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Review Article

Phytopharmacological Activities of *Spondias mombin* Linn: A Review

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ABSRTACT

This review describes the phytopharmacological activities of *Spondias mombin*. *Spondias mombin* (*S. mombin*) is a fructiferous tree native to tropical areas like America, Brazil, Nigeria and West India. It belongs to the cashew family of Anacardiaceae. *Spondias mombin* has been used as an herbal medicine from ancient times. *Spondias mombin* plant parts (leaves, bark, seeds, and fruits) are used for therapeutic purposes. Traditionally, the plant is being used in inducing labour, preventing miscarriages, reducing inflammation, reducing blood glucose level, amongst others. Various plant parts are also used for non-medicinal purposes like the production of cider-like drinks, wine, soap and ornamental purposes. The main bioactive compounds reported in *S. mombin* include tannins, phenols, saponins, anthraquinones, berberine, naphthoquinones, sesquiterpenes, indole and quinoline alkaloids, proanthocyanins, and flavonoids. *Spondias mombin* possesses beneficial pharmacological properties that are well-utilized in medicinal herbal therapy of several disease conditions.

Keywords: Anacardiaceae, ethnopharmacology, herbal medicine, phytochemicals, *Spondias mombin*

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Introduction

Acceptance of herbal medicine usage in traditional medicine amongst developing countries continue to rise.[1-3] Among such medicinal plant is *Spondias mombin*, belonging to the family 'Anacardiaceae' (*Spondias* genus), commonly found in the lowland moist forest of the Amazon and tropics of Africa.[4, 5] It is popularly identified as yellow mombin or hog plum.[6-8]

Spondias mombin (*S. mombin*) is widely depended upon in certain health conditions, and essentially every portion of the tree have been found useful ranging from its thickly corky bark to its leaves, fruits and even its flower (Figure. 1-2). The plant's leaves have been shown to exhibit abortifacient, lipid-lowering, and hypoglycaemic actions.[7, 9-11] It is a medicinal plant that has wide acceptability and proven to exert certain beneficial health activities which include antiepileptic, antidementia, antipsychotic, anticancer, cytotoxic, anthelmintic, antiviral, and anxiolytic pharmacological activities.[12-15]

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Bioactive compounds such as tannins, phenols, saponins, anthraquinones, berberine, naphthoquinones, sesquiterpenes, indole and quinoline alkaloids, proanthocyanins and flavonoids have been found to be present following qualitative and quantitative phytochemical analysis.[14, 16] These phytochemicals are responsible for its important pharmacological actions.[16]

Although, there are documented instances of the harmful effects of medicinal herbs when utilized in traditional medicine following acute or repeated (sub-acute, sub-chronic and chronic) exposures, findings have shown that *S. mombin* is relate safe.[17, 18]

Materials and Methods

This review adapted 71 articles which covered the periods of 2006 to 2023 retrieved following extensive literature search using search engines or databases including: Google, ResearchGate, PubMed and Elsevier. The keywords that directed our literature search were: Phytopharmacological activities, phytochemistry, ethnopharmacology and *Spondias mombin*.

Plant description

Spondias mombin L. (Anarcardiaeae) is a deciduous erect tree with a height of about 30 m and a trunk of 60-75 cm width, with branches 2-10 m above ground level to form a spreading crown up to 15 m in diameter and forming an open or densely closed canopy. Its trunk has some deep incisions located in the bark of the tree and sometimes, it produces a brown resinous substance.[19] The leaves and flowers of the plant are situated at the end of the branches. The tree exhibits a grayish bark with a somewhat buttressed, thick, and coarse trunk. The leaves have an alternate arrangement, with a single pinnate structure and an unusual terminal leaflet. Stipules are not present. The rachis is 30-70 cm in length. The leaflets are arranged in 5-10 pairs and are elliptic in

shape, measuring 5-11 x 2-5 cm. The apex of the leaflets is long and pointed, with an asymmetric, truncated or wedge-shaped base. The margins of the leaflets are smooth, and they are either hairless or sparsely covered in fine hairs. Commonly in young plants, the leaf stalk tends to be reddish towards the outer leaflets.[19] The fruit is an ovoid or ellipsoid drupe, 3-4 x 2-2.5 cm in diameter; dull light orange to yellow or brown; in clusters of 1-20; epicarp thin, enveloped by a succulent orange or yellow middle layer that is 3-6 mm thick. The endocarp is relatively large and has a soft, fibrous texture with grooves. It surrounds 4-5 tiny seeds.[19]

