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Review

Oriental medicine *mangifera indica*

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SUMMARY

Mangifera indica Linn. (MI) (Family: Anacardiaceae) is commonly known worldwide as mango and 'Aam' in India. MI shares an important place in treatment of several diseases in various ancient system of medicine like Ayurveda and other Indian System of Medicine and some other Traditional Medicines world wide. Almost all the parts of MI have been used in oriental medicine, so in this review attempt has being made to review the history, traditional uses, phytoconstituents and therapeutic potentials of mango.

Key words: *Mangifera indica*; Traditional uses; Phytoconstituents; Therapeutic potentials

INTRODUCTION

Plants and plant derived products are part of health care system since ancient civilization. The need of new chemical entities (NCEs) for health care is explored and served through the plant sources (Mukherjee and Wahile, 2006). Hence there is need to focus our attention towards the potential plants which can be explored for new drug development.

Mangifera indica (MI) is a large genus of evergreen trees, distributed in tropical and sub-tropical parts of South-East Asia, from India and Ceylon in the west to the Philippines and New Guinea in the east, from Yunnan (China) and Indo-China in the north, to Sunda and Sulu Archipelago in the south. Three or four species are recorded in India, of which MI is by far the best known and most widely cultivated for its fruit (Anonymous, 1992). MI Linn. commonly known as mango belonging to family Anacardiaceae. It has several synonyms e.g. *Mangifera anisodora* Blanco, *Mangifera fragrans* F-Vill., *Mangifera rostrata* Blanco, *Mangifera sylvatica*, F-Vill and Vernacular names like Sanskrit, Alipriya, Amra, Bhramavapriya, Kamaphala, Kamayudha, Kamavallabha, Kok-ilavasa, Kires, Kokilananda, Pitavallabha; Hindi: Am; Italian: Mango; English: Mango tree, Spring tree; French: Abricotierde St. Domingue, Amb, Loubi, Freycinet, Manguier, Saint Michel; German: Mango; Chinese: AnLoKuo; Nepalese: Angp. Mango is a large evergreen tree, 10.0 - 45.0 min height. MI shares an important place in treatment of various diseases in ancient system of medicine like Ayurveda and other Indian System of Medicine (ISM) and other Traditional Medicines (TM). Fruits, flowers, roots, bark, seeds and leaves of MI have been used in

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treatment diseases, in Ayurveda (Anonymous, 1992; Kirtikar and Basu, 1993; Anonymous, 2001), so in this review attempt has being made to review the history, traditional uses, phytoconstituents and therapeutic potentials of various parts of mango.

HISTORY

There are many synonyms of mango derived from many culture, regions and language. Mangifera comes from Tamil man–kay or man-gay, which becomes mangain in Portuguese, and from Latin fer-fero i.e. to produce (Sahni, 1998). It has been grown in India for 4,000 years, not only for the fruit but also because it creates a lot of shadow (Nadkarni, 1993). Buddha used to rest under the mango tree. The plant has an important symbolic meaning: its scented flowers are used in Shivaworshipping. The Moghul Emperor Akbar the Great (1542 - 1605) created a big garden of 100,000 mango trees at Darbhanga, North India. It was extraordinary at that time because intensive cultivation was unknown. In the first half of 18th century the mango was exported to the other tropical countries by the Portuguese (Cal-abrese, 1993). In Sanskrit there are many synonyms of mango: Kamaphala (kama means desire, love or wish; phal means fruit), Kamavallabha (vallabha means favorite or lover), Kamayudha (yudha means fighter, hero or warrior), which means fruit of love, aphrodisiac; Kireshta (kira means a parrot; stha means to stand); Kokilavasa, Kokilananda, (kokila means Indian cuckoo; vasa means dwelling or residence; ananda means joy or happiness) (Anonymous, 1992; Scartezzini and Speroni, 2000). In this era of biosynthesis, mango is also being cultured by *in vitro* somatic embryogenesis (Litz *et al.*, 1984)

LEAVES

Leaves are commonly known in India as amrapallava. The leaves are evergreen, coriaceous, 10 - 30 cm long and 5 - 10 cm wide, occurring at the end of the branches. They are arranged on the branches in alternate fashion. The leaves may be oblong or lanceolate. The margins are often undulate, shining, green bright up and yellow-greenish in the down. They seem a little pinkish when young; petiole is 2 - 5 cm long, swollen at the base. The ash of burnt leaves is a household remedy for burns and scalds. The leaves are masticated to give tone to the gums. Fumes from the burning leaves are inhaled for relief from hiccups and affections of the throat (Anonymous, 1992).

