155/2015/343610>).
- Girish K., Shankara B.S. Neem-A green treasure. Electron. J. Biol. 2008; 4(3): 102–111.
- Shah J.S, Shah M.B., Goswami S.S., Santani D.D. Mechanism of action of antiulcer activity of bark extract of *Manikara hexandra* against experimentally induced gastric ulcer in rats. Phcog. Mag. 2006; 2: 40–45.
- Natarajan V., Veugopal P.V., Menon T. Effect of *Azadirachta indica* (neem) on the growth pattern of dermatophytes. Indian J. Med. Microbiol. 2003; 21: 98–101.
- Akula C., Akula A., Drew R. Somatic Embryogenesis in colonial neem (*Azadirachta indica*). A. Juss. J. Microbial. Res. 2013; 3: 162–166.
- Trease G.E., Evans W.C. A Textbook of Pharmacognosy. (13th ed). Bailliere Tinnall Ltd, London. 1989; 100–101.
- Hugo S.B., Rusell A.D. Pharmaceutical Microbiology. Blackwell Scientific Publication 1983; 3: 105–125.
- Silver O.A., Cabrita P., Diniz A., Gomes B. Antimicrobial activity of *Guinea Bissau* traditional remedies. J. Ethnopharmacol. 1997; 50: 55–59.
- Khan A.M., Alam M.M., Ahmad R. Mechanism of the control of plant parasitic nematodes as a result of the application of oil cakes to the soil. Indian J. Nematol. 1974; 4: 93–96.
- Mankau R., Das S. Effect of organic materials on nematode bionomics in citrus and root-knot nematode infested field soil. Indian J. Nematol. 1974; 4: 138–151.
- Jayarajan R. Effect of neem and other plant product in the management of plant disease in India. In natural pesticides from the neem tree (*Azadirachta indica* A.Juss) and other tropical plants (Ed. Schmutter). Eschborn, GFR, Deutsche GTZ. 1987: 635–644.
- Saxena R.C., Khan Z.R., Bajet N.B. Reduction of Tungro virus transmission by *Nephotettix virescens* (Homoptera: Cicadellidae) in neem cake treated rice seedlings. J. Econ. Entomol. 1987; 80: 1079–1082.
- Tripathi R.K.P., Tripathi R.N. Reduction in bean common mosaic virus (BCMV) infectivity vis-à-vis crude leaf extract of some higher plants. Experimentia 1982; 38(3): 349.
- El-Mahmood A.M., Ogbonna O.B., Raji M. The antibacterial activity of *Azadirachta indica* (neem) seeds extract against bacterial pathogens associated with eye and ear infection. J. Med. Plants. Res. 2010; 4(14): 1414–1421.
- Jahan T., Begum Z.A., Sultana S. Effect of neem oil on some pathogenic bacteria. Bangladesh J. Pharmacol. 2007; 2: 71–72.
- Thakurta P., Bhowmik P., Mukharjee S., Hajra T.K., Patra A., Bag P.K. Antibacterial, antisecretory and antihemorrhagic activity of *Azadirachta indica* used to treat cholera and diarrhea in India. J. Ethnopharmacol. 2007; 111(3): 607–612.

17. Winee S.L., Charan A.A., Bind A. Antimicrobial activity Of methanolic and acetonc extracts of *Azadirachta indica*, *Saraca asoca* and *Curcuma longa*. Int. J. Med. Pharm. Sci. 2013; 3(2): 79–86.
18. Irshad S., Butt M., Younus H. In vitro antibacterial activity of two medicinal plants neem (*Azadirachta indica*) and peppermint. Int. R. J. Pharmaceuticals. 2011; 1(1): 9–14.
19. Ranganathan S.M., Thangam B.A.M., Raja S.M. Antidermatophytic activities of *Azadirachta indica*: an in vitro and in vivo studies. Indian J. Derm. 1996; 41(4): 113–117.
20. Rao B.S.N., Rao M.J. Antifungal activity of gedunin. Cur. Sci. 1999; 46: 714–716.
21. Plant N., Garg H.S., Madhusudanan K.P., Bhakuni D.S. Sulfurous compounds from *Azadirachta indica* leaves. Fitoterapia 1986; 57: 302–304.
22. Dua V.K., Nagpal B.N., Sharma V.R. Repellant action of neem cream against mosquitoes. Indian J. Malaria 1995; 32: 47–53.
23. Pillai N.R., Santhakumari G. Effect of nimbidin on acute and chronic gastro-duodenal ulcer models in experimental animals. Plant. Medica. 1984; 50: 143–146.
24. Paul R., Prasad M., Sah N.K. Anticancer biology of *Azadirachta indica* L (neem): a mini review. Cancer Biol. Ther. 2011; 12: 467–476.
25. Dohroo N.P., Gupta S.K. Neem in plant disease control. Agricultural Reviews. 1995; 16(3): 133–140.
26. Autade R.H., Saini S., Reddy P.G., Deorukhkar S.C. Effect of neem extract against opportunistic bacterial and fungal pathogens associated with AIDS. Int. J. Curr. Micro. App. Sci. 2015; 4(3): 988–999.
27. Alam M.M., Khan M.W., Saxena S.K. Inhibitory effect of culture filtrates of some rhizosphere fungi on okra on the mortality and larval hatch of certain plant parasitic nematodes. Indian J. Nematol. 1973; 3: 94–98.
28. De N., Ifeoma E. Antimicrobial effect of components of the bark extract of neem (*Azadirachta indica*: A. Juss). J. Technol. Dev. 2002; 8: 2328.