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Review Article

PHARMACEUTICAL IMPORTANCE OF *MANGIFERA INDICA*: A REVIEW

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ABSTRACT

Mangifera indica is a tree found in nature from ancient time and full of benefits to health and disease preventive strategies. It bears the botanical name as - *Mangifera indica* L. It has a lot of medicinal and nutritional importance as well as used in auspicious rituals. Having multiple health benefits *M. indica* has been proven a natural alternative medicine to many of life threatening disorders. Various research studies on *M. indica* have been reported remedial effect against different ailments including diabetes mellitus, certain bacterial diseases and oxidative stress induced disorders. In this context, the main aim of this review is to present various pharmacological activities of *M. indica*. From literature survey finally it is concluded that *M. indica* in its various forms are beneficial in multiple health aspects without having any adverse side effects. So it can be an effective way to minimize the complications of certain disorders as well as promotion of health.

Keywords: *Mangifera indica*, Health promotion, Disease prevention, Alternate medicine

1. INTRODUCTION

In last few decades' lots of lifestyle related disorders are capturing and engulfing a lot of fresh lives. Day by day its prevalence is increasing rapidly and peak of such incidence are also expanding. For such situation a lots of synthetic medicines are there for treatment purpose but apart from good effects a lots of side effects associated with the use of such medicines [1]. Hence, the need of natural alternative solutions and incorporation of such natural products in the synthesis of drugs and supplementation in health management is not in contraindication to environmental health. Out of so many herbs and plants, *Mangifera indica* is of very useful in various terms.

Mangifera indica (Mango Tree) is the plant since ancestral time prevailing in across various countries. Since ages, mango tree has been described as Kalpavriksha (wish granting tree) in India. It is known as the *king of fruits* and is the choicest fruit in India and abroad. Its long period of domestication in India is well evidenced from its mention in ancient scriptures. In Indian perspective its fruit, flower and leaves are used in various auspicious and religious rituals [2].

Literature indicated that different parts of *M. indica* like leaves, bark, stem, fruit, and seeds are having many natural beneficial effects on human health. Scientists reported the different pharmacological properties of *M. indica* including antioxidant, anti diabetic, antimicrobial, antitumor, anticancer, anti inflammatory etc [3, 4]. In this review, we try to present the different pharmaceutical activities of this medicinally important plant.

2. GENERAL DESCRIPTION OF THE PLANT

There are over 1000 varieties but mostly *M. indica* species are generally known as Mango, others species are called wild Mangoes. The native range of the plant is the genus *Mangifera* originates in tropical Asia, with the greatest number of species found in Borneo, Java, Sumatra, and the Malay Peninsula. The most-cultivated *Mangifera* species, *M. indica* (mango), has its origins in India and Myanmar. Mango trees prefer a warm, frost-free climate with a well defined winter dry season. Rain and high humidity during flowering and fruit development reduces fruit yields. The tree generally flowers in mid to late winter, with fruit maturing in the early to mid-summer months. Mango trees are usually between 3 and 10 metre (10-33 ft) tall but can reach up to 30 metre (100 ft) in some forest situations.

Various names are there for this plant according to different region or country languages. Pacific islands names include *mango*, *am* (Fiji), *mangko* (Kiribati), *mango*

(English), *mango* (Tonga), *mangot*, *mangue*, *manguier* (French), *mangueira* (Yap), *idele* (Palau), *kangit* (Chuuk, Pohnpei), *mago* (Niue, Samoa, Tuvalu).

Common names from other part of the world include *aam*, *am*, *amb* (Hindi), *ampleam* (Tamil) *bobbie manja*, *kanjanna manja*, *maggo*, *manggaboom*, *manja* (Dutch),*ma muang* (Indochina), *mamung* (Thailand), *manga*, *mango* (Spanish), m*anga* (Portuguese), *manga*, *mempelam*, *ampelam* (Malaysia) etc [5].

