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Pharmacognosy
Ethnobotany, ecology, pharmacology, and chemistry of *Anredera cordifolia* (Basellaceae): a review

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Abstract

The potential of a plant with medicinal and nutritional properties, *Anredera cordifolia*, is reviewed. Its common names include "Bertalha" and "folha gorda" and it is popularly used for wound healing and against fungal infections and other types of infection. Its pharmacological properties have been widely investigated and acknowledged, especially with regard to its antibacterial activity, which improves the healing of wounds infected by *Staphylococcus aureus*, and to its antifungal activity against *Candida albicans*. It is an unconventional food plant, with leaves and aerial tubers used as food prepared in varied ways. It is also considered an invasive plant in several countries and thus classified as a weed. Its characteristics of a Brazilian native plant, with proven medicinal properties and unconventional use as food, underlie our study on its ecology and botanical classification, as well as the pharmacological assays and screening of chemical constituents.
Key words: antimicrobial activity, invasive plants, medicinal plants, phytochemistry, unconventional food plant.

Resumo

O potencial de uma planta com propriedades medicinais e alimentícias, *Anredera cordifolia*, é abordado nesta revisão. Esta planta é conhecida no Brasil por "bertalha" ou "folha gorda", sendo utilizada popularmente para o tratamento de feridas, fungos e infecções. Suas propriedades farmacológicas têm sido amplamente investigadas e confirmadas, com destaque para a ação antibacteriana, melhorando a cicatrização de feridas infeccionadas por *Staphylococcus aureus*, e ação antifúngica contra *Candida albicans*. É uma hortaliça não convencional, sendo suas folhas e bulbos aéreos consumidos na alimentação sob diversas formas. Também faz parte da flora invasora de vários países, e classificada popularmente como "erva daninha". Suas características de planta nativa brasileira, com reconhecido efeito medicinal e uso alimentício não convencional, conduzem as nossas investigações sobre ecologia e classificação botânica, ensaios farmacológicos e rastreio de constituintes químicos realizados com essa espécie.
Palavras-chave: atividade antimicrobiana, plantas invasoras, plantas medicinais, fitoquímica, planta alimentícia não convencional.

Introduction

The traditional medicine approaches to the prevention and diagnosis of diseases, improvement of physical and mental functions, and maintenance of health also include medicinal plants (OMS 2013). These plants are used in different formulations (infusions, ointments, syrups, among others) for the treatment and cure of diseases, and they are considered to be an age-old tradition in healthcare (Veiga Junior *et al*. 2005; Oliveira *et al*. 2007).

In Brazil, a country rife with biodiversity, species regarded as medicinal tend to be highly estimated. For example, 89 new monographs on plants and the review of another 58 (Brasil 2017) were included in the second supplement of Brazilian Pharmacopeia 5. Even though plants

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are broadly investigated in Brazil, it is widely known that many gaps still exist, especially in the case of angiosperms (Stehmann & Sobral 2017). Many plant species continue to be used in popular medicine without proven medicinal effects and despite the lack of knowledge of their possible undesirable effects (Heinzmann & Barros 2007).

With irrefutable medicinal properties *Anredera cordifolia* (Ten.) Steenis stands out in the treatment of wounds, fungal infections, and other types of infections (Heisler *et al*. 2012). *Anredera cordifolia*, which belongs to the family Basellaceae, is of great interest, not only because of its pharmacological properties, but also because of its high nutritional value.

The family Basellaceae includes genera without fleshy to succulent tendrils, herbaceous plants, or occasionally woody plants and erect plants. These perennial plants have subterranean and aerial tubers, with simple leaves without stipules, and with succulent, herbaceous, or lignified stems (Erikson 2007; Pellegrini & Imig 2019).

Basellaceae has a pantropical distribution of the genera *Anredera* Juss., *Basella* L., *Tournonia* Moq., and *Ullucus* Caldas. In Brazil, *Anredera cordifolia* and *Anredera tucumarensis* (Lillo & Hauman) Sperling are native species (Pellegrini & Sakuragui 2017), and the genus *Basella* was introduced in Brazil (Souza & Lorenzi 2012).

