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Albizia lebbeck (L.) Benth: A review of its botanical characteristics, phytochemistry, and pharmacological applications

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ABSTRACT

Albizia lebbeck, commonly known as the lebbeck tree, is a notable member of the Fabaceae family, recognized for its ecological, cultural, and economic significance across tropical and subtropical regions. This study provides a comprehensive overview of the botanical characteristics, historical context, and multifaceted applications of *A. lebbeck*, emphasizing its rich phytochemical composition, which includes alkaloids, flavonoids, saponins, and phenolic compounds. These compounds contribute to a diverse range of pharmacological activities, including anti-inflammatory, anti-allergic, antimicrobial, antioxidant, antidiabetic, and analgesic properties. The tree's bark, leaves, seeds, flowers, and roots have been extensively researched, validating traditional uses in treating respiratory disorders, skin diseases, and inflammatory conditions. Furthermore, *A. lebbeck*'s role in agroforestry and soil conservation highlights its ecological benefits, such as nitrogen fixation and soil fertility enhancement. This research underscores the enduring importance of *A. lebbeck* as a valuable resource for human health and environmental sustainability, while also acknowledging the need for careful management due to its invasive potential in non-native regions.

Keywords: *Albizia lebbeck*, Fabaceae, Phytochemicals, Plant Extracts, Pharmacological Applications.

INTRODUCTION

A. lebbeck (L.), a member of the Fabaceae family, is a multipurpose deciduous tree commonly known as the lebbeck tree or "Siris" in Hindi. The species is characterized by its large bipinnate leaves, fragrant greenish-yellow flowers arranged in dense clusters, and elongated, flattened seed pods. It is widely distributed throughout tropical and subtropical regions, including India, the Andaman Islands, Myanmar, tropical Africa, Southeast Asia, and northern Australia [1,2]. Owing to the characteristic rattling sound produced by its mature seed pods when swayed by the wind, *A. lebbeck* is also commonly referred to as "woman's tongue" or "rattle pod."

A. lebbeck is recognized as a valuable multipurpose tree because of its rapid growth, high biomass production, and nutrient-rich foliage, making it an excellent source of fodder and green manure. The species is extensively cultivated as a shelterbelt and windbreak tree and is widely planted as a shade tree in coffee and tea plantations [3,4]. It commonly occurs in gardens, roadside plantations, and degraded landscapes, thriving from sea level up to approximately 1,500 m above mean sea level. Under favorable environmental conditions, the tree can attain heights of up to 18 m.

Phytochemical investigations have revealed that *A. lebbeck* contains a diverse array of bioactive compounds, including alkaloids, anthraquinones, essential oils, flavonoids, glycosides, phenolic compounds, phytosterols, saponins, steroids, and triterpenoids [1,5]. These secondary metabolites contribute to its broad spectrum of pharmacological activities and have established the species as an important medicinal plant in traditional healthcare systems. Different parts of the plant have been traditionally employed for the treatment of ulcers, night blindness, respiratory ailments, skin disorders, snakebite, piles, leprosy, and several other health conditions [6]. Furthermore, extracts of *A. lebbeck* have long been used in traditional medicine for detoxification and for managing respiratory disorders, including asthma, allergic conditions, the common cold, and other respiratory tract infections [7,8]. Apart from the medicinal uses, *A. lebbeck* has considerable ecological and economic significance.

In several Asian countries, the plant is widely used for fuelwood, timber, agroforestry plantations, and rehabilitation and restoration of degraded lands. The seeds are rich in nutrition as they contain significant amounts of protein, crude fiber, saponins, and minerals like magnesium, iron, and selenium. Upon proper processing to eliminate anti-nutrients, the seeds can be used as an important livestock feed ingredient [4,9].