M. indica has several other species. *M. pentandra* (Malay Peninsula), *M. foetida* Lou. (Throughout South East Asia), *M. odorata* Griff. (Philippines, Malay Peninsula, Java), and *M. caesia* Jack. (Malay peninsula, Papua New Guinea, Java, and the Philippines) are the most wide spread [6].

BOTANICAL DESCRIPTION	
Kingdom	**Plantae - Plants**
Subkingdom	Tracheobionta - Vascular plants
Super division	Spermatophyta - Seed plants
Division	Magnoliophyta - Flowering plants
Class	Magnoliopsida - Dicotyledons
Subclass	Rosidae
Order	Sapindales
Family	Anacardiaceae - Sumac family (cashew family)
Genus	*Mangifera* - mango
Species	*Mangifera indica* L. - mango
Scientific Name	*Mangifera indica L.*

3. NUTRITIONAL COMPOSITION OF *M. INDICA*

Various nutritional components are found in *M. indica* both in term of micro and macronutrients. Different part of the tree e.g. fruit, leaves, bark may vary in little bit in different nutrient value. Micro nutrients like Vitamin C, Vitamin B1, B2, B3 and minerals Ca, Mg, Na, K, and P are present in both mango leaves and stem bark. Such essential micro nutrients are needed for normal physiological function including immunity modulation, growth and development, as well as prevention of various deficiency disorder prevention etc [7]. Side by side different fatty acids like palmitic, oleic and linoleic acids with a minor proportion of myristic and estearic acids are present. Many polyunsaturated and dicarboxylic acids of biological importance such as eicosatriencoic, succinic and malonic are also present in mango stem bark in trace levels [8].

According to Indian Food Composition Table (IFCT), raw *M. indica* fruit contains 205KJ of energy, 0.69g protein,0.08g total fat, 10.59g carbohydrate out of which 3.01g dietary fibre are present as total dietary fibre, 0.02 mg thiamin, 0.02mg riboflavin, 0.26 mg niacin, 25.86 µg folate, 90.24mg ascorbic acid, 72.37µg of beta carotene and 517µg of total carotenoids. Whereas ripe *M. indica* fruit contains 175KJ of energy, 0.54g protein, 0.55g total fat, 8.18g carbohydrate out of which 1.88g dietary fibre are present as total dietary fibre, 0.03mg thiamin,0.04mg riboflavin, 0.26mg niacin, 82.05 µg folate, 32.97mg ascorbic acid, 1168 µg of beta carotene and 1424 µg of total carotenoids. All the value expressed in terms of 100g [9].

4. PHARMACEUTICAL ACTIVITIES OF *M. INDICA*

4.1. Antioxidant properties

M. indica plant has potent anti oxidant properties for which it is used as antioxidant in several cases. Various parts of this plant like bark, leaves are rich in numerous phytochemicals like polyphenols (flavonoids, flavonol, tannins etc.) exhibit their antioxidant properties. Thus these are used as functional foods. Phytochemicals act as anti oxidant by inducing protecting enzymes, stimulating human system mechanism and also perform a lot of biological activities in human body through its antioxidant properties [10].

Various polyphenols protect from Oxidative Chemical Species (OCS) by scavenging free radicals which is associated with the lipid peroxidation initiation. Phenols being a phytonutrients can protect both human and the plant and these phenols are able to do this by preventing inflammation through the mechanism of blocking specific enzymes [11].

Beta-elemene which is one of the important phytochemicals of the terpenoids family and other phytoconstituents like linesol, beta-endesmol, alpha-guaience and B-seline etc. are also serves their antioxidant properties [8].

Another research study conducted in recent past evaluated antioxidant effects of mango peel powder and proved that the acetone extract of the *M. indica* peel exerts strong radical scavenging effects [12, 13].

