



## ARTOCARPUS : A REVIEW OF ITS PHYTOCHEMISTRY AND PHARMACOLOGY

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**ABSTRACT:** Moracea is a large family comprising about sixty genera and nearly 1400 species, including important group such as Artocarpus, Morus, and Ficus. A number of *Artocarpus* species are used as food and for traditional folk medicines in South-East Asia, Indonesia, Western part of Java and India. *Artocarpus* species has long been recognized for their exceptional medicinal value and for their edible aggregate fruits. *Artocarpus heterophyllus* (Jack fruit), *Artocarpus altilis*(bread fruit), *Artocarpus hirsutus*(wild jack), *Artocarpus lakoocha* and *Artocarpus camansi*(bread nut) are the important species belonging to this genus. These species are known to possess potential phytochemicals and high nutritional value. This review compiles traditional, phytochemical and pharmacological data on different Artocarpus species.

**KEYWORDS:-** *Artocarpus*, Moracea, medicinal uses, pharmacology, phytochemicals, antioxidant.

### 1. INTRODUCTION

The consumption of bioactive plant products is gaining significance all over the world. Their potential phytochemical constituents are being extensively studied for several pharmacological activities. The genus artocarpus belongs to the family Moracea which comprises of about 60 genera and over 1000 species. Many of these species are used as a source of food and in traditional medicinal practises. Artocarpus species are known for its large edible fruit with high nutritive values. The important species belonging to this genus are *Artocarpus heterophyllus*, *Artocarpus altilis*, *Artocarpus hirsutus*, *Artocarpus lakoocha* and *Artocarpus camansi*. Other than fruits and seeds, extracts of aerial and underground parts have been used traditionally in the treatment of diabetes, diarrhoea, dermatitis, malarial fever, asthma, tapeworm infection, anaemia and many other diseases. This review intends to describe the medicinal and nutritional properties of the species based on its traditional uses. These plants are known to contain many potential bioactive phytochemicals which possess many

validated pharmacological properties.<sup>1-2</sup>

### 2. GEOGRAPHIC DISTRIBUTION

Artocarpus species are mainly distributed in tropical and subtropical regions of Asia. *Artocarpus heterophyllus* (jack fruit) is believed to be originated in the rain forests of India. Today the jack fruit trees are widely grown in Bangladesh, Burma, Indonesia, China, Sri Lanka, Thailand, Philippines, parts of Africa, Australia, Brazil and Florida.

Areas of distribution of *Artocarpus lakoocha* are India, Nepal, Bhutan, Bangladesh, Myanmar and Malaysia.

*Artocarpus altilis* (bread fruit) is native to New Guinea, Indonesia and Philippines. Currently they are cultivated on central and south America, Africa, India, Southeast Asia, Maldives, Indonesia, Sri Lanka and northern Australia.

*Artocarpus hirsutus* is an endemic tree species of southern Western Ghats of peninsular India, commonly called as 'wild jack'.

*Artocarpus lakoocha* is widely distributed in the tropical regions of south and south-east Asia, mainly Nepal, Sri Lanka, India, Myanmar,

Indonesia, Vietnam and Thailand. In Thailand the plant is commonly called as 'Ma-haad'.

*Artocarpus camansi*, commonly called as breadnut, is distributed throughout the tropical regions including some pacific regions.<sup>2-3</sup>

### 3. TRADITIONAL MEDICINAL USES

Different parts of the *Artocarpus* species are used in traditional folk medicinal practices. Leaves, fruits, seeds, roots and barks of jackfruit are of great medicinal importance and used in various Ayurvedic and unani preparations. The ripe fruits are delicious, cooling, laxative, nutritious, and used to prevent excessive formation of bile. Extract from the seeds are useful in the treatment of diarrhoea and dysentery. Roasted seeds are believed to possess aphrodisiac properties. The leaves are believed to be effective in the treatment of asthma, ringworm infestation, diabetes and gall stones. Leaves are thought to possess wound healing, antisyphilitic, vermifuge activity and to induce lactation in women and domesticated animals. Roots are used in treating various skin diseases, asthma and diarrhoea. Bark of a mature tree is believed to be used in the treatment of dysentery and releasing the placenta after calving in cows. Latex mixed with vinegar is supposed to promote healing of abscesses, snakebite and glandular swellings.

