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Review

Phytochemical and therapeutic potentials of *Morinda tinctoria* Roxb. (Indian mulberry)

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SUMMARY

Morinda tinctoria Roxb. (Family: Rubiaceae) is commonly known as Indian mulberry or Aal in India. This plant is very well known for its therapeutic benefit in Indian systems of medicine including Ayurveda and Siddha and in other forms of traditional Medicine worldwide for the treatment of several ailments. Almost all parts of this plant have been explored for its medicinal uses. Several reports on the phytochemical and therapeutic benefits of this plant have been reported. In this article an attempt has been made to review the traditional uses, phytochemical profiles and therapeutic potentials of Indian mulberry.

Key words: *Morinda tinctoria*; Therapeutic potential; Phytoconstituents; Ayurveda; Siddha; Indian mulberry

INTRODUCTION

Botanical drugs and dietary supplements may be derived from a broader variety of plants that are normally present in the human diet. Botanicals or phytopharmaceuticals are a perfect fit for prophylactic use in order to prevent diseases and also for our normal wellbeing. The screening and evaluation of medicinal plants mostly depends on proper cultivation and collection of the plant materials followed by their extraction and deriving the phytochemical entities to access the optimized bioactive compound production and use in therapy. This is very much required for multi-component drugs and their standardized extracts for assuring the quality and batch to batch consistency (Mukherjee, 2002). The Indian subcontinent, with the history of one of the oldest civilization, harbours many traditional health care systems. Their development was supported by the diverse biodiversity in flora and fauna due to variations in geographical landscaping (Mukherjee and Wahile, 2006). Therefore the potential plants need to be explored for new drug development. Reviews of several medicinal plants including oriental medicine *Mangifera indica* (Rai *et al.*, 2007), therapeutic potentials and untoward effects of *Piper betle* (Rai *et al.*, 2005) has been reported from our laboratory. Beside this

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we have reported reviews on several therapeutic categories of medicinal plants with different aspect on the leads from Indian medicinal plants with hypoglycemic potentials (Mukherjee *et al.,* 2006), acetyl cholinesterase inhibitors from medicinal plants (Mukherjee *et al.,* 2007) and others. This review aims at reviewing the traditional uses, phytochemical profiles and therapeutic potential of various parts of *M. tinctoria,* which has been used in traditional practice for many years.

There are different *Morinda* species found worldwide as *Morinda citrifolia* Linn., *Morinda elliptica* Ridley., *Morinda trimera* Hillebr. and *Morinda tinctoria* Roxb.; of which, *M. umbellate* L. *M. citrifolia* L. and *M. tinctoria* Roxb. are best known and most widely cultivated in South India and are medicinally used in India and China (Kritikar and Basu, 1935). *Morinda tinctoria* is an evergreen shrub native to southern Asia, upper and lower Burma, Bengal, Bihar, central provinces and in the Deccan westwards to the eastern slopes of the ghats in India. The genus *Morinda* grows wild and is widely distributed in southern India. Many species of *Morinda* are available in India of which *Morinda tinctoria* predominantly grows as a weed in vacant agricultural land (Narayanasamy *et al*., 2006). *Morinda tinctoria* Roxb. commonly known as Aal or Indian mulberry belongs to the family Rubiaceae. Its synonymns are *Morinda tomentosa* Heyne, *Morinda pubescens* JE Smith and have several vernacular names in India like : Bengal-Ach, Auch, Darnaharidra; Hindi-Al, Ach; Marathi-Aseli, Nagkura; Tamil-Manjanatti, Manjanuna; Telugu-Bandamaddi, Maddi, Mogali, Arabic-Bakam, Assam-Asukhat, Larnong, Canarese-Maldi, Molagu, Mulgal, Gujarati-Al, English-Indian mulberry. *M. tinctoria* is an evergreen shrub or small tree growing to 5 - 10 m tall. The different parts of *M. tinctoria* have been used traditionally for various purposes.

South Indian ancestors realized the therapeutic value of *M. tinctoria* and used it in traditional medicinal systems, lack of proper documentation resulted in loss of that knowledge (Narayanasamy *et al*., 2006). Indian mulberry is reportedly used by the African aborigines medicinally. Fruits, flowers, leaves and heartwood of *M. tinctoria* have been used in treating several diseases, in Ayurveda (Kritikar and Basu, 1935). So an attempt has been made to review various aspects of its traditional uses, phytoconstituents and therapeutic potential of various parts of this plant.

