

## Research Article

## Neem: Treasure of Natural Phytochemicals

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**Abstract**

Neem, “the bitter gem” is one of the most valued trees with many medicinal applications. The scientific name of neem is *Azadirachta indica* and belongs to Meliaceae family. It is the world’s most studied tree in the world and most promising one in the 21<sup>st</sup> century. Every part of the tree has medicinal value, such as flowers, leaves, neem cake, fruits and seed oil. Almost 300 different phytochemicals have been found in neem tree with versatile application. The aqueous and alcoholic leaf extract of neem is accounted for to have different pharmacological activities like anti-inflammatory, hypolipidaemic, immune stimulant, hepatoprotective and hypoglycaemic impacts. Considering the pharmacological importance of neem, different studies reviewed in this chapter confirming the immense possibilities of neem for prevention and treatment of diabetes. Neem tree is a rich source of flavonoids, terpenoids, tannins, saponins, anthraquinones, sterols and alkaloids which helps in diabetes management.

**Keywords:** Neem leaf, Seed oil, Bark, Phytochemicals, Pharmacological activity

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**Introduction**

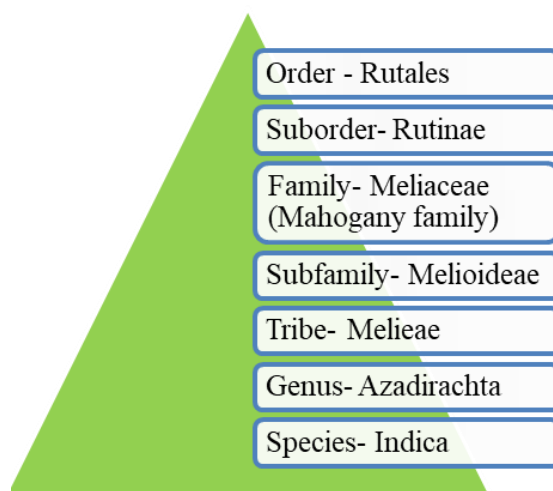
For millennia, the primary source of medicine has been the agents that are originating from natural sources especially the plant sources. *Azadirachta indica*, often known as Indian neem (Margosa tree) or Indian Lilac, is an evergreen tree that is widely planted throughout the Indian subcontinent. Since long back, Ayurveda has considered neem (*A. indica*) as a cure for many ailments, predominantly due to its superb antimicrobial activity [1]. Neem is widely utilised in ayurvedic and homoeopathic medicine, and it has become a modern medicine cynosure. The Sanskrit name for the neem tree is ‘Arishtha,’ which means ‘Reliever of Sickness.’ It is also known as ‘Sarba-roga-nibarini’. The neem tree is still referred to as a “Village Dispensary” in India. Every part of the neem tree has medical potential and can thus be profitably exploited. During the most recent fifty years, extensive advancement has been accomplished with respect to the biological and therapeutic utilizations of neem. It is now regarded as a vital source of unique natural compounds, both for the creation of drugs to treat various diseases and for the manufacture of industrial goods. The medicinal plant's therapeutic effectiveness is due to a bio-chemical ingredient that has a specific physiological effect on the human body. The bioactive isolates of the plant include: nimbin, nimbolide, azadirachtin, meliacin, gedunin, valassin, salanin etc. The bitterness of neem seed oil is created by Meliacin. Tignic acid (5-methyl-2-butanoic acid), which is derived from neem seeds, is responsible for the oil's distinctive odour [2, 3]. These substances are triterpenoids, which are natural products. The active ingredients are marginally hydrophilic, but predominantly lipophilic and soluble in organic solvents such as hydrocarbons, alcohols, and other alcohols [4]. In the on-going time, the use of medicinal plants for treating regular ailments has accepted extraordinary contemporary significance because of the increased side effects of chemical drugs. In this view, numerous studies on the biological role of certain neem components, neem extract pharmacological activities, clinical trials and plausible medical application of neem are already available [5].