4.2. Anti microbial activity

M. indica possess anti bacterial, anti fungal and antiviral potentiality. This potential has been proven against numerous gram positive and gram negative bacteria. *Staphylococcus aureus*, *Staphylococcus epidermidis* and *Bacillus cereus* are few examples of gram positive and three gram negative bacteria *Escherichia coli*, *Pseudomonas*

aeruginosa and *Klebsiella pneumonia against which anti bacterial property of M. indica* been proven. It has been reported that the phytochemicals present in the leaves of *M. indica* are responsible for such properties [14]. Another study by Doughari and Manzara reported that the extract of *M. indica* showed a potent antibacterial activity against Gram-positive and Gram-negative bacteria with MIC values ranging from12.5 to 175 mg/Ml [15].

Plant saponins help humans to fight against fungal infections, combat microbes and viruses. Mango stem barks contained 8.48 mg of saponins and the leaves contained 3.22 mg of saponins per 100 gm. These compounds served as natural antibiotics, helping the body to fight infections and microbial invasion [11]. Presence of phytoconstituent which are volatile in nature and having antiparasitic activity against *P. falciparum* and thus bark and mango leaves are used in malaria treatment [8].

Other study using methanol and ethanolic extract of bark of *M. indica* showed significant anti plasmodial effect [16]. Bidla *et al.* reported that methanol/chloroform extract derived from leaves of *M. indica* has shown moderate activity against *P. falciparum* and thus helpful in usage as plant medicine against malaria parasite which are getting resistant to different drugs [17].

Fungal infection is another worldwide problem, whereas limited antifungal drugs are effective. Therefore natural source of antifungal remedy is very important aspects. Laboratory studies show strong evidence of moderate antifungal effects on *Fusarium oxysporum*, *Fusarium avenaceum*, and *Pythium aphanidermatum by the organic solvent extrat of M. indica* [18]. Another study shows moderate anti fungal effects of leaves of *M. indica* ethanolic extracts against *Aspergillus ochraceus, Aspergillus niger,* and *Aspergillus ustus* [19]. Fungal strain *Colletotrichum gloeosporioides has been proven to be prevented by M. indica* aqueous extract of leaves of *M. indica* [20].

Mango kernel has also been reported to possess antifungal effects. A study carried out by Mutua *et al.* has reported methanolic kernel extracts of four mango varieties grown in Kenya exert inhibitory effects against *C. albicans* [21].

4.3. Anticancer activity

Now a day Cancer is been occurring so frequent and in large instances in different age group and community. Cancer is caused by several factors such as chemicals, radiations, tobacco, infectious microorganisms, hormones, gene mutations, and immune conditions. Though, modern surgeries have considerably reduced the cancer death rates, use of radiotherapy, chemotherapy, and hormone therapy treatments cannot completely reduce the number of deaths due to cancer. Plant-based treatments have been used in traditional medicine to treat different diseases including cancer since ancient times and a number of *in vitro* and *in vivo* studies have already been reported in literature to validate these uses [22].

M. indica due to its certain active compound has been proven as anticancer agent. Saponin is the component which destroys cancer cells and also inhibits it. Saponin have the capability to kill the cancer cell without killing normal cell by its virtue to bind with cholesterol which is present in higher quantity in cancerous cell and stops the proliferation of such cells [11].

Plant flavonoids, phytochemicals like isoflavones which are found naturally in *M. indica* have been proven to be anti carcinogenic. Such components protect human being from various cancers like testicular cancer, breast cancer which are very common now a day's [14, 23, 24]. Another study in Cuba on *M. indica* reported ethnomedical usage of this plant against many disorders including cancer [8].

Phenolic acid, hydroly-sable tannins and flavonoids are the potential phytoingredient found in *M. indica* which act as anti mutagenic and anti carcinogenic [25, 3].

Mangiferin is a well-known bioactive compound found in various parts of the mango tree. A number of studies have been carried out to illustrate antitumoral effects of mangiferin in various cancer cell lines such as breast, lung, ovary, brain, and cervix, and possible antitumoral mechanisms of mangiferin in several cancer cell lines have also been well-documented [26].

