PHARMACOLOGICAL ACTIVITIES OF TAMARIND AND AMARANTHUS SPINOSUS

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ABSTRACT

Tamarind (Tamarindus indica) and Amaranthus spinosus are two common species used for various purposes in the field of traditional medicine and pharmacological therapy. Tamarind contains bioactive compounds like flavonoids and polyphenols and is rich in vitamins that offer antioxidant, anti-inflammatory, antimicrobial, and hepatoprotective properties. It also has benefits for digestive health and cardiovascular support. Amaranthus spinosus is a common weed found with a variety of pharmacological activities due to its bioactive compounds, which include alkaloids, saponins, and tannins. It has been shown to possess anti-diabetic, anti-inflammatory, and antioxidant properties apart from wound healing and antimicrobial activity. Although the two plants hold enormous potential within the therapeutic practice of combating diseases, more work is needed to discern the pharmacological mechanisms and the potential side effects. This review highlights the medicinal properties of Tamarind and Amaranthus spinosus, explicating its pharmacological profiles relative to health benefits.

KEYWORDS

Tamarindus indica, Amaranthus spinosus, pharmacological activities, antioxidant, anti-inflammatory, antimicrobial, hepatoprotective, anti-diabetic, wound healing, bioactive compounds, traditional medicine.

INTRODUCTION:

TAMARIND:

Due to its ability to combat a wide range of human illnesses, Tamarindus indica is one type of medicinal plant that is frequently utilized for health issues in different medical systems.[1] It has been discovered that practically every portion of the plant has therapeutic use. High levels of ascorbic acid and β-carotene, found in its fruits, leaves, and bark, have been shown to have strong antioxidant, antilipoperoxidant, and antihepatotoxic properties.[2] T. indica has a significant impact on the heath system and offers potentially abundant nutrients. When it comes to treating joint pain and inflammation, turmeric is especially helpful. It has been observed that applying crushed leaves and pulp to inflamed joints provide significant relief and lowers inflammation. For the treatment of sore throats, use tamarind.[3]

Northern Nigeria, yellow fever, jaundice, stomach disorders, general body pain, and skin and blood cleansing are all treated with a decoction of fresh stem bark and leaves mixed with potash. The pharmacological action of several sections, including strong antibacterial, antifungal, hypoglycaemic, hypolipidemic, antioxidant, antihepatotoxic, anti-inflammatory, and antidiabetic qualities, has been extensively researched.[4] Tamarind is a plant with many uses. Asian cuisine, particularly that of southern India, has traditionally employed the pulp of the fruit as a spice. Nearly every part of the tree is used in the textile, chemical, food, and medicinal industries.[5]

From Burma to Afghanistan, and up to an altitude of roughly 500 meters, tamarind grows naturally throughout Asia. It is widely dispersed in the southern and central portions of the Indian subcontinent, which share the tropical regions' semi-arid and moist climate. It can also be found in isolated areas in northern India. In Africa, T. indica is widely found in forests and is well adapted to the arid and semiarid zones. It is essentially a tropical tree that can withstand temperatures as high as 47°C but is extremely vulnerable to frost.[6]

Kingdom: Plantae

Class: Magnoliopsida

Family: Fabaceae

Genus: Tamarindus

Species: indica

Scientific name: Tamarindus indica

AMARANTHUS SPINOSUS:

About 20 species of Amaranthus are either cultivated or found in the wild in India. Amaranthus species are found in tropical, subtropical, and temperate temperature zones. Allelopathic potential refers to the ability of certain Amaranthus species to function as antibiotics. The species with allelopathic potential are Amaranthus blitoides, Amaranthus hybridus, Amaranthus retroflexus, Amaranthus spinosus, and Amaranthus viridis. Allelochemicals found in A. spinosus have been shown to prevent seedlings from different species from germinating and growing.[7]

In Hindi, Amaranthus spinosus is known as Kantabhaji or Kate Wali Chaulai, and in English as the pigweed plant. This plant is grown for its vegetable qualities; other species, such as leafy vegetables and cereals, are used as food, and ornamental plants are grown throughout India, Sri Lanka, and other tropical nations.[8]

