



Biochemical Properties of Neem (*Azadirachta indica*) and Its Use by the Tribals of Northern West Bengal: A Brief Review

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Abstract:

There are still many primitive societies scattered in different parts of India. They largely depend on their traditional knowledge-based skills and practises. Based on this knowledge, tribal communities try to exploit different kinds of natural resources in their neighbouring areas. It is in such cases that their dependence on ethnomedicinal treatments is maximum. The north of West Bengal is rich in environmental resources. Several tribal communities have lived there for a long time and rely heavily on traditional resources to cope with various disease situations. Neem is a very important local herbal resource in these areas that has strong ethnomedicinal properties. The local tribal communities in northern West Bengal show their absolute dependence on neem and neem-based products to treat various diseases and health problems. Although their traditional ethnomedicinal knowledge and practises have changed very slowly over time, this may be due to the influence of various external and internal forces. A wide range of literature is helpful in gaining in-depth knowledge on this topic. In the present paper, an attempt has been made to ascertain the ethnomedicinal significance of neem among the local tribal communities in northern West Bengal based on the available literature sources as well as direct field experiences. Various secondary literature sources were used. At the same time, some field methods like interviews, direct observation and FGDs with due importance were also used.

Keywords: Neem, Ethnomedicinal practises, Tribals, Northern West Bengal

Introduction:

Every community has its history and heritage in terms of its status in life, process of daily livelihood, socio-cultural characteristics and several traditional practises. Mostly, it is observed that these communities use the ecological resources of the environment to meet their daily needs [1,2,3,4]. With regard to health and disease, most indigenous peoples use their traditional knowledge and apply different types of folk medicine. For this purpose, they have taken various ethnomedicinal substances [5]. All this is closely linked to the ethnobotanical knowledge system of the different societies [6]. Based on this knowledge, the tribal communities try to use different types of natural resources available in the neighbouring areas. Although their traditional knowledge and practises have changed over time in a very slow and continuous process, this is perhaps the ultimate result of

globalization, modernization and some other processes. According to the World Health Organisation (WHO), more than 80 percent of indigenous people in developing countries rely mainly on traditional medicine for primary health care. A large proportion of them use medicinal plants [7].

India is a very large country and known for its rich ethnic diversity, where many indigenous cultures have preserved their traditional knowledge of the medicinal benefits of indigenous flora. Northern India is known for its great diversity, especially in terms of traditional knowledge systems and practises, which is supported by the great intra-ethnic diversity [8]. People living in villages and remote areas are completely dependent on forest resources for their daily needs of medicines, food, fuel and household items. The Darjeeling Himalaya also has rich ethnomedicinal traditions for which number of literatures exists [9]. Due to geographical and environmental obstacles and lack of infrastructural and modern medical facilities, people in the foothills of the Darjeeling Himalaya rely much more on their traditional medical practises and the use of their local ethnomedicinal resources. The medicinal value of neem is mentioned in various ancient religious books, epics and documents. Numerous religious documents such as Veda, Bible, Quran etc. also supported the herbs' role in health care and prevention [10, 11].

In modern times, this is a very popular subject and object of study, especially to give more importance to the traditional medical systems of different castes and communities, especially indigenous communities. For this reason, ethnobotanical research is deeply rooted in India. There are many examples of ethnobotanical surveys of medicines conducted in India in the past, which recorded numerous ethnobotanical remedies of many indigenous groups: Malasars [12]; Malamalasars [13]; Malayalis [14]; Irulas [15]; Gonds [16]; Konda Reddish, Valmiki, Konda Doras, Koyas, Chenchus, Lambadis, Jatapus, Savaras, Bagatas, Kammaras, Khondas (Samantas), Nuka Doras (Muka Doras), Porjas (Gadabas), Jatapus, [17, 18]; Paliyar [19]; Kanikkar [20]; Todas, Kotas [21]; Kattunayakas [22]; Apatani [23]; Chellipale [24].

Objectives of the Study:

In the present paper, an attempt has been made to ascertain the ethnomedicinal importance of neem (*Azadirachta indica*) among the local tribal communities of northern West Bengal based on the available literature sources as well as direct field experiences.

Methodology:

The present study deals with the ethnomedicinal uses and practises of neem tree among the different tribal groups in northern West Bengal. It is based on the various literature sources and the personal experiences of the authors during several field visits to the area in the last decade. Google, PubMed, Science Direct, Scopus and Google Scholar databases were used to search for information from journal articles and related books.

