Minireview Article

A mini review on *Artocarpus nobilis* Thw. (Moraceae): An endemic plant of Sri Lanka

ABSTRACT

The genus *Artocarpus* consists of about 50 species of large evergreen trees with various medicinal and economical uses. *Artocarpus nobilis* (Family: Moraceae) is commonly referred to as Ceylon breadfruit and it is endemic to Sri Lanka. Synonyms of *A. nobilis* are *Artocarpus imperialis* André, *Artocarpus pubescens* Moon and *Saccus nobilis* (Thwaites) Kuntze. *Artocarpus* species consist of many phytochemical compounds such as flavanones, flavonoids, triterpenoids, xanthones, stilbenes and chalcones. Ceylon breadfruit (*Artocarpus nobilis*) has many bioactivities and is used in Ayurvedic and folk medicine. Some of the research that has been carried out on this plant include the evaluation of antibacterial activity, anti-inflammatory activity, antioxidant, antifungal, biosorption and Glutathione-S transferase inhibitory activities. A combination of traditional and new technologies will be important in the future to develop therapeutic products from *Artocarpus nobilis*. This review will aid in providing comprehensive information on research conducted on this plant.

Keywords: Artocarpus nobilis, Ceylon breadfruit, Endemic plant, Sri Lanka

1. INTRODUCTION

The family Moraceae consists of about 37 genera of plants and *Artocarpus* is one of the important genera, which consists of about 55 species [1,2]. In Sri Lanka, mainly *Artocarpus heterophyllus* and *Artocarpus nobilis* can be found [3,4]. This review mainly focused on reviewing *Artocarpus nobilis,* also known as Ceylon breadfruit, which is endemic to Sri Lanka. Previous studies have been reported on the evaluation of the antibacterial and anti-inflammatory activities of *Artocarpus nobilis* [3,5]. This review focuses on the morphology and distribution, bioactivity, pharmacological properties, ethnomedicinal properties, and phytochemistry of *Artocarpus nobilis*.

1.1 Synonyms and other names

The synonyms of ***Artocarpus nobilis Thwaites*** are *Artocarpus imperialis* André, *Artocarpus pubescens* Moon, *Saccus nobilis* (Thwaites) Kuntze
English name: Breadfruit, Ceylon Breadfruit
(Most *Artocarpus* species have edible bread-like fruits, which give them the names breadfruit or Ceylon breadfruit)
Sinhala name: Bedi del, Wal del ,Hingala del
Tamil name: Arsini Pla Irappala, Aresini-pilaka, Asiri-pillakai [6]

1.2 Taxonomic classification

Kingdom: Plantae, Sub kingdom: Tracheophytes, Division: Angiosperms, Class: Eudicotyledons, Subclass: Rosids, Order: Rosales, Family: Moraceae, Genus: *Artocarpus*, Species: *nobilis* [7].

2. GEOGRAPHICAL DISTRIBUTION

Artocarpus genera includes *Artocarpus heterophyllus, Artocarpus altilis, Artocarpus nobilis, Artocarpus anisophyllus, Artocarpus camansi, Artocarpus hirsutus,* etc. These species are spread throughout the East, South, Southeast Asia, New Guinea, and South Pacific areas. It is abundant, up to an elevation of 2,500 ft in wet zones in low country. It is commonly found in the mid-country homesteads and the wet zone forests in Sri Lanka [8].

3. MORPHOLOGY OF *ARTOCARPUS NOBILIS*

Artocarpus nobilis is a large evergreen tree, to 25 m high with immense crown, stem, stout, boughs and wide spreading roots. Bark is thick, dull brown irregularly furrowed and exfoliating. Leaves alternate, large, dark green above and paler below. Stipules 3-12 cm long; leaf lamina 14-32 x 8-23 cm; lateral veins 10-13 pairs; petiole 2-3 cm long; Sapling leaves pinnately lobed. Male head 7-13 x 1.5 cm, cylindric, covered by flowers and bracts; peduncle 3-7 cm long. Female head covered by peltate bracts. Syncarp up to 20 x 10 cm, cylindric, covered with persistent peltate bracts; peduncle 10-15 cm long. Flowers Monoecious, male spikes, female dense, on a terminal or axillary club like in a receptacle. Seeds 8 x 7 mm in size pale chestnut brown [6,9].

