An Overview: Beneficial Role Of Pithecellobium Dulce In Human Health

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Abstract- *Chronic diseases resulting from poor lifestyle habits are the leading cause of illness and mortality worldwide. Many of these conditions can be managed or prevented through the principles of Ayurveda, which emphasizes holistic lifestyle changes and the regular use of adaptogenic herbs. Pithecellobium dulce, an indigenous fruit, has long been valued in traditional medicine for its remarkable therapeutic properties. Historically, various parts of the tree—from root to fruit—have been employed to treat a wide range of ailments. In Ayurvedic and other traditional medicinal systems, P. dulce has been extensively utilized due to its rich profile of bioactive compounds, including triterpenoids, flavonoids, sterols, and tannins. Research has demonstrated that the fruits of Pithecellobium dulce contain high levels of phenols, flavonoids, and saponins, which contribute to reducing oxidative stress, managing diabetes, and alleviating digestive disorders. The fruit also exhibits a wide range of pharmacological properties, including antiviral, antibacterial, antioxidant, antidiabetic, antipyretic, antihelminthic, anti-inflammatory, and sedative effects. In addition to the fruit, the leaves and seeds of P. dulce have shown significant adulticidal, antifungal, and antibacterial activities. Nutritionally, the fruit is a valuable source of carbohydrates, plant steroids, and proteins. Given its broad therapeutic potential and the growing body of scientific evidence supporting its efficacy, P. dulce—a long-utilized component in traditional medicine—may be effectively integrated into modern, evidence-based healthcare approaches.*

Keywords: Pithecellobium Dulce, Antibacterial Action, Neuropharmacological Action

I. INTRODUCTION

Traditional systems of natural medicine are experiencing a resurgence in popularity, extending from rural communities to urban populations. [1] Medicinal plants are a rich source of natural compounds with diverse pharmacological properties. For generations, indigenous and tribal communities have recognized the therapeutic value of these plants, often relying on them to promote and maintain health. Today, researchers continue to identify new bioactive phytochemicals with promising therapeutic potential against a wide range of ailments, including diabetes, cancer, and inflammatory conditions[2]. While allopathic medicine continues to advance and produce new pharmaceuticals, concerns persist regarding long-term effectiveness, potential side effects, and whether such treatments offer permanent solutions. In this context, plant-based medicines present a compelling, complementary alternative with a long-standing history of efficacy and safety in traditional healing systems[3]. Conventional medications, while effective, can sometimes lead to severe side effects such as elevated blood pressure, liver and kidney failure, and various other complications. In contrast, *Pithecellobium dulce* (commonly abbreviated as *P. dulce*) is a significant medicinal plant of American origin, belonging to the Fabaceae family, and is now widely cultivated across India and the Andaman Islands. It is a medium-sized, thorny, evergreen tree, locally known by various names such as "Jungal Jalebi," "Black Bead Tree," "Vilayati Babul," and "Kodukkapuli" in Tamil. This review focuses on the nutritional composition, therapeutic potential and overall health.[16]

Benefits of *P. Dulce*:

Its nutritional profile is particularly promising due to its high content of protein, fiber, and carbohydrates [9]. The plant's major health-promoting effects—such as antidiabetic, antioxidant, antibacterial, cardioprotective, antifungal and antidiarrheal properties—are largely attributed to its diverse array of bioactive compounds.[21-27]

Chemical constituents:

Fruits and seeds: The seeds of *Pithecellobium dulce* contain 13.5% moisture, 17.6% protein, 17.1% crude fat, 7.8% crude fibre, 41.4% starch, and 2.6% ash. They are also rich in essential vitamins, including vitamin C, known for its antioxidant properties, and vitamin E, which supports skin and hair health while delaying the effects of aging. Furthermore, the seeds contain key amino acids such as glutamic acid, arginine, aspartic acid, threonine, and leucine. Among all parts of the plant, the seeds exhibit the highest protein

concentration, followed by the stems, roots, leaves, flowers, and fruits. Analysis of seed protein flour revealed a protein content of 39.22%, along with calcium and phosphorus levels of 48 mg and 542 mg per 100 g, respectively. Overall, *P. dulce* seeds are a rich source of proteins and peptides, showing strong potential for addressing protein deficiency and contributing to nutritional health [1].

