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Review Article

Exploring the Phytochemistry and Pharmacological Potential of Artocarpus lakoocha: A Comprehensive Review

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ABSTRACT

Artocarpus *lakoocha Roxb*. (Moraceae), commonly known as Monkey Jack, is a tropical fruit-bearing tree widely distributed across South and Southeast Asia and traditionally used for the management of infections, inflammatory disorders, liver ailments, and other health conditions. The fruit is rich in vitamin C, beta-carotene, and essential antioxidant minerals such as zinc, copper, manganese, and iron, which contribute to its strong antioxidant potential and immune-supportive properties. This review summarizes the available literature on the ethnomedicinal uses, nutritional composition, phytochemical constituents, and pharmacological activities of Artocarpus *lakoocha*. Phytochemical investigations have identified diverse bioactive compounds responsible for a wide range of biological activities, including antibacterial, antiviral, antifungal, antitubercular, anthelmintic, anti-inflammatory, hepatoprotective, neuroprotective, cytotoxic, antihyperlipidemic and antioxidant effects. Although numerous pharmacological properties have been reported, limited information is available regarding its immunomodulatory mechanisms and clinical validation. This review highlights the therapeutic significance of Artocarpus *lakoocha* and emphasizes the need for further studies on standardization, safety assessment, and clinical investigations to support its development as a potential phytopharmaceutical agent.

INTRODUCTION

Artocarpus lakoocha (*A. lakoocha*) is a versatile, multipurpose tree belonging to the Moraceae family. It plays a significant role in environmental sustainability, economic development, and nutritional enhancement. This species is known by various regional names, such as monkey jack or lakuchi in India, tampang in Malaya, and lokhat in Thailand. The tree is highly valued for its strong,

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durable timber and its edible fruits, which are traditionally regarded as having medicinal properties.[1] Botanically, *A. lakoocha* is a medium to large-sized deciduous or semi-evergreen tree, attaining heights of 15–25 m with a broad spreading crown and rough greyish-brown bark. The leaves are simple, alternate, elliptic to obovate, and coriaceous. The plant bears unisexual flowers arranged in globose heads, and the fruit is a syncarpous (multiple) structure, subglobose, yellow to brown when ripe, with a characteristic sweet-sour pulp.[2] Apart from its nutritional value, *Artocarpus lakoocha* has been extensively employed in traditional medicinal systems, including Ayurveda and various folk practices. Different parts of the plant-such as the bark, seeds, leaves, and fruits-are traditionally used to treat digestive ailments, dermatological conditions, inflammatory disorders, helminth infections, and wounds. Phytochemical studies have revealed the presence of numerous bioactive constituents, particularly flavonoids, stilbenes, terpenoids and phenolic constituents. Oxyresveratrol isolated from the heartwood, which demonstrates significant antioxidant, antimicrobial, anti-inflammatory, and tyrosinase-inhibiting properties. These pharmacological attributes have increased scientific interest in its potential utilization in the development of pharmaceutical products, cosmetic formulations, and functional food ingredients.[3] Despite promising findings, further studies are required to elucidate mechanisms of action, establish safety profiles, and conduct clinical evaluations. Comprehensive phytochemical profiling combined with pharmacological validation will enhance the potential of *A. lakoocha* as a valuable source of natural bioactive compounds for pharmaceutical and nutraceutical applications.

Botanical Name: *Artocarpus lakoocha Roxb.*

Common names: Monkey jack, Lakoochi, Dahu, Vaate huli.

TAXONOMY: [4]

Kingdom	Plantae
Division	Tracheophyta
Class	Magnoliophyta
Order	Rosales
Family	Moraceae
Genus	Artocarpus
Species	Artocarpus lakoocha

VERNACULAR NAMES: [4]

English	Monkey jack, Lakoocha.
Hindi	Lakuch, Lakoochi, Barhal, Dahu, Dahua.
Kannada	Esuluhuli, Vaatehuli.
Tulu	Ontepuli,Yesalpuli.
Malayalam	Chimpa, Pulinjakka.
Marathi	Badhar, Kshudraphanas.
Tamil	Ilagusam, Irappala.
Urdu	Theitat

DISTRIBUTION: [5]

Lakoocha (Monkey Jack) is a tropical tree native to India, thriving up to 1200 m in the humid sub-Himalayan belt. It is widely found in South and Southeast Asia, including Sri Lanka, Bangladesh, Thailand, Cambodia, Malaysia, Indonesia, and Singapore, but hasn't spread beyond this range due to its strict climate needs. In India, it's common in the peninsular tropics, Western Ghats, and the sub-tropical zones of the East and Northeast. States like Bihar, Jharkhand, Chhattisgarh, and Odisha see frequent growth, especially in rural areas, riverbanks, and fields particularly large wild specimens in Jharkhand.