**Morphology of Neem Tree**

The tree is flexible for a wide variety of climates and can flourish in sandy, stony shallow soils, as well as hard clay p an soils. Little water and plenty of daylight are needed for the tree. In a wide range of (0 – 49°C) temperatures, it can grow well. The needed pH for neem tree growth is between 4 to 10 and it is also capable of neutralising acidic soils through a specific calcium mining property [6]. Neem is most likely native to the Indian subcontinent and drier places in South Asia. Parts of Africa, the Caribbean, and other South and Central American countries have also been added. Neem tree belongs to the Meliaceae family (Figure 1). The word “*Azadirachta*” came from “azaddhirakt” in Persia, that means “Noble tree”.

## Taxonomy of Neem Tree

The taxonomy of neem tree is the **Figure 1**.



**Figure 1** Taxonomy of neem plant [7]

## Neem as a Medicinal Plant

Since the dawn of civilization, medicinal plants have been an integral part of human society's efforts to combat disease. Over 2000 years, Neem is one of the most versatile medicinal plants in India and its neighbouring countries, with a wide range of biological activity. The neem leaves, flowers, fruits, seeds, roots, and bark of the neem tree have immense therapeutic value and been used to treat inflammations, infections, fever, skin diseases, and dental problems [8]. Some of the medicinal properties of the various parts of the neem tree are listed below [9]

**Seeds:** Neem oil and cake are obtained from neem seeds. Neem oil is used as analgesic, anti-helminthic, anticholinergic, antihistaminic, antipyretic, antiviral, antiprotozoal, insecticides, bactericidal, insect repellents, fungicides and as veterinary medicines. Neem cake is used as animal feed, soil protectant, soil fertilizer and soil neutralizer.

**Leaves:** Neem leaves have antiemetic, antifungal, anticlotting agent, anti-helminthic, anti-tuberculosis, antitumor, antiseptic, antiviral, insecticides, nematocides, insect repellents activity.

**Twigs:** Twigs are used as oral deodorant, tooth cleaners, toothache reliever.

**Bark:** Neem bark has antidermatic, antiallergenic, antiprotozoal, antitumor and antifungal property.

**Flowers:** Neem flowers have analgesic and stimulant property.

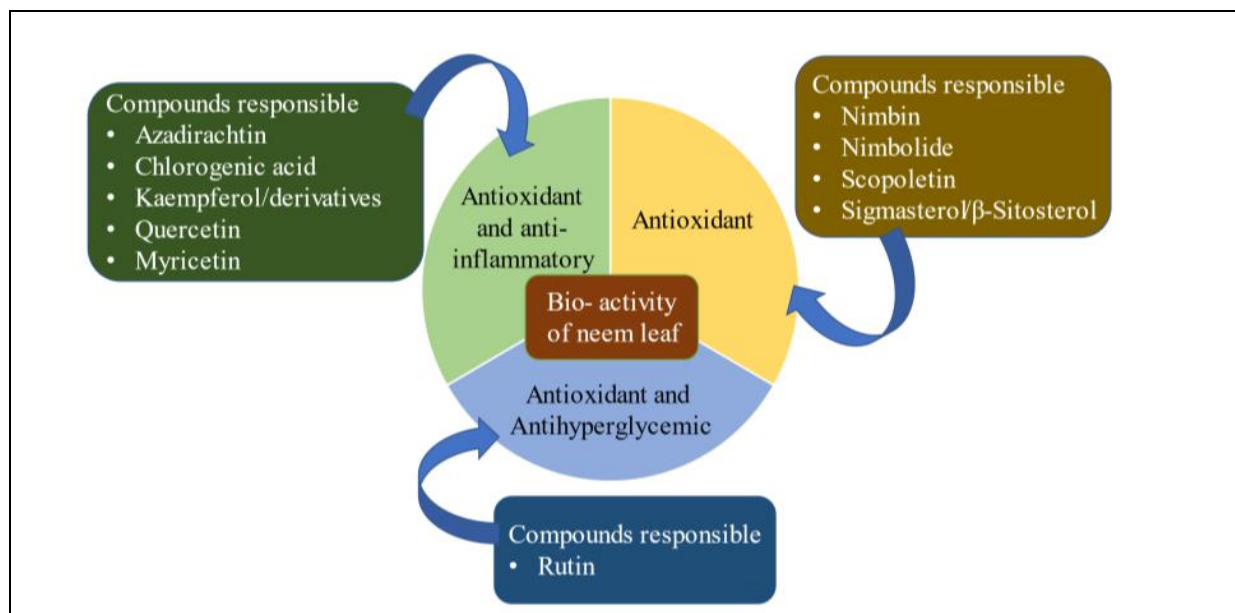
## Phytochemicals Present in Different Parts of Neem Tree