In recent times, more interest has been shown concerning the use of *A. lebbeck* wood wastes in the sustainable development of materials. The waste sawdust from *A. lebbeck* has been successfully used in recycled polyvinyl chloride (PVC) matrices plasticized with polypropylene glycol in the production of wood-plastic composite products. It has been established that the use of 1% *A. lebbeck* sawdust in recycled PVC composites improves their tensile strength, thermal stability, and morphology, which promotes the sustainable development of materials by the efficient use of forest and plastic waste [10,11].

Botanical Description

Biologically, *A. lebbeck* possesses a normal structure for a leguminous tree. This tree may grow up to 18–30 m tall with an expansive crown that offers considerable shade. Its trunk is normally straight and cylindrical in shape, having a maximum width of 1 meter under favorable conditions [12]. The bark is gray to dark brown in color, rough-textured, and develops cracks with time, usually peeling off in irregular pieces. Branches of this tree are initially smooth and green in color but become woody and darker with age. Its roots are strong and well-developed, enabling it to withstand drought and stabilize the soil [13,14].

The leaves of *A. lebbeck* are characterized by being bipinnately compound leaves, which is an important morphological feature of the leguminous plants. A typical leaf of *A. lebbeck* is made up of 2–4 pairs of pinnae, with each pinna having 3–11 pairs of oblong leaflets (Fig. 1). These leaflets are asymmetrical at their base, glabrous, and are bright green-colored on the upper side and paler on the underside [15]. These leaves are sensitive to the changes in environment and can show nyctinastic movements by folding at night or under stress due to drought.

It has fragrant flowers with creamy white to greenish yellow color arranged in globose heads either axillary or terminal (Fig. 1). These flowers are made up of many small flowers with elongated stamens that make them look like fluffy balls [16,17]. Flowering season usually comes during the spring and early summer, but it varies according to the climate of each area. The flowers have abundant nectar and attract a lot of pollinators such as butterflies and insects, hence playing a major part in biodiversity of the area. The reproduction of *A. lebbeck* involves mostly cross-pollination.

The fruit of *A. lebbeck* is an elongated oblong-shaped pod, having a length of 15–30 cm and width of 3–5 cm. The pods are usually green in color and change their color to straw-yellow or light brown during maturation (Fig. 1). One of the unique characteristics of the plant is the sound that is made by the seeds inside the dried pods because of their shaking due to the wind, for which they are known as “woman’s tongue trees” [1,18]. Each pod has 6–12 seeds that are oval, flat, and brown (Fig. 1). The seeds are physically dormant with a hard seed coat, which may be broken down by using the process of scarification for successful germination.

In terms of wood anatomy, *A. lebbeck* has medium-hard and durable wood. It has light brownish or medium brown wood with coarse texture and interlocking grain. Growth rings are not visible since the tree grows in tropical regions where there are few seasonal variations [19,20]. In the xylem, the vessels have mostly solitary arrangement or form small groups with simple perforation plates. The fibers have thick walls and are involved in giving the mechanical strength to wood. Parenchyma cells are highly abundant and are involved in radial transport [21].

Morphologically, *A. lebbeck* is quite adaptive to stressful environmental conditions. It is able to survive in poor soil quality, such as saline and alkaline soils, and is moderately resistant to drought. The leaves of this species fall during drought periods as an adaptation feature characteristic of deciduous trees growing in drought conditions. Also, the fast-growing nature of the tree along with the nitrogen fixation feature makes it a good choice for reforestation and soil fertilization [22,23].

Ecologically, *A. lebbeck* is capable of supporting many living beings. Nectar from flowers attracts pollinators, while foliage can be used as fodder for livestock. Moreover, it provides shelter and habitat for birds and small animals. Nevertheless, in some areas where it was introduced, it turned out to be invasive due to the ability to produce seeds actively [24].

Historical Background

The *A. lebbeck* has a very interesting history of its own which represents its important role in the ecology, culture, and economics in tropical and subtropical zones. Being a native to India and Southeast Asia, this plant has been used by humans for a long time now (Fig. 2). Today, the wide spread of the plant can be explained mainly by its natural spreading and intentional introduction by people [25,26].

