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A COMPREHENSIVE REVIEW ON *INDIGOFERA TINCTORIA* LINN

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ABSTRACT

A large portion of the world's population, especially in developing countries, depends on traditional medicine. Due to its natural origin and minimal side effects, herbs are getting more popular in medicine. A branching shrub, *Indigofera tinctoria* is used in traditional medicines such as Ayurveda, Siddha, and Unani. The main phytochemical constituents of *Indigofera tinctoria* are a galactomannan, consisting of galactose and mannose in molar ratios of 1:1.52, Glycosides (Indican), Flavonoids, Terpenoids, Alkaloids and Glycosides, Indigotone, Indirubin, and Rotenoids which are contributes for its wide therapeutic actions. *Indigofera tinctoria* has been shown to possess a variety of properties, such as anthelmintic, anti-inflammatory, antibacterial, anti-ulcer, anti-HIV, antiurolithiatic and hypolipidemic activities. This review aims to provide a complete summary of Phytopharmacological properties of *Indigofera tinctoria* Linn for further research.

Keywords: *Indigofera tinctoria*, Indican, Ayurveda, Phytochemical constituents, Research.

INTRODUCTION

India is a vast country with rich natural resources with variety of medicinal plants. In contrast to synthetic drugs, herbal drugs enjoy the advantages of comparatively less toxic than synthetic drugs, more harmony with the biological system and affordable to all classes of people. The plant *Indigofera tinctoria* belongs to the family Fabaceae which is popularly known as Neeli in Tamil and found throughout India. ^[1] It is a shrubby perennial legume valued for its indigo dye and medicinal properties. Indigo dye is a popular entity of international commerce. ^[2] In Ayurvedic practice, nili is considered as a reputed drug for the promotion of hair growth and forms a major ingredient of preparations like nilibhringadi oil. Due to antitoxic property, it is also good remedy against all poisonous affections. According to bhavaprakash, Nili is purgative in action, bitter, hot, cures meha (urinary diseases with excessive urine), giddiness, abdominal enlargement (ascites), enlargement of spleen, gout and intestinal obstruction (udavarta). ^[3]

History of the plant

For centuries, *Indigofera tinctoria* has been used as a textile dye and as a medicine in Southeast Asia and India but its origin remains obscure. An Egyptian mummy, dated at 2300BC, was discovered to have dye made from several indigofera species, mostly *Indigofera tinctoria*, which has also been found in Inca tombs. ^[4,5]

In the late 1700s, *I. tinctoria* was reported (as synonym *I. sumatrana*) to have been introduced to Bengal,

India for dye production, somewhere between Malabar and Malaya, and proving to be more satisfactory than the Egyptian or the Indian varieties, has spread westward through upper India as far as the Punjab and more recently Southward to Madras. ^[6]

Plant profile

Biological source

Nili (leaf) consists of dried leaf of *Indigofera tinctoria* Linn., belongs to the family Fabaceae. *Indigofera tinctoria* is a shrub, growing 1.2-1.8 meters high, that is widely cultivated across the country. ^[7]

- Vernacular names8
- Sanskrit: Nilika, Nilini, Rangapatri
- Assam: Nilbam
- Bengali: Nil
- English: Indigo
- Gujarat: Gali
- Hindi: Nili
- Kannada: Karunili
- Tamil: Avuri
- Malayalam: Neelamar
- Marathi: neel
- Taxonomy of plant7
- Kingdom: plantae
- Division: Magnoliophyta

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- Class: Magnoliopsida
- Order: Fabales
- Family: Fabaceae
- Subfamily: Faboideae
- Tribe: Indofereae
- Genus: Indigofera
- Species: *L. tinctoria*
- Binomial name: *Indigofera tinctoria*

Habitat

Indigofera tinctoria has been widely cultivated in tropical regions, usually between 0 and 300 m altitude, and grows well in brushwood, bush margins, grassy fields, and secondary forest, seasonally flooded grassy fields, and sandy coasts and along roadside and riverbanks, although the species cannot tolerate excessive water or heat. Aside from cultivated areas, the species was also common in thickets and roadsides in Puerto Rico and the Virgin Islands. In Madagascar, *Indigofera tinctoria* is widely naturalized around villages, roadsides, disturbed areas, and grassland, at altitudes up to 800m.^[9]

Description of plant

Branched shrub reaching a height of 2m with 7-13 leaflets. The leaves are green when fresh and turn black upon drying, tender branches are bluish red in color with many flowers in sessile lax spicate axils which are much shorter than the leaves and have a reddish or pinkish color; fruits are cylindrical pods with 10-12 seeds that are greenish gray when young and turn dark brown upon ripening.^[10]