Leaves contain flavonoids, phenolic constituents, glucose, galactose, arabinose, xylose, rhamnose, tannins, leucine, tyrosine, valine, protocatechuic acid, catechin (VI), mangiferin (I), alanine, glycine, γ-aminobutyric acid, kinic acid, shikimic acid, methylic, ethyl, propyl, butyl, amyl and iso-butyl alcohols, α-pinene, β-pinene (VI), camphene, myrcene (IX), car-3-ene, limonene, β-ocimene, γ-terpinene, α-terpinolene, linalool, estregole, δ-lemene, β-elemene, α-cubebene, methyleugenol, β-caryophyllene, humulene, alloaromadendrene, α-guaiene, β-bulnesene, α-farnesene, δ-cardinene, elemicin, chinomin, protocatechuic acid, gallic acid (VIII), methyl chinomin, isochinomin, quercetin (X), hyperin, taraxerone, taraxerol, friedelin (V), lupeol, ß-sitosterol (Anonymous, 1992; Rastogi and Mehrotra, 1993; Rastogi and Mehrotra, 1995). Tender mango leaves are consumed as vegetable in Java and Philippines. They are a good source of ascorbic acid. Mango tops contains moisture 78.2%, protein 3.0%, fat 0.4%, total carbohydrates 16.5%, fibre 1.6% and ash 1.9%, calcium 29 mg, phosphorus 72 mg, and iron 6.2 mg/100 g, carotene 1,490 i.u., thiamine 0.04 mg, riboflavin 0.06 mg, niacin 2.2 mg and ascorbic acid 53 mg/100 g. Mature mango leaves are used as cattle fodder in times of scarcity. They contain (dry basis) crude protein 7.8, ether extract 3.8, N-free extract 54.0, fibre 21.1, ash 13.3, phosphorus (P_2O_5) 0.38 and calcium (CaO) 2.93%. The leaves contain the glucoside mangiferin (I) ($C_{19}H_{18}O_{11}$, m.p. 280 - 281°C decomposition. Phytoconstituents of mango varies appreciably

with various infections caused by different parasites in different conditions. Such as the concentration of mangiferin (I) is highest in healthy tender leaves, which gradually declines with maturity of the leaves. Again, among flower-bearing and non-bearing healthy plants, the concentration of mangiferin (I) is much higher in tender leaves of the latter (Anonymous, 1992).

Leaves of mango possess antioxidant activity (Richards and Sharma, 1991). This activity is mainly due to the presence of mangiferin (I)-the chief marker of leaf, different tannin derivatives like protocatechuic acid, catechin (VI), gallic acid (VIII) and flavonoids especially quercetin (X). It has been proved that the leaf extract bears significant antioxidant activity so that it stimulates after 48 h the proliferation of thymocytes and spleenic lymphocytes with a peak response at 5.0 mg/ml and 20.0 mg/ml, respectively (Rastogi and Mehrotra, 1993). The leaves also have antidiabetic and antiatherogenic properties. According to the Randle's glucose-fatty acid cycle, the reduction of triglycerides following treatment with mangiferin (I) would also facilitate the glucose oxidation and utilization and subsequently the reduction of hyperglycemia. In the earlier studies, it was found that mangiferin (I) significantly reduced malonaldehyde (MDA) level which is advantageous in treatment of diabetic complications (Muruganandan *et al.*, 2002, Muruganandan *et al.*, 2005; Mukherjee *et al.*, 2006). The isolated mangiferin (I) (10 and 20 mg/kg, i.p.) at the dose levels exhibits potent antidiabetic, antihyperlipidemic and antiatherogenic activities in STZ induced diabetic rats and also shows the improvement in oral glucose tolerance in glucose-loaded normal rats without inducing hypoglycemic state. This has been proved to be of greater therapeutic benefit in the management of diabetes mellitus. The leaf extract also produces significant immunomodulatory activity at an optimum dose of 400 mg/kg body wt. of rats (Makare *et al.*, 2001). It is also used in burns and scalds (Anonymous, 1992). It has been observed that extract of the leaves is used against 10 Gy gamma radiations, which is mainly due to the phytoconstituent mangiferin (I). The administration of 0.5, 1, 2, 5, 10 and 17.5 mg/kg mangiferin (I) reduced the radiation-induced gastrointestinal death as evident by a greater number of survivors up to 10 days in this group when compared with the DDW +10 Gy irradiation group. A similar effect of mangiferin (I), found in the plant extract, was observed for the radiation-induced bone marrow deaths also (Jagetia and Baliga, 2005). Jagetia and coworkers investigated the chief marker mangiferin (I), for its ability to reduce the frequency of radiation-induced micro nucleated binucleate cells (MNBNCs) in cultured human peripheral blood lymphocytes (HPBLs). The maximum decline in radiation-induced micronuclei was observed at a concentration of 50 µg/ml (Jagetia and Venkatesha, 2005).

