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REVIEW ARTICLE

The ecological and economic values of Albizia lebbeck (L.) Benth. – A review

Muhammad Shafiq[1*], Muhammad Zafar Iqbal[1], Mohammad Athar[2]

[1] *Department of Botany, University of Karachi, Karachi, 75270, Pakistan*

[2] *California Department of Food and Agriculture, 1220 N Street, Sacramento, CA 95814, U.S.A.*

*** Corresponding author:** Muhammad Shafiq, shafiqeco@yahoo.com

ABSTRACT

Albizia lebbeck (L.) Benth. is a multipurpose fastly growing woody flowering plant species which helps in maintaining the quality of environment. *A. lebbeck* is perennial tree, widely grown in Tropical Asia, Tropical Africa, North Australia and in Pakistan as ornamental tree and street tree for shade. The leaves, fruits, flowers, bark, stems, seeds and whole parts of *A. lebbeck* have traditionally been used to cure asthma, malaria, cancer, dysentery, jaundice, rheumatism, diabetes, and many skin disease problems in human beings. The phytochemical studies have shown the presence of protein, carbohydrates, minerals, fatty acids, minerals and vitamins.

The seed germination and seedling growth abilities of a tropical plant species, *A. lebbeck* respond differently to the immediate environmental conditions. *A. lebbeck* also plays a helping role in balancing the ecosystem due to its better adaptation potential to climatic conditions. However, scarcity of water, increase in temperature, indiscriminate discharge of toxic pollutants, deforestation, global warming, automobile emission, and anthropogenic activities are the main reasons for decline of this plant for last couple of decades.

The objective of this review is to search and analyze the scattered research articles available on the ecological and economic properties of *A. lebbeck.* In this regard, the published research articles was searched from different electronic search engines, such as, Google Scholar, NIH (National Library of Medicine), Conbio (Society for Conservation of Biology), PubMed and ScienceDirect covering the period 1986–2024.

The findings would be helpful for conservation groups, plant ecologists, governmental and nongovernmental environmental protection organizations, researchers, land managers, environmental managers, horticultural, floriculture managers, industrial sectors, and pharmaceutical sectors that are working at regional and international levels for *A. lebbeck*.

Keywords: biodiversity; biodegradability; climate change; ecology; invasive species

1. Introduction

A. lebbeck is a large multipurpose and ornamental deciduous flowering tree species from *Fabaceae* family

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that can grow up to 30 meter height. The species is economically a valuable tree for the use of fuel, fodder, shelter and can tolerate wide range of climatic, saline and drought conditions to some extent. *A. lebbeck* is also find a suitable tree species for reforestation of degraded sites due to its ability to nitrogen fixation, improvement in soil structure, control soil erosion, construction, charcoal, furniture, improvement in nutrient status and forage tree in semiarid region[1-4]. It is well adapted plant in the hot environment and geographically distributed from North Africa, Asia, Australia, Bangladesh, Burma, Caribbean nations, China, India, Nigeria, Pakistan, Saudi Arabia; Tanzania and Vietnam[5-11]. *A. lebbeck* has variation in seed weight and size. Missanjo and Chikumbutso[12] demonstrated the merits of grading seeds size and recommended large size seeds for production of high quality of *A. lebbeck* in the nursery. The phytogeographic, fossil and paleobotanical studies on *A. lebbeck* are documented also in scientific literature. The different parts of *A. lebbeck* are available in the fossil forms. In the Pliocene time at global scale showed the biography of *Albizia* from India[13]. The pod fossils of *Albizia* (*Fabaceae: Caesalpinioideae*) was noted[14]. Pollination play an important role in plant life cycle. Insects performs a crucial role in the pollination biology of flowering plants and the pollination biology of *A. lebbeck* with special reference to insect floral visitors was investigated during 2012 and 2013 which showed effectiveness of floral visitors in term of visitation frequency, visitation rate and pollen load[15].

