

COMPARATIVE PHYTOCHEMICAL, NUTRITIVE AND MEDICINAL ANALYSIS OF
PITHECELLOBIUM DULCE AND *MORINGA OLEIFERA*: THE UNTAPPED POTENTIAL
OF INDIGENOUS SPECIESSuseela Lanka^{1*}, Ashok Kumar Kota², Y.A.V.A.S.N Maruthi¹¹Department of Bioscience and Biotechnology, University College of Arts and Sciences, Krishna University,
Machilipatnam, Andhra Pradesh, India.²Research Scientist-B, Department of Multidisciplinary Research Unit (MRU), Govt. Siddhartha Medical College,
Vijayawada, Andhra Pradesh-520008.***Corresponding Author: Suseela Lanka**Department of Bioscience and Biotechnology, University College of Arts and Sciences, Krishna University,
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ABSTRACT

Indigenous plants have long served as critical sources of nutrition and traditional medicine. Among them, *Moringa oleifera* is widely recognized for its exceptional nutritional and medicinal properties, leading to its extensive cultivation and commercialization. In contrast, *Pithecellobium dulce*, though traditionally used in various folk remedies, remains largely underexplored and underutilized despite its widespread availability in tropical regions. The present paper is designed to emphasize the importance of scientifically validating indigenous and neglected species. It seeks to comparatively analyze the phytochemical, nutritive, and medicinal attributes of *P. dulce* and *M. oleifera* with the aim of evaluating their potential health benefits. By doing so, the paper aims to determine whether *P. dulce* can emerge as a promising alternative to the more established *M. oleifera*, particularly in the context of affordable and sustainable plant-based therapeutics and nutrition. This paper is significant in its potential to promote biodiversity-based food and medicine systems, encourage the use of locally available plant resources, and contribute to the broader goals of food security, traditional knowledge preservation, and alternative medicine development.

KEYWORDS: Indigenous plants, *Moringa oleifera*, *Pithecellobium dulce*, nutritive, and medicinal properties.**1. INTRODUCTION**

Indigenous plant species have long contributed to human health and nutrition, serving as primary sources of food and medicine in traditional systems. Across cultures and ecosystems, these plants are not merely survival tools, but symbols of ancestral knowledge and sustainability. In the present era of nutraceuticals and natural remedies, the resurgence of interest in medicinal plants demands scientific validation of both well-known and underutilized species.

In recent years, there has been a growing global interest in the use of plants as sources of natural bioactive compounds for nutrition and therapeutic purposes. *Moringa oleifera* is one such plant, extensively studied

and widely recognized for its nutritional richness and medicinal value. It is often referred to as the "miracle tree," has earned global recognition for its dense nutritional profile and a wide range of pharmacological properties. It is a staple in many indigenous communities and has transitioned into mainstream global markets as a super food. The bark, leaves, roots, seeds, pods, fruits, and flowers of this native tree are all used as medicinal alternatives to treat a variety of illnesses.

Moringa oleifera has been the subject of multiple studies, especially the leaves are highly nutritious with high levels of vitamin A, C, iron, calcium, potassium, phosphorous, essential amino acids, and powerful antioxidants such as quercetin, chlorogenic acid and

bioactive substances, such as glycosides, anthraquinones, and terpenoids (Rahman et al., 2021; Sultana 2020; Anwar et al., 2007; Fahey, 2005). The plant especially the leaves have demonstrated medicinal benefits such as antidiabetic, hypotensive, anti-inflammatory, antiulcer, hypocholesterolemic, antispasmodic, antioxidant, antitumor, hepatoprotective, and antimicrobial effects (Bhattacharya et al., 2018). The presence of isothiocyanates makes the plant to exhibit antibacterial properties (Paikra et al., 2017). The anti-tumor effect of alcoholic leaf extracts of the plant was demonstrated by Tiloke et al. (2013) owing to the presence of phenolics such as Quercetin and Kaemferol. Several studies (Kou et al., 2018; Berkovich et al., 2013; Shaban et al., 2012), including the works of Hussein et al. (2014) revealed the anti-tumor effects of leaf, fruit, seed, bark and flower of this miracle plant. The low-fat content of the leaves makes it an ideal source to prevent coronary heart diseases (Sultana 2020). Besides the nutritive value, the plant also shows significant water purification properties (Paikra 2017). Studies by Sultana et al. (2020) revealed that the protein content and other nutrient composition of the *Moringa oleifera* are influenced by environmental factors.

