Neem : A Great Boon to Mankind

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The Latin name of Neem is *Azadirachta indica* to Juss (syn: *Melia indica* Brandis, Melia *azdirachta* Linn & *Melia parviflora* Moon) and the species belongs to the family Meliaceae. Well known since ancient times in the Indian subcontinent, neem has several common names in different languages.

Language	Name
Assamese	Nim
Bengali	Nim
English	Neem, Margosa tree, Indian lilac
Hindi	Nim, Nimb
Sanskrit	Arishta, Nimb,
Urdia	Neem
French	Azadirach de l'Inde, Margosier
German	Grossblacttiger zedrach

Distribution:

Neem is believed to be a native of upper Burma and possibly to the Siwalic decan and other parts of South India. The commercial use of neem was known from the Vedic period in India over 4000 yrs B.C. and the domestic uses have been mentioned by Kautilya in his Arthasastra(4^{th} century B.C.).

Presently neem is widely cultivated in Arid, semi-arid, wet-tropical, tropical and sub-tropical regions of the Indian subcontinent.

Climate & soil for growth:

Neem thrives successfully on dry, stony, clayey and shallow soils. The optimum pH needed for optimum growth is 6.2. In pH 5 (acidic soils), it also thrives. Neem can also flourish on calcareous soil with pH 8.5. It can survive 0 degree -49 degree centigrade and can't survive frost.

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Bitterness:

Neem is known for its bitterness. Almost every part of neem has a sharp pungent taste. However there are of non-bitter neem trees.

Chemistry:

Neem elaborate a vast array of biologically active compounds which are chemically diverse and structurally complex.

Neem chemistry dates back to 1880-90 when influenced by its folk-lore medicinal values, the chemist took up the isolation of active principle from its seed and other parts. Siddiqui was the first to report the isolation of three products viz. nimbin, nimbidin and nimbinin from its oil.

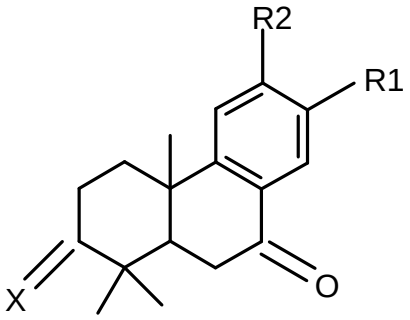
Development since 1960 have been breath-taking essentially because of the induction of modern methods of separation and structure elucidation.

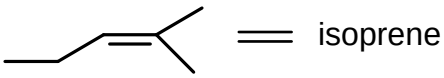
The neem constituent belonging to chemically diverse classes have been divided into two major sections viz. I) Isoprenoids & II) Non-Isoprinoids. The later category comprises glycerides, polysaccharides, sulphurones compounds, flavonoids and their glycosides, amino acids, aliphatic compounds etc.

I) ISOPRENOIDS:

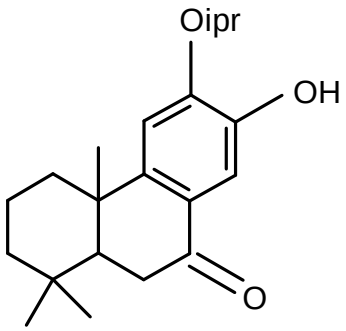
i) Diterpenoids : 24 compounds of this class have been isolated from root and stem bark of neem. These chiefly belongs to two groups – **podocarpanoids** and **abietanoids**.

In early ’60, **sugiol** and **nimbiol** were reported first time. Structures of few compounds are given below-





	R1	R2	X	
sugiol	Me	OH	H,H	**(1)**
nimbiol	ipr	OH	H,H	**(2)**
margocin	ipr	H	O	**(3)**



margosone (4)

ii) Triterpenoids :