Anredera is the largest genus of this family with approximately 12 species, with broader diversity in the Andean region. It differs from the genus *Basella* because of its inflorescences with thin rachises (*vs.* fleshy ones in *Basella*), connate sepals (free ones in *Basella*), stalked and fragrant flowers (odorless and sessile in *Basella*), and spheroidal and echinate pollen (cuboidal and reticulate in *Basella*) (Erikson 2007; Pellegrini & Sakuragui 2017).

Native but not endemic to Brazil, *Anredera cordifolia* is popularly known as "bertalha, basela, folha-gorda, or trepadeira-mimosa" (Pellegrini & Imig 2019; Souza & Lorenzi 2012). In Indonesia and neighboring regions, it is known as "binahong" (Sumartiningsih 2011), whereas in Australia it is called "madeira vine" (Vivian-Smith *et al*. 2007). In Argentina, it is known as "zarza-parilla" (Scarpa 2004) and "papa santa" (Hilgert 2001).

It is considered an unconventional food plant, as its leaves and aerial tubers are eaten in varied forms (Kelen *et al*. 2015), serving as an excellent source of proteins and fibers (Martinevski *et al*. 2013). The leaves are used for making breads (Martinevski *et al*. 2013) and the tubers can be eaten either cooked or fried (Kinupp & Lorenzi 2014). It is also grown as an ornamental plant (Souza & Lorenzi 2012) *e.g.*, as hedge (Mogale *et al*. 2019). This species has a wide tropical distribution in America, Australia, China, Malaysia, Southern Pacific Islands, and Africa (Rasingam & Lakshminarasimhan 2012). In Brazil, it is found in the northeast (Bahia, Ceará, and Pernambuco); midwest (Mato Grosso do Sul); southeast (Espírito Santo, Minas Gerais, Rio de Janeiro, and São Paulo); and south (Paraná, Rio Grande do Sul, and Santa Catarina) (Pellegrini & Imig 2019).

In Brazil, this species has fallen into disuse (Kinupp *et al.* 2004), and it has been underinvestigated in pharmacological studies. In other countries such as Indonesia, many studies have been conducted, corroborating its pharmacological potential. A literature review was performed, demonstrating the medicinal and nutritional properties of this species, as well as its potential for the development of pharmaceuticals.

Materials and Methods

A literature search was conducted in Scielo, Scopus, Web of Science, Medline, and BioOne databases, in addition to books and other sources such as botanical gardens around the world. The scientific names (*Anredera cordifolia* and *Bossingaultia gracilis*) were used as descriptor, with no restriction imposed on year of publication. The species *Anredera cordifolia* was photographed in the city of Sarandi-RS (27º58'11,9064"S - 52º54'29.7864"W) and was identified by the curator Prof. Cristiano Roberto Buzatto. The exsiccates are stored under the number: RSPF 14413, at the Herbarium RSPF which is linked to the Zoobotanic Museum Augusto Ruschi (MUZAR), from the Institute of Biological Sciences of the University of Passo Fundo (UPF).

Results and Discussion

Botany, ecology, and chemical and biological control

Anredera cordifolia is a climbing plant, found in forest borders, on fences along roads, and in plots of land at 1,000 m to 2,000 m (Rasingam & Lakshminarasimhan 2012). It is also seen in anthropized regions, such as in vacant lots in urban areas (Fig. 1a) (Imig *et al*. 2015), as it is considered to be ruderal (Pellegrini & Sakuragui 2017). In

Brazil, more specifically in the state of Rio Grande do Sul, it is found on the borders of rainforests and in the Pampa region (Souza & Lorenzi 2012; Pellegrini & Sakuragui 2017).