DESCRIPTION OF PLANT: [6]



Fig.no.01: A. lakoocha tree



Fig.no.02: A. lakoocha fruit



Fig.no.03: A. lakoocha leaves

Tree Structure: *Artocarpus lakoocha* is a medium-to-large deciduous tree with a dense, dome-shaped crown, leathery clustered leaves, and cauliflorous fruiting directly from its trunk. **Size:** The tree typically grows to a height of 6 to 9 meters, with branchlets 3 to 6 mm thick. A mature tree can yield up to 80 kg of fruit.

Bark: Light brown to dark brown, with deep red slash and milky latex
Leaves: The leaves of *Artocarpus lakoocha* are large, leathery, and elliptical, measuring 10-25 cm in length.

Flowers: Monkey Jack bears unisexual flowers on the same tree, with male flowers being yellow-orange and female flowers being reddish

Fruits: The ripe Monkey Jack fruit is an irregularly rounded, 5-12 cm fruit with a pinkish-brown color and yellow tinge, featuring a velvety surface and few soft, brown-black spikes.

Seeds: The Monkey Jack fruit contains 10-30 seeds, varying in size and shape depending on the fruit's maturity, with each seed covered in a thin white coat and latex.

ACTIVE CONSTITUENTS: [7]

The whole fruit of *Artocarpus lakoocha* is characterized by a high moisture content (~82%) and dietary fiber (~2%), contributing to its hydrating and digestive properties. It is nutritionally rich, containing β-carotene, Vitamin A (423 IU), and Vitamin C (135 mg/100 g), which support antioxidant activity and immune function. Mineral analysis revealed the presence of calcium (66.6 mg), magnesium (23.6 mg), potassium (350 mg), phosphorus (22.1 mg), iron (778 µg), zinc (3,981 µg), copper (7,974 µg), and manganese (2,025 µg), indicating a broad spectrum of essential micronutrients. Phytochemical screening of the pericarp confirmed the presence of

triterpenoids such as cycloartenone, cycloartenol, leupeol acetate α-amyrin acetate, and β-amyrin acetate, compounds known for their potential pharmacological properties. The seeds were also found to contain a measurable amount of lectin, a bioactive protein with various biological effects.

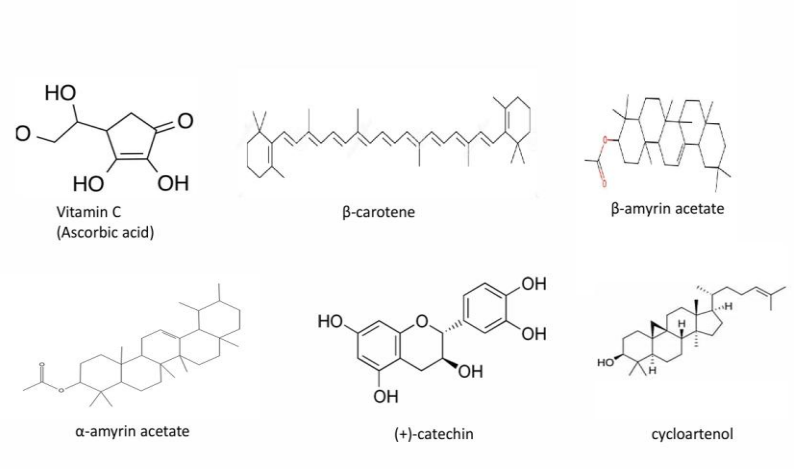


Fig. No. 04: Chemical constituents of *Artocarpus lakoocha*

Traditional uses: [8]

Artocarpus lakoocha, or monkey jack, holds an esteemed place in traditional medicine systems like Ayurveda and folk healing practices across South and Southeast Asia. Its ripe fruit is not only consumed for its tangy flavour but is also believed to act as a liver tonic and appetite stimulant. In Ayurvedic medicine, lakoocha is used to manage digestive ailments such as diarrhoea due to its absorbent and astringent properties. The fruit and bark are also recognized as blood purifiers, supporting detoxification and internal balance. Beyond internal health, it serves in skin care by treating wounds, reducing inflammation, and promoting a clear complexion, as well as stimulating hair growth and strengthening follicles. The fruit is also appreciated for its aphrodisiac qualities that enhance vitality and taste. Traditional external applications are equally diverse. A powdered form known as *Puag Haad*, created by boiling wood chips and evaporating the liquid, has long been used in Thailand as an anthelmintic treatment against tapeworms. The bark, rich in tannins (about 8.5%), is chewed much like betel nut for medicinal purposes and applied to skin conditions. Its therapeutic versatility extends to use in treating arthritic swelling, darkened skin, and general skin disorders. Together, these practices reflect a deep cultural knowledge of the lakoocha tree's healing potential, a testament to how one species can nourish and restore from root to leaf.