MATERIALS AND METHODS

Leaves of *M. tinctoria*

The leaves are 15 - 25 cm long, oblong to lanceolate; blade 4 - 8, narrowed into petiole 1.3 - 2.5 cm long. Peduncles solitary auxiliary or leaf opposed, frequently in short trichotomous panicles at the ends of the branchlets (Kritikar and Basu, 1935). The leaves yielded ursolic acid (1) (Rao and Rao, 1983), polyphenolic compounds such as quercetin (2), kaempferol-3-O-rutinoside (3), acacetine-7-*O*-β-Dglucopyranoside (4) and apigenin 5,7-dimethylether 4′-galactoside have been reported to be isolated from the leaves and flowers of *M. tinctoria* Roxb. (Subramanian and Nair, 1971). The Larvicidal activity has been studied by Bagavan et al (2008). Crude protein and crude fibre content of the leaves ranged from 5.07 to 23.93% and from 6.37 to 30.24%, respectively. Leaves are generally rich in Ca, respective ranges for Fe, Cu, Mn, and Zn contents were 20.20 - 79.28%, 2.67 - 12.67, 0.15 - 7.20 and 6.0 - 45.0 ppm (Desai *et al*., 1980).

Traditionally the leaf juice is given orally to children before food for easy digestion (Muthu *et al.,* 2006). The charred leaves made into a decoction with mustard are a favourite domestic remedy for infantile diarrhoea. The expressed juice of leaves is externally applied to gout to relieve pain. The leaves are administered internally as a tonic and febrifuge (Kritikar and Basu, 1935). The n-Hexane, dichloromethane and methanol extracts of the leaves were shown to possess antibacterial and antifungal activities (Jayasinghe *et al.,* 2002). The petroleum ether extract showed anticonvulsant

activity against seizures induced by maximal electroshock and Pentylenetetrazol (Kumaresan and Saravanan 2009).

Bark and heartwood of *M. tinctoria*

M. tinctoria is a small or medium sized tree, usually pubescent or tomentose bark, spongy, deeply cracked greyish yellow in colour (Kritikar and Basu, 1935). Stem bark has been found to contain alizarin-1-Methyl ether, rubiadin (5), and D-mannitol (6). Anthragallol-2, 3-di- methyl ether, soranjidiol, and ibericin was obtained from the root bark besides the 6-primeveroside of morindone (Rao and Rao, 1983). The glycoside of morindone isolated from the ethanol extract of the root bark has been proven through the chemical and spectral evidence to be the 6-primeveroside of morindone (Rao and Reddy, 1977). Morindone is used for dyeing of cotton, silk and wool in shades of red, chocolate or purple. The colouring matter is found principally in the root bark and is collected when the plants reach three to four years of age. The active substance is extracted as the glucoside known as morindin that upon hydrolysis produces the dye. Morindone (7) is a mordant dye giving a yellowish-red colour with an aluminium mordant, chocolate with a chromium mordant, and dull purple to black with an iron mordant. A diglucoside of morindone was isolated from the root bark of *M. tinctoria* and was named morindonin (Balakrishna *et al.,* 1960, Mell, 1928).

The heartwood yields tinctomorone (8) an anthraquinone ester, morindone, damnacanthal (9), and nordamnacanthal (1, 3-dihydroxy-2-formylanthraquinone) (Murti *et al.,* 1959; Eswaran *et al.,* 1979). The n-Hexane, dichloromethane and methanol extracts of the stem and bark have been reported to possess antibacterial and antifungal activities (Jayasinghe *et al.,* 2002). *M. tinctoria* was found to possess excellent fuel wood characteristic (Jain and Singh, 1998).

Flowers and fruits of *M. tinctoria*

Flowers are scented 5-merous, corolla usually tomentose outside, tube 1.3 – 2 cm long, anthers exseited or included. The fruit is a green syncarp, 2 - 2.5 cm diameter. Amino acids and sugars from floral nectars were detected by paper chromatography. Glutamic acid and fructose were found more commonly among amino acids and sugars (Dhore *et al.,* 2001).

A study investigated the wound healing properties of the chloroform extract of *M. tinctoria* fruit in rats. Topical application of *M. tinctoria* fruit extract at 20 mg/ml and 10 mg/ml concentrations appreciably accelerated wound healing in rats compared with controls (Mathivanan *et al.,* 2006). *M. tinctoria* used internally as astringent, externally for gout and rheumatism. It relieves diarrhoea and cholera. Fruits are mashed and applied to boils (Pal and Jain 1998).

Chemical analyses have revealed that most of the essential elements are present in higher amount in the fruits of *M. citrifolia* compared *M. tinctoria*. But manganese was present in high quantity in *M. tinctoria*, whereas calcium, potassium, phosphorus and magnesium were found to be on par in both the fruits. The reducing sugars and lipids were present in high levels in the fruits of *M. citrifolia* whereas, the total soluble sugars, starch and crude fibers were high in *M. tinctoria*. The natural antioxidant content was found to be high in the fruit extracts of *M. tinctoria* compared to *M. citrifolia* (Mathivanan and Surendiran 2006).