Additionally, it has a red pigment in it that is used to color food or medicine. Dietary fibers are plentiful in A. spinosus. Ash, moisture, crude fat, and crude protein are also present.[9] Tribes in Kerala, India use the juice of A. spinosus to avoid swelling around the stomach, and they boil the leaves in water without salt for two to three days to treat jaundice. Because of the plant's high concentration of antioxidants and high nutritional value resulting from the presence of fiber, proteins, and vital amino acids, particularly lysine, it is consumed as a vegetable. The root is an expectorant; it reduces menstrual flow and is beneficial for leprosy and leucorrhea.[10]

As a poultice, the seed is applied to fractured bones. Many active secondary metabolites have been identified and tested over the past ten years for a range of in-vitro and in-vivo pharmacological actions, which have suggested potential use in the promotion and maintenance of health.[11]

Kingdom: Plantae

Class: spiny amaranth

Family: Amaranthaceae

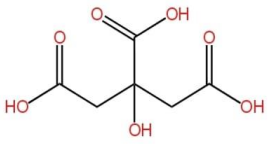
Species: spinosus

Scientific name: Amaranthus spinosus

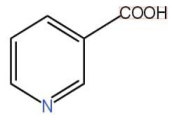
Chemical constituents of different parts of Tamarindus indica: [12,13]

Parts	Chemical constituent
Leaves	Invert sugar, citric acid, Pulps contain the following: benzyl benzoate (40.6%), cinnamates, serine, pectin, beta alanine, proline, phenylalanine, leucine, potassium, 1-malic acid, orientin, isoorientin, lupanone, lupeol, vitamin B3, vitamin C, vitexin, isovitexin, benzyl benzoate, glycosides, and serine. .
Fruits	Carboxylic acid and furan derivatives. Fruit acids (apple, grape, succinic, citric, tartaric), pectin, phenol tannins, and invert sugar.
Seeds	Campesterol, palmitic acid, oleic acid, linoleic acid, β-amyrin, β-sitosterol, and eicosanoic acid. There was also uronic acid, glucose, arabinose, xylose, galactose pectin, and mucilage. From the seed extract, two novel bufadienolides were identified: uzarigenin-3-O-β-Dxylopyranosyl (1-2)-α-L rhamnopyranoside and Scilliroside 3-O-β-D glucopyranosyl - (1-2)-L rhamnopyranoside. Amyloids, phytohemagglutinins, cellulose, albuminoid, and chitinase.
Stem bark	lipids, peroxidase, glycosides, tannins, and saponins.
Root bark	Octacosanyl ferulate, β-sinosterol, n-hexaoxane, eicosanoic acid, (+)-pinitol, and 21-oxobehenic acid.

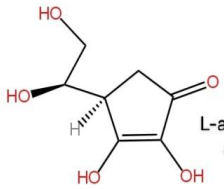
Chemical structure of various phytoconstituents from Tamarindus indica [14,15]