Spondias mombin is a fruit-bearing tree that is found in Nigeria, Brazil, and various other tropical forests worldwide. The tree is cultivated around Africa, India, Nepal, Bangladesh, Sri Lanka, Bahamas, and Indonesia. The plant is distributed in tropical America, Brazil, Nigeria, the West Indies, and several tropical rainforests worldwide. This plant is commonly found around the South West of Nigeria (Yoruba) and is commonly used in folk medicine. The plant is known by several names in various regions. In Costa Rica, it is called 'Bala', while in Panama it is known as 'Jobito'. In Colombia, it is referred to as 'Jobo blanco', and in Venezuela, it is called 'Jobo corronchoso'. In Surinam, it is known as 'Hoeboe', and in Brazil, it goes by the names 'Acaiba', 'Caja', and 'Pau da tapera'. In Peru, it is called 'Ubo', while in Mexico it is known as 'Hobo'. In Nigeria, the Hausa people refer to it as 'Tsardarmasar', while the Yorubas call it 'Iyeye' or 'Akika etikan', and in the Igbo language, it is known as 'Ichikara'.[20, 21]

Phytochemical constituents of S. mombin

Spondias mombin is rich in several secondary metabolites which includes phenols, sterols, triterpenes, saponins, essential oils, amino acids, and polysaccharides (Figure 3-5).[16] Geraniin and galloyl geraniin, which are phenolic compounds, were derived from the ethanol extract of the leaves and stems of *S. mombin*. Additionally, lupeol was obtained specifically from S. mombin leaves.[22] The methanolic extract of *S. mombin* bark yielded sterols, specifically stigmasta-9-en-3,6,7-triol and 3-hydroxy-22-epoxystigmastane.[23] Both *S. mombin* and *S. purpurea* leaves were subjected to hydrodistillation, resulting in the extraction and identification of several volatile oil constituents, including α-pinene, β-pinene, caryophyllene, humulene, indene, and cadinene.[22\]

Figure 1: *Spondias mombin* leaves with fruits

Figure 2: Thick bark of *Spondias mombin*

Abiodun and colleagues identified the following major compounds in the seed of *S. mombin*: dodecanoic acid (22.48%), tetradecanoic acid (17.95%), n-hexadecanoic acid (15.35%), and phenol amides capsaicin (12.11%) and dihydrocapsaicin (5.23%).[24] Lauric acid (dodecanoic acid) had antibacterial activity against *Propionibacterium* acnes in laboratory tests and demonstrated positive results in reducing inflammation caused by *Propionibacterium* acnes in a mouse ear model.[25] Tetradecanoic acid (myristic acid) serves as a dietary supplement and flavoring agent in the food industry. Furthermore, it is utilized in the cosmetic sector for producing facial creams, lotions, toiletries, and emulsifiers. Additionally, it finds application in the pharmaceutical industry.[26,27] Hexadecanoic acid (palmitic acid), capsaicin, and dihydrocapsaicin exhibit antioxidant, anti-inflammatory, and analgesic properties.[28-30]