The total polyphenol content in *Pithecellobium dulce* seeds was measured at 294 mg per 100 g. Fatty acid analysis of the seed extract revealed the presence of nine saturated and seventeen unsaturated fatty acids. Both the fruits and seeds of P. dulce are rich in bioactive compounds such as polysaccharides, lipids, phospholipids, glycosides, steroids, and saponins. Water-soluble polysaccharides extracted from the seeds have been utilized in the treatment of human diseases and exhibit significant antioxidant activity, helping to prevent oxidative stress [2].

Arils: The nutritional composition of the aril includes moisture (77.9%), protein (0.7%), fat (0.6%), fiber (1.2%), carbohydrates (19.9%), and mineral matter (0.7%). Mineral analysis showed calcium at 13.0 mg, phosphorus at 54.0 mg, and iron at 1.4 mg per 100 g. Vitamin content included thiamine (222 μg), riboflavin (59 μg), nicotinic acid (0.36 mg), and ascorbic acid (120 mg/100 g). Essential amino acids detected in the aril were valine (143 mg), lysine (178 mg), phenylalanine (41 mg), and tryptophan (26 mg) per 100 g [9].

Fruits: The ethanolic extract of *P. dulce* fruits yielded ten different chemical compounds, including 2,5,6-trimethyl-3-oxathiane, trans-3-methyl-2-N-propylthiophane, 2-furan carboxaldehyde-5-(hydroxymethyl), hexadecanoic acid, D-pinitol, heptacosanoic acid, tetracosanol, 22-tricosenoic acid, methyl-2-hydroxy icosanoate, and stigmasterol. Additionally, three distinct heteropolysaccharides have been isolated from the fruits and are currently employed as adjuvants in pharmaceutical formulations [2].

Leaves: The leaves of *Pithecellobium dulce* contain 29.0% crude protein, 17.5% crude fibre, and 5.6% ash, along with trace amounts of calcium (1.14%) and phosphorus (0.35%). Fatty oil analysis from the leaves revealed the following properties: specific gravity of 0.9044, refractive index of 1.4546, saponification number of 185.3, iodine number of 80.7, acid value of 1.2 thiocyanogen value of 56.0, and unsaponifiable matter at 0.6%. Phytochemical investigations identified several primary components in the leaf extract, including kaempferol-3-rhamnoside, dulcitol, octacosanol, α-spinasterol, quercetin, cyclitol, and afzelin-3. Gas chromatography- mass spectrometry (GC-MS) analysis further revealed bioactive constituents such as phytol, 3- butenyl anthracene, diisooctyl phthalate, 13-docosenamide, 3,6,9-triethyl-3,6,9-trimethyl formic acid, cyclotetrasiloxane octamethyl, and L-(+) ascorbic acid 2,6-dihexadecanoate [3].

Bark: The bark of *P. dulce* is rich in plant polyphenols, with approximately 37% tannins of the catechol type reported. Similar to the leaves, compounds such as quercetin, kaempferol, cyclitol, dulcitol, and afzelin have been isolated from the bark. Additionally, alcoholic extracts of the leaves have been found to contain octacosanol, β-D-glucoside of α-spinasterol, α- spinasterol, and kaempferol-3-rhamnoside [17].

Traditional health benefits like:

The high dietary fiber content in *Pithecellobium dulce* (commonly known as jungle jalebi) helps regulate appetite and reduce hunger, making it a natural aid for weight management. Drinking a glass of lemon juice mixed with extracts from jungle jalebi pods may assist in shedding extra pounds and maintaining healthy weight control. Additionally, the fruit peel extract exhibits antimicrobial properties, capable of inhibiting the growth of various microorganisms. Metabolites from the fruit peel have been found to possess antibacterial and wound-healing effects. [9] Seed extracts of *P. dulce* also demonstrate antibacterial activity against multiple bacterial species, suggesting potential therapeutic uses in treating infections [1]

Moreover, jungle jalebi juice is rich in vitamin C, a powerful antioxidant that boosts the immune system. Beyond enhancing immunity, vitamin C improves skin health by reducing dark spots and pimples, resulting in a clearer and more radiant complexion. [10]