The fruit extracts of *M. citrifolia* and *M. tinctoria* have also shown effective antidiabetic activity in alloxan induced experimental rats. This activity was more pronounced with *M. tinctoria* than *M. citrifolia* (Mathivanan and Surendiran 2006). The fruit extract of both the plant sowed good plant growth promoting activity in rice and green gram. However, this activity was more pronounced with *M. citrifolia* than *M. tinctoria* (Mathivanan and Surendiran 2006).

Root of *M. tinctoria*

Petroleum ether extract of the root of *M. tinctoria* yielded morindone, damnacanthal, nordamnacanthal,

Table 1. Major Phytoconstituents present in different parts of *M. tinctoria*

Sl No.	Phytoconstituents	Present in	Reference
1.	Ursolic acid	Leaves	Rao and Rao, 1983
2.	Quercetin	Leaves and Flowers	Subramanian and Nair, 1971
3.	Kaempferol-3-rutinoside	Leaves and Flowers	Subramanian and Nair, 1971
4.	Acacetine-7-glucopyranoside	Leaves and Flowers	Subramanian and Nair, 1971
5.	Apigenin 5,7-dimethylether4'-galactoside	Leaves and Flowers	Subramanian and Nair, 1971
6.	Alizarin-1-Me ether	Stem bark	Rao and Rao, 1983
7.	Rubiadin	Stem bark	Rao and Rao, 1983
8.	D-mannitol	Stem bark	Rao and Rao, 1983
9.	Anthragallol-2, 3-di-Me ether	Root bark	Rao and Rao, 1983
10.	Soranjidiol	Root bark	Rao and Rao, 1983
11.	Ibericin	Root bark	Rao and Rao, 1983
12.	6-primeveroside of morindone	Root bark	Rao and Rao, 1983
13.	Morindonin	Root bark	Balakrishna *et al.*, 1960
14.	damnacanthal	Heartwood	Eswaran *et al.*, 1979; Murti *et al.*, 1959
15.	nordamnacanthal (1,3-dihydroxy-2-formylanthraquinone)	Heartwood	Eswaran *et al.*, 1979; Murti *et al.*, 1959

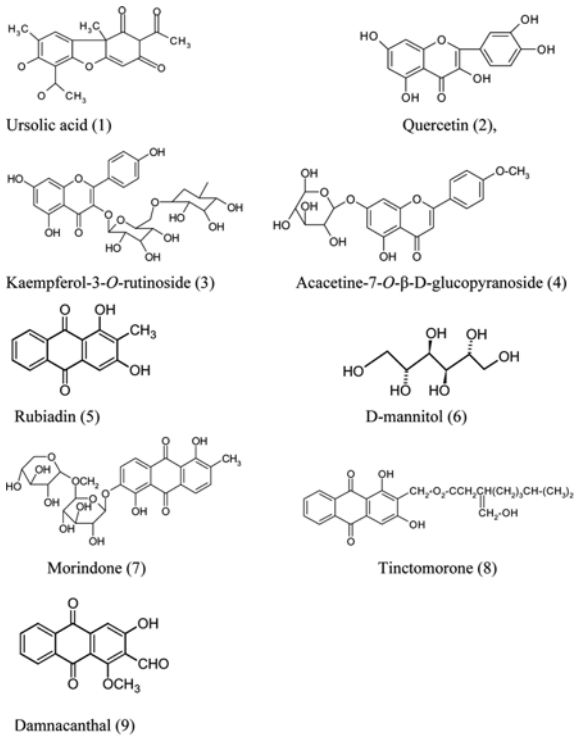

Fig. 1. Phytoconstituents of *M. tinctoria.*

β-sitosterol, and 2-nonidentified colouring substances (Mishra and Gupta, 1982). Beside these several constituents have been isolated from the root bark viz., 6-primeveroside of morindone, anthragallol-2, 3-di-Me ether, soranjidiol, and ibericin (Rao and Reddy, 1977; Rao and Rao, 1983). The root is styptic, astringent to the bowels and dries boils; the infusion is tonic and is used as bath (Kritikar and Basu, 1935). Major Phytoconstituents present in different parts of this plant has been described in Table 1 and their structural features have been discussed in Fig. 1.

CONCLUSION

The medicinal history and accumulated scientific studies, to date, have revealed and confirmed the Polynesian's claim of the health benefits of *M. tinctoria*. This article highlights some of the nutritive values of this plant based on its scientific reports and use in medicinal claims in traditional therapy. Further the claim on individual parts of the plant has been confirmed through this study with the phytoconstituents present therein.

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