Neem can be called as the “storehouse” of a number of phytochemicals. More than 300 phytochemicals were extracted from neem tree [5, 8, 10]. The most two important classes of phytochemicals which have been isolated from various parts of neem are isoprenoids, and non-isoprenoids. Diterpenoids, vilasinins, triterpenoids, limonoids, and C-secomeliacins are the most well-known isoprenoids while the non-isoprenoids are proteins, carbohydrates (polysaccharides), sulphur compounds, tannins, polyphenolics such as flavonoids and their glycosides, dihydrochalcone, coumarin and aliphatic compounds, phenolic acids [5, 10-13].

Each part of the neem tree viz. leaves, fruit, seeds, oil, roots, bark and twigs contain large number of phytochemicals with verified antimicrobial, antiviral, antifungal, anti-inflammatory, antiplasmodial, antiseptic, antipyretic, anti-diabetic, anti-ulcer properties [14]. The neem tree can be used to extract a variety of biologically active compounds such as triterpenoids, alkaloids, flavonoids, carotenoids, phenolic compounds, steroids, and ketones. Nimbin is the first compound to be studied. Nimbolide, azadirachtin, azadiradione, gedunin, and azadirone are some of the other phytochemicals derived from neem [15]. The complex structure of the phytochemicals has made a large diversity. Azadirachtin is made up of seven isomeric chemical compounds as azadirachtin A-G. Among them, the more adequate is azadirachtin E [16]. The neem leaves are enormously used among the tribal people of India in house hold level to cure cuts, wounds and other minor dermis illnesses [17]. The triterpenoid nimbin constitute maximum biological activity which is present in neem seed oil. It has antipyretic, antiseptic, anti-inflammatory, fungicidal and antihistamine properties [15].

## Phytochemicals Present in Neem Leaves

In Ayurveda, neem is widely employed and has become a modern medical platform's cynosure. The therapeutic properties of neem leaf have been characterised more specifically than those of any other portion of the neem tree [11, 10]. The following discussion will be limited to neem leaves on pharmacological activities. Neem leaves are available throughout the year. The easy extraction of the phytochemicals has made neem as widely used ingredient in ancient as well as modern medicinal preparations. More than 200 chemicals have been identified from various aspects of neem tree, among them contribution of leaves are more than 50 compounds. New young neem leaf contains water, carbohydrate, protein, minerals, calcium, phosphorus [18]. Neem leaf is a high source of different type of amino acids and fatty acids like tyrosine, alanine, cysteine, glutamic acid, and glutamine etc. Neem leaf extracts and components have antibacterial and anticarcinogenic properties [19-21], antihyper-glycemic [22], anti-inflammatory [23], antimutagenic [11], antioxidant [24], antiulcer [25] cardioprotective [26], hepatoprotective [27] and immunomodulatory [28] properties (**Figure 2**).



