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A Review of Phytochemical and Pharmacological Activity of *Mangifera indica* Linn.

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ABSTRACT

Ayurvedic medicine frequently use the herb Mangifera indica. Review articles on this plant have already been published; however this one is meant to gather the most recent data on its pharmacological and phytochemical activity, which were investigated extensively using various techniques. Mango is said to have anti-inflammatory, anti-viral, cardiotonic, anti-oxidant, and anti-diabetic qualities. Numerous effects have also been examined, including immunomodulation, hypolipidemia, antimicrobial, hepatoprotective, gastroprotective, antibacterial, antifungal, anthelmintic, antiparasitic, antitumor, anti-HIV, anti-bone resorption, antispasmodic, antipyretic, antidiarrheal, antiallergic, and immunoregulation. These promising trials suggest that further research on this plant is necessary to validate these findings and uncover further potential medicinal benefits. Mango should also be used in clinical trials for a range of illnesses.

Keywords: Mangifera indica; mangiferin; pharmacological activities; phytochemistry.

INTRODUCTION [1]

Mangifera indica (MI), also referred to as mango or aam, has been used for more than 4,000 years in indigenous and Ayurvedic medicine systems. Mangoes are members of the Anacardiaceae family of flowering plants, specifically the genus Mangifera, which includes roughly thirty species of tropical fruiting trees. Ayurveda attributes various therapeutic virtues to various portions of the mango tree. Among all tropical fruits, mangos are among the most widely consumed. Mangiferin has potent antioxidant, anti-lipid peroxidation, immunomodulation, cardiotonic, hypotensive, wound healing, antidegenerative, and antidiabetic properties. It is a polyphenolic antioxidant and glucosyl xanthone. Plant parts are utilized for treating diarrhea, dysentery, anemia, asthma, bronchitis, cough, hypertension, insomnia, rheumatism, toothache, leucorrhoea, hemorrhage, and piles. They are also employed as a dentrifrice, antiseptic, astringent, diaphoretic, stomachic, vermifuge, tonic, laxative, and diuretic. Abscesses, broken horns, spitting, datura poisoning, heat stroke, miscarriages, anthrax, blisters, mouth wounds, diarrhea, glossitis, indigestion, bacillosis, bloody dysentery, liver disorders, excessive urination, tetanus, and asthma can all be treated with all of the parts. Mango fruit that is ripe is said to be energizing and refreshing. The juice is used to treat heat stroke and is a restorative tonic. The seeds have astringent and asthmatic properties. Inhaling the fumes from the burning leaves might help relieve sore throats and hiccups. The bark is thought to have a tonic effect on mucous membranes, be used in rheumatism and diphtheria, and be astringent. Gum is utilized in scabies and cracked foot treatments. It is regarded as anti-syphilitic as well. After being soaked in water to remove the astringent properties, the kernels are ground into flour. The majority of the tree's parts are utilized medicinally, and tannins found in the bark are used to color fabrics.

TAXONOMICAL CLASSFICATION [1]

- Kingdom :Plantae
- Subkingdom : Tracheobionta
- Superdivision : Spermatophyta
- Division : Magnoliophyta
- Class : Magnoliopsida
- Subclass : Rosidae
- Order : Sapindales
- Family : Anacardiaceae

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- Genus : Mangifera
- Species : M. indica

SYNONYMS [1]

Sanskrit	: Ambrah; Madhuulii; Madhuula; Madhuulaka;
English	: Mango;
Hindi	: Aam;
French	: mango; mangue; manguier;
Portuguese	: manga; mangueira;
Dutch	: manja;
Tamil	: Ambiram; Mambazham; Mambalam; Mangai;
Punjabi	: Amb; Wawashi;
Gujarati	: Ambo, Keri; Marvo (unripe);
Kashmiri	: Amb;
Malayalam	: Amram; Choothaphalam; Manga; Manpalam; Mavu;
Marathi	: Amchur; Amba

BOTANICAL DESCRIPTION [1]

Within the Anacardiaceae family, MI is a huge evergreen tree that can reach a height of 10-45 meters. It has a dome-shaped canopy with dense foliage that is usually heavily branched from a sturdy trunk. The leaves are spirally organized on branches; they are linear-oblong, lanceolate-elliptic, pointy at both ends, and typically measure approximately 25 cm by 8 cm, however they can occasionally grow considerably larger. When the leaves are first developed, they are reddish and thickly flaccid, and when they are crushed, they release a fragrant odor. The inflorescence takes the form of panicles with roughly 3000 small yellowish-green or whitish-red flowers. The fruit, a well-known big drupe, varies greatly in size and shape. When ripe, it has a thick, yellow pulp, a solitary seed, and a thick, reddish-yellow skin. The seed is single, round, or oval in shape.