Macroscopic characters

Leaves: Macroscopically the leaves are opposite, oblanceolate with short mucronate tips, pale greenish black in color, mucronate apex, cuneate base, smooth texture, characteristics odor and taste. Leaflets measure 1 to 2.5cm in length and 0.3 to 1.2 cm in width.^[11]

Roots: Mostly cylindrical in shape, woody, hard, and yellowish brown in color. The root odor is not distinct and tastes mildly bitter. The root is 0.1 cm to 2cm thick and has a smooth surface except for a few scattered lenticles.^[7]

Microscopy

Leaves

Petiole: The petiole is nearly circular, with two lateral wings; the epidermis is single layered, covered externally with a thin cuticle and followed internally by single layered cells; the pericycle is continuous or discontinuous in appearance. Three vascular bundles are present, one large in the center and two smaller in the lateral wings; the pith is formed by round to oval, thin-walled cells, a few prismatic calcium oxalate crystals in the phloem and pith regions.

Midrib: A midrib is characterized by epidermis, cuticle, and hair similar to that found in a petiole; beneath epidermis on the lower side, there is a single or several layers of collenchyma followed by two to three layers of thin walled parenchyma; vascular bundles are single, collateral, and crescent-shaped.

Lamina:

There is a dorsiventral layer, epidermis, cuticle, and hair, similar to petiole and midrib. There are 2-3 layers of palisade, 2-4 of spongy parenchyma, and there are a few patches of veins scattered between palisade and spongy parenchyma. There are rare prismatic crystals of calcium oxalate rarely present in mesophyll cells, paracytic stomata and hair present on both surfaces but abundant in lower surface.^[12]

Root:

On root transfer section, there is a narrow zone of cork consisting of 3-8 layers of tangentially elongated, rectangular, thin walled cells with lenticles. A narrow zone of secondary cortex consists of polygonal to rectangular thin walled cells, thick walled, and lignified, with wide lumens group of fibres. Secondary phloem consists of normal elements; vessels are solitary or groupings of two to four with simple pits; fibres alternate with bands of parenchyma; medullary rays are 1-4 cells wide; oxalate crystals of calcium are present in secondary cortex, phloem, and xylem parenchyma. There are simple starch grains in the cortex, phloem, and xylem parenchyma, as well as medullary rays. Secondary xylem is dense, very compact and contains circular thick-walled vessels (mostly arranged tightly) within conjunctive tissue.^[13]

Powder Microscopy:

Leaves

The powder is Creamish brown to yellowish; there are aseptate fibres, Pitted vessels, simple and compound starch grains, measuring 3-11mm in diameter; rare oil globules and calcium oxalate, prismatic crystals can also be found.^[12]

Root

The powder is pale yellowish brown in color with no distinct odor and a slightly bitter taste. Under the microscope, the powder was found to have prismatic crystals of calcium oxalate, cork cells sectional view and surface view and round to oval starch grains 2-10mm in diameter.¹

Phytochemistry

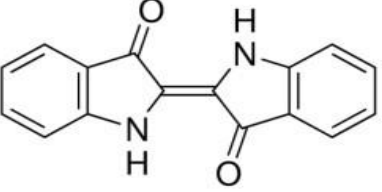
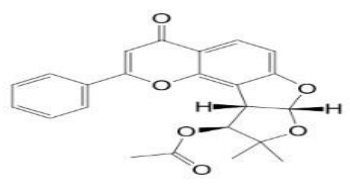
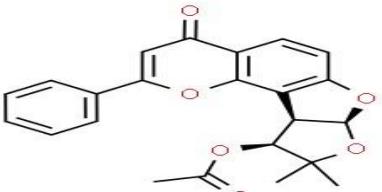
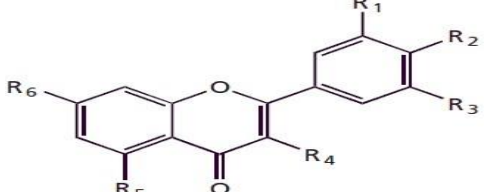
An extract of the whole plant of *Indigofera tinctoria* contained 2.5 percent alkaloids and 0.5 percent deobsurens. A galactomannan compound was isolated from the seeds that contain galactose and mannose in proportions of 1:1:52^[14].