Pithecellobium dulce, commonly known as Manila tamarind or jungle jalebi, remains relatively neglected despite its wide distribution in tropical regions and use in traditional medicine. The species, though traditionally used in indigenous medicine, has not received equivalent scientific attention. With increasing demands for plant-based alternatives in pharmaceuticals and nutraceuticals, it becomes essential to explore lesser-known, underutilized species like *P. dulce*. *Pithecellobium dulce* has been traditionally used for treating ulcers, wounds, and diarrhea. Limited studies have reported the presence of flavonoids, saponins, and tannins in its leaves and pods (Kirtikar and Basu, 1935; Al-Obaidi et al., 2024). However, comprehensive phytochemical and nutritional profiling is still scarce, making it a candidate for further exploration.

This chapter aims to bring such a neglected species into scientific focus and determine whether it can serve as a viable alternative to *M. oleifera* in terms of phytochemical, nutritive, and medicinal potential.

2. Botanical Overview

2.1 *Moringa oleifera*

Moringa oleifera belongs to the family Moringaceae and with 13 species spread across tropical and subtropical climes, this genus is indigenous to the sub-Himalayan region of India, Pakistan, Bangladesh, and Afghanistan (Doménech et al., 2017). Virtually every part of the tree — leaves, seeds, pods, flowers, and roots — is utilized for food or medicine. Figure 1 shows *Moringa oleifera* plant. Table 1 shows the taxonomic classification of the *Moringa oleifera*.

Common Names: Drumstick tree, horseradish tree, ben oil tree

Parts Used: Leaves, pods, seeds, flowers, bark, root



Figure 1: *Moringa oleifera* plant.

Table 1: Taxonomic classification of *Moringa oleifera*.

Kingdom	Plantae
Subkingdom	Tracheobionta
Super division	Supermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Dilleniidae
Order	Capparales
Family	Moringaceae
Genus	<i>Moringa</i>
Species	<i>oleifera</i>

2.2 *Pithecellobium dulce*

Pithecellobium dulce, a member of the Fabaceae family, is native to Central America but naturalized across South and Southeast Asia. It is a thorny tree that produces edible pods with a sweet-sour pulp, often consumed raw or in traditional preparations. Figure 2 shows *Pithecellobium dulce* plant. the Table 2 shows the taxonomic classification of *Pithecellobium dulce*.

Common Names: Manila tamarind, jungle jalebi, guamúchil.

Parts Used: Pulp, seeds, bark, leaves, pods.



Figure 2: *Pithecellobium dulce* plant with its fruit.

Table 2: Taxonomic classification of *Pithecellobium dulce*.

Kingdom	Plantae
Phylum	Streptophyta
Class	Equisetopsida
Subclass	Magnoliidae
Order	Fabales
Family	Fabaceae
Genus	<i>Pithecellobium</i>
Species	<i>Pithecellobium dulce</i>

3. Phytochemical Profile

Phytochemicals are bioactive compounds in plants that contribute to their medicinal effects. Both *M.oleifera* and *P.dulce* possess a rich spectrum of secondary

metabolites.

Moringa oleifera contains Alkaloids like moringine (similar to ephedrine), moringinine; flavonoids such as myricycin, Quercetin, kaempferol; phenolics such as gallic acid, chlorogenic acid; saponins and tannins exhibiting antioxidant and anti-inflammatory properties and Glucosinolates with known anticancer potential, isothiocyanates with antibacterial potential (Sivapragasam et al., 2024; Karima Gharsallah et al., 2023; Anzano et al., 2021; Abideen et al., 2020; Ma et al., 2020; Sudha et al., 2020; Tshabalala et al., 2019; Abd Rani et al., 2018; Paikra et al., 2017; Saini et al., 2016). Table 3 shows Phytochemicals, their bioactive compounds and reported health benefits associated with *Moringa oleifera*.