Habitat [1]

It originated in tropical Asia, was domesticated for more than 4,000 years on the Indian subcontinent, and is today a found naturalized of most tropical nations.

Parts used: Roots, bark, leaves, fruits, seeds, flowers and kernels are used.

LEAVES

BARK

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FLOWERS

FRUITS

ROOT

SEED

PARTS OF *MANGIFERA INDICA*

ETHNOMEDICINAL USES [2]

Various parts of mango are used for more than thousands of years as wide variety of ethnomedicinal use.

Bark and Roots

Used as acrid, styptic, anti-emetic, astringent, refrigerant, anti-inflammatory, vulnerary and anti-syphilitic. In cases of pneumonia, calonorrhagia, pitta, lecorrhoea, metrorrhagia, vomiting, sores, syphilis, ulcers and uteritis, they are useful. Freshly prepared bark juice has a remarkable impact on mucous membranes, resulting in diarrhea, bleeding piles, leucorrhoea, and menorrhoea.

Leaves

Used as astringent, constipating, vulnerary, styptic, and refrigerant. Additionally, they are helpful in administering affected conditions such as burning sensation, coughing, hiccups, hyperdipsia, hemorrhages, hemoptysis, hemorrhoids, ulcers, dysentery, wounds, diarrhea, pharyngopathy and stomachopathy. The ash from burned leaves can help with scalds and burns. The smoke from burning leaves can be inhaled to alleviate throat conditions.

Flowers

Have vulnerary, cooling, constipating, astringent, styptic, and hemostatic properties. The dehydrated blossoms are beneficial for treating vitiated pitta problems, hemorrhages, hemoptysis, wounds, ulcers, uroedema, anorexia, gleet, dyspepsia, bladder catarrh, diarrhea, chronic dysentery, and anemia.

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Fruits

The fruits which are unripe have acidic, refrigerant, acrid, carminative, antiscorbutic and digestive properties. They help with urethrorrhea, vaginopathy, eruptions, and dysentery ophthalmia. The properties of ripe fruits include the following: they are sweet, tonic, cardiotonic, laxative, haemostatic, emollient and aphrodisiac. In vitiated disorders including cardiopathy, anorexia, dyspepsia, hemoptysis, hemorrhages from the lungs, intestine and uterus, emaciation, and anemia, are employed as well.

Seed

The seed kernel is an abundant source of gallic acid and protein (8.5%). It has astringent, acrid, sweet, vulnerary, constipating, uterine tonic, refrigerant, haemostatic and anthelmintic properties. The affected conditions of cough, pita, helminthiasis, hemorrhages, menorrhagia, hemoptysis, diabetes, bruising, vomiting, heat burn, ulcers and hemorrhoids can profit from it together.

PHYTOCHEMISTRY [3-31]