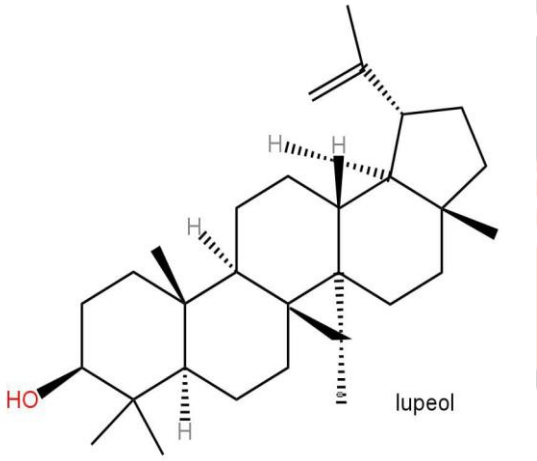
citric acid



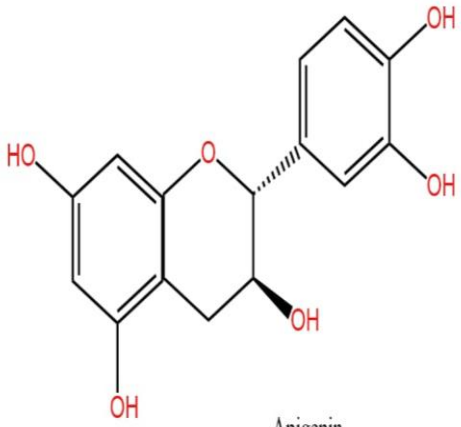
Niacin



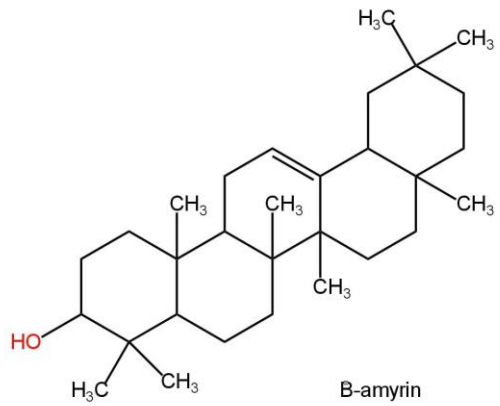
L-ascorbic acid



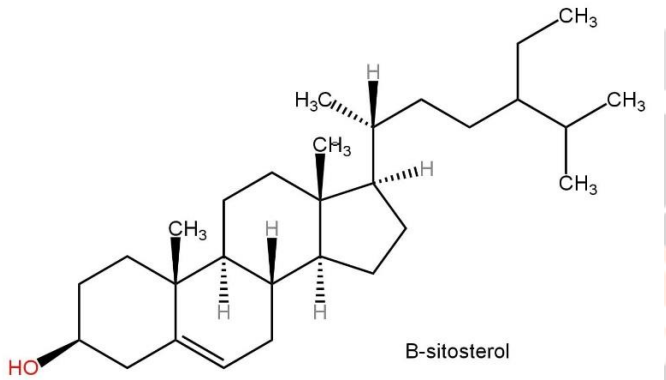
lupeol



Apigenin



B-amyrin



B-sitosterol

PHARMACOLOGICAL ACTIVITY OF TAMARIND:

Antioxidant activity: Research has shown that Tamarindus indica seeds and pericarp include phenolic antioxidant compounds. When compared to artificial antioxidants such as butylated hydroxyl ascorbic acid and anisole, all the extracts demonstrated strong antioxidant activity against the linoleic acid emulsion system. By employing ascorbic acid as a standard and the DPPH (2,2-diphenyl-1-picrylhydrazyl) free radical scavenging method, the antioxidant activity of the ethanolic extract of the seed coat was also evaluated. The extract's capacity to scavenge free radicals may be the cause of this activity. [16,17]

Various antioxidant compounds isolated from different parts of Tamarindus indica: [18]

Various part	Compound
Seed	3-Hydroxybenzoate, methyl 3-Hydroxy-30,40 dihydroxy acetophenone, 3,4-dihydrophenyl acetate, epicatechin, and caffeic acid
Fruit pulp	vitamins (B3, E, C), formic acid, oxalic acid, acetic acid, malic acid, tartaric acid, succinic acid, and citric acid
Leaves	isorientin, isovitexin, orientin, isoorientin, vitexin, caffeic acid, limonene, naringin, Caryophyllene, p-cymene, ß-sitosterol, and vitamin C.

Test organism: All isolates were aseptically introduced into a nutrient broth for resuscitation purposes and incubated at 37 °C for 24 h prior to the antibacterial activity test.

Anti-inflammatory activity: Aqueous ethanol and chloroform extracts from T. indica were evaluated for anti-inflammatory properties in mice (ear oedema induced by arachidonic acid) and rats (sub plantar oedema induced

by carrageenan) after topical or i.p. administration, respectively. Results showed that the plant exhibits anti-inflammatory activity. In the evaluation of the anti-inflammatory properties of the stembark and root extracts of Tamarindus indica L., the carrageenan-induced paw edema model of inflammation was used. [19,20] The carrageenan-induced paw edema model of inflammation is a common technique used to screen natural products with potential anti-inflammatory activity. After carrageenan is administered, there are two distinct phases to the induction of inflammation: a first phase marked by the release of histamine and serotonin, and a second phase characterized by the release of inflammatory mediators like prostaglandins, bradykinins, leukotrienes, proteases, and lysosomes. Aspirin, indomethacin, and diclofenac are examples of medications that work by interfering with the second phase of inflammation. The time course curves of the extracts and diclofenac and dexamethasone exhibit similarities, suggesting that the extracts could potentially disrupt the second phase and prevent the release of comparable inflammatory mediators.[21]

