

BAUHINIA SPP. (PATA-DE-VACA) AND ITS BIOLOGICAL POTENTIALITIES – LITERATURE REVIEW

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ABSTRACT: The genus *Bauhinia* popularly known as “pata-de-vaca”, “unha de vaca”, “unha de boi”, “unha de anta” e “casco de vaca” is widely used in the form of teas and other herbal preparations. The aim of this literature review was to show the diversity and biological potential of *Bauhinia* species for health promotion. A search was carried out for articles listing some species of medical interest. The pharmacological activities of *B. forficata* were also highlighted in articles published in the last twenty years using the PubMed database. Research has shown that *Bauhinia* is used as a hypoglycemic and antidiabetic agent, diuretic, cholesterol reducer, in the treatment of cystitis, intestinal parasites, elephantiasis, tumors and other ailments, including infections and painful processes. In the last eleven years, 86% of the works carried out with *B. forficata* used the plant collected or acquired in Brazil, predominantly publications from the southern region of the country where almost 60% reported activity on diabetes and its complications and/or antioxidant effect. Despite the literature pointing out the great medicinal potential of *Bauhinia* in chronic diseases and their complications, there is still a need for more translational research.

KEYWORDS: Bioactives; Phytotherapy; Hypoglycemic; Therapeutics; Pata-de-vaca.

BAUHINIA SPP. (PATA-DE-VACA) E SUAS POTENCIALIDADES BIOLÓGICAS – REVISÃO DA LITERATURA

RESUMO: O gênero *Bauhinia* conhecido popularmente como “pata-de-vaca”, “unha de vaca”, “unha de boi”, “unha de anta” e “casco de vaca” é amplamente utilizado em forma de chás e outras preparações fitoterápicas. O objetivo desta revisão de literatura foi mostrar a diversidade e potencial biológico das espécies de *Bauhinia* para a promoção a saúde. Foi realizada a busca de artigos elencando algumas espécies de interesse médico. Destacou-se também as atividades farmacológicas

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de *B. forficata* em artigos publicados nos últimos vinte anos utilizando a base de dados PubMed. A pesquisa mostrou que a *Bauhinia* é utilizada como hipoglicemiante e antidiabética, diurética, redutora de colesterol, no tratamento da cistite, parasitoses intestinais, elefantíase, tumores e outros males, incluindo infecções e processos dolorosos. Nos últimos onze anos, 86% dos trabalhos realizados com *B. forficata* utilizaram a planta coletada ou adquirida no Brasil sendo predominante publicações oriundas da região sul do país onde quase 60% relataram atividade sobre o diabetes e suas complicações e/ou efeito antioxidante. Apesar da literatura apontar o grande potencial medicinal da *Bauhinia* em doenças crônicas e suas complicações ainda há a necessidade de mais pesquisas de caráter translacional.

PALAVRAS-CHAVE: Bioativos; Fitoterapia; Hipoglicemiante; Terapêutica; Pata de vaca.

BAUHINIA SPP. (PATA-DE-VACA) Y SUS POTENCIALIDADES BIOLÓGICAS - REVISIÓN DE LA LITERATURA

RESUMEN: El género *Bauhinia*, conocido popularmente como "garra de vaca", "garra de ganado", "garra de tapir" y "pezuña de vaca", se utiliza ampliamente como té y otros preparados fitoterapéuticos. El objetivo de esta revisión bibliográfica era mostrar la diversidad y el potencial biológico de las especies de *Bauhinia* para la promoción de la salud. Se llevó a cabo una búsqueda de artículos que incluyeran algunas especies de interés médico. Las actividades farmacológicas de *B. forficata* también fueron destacadas en artículos publicados en los últimos veinte años utilizando la base de datos PubMed. La investigación demostró que la *Bauhinia* se utiliza como hipoglucemiante y antidiabético, diurético, reductor del colesterol, en el tratamiento de la cistitis, la parasitosis intestinal, la elefantiasis, los tumores y otras dolencias, incluyendo infecciones y procesos dolorosos. En los últimos once años, el 86% de los estudios realizados con *B. forficata* utilizaron la planta recolectada o adquirida en Brasil, siendo predominantes las publicaciones de la región sur del país, donde casi el 60% reportó actividad sobre la diabetes y sus complicaciones y/o efecto antioxidante. Aunque la bibliografía señala el gran potencial medicinal de la *Bauhinia* en las enfermedades crónicas y sus complicaciones, todavía es necesario realizar más investigaciones traslacionales.