The leaves of *artocarpus altilis* have been traditionally used in the treatment of liver cirrhosis, hypertension and diabetes.

*Artocarpus lakoocha*, commonly called as Monkey jack, is a plant used in traditional Thai medicine for anti-inflammatory therapy and as well as an anti-skin aging agent. The dried aqueous extract of its heartwood has been used as a traditional anthelmintic agent. The edible fruit pulp is considered as a liver tonic.

*Artocarpus hirsutus* (wild jack) endogenous to Kerala has wide medicinal values which is well documented in the third volume of Hortus

Malabaricus, the oldest comprehensive printed book on the natural plant wealth of Asia. The decoction of roots and bark are supposed to cure diarrhoea. The leaves when used with white camphor and root of curcuma are believed to treat venereal bubones and chronic haemorrhage respectively. The juice from the cooked fruits are believed to induce appetite and also when applied to the anus, relieve the pains of haemorrhage.

*Artocarpus camansi* is believed to have similar medicinal properties as *Artocarpus altilis*. The seeds are considered to have high protein content than chestnuts.<sup>3-7</sup>

### 4. NUTRITIONAL AND PHYTOCHEMICAL ASPECTS

Jack fruit is a highly nutritive seasonal food, which is considered as poor man's food in south East Asia. Edible portion of jack fruit is rich in carbohydrate, protein, fat, fiber, calcium, phosphorous, iron, vitamin A and thiamine. Fructose, glucose and sucrose are the major sugars present in jack fruit. The major fatty acids found in various parts of jack fruit are palmitic, oleic, stearic, linoleic, lauric, arachidic acids. Jack fruit seeds are good sources of starch, protein, mineral and fibre contents. A major protein, jacalin identified from the *Artocarpus heterophyllus* seeds, is a tetrameric two-chain lectin combining a heavy chain of 133 amino acid residues with a light  $\beta$  chain of 20-21 amino acid residues.

Jackfruit plant is also reported to contain artocarpine, artocarpetin, artocarpetin A, cycloheterophyllin, artonins A, artonins B, morin, dihydromorin, artocarpin, oxydihydroartocarpesin, cynomacurin, isoartocarpin, cyloartocarpin, artocarpesin, artocarpetin, norartocarpetin, cycloartinone and artocarpanone. The bark also contains betullic acid and two new flavone pigments, cycloheterophyllin, triterpenic compounds like

cycloartenyl acetate, cycloartenone, heterophyllol and tannin. The leaves and stem are also reported to contain sapogenins, cycloartenone, cycloartenol,  $\beta$ -sitosterol and tannins. The roots are reported to contain  $\beta$ -sitosterol, ursolic acid, betulinic acid, cycloartenone, trioxxygenated flavanones, heteroflavanones A and heteroflavanones B.

Breadnut (*Artocarpus camansi*) fruits and seeds are having high nutritive value. The seeds contain appreciable amount of protein, carbohydrate and mineral contents. The seed oil is found to be rich in unsaturated fatty acid which can be utilised as edible fat.

Breadfruit like jack fruit is an important edible fruit mainly because of its nutritional benefits. The fruits are rich sources of carbohydrates, protein, fatty acids, pro-vitamins, potassium, calcium, iron and dietary fibres. Various triterpenes and flavonoids have been isolated from breadfruit.

*Artocarpus lakoocha* fruits are reported to contain alkaloids, flavanoids, phenols, tannins, steroids and saponins. The edible fruits and seeds of monkey jack contain carbohydrates, proteins and minerals. Also a lectin, *Artocarpus lakoocha* agglutinin was isolated from the seeds. Nutritional facts of fruits and seeds of *Artocarpus hirsutus* are yet to be validated but several potential phytochemicals have been identified from the fruit pulp.