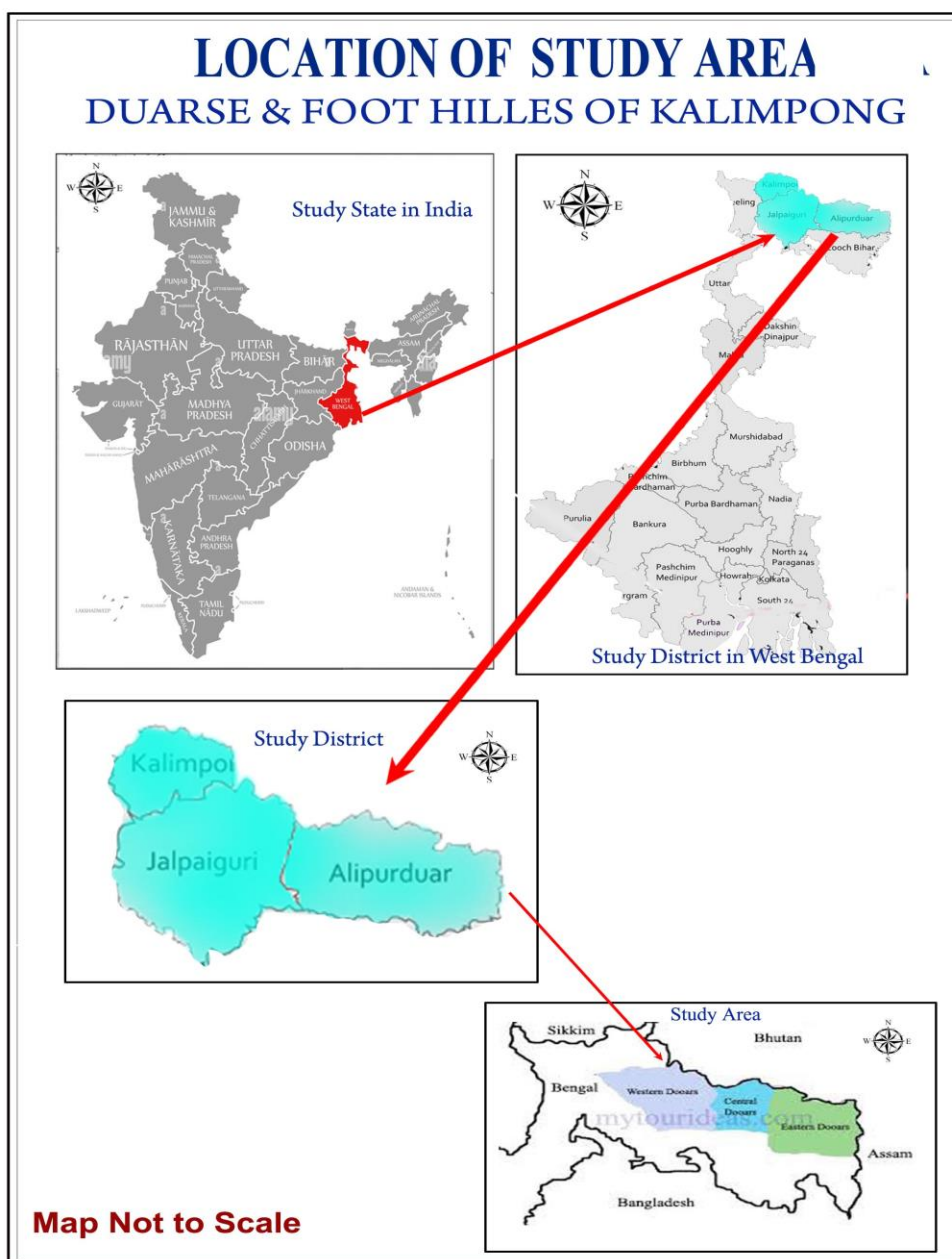
Study Areas and Study Community:

The use of neem (*Azadirachta indica*) by indigenous peoples in North Bengal has a very long tradition. Traditionally, neem (*Azadirachta indica*) has been a very useful tree for all tribal communities in the Dooars region of northern West Bengal. Most of these tribal communities live in the forested areas of the Dooars and the foothills of the Himalayan region in northern West Bengal. Therefore, the neem tree (*Azadirachta indica*) is present in sufficient numbers in these areas. The authors have conducted numerous field studies on the tribal population in northern West Bengal, particularly in Alipurduar, Jalpaiguri and Kalimpong districts. Among

these tribal groups, the Rabha, Toto, Mech, Lepcha, Bhutia, Munda and Korwa deserve special mention.