4. ETHNOMEDICINAL INFORMATION

When considering the medicinal properties of the *Artocarpus nobilis*, according to Compendium of medicinal plants: a Sri Lankan study, 2004, crushed stem bark extract is used for fracture healing and muscle strains, for the treatment of dysentery. Both latex and steamed bark parts with herbal leaves are used for the treatment of abscesses and blisters. Latex mixed with ginger extract, castor oil used for vermifuge, worm infestations in children. Latex is also used for “Krimi dosha” and “Muha kassa”. Seeds are good for Asthma patients. Roasted seeds are used to improve the sexual ability of males, latex of the young shoots is used for skin diseases and also roots are used in folk medicinal recipes “Chandana guli wattoruwa”. Edible fruits and seeds possess good nutritional value and are mainly used for worm infections (e.g., Ascariasis) [6, 9,10].

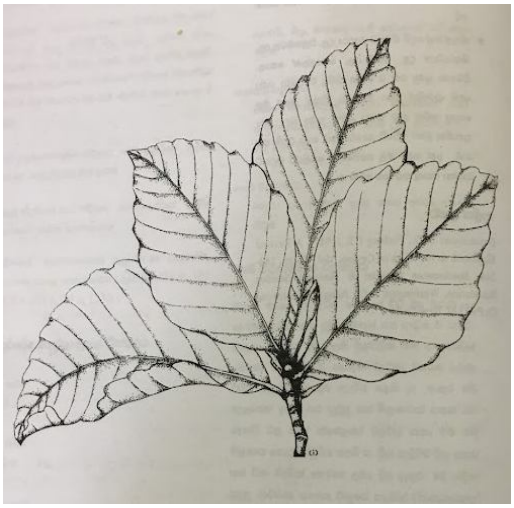
5. PHYTOCHEMISTRY

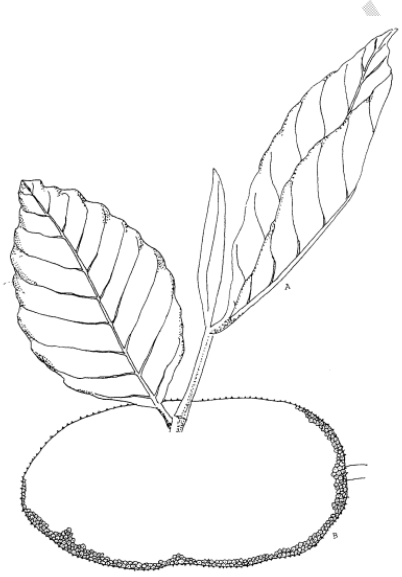
The chemistry of Moraceae has been reviewed and some of the triterpenoid bark constituents of several species of the genus *Artocarpus* have been reported (refere to the supplementary data provided at the end of this review).

5.1 Stem Bark

Six chromeno flavonoids were identified in benzene and methanol extracts from the

Figure 1: Artocarpus nobilis Leaves [10] Figure 2: Artocarpus nobilis leaves and fruit [9]





bark of *Artocarpus nobilis*. Five flavonoid compounds present in the benzene extract were shown in thin layer chromatography (TLC). These were isolated and purified over silica gel followed by fractional precipitation. Arto-bilochromen (0.8%) was the main compound in the extract [11]. A study conducted on the bark of *A. nobilis* identified two new pyranodihydrobenzo xanthones. This finding was significant because it was the first report of the occurrence of dihydrobenzo xanthones in plants [12]. In another recent study two new cycloartane-type triterpenoids, Artocarpuate A

and Artocarpuate B were identified. With the help of extensive NMR spectroscopic studies, the structures of these new compounds have been identified [13]. Antifungal activity-guided fractionation of n-butanol extract from *Artocarpus nobilis* stem bark methanol extract contained two derivatives of stilbene. In the TLC bioautography method, both compounds showed strong antifungal activity against Cladosporium cladosporioides and high radical scavenging activity against the DPPH radical [14].