BARK

Bark of mango is thick, acrid, dark grey and fibrous. It is available in Indian market with the name of amrakastha and occurs in pieces of variable sizes and thickness. The surface of bark rough due to longitudinal cracks, fissures and scattered raised lenticels. It is grayish to dark brown externally and yellowish-white to reddish, internally, odor is pleasant and the taste is astringent. Sections of bark shows a wide cork of tangentially elongated cells, outer layers are brown and inner are lighter in color, at few places lenticels also appear. Secondary cortex is almost absent and secondary phloem is wide, consisting of sieve elements, medullary rays traverse parenchyma and phloem fibers, resin canals and yellow colored elongated, tannin sacs are abundantly scattered through the phloem region. The stone cells are thick walled, lignified, rectangular with wide lumen also present in single or in groups. Starch grains and prismatic crystals of calcium oxalate are present in a number of phloem cells. Phloem fibers are in groups, composed of 2 - 15 or more cells,

which are long and thick walled. The phloem cells 1 - 3 seriate, in which 3 seriate rays are more common, wavy and thin walled. Phloem cells are radially elongated and filled with crystals of calcium oxalate and simple round starch grains, measuring 12 - 16 μ in diameter. Traditionally, the bark is used in the treatment of pimples, dyspepsia and peptic ulcer, malabsorption syndrome, carbuncles and in sexual disorders (Anonymous, 2001).

The bark contains protocatechuic acid, catechin (VI), mangiferin (I), alanine, glycine, gamma-aminobutyric acid, kinic acid, shikimic acid, tetracyclic triterpenoids, cycloart-24-en-3b, 26-diol, 3-ketodammar-24 (E)-en-20S, 26-diol, C-24 epimers of cycloart-25-en-3b, 24, 27-triol and cycloartan-3b, 24, 27-triol. It contains tannin, 16 - 20%. Bark yields a coloring matter which produces beautiful, though light, yellow shades on cotton, silk and wool; in conjunction with turmeric and lime, the bark dyes cotton a bright rose-pink (Anonymous, 1992).

Bark extract of mango showed potent anti-inflammatory activity. In rat ear oedema method, the extract at a dose of 0.5, 1 and 2 mg per ear caused significant reduction of edema induced by 4 μg/ear of phorbol myristyl acetate (Garrido *et al.*, 2004). Anti-inflammatory activity showed may be due to the presence of polyphenols, terpenoids, steroids, fatty acids and other microelements present in extract of the bark. Mangiferin (I) obtained from the bark of mango, showed good *in vitro* immuno-stimulating and anti-viral activities. It also inhibits the production of prostaglandin from membrane arachidonic acid by inhibiting the COX pathway and together with this; it also cuts-off the production of LTA_4, LTB_4 by blocking the LOX pathway. Bark also showed antioxidant activity, which may be due to the presence of mangiferin (I) and other polyphenols. The bark extract inhibits lipoperoxidation *in vivo* at IC_{50} value of 50 μM/ml (Andreua *et al.*, 2005). It also has cardiotonic and diuretic properties. It can relieve oxidative stress of the body by inhibiting lipid peroxidation, by initiating polymer chain reaction and by maintaining cellular oxidant level (Scartezzini and Speroni, 2000). The mango bark extract also possess significant antiamoebic activity at MIC (< 7.81 μg/ml), which may be due to the presence of tannin, saponin and steroids (Tona *et al.*, 1998). The bark extract also possesses significant smooth muscle relaxant activity at doses of 1, 2, 4 mg/ml each (Agbonon *et al.*, 2002) Bark extract showed good immunomodulatory activity in rats at an optimum dose of 400 mg/kg body wt. (Makare *et al.*, 2001). The bark is astringent; it is used in diphtheria and rheumatism; it is believed to possess a tonic action on the mucous membrane (Anonymous, 1992). The stem bark also possesses anthelmintic and antiallergic activities at a dose of 250 mg/kg body weight (Garcia *et al.*, 2003). The method for estimation mangiferin in the bark extract has been established with the help of High Performance Thin Layer Chromatography (HPTLC) by Mukherjee (2000).