This species grows in well-lit environments and has fleshy tubers that may be seen in the nodes of aerial petioles (Fig. 1b) (Vivian-Smith *et al*. 2007). Its leaves are cordate to ovate (Boyne *et al*. 2013) very fleshy, dark green, shiny, and rarely elliptical (Imig *et al*. 2015; Pellegrini & Sakuragui 2017). It is characterized by white, pendent, and fragrant inflorescences (Souza & Lorenzi 2012) such as racemes or panicles, either axillary or terminal (Fig. 1c). The flowers are perfect with triangular to broadly ovate bracteoles, the sepals are broadly ovate to broadly elliptical, the petals are uniform, patent, elliptical to obovate, white or greenish white, with trifid style and capitate stigma. The fruit is a patent brown achene (Pellegrini & Sakuragui 2017).

Anredera cordifolia differs from *Anredera tucumarensis* because of the presence of aerial tubers, membranous leaves with no involute margins *in sicco*, poorly apparent secondary veins, connate bracteoles, uniform petals larger than the sepals, and trifid style (Erikson 2007; Pellegrini & Sakuragui 2017). In terms of leaf anatomy, the epidermis of *A. cordifolia* lacks trichomes and the stomata have two to three subsidiary cells on both leaf surfaces. The mesophyll has mucilage cells, calcium oxalate, narrow vascular bundles, and no sclerenchyma (Boyne *et al.* 2013). Chromosome analysis revealed that *A. cordifolia* subspecies *gracilis* has sexual reproduction, bearing viable fruits, with 2n = 24 chromosomes. *Anredera cordifolia* subspecies *cordifolia* only reproduces vegetatively, with 2n = 36 chromosomes (Xifreda *et al*. 2000).

Widely known in Portugal, this species was introduced there in 1961, when it was regarded as a species that would be problematic in the future (Silva *et al*. 2015). *Anredera cordifolia* includes highly invasive lianas, as a result of phenotypic plasticity (Pintó-Marijuan & Munné-Bosch 2013) and it is therefore classified as an "invasive plant" (Kinupp *et al*. 2004) or "weed" (Palmer *et al*. 2010). It is known as an "*alien plant*" in Australia, China, and Africa (Jian *et al*. 2008; Baard & Kraaij 2014; Byrne *et al*. 2017; Gao *et al*. 2018; Shen *et al*. 2018), where sustained effort has been put in for its control (Van Driesche *et al*. 2010).

In China, it is found in vacant lots, orchards, forests, roads, and conservation units, and it has been reported to invade crops such as banana, lemon, and orange (Shen *et al*. 2017; Zhu *et al*. 2018). In abandoned lands with yellow soil, there are a large number of vines as compared to other species, and these vines eventually reduce the number of seedlings, inhibiting restoration and ecological succession (Haitan *et al*. 2011). *Anredera cordifolia* is a threat to several plant communities (Vivian-Smith *et al*. 2007) and it is also harmful to riparian vegetation (Floyd 1989).

In New South Wales, Australia, it has been a threat to the local biodiversity, requiring control measures (Downey *et al*. 2010). A study undertaken in Argentina revealed that a beetle belonging to the family Chrysomelidae, *Plectonycha correntina* Lacordaire, may be used as a biocontrol agent against *A. cordifolia* (Cagnotti *et al*. 2007; Westhuizen 2011). This species is host to Dichotomophthora, they are used for the biological control of *A. cordifolia*, as they cause leaf abscesses, spots, and seed rot (Marin-Felix *et al*. 2019). Regarding chemical control, *Anredera cordifolia* is tolerant of glyphosate and fluroxypyr-meptyl treatments in some cases (Waryszak *et al*. 2018).

Figure 1 – a-c. *Anredera cordifolia* – a. aerial parts; b. tubers; c. flowers. Scale bars: a. 21 mm; b. 10 mm; c. 4 mm.

