

# An Overview of *Artocarpus Heterophyllus* and Their Activity

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## ABSTRACT

Jackfruit (*Artocarpus heterophyllus*), a versatile tree from the Moraceae family native to India and Malaysia, holds significant nutritional, medicinal, and industrial value. Its fruit, the largest among cultivated plants, features succulent flesh and starchy seeds rich in carbohydrates, vitamins, proteins, and bioactive compounds like flavonoids, carotenoids, and phenolics. These contribute to low glycemic index properties, supporting blood sugar management, while potassium, fiber, and antioxidants promote heart health by countering sodium effects and lowering cholesterol. Medicinally, jackfruit exhibits anti-inflammatory effects via compounds like artocarpain-H, which inhibit edema and inflammatory mediators in preclinical models. Antibacterial activity targets pathogens such as *E. coli* and *Staphylococcus aureus*, particularly from root bark and fruit butanol fractions, while anticariogenic flavonoids like artocarpin combat oral bacteria. Antifungal lectins from seeds inhibit specific fungi, and antineoplastic potential arises from prenylated flavonoids inducing apoptosis in cancer cell lines, including colon and breast cancers. The plant's parts—leaves, bark, seeds, and wood—offer additional benefits: wound healing through enhanced collagen synthesis via flavonoids and tannins; transient sedative effects reducing sexual activity in high doses without toxicity; and fodder, timber, and dye applications. Nutritional analyses highlight seeds' foaming and emulsifying proteins for food additives, alongside sugars like fructose and raffinose.

**Keywords:** *Artocarpus heterophyllus*, anti-inflammatory, antibacterial, antineoplastic, wound healing, low glycemic index, flavonoids, phenolic Compounds.

## INTRODUCTION

Jackfruit (*Artocarpus heterophyllus*) is reported to have originated in India and Malaysia. The jackfruit is a species of the mulberry family (Moraceae). In Sri Lanka it is known as "Kos" (Sinhala) and "Pala" (Tamil). Jackfruit (*Artocarpus heterophyllus*) is one of the most significant trees in tropical homegardens and perhaps the most widespread and useful tree in the important genus *Artocarpus*. It is a medium-size evergreen tree typically reaching 8–25 m (26–82 ft) in height that is easily recognized by its fruit, the largest among cultivated plants. The succulent, aromatic, and flavorful fruit is eaten fresh or preserved in myriad ways. The nutritious seeds are boiled or roasted and eaten like chestnuts, added to flour for baking, or cooked in dishes. It is also known for its remarkable, durable timber, which ages to an

orange or red-brown color. The leaves and fruit waste provide valuable fodder for cattle, pigs, and goats. Many parts of the plant including the bark, roots, leaves, and fruit are attributed with medicinal properties. Wood chips yield a dye used to give the famous orange-red color to the robes of Buddhist priests. The fruit contains fleshy bulbs and starchy seeds both of which are used as foods in Sri Lanka. The mature jackfruit is consumed either as a main meal or a meal accompaniment with rice and the ripe flesh as a fruit. Jackfruit is reported to possess many medicinal properties. The phenolic compounds isolated from jackfruit are reported to exhibit anti-inflammatory effect. Raw jackfruit flesh is regarded as a good source of carbohydrate (25%), vitamin A and a fair source of protein (1.6%). The postprandial glycaemic response to raw and ripe jackfruit elicits low glycaemic index (GI). Various researches have

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been carried out to study the nutritional benefits and consumer acceptability of jackfruit seed flour infused food products. Introduced to most Pacific islands after European contact, the tree can be found throughout the Pacific, mainly in homegardens, where it finds a place among other favorite multipurpose plants. It is easy to grow and more adaptable than some of the other common *Artocarpus* species such as breadfruit (*A. altilis*). It is not considered to be an invasive species. In general, jack fruit seed protein isolates and protein fractions showed strong foaming and emulsifying abilities. Jackfruit seed proteins therefore have the potential to be useful and nutritive food additives. Such characteristics could be exploited to obtain products of natural origin for the cosmetic, pharmaceutical and food industries. Inositol, sorbitol, glucose, fructose, sucrose, maltose, and raffinose are among the compounds found in jackfruit seed flour. In general, jack fruit seed protein isolates and protein fractions showed strong foaming and emulsifying abilities. Jackfruit seed proteins therefore have the potential to be useful and nutritive food additives.

