CHAPTER IV

BOTANICAL DESCRIPTION AND GEOGRAPHICAL DISTRIBUTION OF Moringa oleifera Lamk. AND Alpinia mutica Roxb.; THEIR REPORTED PHYTOCHEMICALS AND PHARMACOLOGICAL ACTIVITIES

I. Moringa oleifera Lamk.

Syn. Moringa pterygosperma Gaertn.

Taxonomic treatments by some authors:


Description of the plant:

Small or medium sized (about 10 m high) deciduous tree with
thick, soft, corky bark, deeply fissured, young parts tomentose; wood soft and white, with gummy juice; leaves alternate, compound tripinnate, petiole slender, sheathing at the base, leaflets opposite, entire, elliptic, all parts stalked, pale beneath, glands linear, hairy, flowers stalked, in large panicles, zygomorphic, bisexual, white, fragrant; disc lining calyx tube; sepal connate, in a cupular 5 cleft calyx, segments unequal, imbricate, the odd one posterior, subpetaloid, deciduous, petals 5, unequal, the upper pair small, the lowest largest; stamens decline, 5 functional, unequal, opposite to petals, villous at the base, 5-7 filiform or setiform staminodes alternately arranged; filaments free, rather thick, insergted on the margin of the disc; anthers versatile, 1-celled, dehiscence longitudinal, extrorse; carpels 3, connate in a stipitate 1-locular ovary with 3 parietal placentas; ovary hairy, style slender, tubular, stigma truncate, perforated; ovules many, 2-seriate on each placenta, pendulous, anatropous, with raphae ventral; fruit a one-celled, loculicidally 3-valved capsule, pendulous, greenish, 22.5–50.0 cm in length, triangular, 9-ribbed; seeds many in the depressions of the valves, trigonous, winged; albumen absent, embryo straight.

The plant is identified by the following characteristics: Leaflets elliptic, ovate or obovate; nerves obscure; flowers white; capsule 9 ribbed; seeds winged (Hooker, 1879).

The plant flowers in February to March and fruits in March to April. In some plants flowers and fruits appear twice or more in a year. A good tree yields as many as 1000 fruits in a single year (Wealth of India, 1962). Mature plants with flowers and fruits are shown in Plates 4A, 4B and 4C.

The tree is valued mainly for the tender pods which are popular as vegetable. Flowers and tender leaves are consumed as pot herb. The roots of the tree are used as condiment or garnish. The oil obtained from the seeds is used for lubricating fine machineries. Wood pulp is suitable as mechanical pulp for newsprint (Singh et al., 1983).
Plate 4: A view of *Moringa oleifera* Lamk plant showing:

A. Plant bearing flowers
B. Flowers in enlarged view
C. Plant bearing fruits.
M. oleifera is known as Drumstick or Horse radish tree in English. In India it is known by the following regional names:


**Distribution of the plant:**

The genus *Moringa* is represented by two species in India, viz. *M. oleifera* Lamk. and *M. concanensis* Nimmo.

*M. oleifera* is indigenous to northwest India and is plentiful on recent alluvial land in or near sandy beds of rivers and streams. It is cultivated all over the plains of India, often in hedges and homeyards (Chatterjee and Pakrashi, 1991). The trees can be propagated by seeds or from cuttings.

**Phytochemicals of M. oleifera**

1. **Root**

   The root bark is reported to contain two alkaloids - Moringine, which is identical with benzylamine and Moringinine (Chopra et al., 1958). Another alkaloid 'Spirochis' has been reported from the root. In high doses it paralyses the the vagus nerve (Chakravarti, 1957). The root bark contains traces of an essential oil with a pungent smell, phytosterol, waxes and resin (Wealth of India, 1962).

2. **Stem**

   The stem bark is reported to contain sterols and terpenes (Bhattacharjee and Das, 1969). The hexane extract is reported to contain a triterpenoid - bayrenol (Anjaneyulu et al., 1965). 4-hydroxy-
mellein, Vanillin, \( \beta \)-sitosterol, \( \beta \)-sitosterone and Octacosanoic acid are also reported to be present in stem (Saluja et al., 1978).