The fruit of *Pithecellobium dulce* contains pinitol, a cyclic polyol known for its antidiabetic properties [6]. Extracts from jungle jalebi pods have demonstrated significant anti-hyperglycemic effects by effectively lowering blood sugar levels in individuals with type 2 diabetes [5]. Traditionally, these pods are also used to treat diarrhea and dysentery, as they help scavenge toxins and harmful free radicals in the stomach and intestines, promoting recovery from these conditions [7]. The pods are rich in essential minerals such as calcium, magnesium, and phosphorus, which contribute to bone health and significantly strengthen tooth enamel [9].

Moreover, the sour fruits of *P. dulce* are abundant in tannins, flavonoids, and alkaloids— phytonutrients with strong antioxidant and antimicrobial properties that aid in healing oral ulcers [4]. Beyond their protective effects, these bioactive compounds have been shown to enhance brain function, memory, and cognition, while also reducing anxiety

and symptoms of depression, thereby promoting improved mood and mental well-being [20].

Therapeutic and Biological Importance of P. Dulce:

A wide range of physiologically active compounds present in all parts of *Pithecellobium dulce* exhibit diverse pharmacological activities, including anti-inflammatory, adulticidal, antibacterial, anti-dysentery, antimycobacterial, anticonvulsant, anti-ulcer, hepatoprotective, antihyperlipidemic, antifungal, antioxidative, and free radical scavenging properties [9–12].

The medicinal benefits of this plant are well-documented; for example, root extracts have demonstrated estrogenic activity [13], while the saponin fraction isolated from the fruits exhibits significant anti-inflammatory effects [14]. Traditionally, various parts of *P. dulce* have been used to treat ailments such as earaches, leprosy, toothaches, and venereal diseases, as well as serving as emollients, abortifacients, anodynes, ovicides, and larvicides [15].

The fruit's traditional use in managing gastrointestinal disorders, including peptic ulcers, has been scientifically validated [4]. Additionally, the bark possesses febrifuge properties and is employed in the treatment of dysentery, diarrhea, and constipation. In regions like Haiti, oral decoctions of root and bark are used to treat diarrhea, whereas in Guiana, root bark serves as a remedy for dysentery and as a febrifuge [7]. The powdered, methanolic, and aqueous seed extracts have shown fungistatic and fungicidal activities against plant pathogens such as *Fusarium oxysporum*, *Botrytis cinerea*, *Penicillium digitatum*, and *Rhizopus stolonifer*. Several triterpene saponins—including pithedulosides A, B, E, F, and I—have been reported to inhibit the in vitro mycelial growth of *Rhizopus stolonifer* and *Colletotrichum gloeosporioides*.[18]

Moreover, *P. dulce* has been used effectively to alleviate eye dermatitis irritation, and the polyphenol content in its bark extracts shows anti-venom properties [24]. Seeds of *P. dulce* have been employed in managing diabetes and its associated symptoms, with studies showing increased glycogen content following treatment with extracts from the fruit, seeds, and bark. Importantly, fruit extracts have demonstrated non-toxicity alongside significant antidiabetic activity [6]. Consequently, the plant has a long history of traditional use in treating diabetes mellitus [5].

Antioxidant Activity:

Oxidative stress, caused by an imbalance of electrons in atoms or molecules, is a major contributing factor in the development of numerous diseases, including cancer, arthritis, diabetes, and renal damage. Unstable free radicals, such as nitric oxide, hydroxyl, and superoxide radicals, can inflict severe damage to internal organs and tissues, leading to various health complications. These radicals are also implicated in autoimmune disorders like rheumatoid arthritis. *Pithecellobium dulce* exhibits significant free radical scavenging activity, effectively neutralizing synthetic radicals such as DPPH, nitric oxide, superoxide, and hydroxyl ions. Studies on water-soluble extracts of *P. dulce* leaves have revealed a high content of flavonoids and other phenolic compounds, which contribute to its potent antioxidant properties [17].

