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A Review on: Therapeutic Potential of *Spondias pinnata* Linn.

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Abstract: **The plant products are natural resources that promise an alternative strategy to replace synthetic drugs. The phytoproducts applied in medicine are increasingly used and are often preferred because of their minimal side effects. According to the World Health Organization (WHO), about 65 to 80% of the world population relies on efforts to fight disease and maintain health by using ingredients prepared from medicinal plants. The medicinal plant *Spondias pinnata*, genus *Spondias* consisting of 18 species, has been used as a traditional medicine for the treatment of various diseases. It is also cultivated commercially in multiple countries to be marketed locally and internationally. The phytochemistry screening of *Spondias pinnata* has found it to contain saponins, tannins, alkaloids, flavonoids, terpenoids, and phenolic acids. These phytochemicals have antimicrobial, anticancerous, antioxidant, immunomodulatory, anthelmintic, antidiarrheal, anti-inflammatory, diuretic, laxative, and other biological properties. The present review highlights the current advances in phytochemical compound screening, biological effects, and the molecular mechanism of action of *Spondias pinnata* in health.**

Keywords: ***Spondias pinnata*, Phytochemicals, Pharmacological therapeutics.**

1. INTRODUCTION

The enormous potential of medicinal plants to develop novel medications for a wide range of human ailments has led to an increased focus on these plants [1]. Medicinal plants may contain bioactive phytochemical constituents for future pharmaceutical analysis and use. A large number of medicinal plants in tribal medicine have uses that have interest for research, functional drug development, and identification of new bioactive phytochemicals. The major part of the world population in developing countries still uses traditional medicines which are formulated from medicinal plant [1]. Thus, according to estimates from the World Health Organization (WHO), between 65 and 80% of the world's population depends on plant-based preparations to stay healthy and fight disease [2]. A medicinal plant, *Spondias pinnata*, commonly known as hog pulm in Hindi, Ambara which have a medium-sized, deciduous tree in the Anacardiaceae family, and it uses for cure various disease. It has ovoid, greenish-yellow fruits, polygamous flowers, and imparipinnate leaves. *Spondias pinnata* is mainly found in India, Bangladesh, Sri Lanka, and Southeast Asian Countries [3]. Historically, this plant is used to treat several infectious disorders, including dysentery, bronchitis, ulcers, and skin conditions [4, 5]. However, in traditional medicine, it is also used to treat a variety of illnesses with its leaves, bark, roots, and fruits [6]. The bark of *S. Pinnata* is aromatic, astringent, and coolant in nature and is used to treat vomiting, diarrhea, and muscular rheumatism. Its fruits are very useful in diarrhea, bile indigestion, and general weakness. The leaves of *S. pinnata* are aromatic, acidic, and astringent in natures which are uses in dysentery.

2. PHYTOCHEMISTRY OF *S. PINNATA*

The aerial portion of *S. pinnata* was extracted with ethanol and found to include 24-methylene cycloartenone, β-D-glucoside, stigmast-4-en-3-one, β-sitosterol, glycoside of β-sitosterol, and lignoceric acid [7]. *S. pinnata* leaves contain a variety of compounds, including tannins, saponins, steroids, triterpenoids, alkaloids, flavonoids, and carbohydrates. The pulps of *S. pinnata* have various essential oils such as esters, carboxylic acids, alcohols, and aromatic hydrocarbons. The

fruit portion of this plant has water-soluble polysaccharides, which are primarily made up of L-arabinose, D-galactose, galacturonic acid, β-amyrin, oleanolic acid, glycine, cystine, leucine, serine, and alanine [8, 9]. The methanolic extract of *S. pinnata* bark yields the methyl gallate chemicals and triterpenoid components, such as β-amyrin and oleanolic acid [10]. The methanolic and chloroform extracts of *S. pinnata* bark contain ergosteryl triterpenes 1 and 2 [11]. According to Saxena and Singh, [12] the fruit of *S. pinnata* has a higher nutritional content and includes several amino acids, including glycine, cysteine, serine, leucine, and alanine.

