

Anti-diabetic activity of mango (*Mangifera indica*): a review

Abstract

Mangoes (*Mangifera indica*) belong to genus *Mangifera* and family *Anacardiaceae*. Mangoes (*Mangifera indica*) consist of about 30 species of tropical fruiting trees. It is cultivated on an area of approximately 3.7 million in the worldwide and it is on the second position as a tropical crop, in terms of production second to bananas. According to Ayurveda and different herbal books and journals mango tree has many medicinal properties in different parts of the tree. Mango possesses anti-diabetic, antioxidant, anti-viral, anti-inflammatory properties. Various effects like antibacterial, anti-fungal, anthelmintic, anti-parasitic, anticancer, anti HIV, anti bone resorption, antispasmodic, antipyretic, antidiarrheal, immunomodulation, hypolipidemic, anti-microbial, hepatoprotective, gastro protective have also been studied by different scholars and scientists. In this review article we have studied about anti-diabetic activity of Mango stems-bark, leaves and seeds.

Keywords: mango (*Mangifera indica*), anti-diabetic activity

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Introduction

Mango (*Mangifera indica* L.) is a juicy fruit belongs to the family of *Anacardiaceae* and is grown in many parts of the world, particularly in tropical countries and is also considered to be the national fruit of India and Philippines and the national tree of Bangladesh. Nearly 1000 varieties of mango are available, out of which few are traded commercially in 87 countries.^{1,2} Mango is cultivated on an area of approximately 3.7 million in worldwide. In terms of production mango is the second most tropical crop cultivated, after banana.³ Mango fruits are an important source of micronutrients, vitamins and other phytochemicals micronutrients, vitamins and other phytochemicals along with it provides energy, dietary fiber, carbohydrates, proteins, fats and phenolic compounds.⁴ Stems, bark, leaves and seeds of mango found to have important role for the treatment of diabetes.⁵⁻¹² The World Health Organization recommended the use of traditional medicine for diabetes treatment.¹³⁻¹⁷ Herbal medicines are used as alternative agents helpful to decrease blood glucose levels, with minimal side effects and low cost.¹⁹ Among those herbal plants Mango (*Mangifera indica* L.) is one of the effective plants which is used for treatment of diabetes in different communities.⁵

Properties of mango seed, leaf, and stem-bark

Mango (*Mangifera indica* L.) family *Anacardiaceae* is one of the most popular, edible, tropical fruit for its unique taste, attractive colour and flavor, affordability and nutritional qualities. It is a rich source of vitamins, organic acids, carbohydrates, amino acids, phenolic acids (e.g., gallic acid, caffeic acid, and tannic acid) and certain volatile compounds.^{19,20} Many of the pharmacological properties present in mango and those might be due to the presence of phenolic acids. These phenolic compounds possess potent antioxidant activity helpful for protecting the body tissues against oxidative stress with their anti-diabetic, antioxidant, anti-inflammatory, antilithiatic and anticarcinogenic properties.^{21,22} Apart from the fruit, mango flesh, leaf, stem-bark also has been reported to have anti-diabetic, antilithiatic and free radical scavenging properties.²³ Even the stem and bark of this plant has antioxidant, anti-inflammatory and Immuno modulator activities and has been formulated (tablet, capsule, syrup and cream)

in various food supplements like antioxidant, anti-inflammatory, analgesic and immunomodulatory and have been extensively used to prevent and cure diseases like HIV/AIDS, cancer, asthma, gastric and dermatological disorders in country like Cuba.²⁴