4.4. Antitumor property

Tumors which are generally known as benign and malignant and this malignant form can cause cancer as well. So early identification and rather prevention of tumor is very much needed in which *M. indica* plays a crucial role. Literature revealed that initiation, promotion and progression of tumors can be prevented by polyphenolic compound present in the plant [25]. These have been proven through various studies against the critical conditions like breast, uterine and prostate tumor growth [27].

M. indica contains certain saponins which effectively control certain kind of tumor cells specifically in cancer

of blood and lung. Another study also reported that beta-elemene, one of the major components in the terpenoids fraction found in this plant performs as anti tumor activity in various kind of leukemia and induce apoptosis of tumor cells [8, 11].

4.5. Antidiabetic activity

Diabetes mellitus is a major health problem affecting 442 million people worldwide [28]. *M. indica* and its various parts have been proven effective remedy against diabetes [8].

Alpha-amylase and glucosidase enzymes are two important enzymes plays an important role in catabolism of carbohydrates into disaccharides or oligosaccharides and their subsequent absorption into blood and thereby increment of glucose level in the blood. Thus control over these enzymes has important mechanism to control hyperglycemia in diabetes mellitus [29]. Alpha-amylase inhibition assay of aqueous extract of leaves of *M. indica* and isolated compound mangiferin was reported significant result and comparable with acarbose [30].

Fruit peel, flesh, seed kernel, leaves, and bark of *M. indica* have been extensively studied for their antidiabetic properties. In a study, Aderibigbe *et al.* found that aqueous extract of *M. indica* leaves can significantly reduce blood glucose level in experimental diabetic rats [31]. Another study using ethanolic extract of mango leaves in normal and streptozotocin-induced diabetic rat's demonstrated hypoglycemic potential of the plant extract [32].

4.6. Immuno-modulatory activity

Immunity is very important aspects of human health both in communicable and non communicable disorders. Immunomodulation can be of two types, namely immunostimulation and immunosuppression. Immunostimulation includes stimulation of the immune system with immunostimulating agents that activate components of the immune system (macrophages, certain T-lymphocytes and granulocytes) Development of desired immunity or boosting up immunity is a long term procedure in which multiple nutrients are involved. So ensuring all such nutrients which got importance to immunity can be called immune nutrients. A lots of natural plants including *M. indica* has got such immunomodulatory property, thus act as immunomodulator which are predominantly present in stem bark of the plant. In such way consumption of right dosage of such extract of this plant enhances the immunity power [8]. In a study Makare *et al.* have assessed immunomodulatory effects of an ethanolic extract of mango bark rich in mangiferin. Study documented that administration of the ethanolic bark extract increased delayed type hypersensitivity and humoral antibody titer suggesting possible immunostimulation by the extract [33].

4.7. Antihyperlipidemic activity

Hyperlidemia also known as dyslipidemia is an important underlying cause of death due to atherosclerosis and related other Cardio Vascular Diseases (CVD). Research study proved that plant source can act as an important anti hyperlipidemic agents and thus effective in production of drugs to treat hyperlipidemia [34]. A study conducted by Gururaja *et al.* reported that methanolic extracts of leaves of *M. indica* able to reduce cholesterol in experimental animals [35].

Several other lab based studies established the cholesterol lowering effect of leaves of *M. indica* in hyperlipemic rat models [36, 37, 38, 39]. Side by side Vasant and Narasimhacharya in their study documented effectiveness of powder of Mango fruit as anti hyperlipidemic agent [40]. Effectivity of mango bark in the form of aqueous extracts has been proven beneficial to reduce serum total cholesterol level in patient with type 2 diabetes mellitus [41].