3. **Leaf**

These are rich in vitamin A and C. 100g of the fresh leaves are reported to contain 100 \( \mu \)g of \( \beta \)-carotene and 13 \( \mu \)g of \( \alpha \)-carotene (Das, 1965). Vitamin C content of the leaf is 79-133 mg/100g of leaf (Verma et al., 1976). Gopalan et al. (1984), however, have reported the presence of the following vitamins in the concentration mentioned in the parenthesis:

- Thiamine (0.06 mg/100g), Riboflavin (0.05 mg/100g), Niacin (0.8 mg/100g), Vitamin C (220 mg/100g), Carotene (6780 \( \mu \)g/100g). The leaves were reported to contain the following amino acids: Aspartic acid (24.5 mg), Glutamic acid (10.5 mg), Serine (7.5 mg), Glycine (5.5 mg), Threonine (14 mg), \( \alpha \)-alanine (13.5 mg), Valine (12.0 mg), Leucine and Isoleucine (4.5 mg), Histidine (9.5 mg), Lysine (4.5 mg), Arginine (9.0 mg), Phenylalanine (4.0 mg), Tryptophan (3.5 mg), Cystine (5 mg), and Methionine (3.5 mg) (concentration in 100g of leaf) [Das, 1965]. The leaves were reported to contain the minerals - Calcium (440 mg/100g), Phosphorus (70 mg/100g) and Iron (7.0 mg/100g) (Gopalan et al., 1984).

4. **Flower**

Flowers are rich in amino acids viz. Alanine, Arginine, Glutamic acid, Serine, Glycine, Threonine, Valine, Aspartic acid and Lysine. Flowers also contain sucrose and \( d \)-glucose (Ramiah and Nair, 1977). The flowers contain traces of alkaloids, minerals viz., Calcium (51 mg/100g) and Phosphorus (90 mg/100g) (Gopalan et al., 1984) a wax (m.p. 69-72°C, acid val. 10.5; sap. val. 29.8 and unsaponifiable matter 75.5%), Quercetin and Kampferol (Rangaswami and Sankara Subramanian, 1946).
5. Fruit

Analysis of the pods gave the following values: moisture 86.9%, protein 2.5%, fat (ether extract) 0.1%, carbohydrates 3.7%, fibre 4.8% and mineral matters 2.0%. The mineral matters include Ca 30 mg/100g; P 110 mg/100g, Fe 5.3 mg/100g, copper 3.1 µg/g, iodine 18 µg/kg (Wealth of India, 1962).

The pods contain the vitamins - Thiamine 0.05 mg/100g; Riboflavin 0.07 mg/100g, Niacin 0.2 mg/100g, Vitamin C 120 mg/100g, Carotene 110 µg/100g, Oxalic acid 101 mg/100g (Gopalan et al., 1984). Ascorbic acid oxidase is present in the pressed juice of the fruit (Health Bull. 1951).

The pods contain a globulin (N 15.6%, S 1.58%) and a prolamin (N 14.02, S 1.43%). The amino acids of the fruit were found to be same as flower but lysine was absent (Ramiah and Nair, 1977). The mucilage isolated from pods contain galactose, dextrose, xylose and sodium, potassium, magnesium, calcium salts of glucuronic acid (Rao and Mishra, 1992).

6. Seed

The seeds (shell 26-30%, kernel 70-74%) are oleaginous. Analysis of the kernel gave the following values: moisture 4.0%, crude protein 38.4%, fatty oil 34.7%, N-free extract 16.4%, fibre 3.5% and mineral matter 3.2% (Wealth of India, 1962).