PALABRAS CLAVE: Bioactivos; Fitoterapia; Hipoglucemia; Terapéutica; Pata de vaca.

1. INTRODUCTION

Bauhinia is a genus of plants classified by Carolus Linnaeus, in 1753, in honor of the brothers Jean Bauhin (1541-1613) and Gaspard Bauhin (1550-1624), Swiss physician and botanist (FORTUNATO, 1986).

These plants belong to the Fabaceae family, which is divided into three subfamilies (Caesalpinioideae, Faboideae and Mimosoideae), presenting about 619 genera and 17,815 species representing one of the largest families of angiosperms with great economic contribution. The species of the genus *Bauhinia* are popularly known as *pata de-vaca* and *unha-de-vaca*, among other denominations due to the bilobed shape of its leaves, having approximately 300 species and, in Brazil, there are 200 native species already cataloged (SIMÕES; ALMEIDA, 2015). As an example, we have *B. forficata* and *B. longifolia*, which are native species with widespread use in Brazilian folk medicine. (SANTOS; BARRETO JUNIOR; KUSTER, 2017).

They are mainly found in tropical areas of the planet and several of these species are used as a remedy in folk medicine in various regions of the world, including Africa, Asia and Central and South America (SILVA; CECHINEL FILHO, 2002; ALVES *et al.*, 2000). Many species have

adapted well to the Brazilian climate and were introduced for ornamental purposes, and today they are found in different regions of the country (SANTOS; BARRETO JUNIOR; KUSTER, 2017).

The leaves, stems and roots of *Bauhinia* species, especially *B. manca*, *B. megalandra*, *B. racemosa*, *B. rufescens*, *B. monandra* Britt. and *B. ungulata* L., *B. forficata*, *B. cheitantha* and *B. splendens* are widely used in Brazil and other countries in the form of teas and other herbal preparations for the treatment of various diseases, mainly infections, painful processes and diabetes (SILVA; CECHINEL FILHO, 2002; ALVES *et al.*, 2000; MENEZES *et al.*, 2007; SIMÕES; ALMEIDA, 2015).

The flowers are zygomorphic arranged in axillary racemes that vary in color depending on the species and subspecies, usually pink or white. The inflorescence is in an axillary raceme, the flowers are showy, have five elongated petals up to 9 cm long and 10 long stamens (SILVA LÓPEZ; SANTOS, 2015).

2. DEVELOPMENT

For the development of this descriptive review, a bibliographic survey was carried out regarding the genus *Bauhinia*, listing some species of medical interest with emphasis on *B. forficata*. Books were used and scientific articles published between 1989 and 2021 found on Scielo, Google Scholar and Pubmed platforms were selected. The keywords “*Bauhinia*”, “medicinal plants”, “bioactive compounds”, “toxicity”, “medicinal use”, “property” and “effect” were used.

2.1 *Bauhinia* spp.

2.1.1 *Bauhinia monandra* Kurz

Synonymy: *Bauhinia Kappleri* Sagot, *Bauhinia Kluggli* Standl., *Bauhinia Kluggli* Urb., *Caspareopsis monandra* (Kurz) Britton & Rose (LORENZI *et al.*, 2003). Popular names: *pata-de-vaca*, *unha-de-vaca* and *Mororó* (ALVES *et al.*, 2000).

It is an evergreen tree native to Burma, measuring 5 to 7 meters in height, with an erect cylindrical trunk with a smooth light brown bark, with sparse branches with a globose crown. The leaves are large, simple leathery, orbicular with a “V” cut forming two lobes 10 to 18 cm long and light green. The flowers are axillary and terminal inflorescences formed from October to December; with several large pink flowers with five petals, the lower one the largest dark pink. Pod-like fruit, flat, glabrous, light brown with rounded light brown seed, flat and hard. It has a single fertile stamen, as a characteristic of the species, this is rare in southern Brazil and more frequent in the north of the country (LORENZI *et al.*, 2003). *Bauhinia monandra* and *Bauhinia ungulata*, popularly known as *pata-de-vaca* and *Mororó*, present an active ingredient against diabetes, controlling the blood glucose level (ALVES *et al.*, 2000).

