CHAPTER 6

Phytochemistry and Medicinal Applications of *Ichnocarpus frutescens* (L.) W.T.Aiton

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ABSTRACT

Ichnocarpus frutescens (L.) W.T.Aiton, is a woody climber belonging to the family Apocynaceae. It is widely distributed across India and other tropical Asian countries. Traditionally, this plant has been used in various indigenous systems of medicine for treating ailments such as diabetes, fever, wounds, rheumatism, and jaundice. Phytochemical investigations reveal the presence of diverse bioactive constituents including alkaloids, flavonoids, tannins, saponins, triterpenoids, and steroids, which contribute to its wide spectrum of pharmacological activities such as antidiabetic, anti-inflammatory, antioxidant, hepatoprotective, and antimicrobial effects. This chapter highlights the botanical description, ethnomedicinal uses, phytochemistry, and pharmacological potential of *Ichnocarpus frutescens*.

Keywords: Apocynaceae, medicinal climber, ethnomedicine, phytochemistry

INTRODUCTION

Ichnocarpus frutescens (L.) W.T.Aiton, is an evergreen and climbing shrub with slender branches, laticiferous, woody creeper with rusty red appearance found almost throughout India. Worldwide, it is distributed in Malaysia, Australia, China, and Thailand in the plains and lower hills up to 4000 m

(Kumarappan et al. 2015; Meher et al. 2018). This plant is also known as Dudhi 'Shyamalata' in Odia and Bengali, 'Black creeper' in English and 'Ananta', 'Sariva' in Sanskrit (Angle and Sardessai 2017). The root of the plant is used in medicine as a substitute for Anantamula (*Hemidesmus indicus*). It is widely used in indigenous medicine for the treatment of rheumatism, asthma, cholera, fever, tumors, etc. Roots are mainly used as a demulcent, alterative, tonic, diuretic, and diaphoretic (Sini and Malathy 2006; Meher et al. 2013). Various parts of this plant are used as a cure for fever, dyspepsia, skin troubles, and headache. it can also improve glucose tolerance in diabetes, lower fasting glucose (Sini and Malathy 2006).

TAXONOMY (Saxena and Bramham 1995; Kumar et al. 2022; Nayak and Kumar 2023; Plate 1)

Leaves: Evergreen, simple, arranged oppositely or alternately. Lamina elliptic-oblong to broadly lanceolate with an entire margin. Apex acute or acuminate; base usually rounded or attenuate. Pinnately veined with 4–7 pairs of lateral nerves. Upper surface glabrous, lower surface pubescent, particularly in young leaves. When injured, fresh leaves exude a creamy white latex.

Stem: Woody, cylindrical, herbaceous, branched, and climbing. Surface rough and hairy. Like the leaves, the stem exudes creamy white latex when incised.

Root: Taproot system, long and cylindrical (1–5 cm in diameter), often irregularly bent. Externally dark or dusty brown with fine longitudinal wrinkles and faint transverse cracks, especially at bends. Fresh roots are turgid and release an abundance of creamy white latex when injured.

Inflorescence: Cymose, pedunculate.

Flowers: Small, white or greenish-white, fragrant, bracteate, bracteolate, and pedicellate. Flowers are complete, bisexual, actinomorphic, hypogynous, and pentamerous.

Calyx: Composed of 5 sepals, united (gamosepalous), with ovate and acute lobes. Surface covered in fulvous (tawny) hairs; inner glands absent.

Corolla: Consists of 5 petals, gamopetalous, sometimes united only at the base to form a tubular or funnel-shaped structure. Aestivation twisted; the corolla tube is often internally appendaged or bearded.

Androecium: Five stamens, free and epipetalous. Filaments are short; anthers are bilobed.

Gynoecium: Bicarpellary with a superior ovary, unilocular, bearing numerous ovules with parietal placentation. Style is long with a capitate stigma.

Fruit: A pair of slightly curved, cylindrical follicles.

Seeds: Black, long, and linear.