The hydroethanolic extract obtained from *S. mombin* leaves contains significant quantities of the phenolic chemicals chlorogenic acid, ellagic acid, and isoquercetin.[31] A current study revealed the existence of (E)-ethyl cinnamate (14.06%) and methyl salicylate (13.05%) in the essential oils derived from the fruit and leaf of *S. mombin*, respectively.[32] The fruit essential oil contained significant quantities of benzyl benzoate (12.27%), n-hexadecanoic acid (8.14%), benzoic acid ethyl ester (5.89%), tetracosane (5.30%), and terpineol (4.61%), whilst the essential oil derived from leaves contained heptacosane (12.69%), caryophyllene (6.77%), octacosane (8.54%), and n-hexadecanoic acid (4.91%) in high amounts.[32]

Quantification of various phenolic chemicals, including flavonols, phenylpropanoids, benzoic acid derivatives, coumarins, stilbenes, dihydrochalcones, flavones, and flavonones, was performed using ultra-high performance liquid-chromatography-MS/MS (UPLC-MS/MS) on the fruit peel of S. mombin.[33] A total of fourteen flavonol substances were measured and determined. Quercetin was the predominant component, with myricetin and Kaempferol-3-Glc following in abundance. The quantification of phenylpropanoids included cinnamic acid, and several derivatives of this chemical, such as certain hydroxycinnamic acids and sinapyl alcohol. The chemical that was most abundant was chlorogenic acid, with p-coumaric and cinnamic acid being present in lesser amounts. The predominant component was ellagic acid, which is a derivative of benzoic acid. Gallic acid was identified in a lesser proportion. Esculin is particularly notable among the quantifiable coumarins. Cis-piceid is notable among the quantified stilbenes in this experiment for its significantly high values. Sinensetin and Luteolin-7-*O*-Glc were the most prominent flavones.[33]

Pharmacological properties of S. mombin Linn

S. mombin is of great ethnopharmacological relevance as virtually every component of the plant has shown useful therapeutic effects. Amongst its medicinal activities include:

Anti-anaemic activity

Reduction in red cell mass or in the quantity and quality of hemoglobin is characteristic of anaemia, which is majorly caused by reduction in haemoglobin production, increased destruction of hemoglobin (or blood loss) and blood pooling within the spleen.[34] In a study conducted to assess the hematinic properties of *S. mombin* leaf extract against phenylhydrazine (PHZ)-induced anaemia in rats, *S. mombin* (150 mg/kg; 300 mg/kg) improved the hematological parameters in comparison to the PHZ-alone treated rats.[35]

Adeyemi and Gbolade had previously reported the hematinic effect of *S. mombin* (dose range of 100-400 mg/kg) on chloramphenicol-induced anaemic rats, as there was a dose-dependent marked rise in haemoglobin and packed cell volume.[36] Likewise, doses of 250 mg/kg and 500 mg/kg of ethanol leaves extract of *S. mombin* has been described to cause significant an augmentation in their erythrocyte count, haemoglobin content, and PCV (packed cell volume) of experimental animals.[37] The anti-anaemic properties of *S. mombin* could very much connected to its phytochemical constituents.[38]

Anti-cancer activity

Plants and plant-based products usage are of positive therapeutic importance when used in therapy for cancer and tumour-related diseases. A study conducted by Metibemu and others revealed the

presence of carotenoids (astaxanthin, β-carotene-15,15'-epoxide, and 7,7',8,8'-tetrahydro-β, β-carotene) extracted from the leaves of *S. mombin* are proapoptotic, displaying antineoplastic impact in DMBA (7,12-dimethylbenz[a]anthracene)-induced breast cancer in experimental rats through XIAP (X-linked inhibitor of apoptosis protein) antagonism.[39] Other studies have also stated the anti-tumour actions of *S. mombin*.[12, 40-42]

Anti-inflammatory activity

During early wound healing stages, inflammatory processes are vital in enhancing proper fibroblast and collagen remodelling and arrangement.[43] Extracts obtained from *S. mombin* L. (Anacardiacea) is very much claimed to be useful in the traditional medicine of Africa and Latin America to treat many inflammatory conditions. A study by Nworu and colleagues revealed that pre-treatment of rats with *S. mombin* leaf extract induced a substantial and dose-dependent reduction in swelling of the paw caused by carrageenan observed over a period of 4 hours, with a substantial lowering of lipopolysaccharide (LPS)-inducible TNF-α levels in the *S. mombin*-treated mice.[12] The study indicated that administering *S. mombin* extract may reduce inflammatory reactions, maybe by inhibiting the production of pro-inflammatory mediators and cytokines such tumor necrosis factor-α (TNF-α) and inducible nitric oxide (iNO).[12]