Ethnobotany

In several regions around the world, *A. cordifolia* has been described and used as a medicinal plant. Studies carried out in Asia, especially in Indonesia and neighboring regions, used ointments and gels made from extracts of the plant, which demonstrated antibacterial activity (Zulfa *et al*. 2017), and efficacy in wound healing (Istyastono & Yuliani 2016; Shrivastav *et al*. 2018) including wounds infected by *Staphylococcus aureus* (Paju *et al*. 2013). The gel aided in the healing of burns (Istyastono & Yuliani 2016; Prasetyo & Herihadi 2013) and in the reduction of diabetic ulcers in rats (Kintoko & Desmayanti 2016). In Malaysia, *A. cordifolia* is used to treat diabetes, liver diseases, hypertension, hypercholesterolemia, blood clots, and mental and physical stress (Astuti *et al*. 2011). Moreover, in Thailand, its leaves and stalks are used by parturients as postpartum tonic (Panyaphu *et al*. 2011; Fitriana *et al*. 2018) and for milk letdown, its leaves are cooked with chicken (Srithi *et al.* 2012).

In Africa, the plant is used as a medicinal agent (Magwede *et al*. 2018) for the treatment of sexually transmitted infections (Tshikalange *et al*. 2005) such as for the treatment of gonorrhea, in which the seeds are used (Mulaudzi *et al*. 2015; Mulia *et al*. 2017).

In Latin America, it is broadly used as a medicinal plant as well. In Colombia, it is used to treat diabetes, fractures, conjunctivitis, and cough (Bussmann *et al*. 2018). In Uruguay, it is utilized against poisonings and as eye wash (Paz *et al*. 1995). In northwestern Argentina, its stems are cut into thick slices and placed on the patient's forehead to treat headaches, and on the cheeks to treat toothaches (Hilgert 2001). A mixture containing a handful of leaves in 2 liters of water is drunk as tea for nine days in a row to treat amenorrhea (Scarpa 2004). In addition, *A. cordifolia* is used against cough and ocular inflammatory disease in Argentina (Paccard 1905).

In Brazil, the plant is used as a medicinal herb, mainly in the southern region (Zank & Hanazaki 2012). For instance, in the state of Rio Grande do Sul, its fresh leaves are used to treat burns, wounds, onychomycosis, and insect bites (Heisler *et al*. 2012). In a village of artesanal fisherman, also in Rio Grande do Sul, in the Biological Reserve of Lami, it is used as a medicinal herb and as food source, its is leaves anda stalks are used as aphrodisiac, and also against skin lesions and circulatory system disordes (Baptista *et al*. 2013).

Pharmacological assays

In vitro

Several studies have shown promising results against microorganisms (Tshikalange *et al.* 2005; Yan *et al*. 2011; Garmana *et al*. 2014; Souza *et al.* 2014). The ethanolic extract obtained from the stem demonstrated antifungal activity against *Candida albicans* (Kumalasari & Sulistyani 2011). The infusion of *A. cordifolia* leaves at high concentrations inhibited the growth of *Porphyromonas gingivalis* and *Prevotella intermedia* (Maharani *et al*. 2018). The n-hexane, ethyl acetate and ethanolic extracts of *A. cordifolia* leaves showed activity against *Mycobacterium tuberculosis* strains, and the hexane extract showed better activity (Pitaloka & Sukandar 2018).

Aqueous and chloroform extracts obtained from the roots inhibited the growth of several bacteria, including *Staphylococcus* and *Pseudomonas*, in a screening in Africa in which six medicinal species were tested (Tshikalange *et al*. 2005). The growth of *Streptococcus mutans* was inhibited by ethanolic extract of leaves (Rimporok *et al.* 2015). *Bacillus cereus*, *Salmonella enteritidis* (Rahmawati & Bintari 2014), *Escherichia coli*, *Staphylococcus aureus, Pseudomonas aeruginosa* and *Bacillus subtilis* (Paz *et al*. 1995), also had their growth inhibited by aqueous leaf extracts of the plant. On the other hand, the methanolic extract prepared from *A. cordifolia* leaves did not inhibit the growth of *Staphylococcus aureus*, *Enterococcus faecalis*, *Escherichia coli*, and *Pseudomonas aeruginosa* (Amertha *et al*. 2012).