Indicine (5-15mg/g, dry basis) and the flavonoids such as luteolin, Kaempferol, quercetin and apigenin are present in distinct plant parts, being maximal in the leaves and minimal in the roots. However, quercetin was present in minor quantities in leaves. The presence of glycosides, saponins, tannins and cardiac glycosides are also reported. The Indigo plant also contains significant amount of conjugated indoxyl (Indican) which is the putative precursor of isatin, together with rotenoids such as sumatrol, tephrosin, rotenol, deguelin, dehydrodeguelin and rotenone. The total rotenoids content was decreases

with increases in age of the plant. However, rotenoid was maximum in leaves (0.64%) and minimum in stem. ^[15]

Indigo, a 2,2'- bisindole alkaloid is a main constituent of *Indigofera tinctoria* which is used a blue dye for commercial purposes. Indirubin is a 3,2'- bisindole, a stable isomer of indigo was documented as the active ingredient of a traditional Chinese medicine (TCM) named

“Danggui Longui Wan,” which has potent activity against myelocytic leukemia. ^[16] Flavanoidal components such as Glabretaphrin, Semiglabin, Pseudoglabin, Flavonol glycoside and Amide group of components like Indigotin are also reported to be present in the plant *Indigofera tinctoria*. ^[16]

<p>Fig.1 Indigotin</p> 	<p>Fig.2 Semiglabin</p> 
<p>Fig. 3 Pseudosemiglabrin</p> 	<p>Fig. 4 Flavanol Glycoside</p> 

Pharmacological actions:

1. Anti –Urolithiatic activity

The present study aims to investigate the effects of ethanolic root extract of *Indigofera tinctoria* in ethylene glycol induced urolithiasis model. Rats weighing 150-180g of either sex were used. Ethylene glycol was administered for 15days then extract 200 and 400mg/kg were given as well as the standard drug, cystone 750mg/kg for 15days. The urine and serum were collected on the 30th day for estimation of urine and serum variables. A dose of ethanolic root extract of *Indigofera tinctoria* extract (200 and 400mg/kg.p.o) showed a significant anti-urolithiasis effect while 200mg showed no significant effect compared to ethylene glycol control. The results of the present work suggested that the *Indigofera tinctoria* root extract has a potent anti-Urolithiatic activity. ^[17]

2. Anti- HIV activity

Methanolic extract of whole parts of *Indigofera tinctoria* have been studied against replication of HIV1(III B) and HIV-2 (ROD) in MT-4 cells. The extract exhibited an average EC₅₀ (µg/ml) of 113 and 125, maximum protection of 7.5 and 9 respectively against HIV-1(III B) and HIV-2 (ROD) strain. ^[18]

3. Hypolipidemic activity.

The therapeutic potential of *Indigofera tinctoria* was evaluated by paracetamol induced fatty liver in rats. Male Albino Wistar rats were orally treated with 75, 150, and 300mg/kg body weight of *Indigofera tinctoria* or silymarin daily with the administration of paracetamol (3gm/kg body weight-p o) only one day. Rats treated with *Indigofera tinctoria* or silymarin for twenty consecutive

days had significantly lower renal lipid profiles compared with rats treated with paracetamol alone. Hence, the methanolic extract of *Indigofera tinctoria* had a potential hypolipidemic properties in rats. ^[19]

Alcoholic extract from *Indigofera tinctoria* as well as its three other components such as chloroform, butanol and aqueous fractions in dyslipidemia hamsters that were fed a high fat diet. The chloroform fraction showed a significant decrease in the plasma triglycerides (TG, 52%) (p<0.001), total cholesterol (TC, 29%) (P<0.05), glycerol (Gly, 24%) and free fatty acids (FFA,14%). A decrease in HDL was also accompanied by an increase in HDL-C/TC ratio of 52% at a dosage of 250 mg/kg of body weight. ^[20]

4 Nephroprotective activity

In this study, the Avuri kudineer (decoction of *Indigofera tinctoria*) made from indigo leaves AKL and the Avuri kudineer made from indigo roots and leaves AKRL were evaluated for their Nephroprotective effects in Cisplatin-induced liver damage in rats. As a result, the Avuri kudineer (AKRL) had greater Nephroprotective activity than the Avuri kudineer (AKL). Hence, the Avuri kudineer (decoction of *Indigofera tinctoria*) showed significant Nephroprotective activity against cisplatin. ^[21]

5. Hair growth promoting Activity

The present study examined the effects of petroleum ether and ethanol extracts of *Indigofera tinctoria* Linn. For their effect on promoting hair growth in Albino Wistar rats. Extracts were incorporated into oleaginous cream (water in oil cream base) and applied topically to shaved denuded skin of albino rats. We assessed the time (in days) required for hair growth initiation as well as completion. Hence, the result showed that treatment with 2 and 5% petroleum

ether extracts were better than the positive control minoxidil 2% treatment. ^[22]