Anti-inflammatory activities of the Extracts from Different Parts of T. indica:[22]

Plant part used	Extract and dosage administered
Stem bark	200 mg/kg body weight of the hexane, ethyl acetate, and methanol fractions were given.
Pulp	Water-based extract given in dosages of 60, 100, 300, and 600 mg/kg.
Seed	25–50 mg of ethanol extract per kilogram of body weight is recommended. Ethyl acetate and petroleum ether fractions were given at doses of 50 and 100 mg/kg of body weight, respectively. Doses of 100 mg/kg, 200 mg/kg, and 400 mg/kg body weight of methanolic extract are given.
Roots	Aqueous extract given at doses of 300 and 600 mg per kilogram of body weight.
leaves	The dosage of the hydro-ethanolic extract is 500, 750, and 1000 mg/kg of body weight. 400 mg/kg of aqueous extract was given to the patient. 400 mg/kg of ethanol extract is given to the body.

Antidiabetic activity: T. indica seed aqueous extract was tested on male STZ-induced diabetic rats and shown a strong antidiabetic effect. When the extract was administered to rats with mild and severe diabetes, fasting blood glucose levels showed a significant reduction in hyperglycemia. Comparably, it was discovered that hyperlipidaemia, as determined by various cholesterol contents, had decreased.[23]

Immunomodulatory activity: A polysaccharide that has been extracted from Tamarindus indica exhibits immunomodulatory properties, including the promotion of phagocytic activity, the suppression of cell division, and the inhibition of leukocyte migration.[24]

Anti-diarrheal & Anti- dysentery activity: Diarrhea and dysentery are other conditions for which turmeric is used. The root is used to cure dysentery (Anti-dysentery activity), and the pulp of thetamarind mixed with lemon is used to treat diarrhea (Anti-diarrheal activity). A form of diarrhea called dysentery, which is typically brought on by an intestinal infection, contains mucus or blood. Inappropriate treatment for diarrhea puts the patient at danger for dehydration and possibly even death.[25]

Anti-emetic activity: Tamarindus indica leaf extracts, both methanolic and butanolic, showed anti-emetic properties like those of commercially available medication, such as chlorpromazine.[26]

Anti-pyretic activity: Additionally, tamarind has antipyretic properties. A polysaccharide derived from Tamarindus indica pulp has demonstrated antipyretic properties against rats induced to become pyretic by yeast and mice induced to become pyrexia by lipopolysaccharide (E. coli).

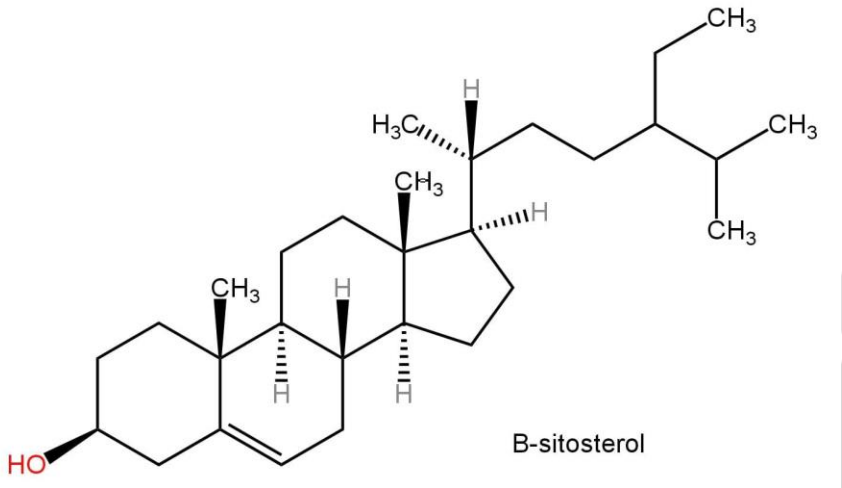
Antimicrobial activity: investigated the antibacterial activity of methanolic leaf extract against Burkholderia pseudomallei. The paper disk diffusion method was utilized to determine the diameter of the zone of inhibition against gram-positive and gram-negative bacteria and fungi to assess the antibacterial activity of the concentrated extracts (aqueous, ethanolic, and acetone).[27]

Test microorganisms: Salmonella typhi, Escherichia coli, Staphylococcus aureus, and Bacillus subtilis were the bacteria species employed. Aspergillus niger and Candida albicans were the fungi that were employed. The medicinal and aromatic plant research institute provided the standard strains of microorganisms employed in this investigation.