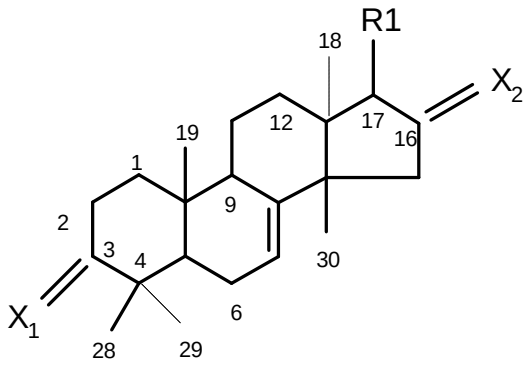
The bitterness of neem is due to the occurrence of **limonoids** which are the **tetranortripenoids** based on apo-euphal skeleton. The term limonoid is derived from limonin , the first tetranortripenoid obtained from citrus bitter principle in 1841;the structure of which could be established only 1960. out of 300 limonoids known today about 1/3 is accounted by neem(*Azadirachta indica*) and chinaberry (*Melia azedarach*) alone.

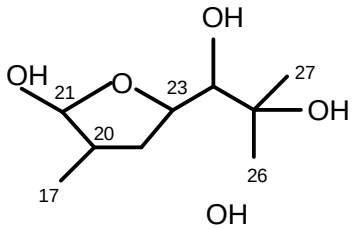
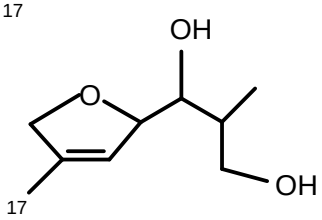
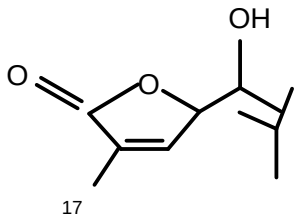
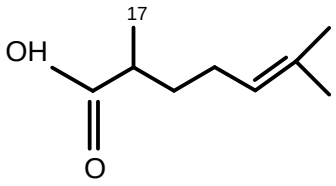
Neem bitter principle can be conveniently classified under 8 groups: Protomeliacins , limonoids with a modified side chain, azadirone and its derivative , gedunin and its derivatives , vilasinin type compounds, C -secomeliacins – nimbin , salanin and azadirachtin.

iii) Protomeliacins :

The triterpenes containing C_8 side chains C- 17 are supposed to be bio-genetic precursors of limonoids and hence known as protolimonoids or protomeliacins.

Meliantriol was the first triterpenyl alcohol , isolated from both neem oil and fresh fruits of *Melia azedarach* and shown to exhibit marked feeding inhibition against Desert locusts. The structure was well established and confirmed by its synthesis from **melianone .**

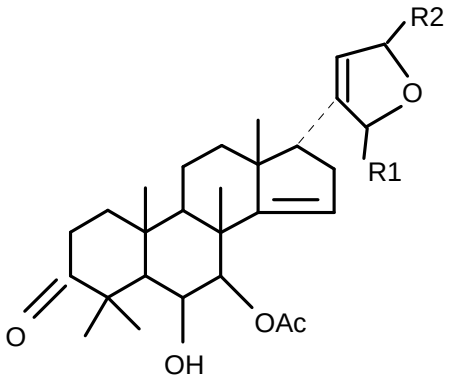


		X_1	X_2	R1
5	Meliantriol	OH,H	H,H	
6	Nimbocinone	O	H,H	
7	Nimolinone	O	H,H	
8	Kulactone	O	H,H	

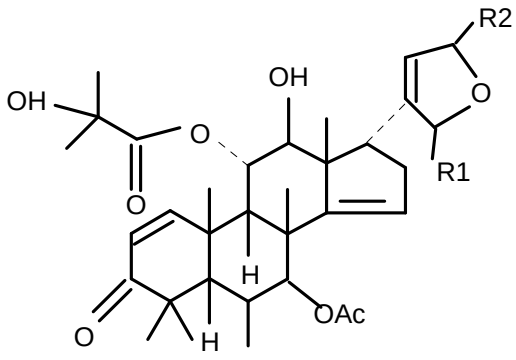
Siddiqui and his co-workers have added other protomeliacins **nimbocinone** (6), **nimolinone**(7) and **kulactone**(8) etc. **Nimbocinone** has been isolated from neem leaves while most of the other constituents from fruit coats and whole fruits.