3. BIOLOGICAL ACTIVITIES OF *S. PINNATA*

Spondias pinnata has a variety of biological effects, such as anti-oxidant, cytotoxic, protective ulcer, anti-inflammatory, hepatoprotective, anti-arthritis, anti-dementia, antipyretic, and analgesic, thrombolytic, hypoglycemia, anti-hypertension, antifertility, anti-microbial, and anthelmintic [10]. This plant has historically been used to treat a wide range of illnesses, including laxatives, diabetes, leprosy, ocular inflammation, diuretics, antithirst, antioxidants, antimicrobials, and thrombolytics [10]. The bark from the roots of *S. pinnata* is used to cure gonorrhea and control menstruation disease. While the chloroform extract of this plant outperforms the other extracts, the bark extract exhibits an anthelmintic function against *Pheritima posthuma* [13]. According to Attanayake et al., [14] it also has anti-diabetic action in mice, with an ideal therapeutic dose of 1g/kg. The ethanol extract of *S. pinnata* bark shows antipyretic effects when taken orally at 200 and 400 mg/kg [15]. But according to Khatoon et al., [9] a crude extract of *S. pinnata* has anti-inflammatory, antibacterial, and antioxidant properties. The leaf extract of *S. pinnata* possesses antimicrobial and antiviral properties [10]. The biological activities of *S. pinnata* are as follows.

3.1. Antimicrobial activity

The ethanolic extracts of *S. pinnata* pulp have antimicrobial properties [16]. According to Sameh et al., [10] the leaf extract of *S. pinnata* possesses antibacterial action against Gram (+) bacteria such *Bacillus cereus*, *B. subtilis*, *Sarcina lutea*, and *Staphylococcus aureus*, as well as Gram (-) bacteria like *Salmonella paratyphi*, *Vibrio parahimolyticus*, *Pseudomonas aeruginosa*, and *E. coli*. At a concentration of 500 mg/disc, it also exhibits a mild and robust cytotoxic effect and antibacterial activities on Gram (+) and Gram (-) bacteria, which have a significant activity against *P. aeruginosa* and *S. epidermidis*, an intermediate sensitivity to *S. typhii* and *S. aureus*, and a mild sensitivity to *S. flexneri*, *S. pyogenes*, and *V. cholera* [17]. The leaf extracts of *S. pinnata* in vitro studies have been reported the antivacterial activity against both Gram-positive bacteria, including *Staphylococcus aureus*, and Gram- negative bacteria such as *E. coli* and *Klebsiella pneumonia*. The inhibition properties varied with the extraction solvent, with ethyl acetate and ethanol extracts generally producing greater zones of inhibition than non-polar extracts, indicating that polar phytochemicals contribute substantially to the antimicrobial effects [18]. Aqueous extract of *S. pinnata* bark showed only modest antibacterial activity against *V. cholera*, *S. typhimurium*, and *E. coli*, while methanolic and aqueous extracts of the bark displayed antibacterial activity [19, 20]. The roots of *S. pinnata* have antibacterial activity against *S. typhi* and *V. cholera* in both ethanolic and chloroform extracts; the chloroform extracts exhibit superior antibacterial efficacy against *S. typhi* [21]. The aqueous and methyl alcohol extracts of *S. pinnata* were evaluated using cup plate diffusion models for its antibacterial properties against *Vibrio cholera*, *E. coli*, and *Salmonella typhi* at concentrations of 50 mg, 100 mg, and 150 mg. The methyl alcohol extracts only showed weak antibacterial activity, it demonstrated strong bactericidal effects against *Vibrio cholera*, *Salmonella typhi*, and *E. coli* [22].

The silver nanoparticles are synthesized by using *S. pinnata* extracts exhibited strong antibacterial and antibiofilm activities against pathogenic microorganisms. These nanoparticles were reported to damage bacterial cell walls, generate reactive oxygen species, and inhibit biofilm formation, suggesting that *S. pinnata* mediated nanoproducts could serve as a promising alternative for combating multidrug-resistant pathogens [23].

