

## Ethnobotanical and pharmacological review on *Indigofera tinctoria*

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### ABSTRACT

The traditional systems of medicine have used the herbs successfully to treat many diseases. The folklore medicine also advocates the use of herbs for diseases. So having this in mind this review article focuses on collecting the documentation of all the research work that is performed on *Indigofera tinctoria* and is the segregation of the pharmacology, chemistry and traditional claims of the activities that are attributed to the plant.



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## INTRODUCTION

In the history of mankind ancient healing methods and treatment strategies were concentrated mainly on herbs. There may be a lack of scientific evidence for the herbs that treat specific diseases but there is enough medical evidence [1]. The ancient knowledge of the healing power of herbs had been poured into next generations through the literature and most of the time through folklore and ethnobotany. Currently tribes continue to use herbs as medicines even without evidence and practice but just through their ancestors. That is why there is an urgent need to establish the literature of herbs so that current researchers will be enriched with documented segregation of the activities and research work performed on any plant.

The current research focuses on establishing the documentation for all the research work performed on the plant *Indigofera tinctoria*. It is native to Asia and widely grown in India. It is used as natural dye which gives deep blue colour known as Indigo which is famous in India. So this paper is a review on all the scientific documents available on this Plant.

### Plant Review

#### Nomenclature

*Indigofera tinctoria* L.

Apart from the formal scientific name, the plant is commonly called by names internationally. They are as follows. In English it is called as Indian indigo, in Spanish it is called as Indigo, French it is called as indigotier, Chinese it is called Mulan. In Brazil as anil; in Cuba as añilcimarrón andañil de Guatemala; in Germany as Faerber- Indigostrauch; in Haiti as digodigot and Lesser Antilles: French indigo; in Myanmar as menai and menet; in Puerto Rico as añil-verdadero. Even though the plant is called with various names, it is well known as indigo all over the world.

In India it is called with various names which varies with the regions as follows

In Hindi it is called as Nili; in Telugu as Nilichettu; in Sanskrit as Nilini; in Kannada as Karunili; in Tamil as Avuri and in Malayalam as Neelamaramar.

## Taxonomy

Domain: Eukaryota

Kingdom: Plantae

Phylum: Spermatophyta

Subphylum: Angiospermae

Class: Dicotyledonae

Order: Fabales

Family: Fabaceae

Subfamily: Faboideae

Genus: Indigofera

Species: *Indigofera tinctoria*

## Habitat and Distribution

Indigo plant usually grows in tropical climate with altitude between 0-300m above sea level. It grows as bushes, grassy areas and flooded banks of the coasts and road sides. These are tolerant for minor changes in head and humidity but intolerant if the changes are excessive [2]. Apart from the cultivated regions, the plant was also known to grow thickly in grassy fields in north american islands [3]. In African countries, it is widely grown in villages, well distributed regions and grasslands Figure 3. [4].

## Morphology

The plant is an erect and straight shrub that grows upto 1.5m high well branched from the base of the plant. The leaves are imparipinnate and divides as leaflets which are opposite, oblongated, puberulent and the apex is micronuated with tapering base and has entire margins. Recemes are axillary and multiple flowered which are 5 cm in length and persistent. The calyx of the flowers is in bell shape which is 1cm in length and pubescent in nature. The corolla is pale pink tomentose and elliptical. The legumes are approximately 3 cm long which are curved at the apical region, they are cylindrical, glabrous and seeds are 2mm in length and squarer in shape. Each cylindrical pod contains about 10 seeds which are greenish grey in colour [5].

## Ethnobotanical uses

Indigofera is famous for its natural dye. Before the advent of synthetic colours and dyes, this natural dye was the choice for blue colour all around the world [2]. It is used as a cover crop of cotton and maize and also used as fodder for livestock. Sometimes it becomes poison to animals when mixed with other members of the indigofera [6]. In some countries it is used as herbal tea where in the plant leaves were beaten, crushed and extracted tea is used for drinking and were admired for its blue colour.