5.2 Root bark

Chemical examination of the n-butanol extract from the *Artocarpus nobilis* root bark methanol extract contained four new prenylated flavonoids together with artonin E 2'-methylether, isoartonin E 2'-methylether, dihydroisoartonin E 2'-methylether, artonin V 2'-methylether, artobiloxanthone, artonin E, and cycloartobiloxanthone. All these compounds were shown to have good radical scavenging properties towards DPPH radical [15].

5.3 Leaves

Several antifungal activities and radical scavenging activity investigations were carried out on *Artocarpus nobilis*. In such a study, antifungal activity directed fractionation of the extract of n-butanol from the methanol extract of the leaves of *Artocarpus nobilis* contained five chalcones. In the TLC bio-autography method, all of these compounds showed good fungicidal activity against Cladosporium cladosporioides and high radical scavenging property against the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical [16].

5.4 Fruits

Dichloromethane and ethyl acetate extracts of fruit produced four new geranylated phenolic constituents together with six known chalcones and flavanones. Spectrophotometric methods demonstrated good antioxidant activity against DPPH radical [17].

6. BIOACTIVITY

6.1 Antioxidant activity

The methanol extract and the n-butanol extract from the methanol extract of the stem bark of *A. nobilis* showed high radical scavenging activity towards the 2,20-diphenyl-1-picrylhydrazyl radical (DPPH) in TLC bio-autography method [14]. N-butanol extract from the methanol extract of the leaves of *A. nobilis* showed high radical scavenging activity towards the DPPH radical in TLC bio-autography method [16]. Generylated phenolic constituents from the fruits of *A. nobilis* showed strong antioxidant activity against DPPH radicals by the spectrometric method [17].

6.2 Antibacterial Activity

The aqueous bark extract showed antibacterial activity against Escherichia coli and methanol bark extract showed marked antibacterial activity against Staphylococcus aureus determined by agar well diffusion method [3].

6.3 Antifungal activity

The n-butanol extract of stem bark of *A. nobilis* showed antifungal activity against Cladosporium cladosporioides [14]. Guided fractionation of the n-butanol extract from

the methanol extract of the leaves of *A. nobilis* showed antifungal activity against Cladosporium cladosporioides [16].

6.4 Anti-inflammatory activity

Methanol extract of stem bark and aqueous extract of leaves of *A. nobilis* showed anti-inflammatory activity by in vitro protein (egg albumin) denaturation method [5].

6.5 Acetylcholinesterase inhibitory activity

New cycloartane type terpenoids isolated from ethanolic extract of *A. nobilis* showed weak acetylcholinesterase activity determined by using modified Ellman's assay [13].

6.6 Biosorption of metal ions

The peel of *A. nobilis* showed remarkable Biosorption capabilities toward Ni(II) heavy metal ions and Cr(III) and Cr(VI) ions. that the peel of *Artocarpus nobilis* fruit can be used as an effective bio-sorbent for the removal of Ni(II) from wastewater [18].

6.7 Glutathione-S transferase (GST) inhibitory activity

Ethanolic extract of *A. nobilis* resulted in GST inhibitory activity. It was found that this activity was mainly due to the presence of flavonoids [19].

7. OTHER USES OF *A. NOBILIS*

Both fruit (tender portions) and seeds are edible. Excavations in the Kitulgala area have revealed that 12,500 years ago, prehistoric men ate roasted seeds of wild breadfruit. Fruit and seeds are boiled and eaten. Seeds contain a high percentage of oil and can be roasted and eaten as a snack.[9] Aside from the edible fruit, the timber of the *Artocarpus* species is used for long lasting construction and furniture making.

8. CONCLUSION

This review highlights the ethnomedicinal, pharmacological and phytochemical properties of *A. nobilis* endemic to Sri Lanka. Although there are many articles on the *Artocarpus* genus, only a few research has been done on *A. nobilis* Thw. Based on the literature review, *A. nobilis* contains various phytochemicals including flavanones, flavonoids, triterpenoids, xanthones, stilbenes and chalcones and currently more than 25 novel phytochemical compounds have been isolated and identified.

