



Pharmacognostical Properties and Medicinal Uses of *Broussonetia papyrifera* (Moraceae): A Review

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ABSTRACT

Broussonetia papyrifera also known as paper mulberry is native to Asia including China, Japan, India, and Burma belonging to the family Moraceae. It grows up to a height of 20 m and a diameter of 70 cm in sub-tropical regions at an elevation of 1600 m. The plant is dioecious, and leaves are papery which vary in shape and are alternate, acuminate, dentate with oblique bases having a dimension of 9.7 x 6.6 cm. The fruit is reddish, fleshy, 1-2 cm long, and drupe. It is mainly used for making the fine quality bark cloth, decoction, and edible fruit. It is medicinally used as an astringent, diuretic, diaphoretic, laxative, and stomachic and possesses antimicrobial, antifungal, antioxidant, anti-inflammatory, and antinociceptive activity. It is also used for animal feed, fodder, forage, shade, shelter, fuelwood, and ornamental use. It contains various phytoconstituents including minerals like calcium, iron, magnesium, potassium, phosphorus, zinc, manganese, copper, lead, mercury, and vitamins like vitamin E, B1, B2, B5, B6, C, beta carotene, fatty acids, and amino acids like aspartate, threonine, glutamate, glycine, leucine, isoleucine, valine, tyrosine, and apigenin, luteolin, flavone, ficustrinol, icaraside, and flavones. The plant grows well at a temperature between 15 to 28°C, annual rainfall of 800 to 2500 mm, and pH of 5 to 7.5. Species are highly invasive, cause of aeroallergen but useful in phytoremediation.

Keywords: Aeroallergen, anti-inflammatory, bark cloth, invasive, paper mulberry, phytoremediation.

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INTRODUCTION

Paper mulberry is also known as pulp mulberry, Tapa cloth tree, and murier a papier is a deciduous shrub or tree which is native to Asia including India, China, Japan, and Burma. Paper mulberry scientifically known as *Broussonetia papyrifera* consists of a spreading rounded crown and grows up to a height of 10-20 m and a diameter of 70 cm.¹ It emanates from subtropical regions of Asia being the most important fibre crop.² Its habitat is in dry or humid mountains and forests at an elevation of 1600 m.^{3,4} It is mainly cultivated for the fibre in its bark which is sold widely in the Pacific islands.⁵ This plant is extremely invasive due to its excessively fast growth so male trees are used as shade or street trees instead of female trees. Leaves vary in shape and blades with toothed edges and rough texture, male and female flowers are on different plants with orange or red fruit. It is mainly used for making the finest quality bark cloth, paper, furniture, and rope.^{6,7} Fruits, leaves, and bark of the plant are used for making medicines mainly laxatives and antipyretics. It is also an ornamental plant that is used for restoration purposes.

The bark of the plant consists of various phytoconstituents such as halocellulose, pentosans, and alpha-cellulose whereas dried leaves consist of calcium carbonate and fruits comprised of crude protein fat and carbohydrate.⁸ The role of species in phytoremediation is of great use in preventing the depletion of soil quality and soil erosion. Taiwan's findings on the species of aeroallergens responsible for allergic rhinitis, asthma, and other allergic disorders are essential in managing and forecasting further patterns for the treatment of asthma in the long term.

Synonyms

Morus papyrifera L. and *Papyrius papyriferus* (L.) Kuntze⁹

Taxonomical Classification

Kingdom	– Plantae
Phylum	– Tracheophyte
Subphylum	– Angiospermae
Class	– Magnoliopsida
Order	– Rosales
Family	– Moraceae
Genus	– <i>Broussonetia</i>
Species	– <i>papyrifera</i>



MORPHOLOGICAL CHARACTERISTICS

The plant is 10-20 m tall and 70 cm in diameter with light grey smooth bark and a spreading rounded crown. The species has greyish brown spreading branches and its stem, branches, and petioles contain a milky latex. Leaves are papery which vary in shape and are alternate, acuminate, and dentate with oblique bases having a dimension of 9.7*6.6 cm. Blades are lobed or unlobed having toothed edges with a hairy and rough texture. The dimension of petioles is of 3-10 cm and stipules ranges from 1.6-2.0 cm. The plant is unisexual and dioecious with catkin type inflorescence of stamina with 3.5*7.5 cm yellowish-white male flowers and the inflorescence of the pistil is spherical which is 2 cm long with greenish female flowers. The fruit is reddish, fleshy, 1-2 cm long, and drupe.^{10,11}