2.1.2 *Bauhinia purpurea* L.

Synonymy: *Bauhinia triandra* Roxb, *Bauhinia platyphylla* Zipp. ex Span, *Bauhinia retusa* Poir., *Caspereopsis purpurea* (L.) Pittier, *Phanera purpurea* (L.) Benth. Popular names: *pata-de-vaca-roxa*, *unha-de-vaca* (LORENZI *et al.*, 2003; TROPICOS, 2021).

Plant native to India and Sri Lanka, being an evergreen tree, 5 - 6 meters tall with a smooth bark, light brown in color with short branches forming a rounded crown. Simple leathery, orbicular leaves with a V-shaped cut forming two lobes 12 to 17 cm long and light green. The flowers are axillary and terminal inflorescences, in short racemes with several dark purple oval-lanceolate five-petaled flowers formed between March to August and with only three long fertile stamens. Pod-type fruits (vegetables), light brown with a leathery texture, dehiscent flat, with rounded and flattened seeds (LORENZI *et al.*, 2003).

Bauhinia purpurea, better known as butterfly, is used in India, Sri Lanka and Pakistani folk medicine to treat conditions such as glandular swellings, skin conditions, ulcers, diarrhea, stomach tumors and wounds, in addition to being used as a hypoglycemic agent for the treatment of diabetes, in addition to other indications, it is suggested that it has laxative and astringent effects, *B. purpurea* flowers are used as a purgative in Pakistan, while its leaves are applied externally to the forehead to treat fever (ZAKARIA *et al.*, 2007).

2.1.3 *Bauhinia blakeana* Dunn

Popular names: Hong Kong Orchid Tree, Hong Kong Bauhinia.

This species was found in Hong Kong by the friars in the Roman cathedral and preserved by them, never being found in a native state. Of unknown origin; suspect that it is hybrid because it does not bear fruit. It is an evergreen tree, 6-8 meters tall with a trunk with irregular bark, reddish-brown in color with dense branches forming a rounded crown. Simple orbicular leaves with short petioles and a V-shaped cut forming two lobes, its surface on both sides and dark green. The flowers are axillary and terminal inflorescences, long reddish-purple flowers are fragrant and large that form and open throughout the year with greater intensity from April to August the flowers are sterile and fruiting does not occur (LORENZI *et al.*, 2003).

Bauhinia blakeana, in Brazil it has adapted well to local climatic and edaphic conditions. Today it is cultivated mainly in the southeastern region of Brazil, where it is known by the name of “*pata-de-vaca*”. The Brazilian population usually uses it for the treatment of diabetes as a therapeutic alternative in the treatment of this disease (FERREIRA *et al.*, 2003).

2.1.4 *Bauhinia variegata* L.

Synonymy: *Bauhinia chinensis* (DC) Vogel, *Bauhinia decora* Uribe, *Bauhinia variegata* var. *chinensis* DC., *Phanera variegata* (L.) Benth. Popular names: *pata-de-vaca-rosa*, *unha-de-vaca*, *pata-de-vaca* (LORENZI *et al.*, 2003).

It is a plant native to India being a semideciduous tree that measures between 7 and 10 meters in height, with a cylindrical trunk with a dark brown rough bark, slightly fissured. It has dense branches with a more or less globose crown. The leaves are simple, leathery, orbicular with a V-shaped cut forming two gray-green lobes, 12 to 18 cm long. The flowers are axillary and terminal inflorescences in short racemes with several corolla flowers with five oval-elongated pink petals, striated with purple spot, formed from June to September. Pod-like fruit, flat, dehiscent, light brown with rounded flat seed somewhat fleshy light green. The Candida strain Roxb. (*Bauhinia alba*-Ham.), producer of white flowers is widely cultivated in Brazil (LORENZI *et al.*, 2003).

The *Bauhinia variegata* plant, commonly known as Mountain Ebony, is widely used in Indian folk medicine: the bark, root, leaves, seeds and flowers are used for dyspepsia, bronchitis, leprosy, ulcer, to prevent obesity, as an astringent, tonic and anthelmintic (DHALE, 2011).