3.2. Anti-cancerous activity

The methyl alcohol (70%) extract of *S. pinnata* bark have anti-carcinogenic properties, which exhibit anti-carcinogenic activities. Ghate et al., [24] have been reported that the bark of *S. pinnata* has anti-cancer activities. It has been discovered that the cell lines A549 (MCF-7) and A549 (lung) in human mammary gland cancer both induce apoptosis. However, the methanolic extract of *S. pinnata* bark also had cytotoxic effects on A549 and MF-7 cells, with IC_{50} values of 147.84, 3.74, 149.34, and 13.30 g/ml, respectively. Das et al., [25] reported that a brine shrimp lethality bioassay test was used to investigate the anti-cancer efficacy of the ethanolic and chloroform extract of *S. pinnata*. Some researchers are supported by flow cytometry and confocal microscopy analyses have shown the methyl alcohol extract of *S. pinnata* bark helped induced

apoptosis in both malignant tumorigenic cell lines [22]. Experimental studies have been demonstrated that methanolic bark extracts of *S. pinnata* exhibit significant cytotoxic effects against human lung carcinoma (A549) and breast adenocarcinoma (MCF-7) cell lines while showing comparatively lower toxicity toward normal lung fibroblast cells. The flow cytometric and immunoblots analyses indicated that the extract induces apoptosis through activation of caspase-dependent pathways, an increased Bax/Bcl-2 ratio, and cleavage of poly (ADP-ribose) polymerase, indicating selective inhibition of malignant cell survival [22, 26].

3.3. Antioxidant activity

Large amounts of phenolic and flavanoids compounds are have strong antioxidant and free radical scavenging properties which are present in the bark extracts of *S. pinnata* [27]. The lipid peroxidation inhibition method induced by ascorbic acid has been used to explore the antioxidant capabilities isolated from *S. pinnata*. This plant has high polyphenol and flavonoid content, and preparations from its leaves and bark it have antioxidant properties [28]. Flavonoids are also having an antioxidant effect that scavenges superoxide and ions [26]. The sugar's radical hydroxyl will be eliminated, stopping additional oxidative stress events. This procedure demonstrates that *S. pinnata* extract is more effective as a hydroxyl radical scavenger [26]. According to Sujarwo et al., [29] the methanolic extract of *S. pinnata* leaves have significant concentrations of phenolic compounds, which have the ability to scavenge free radicals. The hydroxyl groups present in the phenolic compounds which are present in *S. pinnata* bark and give them the potential to scavenge. According to Ghate et al., [24] the bark contains flavonoids and phenols with antioxidant and free radical scavenging qualities. Similarly, *S. pinnata* extract causes DNA breakage in A549 and MCF-7 cells and apoptosis in both cancerous cell lines. However, the *S. pinnata* bark methanol extract causes an increase in the Bax/Bcl-2 ratio, which activates the cascade caspase and promotes the breakdown of poly adeno ribose polymerase, so inducing apoptosis through an intrinsic mechanism [24].

3.4. Immunomodulatory activity

The medicinal plant *S. pinnata* gained attention with potential immunomodulatory properties due to its abundance of tannins, phenolic acids, flavonoids, and triterpenoids. These phytochemical constituents are believed to regulate both adaptive and innate immune responses by influencing lymphocyte activation, macrophage function, cytokine secretion, and oxidative stress pathways. Instead of indiscriminately stimulating the immune system, *S. pinnata* appears to maintain immune homeostasis by enhancing host defense while limiting excessive inflammatory responses, making it a promising candidate for immune-related disorders [30, 31]. The immunomodulatory effect has been associated with the high flavonoid content of the extract, which may promote T-cell activation and improve immune cell communication through regulation of cytokine production. These findings support the traditional use of *S. pinnata* in maintaining general health and resistance against infections [30].

