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## RESEARCH ARTICLE

### INDIGOFERA SUFFRUTICOSA MILL (FABACEAE): A LITERATURE REVIEW

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#### ABSTRACT

*Pena Indigofera suffruticosa* belongs to the Fabaceae family and stands out among the genus for its pharmacological properties. A literature review was carried out based on 30 articles taken from databases in virtual libraries such as Lilacs, Pubmed, Scielo, and Science Direct, in order to verify the traditional uses, biological activities, and phytochemistry of *Indigofera suffruticosa*. Its biological activities were evaluated: anti-inflammatory, embryotoxic, antimicrobial, and antitumor. This range of already demonstrated phytotherapeutic properties means it is a plant with great therapeutic potential and its properties can assist in various studies.

#### INTRODUCTION

Innumerable benefits are provided by plants with phytotherapeutic properties, especially phenolic substances, which are verified in most vegetables. Such compounds develop reactions, protecting the human body from oxidative elements, which lead to various diseases (Sultana and Anwar, 2008). These plants are of great importance for maintaining health and in certain populations their use is routine (Tomazzoni, Negrelle, and Centa, 2006). Around 700 vegetable species belong to the *Indigofera* genus, mostly represented by herbaceous and arbustive plants widely spread throughout Africa, Asia, Australia, North America, and South America (Lewis et al., 2005; Hassen et al., 2007). In Brazil, eleven phyto species were identified, which are geographically established in the state of São Paulo and also in the semi-arid or scrub regions of Pernambuco (Barros and Teixeira, 2008). Undemanding and growing in and adapting to any type of soil, *Indigofera suffruticosa* is a wild plant that is popularly known as anileira or anil due to the indigo, a blue substance that is extracted with leaf fermentation (Vieira, 2007).

This vegetable has been studied since the 1980s as it is the genus that stands out the most due to its high territorial representativeness and it presenting different substances of medicinal interest (Moreira and Tozzi, 1997). In particular, *Indigofera* species started to raise pharmacological interest because they contain various compounds, such as flavanoids derived from kaempferol (Di Stasi and Hiruma, 2002). *Indigofera suffruticosa* is already quite widely used for its medicinal properties (Bhaskar et al., 1982; Leite et al., 2003; Agra et al., 2007) and therefore is beginning to raise the interest of researchers in the area of phytotherapy. Many studies have found that dry *I. suffruticosa* leaves have excellent anti-microbial and anti-inflammatory potential, as well as cytotoxic activity for embryonic cells in development (Leite et al., 2006). The different properties of *I. suffruticosa* have drawn attention to the need for a literature review regarding the main pharmacological activities as well as a phytochemical analysis of this plant.

#### MATERIALS AND METHODS

This paper was elaborated based on a literature review of the Lilacs, Pubmed, Scielo, and Science Direct databases. The keywords used were “*Indigofera*” and “*Indigofera suffruticosa*”.

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Table 1. Popular use of *I. suffruticosa*

Popular use	Part	Region	Reference
Antiblenorrhagic, diuretic, stomatal, febrifuge, sedative, and in urethrites.	The whole plant	Southeast Region	(Rodrigues, 2001)
Anti-inflammatory, analgesic, and digestive activities.	Not informed	Central America	(Calvo et al, 2007)
Joint and nevralgic pains, circulatory disorders, disorder of the respiratory passages, acute inflammation of the skin, and nose hemorrhages.	The whole plant	Not informed	(Vieira, 2007)

Table 2: Phytochemical analysis of *Indigofera suffruticosa*

Chemical component	Part of the plant	Type of extract	Reference
Phenolic compounds	Stem	Aqueous extract	(Barros and Teixeira, 2008).
Alkaloids	Root and leaves	Aqueous extract	(Lopes <i>et al.</i> , 2011)
Lipidic substances	Root	Aqueous extract	(Barros and Teixeira, 2008).
Protein substances	Leaves	Aqueous extract	(Barros and Teixeira, 2008).
Lectin	Leaves	Aqueous extract	(Leite <i>et al.</i> , 2006)
Sterols	Leaves	Methanolic extract	(Leite <i>et al.</i> , 2006)
Triterpenes	Leaves	Methanolic extract and hexanic extract	(Leite <i>et al.</i> , 2006)
Flavonoids	Leaves	Methanolic extract	(Leite <i>et al.</i> , 2006)
Coumarins	Leaves	Methanolic extract	(Leite <i>et al.</i> , 2006)
Carbohydrates	Leaves	Methanolic extract	(Leite <i>et al.</i> , 2006)
Indigo	Leaves	Methanolic extract	(Leite <i>et al.</i> , 2006)

Table 3: Pharmacological properties of *Indigofera suffruticosa*

Pharmacological property	Part of the plant	Reference
Anti-inflammatory	Leaf extract	(Leite, 2003)
Anti-microbial	Leaf extract	(Leite, 2006)
Antitumor activity	Leaf extract	(Vieira, 2007)
Hapatic protection activity	Leaf extract	(Lima, 2014)
Renal protection activity	Leaf extract	(Santana, 2015)
Repellent	Leaf extract	(Vieira, 2012)

404 articles were found, of which only those articles from between 2003 and 2016 were selected, totaling 250, of which 220 were excluded after verifying the content presented, due to them not being in line with the aim of this study. Finally, 30 articles were selected that fulfilled the initially proposed criteria.