#### COMPONENTS:

##### STEM :



Jackfruit stem (wood) is straight, moderately hard and durable, with yellowish to orange-brown heartwood used for furniture, construction and musical instruments. It contains prenylated flavonoids and other polyphenols that show antioxidant, anti-inflammatory, antimicrobial and potential antineoplastic activities in experimental studies.

##### LEAF:



Leaves are dark green, alternate, entire, simple, glossy, leathery, stiff, large (up to 16 cm [6 in] in length), and elliptic to oval in form. Leaves are often deeply lobed when juvenile and on young shoots.

##### FLOWER:



This species is monoecious, having male and female inflorescences (or “spikes”) on the same tree. Male and female spikes are borne separately on short, stout stems that sprout from older branches and the trunk. Male spikes are found on younger branches above female spikes. Male spikes are dense, fleshy, cylindrical to club-shaped, and up to 10 cm (4 in) in length. Flowers are tiny, pale green when young, turning darker with age. Female flowers are larger, elliptic or rounded, with a tubular calyx. The flowers are reportedly pollinated by insects and wind, with a high percentage of cross-pollination.

##### SEEDS:



Seeds are light brown, rounded, 2–3 cm (0.8–1.2 in) in length by 1–1.5 cm (0.4–0.6 in) in diameter, and

enclosed in a thin, whitish membrane. There may be about 100–500 seeds per fruit. Seeds are recalcitrant and can be stored up to a month in cool and humid conditions. The seed coat consists of a thin, waxy, parchment-like and easily removable testa (husk) and a brownish, membranous tegmen. The cotyledons are usually unequal in size, and the endosperm is minimally present. An average fruit consists of 27% edible seed coat, 15% edible seeds, 20% white pulp (undeveloped perianth, rags) and bark, and 10% core

### FRUITS:



The inflorescences are formed on the trunk, branches or twigs (cauliflory). Jackfruit trees are monoecious, having both female and male flowers on a tree. Fruit of jackfruit has a compound or multiple fruit with a green to yellow brown exterior rind that is composed of hexagonal, bluntly conical carpel apices that cover a thick, rubbery, whitish to yellowish wall. The ellipsoidal to roundish fruit is a multiple fruit formed from the fusion of the ovaries of multiple flowers. The fruits grow on a long and thick stem on the trunk. The heavy fruit is held together by a central fibrous core. They vary in size and ripen from an initially yellowish-green to yellow, and then at maturity to yellowish-brown. They possess a hard, gummy shell with small pimples surrounded with hard, hexagonal tubercles. The large and variously shaped fruit have a length of 30 to 100 cm (10 to 40 inches) and a diameter of 15 to 50 cm (6 to 20 inches) and can weigh 10–25 kg (22–55 pounds) or more.

### TAXONOMY :

Kingdom: Plantae -- planta, plantes, plants, vegetal

Subkingdom: Tracheobionta -- vascular plants

Division: Magnoliophyta -- angiosperms, flowering plants, phanérogames

Class: Magnoliopsida -- dicots, dicotylédones, dicotyledons

Subclass: Hamamelidae

Order: Urticales

Family: Moraceae – mulberries

Genus: Artocarpus – breadfruit

Species: Artocarpus heterophyllus Lam.

### Parts used:

Apart from whole plant, seeds, fruits, bark, root, leaves and latex are also used.