Table 1 : Supplementary Data

Plant part	Extraction method/solvent used	Isolated and identified chemical	Identification method
Stem Bark [11]	Benzene and Methanol extracts	Six chromenoflavinoids 1. Artobilochromen 2. chromanoartobilochromen b 3. dihydrofuranoartobilochromen a	Thin Layer Chromatography - five flavonoid compounds in the benzene extract. Further purified by column chromatography over silica gel

		4. dihydrofuranoartobilochromen b 5. dihydrofuranoartobilochromen b2 6. Artobilochromen with formic acid gave chromanoartobilochromens a and b with dichlorodicyanobenzoquinone gave dihydrofuranoartobilochromen *a*	followed by fractional precipitation. Further analysis by Nuclear Magnetic Resonance (NMR) spectroscopy.
Stem Bark [12]	Extraction method: Sequential extraction Hot petrol Hot C_6H_6 Hot Methanol	Two pyranodihydrobenzoxanthones 1. 5,6,1 l-trihydro-1,3,4,8-tetrahydroxy-5-isopropenyl-l1,1 1-dimethylbenzo[1,2:u]pyrano [2',3':j]xanthene-7-one (artobiloxanthone) 2. 5,5a, 6,11-tetrahydro-1,3,8-trihydroxy-5,5, 11, 1l-tetramethylbenzofuro [3,3a,4:ab] pyrano [2',3'q]xanthen-7-one (cycloartobiloxanthone)	Mass spectrometry NMR spectroscopy IR spectroscopy UV spectroscopy
Stem Bark [13]	95% ethanol Filteration and Evaporation	two new cycloartane-type triterpenoids 1. Artocarpuate A 2. Artocarpuate B	Thin Layer Chromatography NMR spectroscopy
Stem Bark [14]	Methanol extract	two stilbene derivatives 1. (E)-4-isopentenyl-3,5,20,40-tetrahydroxystilbene 2. (E)-4-(3-methyl-E-but-1-enyl)-3,5,20,40-tetrahydroxystilbene	Mass spectrometry (Electrospray Ionization-MS) NMR spectroscopy HPLC analysis UV spectroscopy
Root Bark [15]	*n*-butanol extract from the methanol extract	Four new prenylated flavonoids 1. Artonin E 2′-methylether 2. Isoartonin E 2′-methylether 3. Dihydroisoartonin E 2′-methylether 4. Artonin V 2′-methylether Other: Artobiloxanthone Artonin E Cycloartobiloxanthone	H UV spectroscopy NMR spectroscopy Mass spectrometry
Leaves [16]	Guided fractionation of the *n*-butanol extract from the methanol extract	Five chalcones were identified. The chalcones 3 and 5 are new natural products whereas 1 and 2 are reported first time from the family Moraceae. 1. 2',4',4-trihydroxy-3'-geranylchalcone 2. 2',4',4-trihydroxy-3'-[6-hydroxy-3,7-dimethyl-2(E),7 octa dienyl]chalcone	UV spectroscopy NMR spectroscopy Mass spectrometry

		3. 2',4',4-trihydroxy-3'-[2-hydroxy-7-methyl-3-methylene-6-octaenyl]chalcone 4. 2',3,4,4'-tetrahydroxy-3'-geranylchalcone 5. 2',3,4,4'-tetrahydroxy-3'-[6-hydroxy-3,7-dimethyl-2(E),7-octadienyl]chalcone	
Fruits [17]	Sequential extraction with dichloromethane, ethyl acetate and methanol	Four new geranylated phenolic constituents 1. 2,4,4'-trihydroxy-3-[(2E)-5-methoxy-3,7-dimethylocta-2,6-dienyl]chalcone 2. 1-(3,4-dihydro-3,5-dihydroxy-2-methyl-2-(3-methyl-2-butenyl)-2H-1-benzopyran-6-yl-3-(4-hydroxyphenyl)-2(E)-propen-1-one 3. 8-geranyl-3',4',7-trihydroxyflavone 4. 3'-geranyl-4',5,7-trihydroxyflavanone together with known related compounds xanthoangelol xanthoangelol B, 3-geranyl-2,3',4,4'-tetrahydroxychalcone, lespeol, 8-geranyl-40,7-dihydroxyflavanone, and isonymphaeol-B.	HPLC analysis UV spectroscopy NMR spectroscopy Mass spectrometry

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