Table 3: Phytochemicals and other bioactive constituents reported in *Moringa oleifera* leaves.

Class	Bioactive compounds	Characteristic	Reported health benefit	References
Isothiocyanate	Moringin	Activates TRPA1 channels	Anti-inflammatory, neuroprotective, and anti-cancer	Source: Arshad et al. (2025), Table 3, with the terminology retained from the supplied source.
Alkaloid	Mamuroside A & Mamuroside B	Mamuroside A: Unique alkaloid with antioxidant properties Mamuroside B: Rare alkaloid with antidiabetic properties	Mamuroside A reduces oxidative stress and inflammation; Mamuroside B, Improves insulin sensitivity and glucose metabolism	
Flavonoids	Quercetin, Kaempferol & Rutin	Antioxidant and anti-inflammatory flavonoids	Protects against cardiovascular diseases and cancer; Reduces risk of chronic diseases and supports immune function	
Phenolic acids	Chlorogenic acid, Caffeic acid & Gallic acid	Antioxidant & Anti-inflammatory properties	Reduces blood pressure and improves glucose metabolism; Protects against oxidative stress and supports liver health; Protects against infections and oxidative damage	
Polyphenol	Tannins	Astringent polyphenols with antimicrobial properties	Protects against infections and supports gut health	
Phytosterol	β -Sitosterol	Plant sterol with cholesterol-lowering properties	Reduces LDL cholesterol and supports heart health	
Catechin	Epigallocatechin gallate (EGCG)	Strong antioxidant with anti-cancer properties	Reduces cancer risk and supports brain health	
Cytokinin	Zeatin	Plant hormone with anti-aging properties	Promotes cell growth and delays aging	
Antioxidant vitamins	Vitamin C (ascorbic acid) & Vitamin E (tocopherol)	Vit C is a water-soluble antioxidant vitamin & Vit E is a fat-soluble antioxidant vitamin	Vitamin C is Immune vitamin and protects against oxidative stress; Vitamin E Protects cell membranes and reduces oxidative damage	
Carotenoid	Carotenoids (β -carotene)	Precursor to vitamin A with antioxidant properties	Supports vision and immune function	

Saponins	Saponins	Natural detergents with cholesterol-lowering properties	Reduces cholesterol and supports immune function	
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Pithecellobium dulce, though less explored, has shown the presence of alkaloids, flavanoids, glycosides, tannins, steroids, polyphenols, and saponins in various parts, viz., leaves, bark, fruit peel, pulp, and seeds (Saravanan et al., 2025; Rajesh Kumar et al., 2022; Saeed Kotb et al., 2022; Sneha et al., 2020; Uma Shankari and Prem Kumar, 2019; Mukesh Kumar et al., 2013). The plant is rich in phytochemicals that have gained international attention for their substantial health benefits (Selvakumar

et al., 2023). These include alkaloids, dulcinine, pithecolobine; flavonoids, Luteolin, apigenin; tannins and saponins that are known for antimicrobial action; coumarins and sterols which potentially aid in cardiovascular health; volatile oils and polysaccharides with possible immunomodulatory effects. Table 4 shows summary of phytochemicals from different parts of *Pithecellobium dulce* and their associated biological function.

Table 4: Summary of phytochemicals reported from different parts of *Pithecellobium dulce*.

Plant part	Major phytochemicals reported	Remarks	Reference
Seeds	Phenolics, flavonoids, tannins, saponins, sterols, fatty acids, amino acids	Associated with antioxidant and anticancer activity	Alhamed et al. (2023)
Flowers	Alkaloids, flavonoids, tannins, saponins, glycosides, steroids, terpenoids, phenolics	Rich source of secondary metabolites	Chandran & Balaji (2008)
Stem bark	Phenolic acids, flavonoid glycosides, tannins, triterpenoids, organic acids	UPLC-ESI-MS/MS metabolite profiling	Kotb et al. (2022)
Leaves	Alkaloids, flavonoids, tannins, saponins, terpenoids, steroids, glycosides, carbohydrates, proteins, amino acids	Supported antimicrobial activity	Kumar et al. (2013)
Leaves	Phenolics, flavonoids, tannins, alkaloids, saponins, glycosides, terpenoids, steroids	Supported antioxidant/antifungal activity	Kumari (2017)
Ripe fruits	Flavonoids, phenolics, tannins, alkaloids, saponins, glycosides, carbohydrates	Supported hepatoprotective activity	Raju & Jagadeeshwar (2014)