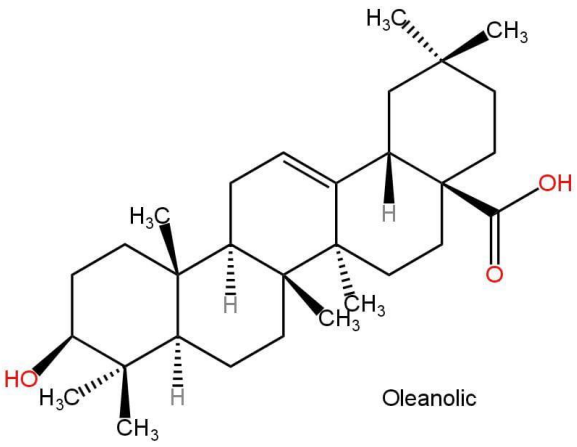
Phyto constituents of Amaranthus spinosus Linn:[28]

Plant part	Therapeutic constituent
Stems	Quercetin, hydroxycinnamates, amaranthine, isoamaranthine, and kaempferol glycosides
Whole plant	α-xylofuranosyl uracil, β-D-ribofuranosyl adenine, 4-O-β-D-glucopyranoside, 7-p-coumaroyl apigenin, and β-sitosterol glucoside
Whole plant	Quercetin and Rutin
ROOTS	stigmasterol glycoside hectriacontane
leaves and stem	Roots, leaves, stem, oleanolic acid, D-glucose, and D-glucuronic acid, aliphatic ester-α-spinasterol, and octacosanoate
Roots	glucopyranosyl-β-D-saponin-(1-4) (1-4) -β-D-glucopyranosyl (1-3)-β-D-glucuronopyranosyl-oleanolic acid
Roots	Saponin I- β-D- glucopyranosyl-(1-2)-β-D-glucopyranosyl – (1-2)- β-D-glucupyranosyl-(1-3)-α-spinasterol Saponin-II- β-D-glucopyranosyl-(1-4)-β-D-glucopyranosyl-(1-3)- α-spinasterol

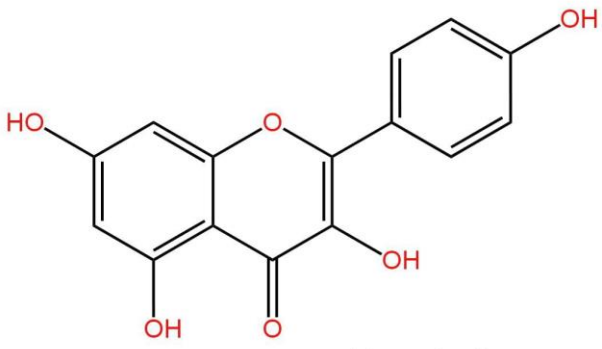
Chemical structure of various phytoconstituents from Amaranthus spinosus:[29]