A. lebbeck has a taxonomic history that is linked to the early explorations of botany and taxonomic systems. It was classified for the first time by the celebrated Swedish botanist Carl Linnaeus, who classified it as *Mimosa lebbeck*, because it belonged to the wider category of sensitive and leguminous plants. However, as the study of plants and taxonomy improved and became more precise with the advent of better taxonomic systems, the plant was later classified under the genus *Albizia* by the Italian naturalist Antonio Durazzini [27,28]. The name *Albizia* is used in honor of the Italian aristocrat Filippo degli Albizzi who introduced species belonging to this genus in Europe during the 18th century.

A. lebbeck is traditionally rooted in agroforestry systems and rural settings in nations like India. The tree was traditionally used as a multipurpose tree for providing shade, livestock fodder, wood, and medicines. Ancient agriculture practices utilized this tree on field borders and roadsides because its large canopy was useful for moderating microclimate conditions and providing protection from excessive sunlight [29,30]. Traditional usage of the tree reflects early understanding of ecological concepts such as soil fertility improvement since it is a nitrogen-fixing tree.

The cultural importance of *A. lebbeck* is another important aspect to consider. The tree has been culturally significant in many parts of South Asia. Its other name “Woman’s Tongue Tree” comes from the characteristic rattling sounds made by the dry pods of the plant, which has been featured in many traditional narratives [31]. The tree has been a subject of traditional medicines in India for a long time especially in Ayurvedic treatments, where the bark, leaves, and seeds have been utilized for respiratory ailments, skin disorders, and inflammatory diseases. The tree has also been mentioned as an anti-allergy and anti-asthma medicine.

However, it was during the colonial era, especially in India, that *A. lebbeck* became more famous for its uses in plantation forestry and landscaping. The fast-growing nature of the tree, its adaptability, and its ability to provide shade made it popular among the British forestry and colonial administrators who planted the trees along the roads, in cantonments, and in public gardens [32,33]. The trees were also brought into other parts of the world, including Africa and the Caribbean.

The invasive nature of *A. lebbeck* was observed when the plant was introduced into non-native areas by way of botanical gardens and plantations. In institutions like Royal Botanic Gardens, Kew, much effort was made for the collection, study and distribution of plant species throughout the British Empire. Seeds and plants of *A. lebbeck*

were taken to various climatic regions in order to study adaptability and economic use of the plant [34,35]. Therefore, it resulted in the establishment of this plant in many regions where it showed invasive properties.

Apart from ecological and economic uses, *A. lebbeck* has also played a role in the advancement of scientific knowledge in the field of botany and forestry. For instance, the morphology of the tree, such as its bipinnate leaf and the nitrogen-fixing nodules, has been studied extensively in an effort to advance knowledge on plant adaptation and symbiosis [36]. Furthermore, the use of the tree has been explored in research on agroforestry practices and soil conservation.

As time passed, the management and perception of *A. lebbeck* have changed. Despite still being recognized for its positive aspects, there is increased attention towards the possible ecological consequences that it can have when used outside its natural habitat [37,38]. It has been found to be an invasive species in some areas, and therefore, proper management and monitoring should take place.

Uses of *A. lebbeck*

A. lebbeck, popularly known by the names siris or woman's tongue tree, is a very useful multipurpose tree that falls under the Fabaceae family. It has found extensive use in tropical and subtropical climates because of its multiple uses in the fields of medicine, agriculture, forestry, and rural economies (Table 1) [37]. Every part of the tree, from its bark to its leaves, flowers, seeds, roots, and wood, is useful.

Among the notable applications of *A. lebbeck* is in the field of conventional medicine and especially in Ayurveda. It has been widely employed for its medical application and has been recognized for being an astringent, anti-inflammatory, and anti-allergic plant. It has been conventionally employed in the treatment of respiratory conditions such as asthma, bronchitis, and cough [3,39]. Decoctions from its bark are also utilized in the management of skin conditions, injuries, and ulcers. Some scientific findings have provided some credence to this by recognizing the presence of bioactive agents in it.