## RESULTS AND DISCUSSION

This species is known by various popular names (anil, anileira) depending on the country and/or region of distribution in Brazil and used in traditional medicine for various processes. Popular knowledge can provide important data for new scientific discoveries and academic studies can lead to new knowledge regarding plants' therapeutic properties (Simões, 1988). According to Filho and Yunes (1998), "only around 5% of vegetal species have been phytochemically studied." The scientific community has shown great interest in validating plants used in popular medicine, especially for producing new drugs that bring benefits to the industry and the Brazilian population. The data found with regards to popular use, phytochemistry, and biological activities are described in the tables below. The anti-inflammatory activity of *I. suffruticosa* was described by Leite *et al.* 2003, given that there was no previous report of this activity in the literature. Tey revealed potent anti-inflammatory activity compared to the same action by non-steroid anti-inflammatory drugs (NSAIDs). The results found using the leaf extract showed that a group treated with *I. suffruticosa* extract presented similar anti-inflammatory activity to a group treated with acetylsalicylic acid (ASA), a NSAID prototype. The studies from Campos *et al.* (2012) showed anti-inflammatory actions in the organic extract of *Indigofera suffruticosa*, specifically acetonic and methanolic, for an acute inflammation model

(foot swelling induced with carrageenan), suggesting that the compounds present in the seeds of this species act in different mediators and chemotaxis. According to Leite *et al.* (2004), media containing an aqueous extract of *I. suffruticosa* leaves interrupted the development of rat embryos, as embryos exposed to a 10mg/ml concentration of the extract did not develop and all remained in a two cell state; embryos exposed to a lower 5mg/ml concentration showed development until morula, blastocyst, and hatched blastocyst. Vieira *et al.* (2012), also highlighted the hypothesis that *I. suffruticosa* has embryotoxic effects, showing delayed general growth of *A. aegypti*, with 93.3% of the larvae remaining in the second stage of development when exposed to a 250 µg/ml concentration; however, with 500, 750, and 1000 µg/ml concentrations the inhibitory effect was lower, at 20%, 53.3%, and 46.6%, respectively. Moreover, the extract presented repellent for *A. aegypti* mosquitoes, significantly reducing egg laying by the females. In accordance with these data, we can suggest that *I. suffruticosa* can cause toxicity and is harmful to those that consume this plant. Antimicrobial activity in *I. suffruticosa* has also been studied. The results found by Leite *et al.*, 2006 revealed that aqueous leaf extracts of *I. suffruticosa* act against bacteria and fungi and that the use of this plant is interesting for treating diseases caused by dermatophytes in the skin. In the study from Nascimento *et al.* (2013), the isolated protein of *I. suffruticosa* associated with cefoxitin antibiotics enhanced the action of this antibiotic against *S. aureus*, suggesting that the use of this plant may be interesting for treating bacterial infections and for reducing antibiotic resistance. Indican (indoxil β-D-glucósideo), the main indirubin formation precursor, which is a component present in the *Indigofera* genus plant, showed antifungal activity against *Candida*, inhibiting *C. albicans*, *C. tropicalis*, and *C. krusei* (Silva *et al.*, 2016). In 2007, Vieira *et al.* evaluated the antitumor effect of aqueous extracts using

infusion (64.5%) and maceration (62.6%) on Sarcoma 180 in mice, using 50 mg/kg i.p. doses, based on the low level of toxicity and comparing with the control group, which showed 100% tumor developed. They concluded that the aqueous extract of *I. suffruticosa* leaves presents antitumor properties and can be used as an alternative therapeutic agent for anticancer treatments. In 2014, Lima *et al.* revealed protective activity in the liver via histomorphologic analysis of animals that were subjected to chemotherapy with the aqueous and macerated extract of *I. suffruticosa* leaves, showing that there were no alterations in the liver and capillary structure in the animals. Renal protective activity was demonstrated via the study carried out by Santana (2015) and his collaborators, after histomorphometric analysis of the renal tissues of mice subjected to daily treatments with aqueous leaf extract over of a seven day period, in which renal structures and functions were preserved. Based on the above, we conclude that *I. suffruticosa* has a range of already proven phytotherapeutic properties, which mean that it is a plant with great therapeutic potential. These results can be used by the academic community and for developing new research.

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