A phytotherapeutic product with *A. cordifolia* seeds and other plants was efficient in inhibiting the growth of *Staphylococcus aureus*, *Klebsiella pneumoniae*, and *Neisseria gonorrhoeae*, and also in inhibiting HIV-1 reverse transcriptase, without causing mutagenic effects (Mulaudzi *et al.* 2015).

Besides the antimicrobial activity of *A. cordifolia*, the literature describes a considerable number of pharmacological studies on this species. Promising effects of leaf extracts have been described against cervical cancer (Yuliani *et al.* 2015), and reduction of a tumor necrosis factor and other inflammatory mediators in macrophage lines (Laksmitawati *et al*. 2017). Ethanolic leaf extract of *A. cordifolia* and *Centella asiatica* L. exhibited anti-inflammatory activity in human red blood cells in a membrane stabilization assay (Sutrisno *et al*. 2016). Leaf extract microemulsion at 0.5 % also demonstrated antiaging effects (Nazliniwaty *et al*. 2018).

In vivo assays

The literature describes a wide variety of *in vivo* pharmacological assays with raw extracts and fractions obtained from *Anredera cordifolia*. The oral administration, in Guinea pig (*Cavia cobaya)*, of 50 mg leaf extract improved immunity and resistance during and after childbirth, also improving the blood parameters and quality of postpartum care (Wijayanti *et al*. 2016, 2017). Its leaf extract was also efficient in the wound healing of guinea pigs (Miladiyah & Prabowo 2012) and demonstrated vasodilatory properties in rabbits and toads (Sukandar *et al.* 2016a).

Tests with Wistar rats revealed that the ethanolic leaf extract of *A. cordifolia* works as an antiobesity medication (Sukandar *et al.* 2016b), has diuretic effects, and lowers blood pressure (Garmana *et al*. 2016), total cholesterol, and triglyceride levels (Lestari *et al*. 2015). Moreover, the ethanolic extract may be used to treat gout, as it reduces serum urate levels (Widyarin*i et al*. 2015; Hendriani & Sukandar 2016).

Other assays indicated that the ethanolic extract was efficient in the treatment of kidney failure in Wistar rats (Sukandar *et al*. 2011, 2013), protected against the effects of ethanol on the renal proximal tubular epithelial cells of Sprague-Dawley albino rats (Asmariati *et al*. 2014). Also, the ethanolic extract exhibited analgesic activity in the "plantar test method" (Yuziani *et al*. 2014). The administration of ethanolic extract of *A. cordifolia* combined with that of black mulberry (*Morus nigra* L.) enhanced the lipid profile of rats (Sukandar *et al*. 2016c), and combined with the extract of *Areca catechu* L., it reduced the incidence of *Ascaridia galli* in *Gallus gallus domesticus* (Prastowo *et al*. 2017). The administration of *A. cordifolia* to Wistar rats for 3 days reduced cellular inflammation by 5% and increased fibroblast growth in bruises (Sumartiningsih 2011). *A. cordifolia* rhizomes contain ancordin, a protein that can inhibit trypsin and stimulate the cellular production of nitric oxide (Chuang *et al.* 2007).

Toxicity

Regarding toxic effects, *Anredera cordifolia* is not toxic to Wistar rats (Salasanti *et al.* 2014), and it does not have teratogenic effects on them (Sukandar *et al.* 2014). The cytotoxic, genotoxic, and antimutagenic effects of *Boussingaultia gracilis* Miers var. *pseudobaselloides* Bailey were investigated in *Salmonella typhimurium* (Ames test) and in human lymphocytes (comet assay), and was found to be non-toxic (Yen *et al*. 2001).