The leaves of *A. lebbeck* are yet another valuable source, especially as a forage material for livestock. These leaves are an excellent source of proteins and minerals and hence constitute a healthy diet for cattle, goats, and sheep. In an agroforestry setup, the tree is often lopped for provision of fresh forage, especially during dry seasons when other sources of forage are scarce [40]. Moreover, extracts from these leaves have been traditionally employed in treatment of eye infections, inflammations, and stomach problems.

A. lebbeck flowers are sweet-smelling and produce ample nectar to attract pollinating agents like bees and butterflies. This characteristic makes the plant useful in the field of apiculture where the flowers contribute to the production of honey [41,42]. The flowers have historically been used in traditional medicines due to their medicinal qualities that help in relieving discomfort caused by breathing problems.

The uses of the seed pods of *A. lebbeck* are also useful. It has been observed that the oil content of its seeds is valuable and some biologically active components of the seed are under study regarding their medical use in the treatment of inflammation and allergies. In some traditional remedies, powdered seeds are used for the treatment of intestinal parasites and other diseases [43,44]. Seeds must be used carefully, as they can have some anti-nutritional factors if not properly treated. Dry seed pods, except their rattling sound, can also be used for fuel or composting.

A. lebbeck wood is medium hard, durable, and easily workable, thus ideal for use in various forms of timber usage. Some of the uses include being utilized in the production of furniture, farm implements, building materials, and plywood. Its attractive grain and ease of working makes it suitable for carving and other decorative items [45,46].

In the rural setup, the wood serves as a significant fuelwood and charcoal material. Its faster growth rate increases its importance as a timber tree species.

The bark and root of *A. lebbeck* have also found their way into traditional healing practices. Extracts of the roots have been traditionally employed in folklore medicine for ailments including arthritis, inflammation, and some kinds of infection. The bark has also been employed in mixtures with other herbs to prepare concoctions that help in cleansing and enhancing immunity [47].

In addition to its practical applications, *A. lebbeck* also has some ecological and environmental values. Being a nitrogen-fixing plant, it helps increase soil fertility through an increase in nitrogen content that is useful for the plants growing around it in agroforestry. The leaves decay fast, adding organic material to the soil, thereby improving its structure and water retention capacity.

The tree is also extensively used as an ornamental plant due to which it can provide adequate shade for many uses. This tree's wide foliage ensures proper shade in urban areas as well as in farms. It is used in parks, gardens, and college campuses due to its ornamental nature. The capacity of *A. lebbeck* to survive in polluted atmosphere also makes it suitable for urban forestry projects [48].

A vital application of *A. lebbeck* is soil conservation and land rehabilitation. The tree has deep roots that help in soil stabilization and reduce the occurrence of soil erosion, particularly on degraded soils and hilly regions. It is often used in forestation programs in order to restore the ecological balance [49]. The ability of the plant to grow in poor soils including salty and alkaline soil renders it suitable for rehabilitating such soils.

Phytochemistry in *A. lebbeck*

A. lebbeck, which is a major species in the family Fabaceae, has been highly valued for its ecological, economical, and medicinal significance; in addition, it has a high phytochemical content [50]. Different plant parts such as bark, leaves, seeds, flowers, and roots harbor a large number of bioactive compounds contributing to their medicinal value (Table 2). The phytochemicals present in the plant have been extensively researched in traditional medicine practices such as Ayurveda, in addition to pharmacology.

A. lebbeck bark is among the most active phytochemically plant parts and subject of many studies on the phytochemistry of this plant. It is highly abundant with tannins which make it an astringent and help to treat wounds, diarrhea, and inflammations [51]. Also, the bark contains saponins that possess anti-inflammatory, anti-allergic and immunomodulatory properties (Table 3). The above-mentioned substances are believed to be the basis of the traditional use of the bark for treatment of diseases of the respiratory system such as asthma and bronchitis. Moreover, flavonoids and glycosides, found in the bark of *A. lebbeck*, increase its antioxidative activity [52].