iv) Limonoids with intact four rings and γ-hydroxybutenolide side chain :

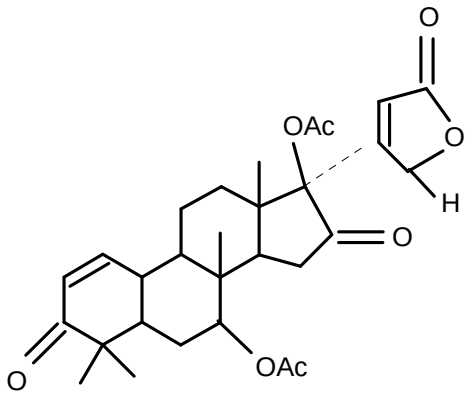
The presence of a γ-hydroxybutenolide side chain in place of the furan ring is the characteristics of this group of compound. Two isomeric constituents, nimocinolides(9 & 10),isonimocinolide(11&12) have been isolated from neem leaves where as isonimolicinolide (13) from fresh fruits. Nimocinolides showed mild insect growth regulating properties.



9 ’10



11’ 12

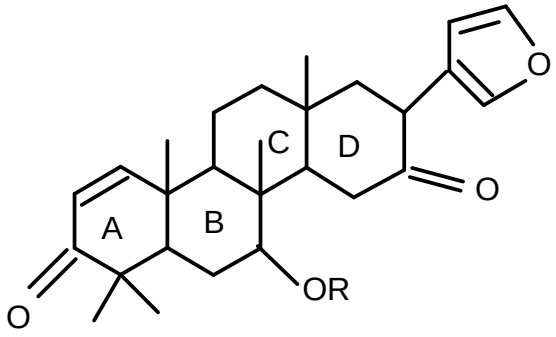


13

	R1	R2	
9	O	OH,H	**11**
10	H,OH	O	**12**

v) Gedunin and its derivatives :

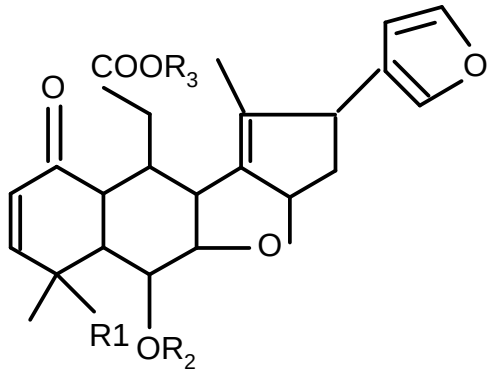
This group consists of compounds wherein the D- ring has undergone oxidative expansion. Gedunin(14) and its deacetyl derivatives (15) have been found in neem bark also in addition to their co-occurrence in seed oil. Gedunin was shown to posses both anti fungal and anti malarial property.



14 R = Ac **15** R =H

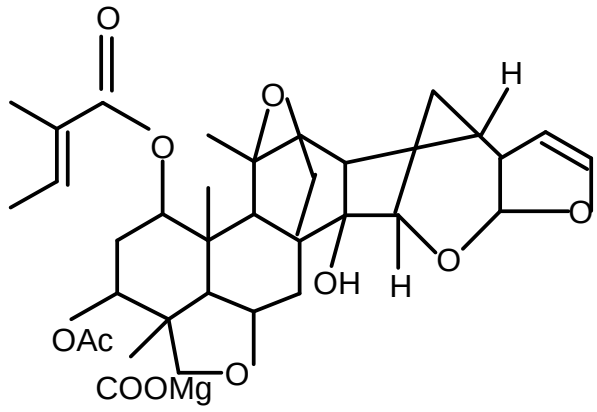
vi) Azadirone and its natural analogues:

This group consists of limonoids in which all rings of the triterpenoid skeleton remain intact characteristics features of this group are presence of oxygen function at C_3 and C_7.