Flavonoids isolated from *Artocarpus* species consists of derivatives of chalcone, flavanones, flavan-3-ol, simple flavone, prenylflavone, oxepinoflavone, xanthonolide, pyranoflavone, dihydrobenzoxanthone, cyclopentenoxanthone, quinonoxanthone, furanodihydrobenzoxanthone, pyranodihydrobenzoxanthone, dihydroxanthone.<sup>7-21</sup>

## 5. VALIDATED PHARMACOLOGIC PROPERTIES

### ANTIOXIDANT ACTIVITY

The prenylflavones, isolated from *Artocarpus heterophyllus* was found to serve as powerful antioxidants against lipid peroxidation. In vitro antioxidant evaluation of chloroform extract of *Artocarpus heterophyllus* fruit pulp by DPPH, ferric reducing power assays and N,N-dimethyl-p-phenylendiamine (DMPD) radical cation decolorization assays confirmed that the Jackfruit pulp is a good source of antioxidant compounds. *Artocarpus heterophyllus* seeds were examined for their DPPH, ABTS scavenging effects and metal ion chelating activity and found to be an appreciable source of antioxidants.

In vitro evaluation of antioxidant activity of methanolic extract of fruits of *Artocarpus hirsutus* revealed potential DPPH scavenging activity and reducing power.<sup>22-26</sup>

### ANTI-BACTERIAL ACTIVITY

Isoprenyl flavones artocarpin and artocarpesin isolated from the methanolic plant extract of *Artocarpus heterophyllus* inhibited the growth of primary cariogenic bacteria and also inhibited plaque-forming Streptococci. The study revealed the potency of phytochemicals from *Artocarpus heterophyllus* in the prevention of dental caries.<sup>27-28</sup>

### ANTI CANCER PROPERTY

Methanolic extract of *Artocarpus heterophyllus* seeds were studied for its cytotoxic activity against A549, Hela and MCF-7 cell lines and showed excellent toxicity on cancer cells and was nontoxic to normal cells.

The anti-cancer studies of the diethylether extract of *Artocarpus altilis* wood was performed in human T47D breast cancer cells and examined for its effect on cell viability, nuclear morphology and sub-G1 formation. The results demonstrated that *Artocarpus altilis* wood extract induced apoptosis and sub-G1 phase formation in breast cancer (T47D) cells, and therefore, has a potential as an anti-cancer

agent.<sup>29-30</sup>

## ANTI DIABETIC ACTIVITY

The hot water extracts of *Artocarpus heterophyllus* leaves were investigated for its anti diabetic activity on normal human subjects and diabetic patients. The extracts appreciably improved glucose tolerance in the normal subjects and the diabetic patients. The antidiabetic activity of methanol extract of root bark of *Artocarpus integrifolia* was investigated through the inhibition of  $\alpha$ -amylase. This study revealed that the methanolic extract of root bark of *A. integrifolia* has the potential to be developed further into a natural antidiabetic drug.

According to several studies conducted on various *Artocarpus* species, they also possess other pharmacological properties such as Anti-inflammatory, Antifungal, effect on Sexual performance, Immunomodulatory effect, Anti-cholinergic, Chelating activity, cosmetic agent, ACE inhibitors, Anthelmintic effect, Protease inhibitors, Inhibition of melanin biosynthesis and wound healing properties.<sup>31-35</sup>

## 6. CONCLUSION

The present review attempts to explore *Artocarpus* species as a source of essential nutrients and bioactive phytochemicals which categorises it as a bifunctional food. This review compiles traditional, phytochemical and pharmacological data on different *Artocarpus* species. Experimental studies performed on edible and non edible parts of the plant, suggests that the plants possess pharmacological properties like, antioxidant, anti-inflammatory, antibacterial, anticarcinogenic, Immunomodulatory, antifungal, hypoglycaemic effects, inhibits melanin biosynthesis, possesses wound healing properties, and causes a transient decrease in the sexual performance.