There have been reports of a wide range of chemical substances in M. indica [3]. Among these, the most prevalent types of compounds in *mangifera indica* are polyphenols, which include flavonoids, xanthones, and phenolic acids [4]. The main polyphenolic substances identified in *mangifera indica* include quercetin, gallic acid, mangiferin, kaempferol, ellagic acids, protocatechuic acid, methyl and propyl gallate, catechins, anthocyanins and rhamnetin [5]. A renowned polyphenolic molecule with many biological applications, mangiferin has been the subject of in-depth research [6]. Varieties of mango and parts vary in their amounts of various polyphenols [7]. It has been established that the primary biological characteristic of nearly all mangifera indica polyphenols is their antioxidant capacity [8]. Two more common polyphenols discovered in M. indica are dehydroascorbic acid and ascorbic acid which is the ascorbic acid in its oxidized form [9]. Many areas of mangifera indica have significant polyphenol content. As a result, this has been demonstrated that pure compounds are less efficient than crude ones, suggesting that the synergy of several M. indica polyphenols is necessary for the best biological activities [10, 11]. Plants also contain a series of naturally occurring chemicals called carotenoids. They are regarded as natural organic pigments. The carotenoids are what give mangifera indica fruit skin and flesh their vivid yellow color [12]. They are excellent biological scavengers of free radicals [13]. This has been noted that mangifera indica fruit biosynthesizes carotenoids, and that as the fruit ripens, the content of carotenoids increases [14]. The carotenoids mainly in mangifera indica fruit peel and flesh include luteoxanthin. β-carotene, neoxanthin, violaxanthin, cryptoxanthin and zeaxanthin. The most prevalent of them is beta-carotene [15]. In similar to terpenoids and terpenes are a type of lipids that are frequently seen in plants [16]. Numerous terpenoids, such as terpinolene, ocimene, myrcene, limonene or careen have been reported to be present in M. indica [17].The smell of mangifera indica is caused by these volatile terpenoids [18]. Mangos also include two more frequent triterpenoids: lupeollinoleate and lupeol [19]. Another type of substances that are chemically present in the leaves, fruit pulp, bark and kernel of mangifer indica are called gallotannins, or hydrolyzable tannins [20]. It has been claimed that M. indica also contains tocopherols. The flesh and fruit peel of M. indica are usually contain alpha-, beta-, and gamma-tocopherols [21]. M. indica contains phenolic lipids, also known as résorcinolic lipids, which are another type of natural chemicals. Bark, fruit peels and flesh of mangifera indica have been shown to yield a broad variety of lipids of resorcinolic with varying biological characteristics [22]. It has been resulted that a new lipid of resorcinolic with anticancer properties from the native Sri Lankan mango's bark, Mangifera zeylanica [23]. It was previously believed that only maritime plants and microbes contain halogenated chemicals. However, an Indian investigation found that halogenated chemicals were included in mangifera indica bark [24]. The new two halogenated chemicals (bromomangiferic acid and chloromangiferamide) were separated from the bark of M. zeylanica, according to a current investigation we conducted [25]. In M. indica, mangiferin and quercetin are most frequently detected. Research on the safety and toxicity of these two compounds-containing foods, which include mango fruits, have been extensively documented [26-28]. This is because these food items are widely present in the diet of humans. In addition, several toxicity and safety tests have been conducted on kaempferol, and also another well-known mango component, to confirm its usage in also the human diet [29-31]. The majority of the research have noted that in examined animal models, mangiferin, kaempferol and quercetin are less hazardous.

PHYTOCHEMICALS IN DIFFERENT PARTS OF *Mangifera indica*

LEAVES[32-37].

Leucine, alanin, valine, glycine and tyrosine and θ-aminobutyric acid are examples of amino acids. Catechin, protocatechuic acid, mangiferin, hyperin, gallic acid, quercetin, ethyl digallate, kainic acid, shikimic acid and ellagic acid are examples of phenolic acids and polyphenols. Etyl, isobutyl, and methylic alcohols are examples of alcohols. Terpenes include friedelin, linalool, lupeol, β-bulnesene, α-guaiene, humulene, α-farnesene, myrcene, car3-ene, limonene, β-ocimene, β–terpinene, and α-terpinolene. Elemicin, methyleugenol, and estragole are examples of phenylpropenes. B, C, and D-sitosterol are examples of sterols.

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FLESH AND PEEL FRUIT[22, 32-37]

Cycloartenol, α-amyrin, β-amyrin, 3b-hydroxycycloart-24-en-26-al, ocotillol, 24-methylene-cycloartan-3b,26-diol, psi-taraxastane-3b and dammarenediol II are examples of triterpenoids and triterpenes. Quercetin, ascorbic acid, hexa-O-galloylglucose, quercetin 3-ara, mangiferin, mangiferin gallate, methyl mangiferolate, quercetin 3-rha, isomangiferin gallate, methyl mangiferonate, ferulic acid, tetra-O-cgalloylglucose, vanillin, methyl isomangiferolate, caffeic acid, kaempferol-hexose, gallic acid, rhamnetin-3-O-galactoside, kaempferol, are examples of phenolic acids and polyphenols. 5-(11 Z-heptadecenyl)-resorcinol and 5(8' Z,11'Z-heptadecadienyl)-resorcinol are examples of lipids of resorcinolic. β-carotene, neochrome, zeaxanthin, luteoxanthin, cis-violaxanthin, 9- or 9-cis-lutein and cis-neoxanthin are examples of carotenoids. Linoleic acid, n-pentacosanol, oleic acid, linolenic acid, are examples of fatty acids of long-chain.