The leaves of *A. lebbeck* also serve as an excellent source of phytochemicals, especially flavonoids and phenolic compounds (Table 3). They are famous for the significant antioxidant and antimicrobial effects. Extracts from the leaves have proved effective at scavenging free radicals and restraining the proliferation of pathogenic microorganisms, thus confirming the application of this plant in traditional medicine for infectious and inflammatory diseases [53]. Besides, the leaves include alkaloids and steroids that play a part in their therapeutic activity. Therefore, the leaves can be used not only as food but also as a source of natural biologically active components.

Apart from this, the seeds of *A. lebbeck* possess a wide range of phytochemicals having considerable biological activities. Saponins are quite abundant among them and have been evaluated for anti-inflammatory and anti-allergenic properties. In addition to proteins and fatty acids, the seeds of *A. lebbeck* also have some enzymes,

which may be useful nutritionally and medicinally (Table 3) [15]. But these seeds may also consist of anti-nutritional components like protease inhibitors and lectins, which can cause digestive problems when consumed without proper processing. Extracts obtained from the seeds of this plant may prove beneficial in treating immune and inflammatory disorders [54].

The nectar from the flowers of *A. lebbeck* contains high amounts of volatile oil and flavonoid content, which make them biologically active (Table 3) [55]. The biological significance of these compounds lies in their ability to attract pollinators, hence facilitating the reproduction process in the tree. In terms of their chemical significance, it is seen that due to the presence of the flavonoid and aromatic components, they can be good antioxidants as well as have some medicinal value [56].

The extracts obtained from the roots of *A. lebbeck* plant also possess active chemical substances that include alkaloids, saponins, and glycosides. The presence of these phytochemicals is linked to several pharmacological actions including anti-inflammatory, analgesic, and antimicrobial properties [57]. These roots have traditionally been used for treatment of joint pain, infections, and some chronic ailments. The chemical richness of roots makes them an ideal candidate for development of new therapeutic drugs.

One of the notable features regarding the phytochemicals present in *A. lebbeck* include the presence of alkaloids that are found throughout the various parts of the plant. Alkaloids are famous for their strong physiological effect and are commonly utilized during the preparation of various pharmaceutical products [58]. With regard to *A. lebbeck*, the alkaloids play a key role in giving the plant its medicinal value especially when it comes to respiratory and neurological disorders. Just like that, the glycosides present in the plant affect heart metabolism.

Another class of phytochemicals in *A. lebbeck* includes phenolic compounds that comprise phenolic acids and tannins. Such substances are recognized for their antioxidative effects that protect against free radical-induced cellular damage [59]. Their presence in various parts of the tree points out at the high antioxidative potential of *A. lebbeck*, which is becoming increasingly important in the context of preventing the development of cancer, cardiovascular disorders, and neurodegenerative diseases [60]. In recent years, much attention in scientific research has been paid to the isolation and characterization of various phytochemicals from the plant to understand their pharmacological properties. It was proved that extracts obtained from different parts of *A. lebbeck* show anti-inflammatory, antimicrobial, antidiabetic, and anticancer effects [61].

PHARMACOLOGICAL APPLICATIONS

A. lebbeck, a commonly distributed plant from the Fabaceae family, has gained prominence in the field of pharmacology because of its numerous medicinal applications. The use of the plant in systems like Ayurveda has helped in realizing its efficiency in curing several diseases [62]. Modern studies in science have proved many of these uses, showing that various parts of the plant's bark, leaves, seeds, flowers, and roots have important pharmacological effects, mainly because of their abundant phytochemistry. Anti-inflammatory effects are among the most studied pharmacological effects of *A. lebbeck* [63]. Bark and leaf extracts have exhibited the capacity to inhibit inflammatory mediators like prostaglandins and cytokines. This property is mainly due to the presence of biologically active chemicals like flavonoids and saponins, which work to prevent swelling, pain, and tissue damage. Thus, the plant is effective in the management of various inflammatory conditions such as arthritis, bronchitis, and skin problems (Table 4). Experiments have proved that extracts of the bark show considerable anti-inflammatory properties in animals and thus