The authors conducted intensive fieldwork at various times, particularly among the matrilineal Garo tribe of Garambosti village in Alipurduar district, the Munda, Korwa, Oraons and other tribal communities, living in the forest areas of the Garumara Tiger Reserve near the Lataguri region in Alipurduar district. They also conducted fieldwork among the Rabha and Mech matrilineal tribal communities at Malbazar in Jalpaiguri district, and among the Lepcha and Bhutia communities at Lolegaon in Kalimpong district.

Study Areas:



(Location of study areas in West Bengal and India)

Methods Used:

Both primary and secondary data sources were used for this study. Great importance was given to the various secondary data sources. Numerous published articles in various journals, books, reports, gazettes, monographs, maps and locally available text documents were used as secondary data sources. The authors also drew on their previous experience with the subject, gained from numerous fieldwork activities in this region in different communities. Thus, structured and unstructured personal and group interviews, FGDs, direct observations and photographic methods were used to collect data. The present study is the final outcome of the findings and experiences collected during the fieldwork conducted earlier with the tribals in the study areas. Numerous secondary literature sources were consulted for the analysis of the chemical constituents of neem. However, in describing the traditional use of neem in the tribal communities, due importance is given to the first-hand experiences and data collected in the fields.

Taxonomic position of *Azadirachta indica* (Neem).

Kingdom: Plants (Plantae)

Order: Rurales

Suborder: Rutinae

Family: Meliaceae

Subfamily: Melioideae

Tribe: Melieae

Genus: *Azadirachta*

Species: *indica*

Taxonomic position of neem [25]

Neem Available Zones:

India still has about 20-25 million neem trees scattered all over the country, though the density of the tree is not the same everywhere. Almost 60 percent of all neem trees in the world are available only in India. The highest concentration of trees (56%) is in Uttar Pradesh, moreover 15% of trees are scattered in Tamil Nadu and Karnataka (6%) is in third position [26, 27]. In West Bengal, the concentration of neem trees is quite high, especially in the densely forested areas of North Bengal. Most tribals of North Bengal live in the foothills of the Himalayas and in the Dooars region. In these areas, neem trees are present in large numbers as most of these areas are in jungle. The local tribal communities use these plants for their daily livelihood and other purposes.

Important Chemical Constituents of Neem:

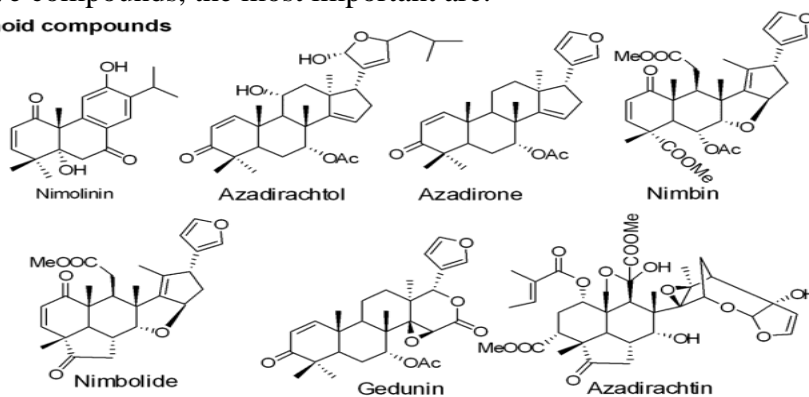
Sl. No.	Name of compound extract of neem	Symbol
1	Ascorbic acid	(C ₆ H ₈ O ₆)
2	Chlorogenic acid	(C ₁₆ H ₄₄ O ₁₆)
3	Kaempferol	(C ₁₅ H ₁₀ O ₆)
4	Kaempferol-3-o-rutinoside	(C ₂₇ H ₃₀ O ₁₅)
5	Myricetin	(C ₁₅ H ₁₀ O ₈)
6	Nimbafalavone	(C ₂₆ H ₃₀ O ₅)
7	Nimbandiol	(C ₂₆ H ₃₂ O ₇)
8	Nimbin	(C ₃₀ H ₃₆ O ₉)
9	Nimbin,6-deacetyl	(C ₂₈ H ₃₄ O ₈)