ROOT[32-37]

Among the triterpenoids and triterpenes are cycloartenol, friedelin, α-amyrin, β-amyrin, and friedellan-3b-ol. Among the steroids are 3-methoxy-2-(4 -methyl benzoyl)-chromone and β-sitostero.

BARK[24, 32–38]

Catechin, protocatechuic acid, benzoic acid, mangiferin, kainic acid, kaempferol, gallic acid, and shikimic acid are examples of phenolic acids and polyphenols. Mangocoumarin, cycloart-24-en-3b,26-diol, friedelin, 3-ketodammar-24(E)-en-20S,26-diol, manglupenone, cycloartan-3β-30-diol and manghopanal are examples of triterpenes and triterpenoids, cycloartan-3b,24,27-triol, mangiferolic acid ethyl ester, 29-hydroxymangiferonic acid, mangoleanone, mangiferolate A and B. 3-chloro-N-(2-phenylethyl), propenamide is an example of a halogenated amide. N-tetracosane, 9,12-tetradecadiene1-ol-acetate and N-triacontane are examples of long-chain hydrocarbons. Indocoside A and B are terpenoid saponins. Glycine, alanine, and N-aminobutyric acid are examples of amino acids.

KERNAL AND SEED [32–40]

Eicosanoic acid, linoleic, arachidonic acid, oleic acid, stearic acid, palmitic acid, linolenic are examples of fatty acids and long-chain hydrocarbons. Campesterol, sitosterol, and stigmasterol are examples of sterols. Myrcene, limonene, α-pinene, and α-pinene are examples of triterpenoids and triterpenes. Mangiferin, gallic acid ascorbic acid and quercetin are examples of phenolic acids and polyphenols.

FLOWERS [32–41]

Tryptophan, alanine, valine, and threonine are examples of amino acids. Mangiferin, ellagic acid, gallic acid and quercetin, are examples of phenolic acids and polyphenols. β-pinene, limonene, nerol, α-phellandrene, and α-pinene are examples of triterpenoids and triterpenes.

PHARMACOLOGICAL ACTIVITIES

Even if the contents of the product have been the subject of numerous pharmacological studies, there is still much more to be discovered, used, and benefited from. The results of these studies are summarized in the section below.

ANTI-OXIDANT [42-50]

Reactive oxygen species (ROS) and strong oxidizers cause damage to biological components such as DNA, proteins and lipids, altering their structure and function in the process.[42] The three main antioxidants found in food, vitamin E, vitamin C, and β-carotene, may help prevent a number of chronic illnesses.[43] There has been a lot of attention in the potential for chemoprevention and therapeutic applications to strengthen antioxidant defenses.[44] The extract functioned as an iron chelator and shown a strong hydroxy radical scavenging ability. Additionally, it demonstrated a strong inhibitory impact on the phospholipid peroxidation of rat brain and avoided DNA damage brought on by copper-phenenthroline or bleomycin systems[45]. The results of a research on the interaction between Vimang (MI extract) and Fe (III) support Vimang's excellent efficacy as a defense against oxidative damage caused by iron.[46] The goal of the study is to determine how three substances with the potential to be carotenoids, total phenolics, ascorbic acid and antioxidants relate to the pulp composition of the four mango growers, namely Tommy, Haden, Ubá and Atkins when the fruit is ripening. These findings supported earlier research suggesting that mangoes are a rich dietary source of antioxidants.[47] The impact of a mango tree (MI) stem bark aqueous extract on the production of reactive oxygen species in PMA- or zymosan-stimulated human polymorphonuclear leukocytes and on superoxide radicals generated in the hypoxanthine–xanthine