are valuable in the treatment of inflammatory diseases. Another vital pharmacological property of *A. lebbeck* is its anti-allergic and anti-asthmatic property. In particular, the bark extract has been traditionally used to treat respiratory problems, such as asthma and allergic rhinitis. Various scientific investigations have revealed that bark extracts have stabilizing effects on mast cells and are capable of inhibiting the release of histamine [64]. The property is a great advantage making *A. lebbeck* an ideal natural drug for the management of allergies. It has been observed in clinical and laboratory tests that the frequent use of extracts from the bark will lead to better respiratory performance and lessening the occurrence of asthma symptoms. Another pharmacological feature of the plant is its antimicrobial properties. The leaf, bark, and seed extracts have been reported to display both antibacterial and antifungal activities against various pathogens [2]. The mechanisms behind the effect are mainly the existence of the phenolic components, tannins, and alkaloids that affect the microorganisms' cell membranes and prevent further reproduction. This antimicrobial activity proves to be valuable for the treatment of infectious diseases, wounds, and skin disorders (Table 4).

Another important property of *A. lebbeck* is its excellent antioxidant activity, which is essential for preventing oxidation stress in the body. Various chronic diseases, such as cancer, cardiovascular diseases, and neurodegenerative illnesses, are caused by the oxidation process [65,66]. The content of various antioxidant compounds, like flavonoids and phenols, found in the leaves and bark helps prevent damage caused by free radicals. According to the existing studies, extracts of *A. lebbeck* may significantly increase the activity of antioxidant enzymes [65-66]. Moreover, the ability of *A. lebbeck* to prevent various diseases may be applied to diabetes treatment as well. Recent research has proved that leaves and seeds of this plant are able to maintain proper blood glucose levels due to their ability to increase insulin sensitivity and decrease glucose absorption in the intestines [67,68]. These actions are attributed to the presence of bioactive compounds like saponins and flavonoids. Experimental studies on animals with diabetes have revealed that there is a decrease in blood sugar concentration upon administration of the extract of *A. lebbeck*, indicating the anti-diabetic activity of this plant. Apart from that, another pharmacological action of *A. lebbeck* is analgesia. The extracts obtained from the bark and root of the plant have proven to be helpful in alleviating pain, as they inhibit pain mediators and modulate the central nervous system [1,69]. The analgesic actions of the plant are beneficial in the treatment of diseases that cause pain such as headache, joint pains, and muscle aches. Anticancer activities of *A. lebbeck* have gained attention of researchers. Some preliminary studies have shown that specific extracts of this plant have inhibitory effect on proliferation of cancer cells and induce apoptosis (programmed cell death) via the action of antioxidants and anti-inflammatory components, which affect the ability of cancer cells to multiply and survive [37,70]. While further research is required for understanding of these mechanisms and their significance for clinical applications, it is possible to conclude about the potential of *A. lebbeck* for development of new anticancer drugs. Besides these activities, *A. lebbeck* has been demonstrated to have hepatoprotective (liver-protective) effect. Extracts of the bark and leaves have a protective effect on liver cells from damaging impact of toxins and oxidation. The effect is very significant in case of liver diseases because oxidative damage is one of the main factors involved in the development of such conditions. It should be noted that the plant's capability to improve the functioning of the liver and detoxify it adds even more significance to the medicinal plant in question. Moreover, besides fruits and flowers, the seeds and roots of *A. lebbeck* can also add to the medicinal properties of this plant. The extracts from seeds have been researched in terms of their immunomodulatory activity.