### Synonyms:

English : Jackfruit

Tamil : Palaa

Malayalam : Chakka

Kannada : Halasa

Bengali : Kanthal

Hindi : Kathal

Marathi and Gujarati : Panas

French: Jacquier

Thai: Banun, Khanun, Makmi

German: Jackfruchtbaum

Spanish: Buen pan, Jaca, Pan de fruta, rima

### Biological source

*Artocarpus heterophyllus* Lam

### Ayurvedic Description

Sanskrit name Properties: Panasa Synonyms: Atibhratphala, **Rasa:** Madhura, kasaya (unripe fruit);



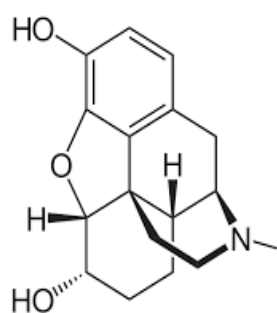
**Guna:** Snigdha, guru, picchila; **Virya:** Sita; **Vipaka:** Seeds- Vrsya, baddhavitkara, mutrala Madhura.

Therapeutic uses: Klibata, durbalya, raktapitta, varna

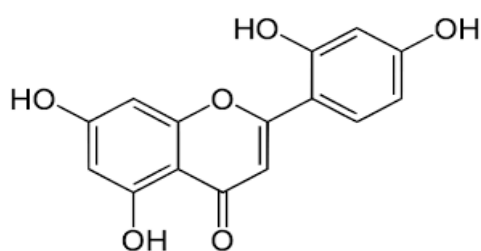
Actions: Vatapittahara, kaphavardhaka, balaya, durjara, sukraprada, tarpana, durjara,

### CHEMICAL CONSTITUENTS:

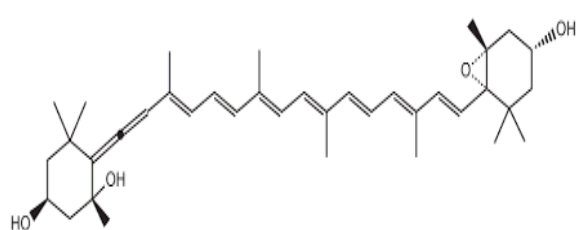
| S.NO | BOTONICAL NAME                                             | MAIN CONSTITUENT                                          | SUB-CONSTITUENT                                                                                                                                                               |
|------|------------------------------------------------------------|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.   | <i>Artocarpus heterophyllus lam</i>                        | Flavonoids (including prenylated flavones and flavanones) | Dihydromorin, steppogenin, norartocarpetin, artocarpanone, artocarpesin, cycloartocarpin, cycloartocarpesin, artocarpetin, isoartocarpin and related isoprenylated flavonoids |
| 2.   | <i>A. heterophyllus</i> fruit pulp and arils               | Carotenoids                                               | All-trans- $\beta$ -carotene, $\alpha$ -carotene, lutein, neoxanthin, violaxanthin, $\beta$ -zeacarotene and related xanthophylls                                             |
| 3.   | <i>A. heterophyllus</i> leaves                             | Phenolic acids and flavonoids                             | Quercetin, kaempferol, catechin, epicatechin, chlorogenic acid and related phenolics                                                                                          |
| 4.   | <i>A. heterophyllus</i> seeds and kernels                  | Alkaloids                                                 | Mixed plant alkaloids detected qualitatively in seed and leaf extracts                                                                                                        |
| 5.   | <i>A. heterophyllus</i> leaves, bark, fruit pulp and seeds | Glycosides (including cardiac and other glycosides)       | Cardiac glycosides and other unspecified glycosidic compounds detected in qualitative screening                                                                               |
| 6.   | <i>A. heterophyllus</i> seeds, stem and bark               | Tannins                                                   | Condensed tannins (phlobatannins) and hydrolysable tannins reported from seeds, stem and bark                                                                                 |
| 7.   | <i>A. heterophyllus</i> leaves and bark                    | Steroids / phytosterols and terpenoids                    | $\beta$ -sitosterol, phytosterols, triterpenoids and related steroidal/terpenoid compounds                                                                                    |