4.8. Gastroprotective effects

Gastric ulcer which generally occurs in the stomach and duodenum lining are having several etiological factors e.g. diet, lifestyle, drug, alcohol, stress in physical or in mental form and generally treated by proton pump inhibitors to reduce secretion of HCL [42, 43]. In search of alternate medicine in situation of rising cases of peptic ulcer, several studies were done to find out best effective gastro protective effect of natural sources where *M. indica* been included. Study conducted by Lima *et al.* showed that decoction prepared from flower of *M. indica* could reduce acidity and gastric juice volume and thus having good gastroprotective effect [44]. Another study by Severi et al., narrates that gastric lesions which is generally induced by HCL, ethanol and Non Steroid Anti Inflammatory Drugs (NSAID) can be controlled by the decoction prepared from *M. indica* leaves [45].

4.9. Analgesic effects

Analgesic, including opioids, steroidal and nonsteroidal anti-inflammatory drugs, aspirin, acetaminophen, antiepileptics, and serotonin-norepinephrine reuptake inhibitors, are medications commonly used to treat many forms of pain. However, all of these agents may have significant adverse side effects [46].

Aqueous extract of *M. indica* leaves has shown significant analgesic activity in hot-plate and acetic acid test models of pain [47]. Study carried out by Ojewole *et al.* showed effective analgesic properties of aqueous extract of *M. indica* when tested in mice with nociceptive pain [48]. Another study conducted by *Islam et al.* has demonstrated analgesic effects of methanol extract of leaves of *M. indica*. Results have demonstrated a significant reduction in writhing response in an acetic acid-induced writhing response rat model [19].

4.10. Anti-inflammatory effects

M. indica is having an important role in pharmacology of plant origin which is natural, having no adverse effect. Different parts of *M. indica* i.e. leaves, bark, fruit, seed, flower are exhibit anti inflammatory properties [49]. Study reported that various compounds which are responsible for anti inflammatory properties are epigallocatechin gallate found in Leaves [50], 5-(11Z-Heptadecenyl)-resorcinold 5-(8'Z, 11'Z-heptadeca-dienyl)-resorcinol found in Fruit [51], Friedelin in Bark [37], Gallic acid in Seed [52], Humulene in Leaf and flower [37], Kaempferol in fruit [53], Mangiferin in Bark, leaves, fruit [54].

Literature indicated that numerous polyphenols components found in the plant *M. indica* which depends upon the chemical structure and their cell oriented target exhibit their anti inflammatory functions by the inhibition of Kappa -B (NF-kB) which is a nuclear factor [55]. Gout which occurs due to urate crystals in joints also was proven beneficial by the administration of ethanol extracts of *M. indica* leaves in rat models. The M. *indica* reduced the level of IL-1β and TNF-α mRNA and corresponding swelling in ankle of rat model with arthritis related to gout [56].

5. CONCLUSION

Mangifera indica serves as ethnomedical properties against a lot of disorders. The plant contains so many phyto constitutes which causes protective effect from various diseases. Extracts prepared from various parts of plants viz. leaves, bark, seed of fruit, fruit pulp, and roots are used extensively. Such extracts are used in preparation of phytomedicine against multiple disorders like cancer, diabetes, asthma, infertility, lupus, prostatic hyperplasia, mouth sores and tooth pain, gastric disorders etc.

Other disorders like asthma, Cancer, HIV/AIDS, gastric relaled concern, dermatological disorders are also being treated with medicines being prepared with the phytochemicals extracted from *Mangifera indica*. Both improvement of quality of human life and disease progression preventive aspects are being attended with usage of such phytochemical extracts of the plant.

Use of herbal medicine being a very integral part of every religion and is very easy to implement across different zone and type of people. Usage of this natural ingredient as nutritional supplementation and in drugs production will not have any adverse impact on natural environment. It is very cost effective way in term of numerous health benefits and treating aspect. If properly implemented in more scientific studies, it can be an effective alternate medicine in field of curative, preventive and promotive health aspect which have cost effectiveness, environment friendly and no such adverse health effect as side effects of synthetic medications.

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