4. Nutritional Composition

Moringa oleifera is renowned for its impressive nutritional value. Its leaves contain up to 30% protein on a dry weight basis and are rich in vitamins A, C, and E, along with calcium, iron, and potassium and magnesium

(Gopalan et al., 2004). It also provides a complete amino acid profile. It is also rich in dietary fibre that promotes digestive health. Table 5 shows nutritional applications of *Moringa oleifera* in functional food products.

Table 5: Nutritional applications of *Moringa oleifera* in functional food products.

Nutritional applications of Moringa	References
Moringa capsules, and powders; Herbal teas, energy drinks, and fortified juices, Moringa- and beetroot-based functional drinks	Source: Arshad et al. (2025), Table 5, with the terminology retained from the supplied source.
Moringa-enriched biscuits, cookies& crackers with improved taste, and energy bars	
Moringa-fortified yogurts, almond milk, and oat milk	
Moringa enriched complementary foods to reduce anemia; Soups, sauces, and ready-to-eat meals; Seeds, pods, and leaves used to create sustainable products; Moringa leaf powder enriched wheat flour & bread	
Moringa based supplements to improve mother and child health	
Moringa fortification in poultry and livestock feed	
Moringa in skin and haircare products	

Pithecellobium dulce pulp offers digestible sugars and dietary fiber, with moderate amounts of proteins and carbohydrates and good source of vitamin C and essential minerals such as iron and zinc. The pulp and seeds are sources of polyphenolic content and hence

exhibits antioxidant properties. Its nutritional profile supports its use as a supplemental fruit in traditional diets (Ravishankar et al., 2012; Selvakumar et al., 2019). Table 6 shows nutritional Importance of *Pithecellobium dulce*.

Table 6: Nutritional Importance of *Pithecellobium dulce*.

Nutritional Aspect	Plant Part	Major Nutrients	Significance	Reference
Vitamin content	Fruit pulp	Vitamin C, thiamine, riboflavin, niacin	Supports immunity and metabolism	Dhanisha et al., 2022b
Essential amino acids	Fruit	Lysine, valine, phenylalanine, tryptophan	Protein synthesis	Dhanisha et al., 2022b
Minerals	Fruit	K, P, Na, Ca, Fe	Bone and metabolic health	Dhanisha et al., 2022b
Seed nutrients	Seeds	41.4% carbohydrate, 17.7% protein, 7.8% fibre, 2.8% ash	Nutritive food source	Murugesan et al., 2019

5. Medicinal Potential

Moringa oleifera exhibits a broad range of pharmacological activities viz., antioxidant (Siddhuraju & Becker, 2003), anti-inflammatory (Tiloke et al., 2013), antimicrobial (Rahman et al., 2009), antidiabetic (Jaiswal

et al., 2009), and anticancer (Sreelatha & Padma, 2011) besides its hepato and cardio protective functions. Table 7 shows medicinal and pharmacological applications of *Moringa oleifera*.

Table 7: Medicinal and pharmacological applications of *Moringa oleifera*.