The industrial and anthropogenic activities significantly polluted the environment of developing countries as compared to developed countries. The use of fossil fuels is causing a great concern for the environment[16] and found an excellent source of renewable fuel product[17]. The results showed the average specific methane production yield for *A. lebbeck* 0.210 Nm^3/kg. *A. lebbeck* can also recover carbon and nutrient stocks and supported removal of metallic Pb(II), Cd(II), Zn(II) and Cu(II) ions[18]. Coal mining is an important environmental issue and application of *A. lebbeck* recovered well about the carbon and nutrient stocks[19].

1.1. Taxonomic classification

Domain - Eukaryota>Kingdom – Plantae > Phylum – Spermatophyta > Subphylum- Angiospermae > Class – Dicotyledonae > Order – Fabales > Family – Fabaceae > Subfamily – Mimosoideae > Genus – Albizia > Species - *Albizia lebbeck*[20].

Considering the significance importance of this plant species to human beings, other living organisms and environment, an attempt was made with the aim to review its economical and significantly ecological properties.

2. Materials and methods – data collection

The information related to the topic was gathered from the research document published and available in different search engine such as Google, Google Scholar, NIH (National Library of Medicine), PubMed, Scopus, Web of Science, springer open, springer link, and science direct covering period of 1986-2024. The reference citation style as AMA in alphabetical order was selected.

3. Economic importance

A. lebbeck is a large tree with dark grey bark and possesses many econmic poperties. *A. lebbeck* commonly planted along street, roadside to provide shade and along river bank to control soil erosion. Its wood resembles to walnut and is excellent for furniture, picture frames, house building, canoes etc. It is also used for cane crushers, oil mills and wheels[21]. *A. lebbeck* is a promising fodder tree for semiarid, semi tropical and tropical region[22-24]. The potential of *A. lebbeck* as a supplementary feed for goats in Tanzania was recorded[25]. The foliage of *A. lebbeck* are used to animal (pig) feed[26]. The *A. lebbeck* pods was design by mixture alternate source of renewable energy for biodiesel[27]. The seed pods of *A. lebbeck* showed a great potential of bioenergy and ability to remove turbidity and removal of other compounds[28].

3.1. Biological – phytochemical properties

The previous literature studies have shown the phytochemical properties from different parts of *A. lebbeck* (**Figure 1**). In an analytical studies, the chemical constituents likewise galactose, mannose, arabinose, glucuronic acid and its 4-O-α-metyl analogue from *A. lebbeck* was determined[29]. Phytochemical and biological potential of *A. lebbeck* heartwood showed a markable and promising strength in anti-inflammatory, antioxidant, antibacterial, and antimicrobial activities[30-36].

The bioactive potential of *A. lebbeck* extract against phytopathogens and protective properties on tomato plant against speck disease in greenhouse was reported[37]. Bobby *et al.,*[38] investigated the anti-bacterial activity of leaves extracts of *A. lebbeck* Benth against some selected pathogens. The flowers of *A. lebbeck* evaluated some biological activities[8]. There are few reports available on an anti-tumor, anti-fungal, anti-yeast and anti-bacterial hemolysin from *A. lebbeck*. The potential of *Albizia* gum to improve the storability and maintain the overall fruit quality of commercially important guava fruits during storage to decrease the losses was assessed[39]. The results concluded that the application of *Albizia* gum markedly improved the storage life of guavas. *A. lebbeck* contain phytochemical compounds namely catechin and considered as a polyphenolic phytomarker[40].