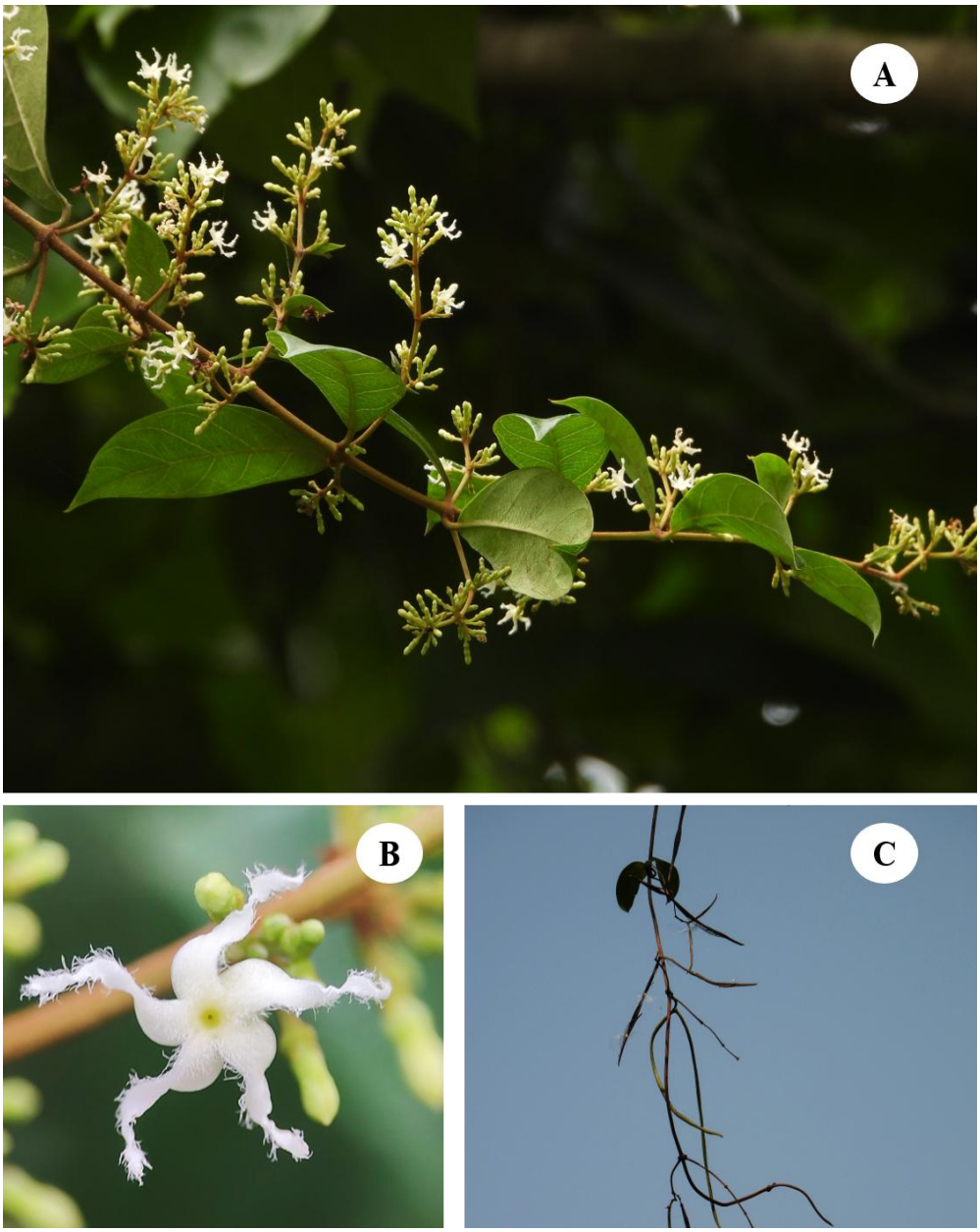


Plate 1: Vegetative parts of I. *frutescens* A) Whole plant, B) Flower, C) Fruits

TRADITIONAL USES

Leaves

The leaves of *I. frutescens* are widely used in traditional medicine across India and neighbouring regions. Boiled in oil, the leaves are applied externally to relieve headaches, fevers, and wounds, particularly those between the fingers. Decoctions made from the leaves are commonly used to treat fever and skin eruptions (Rajith and Ramachandran 2010; Meher et al. 2018). In Southern Rajasthan, tribal communities apply warmed leaves on swellings to cure guinea worm infections. In Tamil Nadu and Bangladesh, decoctions of dried or fresh leaves are used to manage fever and diabetes, respectively (Naidu et al. 2013). Additionally, the people of Karnataka and Madhya Pradesh apply leaf extracts for ailments like tongue ulcers, stomach pain, cramps, night blindness, and bleeding from cuts (Rajith and Ramachandran 2010).