Health benefit / application	Plant Part & active compounds responsible for the health benefits and key findings	References
Antioxidant activity	Aqueous and hydroethanolic Leaf extracts of <i>Moringa</i> with Bioactive Peptides and Specific amino acid make up (high concentration of aromatic and branched-chain amino acids, such as phenylalanine, leucine, and tryptophan, which drive antioxidant and anti-inflammatory bioactivity)	Source: Arshad et al. (2025), Table 4, supplied source. These findings include experimental and animal-model evidence as reported in the review; they should not be interpreted as established clinical treatments.
Neuroprotective and Anti-inflammatory activity	Ethanol Leaf extracts of <i>Moringa</i> with Quercetin & Derivatives; Kaempferol & Derivatives; Phenolic acids such as chlorogenic acid and gallic acid. Mairuae et al. (2023) demonstrated that the ethanolic extract of <i>Moringa oleifera</i> leaves suppresses bacterial lipopolysaccharide (LPS)-induced neuroinflammation in BV2 microglial cells. By dose-dependently inhibiting the NF- κ B/I- κ B α signaling pathway, the extract reduces inducible nitric oxide synthase (iNOS) expression and cellular nitric oxide (NO) production	
Cardiovascular protection	Alia et al. (2022) comprehensively reviewed the cardiovascular protective mechanisms of <i>Moringa oleifera</i> leaves. They demonstrated that both aqueous and hydroethanolic extracts target endothelial dysfunction by activating endothelial nitric oxide synthase (eNOS) , which promotes vasodilation and effectively lowers blood pressure. This cardioprotective efficacy is driven by a synergistic matrix of key minerals (potassium, magnesium, and calcium) alongside powerful secondary metabolites, specifically quercetin, isoquercetin, quercetrin, and isothiocyanates , which mitigate oxidative stress and reduce peripheral vascular resistance	
Antidiabetic potential	The review article heavily evaluated the aqueous (water) extracts and ethanolic/hydroethanolic moringa leaf extracts (both as raw leaf powder and crude extracts) as the primary therapeutic component, alongside a secondary evaluation of the seeds for targeting diabetic metabolic complications. Flavonoids like quercetin and rutin reduce oxidative stress, and isothiocyanates, suppress pro-inflammatory pathways. Phenolic acids such as chlorogenic and gallic acid further aid in managing glucose metabolism and reducing triglyceride synthesis.	
Immune booster	<i>Moringa oleifera</i> leaves and seeds, containing bioactive compounds like flavonoids and isothiocyanates extracted via aqueous, ethanolic, and hydroethanolic solvents, act as potent immunomodulatory agents that enhance immune function by suppressing hyper-inflammatory pathways and modulating responses in autoimmune conditions	

Neuroprotective activity	Hashim et al. (2021), verified that ultrasonic-assisted aqueous and alcoholic leaf extractions optimize the retrieval of flavonoids and isothiocyanates, which target anti-inflammatory and neuroprotective phytochemicals. Consequently, Islam et al. (2021), reported that the complete macro- and micronutrient profile establishes the plant as a prominent therapeutic superfood capable of suppressing systemic oxidative stress, metabolic inflammation, and chronic tissue degradation
Skin protection	Cretella et al. (2020) demonstrated that topically applied <i>Moringa oleifera</i> seed oil (MOSO), rich in oleic acid, possesses significant anti-inflammatory and anti-hyperproliferative properties in skin, particularly against conditions like psoriasis and eczema. The study highlights that the seed oil inhibits neutrophil migration and reduces skin keratinocyte hyperproliferation, positioning it as a potent therapeutic agent for chronic skin disorders
Gastrointestinal health	<i>Moringa oleifera</i> bioactive compounds regulate gut microbiome composition and intestinal immune signaling, while inhibiting carbohydrate-digesting enzymes and offering potential therapeutic effects for chronic digestive tract disorders [Camilleri and Blundell, 2024]. The review highlights that specific polyphenol and carbohydrate fractions act on the gut to reduce gastric emptying and ease the digestive tract's glycemic load.
Cognitive function	Arozal et al. (2022) demonstrated that both <i>Moringa oleifera</i> seed oil (Mechanical expeller pressed) and aqueous leaf extract mitigate cognitive decline and memory impairment in mice by inhibiting Acetylcholinesterase (AChE) activity and suppressing neuroinflammation. The study,, particularly highlighted that Moringa Seed Oil (MOO) provided superior neuroprotection by modulating TrkB expression levels, supporting enhanced brain-derived neurotrophic factor (BDNF) signaling.
Antihypertensive activity	Randriamboavonjy et al. (2016) evaluated the Cardiac Protective Effects of <i>Moringa oleifera</i> Seeds in Spontaneous Hypertensive Rats, demonstrating how the plant prevents hypertension-induced heart damage. The researchers evaluated the dietary administration of crushed, crude moringa seed powder directly mixed into the animal food over a chronic timeline.
Immune-boosting properties	Mahfuz and Piao (2019) reviewed the use of <i>Moringa oleifera</i> in poultry, highlighting its role as a natural growth promoter and immune-boosting agent that enhances antioxidant systems and improves gut health. The study indicates that incorporating Moringa leaf powder or extracts (crude powder and as well aqueous and ethanolic extracts) into poultry diets can significantly increase glutathione peroxidase activity, reduce malondialdehyde markers, and improve overall growth performance.
Anti-cancer mechanisms	<i>Moringa oleifera</i> leaf and seed extracts, containing bioactive compounds like isothiocyanates, act as potent anticancer agents by inducing apoptosis through ROS production and activating the caspase cascade [Shahbaz et al., 2024; Tiloke et al., 2018]. These extracts, alongside green-synthesized gold phytonanoparticles, effectively inhibit proliferation in various cancer cell lines, demonstrating significant therapeutic potential [Shahbaz et al., 2024; Tiloke et al., 2018].
Liver protection	Aja et al. (2015) demonstrated that ethanolic <i>Moringa oleifera</i> leaf extracts provide significant liver protection by regulating hepatic function indices in alloxan-induced diabetic rats. The study indicates that the extract effectively manages blood glucose levels while mitigating metabolic enzyme leakage associated with diabetes-induced liver damage.
Neurodegenerative diseases	<i>Moringa oleifera</i> extracts, rich in flavonoids and glucosinolates, exhibit neuroprotective effects by mitigating Alzheimer's-related