A pale yellow non-drying oil with a mild pleasant flavour can be extracted from the kernel. It is known as Ben oil or Behen oil. It deposits stearin on chilling. The characteristics of the oil are: sp. gr. 30°C 0.8984; n°C 1.4652; acid val. 3.5; sap. val. 182.2; Iod. val. 64.2; R.M. val. 0.44; acet. val. 11.5; Hchner val. 91.6; and unsapon. matter 3.05%. The component fatty acids of the oil are: palmitic 9.3%, stearic 7.4%, behenic 8.6% and oleic 65.7%. The
presence of myristic acid and lignoceric acid has been reported by some authors. Glyceride composition is: trisaturated 1.40; di saturated monounsaturated 23.47; monosaturated di-unsaturated 25.62; and triunsaturated 49.51% (Wealth of India, 1962).

7. Gum

The exudate of the stem is a polyuronide consisting of arabinose, galactose and glucuronic acid in the proportion of 10:7:2 moles; Rhamnose is present in traces (W.O. India, 1962).

Pharmacological Activities of M. oleifera

In Traditional Medicine: Roots are carminative, stomachic, abortifacient, cardiac tonic, used in paralytic condition, intermittent fever, as rubefacient in rheumatism, in spasmodic affections of the bowels, hysteria and flatulence. The fruit is used in diseases of liver and spleen, in tetanus and paralysis. Flowers are stimulant and aphrodisiac. Seed oil is applied externally in rheumatism. Leaves are emetic. Poultice of leaves is applied on glandular swelling. Gum is given in dental carries. Seeds are used in venereal affections (Chopra et al., 1958; Nadkarni, 1989).

Antibiotic activity: The presence of an antibacterial and antifungal compound in the root of Moringa oleifera Lamk. was reported by Rao et al. (1946). The antibiotic was purified by Kurup and Rao (1952) and the chemical nature of the antibiotic (Pterygospermin) was also determined by them in 1954.

Antibacterial activity was reported from the leaves and stem bark (Bhawasar et al., 1965). Anti-tubercular activity was reported from the bark extract against Mycobacterium phlei and M. 607 (Bhatnagar et al., 1961). Antifungal activity was also reported from the bark extract by them. However, Dhar et al. (1968) reported the
absence of any antibacterial activity in 50% ethanolic extract of fruit and root bark. In an experimental model of Staphylococcus aureus Pyoderma in mice was cured with an ointment of M. oleifera (Caceres et al., 1991).

**Antiviral activity**: 50% ethanolic extract of root bark of M. oleifera was antiviral against vaccinia virus (Dhar et al., 1968) and inhibited the replication of Ranikhet disease virus (Babbar et al., 1970).

**Anticancer activity**: 50% ethanolic extract of the whole plant except the roots showed anti-cancer activity against human epidermoid carcinoma of nasopharynx in tissue culture and P388 lymphocytic leukaemia in mice (Dhawan et al., 1980).

**Spasmogenic effect**: 50% ethanolic extract of fruit, root and root bark were found to have spasmogenic effect on the isolated guineapig ileum (Dhar et al., 1968).

**Effect on blood pressure**: The alcoholic extract of M. oleifera leaves caused an initial rise in blood pressure in Mongrel dogs and cats followed by a gradual fall lasting for a considerable duration and it also potentiated the response of norepinephrine on blood pressure and nictitating membrane. Its action on blood pressure suggested the presence of a potent adrenergic neurone blocking substance(s) in the alcoholic extract of M. oleifera leaves (Singh et al., 1976).

**Anti-inflammatory activity**: The alcoholic extract of M. oleicera root bark showed anti-inflammatory activity against formalin-induced rat paw oedema, cotton pellet implantation and granuloma pouch in albino rats (Singh et al., 1972).

**Haemagglutination**: M. oleifera seed extract agglutinated blood cells of various animals (Sathe et al., 1970).
II. *Alpinia mutica* Roxb.

Syn. *A. korthalsii* Schum; *Renealmia mutica* (Roxb.) Salisb.; *Languas mutica* (Roxb.) Degener.; *Catimbium muticum* (Roxb.) Holtum.