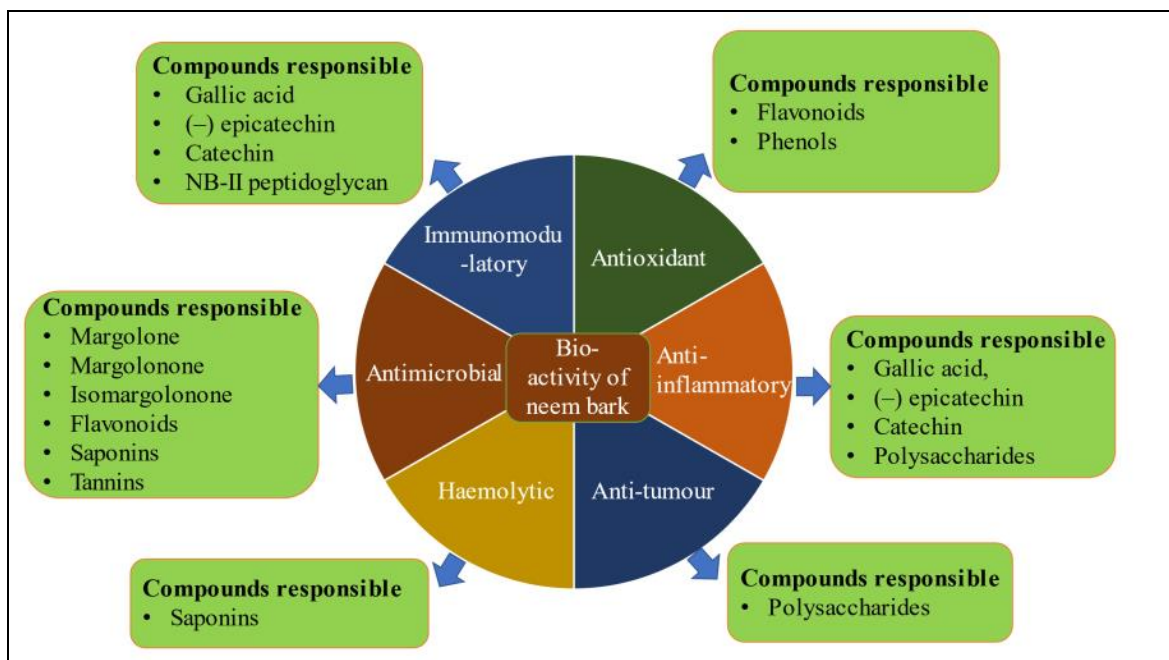
**Figure 2** Bio-activity of the compounds extracted from neem leaf [29]

## Phytochemicals Present in Neem Bark

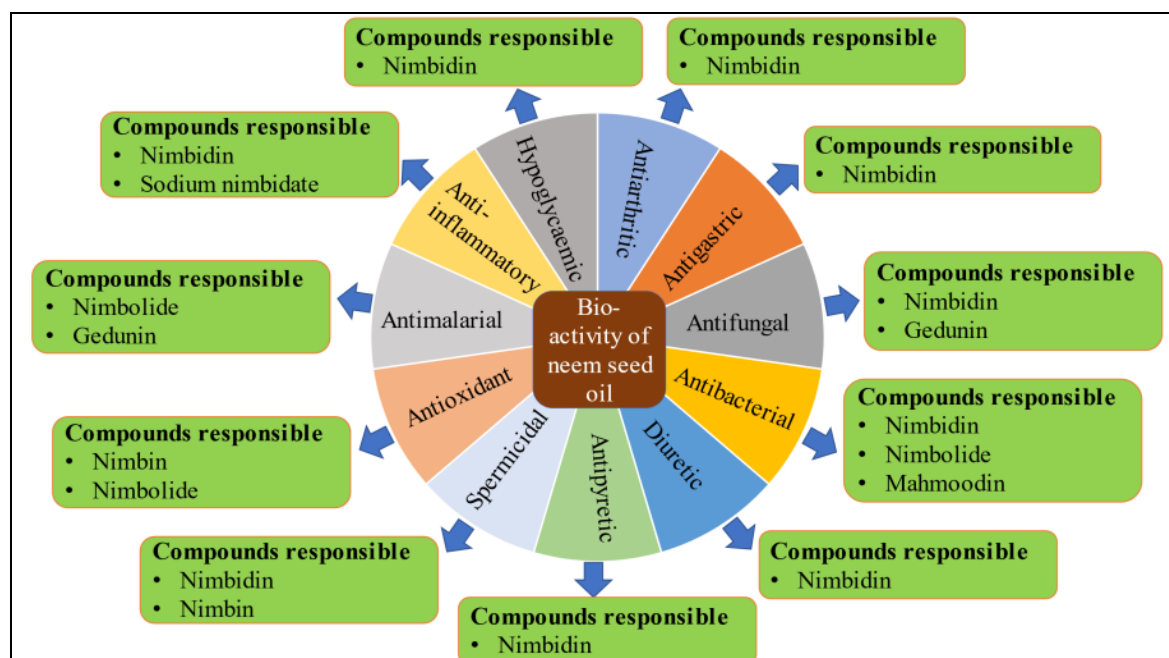
Alike neem leaves neem bark also contains a number of phytochemicals having different therapeutic value (**Figure 3**). It is very effective against many skin diseases. Neem bark is said to be cool, bitter, astringent and helpful to cough, fever, loss of appetite, worm disease, skin disorders, excessive thirst, and diabetes in literature. Gastroesophageal and gastroduodenal ulcers may be treated with neem bark extract [30]. Phenols, sterols, triterpenes, and saponins abound in the bark extract [31]. Bark also yields a number of phenolic diterpenoids, c-secomeliacins and limonoides [32, 33]. The glycosides in neem bark aqueous extract have antiulcer and antisecretory properties [34, 35]. Neem bark yields gum and tannins, which are utilised in tanning, tainting, and other processes.