oxidase reaction were investigated using luminol-enhanced chemiluminescence. The formulations of this extract are used as dietary supplements in Cuba under the brand name Vimang. The primary component of this MI extract, mangiferin, may be responsible for some of its antioxidant properties.[48] It was discovered that Vimang's ability to complex iron serves as the main defense mechanism for rat liver mitochondria against Fe2+-citrate-induced lipoperoxidation. Since Vimang may be a viable option for antioxidant therapy in conditions linked to aberrant intracellular iron transport or iron overload, the findings have pharmacological significance.[49] A comparison was made between the protective effects of MI mangiferin 50 mgkg(-1) and stem bark extract (Vimang) 50-250 mgkg(-1) as well as specific antioxidants (vitamin E 100 mgkg(-1), beta-carotene 50 mgkg(-1), vitamin C 100 mgkg(-1)), against the damage caused by oxidation by 12-O-tetradecanoylphorbol-13-acetate (TPA) in brain, liver and serum and the hyperproduction of species of reactive oxygen (ROS) by peritoneal macrophages.[50]

ANTI-DIABETIC [51-58]

At 250 mg/kg, a 50% ethanolic extract of MI leaves significantly reduced blood sugar amounts in each streptozotocin-induced diabetic rats and healthy animals. One possible method of operation was the activation of β-cells to release insulin.[51] The impact of the MI leaf aqueous extract on the amount of blood glucose in glucose-induced hyperglycemic rats, streptozotocin (STZ)-induced diabetic rats and normoglycemic rats has been assessed. The findings suggest that the MI leaves' aqueous extract has hypoglycemic properties. This could be the result of a decrease in intestinal glucose absorption.[52] Using normoglycemic, glucose-induced hyperglycemia, and diabetic mice provoked by streptozotocin (STZ), leaves from MI were investigated as part of their antidiabetic potential. The MI leaves' aqueous extract has hypoglycemic properties.[53] Mango (MI) consumption has demonstrated to affect the blood sugar levels of both diabetic and normal rats. The study's findings imply that mango flour may have some utility in the oversight of diabetes.[54] The liquid extract of MI's stem-bark was utilized to investigate its antidiabetic, anti-inflammatory and analgesic qualities. The plant's various chemical components, including its polyphenolics, flavonoids, triterpenoids, mangiferin, and other chemical compounds, may be responsible for the extract's reported anti-inflammatory, analgesic, and hypoglycemic properties. The findings of this research on experimental animals provide pharmacological assistance with the traditional applications of the plant in some rural African communities for the manner in which adult-onset diabetes mellitus type 2 as well as for the management of painful, arthritic, and other inflammatory conditions.[55] Rat intestinal preparations were employed in situ for investigations to assess the result of MI on glucose absorption. Throughout the whole perfusion time, the type 2 rats' glucose absorption was gradually decreased by the ethanol extracts of stem barks.[56] Mangiferin significantly improves oral glucose tolerance in glucose-loaded normal rats without changing baseline values of plasma glucose. Mangiferin (10 and 20 mg/kg, i.p.) exhibits potent antihyperlipidemic, antidiabetic and antioxidant, antiatherogenic attributes that prevent hypoglycemia, according to these studies[57]. This means that mangiferin would be more beneficial therapeutically characteristics without leading to hypoglycemia, linked to alterations in lipid profiles. Long-term hyperglycemia in diabetes mellitus has a connection to the creation of advanced glycosylated end products, which contribute to the generation of ROS, or reactive oxygen species and oxidative damage, especially to the kidney and heart.[58]

ANTIVIRAL ACTIVITY [59-62]

The impact of mangiferin on the type 2 Herpes simplex virus has been studied in vitro; while it does not cause HSV-2 to become inactive, it does block the late stage of HSV-2 reproduction.[59, 60] Additionally, in vitro mangiferin was able to counteract HIV's cytopathic consequences and prevent the replication of the HSV-1 virus within cells. [61, 62]

ANTHELMINTIC AND ANTI-ALLERGENIC ACTIVITY [62-63]

Stem bark of mangifera indica components' antiallergic and anthelminthic properties mangiferin and Vimang were studied in mice who were tested for infection with Trichinella spiralis worms.[62] The purpose of the research was to determine whether the C-glucosylxanthone mangiferin, which was separated from MI extract, and vimang have anti-allergic qualities. The outcomes demonstrate Vimang's anti-allergic qualities in allergic animals and imply that treating allergic illnesses with this organic extract may be effective. The main component of Vimang, mangiferin, aids in the extract's anti-allergic properties.[63]

ANTIPARASITIC ACTIVITY [64]

Mangiferin at 100 mg/kg inhibits Cryptosporidium parvum in a study of newborn mice is comparable to that of paromomycin, an active medication, at the identical dosage (100 mg/kg).