Mango seed, stem-bark and leaf constituents

Major chemical constituent present in mango leaf is mangiferin (Figure 1), other constituents are selected anthocyanidins including delphinidin, peonidin and cyanidin, leucoanthocyanins, catechin and gallic tannins. The mangiferin content of mango leaves ranges from about 2-15% depending on the variety and geographic source, while extracts of mango leaves contain up to approximately 60% mangiferin. Mango leaf oil is rich in sesquiterpene and also contains mangiferin, δ -3-carene, α -gurjunene, β -selinene and β -caryophyllene. Mango leaves also contain alkaloids (0.84 \pm 0.11mg/100g), phenols (0.09 \pm 0.20 mg/100 g), flavonoids (11.24 \pm 0.10 mg/100g), saponins (3.22 \pm 0.10mg/100g) and tannins (0.45 \pm 0.10 mg/100 g). Those also contain high amounts of polyphenolic antioxidants including xanthonoids, mangiferin and gallic acid.^{25,26} Yusukol et al., confirmed the content of mangiferin and it ranged from 1.94 to 13.79mg/g (%w/w).²⁷ Sharma et al.,²⁸ assessed the mangiferin content of aqueous extracts of 30 varieties of mango from west India using HPLC and UV detection.²⁸ The average mangiferin content from these varieties was 17.5mg/g with the highest content from a Ladvo variety being 47.02mg/g. Mango leaves also contain calcium (3.82 \pm 0.1mg/100g), magnesium (0.91 \pm 0.20mg/100g), potassium (0.83 \pm 0.10 mg/100g), sodium (0.38 \pm 0.11 mg/100g), zinc (7.88 \pm 0.10mg/100g), cadmium (1.50 \pm 0.20 mg/100g), copper (8.68 \pm 0.10 mg/100 g) and phosphorus (0.78 \pm 0.10mg/100g).²⁹ Furthermore, mango leaves are a good source of ascorbic acid (29.92 \pm 0.11mg/100g), riboflavin (0.09 \pm 0.10mg/100g), niacin (0.75 \pm 0.20 mg/100g) and thiamine (0.45 \pm 0.11mg/100g).²³ Mangiferin is the major phytochemical component in mango stem bark. Other flavonoids and flavonol constituents include quercetin, catechin and epicatechin (Figure 2).²⁴ Mango stem bark also contains polyphenols, terpenoids, sugars and saponins. Many phenolic constituents, benzoic acids and its propylester (Figure 3), three free sugars (galactose, glucose and arabinose) and three polyalcohols

(sorbitol, myo-inositol and xylitol) are identified and tested from the mango fruits and stem bark. Volatile components present in mango stem bark are β -elemen, aromadendrene, β -selinene, hinesol, β -endesmol, β -sitosterol and β -campesterol (Figure 4).²⁴

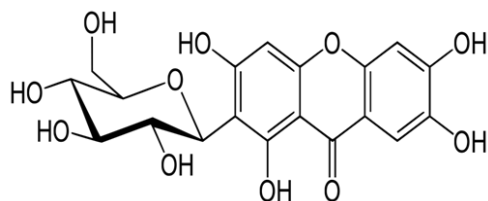


Figure 1 Structure of Mangiferin.

Chemistry and structure of mangiferin

The significant potential of mangiferin (2C- β -D-glucopyranosyl-1,3,6,7-tetrahydroxyxanthone; molecular formula C₁₉H₁₈O₁₁; CAS

4773-96-0; molecular weight 422.34), a xanthone-C-glycoside is present in different plant species, having versatile anti-inflammatory responses, potent antioxidant, radio protective, immunomodulatory and anti-cancer properties, as well as for disease management and health benefits. The antioxidant efficacy of mangiferin is stronger than cinnamon. Furthermore, mangiferin exerts a pro-hypoglycemic activity by modulating glucose metabolism, ameliorating insulin resistance, lowering cholesterol synthesis, and inhibiting the expression of the TNF- α and inducible nitric oxide synthesis.³⁰ Chemically, mangiferin is composed of a glucose unit C1 \rightarrow 2 chemically bonded to a 1,3,6,7-tetrahydroxyxanthone aglycone, and lately it has been recognized as a potential pharmacophore. It is a light yellow colour crystalline powder, slightly soluble in ethyl alcohol, sparingly soluble in methyl alcohol and water, and insoluble in diethyl ether, acetone and hexane.^{29,31,32} The solubility of mangiferin decreases with increasing temperature in the order ethanol>methanol>water>diethyl ether>acetone >n-hexane.^{26,29}

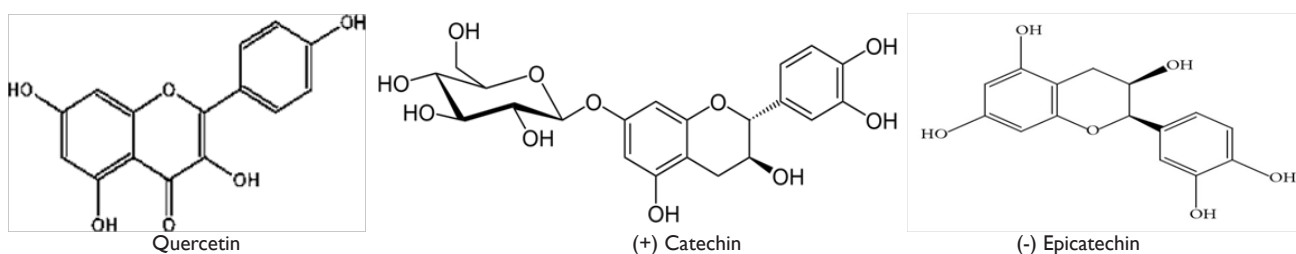


Figure 2 Flavonoid constituents of mango stem barks.