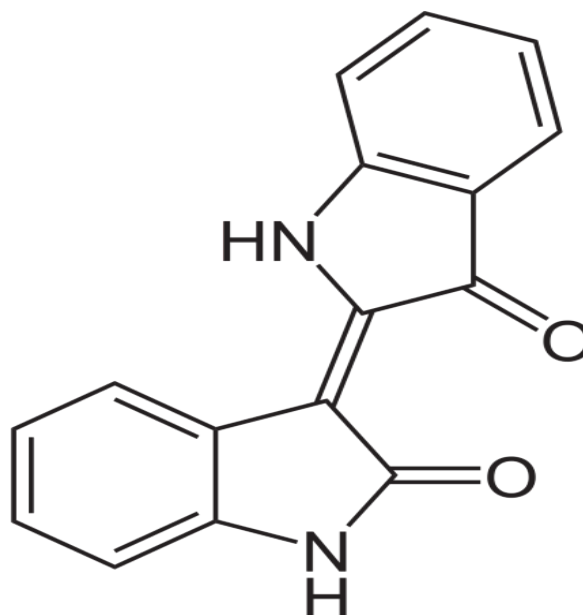


Figure 1: Indirubin

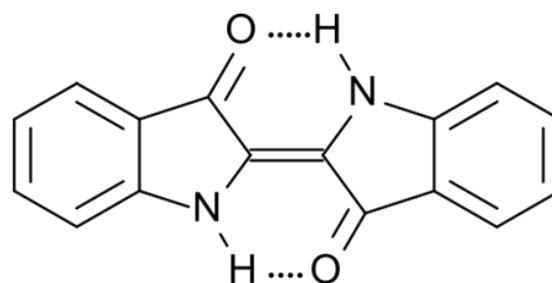


Figure 2: Indigotin

There are traditional claims that the decoction extracted from the plant had been used to treat blennorrhagia. The plant leaves are used to extract juice and is used to prevent hydrophobia. The plant extract is used to treat many disorders like epilepsy, bronchitis, and brain disorders. The ointment made from the leaves is used to cure sores and ulcers. It is also used to heal hemorrhoids. The roots of the plant are used to prevent urinary disorders and hepatitis. The juice extracted by crushing the roots is used as antidote for scorpion bites [2]. As per reports from DOMAP, directorate of Medicinal and Aromatic Plants in Rajasthan, India, the plant is used to facilitate rapid hair growth and colouring agent as hair dye. It is used in gastroparesis, asthma, and skin diseases (DOMAP). The plant is also used to treat constipation, gout, heart disorders like palpitations and heart wall diseases and even liver disorders like hepatomegaly [7].

The leaf juice is mixed with honey and consumed orally to treat splenomegaly and other infections.



**A**



**B**

**Figure 3: (A) Indigoferatinctoria (B) Calyx flower**

The fresh juice from the leaves is mixed with equal quantity of milk and given thrice in the mornings to prevent dropsy. The decoction of root is given to treat calculus. The decoction is used as antidote for arsenic poisoning. The leaves are powdered and mixed with castor oil and applied on the navel region of children which promotes bowel actions and warm water is added and rubbed to the pubic region to stimulate bladder contractions and prevent urinary retention [8].

Indigo plant has an ocular irritant property and so there is caution advised always when using the plant. On this basis it is also hypothesized that it causes dermatitis in people using indigo as a dye in the clothing industry [2]. Adverse drug reactions like colitis induced by phlebitis and PAH (Pulmonary Artery Htn) were also asserted with the use of the plant. Liver dysfunction was also attributed to Indigo that contradicts the use of the plant to treat hepatomegaly. Headache and Abdominal pain are the commonest symptoms that are attributed to the plant [9, 10].

**Pharmacological Properties**

**Toxicity**

There was a case study where a child of 3yrs was administered with the plant for treatment of some condition but the plant turned into poison which led to multiple organ failure. This finally caused the mortality of the child due to an unknown compound in the plant. This demands for an intensive toxicological study on the plant to discover methods to prevent the toxic effects of drug [11].

Other plants of indigo genus have been confirmed with the presence of indospicine. This compound

is a hepatotoxic drug and is considered as a teratogenic drug. In livestock also the compound was found to cause various disorders like embryo mortality, clefted palate, poisoning and sometimes even death [12, 13].

**Anti-inflammatory activity**

Indigofera genus as discussed have very similar plants and one of those plants is Indigofera aspalathoides. It has been used to investigate the anti-inflammatory activity and can be advocated that the *Indigofera tinctoria* can also possess the same properties [14].

**Skin disorders**

Another member of genus Indigo, *I. naturalis* was investigated for the treatment of psoriasis and was established as an alternative therapy. The mechanism of action was found to be the antiproliferative effect that works on keratinocytes and the epidermal barrier was repaired. This activity was inferred to *Indigofera tinctoria* too [15].

**Hepatoprotective effect**

Anand et al in 1981 tested *Indigofera tinctoria* for its hepatoprotective property based on the folklore claims. It was evident that the plant was effective to treat liver disorders and prevent liver damage in CCl4 induced liver damage method. This is a contradiction to the other members of the family, that they have hepatotoxic effects. There needs to be an intensive work to be done in this area to prove this plant is an exception to other plants in this genus Indigofera [16].