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ANTI-BONE RESORPTION[65]

Four water extracts from Kampo formulae were evaluated for their capacity to inhibit parathyroid hormone-induced bone resorption in an organ culture of neonatal mouse parietal bones. In vitro testing on isolated mangiferin revealed a strong inhibitory effect in this model.

ANTI-TUMOR AND ANTI-HIV [66-69]

Extracted mango stem bark has been demonstrated to have substantial cytotoxic activity against **a** number of cancer cell lines, including MCF 7, MDA-MB-435, and MDA-N; it has additionally demonstrated efficacy against renal cancer cell line 786-0 and colon cancer cell line SW-620.[66] Leuk-P388 was not affected by the ethanol:water (1:1) mixture of dehydrated mango aerial parts administered intraperitoneally to mice at a 250.0 mg/kg dosage.[67] In vitro, mangiferin induced apoptosis in the K563 cell line and reduced the development of K562 leukemia cells in a dose- and time-dependent manner, most likely via down-regulating the expression of the bcr/abl gene.[68] These findings imply that mangiferin may have use as a chemopreventive agent found in nature.[69]

ANTIPYRETIC AND ANTISPASMODIC ACTIVITY [70-71]

MI's stem bark extract was evaluated for its antiplasmodial efficacy against Plasmodium yoelii nigeriensis. Additionally, the extract's antipyretic potential in mice was examined. The extract demonstrated both a schizontocidal impact during early infection and signs of repository action. Additionally, the extract decreased the amount of hyperpyrexia caused by yeast.[70] The antimalarial activity of MI in vitro was assessed using a chloroform:methanol (1:1) extract. At 20 µg/mL, the extract resisted P. falciparum growth by 50.4%, demonstrating good action against the bacterium.[71]

IMMUNOMODULATORY [72-73]

The immunomodulatory effects of the alcoholic extract of MI stem bark were tested on mice. Experiment extract is a potentially effective medication with immunostimulant qualities, that concludes. Since mangiferin increases intracellular glutathione (GSH) levels, suppresses NF-xB activation induced by inflammatory agents like tumor nuclear factor (TNF), mediates the down-regulation of NF-xB, and potentiates chemotherapeutic agent-mediated cell death, it may be involved in combination therapy for cancer. [72] It is probable that these impacts are enabled by higher levels of intracellular GSH and mangiferin quenching of ROS, as it is known to prevent TNF-induced NF-κB activation.[73]

ANTI-DIARRHOEAL [74]

Magnesium sulfate and castor oil and induced experimental diarrhea in mice has been employed to assess the possible anti-diarrheal effect of aqueous (AMI) and methanolic (MMI) extracts of mangifera indica seeds. The findings show that MI extracts have strong anti-diarrheal properties, and part of MI's efficacy may be attributable to its impact on intestinal transit.[74]

ANTI-INFLAMMATORY [75-77]

Significant anti-inflammatory efficacy was shown by the MI seed kernel's 95% ethanolic extract in cases of chronic, acute and subacute, and inflammation. The leaf extract of MI shown antibacterial properties against Albus Staphylococcus, Vibrio cholerae, and Bacillus subtilis.[75] Study has been done on the anti-inflammatory and analgesic properties of extract MI (Vimang). It was discovered that the extract's polyphenols were responsible for the stated action.[76] The anti-inflammatory properties of MI extracts (VIMANG) were studied both in vitro and in vivo. Mice's ear edema caused by phorbol myristate acetate (PMA, ED50 = 1.1 mg per ear) and arachidonic acid (AA) was lessened when the extract of MI was applied externally (0.5-2 mg/ear). The findings provide valuable insight into the mechanism underlying the anti-nociceptive and anti-inflammatory actions of the typical MI extract VIMANG.[77]

ANTI-BACTERIAL AND ANTI-FUNGAL ACTIVITY [78]

Klebsiella pneumonia, Bacillus pumilus, B. cereus, Staphylococcus aureus, Salmonella agona, Escherichia coli, one yeast (Saccharomyces cerevisiae), S. citreus and four fungi (Aspergillus flavus, Thermoascus aurantiacus A. fumigates and Trichoderma reesei) were among the seven bacterial species against which mangiferin demonstrated activity using the agar diffusion method in vitro.