10	Nimbinene	(C ₂₈ H ₃₄ O ₇)
11	Nimbocinolide	(C ₃₂ H ₄₂ O ₁₀)
12	Nimocinol	(C ₂₈ H ₃₆ O ₅)
13	Nimocinolide	(C ₂₈ H ₃₆ O ₇)
14	Quercetin	(C ₁₅ H ₁₀ O ₇)
15	Rutin	(C ₂₇ H ₃₀ O ₁₆)
16	Scopoletin	(C ₁₀ H ₈ O ₄)
17	Stigmasterol	(C ₂₉ H ₄₈ O)
18	Valasinin	(C ₂₆ H ₃₆ O ₅)
19	Zafaral	(C ₂₉ H ₄₀ O ₆)

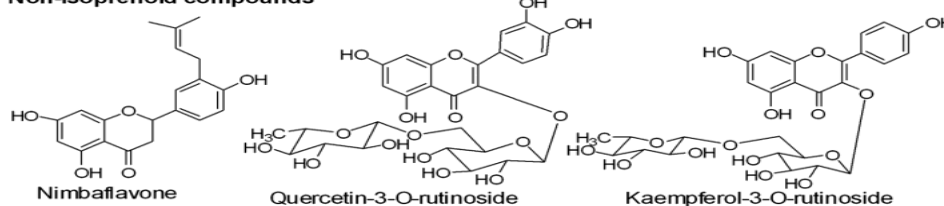
Through various researches, it has already been found that neem contains many phytochemicals. These biochemical compounds are mainly extracted from leaves, stems, fruits, flowers, roots and barks. To date, more than sixty compounds have been isolated [26, 27, 28, 29, 30, 31]. The tribals collect all these materials at different times of the year to use them for different purposes, although they have little scientific knowledge about the biochemical compounds available. They did not know the names of the specific compounds. But they know very well which part of the neem tree is used, in what quantity and how. All these tribal groups like Rabha, Toto, Mech, Lepcha, Bhutia, Munda and Korwa show the same trend. Among these bio-chemical compounds, more than thirty compounds play a very important biological role [32].

Among the above compounds, the most important are:

Isoprenoid compounds



Non-isoprenoid compounds



Miscellaneous compounds

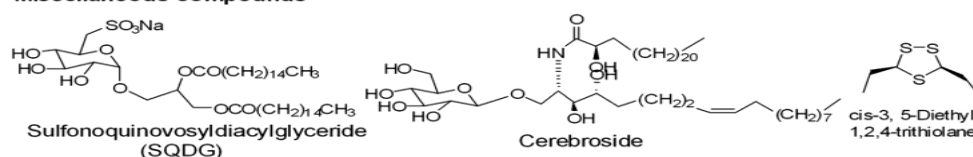


Fig. — The main chemical compounds of the neem leaf. [33]

Existence of different bio-chemical substances in tribal ethnomedicinal resources: [34]