Antibacterial characteristics:

The secondary metabolites like flavonoids, saponins, etc. of *Pithecellobium dulce* inhibit the growth of bacteria. It is evident that seed, fruit peel, and pulp of Pithecellobium dulce pods possess a broad spectrum of activity towards Gram-positive (*Bacillus subtilis*) and Gram- negative (*Klebsiella pneumonia*) tested bacterial strains with almost similar MIC values.

Research study on fresh *Pithecellobium dulce* flowers has been carried out which shows the presence of quercetin, a glycoside. The antibacterial and anti-inflammatory properties of the flavonol glycoside have been confirmed by its activity [14]. Additionally, *Pithecellobium dulce* fruit peel metabolites may be employed as a wound-healing and antibacterial treatment. Its ethanolic extract has also been shown to possess strong antibacterial properties.[9]

Antifungal action:

Pithecellobium dulce is a natural resource that can be employed to combat fungal infections. Preparations of *P. dulce* in alcohol and water have shown significant antifungal properties against a variety of ailments. These extracts can be developed into natural products for fungal infections, offering an alternative to conventional antifungal medications. Dulce has potentiality against *Botrytis cinerea, Rhizopus stolonifera*, and *Penicillium digitatum* contamination. In the aqueous extract, the secondary metabolite of kaempferol and some other mixture of compounds inhibit the growth of the fungal contamination, and when the activity of aqueous and hydroalcoholic extracts were compared, the aqueous extract showed better activity against fungal contamination.[18] This suggests that the aqueous extract may be a more effective natural remedy for treating fungal infections, making it a

promising candidate for further research and development in the field of mycology and natural therapeutics [26].

Neuropharmacological Characteristics:

The therapeutic potential of ethanolic and aqueous extracts of *Pithecellobium dulce* leaves has been evaluated for effects on spontaneous motor activity and motor coordination. Studies conducted on Swiss albino mice revealed significant neuropharmacological activity, with a notable decrease in spontaneous motor activity observed following treatment with these extracts. This reduction suggests potential sedative effects, highlighting the need for further investigation into the underlying mechanisms. Such findings may pave the way for developing new therapeutic agents targeting central nervous system disorders.[21]

Antidiabetic Properties:

Diabetes mellitus is a complex metabolic disorder characterized by impaired insulin secretion or action. Conventional synthetic antidiabetic drugs often cause adverse effects, including liver and kidney damage. Plant-based bioactive compounds offer a promising alternative. Methanolic extracts of *P. dulce* seeds were studied using a streptozotocin (STZ)-induced diabetic rat model (albino Wistar males), where the crude extract demonstrated the potential to preserve the function of pancreatic β-cells responsible for insulin production and regulation. This protective effect may help mitigate diabetic complications and presents *P. dulce* as a potential safer alternative to traditional allopathic treatments. Further research is needed to elucidate the mechanisms behind β-cell preservation and the extract's overall role in diabetes management.[22]

Antidiarrheal Activity:

Ethanolic and aqueous fractions of *Pithecellobium dulce* leaves were tested for antidiarrheal effects in castor oil-induced diarrhea models in albino Wistar rats. Both extracts significantly reduced the frequency and looseness of stools compared to controls, with the aqueous fractionshowing markedly greater efficacy than the ethanolic extract at the tested doses. These results suggest that compounds within the aqueous extract may be more effective for alleviating diarrhea, warranting further studies to isolate the active constituents and clarify their mechanisms of action.[23]

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Ovicidal, Larvicidal, and Adulticidal Properties:

Methanolic leaf extracts of *P. dulce* exhibited the highest larvicidal and ovicidal activities when compared to other solvent extracts from leaves and seeds. These findings suggest that extracts from the seed and leaf could serve as eco-friendly alternatives for mosquito vector control. Hexane-based seed extracts showed less efficacy against mosquitoes, whereas methanolic extracts achieved the highest larval mortality rates. The bioactive compounds in *P. dulce* have potential as natural insecticides targeting mosquito-borne diseases such as dengue, filariasis, malaria, and viral encephalitis, which are prevalent in developing countries. Importantly, *P. dulce* leaf and seed extracts are considered safe for use and could help reduce reliance on chemical insecticides, which pose respiratory risks to humans. Thus, *P. dulce* phytochemicals offer a promising natural approach to mosquito control and public health protection.[24]

Antivenom Action:

Tannins extracted from *P. dulce* bark using aqueous methods have demonstrated notable antivenom properties. The crude extract effectively reduces venom-induced necrosis and limits lethality. High tannin content, particularly hydrolyzable tannins, inhibits acetylcholinesterase activity by up to 90%. The extract acts by selectively blocking nicotinic acetylcholine receptors and non-selectively precipitating venom proteins, thereby neutralizing venom effects [25].