PHARMACOLOGICAL USES:

Antioxidant activity [9]

The ethanolic extract of *Artocarpus lakoocha* leaves demonstrated the highest antioxidant activity (IC_{50} 99.23 ± 0.07 ppm), followed by the ethyl acetate (323.18 ± 0.02 ppm) and n-hexane extracts (1062.03 ± 1.42 ppm), while quercetin showed an IC_{50} of 2.32 ± 0.01 ppm. Sequential maceration with n-hexane, ethyl acetate, and 96% ethanol was performed, and antioxidant activity was evaluated using the DPPH radical scavenging assay at 516 nm. Phytochemical screening revealed steroids in the n-hexane extract; steroids, tannins, glycosides, flavonoids, and saponins in the ethyl acetate extract; and tannins, glycosides,

flavonoids, and saponins in the ethanolic extract. The findings indicate that the ethanolic extract possesses the strongest antioxidant potential, likely associated with its phenolic and flavonoid constituents.

Anti-inflammatory activity [10]

The ethanolic extract of *Artocarpus lakoocha* Roxb. rich in oxyresveratrol, exhibited significant anti-inflammatory activity in LPS-stimulated RAW 264.7 macrophages. The extract reduced IL-6, TNF-α, MCP-1, nitric oxide production, and suppressed iNOS and COX-2 expression. It inhibited NF-κB activation by preventing IκB degradation and nuclear translocation, and blocked Akt phosphorylation with minimal effect on MAPK pathways. These findings suggest that its anti-inflammatory effects are primarily mediated through inhibition of the PI3K/Akt and NF-κB signaling pathways.

Hepatoprotective activity [11]

The methanolic extract of *Artocarpus lakoocha* fruits demonstrated dose-dependent hepatoprotective activity against paracetamol-induced liver toxicity in mice. HPLC analysis identified flavonoids and phenolic compounds, including chromatropic acid, quercetin, gallic acid, vanillic acid, cinnamic acid, ferulic acid, and kaempferol. Acute toxicity tests showed no adverse effects at doses above 2,000 mg/kg. The extract prevented elevations in liver function markers and histopathological damage, confirming its protective effect on the liver.

Antimicrobial and Antibiofilm Activity [12]

The aqueous extract of *Artocarpus lakoocha* exhibited antimicrobial and antibiofilm activity against a range of oral pathogens, including *Streptococcus mutans*, *S. sobrinus*, *Enterococcus faecalis*, *Lactobacillus* spp., *Aggregatibacter actinomycetemcomitans*, *Porphyromonas gingivalis*, and others. MIC values ranged from 0.10–0.39 mg/ml and MBC from 0.10–3.12 mg/ml, with time- and concentration-dependent killing effects. The extract also demonstrated potent antibiofilm activity, inhibiting biofilm formation and eradicating established biofilms. These findings suggest that *A. lakoocha* contains bioactive compounds with potential applications in oral care products, such as mouthwashes or toothpastes, to prevent or manage dental caries and periodontal infections.

Anthelmintic activity[13]

The methanolic extract of *Artocarpus lacucha* leaves showed significant dose-dependent anthelmintic activity against *Perthima posthuma*, comparable to albendazole. It also exhibited moderate antioxidant and modest anti-inflammatory effects, highlighting its potential as a source for developing new anthelmintic agents.

Antinociceptive activity [14]

The hydro-methanolic extract of *Artocarpus lacucha* bark demonstrated significant antinociceptive activity in mice, reducing pain in hot plate, tail immersion, acetic acid-, and formalin-induced nociception, as well as carrageenan-induced paw edema. The extract contains high levels of phenolics, including (+)-catechin, which also exhibited similar analgesic effects. Mechanistic studies indicated involvement of opioid receptors and ATP-sensitive K^+ channels, as effects were reversed by naloxone and glibenclamide, respectively. These findings support both central and peripheral antinociceptive properties of *A. lacucha* bark, consistent with its traditional medicinal use.