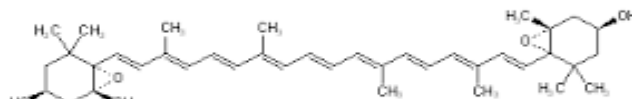
**Dihydromorin**



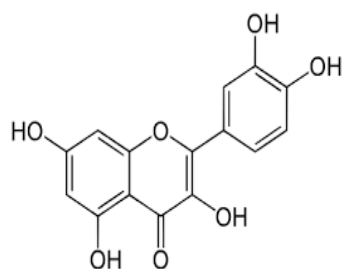
**norartocarpetin,**



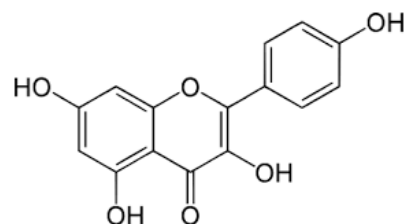
**Neoxanthin**



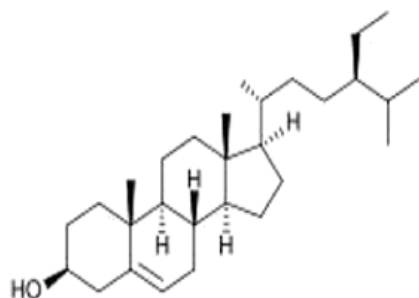
**violaxanthin**



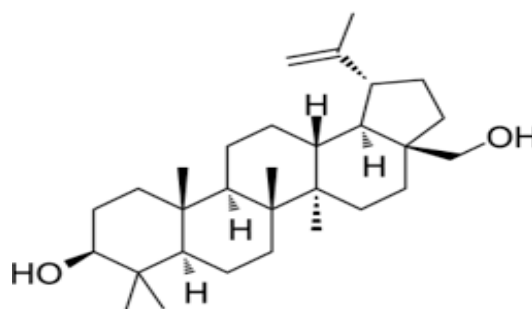
Quercetin



kaempferol



B-sitosterol



phytosterols

## THERAPEUTIC ACTIVITY:

### Heart Healthy Diet

Research shows that eating jackfruit can potentially reduce the risk of heart disease. "The combination of potassium, fiber and antioxidants can benefit heart health," Culbertson says. Potassium combats the negative effects of sodium on your blood pressure, while fiber contributes to lowering your cholesterol levels.

### Blood Sugar Level

First, jackfruit has a low glycemic index (GI) score, which means eating it shouldn't affect your blood glucose levels like other foods with higher scores. Second, a study shows that its leaf may help lower fasting blood sugar levels. Another study shows that jackfruit's bark may prevent fats and complex carbohydrates from breaking down into sugar. Both pieces of research could be beneficial for managing diabetes.

### Anti-inflammatory Effect

Surfeit generation of free radicals especially under conditions of chronic inflammation is harmful to the

cells. Preclinical studies with experimental animals have shown that the protease fraction and the phytochemical artocarpain-H extracted from the fruit stem latex possess anti-inflammatory effects. Artocarpain-H inhibited carrageenan-induced rat paw edema and reduced the weight of the granuloma in cotton pellet method and the effects were concentration dependent. Cell culture studies have also shown that the jackfruit flavanoids are effective in inhibiting the release of inflammatory mediators from the mast cells, neutrophils and macrophages. The phytochemicals cycloheterohyllin, artonins B, and artocarpanone inhibited the superoxide anion formation in fMLP-stimulated rat neutrophils. Dihydroisocycloartomunin inhibited the release of  $\beta$ -glucuronidase and histamine from rat peritoneal mast cells stimulated with P-methoxy-N-methylphenethylamine, while artocarpanone inhibited formyl-Met-Leu-Phe stimulated release of lysozyme from the rat neutrophils. Artocarpanone also exhibited significant inhibitory effect on lipopolysaccharide-induced production of NO and iNOS protein expression in RAW 264.7 cells.