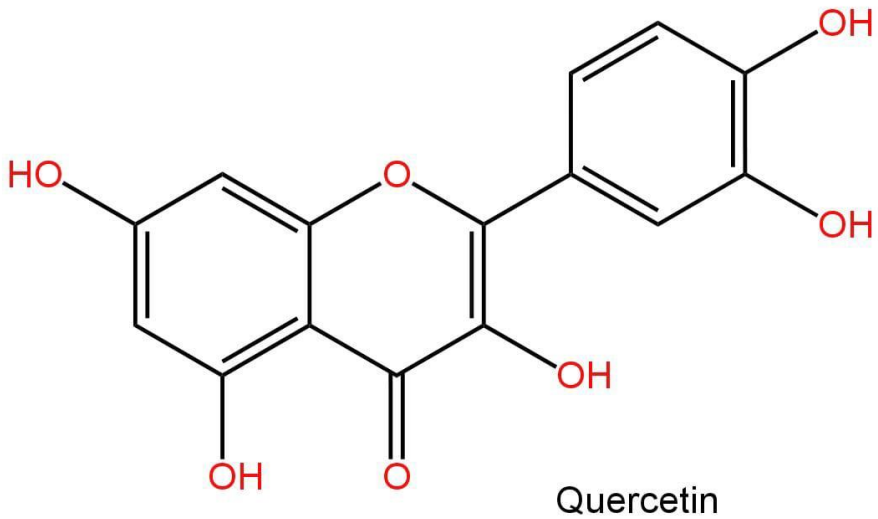
B-sitosterol



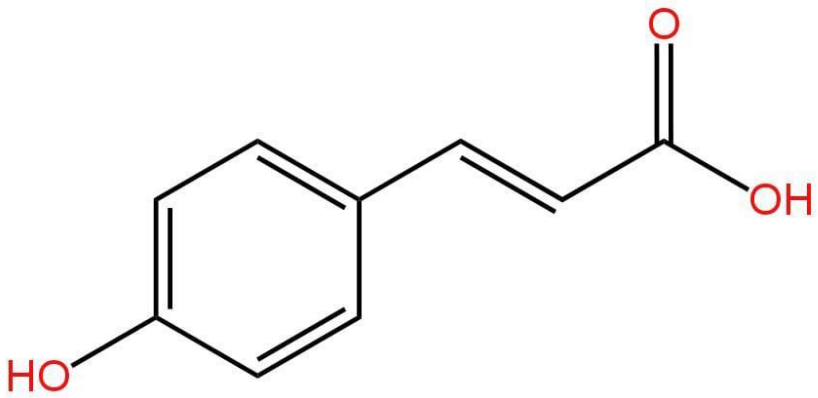
Oleanolic



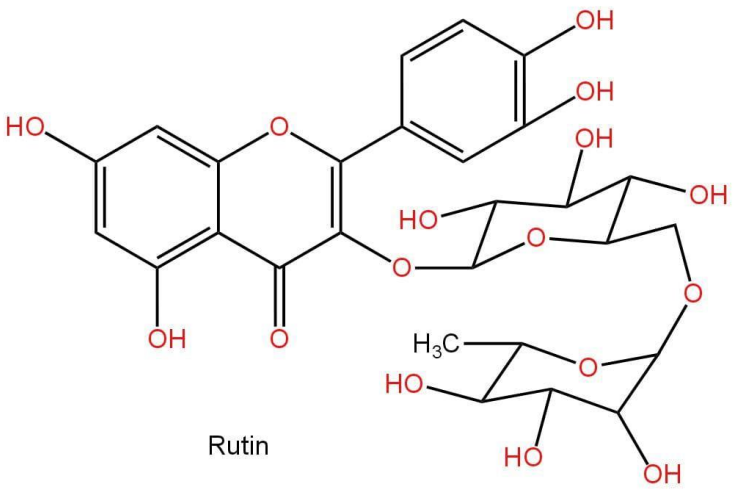
Kaempferol



Quercetin



Hydroxycinnamic acid

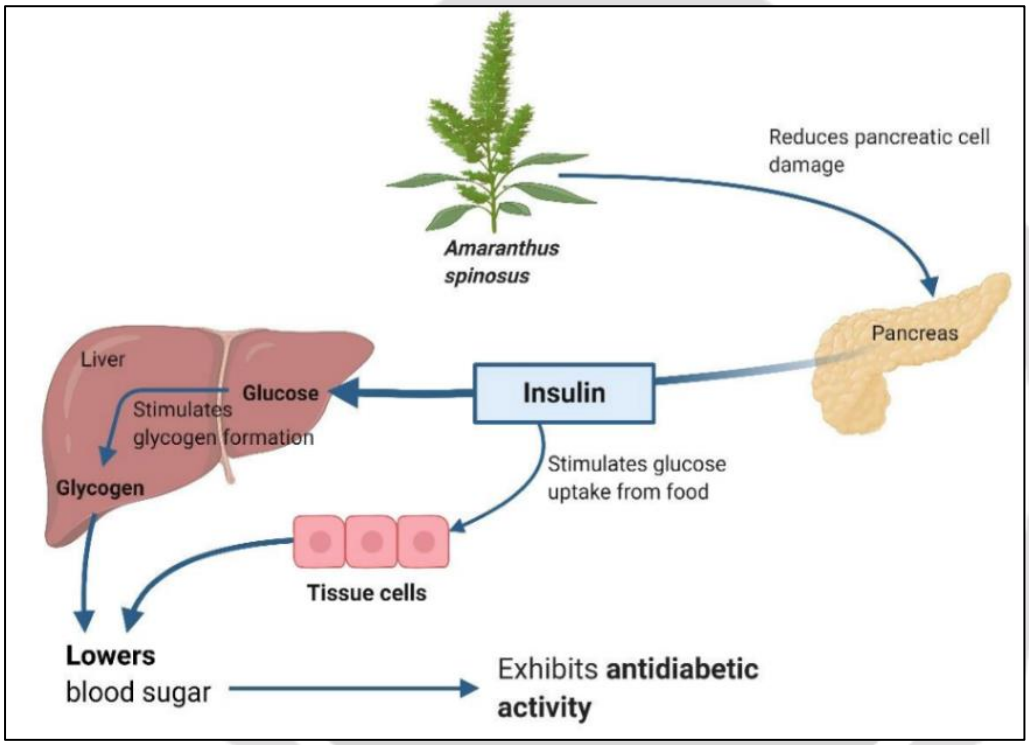


Rutin

PHARMACOLOGICAL ACTIVTIES OF AMARANTHUS SPINOSUS:

The antioxidant activity: Using a non-enzymatic haem glycosylation assay, A. spinosus was assessed. According to the results, the secondary metabolites quercetin and rutin inhibited hemoglobin glycosylation to a maximum of 52% and 42%, respectively. Roadside plants, which were assumed to be continuously exposed to high concentrations of pollutants like nitrogen oxides and sulphur dioxides, were used to study the antioxidant activity of A. spinosus. According to the DPPH test, betalain pigments found in Amaranthaceae plants exhibit antioxidant properties. The range of their EC50 values is 3.4–8.4 μM. The extract of A. spinosus may have antioxidant properties because of the bottling content. [30,31]

Anti diabetic activity: The alpha amylase and the antioxidant potential of methanol extract of A. Malondialdehyde (MDA)'s in vivo antioxidant potential and CNPG3 (2-chloro-4-nitrophenol a-D-maltotrioside)'s in vitro suppression of the alpha amylase enzyme were used to create spinosus (MEAS). This study demonstrated the strong alpha amylase, anti-diabetic, and antioxidant properties of A. spinosus methanolic extract..[32]



Anti-inflammatory activity: In carrageenan-induced paw oedema, the petroleum ether, ethanol extract of the entire plant, and methanol extract of the leaves of A. spinosus produced significant inhibition of the acetic acid-induced increase in vascular permeability, indicating that the extract has anti-inflammatory activity. In an anti-inflammatory model test system, Amaranthus spinosus extract also shown a highly selective prostaglandin synthesis inhibitory action in vitro, suggesting that it has anti-inflammatory properties. The outcome implied that the plant extract most likely inhibits the production of prostaglandins. The examined animals showed a notable, dose-dependent peripheral analgesic effect from the Amaranthus spinosus methanol extract. The extract dramatically lessened the spasms of the abdomen brought on by acetic acid. [33,34]

Anthelmintic activity: Using piperazine citrate as the reference standard, the anthelmintic activity of the aqueous extracts of the entire A. spinosus Linn plant was assessed on adult Indian earthworms. For both worms, the aqueous extract demonstrated dose-dependent anthelmintic action, resulting in the shortest times to paralysis (P) and death (D) at 50 mg/ml concentration. In comparison to Tubifex tubifex, the extract exhibited more strong action (15 mg/ml).[35]