**Anti-bacterial property**

Vijayan et al in 2012, investigated the antibacte-

rial properties and mutation inducing properties of the extract. The Minimum inhibitory concentration of the extract was calculated for MSSA, MRSA and *Staphylococcus*, *Enterococcus*, *Streptococcus*, *Moraxella* and *Haemophilus* bacteria. The methanol extract showed a significant antibacterial property and compared to linezolid that is a standard drug. The highest concentration was seen in case of moraxella and haemophilus. The lowest was seen in MRSA and MSSA [17].

The plant *Indigofera tinctoria* had been tested for its antibacterial activity against *Staphylococcus aureus*, *Enterococcus faecalis*, *Klebsiella pneumoniae*, *Enterobacter aerogenes*, and *Salmonella paratyphi* by using cup plate agar diffusion method and the results proved that the extract showed a better activity against all the bacteria compared to the standard drug antibiotic which is obvious [18].

#### **Antihyperlipidemic property**

The alcohol extract of the plant was investigated for dylipidemic property along with chloroform, butanol and water fractions. The test was performed on hamsters using high fat diet method. The serum parameters like TG, TC, LDL, HDL were calculated. Out of the three the chloroform extract showed better activity against the high fat diet induced lipids [19].

#### **Antioxidant activity**

The antioxidant activity of methanol extract of leaf and roots was investigated in DPPH assay and also eluted the phytochemistry of the plant which included carbohydrates, alkaloids, saponins, phenols and flavonoids. The DPPH assay resulted in the 89% activity in the root extract and 46% activity in leaf extract [18].

Another study on the aqueous extract for its antioxidant activity in DPPH method and NO method and also estimated for its phenol, flavonoid and antioxidant concentration in the extract. The results were compared with the standard drug Ascorbic acid. The extract showed total phenol content of about 267mg/g, Flavonoids of 75 mg/g and antioxidants of 350 mg/g of the drug. The antioxidant activity in DPPH method was 52 % and in nitric oxide method was 25% which was similar to that of standard drug [20]

#### **Immune stimulating effect**

Ethanol and aqueous extracts of indigofera were tested for immune stimulating effect based on the claims from folklore. The tests were performed taking the nitric oxide levels, arginase production, phagocytic levels and cytokines production into consideration. The proliferation was estimated by MTT

assay. Both the extracts showed a significant activity in boosting the immune system and hence proving the immunomodulatory effect of *Indigofera tinctoria* [21].

#### **Antidiabetic activity**

The leaves of the plant were extracted with chloroform and ethanol and tested for it antidiabetic activity in 2011 in STZ-induced diabetes method. The dose of 40,80,10 and 200mg/kg were tested which demonstrated a significant lowering of blood sugar level and also showed a nephroprotective activity [22].

Another study which tested for antidiabetic activity in the methanol extract in diabetes induced rats model [23].

#### **Anti-epileptic activity**

*Indigofera tinctoria* was investigated for antiepileptic activity in albino wistar rats in lithium chloride/pilocarpine induced epilepsy model at doses of 500 and 100mg/kg. the brain tissue was also analyzed by studying the histopathology of the brain. The ethanol extract proved that it can be used to treat status epilepticus in wistar rats [24].

#### **Anthelmintic activity**

Gunasekaran et al in 2009 investigated for the anthelmintic activity of the plant as a whole in various concentrations like 50 and 100mg/ml. The activity was performed on *Pheretima posthuman*. The paralysis and death time were calculated and test were performed using the methanol extract of whole plant and is compared to the standard drug piperazine citrate which showed better activity [25].

#### **Phytochemistry**

The extracts of the whole plant of *Indigofera tinctoria* was estimated to contain 2.5 % of alkaloids, 0.5% deobsurents. Galactomannan compound was isolated from the seeds that is composed of galactose and mannose in the ratio of 1:1.52 [26]. Retenoids were isolated from the plant leaves and steroids like beta sitosterol and flavonoids were isolated from leaves.

The plant was investigated for phytochemical analysis using HPLC and HPTLC and isolated 5 compounds from pet ether and methanol extracts. UV, IR, NMR were used to characterize the compounds that belong to terpenoids class.

The blue colour dye that is present in the leaves is achieved by combining the caustic soda and sodium hydrosulfite. This was fermented and the dye extracted was Indigo compound. There was another compound that is red colour which is isolated that is called as Indirubin [27]. Another dye, Indican is

a glycoside that is isolated from the indigofera and Indigotin was also isolated from leaves Figures 1 and 2 .

## CONCLUSION

In view of the activities that are established and proven scientifically for antidiabetic, helminthic, epileptic, inflammatory, immune modulatory activity etc. the plant had been used traditionally for treatment of many diseases in the folklore. It is used in tanning industry of clothes and leather too. Considered this scientific evidence, the other claims have to be established.

## CONFLICT OF INTEREST

Authors declared no conflict of interest.

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