	amyloid-beta plaque aggregation and suppressing neuroinflammation through the inhibition of microglial activation and pro-inflammatory pathways	
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The phytochemicals of *P. dulce* contribute to its antimicrobial and antioxidant activity (Gupta et al., 2011; Singh et al., 2014). Its varied pharmacological qualities have been emphasized by recent scientific investigations, supporting conventional assertions (Kondabolu et al., 2023; Kumari, 2017). Numerous chemicals in *P. dulce* have been identified by chemical analysis as being responsible for antibacterial, antioxidant, and anti-inflammatory qualities, among other therapeutic advantages (Getie et al., 2002). Sampath Kumar et al., 2010 revealed the antimicrobial potential. Additionally, *P. dulce* exhibits potential in the treatment of diabetes (Gupta et al., 2011), as some extracts have inhibitory effects on important enzymes (Nagmoti and Juvekar, 2013). These noted pharmacological activities are further supported by the existence of particular bioactive

chemicals (Niranjan et al., 1999; Yoshikawa et al., 1997).

Pithecellobium dulce shows promise as an antimicrobial (Sampath Kumar et al., 2010), anti-inflammatory (Sahu et al., 2012), and antidiabetic agent (Gupta et al., 2011). Also exhibits anti ulcerative, analgesic and anti diarrhoeal functions. The leaf paste also promotes skin regeneration. Suresh et al. (2022) reported the anticancer activity of *P. dulce*. Aldarhami et al. (2023) reported the antimicrobial potential of *P. dulce* seed extracts. Though not as widely studied, its traditional uses are increasingly being validated by experimental data. Table 8 shows biological importance of *Pithecellobium dulce*.

Table 8: Biological Importance of *Pithecellobium dulce*.