Figure 1: Morphological Charecteristics of *A. lebbeck* tree

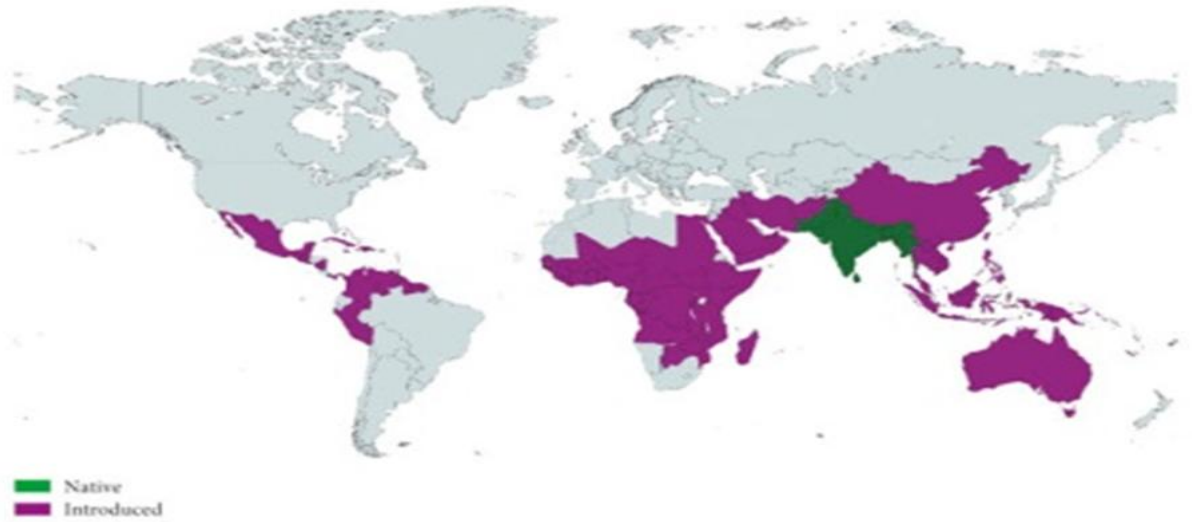


Figure 2: Global distribution of *A. lebbeck* (L.) Benth. ^[25]

Table 1: Plant parts use in *A. lebbeck*

Plant Part	Common Uses	Description of Use
Bark	Medicinal	Used in traditional medicine for treating respiratory disorders (asthma, bronchitis), skin diseases, and inflammation due to its astringent and anti-inflammatory properties.
	Tanning	Rich in tannins, used in leather tanning industry.
Leaves	Fodder	Nutritious leaves used as fodder for livestock.
	Medicinal	Applied in treatment of ulcers, eye diseases, and as an antiseptic.
Flowers	Ornamental	Fragrant flowers used for decorative purposes in gardens and landscapes.
	Medicinal	Used in traditional remedies for respiratory ailments and allergies.
Pods (Fruits)	Fodder	Pods are used as animal feed.
	Medicinal	Used in some traditional treatments for digestive issues.
Seeds	Medicinal	Possess anti-allergic, antimicrobial, and anti-inflammatory properties; used in Ayurvedic formulations.
	Oil Extraction	Seeds may be used for extracting oil (limited use).
Wood	Timber	Used for making furniture, construction materials, and agricultural implements due to its durability.
	Fuelwood	Provides good-quality firewood and charcoal.
Roots	Medicinal	Used in traditional medicine for treating various ailments like inflammation and infections.
Whole Tree	Shade Tree	Commonly planted along roadsides and in parks for shade.
	Agroforestry	Improves soil fertility through nitrogen fixation and is used in reforestation programs.
	Environmental	Helps in controlling soil erosion and improving ecological balance.