In another study, the anti-inflammatory property of the leaf extract of *S. mombin* was assessed via the carrageenan-induced peritonitis in mice (*in vivo* model). [31] The extract exhibited anti-inflammatory properties at varying doses, however, the ethyl acetate fraction at 200 mg/kg demonstrated particularly noteworthy benefits. The chemical components of *S. mombin*, namely ellagic acid and chlorogenic acid, at quantities of 2.5, 5, and 10 mg/kg, effectively suppressed the movement of white blood cells to the inflammatory site.[31]

A recent study established that the essential oil derived from *S. mombin* leaves contains therapeutic components that accelerates wound healing through mechanisms including counter-inflammation, modulation of anti-inflammatory cytokines, modulating other biomarkers that help in formation of granulation tissues, neo formation of blood vessels and construction of extracellular matrix, converging activity of keratinocytes at the re-epithelization phase and tissue remodeling.[44]

Anti-ulcer activity

Pathologically, peptic ulcers are damages done to the mucosal wall, affecting components of the epithelial and connective tissue, including subepithelial myofibroblasts, smooth muscle cells, vessels, and nerves, which can reach from the muscle layer to deeper regions.[45] Findings have revealed that *S. mombin* possess antiulcer potential.[46-48] *S. mombin* L has shown favorable gastroprotective activities both with its leaves extracts and tablets formulations.[49] The gastroprotective effect is well related to both cytoprotective mechanisms, including the participation of endogenous prostaglandins and ATP-sensitive potassium (KATP) channels, and antisecretory properties with systemic actions.[49]

A study by Oluwatosin and Deborah indicated that leaf extract of *S. mombin* L. has antiulcer property as compared with standard drugs, showing protective effect on gastric mucosa in models of ibuprofen and alcohol-induced ulcer and an inhibitory effect on gastric acid secretion in the pylorus-ligated models.[50] The study suggested several potential pathways for *S. mombin* L. cytoprotective activity to include the non-protein sulfhydryl (NP-SH) and nitric oxide synthase (NOS) pathways.