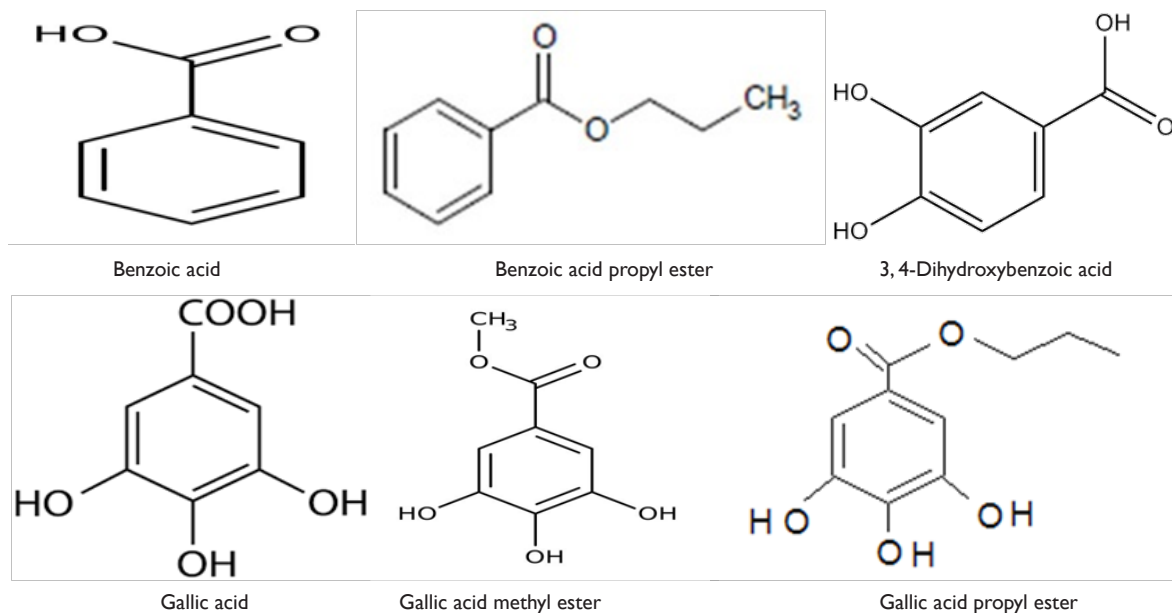


Figure 3 Phenolic constituents, benzoic acid and benzyl ester derivatives from mango stem Barks.

Ethno medicinal uses of mango (*Mangifera indica*) plant

Roots and bark are used as as astringent, acid, refrigerant, styptic, anti-syphilitic, vulnerary, anti-emetic, anti-inflammatory and constipating. They are useful in vitiated conditions of pitta, metrorrhagia, calonorragia, pneumorrhagia, leucorrhoea, syphilis, uteritis, wounds, ulcers and vomiting. The juice of fresh bark has a marked action on mucous membranes, in menorrhoea, leucorrhoca, bleeding piles and diarrhoea. Leaves are used as astringent, refrigerant styptic, constipation, cough, hiccup, hyperdipsia, burning sensation,

hemorrhages, haemoptysis, haemorrhoids, wounds, ulcers, diarrhoea, dysentery, pharyngopathy and stomachopathy. Leaves ashes are useful in burns, scalds and smoke from burning leaves is inhaled for relief of throat diseases. Flowers are used as astringent, refrigerant, styptic, vulnerary, constipating and haematinic. The dried flowers are useful in vitiated conditions of pitta, haemorrhages, haemoptysis, wounds, ulcers, anorexia, dyspepsia, and uroedema gleet, catarrh of bladder, diarrhoea, chronic dysentery and anemia. The unripe fruits are acidic, acid, antiscorbutic, refrigerant, digestive and carminative. The ripe fruits are refrigerant, sweet, emollient, laxative, cardiotoxic, haemostatic, aphrodisiac, and tonic. They are also used

in vitiated conditions vata and pitta, anorexia, dyspepsia, cardiopathy, haemoptysis, haemorrhages from uterus, lungs and intestine, emaciation, and anemia. The seed kernel is rich source of protein (8.5%) and gallic acid. It is sweet, acrid, astringent, refrigerant, anthelmintic,

constipating, haemostatic, vulnerary and uterine tonic. It is useful in vitiated conditions of pitta and cough, helminthiasis, chronic diarrhea, dysentery, haemorrhages, haemoptysis, haemorrhoids, ulcers, bruises, leucorrhoea, menorrhagia, diabetes, heat burn and vomiting.³³