Taxonomic treatments by some authors:

Bentham and Hooker (1862-1883) placed the Genus *Alpinia* under Class: Monocotyledones; Series: Epigynae; Natural order: Scitamineae.

Engler and Prantl (1897-1915) treated *Alpinia* under Class: Monocotyledoneae; Order: Scitamineae; Family: Zingiberaceae.

Hutchinson (1975) considered *Alpinia* under Phylum: Angiospermae; Subphylum: Monocotyledones; Division: Calyciferae; Order: Zingiberales; Family: Zingiberaceae.


Thorne (1992) considered *Alpinia* under Class: Angiospermae; Subclass: Monocotyledoneae, Superorder: Commelinanae, Order: Zingiberales; Suborder: Zingiberineae; Family: Zingiberaceae.

[According to Smith (1990) *Alpinia mutica* Roxb. belongs to Subsection: Catimbium (Horan) Smith, Section: Alpinia; Subgenus: Alpinia; Genus: *Alpinia* of family Zingiberaceae.]

Description of the plant:

Strong, biennial and excellent free flowering species with well-developed rhizome system. Rhizome creeping, thick, hard; root stout, many, root tubers absent; leafy stem, robust, upto 2m high; leaves many, in alternate phyllotaxy, on the aerial stem, plane of
Distichy transverse to rhizome, bifarious, petiolate, petiole short, pubescent, lamina oblong-lanceolate, acuminate, 40-60 cm long and 10-13 cm broad, glabrous above, more or less densely pubescent below; ligule c. 8 mm long, coriaceous, entire, glabrous or fringed with hairs; sheaths pubescent; inflorescence raceme or panicle, up to 16 cm long, emerging from the uppermost leaf sheath, erect or slightly curved, rachis densely pubescent, protected when young by 2-3 bladeless sheaths, 11-16 cm long and 2.5-4.5 cm broad, cincinnus 1-3 flowered; flower pedicellate, 0.5 to 1 cm long, pubescent, bracts absent, bracteoles absent or very small, up to 6 mm long on the upper cincinni only, deciduous; calyx white, 1.8-2 cm long, funnel shaped, 3 lobed, outer surface sparsely hairy; corolla white, tube c. 1.3 cm long, curved, shorter than the calyx, dorsal lobe 2.5 cm long and 1.8 cm broad, linear-oblong, concave, margins shortly ciliate, lateral lobes as long as the dorsal lobe but narrower, 2.5 cm long and 1.5 cm broad, margin shortly ciliate, labellum c. 3 cm x 3.5 cm, broadly ovate, narrowing to an emerginate apex, yellow, variegated with crimson, the basal part strongly concave, sides incurved; stamens reduced to one pollen bearing organ and few staminodes, lateral staminodes reduced, 5 mm long, subulate, filament 1-1.2 cm long, anther as long as filament, thecae parallel, ecrestate; gynoecium epigynous, gland one, style filiform, stigma funnel shaped, ciliate, ovary 5-8 mm long, trilocular, pilose with many ovules in parietal placentation; fruit globose capsule, capsule buried 3-3.5 cm x 2-2.5 cm, red when mature, pubescent with accrescent calyx; seeds many in each fruit, angular, 6-7 mm long, black with white lacerate aril.

The plant is identified by the following characteristics:
Leaves short petioled, narrow-lanceolar, polished; racemes erect, compound; lip three lobed, base spurless; capsule buried; seeds numerous, angular; aril evanescent (Roxburgh, 1874).

The plant flowers and fruits between February to October. Mature plants, flowers and rhizomes of *A. mutica* plant are shown in Plates 5A, 5B and 5C.
Plate 5: A view of *Alpinia mutica* Roxb. plant showing:

A. Plants with aerial stem and leaves
B. Flowers
C. Underground rhizomes
The plant is valued for its beautiful flowers and rhizomes. Rhizomes are used in traditional medicine and they are sometimes substituted for *Alpinia galanga* (Greater galangal) rhizome.