2.1.5 *Bauhinia longifolia* (Bong.) Steud.

Synonymy: *Pauletia longifolia* Bong. Popular names: *pata-de-vaca*, *unha-de-vaca*, *unha-de-vaca -do-campo*, *unha-de-boi* (LORENZI, 1998).

B. forficata and *B. longifolia* are native species of widespread use in Brazilian folk medicine, known as *pata-de-vaca*, due to the bilobed shape of their leaves (SANTOS; BARRETO JUNIOR; KUSTER, 2017).

It is a plant without thorns, measuring between 4 and 7 meters in height, with a thin, slightly rounded crown and its new, rusty, stormy branches, the trunk is slightly crooked and with fine helical flutes and the bark is thin and rough. Leaves alternate, simple bipartite up to the middle of the leaf, with acute or obtuse apices, slightly discolored with a subcoriaceous texture measuring from 6 to 14 cm, glabrous upper and lower surface with 5 to 8 cm long, the flowers are axillary inflorescences and terminals confertiflorous, puberulous, 6 to 8 cm long, with reddish white flowers, pod-like fruit, flattened, dehiscent, woody, ferruginous-tomentose when young (LORENZI, 1998).

This plant occurs in the State of São Paulo and Minas Gerais, in the cerrados and in the high-altitude semideciduous broadleaf forest (LORENZI, 1998).

2.1.6 *Bauhinia unguolata* L.

Synonymy: *Pauletia unguolata* (L.) A. Schmitz, *Bauhinia bethamiana* Taub., *Bauhinia cavanilles* Millsp, *Bauhinia inermis* Perr, *Bauhinia inermis* Forssk, *Bauhinia inermis* (Cav.) Pers, *Bauhinia macrostachya* Benth, *Bauhinia macrostachya* var. *tenuifolio* Ducke, *Bauhinia unguiculata*

Sesse & Moc, *Cansenia ungulata* (L.) Raf, *Pauletia ungulata* (L.) A. Schmitz, *Pauletia inermis* Cav. (TROPICOS, 2021).

Bauhinia ungulata is a legume native to Brazil known as *pata-de-vaca* or *mororó* found mainly in the north, northeast, midwest and southeastern regions of Brazil. (PAULA *et al.*, 2015). *B. ungulata* is a poorly studied plant, Morais *et al.* (2005) cite its use by the Tapebas Indians and by the inhabitants of Ceará as a hypoglycemic agent in the treatment of diabetes.

2.1.7 *Bauhinia forficata* Link

Synonymy: *B. candicans* Benth, *Bauhinia armata* Otto, *Bauhinia brasiliensis* var. *longiflora* Wawra, *B. forficata*, *Bauhinia aculeata* Vellozo, *Bauhinia aculeata* Vell, *Bauhinia brasiliensis* Vogel. (PONTES *et al.*, 2017; CARVALHO, 2003; TROPICOS, 2021).

B. forficata is a native species that extends from Rio de Janeiro to Rio Grande do Sul and can be found in South America in countries such as Argentina, Paraguay, Uruguay and Bolivia (PONTES *et al.*, 2017; NOGUEIRA; SABINO, 2012; CARON *et al.*, 2014). Studies report the presence of other subspecies, such as *B. forficata pruinosa* (Vogel) Fortunato & Wunderlin (PONTES *et al.*, 2017).

B. forficata is known by several popular names in different states of Brazil as shown in Chart 1.

Chart 1. Common names of *B. forficata* in different Brazilian states.

Bahia	<i>Mororó; unha-de-vaca</i>
Ceará	<i>Mororá-de-espinho, Mororó, casco-de-vaca</i>
Espírito Santo	<i>Unha-de-vaca</i>
Minas Gerais	<i>Unha-de-boi, unha-de-vaca</i>
Rio de Janeiro	<i>Bauínia, capa-bode-grande. Unha-de-vaca</i>
Rio Grande do Norte	<i>Mororá-de-espinho</i>
Rio Grande do Sul	<i>Pata-de-vaca-branca pata-de-vaca-com-espinho e unha-de-vaca-de-espinho</i>
Paraíba	<i>Pata-de-boi,</i>
Paraná	<i>Mão-de-vaca e miroró; unha-de-vaca</i>
Pernambuco	<i>Mororá-de-espinho</i>
Piauí	<i>Mororó</i>
São Paulo	<i>Pata-de-vaca-branca, pata-de-vaca-com-espinho e unha-de-vaca-de-espinho, unha-de-vaca</i>
Santa Catarina	<i>Unha-de-vaca</i>

Source: Carvalho (2003).