Phytochemistry

Even though the pharmacological properties of *Anredera cordifolia* have been widely investigated, reports on the chemical compounds present in its extracts are limited to phytochemical screening, to a study on its volatile constituents, and to some compounds in particular, such as saponins and flavonoids.

Lin *et al*. (1988) isolated a new triterpenoid sapogenin, elucidated as ethyl 3β-hydroxy-30-noroleana-12,18-dien-29-oate, from *Boussingaultia gracilis* (*A. cordifolia* synonym). Their study also describes the isolation of another five sapogenins: larreagenin A, 3β-hydroxy-30-noroleana-12,19-dien-28-oic acid and its ethyl ester, ursolic acid, 28-ethyl hydrogen 3β-hydroxyolean-12-ene-28,29-dioate.

Other compounds isolated from *A. cordifolia* leaf extracts include 3,5,3',4'-tetrahydroxyflavone (Rahmawati *et al.* 2013) and the flavonoid 8-glucopyranosyl-4',5,7-trihydroxyflavone (vitexin) (Djamil 2012). Vitexin exhibited antioxidant activity when tested with the 2,2-diphenyl-1-picrylhydrazyl (DPPH) method (Djamil 2012), and demonstrated *in vitro* α-glucosidase inhibitory activity and antidiabetic activity in alloxan-induced mice (Djamil 2012; Djamil *et al.* 2017). A new method for the extraction of this compound from *A. cordifolia* leaves, with a non-toxic and environmentally friendly solvent, was proposed (Mulia *et al*. 2017). Myricetin and morin were detected by high-performance liquid chromatography (HPLC), whereas kaempferol and quercetin were not found in *A. cordifolia* leaves extracts. The concentrations of polyphenols, flavonoids, and flavonols were determined by spectrophotometric methods, but anthocyanidins were not detected (Chao *et al*. 2014). On the other hand, Yang *et al*. (2008), in a work with 91 edible species, related the presence of quercetin in shoots of *A. cordifolia*.

The volatile constituents of the aerial parts were analyzed and the major compounds were phytol (15.33 %), alpha-pinene (9.0 %), and 6,10,14-trimethyl pentadecanone (6.12 %). In this work vitexin and isovitexin were also isolated (Abou-Zeid *et al.* 2007). The essential oil was analyzed by GC and GC-MS and 19 compounds were identified. Hydrocarbons were the main constituents (67.7 %) (Souza *et al*. 2014).

Lupeol and β-sitosterol (Basyuni *et al*. 2017), and ursolic acid (Yuliani & Istyastono 2013) were detected by thin-layer chromatography (TLC). Using TLC as a support, UV-VIS, and FTIR spectrophotometry, Ekaviantiwi *et al*. (2013) concluded that ethanolic extracts of leaves might contain *p*-coumaric acid. The presence of saponins was verified by general detection tests (foam formation), using TLC, and also by the analytical method (Astuti *et al*. 2011). The tests were positive for saponins in all plant parts.

Phytochemical screening was positive for flavonoids, saponins, steroids/terpenoids, and alkaloids (Ekaviantiwi *et al*. 2013; Rahmawati *et al*. 2013; Elya *et al*. 2015; Lestari *et al*. 2015, 2016; Sukandar *et al*. 2016c; Pitaloka & Sukandar 2018). Screening of alkaloids showed also negative results (Kumalasari & Sulistyani 2011; Garmana *et al.* 2014; Sukandar *et al.* 2016b; Kaunang & Semuel 2017) or positive ones only for Dragendorff's reagent, with negative results for Bouchardat's, Wagner's, and Mayer's reagents (Basyuni *et al*. 2017). Some authors found negative results in the screening test for tannins (Kumalasari & Sulistyani 2011; Elya *et al*. 2015; Lestari *et al*. 2015, 2016; Sukandar *et al.* 2016b) whereas some obtained positive results (Ekaviantiwi *et al*. 2013; Rahmawati *et al*. 2013; Garmana *et al*. 2016; Sukandar *et al.* 2016c; Kaunang & Semuel 2017; Pitaloka & Sukandar 2018). Polyphenols (Kumalasari & Sulistyani 2011; Sukandar *et al*. 2016b, c; Basyuni *et al*. 2017; Pitaloka & Sukandar 2018) and glucoside (Astuti *et al*. 2011; Elya *et al*. 2015) were also detected in screening tests. Some studies checked for the presence of quinones but all tests were negative (Garmana *et al*. 2014; Elya *et*