Figure 1: Unlobed leaf



Figure 2: Lobed leaf



Figure 3: Bark



Figure 4: Pistillate flower



Figure 5: Staminate flower



Figure 6: Fruit



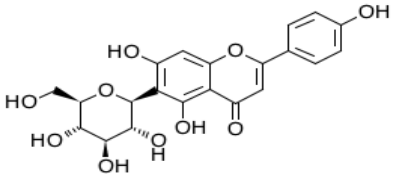
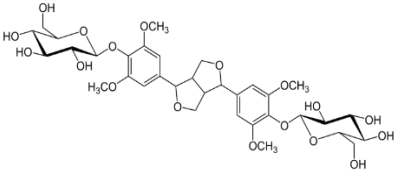
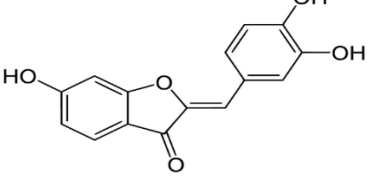
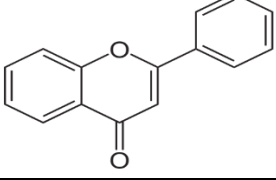
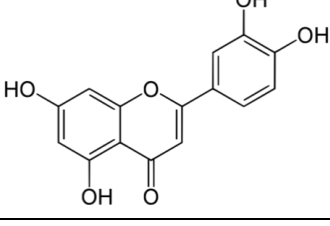
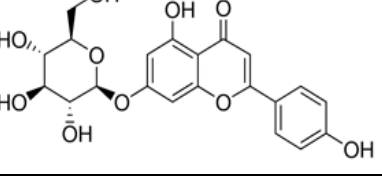
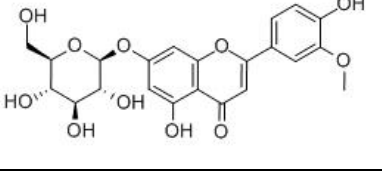
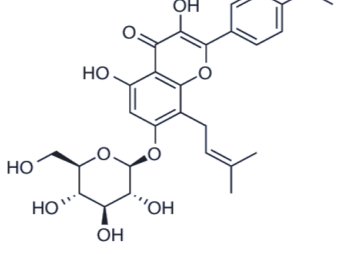
Figure 7: Plant

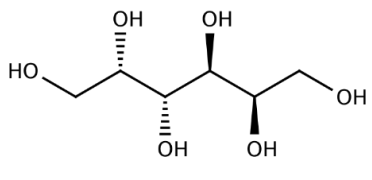
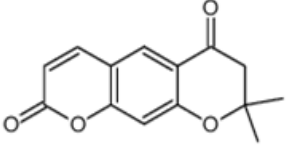
CHEMICAL CONSTITUENTS

Fruits of the plant contain various phytochemicals such as minerals like calcium, iron, magnesium, potassium, phosphorus, zinc, manganese, copper, lead, and mercury. It also contains vitamins like vitamin E, B₁, B₂, B₅, B₆, C, beta carotene, fatty acids, and amino acids like aspartate, threonine, glutamate, glycine, leucine, isoleucine, valine, and tyrosine.¹² Leaves of the plant contain various phytoconstituents such as apigenin-7-O-β-D glucopyranoside, chrysoeriol-7-O-β-D glucopyranoside, vitexin-7-O-β-D glucopyranoside, luteolin, flavone, saponaretin, benzyl benzoate-2,6-di-O-β-D glucopyranoside, ficustriol, icaricide, sammangaoside A. Compounds isolated from the branch of the plant are (2S)-7, 3'-dihydroxy-4'-methoxyflavan, ergosterol peroxide, D-galactitol, sulfuretin, lirioidendrin, graveolone. The average oil content of the seed is 30.1% and the average protein content is 18.5%. Root barks of the plant contain

benzofurans, biphenylpropanoids, coumarins, and distinct types of flavonoids (chalcones, flavans, flavanones, and flavones).¹³⁻¹⁵

Table 1: Table of Phytoconstituents

Saponaretin	
Liriodendrin	
Sulfuretin	
Flavone	
Luteolin	
Apigenin-7-O-β-D-glucopyranoside	
Chrysoeriol-7-O-β-D-glucopyranoside	
Icariside	