Pata-de-vaca, develops mainly in the surroundings of the forests, can be found in the form of shrub or tree with approximately six meters of stature. These plants, in addition to having medicinal properties, stand out for having landscape characteristics suitable for urban afforestation, such as: medium size, large leaves, medium crown width, and flowers with an admirable visual appearance (CARON *et al.*, 2014; SILVA LÓPEZ; SANTOS, 2015).

B. forficata is a potential plant for use in the recovery of degraded areas, being also used as an ornamental plant (SILVA LÓPEZ; SANTOS, 2015).

The leaves of *B. forficata* differ from other leaves of other species of the genus *Bauhinia*, as they have two thorns on the petiole branch of each leaf forming a gallows and their flowers are white, which is their main morphological characteristic, thus facilitating their differentiation. (SILVA LÓPEZ; SANTOS, 2015). It is a thorny tree that measures between 5 and 9 meters in height, its crooked trunks measure 30 to 40 cm in diameter (LORENZI, 2002)

The leaves are large, beautiful, greenish in color and very fragrant; resemble a cow's hoof, measuring from 8 to 12 cm in length, the trunk is covered by a deep brown suber and, generally, tortuous and slightly striated in the longitudinal direction, the fruits are of the flattened and dehiscent pod type measuring from 15 to 15 to 25cm (NOGUEIRA; SABINO, 2012; SILVA *et al.*, 2003). It is considered a heliophilic plant, that is, it needs sunlight, with no choice in terms of soil moisture conditions, in addition to having characteristics of exclusivity of the semi-deciduous forest of altitude, occurring with high constancy, but with a rather irregular and discontinuous distribution (PONTES *et al.*, 2017).

The plant's sexual system is functionally hermaphroditic and the reproductive system is predominantly crossed, with no agamospermy, and geitonogamy may occur, suggesting that the species is self-incompatible. Pollination occurs mainly by bats. Flowering occurs from September to October, in Minas Gerais; from October to December, in Ceará and Pernambuco; from October to January, in the State of São Paulo; from November to March, in Paraná; and from January to March, in Rio de Janeiro (CARVALHO, 2003).

The petals of fresh flowers of *B. forficata* are edible *in natura*, being fleshy and sweet, or can be added to jams, jams and jellies, and also, they are honey and provide pollen. Its leaves are used in animal feed as fodder, as they are rich in proteins and carbohydrates (SILVA LÓPEZ; SANTOS, 2015).

2.2 Popular and Medicinal Use

The South American natives used the infusion of the leaves as a healing agent, to wash wounds, and also as a diuretic, digestive and expectorant, before they were known as hypoglycemic agents. In Brazil, it is popularly used as an antidiabetic, diuretic, cholesterol reducer and also against cystitis, intestinal parasites and elephantiasis (SAAD *et al.*, 2016).

They are used in homemade medicine as syrup, the zest of the stem for cough and cold, also for kidney problems, diabetes and, for treatment and urinary infections, leaves, bark, wood and roots are used both in bathing and drinking. The leaves and flowers have a great calming effect, acting directly on the sympathetic system (SILVA *et al.*, 2003).

It is indicated as an adjuvant in the treatment of skin diseases, ulcers and hypertension, to increase the elimination of uric acid, in back pain, in bladder disorders, constipation and elephantiasis. It has mucilaginous and astringent properties. In the past, its medicinal use was as a diuretic, tonic, stimulant, and also against diabetes, gonorrhoea, tuberculosis and anemia (SILVA LÓPEZ; SANTOS, 2015).

2.3 Scientific Studies of the *Bauhinia* Genus with Health-Related Effects

The dry extract of *B. forficata* leaves in infusion showed anti-ulcerogenic activity in several experimental models with rats. The possible activities would be linked to the inhibition of the H⁺/K⁺/ATPase carrier molecule, and there may be other molecules to increase cytoprotection (CID *et al.*, 2018).