6. Antidote

In a study, the antidote effect of boiled aqueous extract of root *Indigofera tinctoria*, also known as Avuri in Tamil, was tested against *Cleistanthus collinus* poisoning by using leaves of the plant. In histopathological studies, it shows that rats poisoned with *Cleistanthus* showed damage to the liver and kidneys, but those treated with boiled aqueous extract of *Indigofera tinctoria* roots showed no such damage. It concludes that boiled aqueous root extract of *Indigofera tinctoria* acts as an antidote to *Cleistanthus collinus* leaves poisoning. The aqueous extract at 100mg/100gm body weight showed better results than 50mg/100gm body weight. ^[23]

7. Larvicidal activity and Anti-microbial activity

This study aimed to examine the Larvicidal effects of *Indigofera tinctoria* on dengue vector (*Aedes Aegypti*) and antimicrobial effectiveness against clinical isolates. Extracts were tested at 64, 128, 256 and 512mg/ml for antimicrobial activity and at 0.1 and 5mg/L for Larvicidal activity dead larvae were counted 24 hours after exposure. Based on the results of the clinical test for Klebsiella spp-1, the lowest MIC value was 128mg/ml and the rest of the pathogens executed their MIC at 512mg/ml. According to these results, the extract exhibited Larvicidal potential against *Aegypti* along with antimicrobial activity against clinical isolates. ^[24]

Using disk diffusion method, ethanolic and aqueous pod extracts of Soxhlet from different concentrations were tested against the following pathogenic bacteria: *Escherichia coli*, *Salmonella typhi*, *Staphylococcus aureus*, and *Bacillus cereus*. As a result, this study suggests that *Indigofera tinctoria* pods can be used in ethnomedicinal as undiluted extracts and could be effective against bacteria. ^[25]

8. Anthelmintic activity.

This study aimed to evaluate the *in vitro* and *in vivo* effects of aqueous extract of *Indigofera tinctoria* as an anthelmintic against adult *Haemonchus contros* isolated from sheep. As a result, the aqueous extract of *I. tinctoria* contains tannins, saponins, flavonoids, alkaloids, and has an anthelmintic effect with decreased FEC, weight gain,

Hb, PCV and TEC, causing damage to the worms' bodies and reducing their protein profiles. ^[26]

Indigofera tinctoria linn extracts from the entire plant were examined for their anthelmintic activity against *Pheretima posthuma*. Different concentrations (20, 50,100mg/ml) of each extract were used in the assay, which included monitoring when each of the extracts caused paralysis and when it killed the parasite. As, a result methanolic extract showed maximum Anthelmintic activity comparable to that of piperazine citrate (10mg/ml). Petroleum ether and chloroform extracts showed modest activity. ^[27]

8. Anti-Ulcer

In this study, root decoction of *Indigofera tinctoria* was examined for its effectiveness in the treatment of Peptic ulcer (Gunmam). The result and findings of this study showed remarkable reduction of symptoms with highly significant improvements of key symptoms like heart burn, epigastric pain, indigestion, nausea and eructation. ^[28]

9. Anti-inflammatory activity

Oral administration of ethanolic extract of *Indigofera tinctoria* Linn. dose dependently improves the potent anti-inflammatory activity and also lowers the carrageenan induced rat paw oedema. ^[29]

Conclusion

According to the extensive survey done on the plant, there are many phytochemical compounds present in the plant including galactomannan, a compound composed of galactose and mannose in molar ratio 1:2.52, Glycoside (Indian), Coloring matter (Indigotin), Flavonoids, terpenoids, alkaloids, terpenoids, rotenoids and other compounds. Many of these compounds have been found to be responsible for several pharmacological activities like antiulcer, anti-inflammatory, anthelmintic, antimicrobial, hypolipidemic activity. Medicinal properties of plants can be used therapeutically in constipation, heart palpitation, gout, liver disease, expectorant, anthelmintic, bitter, thermogenic, laxative, tonic and diuretic and are useful for promoting growth of hair and in cardiopathy, chronic bronchitis, naturopathy, splenomegaly, echolalia, asthma, ulcers, and skin diseases. This plant therefore plays an important role in the prevention and treatment of diseases, as well as the protection of the system. The therapeutic potential of *Indigofera tinctoria* is excellent, and its versatility makes further research vital.

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