Table 1 – Phytochemical screening test results for *A. cordifolia* described in the literature.

Reference	Saponins	Steroids/ terpenoids	Flavonoids	Alkaloids	Tannins	Polyphenols	Glucosides	Quinones
Astuti *et al.* (2011)	(+)	(+)	----	(+)	----	----	(+)	----
Kumalasari & Sulistyani (2011)	(+)	----	(+)	(-)	(-)	(+)	----	----
Ekaviantiwi *et al.* (2013)	(+)	(+)	(+)	(+)	(+)	----	----	----
Rahmawati *et al.* (2013)	(+)	(+)	(+)	(+)	(+)	----	----	----
Garmana *et al.* (2014)	(+)	(+)	(+)	(-)	----	----	----	(-)
Elya *et al.* (2015)	(+)	(+)	(+)	(+)	(-)	----	(+)	(-)
Lestari *et al.* (2015, 2016)	(+)	(+)	(+)	(+)	(-)	----	----	(-)
Garmana *et al.* (2016)	(+)	(+)	(+)	----	(+)	----	----	----
Sukandar *et al.* (2016b)	(+)	(+)	(+)	(-)	(-)	(+)	----	(-)
Sukandar *et al.* (2016c)	(+)	(+)	(+)	(+)	(+)	(+)	----	(-)
Basyuni *et al.* (2017)	(+)	(+)	----	*(+) **(-)	----	(+)	----	----
Kaunang & Semuel (2017)	(+)	(-)	(+)	(-)	(+)	----	----	----
Pitaloka & Sukandar (2018)	(+)	(+)	(+)	(+)	(+)	(+)	----	(+)

(+) = positive tests; (-) = negative tests; *(+) = with Dragendorf's reagent; **(-) = with Mayer, Bouchardat and Wagner's reagents.

al. 2015; Lestari *et al*. 2015, 2016; Sukandar *et al.* 2016b, c). However, Pitaloka & Sukandar (2018) found positive results for quinones. Table 1 lists the articles and results obtained from phytochemical screening tests with *A. cordifolia* extracts.

Therefore, vitexin, isovitexin, myricetin, morin, 3,5,3',4'-tetrahydroxyflavon and ursolic acid; larreagenin A, 3β-hydroxy-30-noroleana-12,19-dien-28-oic acid and its ethyl ester, 28-ethyl hydrogen 3β-hydroxyolean-12-ene-28,29-dioate, and ethyl 3β-hydroxy-30-noroleana-12,18-dien-29-oate were isolated from *A. cordifolia* extracts. The probable presence of *p*-coumaric acid, lupeol, and β-sitosterol was verified by TLC using a reference standard.

The present review demonstrates the main uses, as well as the medicinal and nutritional properties, of *A. cordifolia*. This plant is an invasive species in several countries, and the problems caused by it and its management should be addressed. *A. cordifolia* is a promising medicinal plant, as several pharmacological assays corroborate its efficacy, especially its antimicrobial activity. Some flavonoids, such as vitexin, isovitexin, morin, and myricetin, in addition to sapogenins such as ursolic acid were isolated from its extracts. Phytochemical screening evidenced the presence of metabolites such as alkaloids, flavonoids, saponins, steroids, and terpenoids. The isolation and identification of other chemical compounds and the characterization of a marker for this species are essential for the development of a phytotherapeutic agent from *A. cordifolia* extracts.

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