A study to evaluate the antimicrobial effect of *B. variegata* with bark and leaf extract on Gram positive strains such as *Staphylococcus aureus* and *Bacillus subtilis* and Gram negative strains such as *Escherichia coli* and *Pseudomonas aeruginosa*. Solvents used for plant extraction were petroleum ether, chloroform and alcohol. The alcoholic extract of leaves and bark of *B. variegata* showed maximum antibacterial activity. The antibacterial activity of the active extract was compared with the standard antibiotic ampicillin (DHALE, 2011).

In another study, the hydroalcoholic extract of *B. forficata* leaves inhibited the growth of eight bacteria, being more active for Gram-positive and inefficient for fungi. The results also showed that at the concentrations administered, there was no increase in micronuclei, there was no action on the growth and differentiation of *Herpetomonas samuelpessoai* and the extract did not show toxicity (PEREIRA *et al.*, 2014).

In the evaluation of the leaf extract of *B. cheilandra* with diabetic rats induced by alloxan and treated with extracts (doses of 300, 600 and 900 mg kg⁻¹), the results showed significant hypoglycemic activity (ALMEIDA *et al.*, 2006). In another study with rabbits with alloxan-induced diabetes, treatment with different fractions of *B. candicans* extract showed hypoglycemic activity, along with a decrease in urinary glucose excretion. Among the fractions, the highest activity was with the butanolic fraction which reduced the plasma glucose level in normal rabbits as well as in diabetic rabbits. These results suggest hypoglycemic activity (FUENTES *et al.*, 2004).

When using streptozotocin to induce diabetes *mellitus*, a decoction of *B. forficata* leaf (150 g/L) was administered orally for one month, with a hypoglycemic effect (PEPATO *et al.*, 2002). In an evaluation with extract of *B. forficata* with pregnant rats induced to diabetes with streptozotocin, the results suggest that pregnant diabetic rats not submitted to treatment with the plant extract had gestational problems, while diabetic rats treated indicated that the extract of *pata-de-vaca* may have favored the implantation of the fetus, as it showed a greater number of live fetuses. It was also

observed that the extract may have contributed to the maintenance of the integrity of the fetus, however, it had no hypoglycemic effect in the diabetic and non-diabetic rats (VOLPATO *et al.*, 1999).

A phytopharmaceutical (DIAMET) composed of: São Caetano melon (*Momórdica charantia*), pata-de-vaca (*B. forficata*), eucalyptus (*Eucalyptus globulus* Labil) and annatto (*Bixa orellana* L.) was tested in media containing human blood cells and glucose. *In vitro* assays were carried out with the phytopharmaceuticals dissolved in normoglycemic saline 0.9% (5.5 mM glucose), demonstrating the hypoglycemic effect, producing a decrease in glucose levels in relation to the control for the different amounts of phytopharmaceuticals (3, 9, 18, 36 and 72 µg) in aqueous solution (MARTINEZ *et al.*, 2014).

The evaluation of diabetic rats treated for a prolonged period with *B. forficata* extract showed weight gain and recovery of the animals, although it was not effective in combating tissue damage caused by the pathology (CURCIO *et al.*, 2012).

In a study with antioxidant and antiedematogenic activity (carrageenan-induced mouse paw edema), the results showed that the antioxidant effect of the butanolic extract had better action than the standard *Ginkgo biloba*. In the antiedematogenic evaluation, the aqueous extract showed a maximum inhibition (ARIGONY, 2006).

Lectins are proteins or glycoproteins found mainly in legume seeds, lectins from all *Bauhinia* species have important agglutinating activity on various cell types, in infection and tumor progression, which can inhibit the adhesion of bacteria or cancer cells to tissues and interfere with the course of the disease. (SILVA LOPEZ; SANTOS, 2015).

The lectin from *Bauhinia forficata* Lectin (BfL), which was purified from seeds and tested on the human breast cancer cell line MCF7. The results showed selective cytotoxic effect and adhesion inhibition in MCF7 breast cancer cells (SILVA *et al.*, 2014).