Schistosomicidal activity [15]

The aqueous extract of *Artocarpus lakoocha* (Puag-Haad), a traditional anthelmintic used for taeniasis, exhibited potent in vitro activity against *Schistosoma mansoni*. Adult worms treated with 250–750 µg/ml of the extract showed reduced motility, lower survival, and extensive tegument damage, surpassing the effects of praziquantel (175 µg/ml). The tegument was the primary target, with higher extract concentrations causing greater damage, likely due to tetrahydroxystilbene (THS), the main active compound. THS may serve as a potential schistosomicidal agent, warranting further in vivo studies on its mechanism, efficacy, and safety.

Anticancer activity [16]

The fruit extract of *Artocarpus lakoocha* was used to biosynthesize silver nanoparticles, which exhibited significant anticancer activity against human prostate adenocarcinoma (PC-3) cells. The nanoparticles were spherical, 6.59–25 nm in size, and displayed FCC crystalline structure. They showed dose-dependent cytotoxicity with an IC_{50} of 30.62 µg/ml, inducing early (48.11%) and late (24.92%) apoptosis, with minimal necrosis (1.19%) as confirmed by flow cytometry. These results suggest that *A. lakoocha*-derived silver nanoparticles have promising potential as anticancer agents.

Antiviral activity [17]

The heartwood of *Artocarpus lakoocha*, rich in oxyresveratrol, exhibited moderate activity against HSV-1 and HSV-2. Oxyresveratrol also showed modest anti-HIV activity (EC50 = 28.2 µM) without cytotoxicity in PBM, CEM, or Vero cells, highlighting A. lakoocha as a potential source for natural anti-HSV and anti-HIV agents.

Anti-aging activity [18]

Extract of *Artocarpus lakoocha* leaves, rich in phytooxyresveratrol, showed significant anti-aging activity, including antioxidant and anti-glycation effects. At 25 µg/ml, it inhibited DNA nicking effectively and was non-toxic up to 100 µg/ml, indicating potential for pharmaceutical applications.

Antitubercular activity [19]

Acetone extracts of *Artocarpus lakoocha* twigs and bark yielded cyclocommunin, which exhibited strong antitubercular activity against *Mycobacterium tuberculosis* H37Ra with an MIC of 12.3 µM, highlighting the plant as a potential source for natural antimycobacterial agents.

Anti hyperlipidemic activity [20]

The methanolic leaf extract of *Artocarpus lakoocha* demonstrated significant antihyperlipidemic activity by lowering total cholesterol, triglycerides, and LDL levels while increasing HDL levels. It also downregulated key cholesterol biosynthesis enzymes, including squalene synthase and HMG-CoA reductase, with effects comparable to simvastatin. These findings suggest its potential as a natural therapeutic agent for managing hyperlipidemia.

Antidiabetic and antiobesity [21]

Extracts of *A. lakoocha* enhance glucose metabolism and improve lipid profiles. Oxyresveratrol has been shown to inhibit α-glucosidase activity and enhance insulin sensitivity. The plant's anti-obesity effects are associated with regulation of lipid metabolism and inhibition of adipogenesis.

Neuroprotective activity [22]

The ethanolic extract of *Artocarpus lakoocha*, containing approximately 45% Oxyresveratrol,

demonstrated marked neuroprotective activity in vitro. In SH-SY5Y neuronal cells, the extract significantly protected against hydrogen peroxide–induced oxidative stress, restoring cell viability to about 80% at concentrations of 6.25–25 µg/mL, and attenuated Aβ25–35-induced cytotoxicity at 6.25–12.5 µg/mL. These results indicate that the ethanolic extract exerts neuroprotective effects primarily through antioxidant and anti-amyloid mechanisms, highlighting its potential therapeutic relevance for neurodegenerative conditions such as Alzheimer's disease.

CONCLUSION:

Artocarpus lakoocha Roxb. is an economically and medicinally significant plant that belongs to the family of Moraceae. Although it has been used extensively in traditional medicine for many years, scientific evidence regarding its phytochemical composition and pharmacological properties remains limited and dispersed across studies. Traditional uses of *Artocarpus lakoocha* are strongly supported by scientific studies demonstrating its potential as a therapeutic agent. The leaves, heartwood, roots, fruits, flowers, and seeds of *Artocarpus lakoocha* contain significant phytochemicals, including flavonoids, phenolic compounds, xanthones, terpenoids, steroids, triterpenoids, vitamins and minerals which have been shown to have wound healing, antibacterial, anti-viral, anti-inflammatory, antinociceptive, schistosomicidal, antiaging, antidiabetic, antihyperlipidemic, anti-cancer, anti-microbial, anti-HIV and anthelmintic effects. Although extensive pharmacological potential has been established, further clinical and mechanistic studies are required to validate its safety and therapeutic efficacy. Overall, *Artocarpus lakoocha* represents a promising natural source for the development of novel therapeutic agents.

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