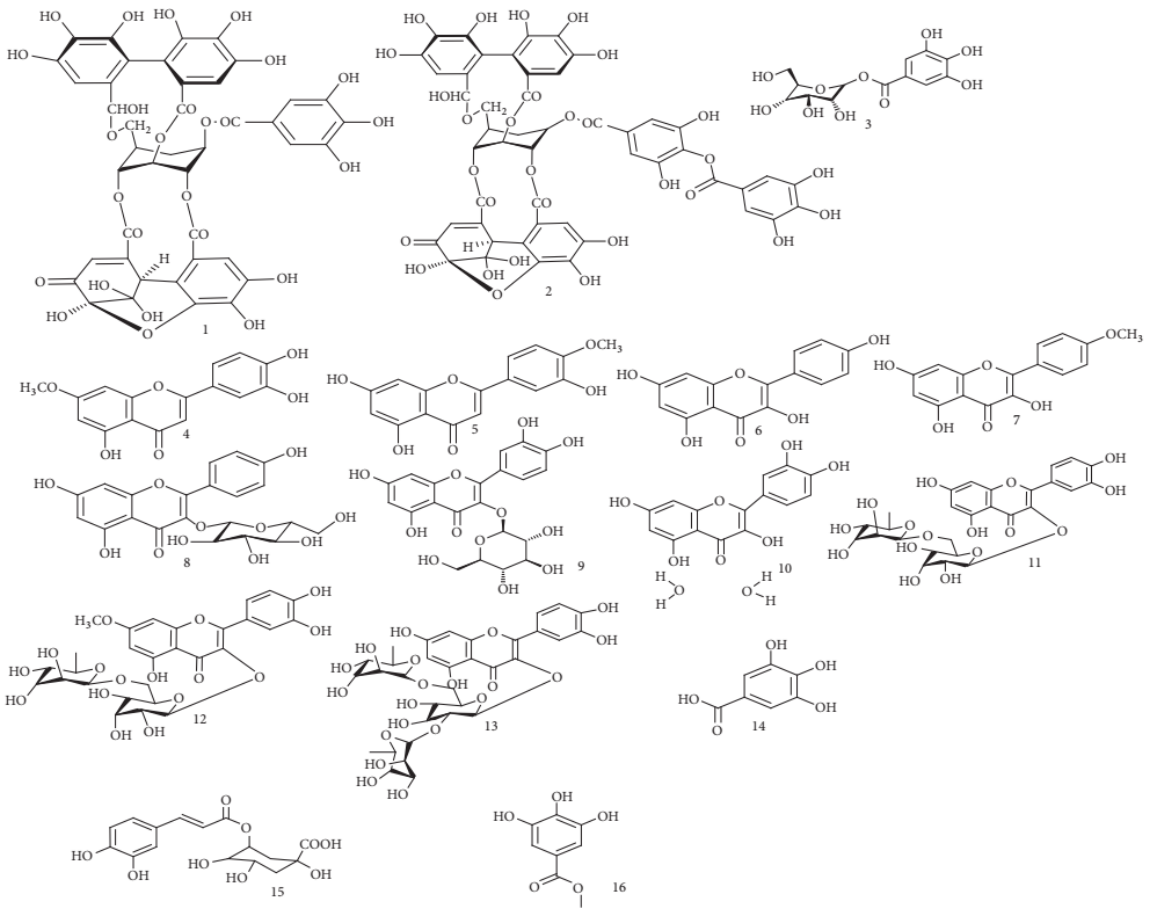

Figure 3: Chemical structure of phenolic compounds isolated from *Spondias* species[16]