**Distribution of the plant:**

About 17 species of the genus *Alpinia* has been reported to occur in India. *Alpinia mutica* Roxb. has been reported to occur in Borneo, Penang, Perak, Singapore, Malesia and north-east and south India (Western Ghats in Kerala and Karnataka) [Mangaly and Sabu, 1992].

It grows well in swampy areas near springs or rivers at high altitudes. It can be propagated from seeds and rhizomes.

**Phytochemicals of *A. mutica***

The genus *Alpinia* Roxb. is distributed mainly in the old World tropics. About 17 sp. are found in India. *Alpinia galanga* Willd. is the type species. There are reports regarding the phytochemicals of *A. galanga* Willd. and some other species of *Alpinia* but reports regarding the phytochemicals of *A. mutica* Roxb. is lacking. However, since identical phytochemicals are found from different species of *Alpinia*, the main phytochemicals of *A. galanga* Willd. are given below:

The fresh rhizomes contain 0.04% essential oil (\(d_{20}^{20} = 0.9847; n_D^{20} = 1.5164\)); cineol \((20-30\%\) \(\text{cineol}, 20-30\%\)), some camphor and probably d-pinene (Nadkarni, 1989). A hydrocarbon \(\left(C_{15}H_{30}\right)\) is also reported to be present (Wealth of India, 1985; Chopra et al., 1958; Janssen and Scheffer, 1985). Janssen and Scheffer (1985) reported the presence of Terpinen-4-ol, 1'-acetoxychavicol acetate, 1'-acetoxyeugenol acetate and 1'-hydroxychavicol acetate. The leaves yield an essential oil containing mostly methyl cinnamate.
The seeds contain two potent anti-ulcer principles viz., 1'-acetoxychavicol acetate and 1'-acetoxyeugenol acetate. Caryophyllene oxide, Caryophyllenol I, Caryophyllenol II, pentadecane, 7-heptadecane and fatty acid methyl esters are also reported from the seeds (Kirtikar and Basu, 1935; Wealth of India, 1985; Chopra et al., 1958; Uphof, 1968).

Pharmacological activities of *A. mutica*

Very few reports are available on the pharmacological activities of *A. mutica*. Since the rhizomes of *A. mutica* and some other species of *Alpinia* are sometimes used as substitutes for the rhizomes of *A. galanga*, it seems that they have some similarity in pharmacological activities.

In traditional medicine: In indigenous medicine the rhizomes are used in rheumatism and catarrhal affections, specially in bronchial catarrh. It is considered to be a good remedy for impotence and nervous debility. The rhizomes are used to cure respiratory troubles, specially of children. The rhizomes are also used in gastro-intestinal affections (Chopra et al., 1958; Nadkarni, 1989).

On blood pressure: The rhizome extract is a depressant to the cardiovascular system. Intravenous injections of small doses of a tincture or an infusion of *A. galanga* produce a sharp fall in blood pressure which however, comes to normal in a short time (Nadkarni, 1989).

On respiratory system: Respirations in experimental animals are stimulated in small doses but depressed with larger ones (Nadkarni, 1989).

Carminative: The essential oil of the rhizome is carminative in action (Chopra et al., 1958).
Antispasmodic: In moderate doses the essential oil has an antispasmodic action on involuntary muscle of the intestine (Chopra et al., 1958).

Antibiotic: The essential oil of rhizome is reported to be bactericidal and fungicidal in action. Terpinen-4-ol, 1'-acetoxychavicol acetate, 1'-acetoxyeugenol acetate and 1'-hydroxychavicol acetate were found to be antimicrobial in action (Janssen and Scheffer, 1985).

Anti-inflammatory: The water soluble fraction of the alcoholic extract of the air dried plant exhibited anti-inflammatory activity in albino rats similar to that of β-methasone (Wealth of India, 1985).

Anti-ulcer: 1'-acetoxychavicol acetate and 1'-acetoxyeugenol acetate present in the seeds and rhizomes are reported to have anti-ulcer activity (Wealth of India, 1985).