Presence of Bio-Chemical substances	Prominent ethnomedicinal sources of neem tree as used by the Indian tribals and other communities
7-alpha-acetoxy-4,4,8-trimethyl-5-alpha-(13-alpha-Me)oxandrosta-1,14-dien-3,16-diol	Use of a coating of ripe fruits and seeds of neem
Azadirachtin	Juice or extract of neem seeds made using indigenous technology
Azadiradione	Homemade neem oil using indigenous knowledge and technology
Azadirinine	Juice and materials made indigenously from the bark of old neem tree roots
Azadirol	Use of a coating made from ripe neem fruits and seeds
Deacetylnimbin	Homemade neem oil using indigenous knowledge and technology
6,8-Dimethoxy-7-hydroxycoumarin	Frequent use of uncrushed twigs
Dimethylnimbinol	Juice made from the bark of an old neem tree boot
Di-tri and tetrasulphide with n-propyl disulphide	An oil produced from neem seeds using indigenous knowledge and technology
Docosane	Raw materials or by-products obtained from growing or mature neem leaves
Docosene	Use of the fruit coat and other materials of the neem tree
Dotriacontane	Raw materials or by-products obtained from growing or mature neem leaves
17-Epinimbinol	Homemade neem oil using indigenous knowledge and technology
Gedunin	Homemade neem oil utilizing indigenous knowledge and technology
Hentriacontane	Both newly growing and matured leaves depend on seasonal availability
17, Hydroxyazadiradione	Homemade neem oil using indigenous knowledge and technology
Icosane	Mainly from the fruit coat
Kulactone	Available from ripe fruits or seeds of neem
Limocin A	Use of a coating made from ripe fruits and seeds of neem
Mahmoodin	Homemade neem oil according to indigenous knowledge and technology
Margocilin	Juice and substances produced indigenously from the bark of old neem tree roots
Margolone	Juice prepared from the bark of old neem tree stem
Margolonone	Juice prepared from the bark of old neem tree stem
Meliantriol	Juice or extract produced from neem seeds using indigenous technology
Methyl grevillate	Juice or extract of neem seeds prepared by indigenous technology
Nimbanal	Juice or extract of neem seeds prepared using indigenous technology
Nimbidiol	Juice and materials prepared from the bark of old neem tree roots using indigenous technology
Nimbinol	Juice prepared from the bark of old neem tree stem
Nimbinolide	Raw materials or by-products obtained from growing or mature neem leaves
Nimbinolcin	Juice and materials prepared from the bark of old neem tree roots using indigenous technology
Nimbolin	Use of stem, wood and branches
Nimbolone	Juice obtained from the bark of old neem tree trunks
Nonacosane	Both newly growing and mature leaves available at different times of the year
Pentacosane	Both newly growing and mature leaves available at different times of the year
Salanin	Juice or extract of neem seeds prepared using indigenous technology
Salannol-3-acetate	Juice or extract of neem seeds prepared using indigenous technology
Triacontane	Both newly growing and matured leaves

Neem Leaf Extracts (Nles) in the Treatment of Diseases

Anti-cancer effect

Neem has very good protective properties against cancer. Neem leaf extracts have anti-cancer and anti-tumour activity [35, 36, 37]. NLEs contain various biochemical compounds such as nimbin, azadirachtin, nimbindiol, nimbatikam, nimbidin and some other substances that have anticancer activity [38]. Extracts of neem leaves, especially quercetin, may help to protect the human body from leukaemia, especially by reacting with cancer cells such as U-937, K-562, Jurkat, etc. [39].

Antimalarial activity:

Extracts of neem bark and neem leaves have good properties in preventing malaria. They control Plasmodium yoelli nigeriensis, one of the vectors of malaria. The use of bark or leaf paste at a concentration of 800 mg/kg has a better effect than chloroquine at a concentration of 62.5 mg/kg [38].

Anti-ulcer effect

Several neem products have an anti-ulcer function. Extracts of neem leaves prevent the breakdown of mucus and cell degranulation is one of the possible mechanisms [40]. The protective property of neem dry bark extracts, especially mercapto-methylimidazole, CRU, indomethacin, generally promotes ulcers. Neem bark extract reduced excessive gastric acid secretion in humans, which ultimately helps prevent gastric and duodenal ulcers [38].

Antidiabetic activity

The common people, especially the indigenous people of India, have been using these substances for a long time. In India, a large number of people are currently suffering from diabetic problems. About 40 million people suffer from various types of diabetes malitus [41]. This number is expected to increase to 70 million by 2025 [42]. The neem tree has several important antibiotic properties. In West Bengal, based on various observations and surveys, it was found that the tribal population is highly dependent on neem trees and neem-containing substances. The extracts prepared from neem leaves are generally used to control blood sugar levels. At the same time, they help to reduce high glucose levels in the blood [43]. More than 30 per cent of the tribals in the studied areas depended on neem leaf extracts to control their sugar levels. Recently, the hyperglycemic property of neem has been demonstrated [40].

Antioxidant activity:

It is a fact that reactive oxygen can sometimes cause various types of diseases and ailments in human population. If free radicals or reactive oxygen can be neutralised, most diseases can be controlled with minimal effort [44]. In general, antioxidants neutralise free oxygen radicals before they hit biological targets in cells. In this way, they control the entire process. Several studies show that numerous medicinal plants of our country have antioxidant properties [45].