The stem exudes a gum resin that is sold in Indian markets and used as a substitute for gum arabica. It has a dull fracture and a reddish brown color and is partly soluble in water. Analysis of mango gum showed the presence of moisture 4%, resin 79%, gum 15% and ash 2%. Gum when distilled with dilute hydrochloric acid yielded furfurol, 1.8% w/w. It is used mainly in dressings for cracked feet and for scabies and considered as anti-syphilitic (Anonymous, 1992). The bark extract also protects injury associated with hepatic ischemia at dose level 250 mg/kg body weight (Sanchez *et al.*, 2003)

FLOWERS

The flowers of mango are very sweet smelling and are famous in Indian society as amramukul. The time of flowering is January-March and the flowers are male and bisexual. They are united in big inflorescence with a pyramidal shape, 10 - 50 cm long and placed at the apex of the branchlets; in any panicle there are about 5,000 small flowers with dark red spotted petals. Petals are four-five

pale yellow in color, three orange colored ridges on the inner face, oblong, sub acute. Sepals are ovate, shorter the petals. Stamen is one, filament is subulate and the anther is purple; ovary is glabrous. The fragrant flowers were formerly used in preparing an otto, Am Attar (a fragrant perfume) (Anonymous, 1992). The air-dried blossoms contain 15% tannin (as Gallo-tannic acid). Two light yellow, crystalline substances (m.p. 244 and 266°C), which are probably flavones, have been isolated from alcoholic extracts of blossoms (Anonymous, 1992). The flowers contain threonine, alanine, valine, tryptophan, glucose, galactose, arabinose as major phytoconstituents. The flowers are a rich source of amino acids (Rastogi and Mehrotra, 1993; astogi and Mehrotra, 1995) and hence serve to maintain the body amino acid pool.

FRUITS

The most common and famous part of *Mangifera indica* is its fruits (i.e. Mangoes). Mango fruits are renowned in India as Aam. It is a large fleshy drupe that can weigh 0.2 - 2 kg depending on the variety. Drupe is ovoid or kidney shaped with a typical goat shape on the extremity. Thick peel is green or yellow or orange depending on the maturity of fruits. Mesocarp is fleshy, yellow or orange, juicy and particularly sweet in April-June when it ripens. Endocarp is woody, covered with woody fibers and contains many seeds (Calabrese, 1993; Kirtikar and Basu, 1993; Sahni, 1998). The mango fruits are air dried, processed, mixed with different spices and sold in market in the name of aamar achar (mango pickles) and amchur. They are also sold in the market in form of jam, jelly, ice-cream flavors etc. The fruits contain cycloartenol, 3b-hydroxycycloart-24-en-26-al, 24-methylene-cycloartan-3b, 26-diol, C-24 epimers of cycloart-25-en-3b, 24-diol, α-amyrin, β-amyrin (III), dammarenediol II, C-taraxastane-3b, 20-diol, ocotillol, methyl mangiferonate, methyl mangiferolate, methyl isomangiferolate, sitosterols, a mixture of 5-(12-cis-heptadecenyl)- and 5-pentadecyl-resorcinols, vitamins A and C (Rastogi and Mehrotra, 1993; Rastogi and Mehrotra, 1995). Sucrose, glucose and fructose are the principal carbohydrates present in ripe mango; maltose is also present. Analyses of ripe fruits gave the following values: total sugars, 11.20 - 16.80%; reducing sugars, 1.40 - 4.83%; and non-reducing sugars, 8.19 - 13.81%. Small amounts of cellulose, hemicelluloses and pectins are also present. The green tender fruit is rich in starch; during ripening, the starch is hydrolysed into reducing sugars and a part of the latter is synthesized into sucrose. In the post-ripening stage sucrose decomposes into reducing sugars (Anonymous, 1992). Unripe, fully developed mangoes contain citric, malic, oxalic, succinic and two unidentified acids (probably di- or tri-basic acids); citric acid is the dominant constituent. Unripe fruits contain polysaccharides, a triterpene, acetates of cycloartanol, amyrin, lupeol, homomangiferin-2C-b-D-glucopyranosyl-3-methoxy-1, 6, 7-trihydroxyxanthone (II). As the fruit ripens, the acidity gradually decreases with a steep fall at the ripe stage. Analyses of mangoes showed that the acid content (as malic acid) ranged from 0.67 - 3.66% in green fruits and 0.18 - 0.56% in ripe fruits. The amino acids present in the non-protein nitrogen fraction of the mango fruit are aspartic acid, glutamic acid, alanine, glycine, methionine, leucines and possibly cystine and γ-amino-butyric acid (Anonymous, 1992). Ripe fruits constitute a rich source of vitamin A; some varieties contain fairly good amounts of vitamin C also. Flesh of mango contains - moisture 90.0%, protein 0.7%, fat 0.1%, carbohydrates 8.8%, mineral matter 0.4%, calcium 0.01%, phosphorus 0.02%, iron 4.5 mg/100 g, carotene 150 i.u., Riboflavin 30 μg, ascorbic acid 3 mg/100 g. The sugar and acid contents vary widely with variety and stage of maturity. The phytoconstituents of mango fruit vary with different factors. Such as, no trace of mangiferin (I) is detected in either healthy or in *A. niger* infected fruits. Instead, a number of free phenols, viz. phloroglucinol, 1, 2, 3, 4- and 1, 2, 3, 5-tetrahydroxy benzenes, were isolated from the