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ANTI-MICROBIAL [79]

The MI's methanolic extracts and P. guajava been examined for their antimicrobial properties. At a 20 mg/ml concentration, the results showed antibacterial activity in the P. guajava and MI extracts. Overall, when examined species are considered, P. guajava extract exhibits more antimicrobial efficacy than MI extract.

HEPATOPROTECTIVE [80]

The chemopreventive qualities of mango pulp extract (MPE) and lupeol were assessed pertaining to the alterations in albino Swiss mice's livers caused by 7, 12-dimethylbenz (a) anthracene (DMBA). By modifying cell-growth regulators, lopeol/MPE was discovered to be beneficial in preventing oxidative stress-induced cellular damage in the liver of mice.

GASTROPROTECTIVE [81]

In mice with stomach damage brought on by indomethacin and ethanol, a glucosylxanthone that occurs naturally in MI is called mangiferin (Anacardiaceae) was tested as a new gastroprotective drug. By measuring variations in the mice's mean gastric lesion area or ulcer score and in amount of gastric secretions and overall acidity in 4-hour pylorus-ligated rats, mangiferin's effects on gastric mucosal damage were evaluated. These results demonstrate that mangiferin, possibly via its antisecretory and antioxidant modes of action, offers gastroprotection against stomach injury caused by ethanol and indomethacin.

ANTICANCER [82-92]

The antitumor effects of polyphenolic portions from a variety of mango types were compared using cancer cells, like A549 lung, Molt-4 leukemia, MDA-MB-231 breast, LnCap prostate, SW-480 colon cancer cells, and the non-cancer colon cell line CCD-18Co [82]. HeLa cells were seen to be very cytotoxic, whereas the bioactive fraction from the crude extract showed anti-proliferative activity with an IC50 value of less than 10 µg/ ml [83,84]. Mango has been shown to exhibit substantial cytotoxic activity against multiple cancer cell lines, including K562 cancerous cells [86], renal cancer cell line 786-0, colon cancer cell line SW-620, MDA-N, MDA-MB-435 and breast cancer cell lines MCF 7 [85]. Whole mango juice and juice extracts have antitumor action, according to Percival S. et al. (2010). In 2010, Percival S et al. discovered that whole mango juice and juice extracts had anticancer effect. Furthermore, research indicates that mangiferin might have hindered or interfered with the growth or functionality of microtubule filaments or cellular matrix components, impairing or obstructing the capacity of cells to adhere to one another [86-90]. Additional potential actions of mangiferin included enhancing cellular apoptosis [88, 91] and inhibiting the telomerase and gene [88]. [92] also looked into the anti-proliferative properties of mango flesh and peels.

ANTI-HEMORRHAGIC [93–94]

Mango extract's anti-hemorrhagic and antidermonecrotic properties against snake venoms were assessed.

ANTI-TETANUS ACTIVITY [95]

MI leaf extracts have anti-clostridium tetani action, which is connected to a number of deaths worldwide. The anti-clostridium tetani activity of leaf extracts in ethanol and ether was demonstrated with MIC values of 12.5 and 6.25 mg/ml, respectively.

ANTI-ULCER ACTIVITY [96-97]

The potential of mango leaf ethanol and petroleum ether extracts as antiulcers against in vivo aspirin-induced stomach ulcer. The ulcer index was dramatically lowered by the 250 mg/kg petroleum ether and 250 mg/kg extracts of mango trees using ethanol leaves [96]. According to additional research, mangaferin protects the stomach from harm by acting through antioxidant and antisecretory pathways [97].