D-galacitol	
Graveolone	

MEDICINAL USES

Leaves are used as an astringent, diuretic, and for fluxes, gonorrhoea. Juice of leaves is also used as a diaphoretic, laxative, and for treatment of dysentery. The stem bark is used as a diuretic, haemostatic, and decoction of stem bark is used for ascites and menorrhagia. Decoction of twig is used for eruption and juice is used for treating anuria. The sap of bark is used for healing wounds and insect bites. Fruit of the plant is used as a diuretic, ophthalmic, stimulant, stomachic, and tonic.

Antimicrobial and antifungal activity

Papriflavanol A, a flavonoid d [5,7,3',4'- tetrahydroxy-6,5'-di-(γ,γ-dimethylallyl)-flavonol] obtained from the roots of the species has antifungal and antimicrobial activity. The values for MICs (Minimum Inhibitory Concentration) were found to be 10.25ug/ml for various species. The test was performed on fungal cells which were grown in nutrient broth at 30°C and MIC values were calculated after serial dilution.¹⁶ After serial dilution, optical density was measured after 48 hours of incubation.¹⁷ The MIC values of PAP A were measured for fungi, gram-positive, and gram-negative bacteria and then compared with standard marketed antibiotics such as Ampicillin, Erythromycin, Amphotericin B, Miconazole, 5-Fluorocytosine against the strains *S. epidermis*, *S. typhimurium*, *C. albicans*, *S. cerevisiae*, and *S. aureus*. PAP A was found to have high MFC (Minimum Fungicidal Concentration) and MIC values than the standard preparations which act by disrupting the membrane of the cell and then the material of the cell comes out.^{18,19}

Antioxidant activity

The fruit of the plant was checked for its antioxidant activity because of the existence of ethanol and other aqueous extracts in it. The concentration of the phenolic group was analysed by the Folin-Ciocalteu assay while its antioxidant activity was analysed by calculating the capability of the two extracts to scavenge DPPH (2,2-diphenyl-1-picrylhydrazyl) radicals, inhibit peroxidation, chelate ferric ions, and their reducing power. Results showed more reducing agent and radical scavenger capability of aqueous extract than of ethanol content. So, the fruit of the plant is widely used to avert oxidation in food items and as a food additive.^{20,21}

Anti-inflammatory activity

The anti-inflammatory action of *Broussonetia papyrifera* was figured by calculating the increment in volume of the hind paw of the rat after injecting 0.1 ml of 1% carrageenan.²² The instrument used was a plethysmograph which shows a rise in water level. Further injection of triterpenoid (botulin, betulinic acid, oleanolic acid, and ursolic acid) was injected and the water level was observed. Conclusions sighted that plant contains anti-inflammatory activity. Only *Broussonetia papyrifera* fruit and radix at 2 gm/kg declined carrageenan-induced edema after 1 to 2 hours of carrageenan administration.²³⁻²⁶

Antinociceptive Activity

The pain-reducing property of the species was elucidated by the acetic acid-induced abdominal writhing response and formalin-induced writhing response in mice. Radix, leaf, fruit, and stem were administered at 2 g/kg orally restrained acetic acid-induced response and declined the licking time lured by formalin. Results showed more pain-reducing activity of radix and fruit than leaf and stem by the action on the peripheral nervous system associated with bradykinins and autocrine.

Agroforestry Uses

The plant grows quickly in degraded sites and prevents further soil erosion due to its dichotomous root system. It is also a useful species for restoration purposes. Leaves of this plant when chopped and applied at 4 tonnes per hectare, increase the moisture content of soil and concentration of phosphorus resulting in increased crop production.

Other uses

Fibre from the bark is used for making paper, cloth, rope, etc. The cloth is made by beating strips of bark with a wooden mallet. More fine cloth can be prepared by beating more with a wooden mallet. Leather can also be made from the bark of the plant. For the making of paper, branches are taken after the falling of leaves in the autumn season then they are steamed, and fibres are taken from them. Oil of seeds is used for making soap and lacquer. Powder of leaf has pesticide action against cotton bollworm. The xylem of plants has certain antifungal activities against *Fusarium* species. Furniture is also made from the plant. It is also used for animal feed, fodder, forage, shade, shelter, fuelwood, and ornamental. Raw fruit contains a less fleshy part which is of good flavour and is edible whereas cooked leaves are used for eating purposes.