R1 =COOMe **R2** = Ac **R3** = Me

Azadirachtin A



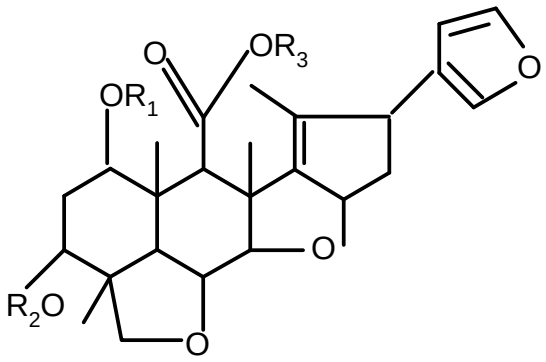
Butterworth and Morgan (1968) isolated Azadirachtin A. Nahanishi first identified the group.

Source: every part of neem but seed kernel is good source and in neem oil 0.03% is present. In seed kernel maximum conc. of Azadirachtin A is 50000 ppm [Grace co (USA) formulation].

vii) C-Secomeliacins

This is a large and important group containing the most complex compound and it is specifically containing to neem. There are 3 important sub-groups in this form-
(i) nimbin
(ii) salanin
(iii) azadirachtin

Correctly 22 members of nimbin and salanin group have been isolated from neem.Salanin has anti-feedant and detorant properties.



Salanin

R1= Tg(Tiglica C = 4), **R2**=Ac, **R3** =Me

The isolation of nimbin in 1942 marked the beginning of the chemistry of neem meliacins. The structure elucidation of nimbin was done very critically, carefully and cumbersome procedure. No technology was known at that time. This particular chemistry was done by 4 chlrol of chemistry.

II) Non-isoprenoid constituents:

i) (Poly) phenolics

a) Flavonoids: The neem leaves were reported to contain two flavonoids, quercetin and Isorhamnetin. The flowers were to contain kaempferol, myricetin and quercetin. The occurrence of a new isoprenylated flavanone, nimbaflavanone (8,3'-di- isoprenyl-5,7-dihydroxy-4'-methoxyflavanone) in leaves is also reported.

b) Flavonolglycosides: The occurrence of glycosides of kaempferol and quercetin in flowers and leaves and that of myricetin in leaves is reported. They are quercetin-3-galactoside, kaempferol-3-glucoside and myricetin 3'-L-arabinose.

c) Dihydrochalcone: From the Aqueous fraction of the fruits, nimbochalcin, a dihydrochalcone derivative was isolated.

d) Tannis: Condensed tannis to the extent of 15% were reported to occur in bark. Aqueous extract of bark contained gallic acid, (+) gallocatechin, (-) epicatechin, (+) catechin were shown to inhibit the generation of chemiluminescence by activated human polymorphonuclear leukocytes.

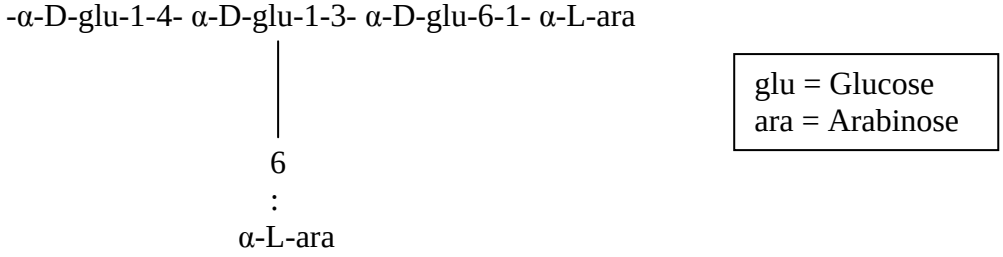
e) Coumarin: There is only one report on the occurrence of a coumarin, scopoletin (7-hydroxy-6-methoxy coumarin) in leaves.

ii) Carbohydrates and Proteins

The gum exudate from the stem was found to be a very complex condensate proteins and heteropolysaccharides. The proteins are linked very tightly to the polysaccharides, which constitute the major components. A variety of smaller gum components have been identified after drastic degradation of the complex, e.g., D-glucose, D-glucuronic acid, L-arabinose, L-fucose mannose, xylose etc were reported. The amino acid composition of the gum was also invested and it has been found the most abundant was aspartic acid. Among others serine and threonine were also found.