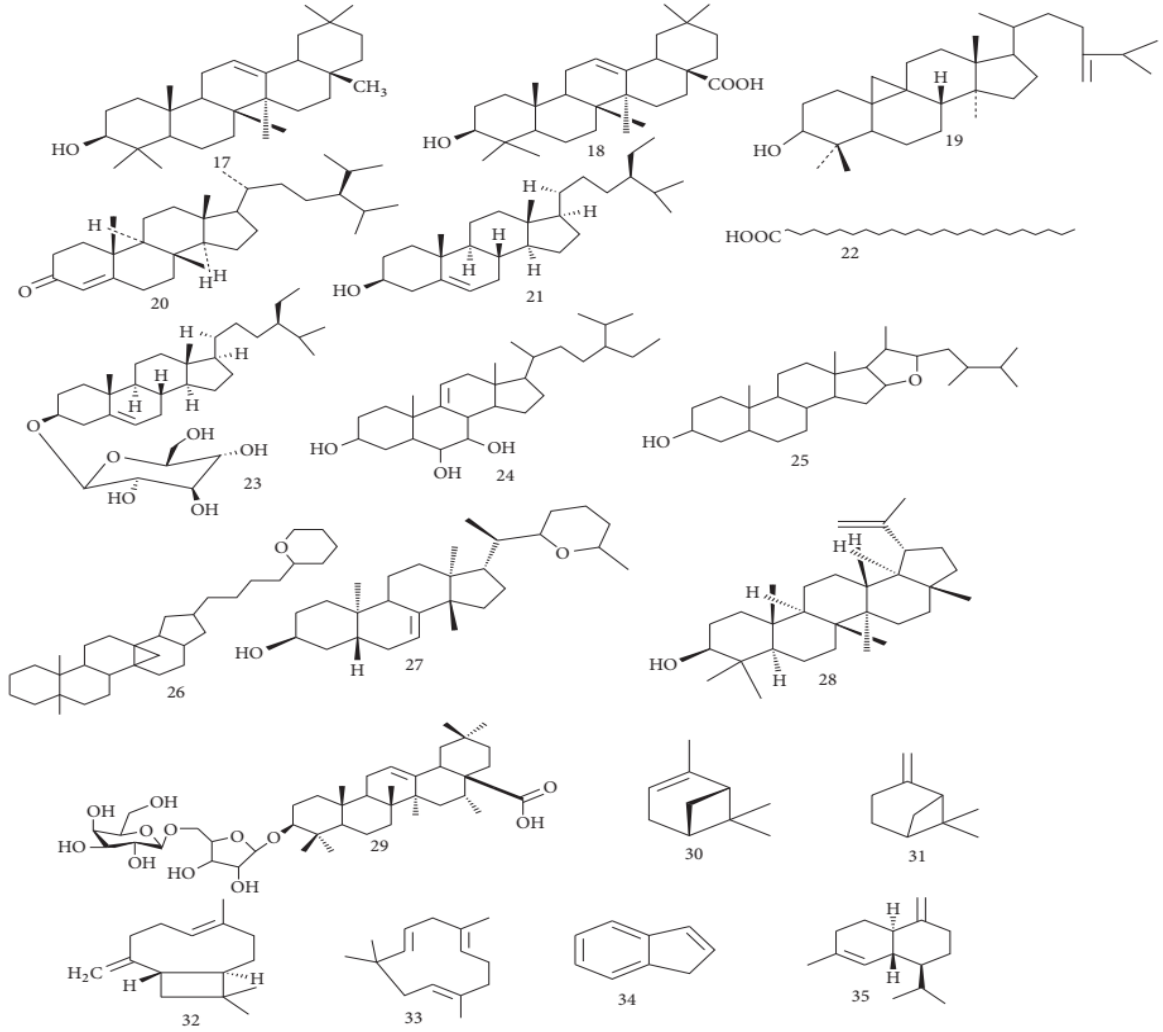

Figure 4: Chemical structure of sterols and terpenoids isolated from *Spondias* species[16]

Antioxidant activity

The antioxidant ability associated with an anti-inflammatory potential are desirable features of a bioactive compound. Antioxidants mitigate the impact of free radicals on biomolecules by consuming them. Increasein free radicals generation exceeding the host's antioxidant is deleterious.[24, 51-53]

Several researches have been done on the antioxidant efficacy of *S. mombin*.[24, 54, 55] A study evaluated the protective actions of the leaf and stem methanol extracts of *S. mombin* in rat model of carbon tetrachloride (CCl_4)-induced hepatotoxicity. Pretreatment with 1000 mg/kg of the extracts markedly increased glutathione, catalase and superoxide dismutase levels.[54] *S. mombin* seed methanol extract was examined and shown to contain safe antioxidant chemicals, such as hexadecanoic acid, capsaicin, and dihydrocapsaicin. These compounds have potential applications in the pharmaceutical and cosmetics sectors for the creation of antioxidant agents.[24]

Hypoglycaemic activity

Induction of diabetes in experimental animals is commonly by chemical method with streptozotocin and alloxan.[56-64] It usually involve the destruction of the beta-cells of the Islets of Langerhans in the pancreas with a consequent reduction in synthesis and release of insulin.[56, 63] Numerous studies have reported the hypoglycemic activities of *S. mombin*.[7, 65-67]

Findings from study by Gobinath *et al.*[67] revealed that methanol extract of *S. mombin* leaves reduced glucose level in the blood and reversed the declined plasma insulin level of the diabetic induced rats following 28 days therapy. The potential mechanism of the extract in exerting hypoglycemic effects may involve the enhancement of insulin secretion from *β*-cells in the pancreatic islets, increased transportation of glucose from the bloodstream to peripheral tissues, inhibition of endogenous glucose production, or activation of gluconeogenesis in the liver and muscles.[67]