above parts. 1, 3, 6, 7-tetraoxygenated xanthones, though obtained in small quantities from healthy twigs and flowers of *M. indica*; its concentration is considerably increased when these parts were infected with *A. niger* and *F. monikformae*.

Like this, various phytoconstituents like 1, 3, 5, 6, 7-pentaoxygenated xanthones, kaempferol (IV), quercetin (X) and myricetin, depside of phloroglucinol carboxylic acid, gallic acid (VIII), C-gluco-depside, protocatechuic acids, triterpenes, amino acids, gluco-peptides, naphtho-γ-pyrones like flavasperone, rubrofusarin, aurasperone-A, aurasperone-A monohydrate and aurasperone-D, zearalenone and 12,13-epoxy-trichothecenes-all vary its contents mainly due to *F. moniliformae* and *A. niger* infection (Ghoshal *et al.*, 1978). The fruits of mango posses several aroma constituents which confers the mango with an aesthetic as well as sweet fragrance. The major components of raw mango odour are cis-ocimene and β-myrcene (IX) which contribute to the green fruit flavour. Ocimene, linalool, furfural, alloocimene, β-myrcene (IX) and lactones are also present in the ripe mango. The ripe mango contains the lactones: γ-butyrolactone, 50; γ-alerolactone, 20; γ-hexalactone, 50; γ-octalactone, 150; δ-octalactone, 30; γ-nonalactone, 30; d-nonalactone, 50; γ-decalactone, 50 and δ-decalactone, 20 ppb in pure form. Among 152 aroma substances characterized in Indian mangoes, ocimene and 2, 5-dimethyl-4-hydroxy-3(2H)-furanone was the prominent constituents (Anonymous, 1992). Most of the volatiles of the fruit are lost during storage and g-irradiation at higher doses. The most abundant terpene hydrocarbons in aroma composition of canned mango juice is limonene, β-myrcene, cis- and trans-ocimene and the most abundant oxygenated hydrocarbons include methyl butanoate, ethyl-2-methylbutanoate, furfural, α-terpineol and -octalactone (Anonymous, 1992). The fruit extract possesses significant immunomodulatory activity at an optimum dose of 400 mg/kg body wt. of rats and also showed immunomodulatory activity (Makare *et al.* 2001). Myricetin and kaempferol are known to posses potent hypolipidemic potential (Mukherjee, 2003). When the fruit is detached from the stem a thin fluid exudes with vesicating properties, known as chep, it has a turpentine-like odor when fresh, but soon dries to a straw-coloured, translucent, semi-solid odorless mass. A resin, mangiferen ($C_{21}H_{34}O$), a resinous acid, mangiferic acid ($C_{40}H_{60}O_4$) and a resinol, mangiferol $(C_{21}H_{36}O_2)_5$, all of which bear a close relationship to the abietic acid series of resins, have been isolated from the ether-soluble fraction of chep. The water-soluble fraction contains gum but no tannic or gallic acid (VIII). Chep is used as antifungal and antibacterial especially against *Micrococcus pyogenes var. aureus* (Anonymous, 1992).