Stem

The stem of *I. frutescens* also holds medicinal value. It is frequently used in decoction form to treat fever and skin eruptions. In some regions, such as the Southern districts of India, a decoction of the stem is also applied to relieve redness and irritation in the eyes. The combination of stem and leaf decoctions is a common remedy among tribal groups for treating skin conditions and febrile illnesses (Naidu et al. 2013).

Roots

Among all parts of the plant, the root of *I. frutescens* is considered the most therapeutically significant. It is traditionally regarded as sweet, refrigerant, febrifuge, aphrodisiac, diaphoretic, diuretic, depurative, demulcent, and tonic (Kumarappan et al. 2015). The roots are used to manage a broad range of ailments such as anorexia, leucorrhoea, syphilis, fever, seminal weakness, nephrolithiasis, skin diseases, leprosy, pruritus, vomiting, diabetes, cephalalgia, and general debility (Sini and Malathy 2006; Kumarappan et al. 2015). In addition, the roots are commonly employed to purify the blood, act as an antidiabetic agent, and dissolve urinary stones. In many tribal communities, roots are administered as a substitute for Indian sarsaparilla (*Hemidesmus indicus*), and used as an antidote for snakebite, rheumatic pain, jaundice, and even stomach cancer (in combination with other herbal roots). The root paste is applied to rat bites and skin infections, and in some traditions, tying the root around the neck is believed to induce sound sleep (Sini and

Malathy 2006). The widespread use of roots in both internal and external treatments illustrates their integral role in indigenous healthcare systems.

Flowers

The flowers of *I. frutescens* are primarily used in the management of diabetes. Traditional healers recommend chewing about ten fresh flowers every morning or swallowing their juice as part of a routine treatment to regulate blood sugar levels. This practice has been noted particularly in communities where diabetes prevalence is addressed through herbal remedies (Yousuf et al. 2004; Meher et al. 2018).

Latex

The latex extracted from the leaves of *I. frutescens* is applied topically for treating skin infections. Among the Siddis of Uttara Kannada district in Karnataka, the leaf latex is a common remedy for dermal problems. Additionally, the latex is applied on painful tumors to reduce pain and retard the progression of tumor growth, indicating its potential in palliative care in folk medicine (Munisamy et al. 2011; Meher et al. 2018).

Whole Plant

The whole plant is extensively used in traditional systems of medicine for a variety of conditions. It is employed in the treatment of bleeding gums, convulsions, cough, delirium, dysentery, glossitis, haematuria, measles, night blindness, and more. Tribal communities, including the Santals, use the plant to manage sores, ulcerated tongue, spleen enlargement, atrophy, cachexia, and various infections such as smallpox and tuberculosis (Meher et al. 2018). It is also considered useful for insect bites and abdominal or glandular tumors. Moreover, *Ichnocarpus frutescens* is used as a febrifuge, blood purifier, hypoglycemic agent, and tonic. In some practices, the root powder is taken with honey for several months to reduce excess body heat. The rural population in parts of Karnataka even uses the plant to relieve general bodyache. The versatility of the plant, used both individually and in polyherbal formulations, underscores its cultural and therapeutic significance in traditional medicine (Prathib et al. 2017).

BIOACTIVE COMPOUNDS

The active constituents of *I. frutescens* include flavonoids, simple phenolic acids, coumarins, and pentacyclic triterpenoids. Phytochemical investigations of the whole plant and its various parts have identified 12 pentacyclic