Phytoremediation

Manganese, a trace element that is also a constituent of chloroplast facilitates photosynthesis while Mn in excess depletes the quality of soil and affects the growth and development process of plants.²⁷⁻²⁹ Mn stress affects different biological processes in plants sometimes leading to even plant death while up to some extent to humans

also as they are a part of the food chain.³⁰⁻³² Phytoremediation is one such process that helps in reducing the heavy metal ions concentration with the help of several plants by absorbing or transferring these substances.³³ Phytoremediation also enriches the quality of soil and prevents the erosion of soil.³⁴ *Broussonetia papyrifera* is one such plant species that absorbs Mn maximally in its leaves followed by roots and stem.^{35,36} The accumulated Mn causes lipid peroxidation which affects chlorophyll synthesis while in the case of *Broussonetia papyrifera* oxidative stress was alleviated by antioxidant enzymes namely SOD, POD, CAT. Therefore, this excellent ability to regulate oxidative stress mechanism to overcome Mn stress helps in the phytoremediation process.³⁷

Aeroallergen in Taiwan

Pollens are prevalently known to be a major cause of asthma, allergic rhinitis, and many other allergic disorders.^{38,39} Taiwan, a marine island with having tropical climate with rich and diverse vegetation reported about 9% of the asthma cases relating to pollen sensitization from rice. The aeroallergen monitoring data which has been reported between the period 1994 to 1996 particularly in Taiwan within 6 different cities suggests that *Broussonetia papyrifera* is a dominant species responsible for the allergic diseases in Taiwan majorly comprising about 79.39% in Taipei followed by 66.82% and 39.08% in Taichung and Tainan respectively and so on.⁴⁰ The role of pollen in asthma development has been established and routine monitoring is being conducted in different parts of the world to report, analyse, and further forecast to reduce allergic illness.⁴¹

Propagation and cultivation

The plant is pollinated by insects and wind whereas self-grown by seeds, stem cutting, and root suckers. It is a fast-growing species in a tropical region at an elevation of 1600 m which is also found in temperate regions. It grows well in an area where the temperature lies between 15 to 28° C.⁴² It propounds, a mean annual rainfall of 800 to 2500 mm and a pH in the range of 5 to 7.5 but can also tolerate 4.5 to 8. The plant grows well in any soil having sufficient nutritional values. The species is lenient to sulphur dioxide, nitrogen, and moisture-containing winds. Plants are coppiced regularly for young and long shoots with a rotation of 10 years yielding 8 to 12 tonnes per hectare in fewer rainfall regions and 21 to 30 tonnes per hectare in heavy rainfall areas.

Invasive nature

Paper mulberry is highly invasive because birds spread seeds from the fruit of female plants. Department of Agriculture, Fisheries and Forestry located in Australia marked this species a severe problem in subtropical coastal and subcostal areas and proposed the removal of trees. In the US plant was first grown as a shade tree. It was found in south Florida and near Texas. Due to its highly invasive nature, officials in Florida proposed not to plant further trees in Florida and existing plants to be eliminated



physically or chemically.⁴³ The plant is considered invasive in most countries such as Pakistan, Argentina, and Uganda.⁴⁴ West Africa noted paper mulberry second most invasive species found in the Ghana region in 1960 since then ECHO seed bank of Florida stopped offering seeds of this species.⁴⁵ But opposite to this, the plant was not found to be invasive on Pacific islands because all trees are male and are mostly propagated vegetatively with cuttings.⁴⁶

CONCLUSION

The extensive study of literature proves its biological importance due to having a wide range of phytochemicals in every part of the plant which is of great pharmacological importance. Various in-vitro studies prove its medicinal uses in humans like antimicrobial, antifungal, anti-inflammatory, antioxidant, and antinociceptive activity. The plant is pollinated by insects and winds and can be propagated vegetatively by stem cutting and root suckers. The species was found to be highly invasive so has been removed and restricted in some places. A thorough pharmacological study and clinical trial for various medicinal uses are still required including the toxicity studies and adverse effects in detail. Its role in phytoremediation is proven to be very essential but a major concern has been raised after the finding reported in Taiwan about aeroallergens more data collection is still going on for better results and control.

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