### Anti-bacterial effect

The antibacterial effects of the crude methanolic extracts of bark of stem and root, heart wood of stem



androots, leaves, fruits and seeds as well as their petrol, dichloromethane, ethyl acetate and butanol partitioned fractions on *Bacillus cereus*, *B. coagulans*, *B. megaterium*, *B. subtilis*, *Lactobacillus casei*, *Micrococcus luteus*, *M. roseus*, *Staphylococcus albus*, *Staphylococcus aureus*, *S. epidermidis*, *Streptococcus faecalis*, *St. pneumoniae*, *Agrobacterium tumefaciens*, *Citrobacter freundii*, *Enterobacter aerogenes*, *Escherichia coli*, *Klebsiella pneumoniae*, *Neisseria gonorrhoeae*, *Proteus mirabilis*, *P. vulgaris*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Salmonella typhimurium* and *Serratia marcescens* by the disc diffusion method at standard concentration of 4 mg/disc and chloramphenicol (10 µg/disc) as positive control. It was observed that of all the extracts and fractions investigated the butanol fractions of the root bark and fruits were found to be the most active (Khan et al., 2003). Recently, Loizzo et al. (2010) also investigated the antibacterial effects of the whole aqueous extract as well as the extract's aqueous and ethyl acetate fraction of jackfruit leaves against the foodborne pathogens *E. coli*, *Listeria monocytogenes*, *Salmonella typhimurium*,

### Anticariogenic activity

The methanolic extract of the leaves possess significant inhibitory effects on the primary cariogenic bacteria. Bioactivity guided fractionated studies have shown that this effect was mediated by 6-(3-methyl-L-butenyl) 5,2',4'-trihydroxy-3-isoprenyl-7-methoxyflavone (artocarpin) and 5,7,2',4'-tetrahydroxy-6-isoprenylflavone (artocarpesin). Detailed evaluation have shown that both artocarpin and artocarpesin possess antimicrobial activities on various strains of *S. mutans*, *S. sobrinus*, *S. rattus*, *S. cricetus*, *S. sanguis*, *L. casei* and the *Actinomyces* in the range of 3.13–12.5 µg/ml (Sato et al., 1996). In milieu of these encouraging observations, studies should be extended to other microbes important in deteriorating the oral hygiene on assessing the toxicity of the extract on normal human epithelial cells, especially at the antibacterial concentrations for it to be of human use.

### Antifungal activity

The extract of the leaf is reported to be ineffective on *Aspergillus niger*, *A. rubrum*, *A. versicolor*, *A. vitis*,

*Candida albicans*, *C. tropicalis*, *Cladosporium cladosporioides*, *Penicillium notatum*, *Trichophyton mentagrophytes* and *T. tonsuratum*. However the chitin binding lectin present in the seeds (denoted as jackin) is shown to inhibit the growth of *Fusarium moniliforme* and *Saccharomyces cerevisiae*. Future studies should be extended to animal models as these studies will clearly indicate the antifungal efficacy in animal system of study

### Antineoplastic activity

Jackfruit (*Artocarpus heterophyllus*) has shown meaningful antineoplastic potential in recent preclinical research, mainly due to its polyphenolic constituents such as flavonoids, lignans, saponins and carotenoids. Ethanolic leaf extracts demonstrate cytotoxic effects against colon, breast and cervical cancer cell lines, often through induction of apoptosis and inhibition of cell proliferation. Seed extracts rich in phenolics and antioxidants also reduce cancer-cell viability and show favorable docking to molecular targets like tubulin, suggesting possible chemopreventive roles. Artocarpin, a prenylated flavonoid isolated from jackfruit wood, is the best-studied compound and exhibits strong antiproliferative effects in lung, liver and glioblastoma models by triggering mitochondrial apoptosis, autophagy and modulation of MAPK and Akt/mTOR signaling. In a mouse model of colitis-associated colorectal cancer, a jackfruit wood extract standardized to high artocarpin content significantly reduced tumor multiplicity and inflammatory markers, supporting its chemopreventive potential. The studies indicate that jackfruit pulp and seed flours may decrease mutagenicity and cancer-cell proliferation while providing antioxidant and prebiotic benefits, which can indirectly contribute to cancer prevention.