Activity	Plant Part	Constituents	Biological Importance	Reference
Antioxidant	Leaves/Fruits/Wood bark/Seeds	Phenolics, flavonoids, Flavanol glycoside kaempferol- 3-O- α -rhamnoside	Reduces oxidative stress	Ponmozhi et al., 2011; Katekhaye & Kale, 2012; Bagchi and Kumar, 2016; Kumari, 2017; Akter et al., 2020; Akter et al., 2022
Anti-inflammatory/Analgesic/Anti arthritic activity	Seeds/Leaves/Bark	Flavonoids, saponins	Reduces inflammation	Sahu and Mahato, 1994; Sugumaran et al., 2009; Selvan and Muthukumaran, 2011; Kalavani et al., 2016; Nagendra et al., 2019; Mishra et al., 2021
Antidiabetic	Leaves/Bark/Fruits/Seed	Phenolics, saponins	Lowers blood glucose	Praveen et al., 2010; Katekhaye and Nagmoti, 2013; Pradeepa et al., 2013; Nagmoti and Juvekar, 2013; Nagmoti et al., 2015; Praylin et al., 2015; Sukantha et al., 2016; Mule et al., 2016; Kumar et al., 2017
Antimicrobial	Leaves/Bark/Fruits/Seeds/Root	Phenolics, alkaloids, flavonoid glycoside quercetin, kaempferol, Saponins (Triterpenoidal saponins Pithedulosides A, B, E, F, and I)	Against bacteria/fungi	Bautista-Baños et al., 2003; Shanmugakumar et al., 2006; Chandran and Balaji, 2008; Sukantha et al., 2011 & 2014; Kumar et al., 2013; Shweta, 2013; Lakshmi et al., 2014; Akter et al., 2020; Idris et al., 2020; Hepzibah et al., 2017; Kulkarni and Jamakhandi, 2018; Bhat et al., 2018; Kotb et al., 2022; Aldarhami et al., 2023
Antiparasitic activity	Fruit	N-malonyl-(p)-tryptophan	Against parasites	LópezAngulo et al., 2019
Antiulcer	Fruits/Seeds	Polyphenols	Protects gastric mucosa Anti gastric and anti- duodenal ulcers	Megala & Geetha, 2012b; Palanivel et al., 2014; Megala and Geetha, 2015
Cardioprotective	Fruit peel/Flowers	Antioxidants	Protects heart	Thangarajan et al., 2015; Srinivas et al., 2018
Anticancer	Leaves/Bark/Seeds	Octadecanedioic acid, Hydroxystearic acid, Linoelaidic acid, Soya-saponin III,	Antiproliferative/Cytotoxic activity	López et al., 2013; Poongodi and Hemalatha, 2015; Sharma, 2016; Jalique et al., 2017; Knauth et al., 2018; Kotb et al., 2020; Akter et al., 2022; Dhanisha et

		Kaempferol glycosides		al., 2022a; Alhamed et al., 2023
Hepatoprotective	Fruits/Bark/Leaves	Phenolics	Protects liver	Manna et al., 2011; Raju and Jagadeeshwar, 2014; Sul et al., 2021
Anticonvulsant activity	aqueous, ethanolic extracts and the crude flavonoid fraction of the leaf	Flavonoids	Neuropharmacological activity	Sugumaran et al., 2008; Dhivya and Niranjana, 2013
Nephroprotective activity	fruit aqueous extract	Phenolics, flavonoids	Kidney protection	Pal et al., 2012; Dhanisha et al., 2021
Mosquito repellent activity	Leaf and Seed extracts	Coumaric acid, Ferulic acid, Quercetin, luteolin 7-O-rhamnoside	Larvicidal activity; Adulticidal activity	Raman et al., 2012; Govindarajan et al., 2013; Govindarajan and Rajeswary (2014); Govindarajan and Rajeswary, 2015; Olmedo-Juárez et al., 2022
Anti-Venom activity	Bark	Tannins, di-gallic acid		Pithayanukul et al., 2005
Anti-Obesity activity	Fruit peel		Weight management	Jagadeeshwar et al., 2021
Anti-hyperlipidemic activity	Leaves/Seeds		Reduces bad cholesterol and increases levels of good cholesterol	Rajan and Kumar, 2010; Nagmoti et al., 2015
Anti-diarrheal activity	Leaves			Sugumaran et al., 2008a; Venu et al., 2016

6. Discussion and Comparative Insights

The comparative analysis shows that while *M. oleifera* has a more thoroughly documented phytochemical and medicinal profile, *P. dulce* offers a promising alternative. Its availability and resilience in tropical climates make it a candidate for increased nutritional and medicinal

applications in underserved communities (Sahu et al., 2012; Singh et al., 2014).