When compared with orange, banana, mango, pineapple, papaya and other tropical fruits, the

*artocarpus* fruits such as jack fruit, bread fruit are less popular and are wasted in large quantities. Despite being delicious and nutritious fruit, the unpopularity is mainly due to the belief that the Jackfruit causes stomach discomfort, which is not scientifically proved. More studies should be promoted in exploring the species to establish scientific evidence for its vast medicinal properties.

## 7. REFERENCES

1. Ahmedullah M, Nayar MP, 1986. Endemic plants of the Indian region. *Am.j.clin.nutr.* 71(6):13.
2. Prior, R.L., 2003. Fruit and vegetables in the prevention of cellular oxidative damage. *American Journal of Clinical Nutrition.* 78: 570-78.
3. Verheij, E.W.M., Coronel, R.E., 1992. *Plant Resources of South-East Asia No. 2. Edible Fruits and Nut.* Prosea, Bogor Indonesia.
4. [www.traditionaltree.org](http://www.traditionaltree.org).
5. Jagtap U B, Bapat V A., 2010. *Artocarpus: A review of its traditional uses, phytochemistry and pharmacology.* *Journal of Ethnopharmacology.* 129, 142-66.
6. *American journal of botany,* 2002; 89 (9):1531-1546.
7. Adeleke R.O, Abiodun O. A., 2010. Nutritional composition of breadnut seeds (*Artocarpus camansi*).
8. Hakim, E.H., Achmad, S.A., Juliawaty, L.D., Makmur, L., Syah, Y.M., Aimi, N., Kitajima, M., Ghisalberti, E.L., 2006. Prenylated flavonoids and related compounds of the Indonesian *Artocarpus* (Moraceae). *Journal of Natural Medicine* 60, 161-84.
9. Cespedes CL, Pavon N, Alarcon J., 2008. Antioxidant and cardioprotective activities of phenolic extracts from fruits of Chilean blackberry *Aristotelia chilensis* (Elaeocarpaceae). *Food Chemistry.* 107(2):820-29.
10. M.C. Nath, 1937b. *Z Physiology Chem.* 247,