### Wound healing

Jackfruit (*Artocarpus heterophyllus* Lam.) has been investigated for its wound-healing potential using leaf and bark extracts in experimental models. Ethanolic or methanolic extracts are usually prepared from dried, powdered leaves or bark by Soxhlet or maceration, then incorporated into an ointment base such as simple ointment I.P. at concentrations around 2–5% w/w. Excision and incision wounds are created



on anesthetized rats, and the test formulations are applied topically once or twice daily, compared with a standard drug (povidone-iodine or mupirocin) and a plain ointment control. Parameters such as percentage wound contraction, period of epithelialization and granulation tissue weight are recorded at regular intervals, while incision models assess tensile strength of the healed skin using a tensiometer. Jackfruit formulations consistently show faster wound contraction, earlier scab fall and higher tensile strength than the control group, indicating enhanced collagen deposition and remodeling. Phytochemical screening reveals that jackfruit leaves and bark contain flavonoids, tannins, saponins and triterpenoids such as ursolic acid, along with trace elements like zinc and copper that are important for collagen synthesis and epithelial repair.

### Effect on sexual performance

Population explosion is a serious problem in many of the third world countries and search for an effective non toxic contraceptive agent or agents which decrease libido from dietary source is preferred. Preclinical studies have shown that feeding the seed (500 mg/kg) to rats decreased the sexual activities the number of mounts, number of intromissions, intromission ratio, copulatory efficiency, and increased the mount latency, intromissions latency, ejaculation latency and intercopulatory interval at early time point of two hour post administration but returned to normal at 6 h. However the seed did not decrease the ejaculatory competence, libido and immediate fertility in terms of quantal pregnancy, number of uterine implants, implantation index and pre and post implantation loss. Behavioral studies have also shown that administering the jackfruit seed caused a concentration dependent impairment and reduced the number of rears and locomotory activities. Additionally, sub chronic treatment of high dose of jackfruit seed did not induce marked changes in the gross appearance or weight of the vital organs and did not alter the levels of AST and ALT, the liver marker enzymes. Together, these observations clearly suggest that the decrease in sexual activity caused by jackfruit seed at the early time point was transient and not due to general toxicity, liver toxicity, stress or reduction in blood testosterone level but due to noticeable sedative activity. However, these observa-

tions have lesser human significance as the dose of 500 mg/kg when extrapolated to human dose amount to approximately 35 to 40 g. It is highly unlikely that humans would appreciate consuming a high dose of the seed daily to cause a transient reduction in the sexual activity, while other effective measures are available for population control.

### CONCLUSION

(*Artocarpus heterophyllus* Lam.) is a highly valuable multipurpose tree that provides food, fodder, timber, dye and several pharmacological benefits. Nutritionally, its ripe bulbs and raw flesh offer carbohydrates, vitamin A and modest protein, while seeds supply functional proteins with good foaming and emulsifying properties suitable for food, cosmetic and pharmaceutical industries. Botanically, all major parts—stem, leaves, flowers, fruits and seeds—are described, along with full taxonomy, vernacular names and Ayurvedic properties such as madhura rasa and vatapittahara action. Phytochemically, jackfruit contains diverse bioactive groups including flavonoids, carotenoids, phenolic acids, alkaloids, glycosides, tannins, steroids and terpenoids. These underpin documented activities: anti-inflammatory effects from flavonoids and protease fractions; broad-spectrum antibacterial action from various solvent extracts; anticariogenic activity due to artocarpin and artocarpesin; limited antifungal effects via the seed lectin jackin; antineoplastic potential of polyphenol-rich extracts and artocarpin; and significant wound-healing enhancement with leaf and bark ointments. The jackfruit is not only an important staple and economic crop but also a promising medicinal resource, with multiple experimentally supported activities (anti-inflammatory, antimicrobial, anticancer, wound-healing and neuromodulatory on sexual behaviour), although most evidence remains preclinical and requires further human studies before routine therapeutic use.

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