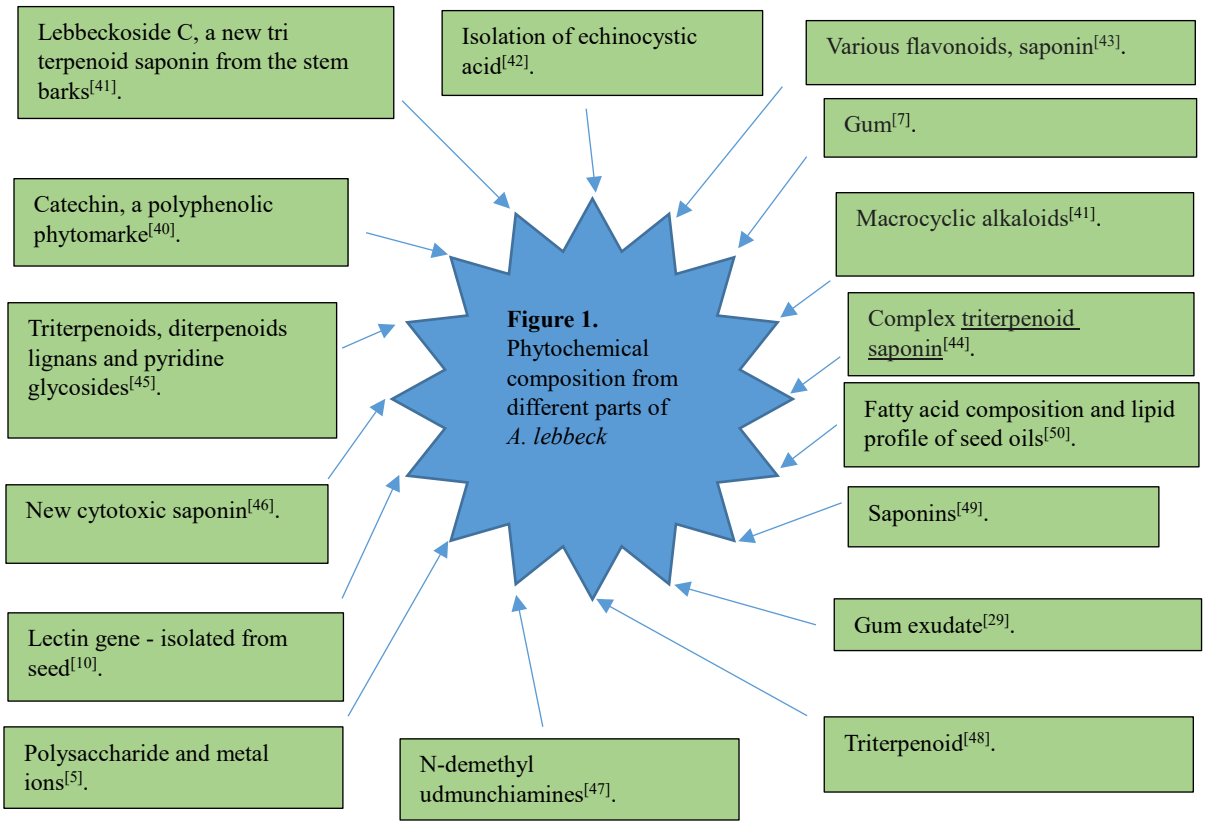

Figure 1. Phytochemical composition from different parts of *A. lebbeck*

3.2. Pharmacological relevance

Plants have been used to cure the local diseases[51]. *A. lebbeck* is an ethnomedicinal plant and has many therapeutic potential for the treatment of different pharmacological diseases[52-55] and Unani and modern medicine trials (**Table 1**).

Table 1. Pharmacological evaluation for traditional treatment of different ailments using A. lebbeck.

Plant parts	Treatment	References
Seed extracts	Antidiarrhoeal activity.	[56]
Bark	Reproductive system of male albino rats.	[57]
Leaves extract (Ethanol)	Anti-ulcer properties.	[58]
Bark and leaves	Mast cell stabilization activity.	[59]
Bark	Arthritis, burns.	[6]
Standardized extract	Anti-allergy.	[40]
Seeds	An anti-tumor, anti-fungal, anti-yeast and anti-bacterial hemolysin.	[60]
Stem bark	Skin diseases.	[39]
Root extract	Wound healing potential.	[61]
Flowers	Antipyretic and estrogenic.	[8]
Dry seeds	Characterization of the AlTI13 protein.	[62]
Stem bark	Antidiabetic. And antioxidant.	[63]
Stem bark	Renal/cardiac.	[64]
Roots	Human brain tumor cells.	[4]
Leaves	Night blindness and syphilis, severe painful, inflammatory disorder.	[65]
Stem bark	Antimalarial efficacy.	[66]
Stem bark	Breast cancer.	[67]
The leaves and pods	against cancer in traditional medicine	[68]
Aqueous leaf extract	Anticarcinogenic effect on colon cancer cell lines.	[69]
Leaves	Flu, fever, pain, epilepsy, and inflammation.	[11]
Tree bark	Effective against speck disease causing phytopathogens	[37]