9. Quoted in Plant, and Chaturvedi, K. *Phytochemistry* 28: 2197-2199 (1989).
11. R. Dayal and T.R. Seshadri. Colourless compounds of the roots of *Artocarpus heterophyllus*. Isolation of new compound arteflavone. *Indian J Chem.* 12: 895-896 (1974).
12. G. Suresh Kumar, P.S. Appuktan and D.K. Basu a- D-Galactose - specific lectin from jack fruit seed. *J. Biosci.* 4: 257-261 (1982).
13. G. Pereira-da-Silva, AN. Moreno, F. Marques, C. Oliver, MC. Jamur, A. Panunto-Castelo, MC. Roque-Barreira, Neutrophil activation induced by the lectin KM+ involves binding to CXCR2. *Biochim. Biophys. Acta.* 1: 86-94 (2006).
14. Chai-Ming Lu and Chun-Nan Lin. Two 2~, 4', 6'--trioxygenated flavanones from *Artocarpus heterophyllus*. *Natural Products Research Center* 33(4): 909-911 (1993).
15. Chun-Nan Lin, Chai-Ming Lu and Pao-Lin Huang. Flavonoids from *Artocarpus heterophyllus*. *Phytochemistry*. 39(6): 1447-1451 (1995).
16. Jagadeesh SL, Reddy BS, Raghavan G, Swamy G, Kirankumar G, Laxminarayan H. Chemical composition of jackfruit (*Artocarpus heterophyllus* Lam.). *Selections of Western Ghats of India. Food Chemistry*, 2007; 102(1):361-365.
17. Hakim, E.H., Achmad, S.A., Juliawaty, L.D., Makmur, L., Syah, Y.M., Aimi, N., Kitajima, M., Ghisalberty, E.L., 2006. Prenylated flavonoids and related compounds of the Indonesian *Artocarpus* (Moraceae). *Journal of Natural Medicine* 60, 161-184.
18. J. Morton, F. Julia, Morton and Miami. In *Fruits of warm climates*. 58-64 (1987)
19. B.R. Barik, T. Bhaumik, A.K. and A.B. Kundu. Triterpenoids of *Artocarpus heterophyllus*, *J. Indian Chemical Soc.* 74: 163-164 (1997).
20. Chun-Nan Lin and Chai-Ming Lu. Heterophyllol, a phenolic compound with novel skeleton from *Artocarpus heterophyllus*, *Tetrahedron letters.* 34(17): 8249-8250 (1993).
21. Nomura T, and Hano Y, 1994. Isoprenoid-substituted phenolic compounds of moraceous plants, *Nat. Prod. Rep.* 11, 205-18.
22. Jeyam M, Peelaja R, Shalini G, Ravikumar P, 2013. Evaluation of *Artocarpus hirsutus* fruit pulp against alzheimer's disease. *Arch. of pharm. and bio sci.* 2(1), 30-40.
23. Gupta D, Mann S, Sood A, Gupta K R., 2011. Phytochemical, nutritional and antioxidant activity evaluation of seeds of jackfruit (*Artocarpus heterophyllus*). *Inter j pharm and bio sci.* 4(2):336-45.
24. Ko FN, Cheng ZJ, Lin CN, Teng CM. Scavenger and antioxidant properties of prenylflavones isolated from *Artocarpus heterophyllus*. *Free Radic Biol Med*, 1998; 25(2):160-168
25. Nagala S, Yekula M, Tamanam R R., 2013 antioxidant and gas chromatographic-analysis of five varieties of artocarpus seed oils. *Drug Invention Today.* 4(5), 315-320.
26. Narayanaswamy N, Balakrishnan KP, 2011. Evaluation of some medicinal plants for their antioxidant properties. *Inter j pharmtech res.* 3(1), 381-85.
27. Sato, M., Fujiwara, S., Tsuchiya, H., Fujii, T., Iimuna, M., Tosa, H., Ohkawa, Y., 1996. Flavones with antibacterial activity against cariogenic bacteria. *Journal of Ethnopharmacology* 54, 171-176.
28. Theivasanthi T, Venkadamani G, Palanivelu M, Alagar M., 2011. Nano sized powder of jackfruit seed: spectroscopic and anti-microbial investigative approach. *Nano Biomed. Engin.* 3: 215-221
29. Patel M R, Patel K S., 2011. Cytotoxic activity of methanolic extract of *Artocarpus heterophyllus* against A549, Hela and MCF-7 cell lines. *J app pharm sci.* 1(7):167-71.

30. Enos T A, Britanto D W, Yohana A H, et al., anticancer properties of diethylether extract of wood from sukun (*artocarpus altilis*) in Human Breast cancer (T46D) cells *Tropical Journal of Pharmaceutical Research*, August 2009; 8 (4): 317-24.
31. Trindade MB, Lopes JL, Soares C, Monteiro M, Moreira RA, Oliva ML, BeltraminiLM. Structural characterization of novel chitin-binding lectins from the genus *Artocarpus* and their antifungal activity. *Biochim Biophys Acta*, 2006; 1764(1):146-52
32. Kabir, S., 1998. Jacalin: a jackfruit (*Artocarpus heterophyllus*) seed derived lectin of versatile applications in immunological research. *Journal of Immunological Methods* 212, 193–211.
33. Ratnasooriya WD, Jayakody JR. *Artocarpus heterophyllus* seeds inhibit sexual-competence but not fertility of male rats. *Indian J Exp Biol*, 2002; 40(3):304-308
34. Umesh B, Bapat V A, Waghmare R S, Lokhande H V., 2011. Preparation and evaluation of antioxidant capacity of Jackfruit (*Artocarpus heterophyllus*) wine and its protective role against radiation induced DNA damage. *Industrial crops and products*. 34 (3):1595-601.
35. Vinay M N, Ramesh B S, H Makari, et al., 2013. Evaluation of antioxidant activity of *Artocarpus hirsutus* methanolic fruit extract: An in vitro study. *Int J Sci Res*. 12 (2):58-60.