Table 2: Phytochemical present in different part of *A. lebbeck*

Parts	Compounds
Flowers	Various sterols (taxerol, cycloartemol, lupeol, campesterol, sitosterol)
Leaf	Pipecolic and derivatives
Root	Echinocystic acid (saponin)

Table 3: Chemical Composition of *A. lebbeck*

Components	Value (% Composition)
Moisture	4.55
Crude Protein	38.04
Crude Lipid	5.66
Crude Fibre	11.96
Ash Content	8.76
Nitrogen Free Extract	32.3

Table 4: Pharmacological activities of various parts of *A. lebbeck*

S. No.	Pharmacological activity	Plant part extract	Doses	Main result	Citation
1	Antiallergic	Stem bark ethanolic extract leaf/stem bark chloroform, methanol, water extracts	50–300 mg/kg p.o.; 50 µg/mL <i>in vitro</i>	Reduced mast cell degranulation and histamine release	[42,71]
2	Anti-Alzheimer's	Seed hydromethanolic extract	100–300 mg/kg p.o.	Improved memory and cognition; increased antioxidant enzymes	[84]
3	Anticancer	Bark saponin fraction; stem bark ZnO nanoparticles; leaf methanol extract; root lebbeckosides A–B	<i>In vitro</i> 5–100 µg/mL	Showed cytotoxic and apoptotic activity against cancer cells	[72,79]
4	Antidiabetic	Bark methanolic extract; stem bark methanol/dichloromethane extract; bark compounds	200–620 mg/kg; 100–400 mg/kg	Lowered blood glucose and improved lipid profile	[81]
5	Antidiarrheal	Seed aqueous methanol extract	2.5–5 mg/kg i.p.	Inhibited castor-oil induced diarrhea	[76]
6	Anti-inflammatory	Leaves, bark, flower, essential oil extracts	50–400 mg/kg	Reduced edema and granuloma in animal models	[83]
7	Antimicrobial	Stem bark, leaves, roots, ZnO nanoparticles	Disc diffusion / MIC assays	Active against several bacteria and fungi	[82]
8	Antinociceptive	Leaf essential oil; leaf extracts; bark extract	50–400 mg/kg	Increased pain threshold and reduced writhing	[73]
9	Antioxidant	Bark compounds, stem bark extracts, leaf methanol extract	<i>In vitro</i> assays	Showed DPPH, ABTS, and H ₂ O ₂ scavenging activity	[74]
10	Antiparasitic	Bark ethanolic extract; pericarp methanol extract	<i>In vitro</i> / <i>in vivo</i>	Active against malaria and other protozoa	[75]
11	Anti-Parkinson's	Seed aqueous methanolic extract	100–300 mg/kg	Improved motor function and catalepsy	[78]
12	Antipyretic	Flower fractions	0.25–1 g/kg i.p.	Reduced fever in animal models	[79]
13	Antivenom	Seed methanolic extract	1:1–1:100 w/w	Reduced venom toxicity	[73]
14	Estrogenic	Flower fractions	200–500 mg/kg i.p.	Altered uterine weight in mice	[80,85]
15	Wound healing	Root ethanolic extract	250–750 mg/kg	Improved wound contraction and healing markers	[77]

CONCLUSION

A. lebbeck, one of the important plants of the Fabaceae family, has been known to possess different utilities in traditional medicines, agriculture, and forestry practices. Being composed of various types of phytochemicals like alkaloids, flavonoids, saponins, and phenolic compounds, the plant is noted for its pharmacological actions, which include anti-inflammatory, anti-allergen, antimicrobial, antioxidant, antidiabetic, analgesic, anticancer, and hepatoprotective effects. The bark, leaves, seeds, flowers, and root parts of the plant have also been known to contain different kinds of medicinal value. Thus, the

knowledge of pharmacological uses of *A. lebbeck* highlights its importance for humanity.

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Author Contributions

VS, RK, HS and SK contributed equally to the conceptualization, methodology, investigation, data curation, formal analysis, and writing of the original draft. RK contributed to supervision, guidance, and critical review and editing of the manuscript. All authors reviewed and approved the final version of the manuscript.

Data Availability Statement

The data that support the findings of this study are available and will be made available upon request.

Use of AI in Drafting of Manuscript

The authors declare that they have not used any generative AI/AI-assisted technologies in the writing of this manuscript.

Conflict of interest

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