4. Ecological importance

A. lebbeck is a woody plant species. The researchers have published many documents on its ecological values in balancing ecosystem. The extensive root system of *A. lebbeck* act as good soil binder that helps in controlling soil erosion. This plant species support to the agroforest system and cultivation in dry areas. However, the increase in population density, industrial revolution, expansion of urban areas, automobile exhaust emission, garbage burning, excess level of fertilizer, insecticide, fungicide, pesticides, mining, climate change, soil infertility, land degradation, metal in the environment without pretreatment also influencing on the quality of environment and growth of flora and fauna at accelerating rate. The ongoing efforts are continues to examine the impact of biotic and abiotic stress on the germination and growth of *A. lebbeck.*

4.1. Toxicity and tolerance to heavy metals

Heavy metals are known to produce toxic effects on living organism at higher concentrations. The impact of heavy metals toxicity and development of tolerance indices in plants varied and studied by plant ecologists. Seed germination and seedling growth of *A. lebbeck* was significantly ($p < 0.05$) reduced at 500 and 700 ppm of lead and cadmium as compared to control[70]. Among the heavy metals, lead treatments at 25 to 125µmol/L produced significant effects on seedling growth performances of *A. lebbeck*[71]. The analysis of some metallic element viz. Fe, Zn, Mn, Ni, Cr, Cd and Pb) using Atomic Absorption Spectrometry from *A.*

lebbeck were carried out[72]. The highest level of Ni, Cr, and Cd were recorded 5.08 ppm, 1.10 ppm, 0.41 ppm in plant samples collected from industrial area. Similarly, the lead content was recorded high (12.19 ppm) in sample collected from heavy traffic site.

4.2. Automobile pollution impact on some growth characteristics

The discharge of pollutants from the faulty automobile and burning of fuel produce negative impact on plant growth. Shahid *et al.,*[73] recorded the negative effects of autoexhaust emission on different plant growth parameters and total plant dry weight of *A. lebbeck*. The potential of *A. lebbeck* to reduce total petroleum hydrocarbon content of a highly polluted soil from the Oredo oil field location (Ologbo near Benin City, Nigeria) with the treatments sas 0%, 40%, 50%, 70%, 80%, and 100% was investigated[74]. Generally, the observations showed depressive effects of crude oil pollution on plant growth along with higher values for pH and EC of soil samples after plant harvest. There were also a significant reductions in total petroleum hydrocarbon (TPH) content after plant harvest was recorded and concluded that *A. lebbeck* showed a good ability to tolerate and sustained growth in highly polluted soil. The impact of locomotive activities affected soil on seedling growth of *A. lebbeck*[75]. The potential of two *Albizia* species planted on mine spoil for restoration in a dry tropical region, India was noted[76] the seeds of *A. lebbeck* converted into activated carbon adsorbents from an aqueous solution[77]. Alabi *et al.,*[78] investigated the unmodified form of *A. lebbeck* seed pods for the biosorption of nitrate ion with the aim to provide a sustainable, an efficient alternative method for nitrate removal in aqueous environment that may solve the nitrate pollution problems from drinking water.