Neem is a locally available plant in northern West Bengal that has very good antioxidant capacity. From the field data, it is found that in almost all the studied areas, the tribals, especially the Rabha, Mech, Lepcha, Bhutia, Migrant Munda, Garo and some other communities, regularly use leaves, barks, stems, twigs, roots, fruits and flowers of neem tree for medicinal purposes. Although most tribals in the area know little about it, as neem is a very good source of antioxidants. They use various materials or products made from neem as

their common cultural heritage. Brinze neem fry and neem *sukto* (a curry made from brinze, green bananas, drumsticks and some young neem leaves) are popular curries that everyone likes to include in their lunch. The general phenomenon in the study areas is that the local tribals try to consume at least one neem material as a regular food or otherwise, especially in summer, spring and winter. There is a common taboo in almost all the tribal study communities to eat young neem leaves and red lentil paste on every chaitra sankranti early morning (the day before Bengali new year) as anti poisonous and anti infectious materials.

Based on the earlier study, it was found that the antioxidant capacity of neem leaf extract can be determined by maintaining the following procedures: Chloroform >butanol > ethyl acetate extract > hexane extract > methanol extract. The results of the various studies suggest that the chloroform crude extracts of neem could be used as a natural antioxidant [26].

Antimicrobial activity

Neem trees and various neem by-products play an important role in protecting against various types of microbial infections. Tribal people used neem materials (such as leaves, barks, twigs, fruits, roots, stems, etc.), and the tree extracts have a preventive effect against microbial growth. Indigenous peoples generally used neem leaves and turmeric paste as ethnomedicinal remedies against fungi. They used them especially for skin problems [3]. Neem products have various antifungal properties [46, 47], which have been studied for their antifungal activity. The raw materials extracted from neem can be used to protect fungal pathogens from any human disease [48].

Neem leaf extracts or some neem products like twigs help to reduce bacterial infections in the mouth. This neem leaf extract has special properties to protect human body from *Enterococcus faecalis*. Most tribals regularly use neem sticks to brush and clean their teeth. Neem extracts or materials are also very effective against various bacteria, especially *Fusobacterium nucleatum*, *Streptococcus mutans* etc. [49] Neem leaf extracts are very effective against viruses such as Cocksackie virus, B-4 virus, etc. The extract mainly inactivates the virus and tries to stop the replication process [50]. Neem bark extract tries to prevent the HSV-1 virus from entering the human body [51].

Mechanisms Anti-inflammatory effect of neem leaves:

Neem leaf extract is generally used to produce anti-inflammatory substances [52, 53]. In different study, the anti-inflammatory properties of neem leaf extracts were observed orally at different doses.

Popular uses of neem:

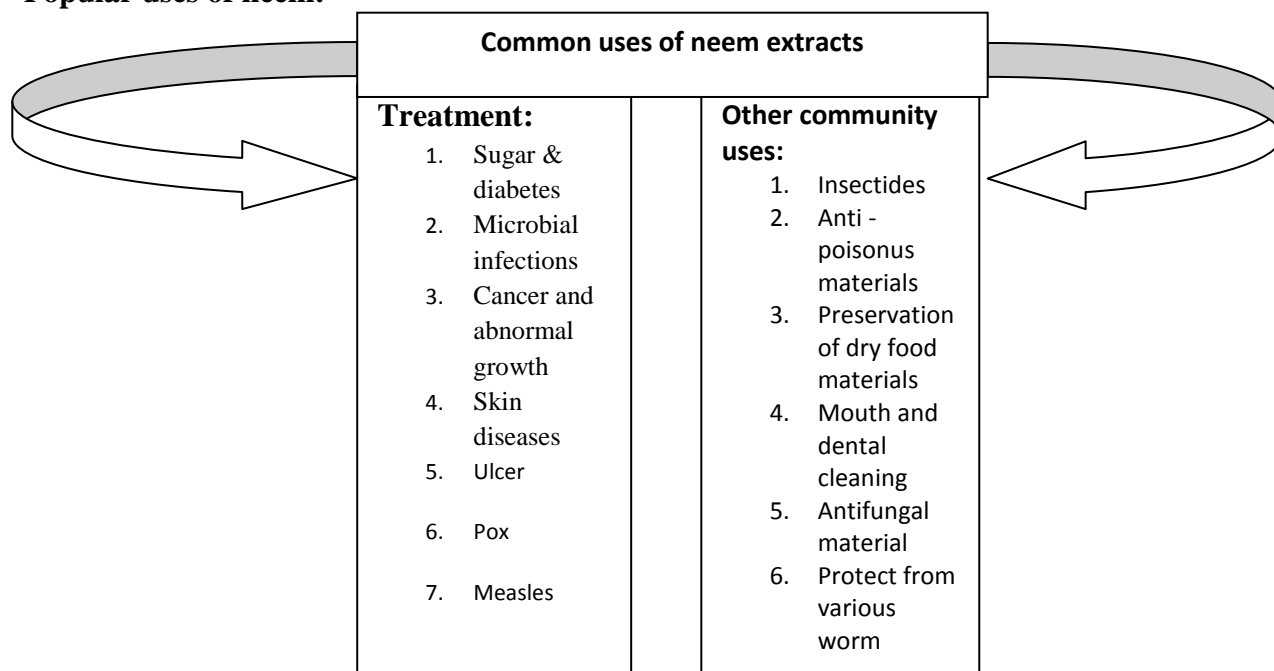


Fig. 4 - Health benefits and general use of neem leaves [33]

Medicinal uses:

Species (Local name)	Parts used	Treatment	Procedures	Important studies
<i>Azadirachta indica</i> A. Juss LC (neem)	leaf, stem & seed	Boils, wounds, fever, stomach, hyperacidity, toothache, blood sugar, high blood pressure, inflammation, skin diseases, leprosy, intestinal worms, snake bite, scorpion sting,	Chewing sticks, leaf paste applied to the affected area, stem juice for blood sugar and leaf ash rubbed on the scars around the snake bite. Some community used root paste along with that of neem, black pepper seeds are made into a paste and the extract is administered orally soon after a snake bite, scorpion sting. However they frequently used bark paste or leaf paste used to treat fever, blood pressure. Leaf juice regularly used in empty stomach for controlling	⁵⁴ Ghosh et al.,2013 ; ⁵⁵ Mitra and Mukherjee, 2012; Mitra and Mukherjee, 2009; ⁵⁶ Bose et al., 2015; Sinhababu and Banerjee, 2013 ⁵⁸ Saha et al., 2018 ³ Samanta, 2016

			blood sugar. Some times they used young neem leaves and turmeric paste for skin disease, rash, scabies treatment.	
<i>Melia azedarach</i> L. LC (Mahaneem)	Young stem	Anti-malarial, anti-fungal, insecticidal and anti-feedant activities	Young stem used for chewing stick. Powder root is used in a dose 1-2 gm per day. Seed extracts also used for medicinal purpose.	⁵⁹ Biswas and Das, 2012
<i>Melia sempervirens</i> Sw (Mahaneem)	Bark	Used as insecticides for stored food grains.	Fresh bark infusion used. Leaves are used as insecticides.	⁶⁰ Mitra and Mukherjee, 2010

(Sources: Field information and literature sources)

Conclusion:

Based on the literature and direct field experiences, it can be concluded that neem is one of the most important ethnomedicinal substances for tribal people of northern West Bengal. Due to various geographical and environmental barriers and a lack of infrastructural and modern medical facilities, people in the foothills of the Darjeeling Himalayas and in the Doars region rely much more on their traditional medicinal practises. They often use their local ethnomedicinal resources as the remedy of first choice for all diseases and health problems. Various studies have shown that neem already contains many secondary plant compounds. These biochemical compounds are mainly found in leaves, stems, fruits, flowers, roots and barks. The tribals collect all these neem materials at different times of the year to use them for different purposes. However, they know little about the biochemical compounds present in the neem materials used, nor do they know the names of the specific compounds. They are also not aware of the specific functions of these compounds. However, they have experience of the effects of using these substances. They know very well which part of the neem tree is used in what quantity and how for what purpose. All these local tribal groups like Rabha, Toto, Mech, Lepcha, Bhutia, Munda and Korwa show the same trend. Among these biochemical compounds, more than thirty compounds play a very important biological role. Generally, these tribal peoples use neem for its antimicrobial, antioxidant, antidiabetic, anticancer, antifungal and other effects. Most commonly, neem is used by the tribal peoples of this region to protect or treat chicken pox, sore throat, skin rashes, scabies, hair loss, ulcers, diabetes, microbial and fungal infections, anti poisonous materials etc. Although their traditional ethnomedicinal knowledge and practises have changed very slowly over time, this may be due to the rise in education levels, increase in awareness, development of infrastructural facilities, administrative efforts etc. At the same time, the effects of globalization, modernisation and some other forces have significant impact in this regard.

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