Proteases, also known as peptidases, are enzymes that hydrolyze peptide bonds in proteins or peptides (SILVA LOPEZ; SANTOS, 2015). Many proteinase inhibitors are reported in several species of *Bauhinia* (30 kDa protease) that are found in leaves of *B. forficata*. This enzyme called baupin is a cysteine protease that releases bradykinin, which is a potent modulator of smooth muscle tone in various organs (SILVA LOPEZ; SANTOS, 2015).

Proteinase inhibitors, isolated from several types of *Bauhinia*, have action on apoptosis, angiogenesis and inflammation. *Bauhinia bauhinioides* cruzipain inhibitor (BbCI) is a Kunitz-type inhibitor that inactivates cysteine proteinases cruzipain and cruzi from *Trypanosoma cruzi*, conducted research with the aim of examining whether the antiproliferative effect of BbCI. Experiments showed that BbCI significantly reduced endothelial cell proliferation (BILGIN *et al.*, 2010).

The pharmacological properties of *Bauhinia forficata* presented in the literature of the last ten years are presented in Chart 2. It is noted that of the works available in the PubMed database, about 86% were carried out with the plant collected or acquired in Brazil, especially in the South region.

Chart 2. Pharmacological properties of *Bauhinia forficata* reported in research published between 2010 and 2021*.

Property/effect	Origin /Acquisition	Reference
Hypoglycemic	Telêmaco Borba, Paraná, Brazil	Cunha <i>et al.</i> (2010).
Hypoglycemic	Not found	Curcio <i>et al.</i> (2012).
Antimutagen	Maringá, Paraná, Brasil	Düsman <i>et al.</i> (2013).
Antioxidant and prevention of involuntary movements induced by antipsychotics	China	Peroza <i>et al.</i> (2013).
Antioxidant	Rio Grande do Sul, Brazil	Salgueiro <i>et al.</i> (2013).
Antioxidant and in mitochondrial dysfunctions	Santa Maria, Rio Grande do Sul, Brazil	Ecker <i>et al.</i> (2015).
Reduction of oxidative damage to the liver in diabetic mice	South of Brazil	Salgueiro <i>et al.</i> (2013).
Antioxidant	Rio de Janeiro, Rio de Janeiro, Brazil	Miceli <i>et al.</i> (2016).
Antimicrobial and antiproliferative	Queimadas, Paraíba, Brazil	Alves <i>et al.</i> (2017)
Diuresis induction	Itajaí, Santa Catarina, Brazil	Souza <i>et al.</i> (2017).
Antioxidant and anti-glycation	Mariporã, São Paulo, Brazil	Franco <i>et al.</i> (2018).
Vasorelaxant	Itajaí, Santa Catarina, Brazil	Cechinel-Zanchett <i>et al.</i> (2019).
Modulation of CYP3A4 and CYP2D6 gene expression (role in drug biotransformation and drug-herb interactions).	Florianópolis, Santa Catarina, Brazil	Feltrin; Brambila; Simões (2019).
Reduction of microbial levels of a mature oral biofilm.	Ribeirão Preto, São Paulo, Brazil	Ferreira-Filho <i>et al.</i> (2019).
Improved lipid profile	Central and southern Chile	Mariángel <i>et al.</i> (2019).
Control of glucose levels	Niterói and Rio de Janeiro, Rio de Janeiro, Brazil	Pedrete; Hauser-Davis; Moreira (2019).
Hypoglycemic and antioxidant	Londrina, Paraná, Brazil	Pinafo <i>et al.</i> (2019).
Antioxidant action on epididymal tissue.	Londrina, Paraná, Brazil	Sampaio <i>et al.</i> (2019).
Dental biofilm treatment	Ribeirão Preto, São, Paulo, Brazil	Ferreira-Filho <i>et al.</i> (2020).
Antioxidant and antiglycant	Mairiporã, São Paulo, Brazil	Franco <i>et al.</i> (2020).
Modulation of norfloxacin resistance against <i>Staphylococcus aureus</i>	Santa Luz, Piauí, Brazil	Sousa <i>et al.</i> (2021).

* database PubMed.