The following table (Table 9) compares *Pithecellobium dulce* and *Moringa oleifera*.

Table 9: The comparative table between *Pithecellobium dulce* and *Moringa oleifera*.

Parameter	<i>Moringa oleifera</i>	<i>Pithecellobium dulce</i>
Nutritional Density	Very high (proteins, vitamins)	Moderate (sugars, fiber)
Phytochemical Richness	Extensive	Moderate to extensive
Medicinal Uses (Proven)	Broad spectrum (well-documented)	Emerging evidence
Traditional Use	Documented and commercialized	Folk medicine, less documented
Commercial Value	High	Low to moderate
Research Status	Well-studied	Emerging interest

7. CONCLUSION

The comparative analysis presented in this chapter highlights the considerable nutritional, phytochemical, and medicinal potential of both *Moringa oleifera* and the relatively underexplored indigenous species *Pithecellobium dulce*. *M. oleifera* has an extensive scientific and commercial foundation, supported by its rich nutritional composition, including proteins, essential amino acids, vitamins, minerals, dietary fibre, and a diverse array of bioactive constituents such as flavonoids, phenolic acids, glucosinolates, isothiocyanates, saponins, and phytosterols. The reported biological activities of *M. oleifera* encompass antioxidant, anti-inflammatory, antimicrobial, antidiabetic, cardioprotective, hepatoprotective, neuroprotective, and anticancer effects, although the evidence described in this chapter largely derives from experimental and preclinical studies rather than established clinical treatments.

In comparison, *Pithecellobium dulce* possesses a broad spectrum of phytochemicals, including alkaloids, flavonoids, phenolics, tannins, saponins, glycosides, terpenoids, steroids, coumarins, and other bioactive constituents distributed across its leaves, fruits, seeds, bark, flowers, and roots. Its fruit pulp provides dietary fibre, carbohydrates, vitamin C, essential amino acids, and minerals, while its seeds also contain appreciable amounts of carbohydrates, protein, and fibre. Experimental and traditional evidence summarized in this chapter indicates diverse biological activities, including antioxidant, antimicrobial, anti-inflammatory, antidiabetic, antiulcer, hepatoprotective, anticancer, antihyperlipidemic, nephroprotective, anticonvulsant, antidiarrhoeal, and mosquito-repellent properties. These findings provide a scientific basis for several of its traditional applications.

The comparison further demonstrates that the two species have complementary strengths. While *M. oleifera* currently possesses greater nutritional density, a more extensively characterized phytochemical profile, broader documentation of pharmacological activities, and substantially greater commercial utilization, *P. dulce* represents a valuable but comparatively underutilized plant resource. Its wide availability, adaptability to tropical conditions, edible fruits, and diverse phytochemical composition make it particularly worthy of further investigation. Thus, *P. dulce* should not necessarily be viewed as a direct replacement for *M. oleifera*, but rather as a complementary indigenous resource with the potential to diversify plant-based nutritional and health applications.

Importantly, the existing evidence also reveals a significant research gap for *P. dulce*. Although numerous in vitro and experimental animal studies have reported promising biological activities, systematic investigations on its nutritional variability, standardized phytochemical profiles, bioavailability, mechanisms of action, toxicity, dosage, formulation, and clinical efficacy remain comparatively limited. Further research employing validated analytical methods, standardized extracts, bioassay-guided isolation of active constituents, mechanistic studies, and well-designed preclinical and clinical investigations is therefore necessary to establish its therapeutic and nutraceutical potential.

Greater scientific attention to *P. dulce* could also contribute to the valorization of locally available and underutilized plant resources. Its incorporation into appropriate food, nutraceutical, pharmaceutical, and other value-added applications may support biodiversity conservation, sustainable utilization of indigenous resources, traditional knowledge preservation, and improved access to plant-based nutritional resources. Overall, the evidence compiled in this chapter supports *P. dulce* as a promising candidate for further scientific exploration while reaffirming the established nutritional and medicinal importance of *M. oleifera*. A systematic transition from traditional knowledge and preliminary experimental evidence toward standardized, evidence-based applications will be essential for realizing the full potential of these indigenous plant species.

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