The seeds are 3 - 4.5 cm long, 1.5 - 2.5 cm wide, ovoid, oblong covered with wrinkled integument, both upper and lower integument closely united, outer integument buff colored. The inner integument is reddish-brown; taste, bitter and astringent (Anonymous, 2001). Seed shows outer integument consisting of tangentially elongated, irregular, thin walled, parenchymatous cells, with poorly developing conducting tissues of vessels. It shows spiral thickenings towards the inner integument, wavy and large thin-walled parenchymatous cells. It has 2 cotyledons, composed of isodiametric parenchymatous cells fully packed of simple and compound starch grains. The starch grains compose of 2 - 6 components, each starch grain round to oval, measuring 2 - 28 μ in diameter, a few conducting tissues with spiral vessels also found scattered in parenchymatous cells of cotyledons (Anonymous, 2001). The kernels are roasted or boiled and used as food in certain parts of India. The seeds are traditionally used in acute diarrhea, gastrointestinal disease, vomiting, and inflammation and in some sexual diseases (Anonymous, 2001). The seeds contain stearic acid, α-pinene, β-pinene (VI), myrcene (IX), limonene, oleic (86.0%), arachidonic, linoleic, linolenic and palmitic acids (Rastogi and Mehrotra, 1993; Rastogi and Mehrotra, 1995). The seed kernels have an astringent taste and contain protein 9.5. fat 10.7, starch 72.80, sugar 1.07, tannin 0.11 and ash 3.66%,