HYPOLIPIDEMIC ACTIVITY [98]

Aqueous extract of Mangifera indica leaves administered to rats showed a large rise in high density lipoproteins and a notable decline in total serum cholesterol, triglycerides, low density lipoprotein, and very low density lipoprotein. On the other hand, treatment with an aqueous extract of mango leaves (200 mg/kg body weight) resulted in a significant increase in high density lipoprotein (HDL-C) and a significant decrease in elevated triglyceride (TG), low density lipoprotein (LDL-C), and very low density lipoprotein (VLDL).

ANTI-AMOEBIC [99]

A study examined the anti-amoebic effects of mango extract.

ANTI-MALARIAL ACTIVITY [100-101]

The stem bark extract from MI has antiplasmodial properties against Plasmodium yoeliinigeriensis was assessed. In addition to showing repository action, the extract exhibited schizontocidal properties during the early stages of infection [100]. The antimalarial properties of MI's chloroform:methanol (1:1) extract were assessed in vitro. The extract demonstrated in vitro considerable action against P. falciparum, inhibiting growth by 20 µg/mL yields 50.4% [101].

RADIO PROTECTIVE[102–103]

At 2 mg/kg concentration, the radioprotective effects of magniferin on radiation-induced immunocytes have been verified without altering the sensitivity of malignant cells.

IMMUNOREGULATION [104-105]

One potential immunoregulator candidate is mangiferin. As an immunostimulant, it prevented the immunological depression brought on by cyclophosphamide, including the atrophy of lymphoid organs, a decrease in cellular responsiveness, a drop in antigen-specific IgM, a rise in lipid peroxidation, and a reduction in superoxide dismutase activities. Additionally, it significantly raised the mice's serum hemolysis IgG and IgM levels [104]. Its immunological modulatory mechanisms may be connected to the suppression of activation-induced T-cell mortality, and the activated macrophage's cellular skeleton resulted in the creation of intercellular connections, lengthy extensions, and cytoplasmic dissemination [105].

CARDIO PROTECTIVE[106]

The effect of mangiferin on rat's myocardial infarction caused by isoproterenol was examined. It was discovered that mangiferin prevented the formation of lipid peroxide, lessened the impact of isoproterenol-induced degenerative alterations, and maintained myocardial marker enzyme activity at or above normal levels. The data above show that mangiferin has a cardioprotective effect [106].

OSTEOPRROSIS PREVENTION [107]

It has been discovered that mango enhance not just bone mineral density but also bone quality, as evidenced by improvements in microarchitecture and strength.

COGNITIVE EFFECT [108]

In vitro, mangiferin induced a significant increase in tumor necrosis factor (TNF)-α and nerve growth factor (NGF) levels in the human U138-MG glioma cell supernatant, concurrently promoting cell proliferation. The findings suggest that mangiferin improves recognition memory via a procedure that may entail elevated levels of cytokines and neurotrophin.

BRONCHODILATOR[109]

The effects of a mangiferin-containing aqueous extract of M. indica stem bark on rats' trachea contracted by histamine and acetylcholine was investigated. These tests revealed that the rat trachea's histaminic and muscarinic receptors could be blocked by the M. indica (mangiferin) aqueous extract, indicating a possible use of the medication in the treatment of asthma.

LAXATIVE[110]

Orally at doses of 100 mg/kg and 30 mg/kg, mangiferin dramatically increased the movement of the gastrointestinal tract (GIT) by 93% and 89% respectively.

CONCLUSION

A thorough analysis of the literature showed that mangifera indica is a significant source of several compounds with pharmacological and therapeutic significance, including hydroxymangiferin, polyphenols, carotenes, mangiferin, and mangiferonic acid. Among

them is Mangiferin is linked to a broad variety of pharmacological effects, including those that are antimicrobial, anticancer, lipolytic, anti-allergic, immunomodulatory, radioprotective, anti-allergic, anti-inflammatory, and antitumor. It also inhibits the action of monoamine oxidase. All of these findings suggest that this mangiferin, or C-glucosyl-xanthone may be responsible for a significant portion of the preparation activities recognized according to MI bark. Given the broad variety of characteristics of phytomedicines and mangiferin must to be suitably standardized with reference to its active ingredient. Since mangifera indica has been effectively employed in Ayurvedic therapy for ages, more clinical studies ought to be executed in order to bolster its therapeutic application.

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