4.3. Phytoremediation

Yousaf *et al.,*[79] described phytoremediation as most efficient, economical, and sustainable approach to combat with terrestrial heavy metal pollution problems. A decent increase in the three month old seedling growth of *A. lebbeck* duet to addition of 6% biochar in Cd-contaminated soil (25 mg/L) was reported and suggested that biochar can be used to enhance the growth of agroforestry tree species like *A. lebbek* in Cd-contaminated soils. The availability of heavy metals such as Pb, Cd, Ni, Cr and Hg produce toxic effects on plant growth and required to remove from the environment. The seedlings of *A. lebbeck* showed phytoremediation potential while planted on soil irrigated with tannery effluent[80]. In another study, the plantation of *A. lebbeck* to examine the physicobiochemical properties after 13 years of planting were assessed in the Federal College of Forestry Jos, Nigeria[81]. The efficacy of phytoremediation in restoring degraded soils, specifically those contaminated with oil residues to compare the phytoremediation performance of *A. lebbeck* was assessed[82]. Additionally, the impact of different rates of humic acid HA (0, 5, 10 g L-1) as a sub-main factor, as well as varying rates of salicylic acid SA (0, 250, 500 mg L-1) as a sub-sub-main factor, on the phytoremediation capabilities of *A. lebbeck* was investigated. The results showed that *A. lebbeck* transplants exhibited the lowest soil Zn concentration (15.62 mg Zn.kg-1 soil). The revegetation of post mining land affects the soil carbon and nutrient stocks[19]. The results showed that the increase in tree height, diameter at breast height, and biomass weight with age was observed to be higher in *C. siamea* than *A. lebbeck***.**

Naveed *et al.,*[83] assessed the morphological indices of *A. lebbeck* in relation to anatomical modifications for survival under both Pb and Ni stress viz. 0 mM, 25 mM, 50 mM and 75 mM. The results showed morphological traits such as shoot length (70.93%), fresh weight (79.27%), dry weight (83.9%), number of root hairs (65.7%), number of leaves per plant (67.4%) and number of leaflets per plant greatly reduced under Pb or Ni stress.

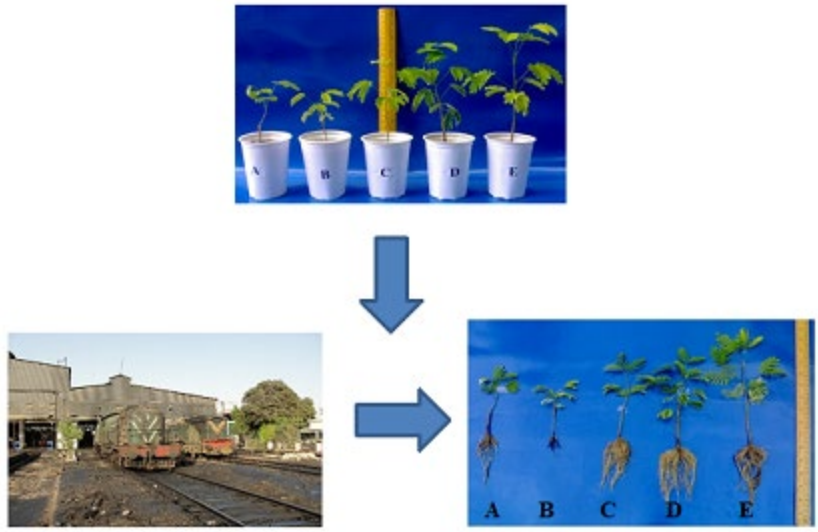

Figure 2. Graphical Abstract: The method utilizes for the seedling growth variable measurement of A.ebbeck was soil of railway line. A= University Campus, B =Cantonment Station, C = Drighroad railway Junction, D=Malir Station, E=Landhi Junction

5. Conclusion

The survey of scientific literature showed the comprehensive ecological and pharmacological potential of *A. lebbeck.* This species is capable of soil erosion control and cultivated in tropical and sub tropical region around the world. This species is growing under biotic and biotic stress due to anthropogenic, industrial and climatic changes in ecent years in some region. Therefore, this species might enter in list of endanger species, if such conditions continue in future at same level of intensity. This review offer an inspiration for researchers, peoples from governments, nongovernment entities, universities, environmentalists, ecologists, and public working on this plant species to save from extinction form this universe. There is a need to increase the vegetative cover of *A. lebbeck* with the help of plant ecologists.

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Authors contribution

Muhammad Shafiq: investigation, writing – literature review & editing. **Athar Tariq**: review and editing.

Conflict of interest statement

The authors declare that they have no known competing financial or personnel interests exist among them and approved this MS.

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