3.5. Anthelmintic activity

The bark of *S. pinnata* also exhibits anthelmintic properties against Indian earthworms due to the presence of various glycosides [10]. Sameh et al., [10] reported that *S. pinnata* acetonic and ethanolic extracts possess anthelmintic characteristics. As a result, compared to the acetone extract, the ethanolic extract shows stronger anthelmintic activity at concentrations between 50 and 100 mg/ml [32]. The bark of *S. pinnata* at concentrations of 10, 15, and 20 mg/ml has anthelmintic activities in its chloroform extract [13]. The methanolic extract of bark and stem of *S. pinnata in vitro* shows anthelmintic potential against *Pheretima posthuma*. In a similar vein, the methanolic extract of stem heartwood showed more potential than the bark extracts [33].

3.6. Anti-diarrheal activity

The adult Wistar rats treated with the methanolic extract of *S. pinnata* bark show anti-diarrheal efficacy against castor oil-induced diarrhea. According to Mondela et al., [34] this activity was noted in comparison to conventional diphenoxylate hydrochloride (5 mg/kg). This extract is effective because it demonstrates anti-diarrheal activity due to the presence of flavonoid compounds. It also reduces intestinal agitation and hydroelectrolytic secretion, which are prevalent in diarrheal situations [19]. In albino Wistar rats are also monitored for anti-diarrheal action using aqueous extracts of the dried fruit powder of *S. pinnata*. This extract showed significant dose-dependent anti-diarrheal properties in castor oil and magnesium sulphate-induced diarrhea when given orally at concentrations of 100, 200, and 400 mg/kg. Its efficacy was evaluated to be comparable to the medication loperamide [35].

3.7. Anti-inflammatory activity

The phytochemical of *S. pinnata* have anti-inflammatory activities with synergistic efficacy. According to Ghate et al., [36] quinoline SPE2 and 7-hydroxy-6-methoxyquinoline-2(1H) are found in the bark of *S. pinnata*. One of these compounds, quinoline SPE2, has anti-inflammatory activity in a lipopolysaccharide-stimulated murine macrophage model, suggesting that it works by preventing NF-kB activation. However, by using 2-acetoxybenzoic acid as a standard medication for activity comparison, the anti-inflammatory effect of *S. pinnata* leaf extract was also mentioned. When compared to 2-acetoxybenzoic acid, the ethyl acetate-soluble fractions significantly reduce the hemolysis of the human erythrocyte membrane that is generated by heat and hypotonic solution, respectively [37]. On the other hand, *S. pinnata* fruit extract peels also demonstrate anti-inflammatory action by significantly reducing nitric oxide generation when lipopolysaccharide is added to the RAW 264.7 cell strain at a concentration of 0.08%, all while maintaining cellular viability [38].

3.8. Diuretic and Laxative activity

Spondias pinnata has been traditionally employed in several Asian systems of medicine for the treatment of urinary disturbances and gastrointestinal disorders. Various pharmacological studies support these ethanomedicinal claims, indicating that the bark of *S. pinnata* possesses both diuretic and laxative properties. These biological effects are thought to arise from the synergistic action of flavonoids, saponins, tannins, and other phenolic constituents that regulate renal function and intestinal motility. Although the exact molecular mechanisms remain incompletely understood, available evidence suggests that these bioactive components may enhance renal electrolyte excretion, increase urine output, and facilitate bowel evacuation without producing severe gastrointestinal irritation [22]. The various extracts of the *S. pinnata* bark exhibit diuretic and laxative activity in Wistar albino rats. For the purpose of comparing activities, agar-agar and furosemide were utilized as reference standards, respectively. Significant diuretic and laxative effects were observed when methanol and chloroform extracts of *S. pinnata* were tested for urinary levels of sodium, potassium, and chlorides [39].

4. CONCLUSION

Spondias pinnata is valuable natural resources for phytochemicals with a wide spectrum of pharmacological activities, which strongaly supported by traditional knowledge and increasing scientific evidences. The phytochemicals of *S. pinnata* contribute to antimicrobial, anticancerous, antioxidant, immunomodulatory, anthelmintic, antidiarrheal, anti-inflammatory, diuretic, laxative, and other biological properties. Although current review of literatures are encouraging, further more studies focusing on the characterization and isolation of bioactive components, molecular mechanisms, and well-designed pharmacological trials are essential to establish its therapeutic efficacy.

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