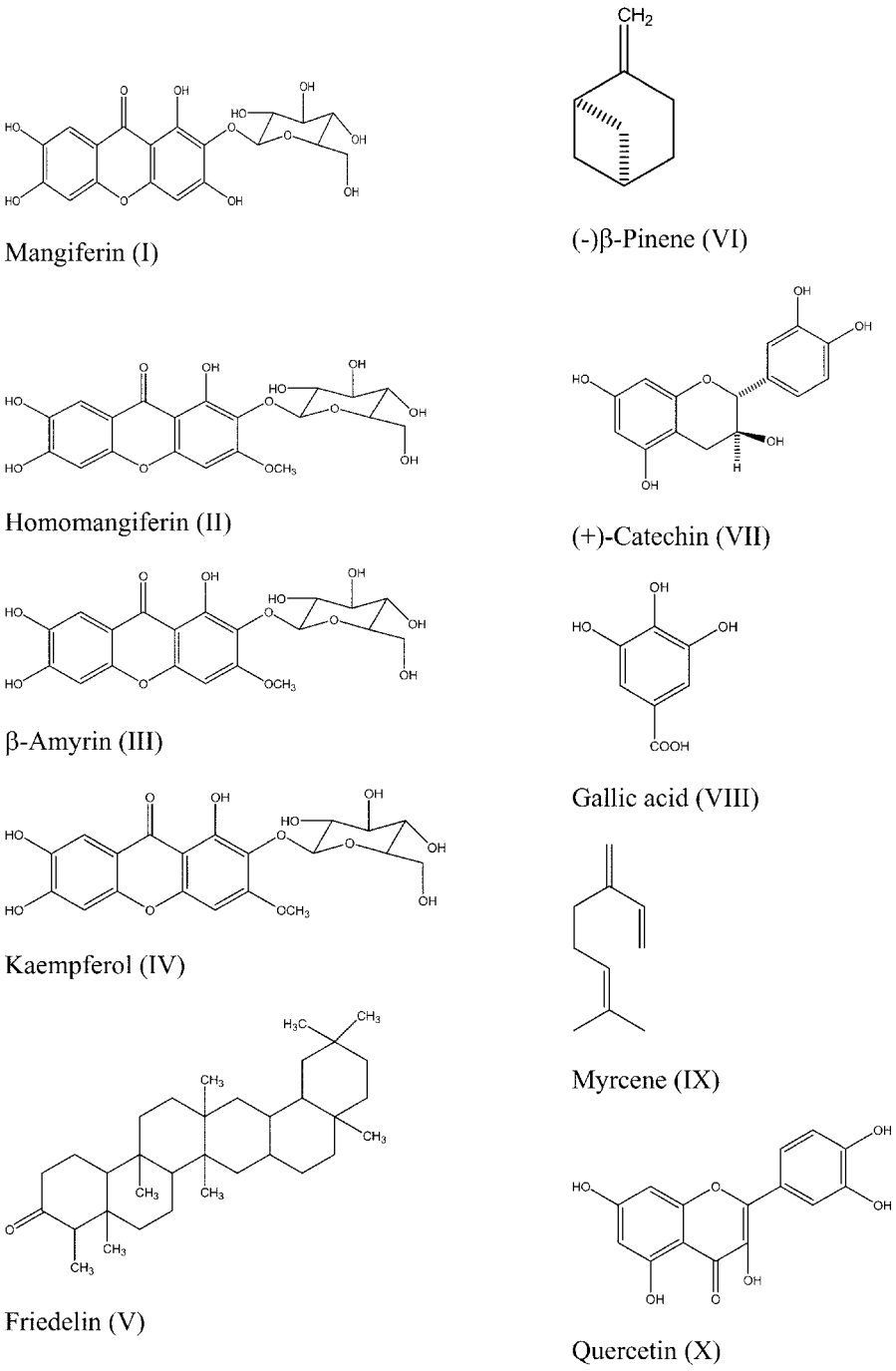

Fig. 1. Some important phytoconstituents from various parts of MI.

silica (SiO_2) 0.41, iron (Fe_2O_3) 0.03, calcium (CaO) 0.23, magnesium (MgO) 0.34, phosphorus (P_2O_5) 0.66, sodium (Na_2O) 0.28, potassium (K_2O) 1.31, sulphur (SO_4) 0.23 and carbonate (CO_3) 0.09%. The amino acids of the kernel proteins are cystine, aspartic acid, glutamic acid, glycine, threonine,

alanine, tyrosine, histidine, arginine, lysine, proline, valine, leucines and phenyalanine (Anonymous, 1992).

The aqueous and methanolic seed extracts of *M. indica* at the dose of 250 mg/kg orally, exhibited significant anti-diarrhoeal activity against castor oil and $MgSO_4$-induced diarrhoea. The results were comparable with that of standard drug loperamide (3 mg/kg) (Galvez *et al.*, 1993; Sairam *et al.*, 2003). The anti-diarrhoeal activity of these extracts may also be due to the presence of tannins and tannic acids (Anonymous, 1992), which denature proteins forming protein tannates. Both the extracts were found to have no significant antimicrobial activity against *E. coli* and *Klebsiella*, the two pathogens that can cause diarrhoea (Jawet *et al.*, 1980). The seeds also have antioxidant and hypolipidemic activity (due to the inhibition of HMG-CoA reductase enzyme inside the body) (Sharma *et al.*, 1992; Anila *et al.*, 2002). One unique property of mango seed is its antimicrobial activity from higher temperature like 121°C to a lower temperature like -20°C at an appreciable pH range 3 - 9 (Kabuki *et al.*, 2000). This property enables mango seeds to be used in antimicrobial medication as well as in food additives in wide temperature and pH range.

Table 1. Major phytoconstituents present in different parts of MI

Sl. No.	Phytoconstituents	Present in
1	α-amyrin	Fruits
2	β-amyrin	Fruits
3	Camphene	Leaves
4	Catechin	Leaves, bark
5	Citric acid	Fruits
6	Friedelin	Leaves
7	Gallic acid	Leaves, bark, flowers, fruits
8	Homomangiferin	Fruits
9	Kaemferol	Fruits
10	Lupeol	Leaves, fruits
11	Mangiferin	Leaves, bark, fruits
12	Myricetin	Fruits
13	β-Myrcene	Fruits
14	α-Pinene	Leaves, fruits
15	β-Pinene	Leaves, fruits
16	Protocatechuic acid	Leaves, bark, fruits
17	Quercetin	Leaves, fruits

ROOTS

The roots of *M. indica* are sold in Indian market for the astrological purposes. The roots contain one primary root and other secondary roots. The roots contain numerous branches. The roots contain friedelin (V), friedelan-3b-ol, α-amyrin, β-amyrin (III), cycloartenol, β-sitosterol (Rastogi and Mehrotra, 1993; Rastogi and Mehrotra, 1995). The mango root showed immunomodulatory activity at a dose 400 mg/ml (Makare *et al.*, 2001). Comparison of major phytoconstituents present MI and their distribution in the various parts of it is being shown in Table 1.

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