This survey (Chart 2) did not include studies performed only with fractions of *B. forficata* extract. Several biological activities were observed, including antimicrobial, antimutagenic, vasorelaxant, gene expression modulation and antibiotic resistance, highlighting the research directed to antioxidant properties and/or related to diabetes control.

The findings mentioned above are extremely relevant because chronic non-communicable diseases (NCDs) are the main health problem worldwide. Recently, in Brazil, a reduction in cardiovascular diseases, chronic respiratory diseases and cancer was signaled. However, diabetes increased during this same period and NCDs were the leading causes of premature death showing that more and more initiatives are needed for control and treatment (MALTA *et al.*, 2017).

2.4 Toxicity

B. forficata is a medicinal plant that can be used as an adjuvant in the treatment of diabetes and is included among the 71 plants in RENISUS, due to its hypoglycemic action (BRASIL, 2009). It has already been reported that its use as a decoction does not cause detectable tissue damage or toxicity (CECILIO *et al.*, 2008).

Pepato *et al.* (2004) evaluated the toxicity of *B. forficata* and its effects on markers of amylase toxicity (pancreatic toxicity), creatine kinase (muscle toxicity), lactate dehydrogenase (muscle and liver toxicity), bilirubin (liver and bile toxicity) and enzyme converting angiotensin (renal microcirculation toxicity and renal toxicity). With the results, the authors concluded that the plant demonstrates potential for treatment for diabetes and does not produce measurable toxic effects.

The genotoxicity of the aqueous infusion of *B. monandra* leaves was evaluated by means of a phytochemical screening of the plant. The tests were performed in an *in vitro* model with plasmid DNA. The concentrations of *B. monandra* infusion tested were: 0.8 µg/µL, 4 µg/µL, 20 µg/µL and 100 µg/µL, and at these concentrations the infusion did not cause mutagenicity or cytotoxicity. At higher concentrations, they were able to induce breakage in DNA phosphodiester bonds and form abasic sites, an effect suggested by the presence of phenolic hydroxyl groups. The results revealed the risks and benefits of this plant extract for therapeutic use and its effects on the integrity of the genetic material, especially when used as a hyperglycemic agent (MACÊDO *et al.*, 2008).

A study where they were tested for mutagenicity by the Ames test using *Salmonella Typhimurium* strains with and without metabolic activation, the genotoxicity of aqueous extracts of two *Bauhinia* species was evaluated. The species *B. variegata* did not produce a mutagenic effect while the species *B. forficata* was mutagenic (RIVERA *et al.*, 1994).

Another study of *B. forficata* demonstrated a possible inhibition of thyroid peroxidase with *B. forficata* extract, where a 50% inhibition of the activity of iodide oxidation catalyzed by TPO (thyroperoxidase) was observed *in vitro* in the presence of 0.011% of plant extract, suggesting that chronic use could lead to hypothyroidism and lead to the formation of endemic goiter (NOGUEIRA; SABINO, 2012).

In *B. variegata* seeds, there are possible toxic or anti-nutritional factors that should be studied in more detail, therefore, care must be taken when using the seed as these components can be harmful to humans and animals (NOGUEIRA; SALBINO, 2012).

It is important to emphasize when there is a mixture of medicines and plants; the active ingredients are complex, and the effects resulting from the mixture can be additive, synergistic or antagonistic. It is urgent to establish rules for the evaluation of medicinal herbs for pharmacological, toxicological, and hemotoxic effects because, currently, instead of being used as a simple tea, they

are being marketed in mixtures and capsules with higher concentrations of these herbs (RIVERA *et al.*, 1994).

3. FINAL CONSIDERATIONS

In the present literature review of the *Bauhinia* genus, popularly known as *pata-de-vaca* due to the shape of its leaves, it was exposed that the different species have similar leaves, flowers with different colors such as purple, white and pink, however, *B. forficata* differs from others for presenting thorns and white flowers, being known as true cow's paw. It has been shown that *Bauhinia* has several therapeutic activities (hypoglycemic, antibacterial, diuretic, cholesterol lowering and antioxidant); having potential for use in the production of herbal medicines, as it has low toxicity. Despite this, there are still few clinical studies that would qualify it to be used in the treatment of diseases of great population impact. Thus, there is still much for future research with this genus, mainly correlating the biological effects with its chemical composition.

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