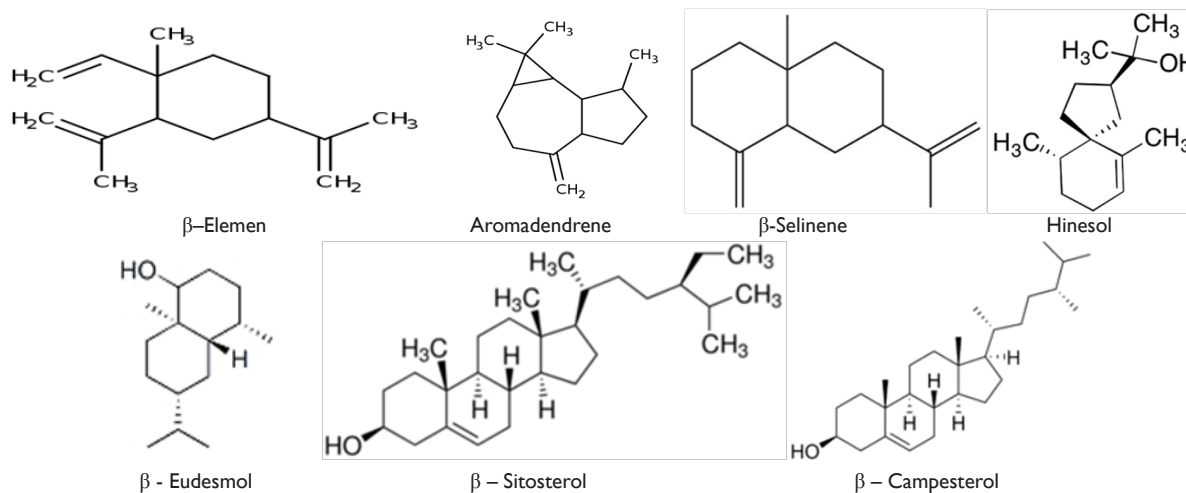


Figure 4 The volatile constituents of mango stem bark.

Anti-diabetic benefits of *Mangifera indica*

OT Adedosu et al., studied that a significant ($P < 0.05$) increase in the fasting blood glucose concentrations was obtained in the alloxan-induced diabetic rats. When those diabetic rats were treated with the ethanol leaves extract of *M. indica* showed significant ($P < 0.05$) decreases in the fasting blood glucose levels compared with the untreated diabetic rats.⁸ CD Luka and A Mohammed studied that aqueous extract of *M. indica* leaf decreased blood sugar level in diabetic rats. It is also confirmed that the extract at a dose of 400mg/kg body weight reduce significantly ($P < 0.05$) the blood glucose level. But the mechanism of action of plant extract was unknown. The extract significantly ($P < 0.05$) decreased the serum cholesterol level in diabetic rats.³⁴ MS Rajesh and J Rajasekhar studied that he long term (21 days) administration of methanolic and aqueous extract of *Mangifera indica* was effective in decreasing the blood glucose level and normalizing the other biochemical parameters in diabetic rats. The single dose study of the extract has no hypoglycemic effect on normal rats. Further studies need to be carried out to define the active principle(s) present in the extracts. They also confirmed that oral administration of *Mangifera indica* seed kernel extracts lowered total cholesterol and triglycerides level in diabetic rats when compared to diabetic controls.⁹ Amrita Bhowmik et al.,¹⁰ investigated about hypo/antihyperglycemic activity of *M. indica* leaf and stem-bark extracts in no diabetic, type 1 and type 2 diabetic model rats. The extracts of *M. indica* leaves and stem barks showed significant antihyperglycemic effect in type 2 diabetic model rats when the extracts were fed simultaneously with glucose. Single oral administration of a dose of 250 mg/kg body weight produces a potent and strong hypoglycemic effect in type 2 rats.¹⁰ Ahmad Muhtadi et al.,³⁵ studied that the leaves extract of *M. indica* L. used for antidiabetic properties using normoglycemic, glucose-induced hyperglycemia, and STZ-induced diabetic mice. The aqueous extract of the leaves of *M. indica* L. possesses hypoglycemic activity.³⁵

Conclusion

In this review article we have studied about anti-diabetic activity of different parts of *Mangifera indica*. Various authors mentioned the

ethanolic, methanolic and aqueous extracts of seeds, stem-bark and leaf of *Mangifera indica*. Among all chemical components Mangiferin was found as a major chemical which is responsible for anti-diabetic activity. A part of anti-diabetic property those extracted media also decreased the serum cholesterol level in diabetic rats.

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None.

Conflicts of interest

The authors declared there is no conflict of interest.

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