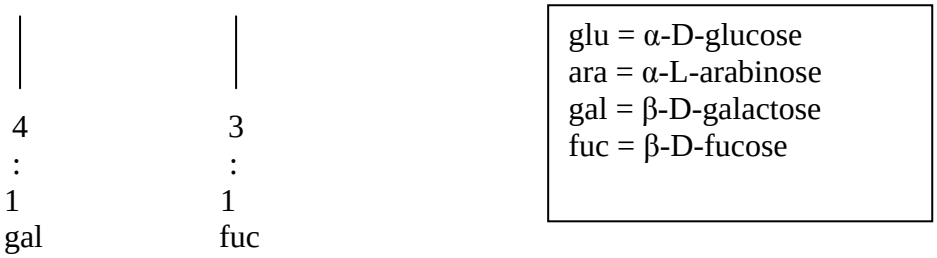
a) Polysaccharides Gla and Glb: Gla is composed of a repeating unit consisting of one molecule of α-L-arabinose and five molecule of α-D-glucose. The arabinose is linked (1-6) to one of the glucose molecules which are mutually linked (1-4). Glb is a branched arabinofucoglucan containing a main chain of (1-4) α-D-glucose molecules substituted in the 6 position with side chains of α-L-arabinose mo;ecules and in the 4 position with 3-O-substituted fucose molecules.

b) Polysaccharides GIIa and GIIIa: GIIa is composed of the following repeating unit:



GIIIa is a branched arabinofucoglucan containg a main chain of (1-4)-linked α-D-glucose molecules substituted in the 6 position with side chain of α- arabinose and β-L-fucose.

c) Polysaccharides GIIIDO'$_2$ Ia and GIIIDO'$_2$IIa: GIIIDO'$_2$ Ia is a branched fucogalactoglucoarabian containing a main chain of (1-5)-linked α-L-arbinose molecules and (1-4) linked α-D-glucose molecules. GIIIDO'$_2$ IIa is contains the following repeating unit:



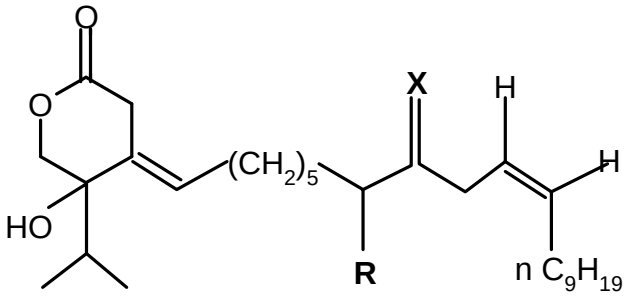
Two functionally different immunomodulators, one methanol insoluble, high molecular weight (10kD) saccharide-containing fraction and the other, methanol-soluble, low molecular weight (10kD) fraction were isolated from aqueous bark extract.

iii) Sulphurous Compounds

A number of cyclic tri- and tetra sulfides were identified from the steam distillate of the fresh matured leaves by GC-MS analysis. Several di- and trisulphides were also identified by capillary GC-MS analysis of the headspace volatiles from crushed seeds. Di-n-propyl disulphide was shown to be the major compound.

Miscellaneous

These include nimbocetin, a substituted aromatic easter from the fruits, methyl grevillate, margosinone, margosinolone (two new polyacetate derivative from the stem bark) etc.



	R	X
Margosinone	H	O
Margosinolone	OH	2H

CONCLUSION

Neem has the potential of providing the best source of selective and environmentally acceptable biopesticdes as different constituents obtained from various parts of the tree have a wide range of applications including insect growth-regulating activity. Besides the neem oil finds its use in the preparation of a variety of cosmetics like soaps, shampoo etc. Much of the usefulness of this evergreen tree is still to be exploited. Therefore it earns popularity not only in subcontinent but in international arena too.

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