## Phytochemicals Present in Neem Seed Oil

Neem seed is greenish yellow in colour having taste is Acrid and bitter. It has Repulsive (Garlic) odour. Neem oil is used as analgesic, anti-helminthic, antipyretic, antiprotozoal, anticholinergic, antihistaminic, antiviral, insect repellents, insecticides, bactericidal, fungicides and as veterinary medicines. Neem seeds are used for the preparation of neem oil and neem cake. The cake is used to feed animal, as soil fertilizer, soil neutralizer and soil protectant. Neem oil contains different phytochemicals like Nimbidin, Sodium nimbidate, nimbin, nimbolide, Mahmoodin, Gedunin etc. (**Figure 4**). Nimbin is assumed to be responsible for many of neem oil's biological functions, including fungicidal, anti-inflammatory, antihistamine, antipyretic and antiseptic effects. Azadirachtin is a tetra-substituted epoxide containing a variety of oxygen-bearing functional groups, including an enol ether, acetal, hemiacetal, tetra-substituted epoxide, and carboxylic esters [37]. The immunostimulant activity of neem oil has been proven by boosting cell-mediated immune systems selectively to increase response to future mitogenic or antigenic challenge [38].



**Figure 3** Bio-activity of the compounds extracted from neem bark [5, 36]



**Figure 4** Bio-activity of the compounds extracted from neem seed oil [5]

## Conclusion

India's one of the most prestigious tree is Neem. Since ancient times, humans have utilised different parts of this ever green and fast-growing tree such as seed, leaf, flower, bark and root to treat a variety of ailments. Modern science, now a days, has discovered molecules behind pleiotropic behaviour of neem and its constituents. Since most investigations on the action of neem are based on preclinical data, only a few studies have proved its therapeutic value. Since ancient times, humans have employed various components of the plant, including flower, leaf, bark, and seed, to treat a variety of diseases. As the era shifts toward the use of nontoxic plant products with traditional therapeutic uses, the development of modern neem medications for the treatment of various ailments should be prioritised. The molecular foundation of the pleiotropic activities of neem and its components has been unveiled in modern science. However, the majority of neem's activities are based on pre-clinical findings; few studies have shown its clinical value. The prevention and treatment of various diseases over the harmful side effect of chemical drugs has been increasingly being considered in medicinal plants and phytochemicals. This pharmacological study is a useful tool for the development of neem medicines in recent years.

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