Learning and memory activity

Learning is involved with the acquisition of knowledge while memory is involved with the ability to retain the knowledge acquired. Stress and aging are among several factors that could influence learning impairment. Aging can lead to neurodegenerative diseases including memory loss, dementia and Alzheimer's disease.[68]

In a study by Asuquo *et al*.[69] on the effects of *S. mombin* on possible learning and memory while studying the histology of the cerebral cortex in adult male Wistar rats, reported that *S. mombin* administered at varying doses (400mg and 800mg/kg) improved learning behavior and enhanced memory which could be attributable to the observed alterations in the cerebrum's structure. The potential mechanism of *S. mombin* on learning and memory may involve a beneficial impact on the production of neurotransmitters (acetylcholine, noradrenaline, dopamine, and serotonin).

Ishola *et al*. reported that *S. mombin* leaf extract and the seed extract of *Cola acuminata* effectively improved the cognitive deficits caused by scopolamine, likely due to their antioxidant characteristics.[70] Another study provided further evidence for the beneficial impact of ethanol fruit extract from *S. mombin* on memory impairment caused by

scopolamine. This outcome is achieved via improving cholinergic function and reducing oxidative stress in the brains of mice.[71]

Conclusion

There is a growing interest in the use of ethnomedicinal plants as alternative therapeutic options in the management of various illnesses, hence their usefulness cannot be overemphasized as numerous researches have consistently reported their beneficial role against a wide array of pathologies. This review examined the pharmacological effects of *Spondias mombin* as a herbal medicine for various pathological conditions and its potential as a therapeutic agent in traditional medicine. Therefore, it is recommended to conduct clinical trials on the active constituents of *Spondias mombin* in order to develop safer and more effective drug formulations for the therapy of these diseases.

Conflict of Interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

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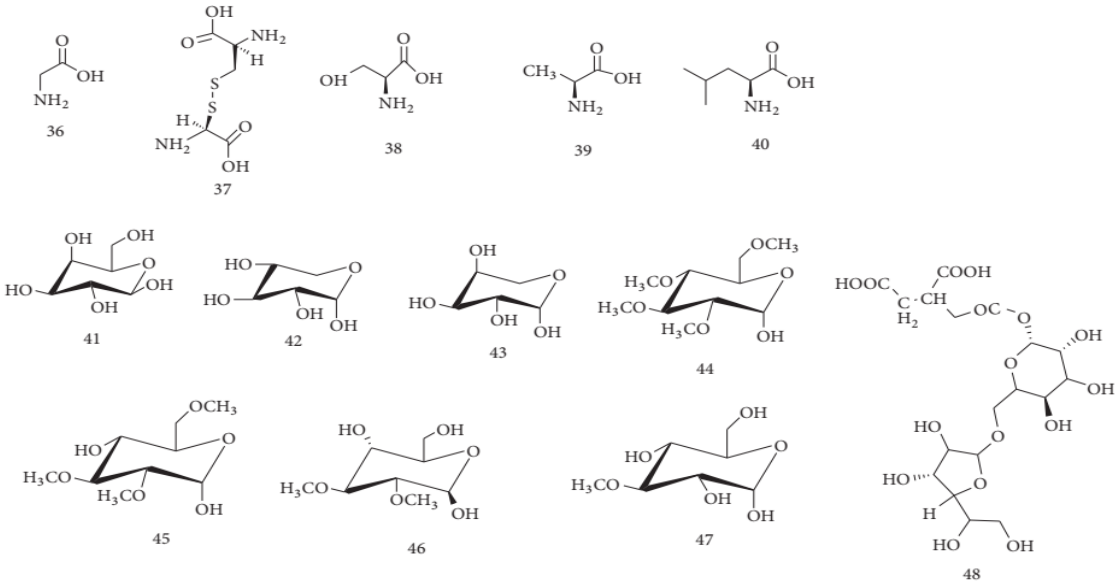

Figure 5: Chemical structure of amino acids and carbohydrates isolated from *Spondias* species[16]

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