triterpenoids, 4 steroids, 7 flavonoids, 3 aliphatic compounds, 4 phenolic acids, and 2 carbohydrates (Table 1). Extensive phytochemical investigations on *I. frutescens* have revealed a wide array of bioactive constituents across different plant parts. The stem has yielded several triterpenoids, sterols, aliphatic compounds, and fatty acid derivatives (Singh and Singh 2012; Kumarappan et al. 2012). Isolated compounds include α-L-rhamnopyranosyl-(1→4)-β-D-glucopyranosyl-(1→3)-α-amyrin, α-amyrin and its acetates, lupeol and lupeol acetate, friedelin, epi-friedelinol, and β-sitosterol, as well as n-butyl oleate, n-octyl tetracontane, tetratriacontadiene, n-nonadecanyl benzoate, and benzocosanyl arachidate (Prathib et al. 2017; Yogeshwari and Kumudha 2018). The leaves are particularly rich in flavonoids, glycosides, and phenolic acids (Meher et al. 2018). Compounds such as apigenin, luteolin, vitexin, isovitexin, and proanthocyanidins have been identified, alongside phenolic acids like sinapic, vanillic, syringic, and protocatechuic acid. Kaempferol, kaempferol-3-galactoside (trifolin), ursolic acid acetate, and mannitol were also reported (Joshi et al. 2011; Das et al. 2018). The roots have shown the presence of ursolic acid and β-sitosterol, along with phenolic aldehydes such as 2-hydroxy-4-methoxybenzaldehyde. Systematic fractionation of root extracts has led to the isolation of triterpene acids, primarily ursolic acid. The flowers are known to contain flavonols, notably quercetin and quercetin-3-O-β-D-glucopyranoside (Prathib et al. 2017; Das et al. 2018). Preliminary phytochemical screening confirmed the presence of polyphenols, flavonoids, alkaloids, terpenoids, glycosides, phytosterols, carbohydrates, and coumarins. However, saponins, anthraquinones, and steroids were found to be absent. In addition, compounds such as 12-dehydrolupanyl-3β-palmitate, oleanolic acid, sitosterol-palmitate, 5-hydroxyoctacosan-25-one, and dotriacontanoic acid have also been reported (Patwekar et al. 2010).

Table 1: Bioactive Compounds in plant parts of *I. frutescens*

Plant Part	**Compounds Identified**
Stem	α-L-rhamnopyranosyl-(1→4)-β-D-glucopyranosyl-(1→3)-α-amyrin, 6,8,8-trimethylpentacosan-7-one, α-amyrin & acetates, lupeol & acetates, friedelin, epi-friedelinol, β-sitosterol, n-butyl oleate, n-octyl tetracontane, tetratriacontadiene, n-nonadecanyl benzoate, benzocosanyl arachidate

Leaves	Apigenin, luteolin, vitexin, isovitexin, proanthocyanidin, sinapic acid, vanillic acid, syringic acid, protocatechuic acid, ursolic acid acetate, kaempferol, kaempferol-3-galactoside (trifolin), mannitol
Roots	Ursolic acid, β-sitosterol, 2-hydroxy-4-methoxybenzaldehyde, 12-dehydrolupeol, oleanolic acid, sitosterol-palmitate, dotriacontanoic acid
Flowers	Quercetin, quercetin-3-O-β-D-glucopyranoside

PHARMACOLOGICAL IMPORTANCE

Several studies explored the pharmacological activities of *I. frutescens*, revealing a range of therapeutic potentials.

Anti-Inflammatory and Analgesic Effects

Root-derived phytosterols, like β-sitosterol glucoside, demonstrated significant anti-inflammatory and analgesic properties. These compounds inhibited pro-inflammatory mediators. Studies supported their potential as anti-inflammatory agents, with notable COX-2 inhibition and anti-denaturation activities (Prathib et al. 2017; Mohsina et al. 2022).

Antidiabetic Activity

Methanolic extracts of the plant exhibited significant antihyperglycemic effects, reducing blood glucose levels in diabetic rats. These extracts also improved lipid profiles and promoted the regeneration of pancreatic β-cells. Polyphenol-enriched leaf extracts enhanced glycolytic enzyme activity and reduced gluconeogenic enzymes, contributing to better glucose metabolism (Mohsina et al. 2022).

Antioxidant Properties

Polyphenolic extracts from the plant showed strong antioxidant activities by reducing lipid peroxidation and enhancing antioxidant enzymes like superoxide dismutase and catalase. These effects contributed to the protection of pancreatic tissues in diabetic models (Naidu et al. 2013; Prathib et al. 2017).

Hepatoprotective Effects

Polyphenolic extracts from the leaves provided protective and curative effects against liver damage induced by carbon tetrachloride and tamoxifen in

experimental models. These extracts helped in restoring liver function (Naidu et al. 2013; Mohsina et al. 2022).

CONCLUSION

I. frutescens holds significant ethnomedicinal and pharmacological importance, with traditional usage, with modern phytochemical and pharmacological studies. Its therapeutic potential, particularly in the treatment of diabetes, inflammation, and liver disorders, makes it a valuable plant for further research and drug development. Despite its traditional relevance, comprehensive clinical trials and toxicological assessments are still lacking. Future studies focusing on isolation of active compounds, mechanism of action, and standardization of extracts will help unlock the full potential of this versatile medicinal climber. Promoting its cultivation and conservation is also essential to ensure sustainable use and biodiversity preservation.

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