Anti-malarial activity: When assessed using a suppressive antimalarial assay for four days, screening with A. spinosus demonstrates remarkable antimalarial activity in mice. A. spinosus at high doses of the plant extract significantly inhibited a study on the Plasmodium berghei berghei parasite strain that was injected in mice. The proportion of parasitemia that is inhibited when a dose of 100 mg/kg is introduced is low; however, higher doses (300 mg/kg to 900 mg/kg) produced a better percentage of inhibition. Even if the plant's antimalarial effect is not

as strong as that of the malaria medication chloroquine, its percentage of parasitemia inhibition can nevertheless be raised by administering comparatively higher doses (1000 mg/kg or more). [36,37]

Immunomodulatory activity: On the spleen cells of female mice, the stimulatory impact of wild A. spinosus water extract was examined. The extract induced splenocyte growth to a great degree. On the other hand, wild A. spinosus may stimulate isolated B lymphocytes in a dose-responsive manner, but not T cells. Through the direct stimulation of B cell activation in vitro, these studies demonstrated immunostimulating efficacy. Furthermore, these findings imply that the water extract's immunostimulating properties may cause B lymphocyte activation and subsequent in vitro T-cell proliferation.[38]

The Antimicrobial Activity: Several pharmacologically active chemicals found in A. spinosus have antibacterial properties in the disc diffusion essay. While the anti-bacterial and anti-fungal activity trends are similar, the potency against fungal strains is lower than that against bacterial ones. Terpenoids are used to manage Listeria monocytogenes because they exhibit antibacterial activity against bacteria, fungi, viruses, and protozoa. By rupturing lipophilic membranes, these terpenoid molecules have antibacterial action. The antibacterial activity of Ent-kaurene diterpenoid compounds will be diminished if the hydrophilic behaviour of these compounds can be enhanced by the addition of a methyl group. It is commonly recognized that flavonoids respond to microbial infections. Flavonoids interact in vivo with bacterial cells and form complexes with soluble and extracellular proteins. Because of this, flavonoids have antibacterial properties as well. [39,40]

Analgesic and Antipyretic Activity: Scientists from all around the world have confirmed the traditional claims made by A. spinosus to treat a variety of pain disorders. Using mice that were given acetic acid to induce writhing and radiant heat tail-flicking, researchers examined the analgesic effects of petroleum ether, ethyl acetate, and methanol extracts of the entire A. spinosus plant. Oral administration of 500 mg/kg body weight of methanol extract to mice resulted in notable antinociceptive effect against thermal (radiant heat tail-flick test) and chemical (acetic acid-induced visceral pain) models of nociception. Additionally, a methanolic extract of A. spinosus leaves demonstrated significant ($P<0.01$) antipyretic effect using the yeast-induced pyrexia method at dosages of 200 and 400 mg/kg, using paracetamol as the standard treatment.. [41,42]

CONCLUSION

The pharmacological activities of Tamarindus indica, more commonly known as tamarind, and Amaranthus spinosus, highly recognized medicinally, vary widely. The plant Tamarind demonstrates potent antioxidant, anti-inflammatory, antimicrobial, antidiabetic, and hepatoprotective effects primarily due to a high concentration of polyphenols, flavonoids, and organic acids. It has also been found to be beneficial in reducing cholesterol and regulating metabolic disorders, thus being an applicant for the therapeutic approach against cardiovascular disease. Amaranthus spinosus is a species used in folk medicine that has properties like anti-inflammatory, antimicrobial, analgesic, and immunomodulatory. Its bioactive compounds such as alkaloids and flavonoids make it effective in treating diseases like gastrointestinal and respiratory disorders.
Therefore, much of what is known now is based on in vitro or animal models and should be validated in a clinical setting for their actual therapeutic effectiveness. Isolation and characterization of bioactive compounds will be critical in drug development leading to pharmacological activities. In addition, there is a potential for synergies when such medicinal plants are combined with other medicinal plants or pharmaceuticals, hence the possibility of new therapeutic options.
In summary, both Tamarindus indica and Amaranthus spinosus have been found to possess significant pharmacological potential. The future research has to bridge the divide between traditional knowledge and modern pharmacology so that plants-based therapeutic agents would indeed be developed to realize safety and potency. Being into metabolic, inflammatory, and infectious diseases, they are promising candidates for future drug development studies.

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