Antitubercular Activity:

Leaf extracts of *P. dulce* prepared using hexane, chloroform, and alcohol were evaluated against *Mycobacterium tuberculosis* strains. Among these, the alcoholic extract showed significant inhibitory and antimicrobial effects, indicating potential as a treatment against tuberculosis and associated secondary infections [26].

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Cardioprotective Effects:

The cardioprotective properties of *P. dulce* fruit peel extract were assessed in Wistar rats with isoproterenol (ISO)-induced myocardial infarction (MI). ISO administration caused significant elevations in cardiac marker enzymes, indicative of myocardial injury. Pretreatment with *P. dulce* extract improved these enzyme activities and modulated biochemical parameters favorably, suggesting protection against myocardial damage. [28]

Anticonvulsant Activity:

The anticonvulsant effect of the crude flavonoid fraction from *P. dulce* leaves was studied using the maximal electroshock-induced seizure (MES) model in rats. Both ethanolic and aqueous extracts significantly reduced the duration of the tonic extension phase associated with seizures. The aqueous extract showed superior efficacy, with results comparable or superior to phenytoin sodium, a standard antiepileptic drug, highlighting its potential as a natural anticonvulsant agent. [29]

Central Nervous System (CNS) Depressant Activity:

Studies on the locomotor activity of aqueous and alcoholic extracts of *P. dulce* in albino mice revealed significant CNS depressant effects. The alcoholic extract exhibited stronger depressant activity than chlorpromazine, a standard antipsychotic, likely due to increased brain gamma-aminobutyric acid (GABA) levels. Models of Parkinson's disease in mice also confirmed these CNS depressant effects, reinforcing the therapeutic potential of *P. dulce* extracts for neurological disorders.[30]

II. CONCLUSION

Pithecellobium dulce is some evergreen tree rich in diverse phytochemicals that contribute to its notable pharmacological and medicinal properties. Extensive research by contemporary scientists has highlighted its significant potential in promoting health, preventing disease, and enhancing longevity. This review concludes that *P. dulce* exhibits multiple beneficial health effects, including anti-ulcer, antifungal, antidiabetic, and anti-venom activities. Moreover, the findings support the traditional use of this plant and encourage the integration of such herbal remedies in addressing modern life-threatening illnesses. The biological activities documented herein validate the ethnomedicinal applications of *P. dulce* and pave the way for future research focused on isolating its bioactive compounds for therapeutic development.

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Figures

Fig1: Parts used**:** Bark, leaves, seeds, flowers, pulp and Pods

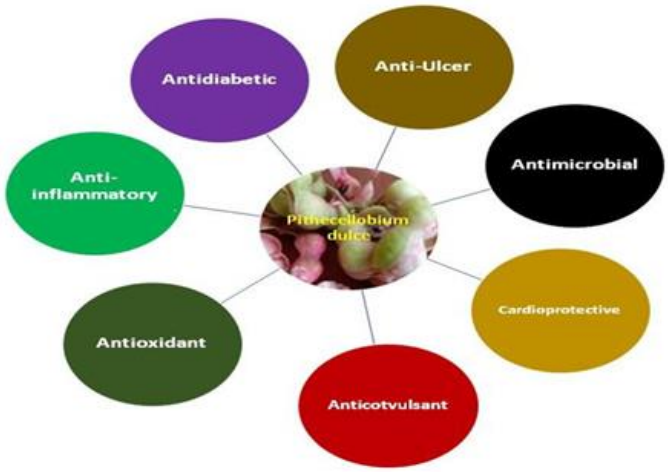

Fig 2: Significant Pharmacological Characteristics of Pithecellobium Dulce

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