UFSM

CIÊNCIA e NATURA

ISSN 2179-460X
OPEN ACCESS

Ci. e Nat., Santa Maria, e86145, v. 47, 2025 • https://doi.org/10.5902/2179460X86145
Submitted: 14/12/2023 • Approved: 24/01/2025 • Published: 01/04/2025

Biology-Botany

Medicinal potential of tree vegetation for respiratory system treatment in southern Brazil

Potencial medicinal da vegetação arbórea para tratamento do aparelho respiratório no sul do Brasil

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ABSTRACT

The Southern coal region of Santa Catarina concentrates 10.5% of Brazil's mineral coal reserves, and the ore extraction process has greatly contributed to the environmental degradation of the Urussanga River Basin in this region. At a global level, areas contaminated by coal mining cause public health concerns, owing to illnesses that may be associated with this practice, for example, respiratory diseases. In this context, the present study aimed to identify tree species with medicinal potential to treat respiratory diseases, sampled along the tributaries of the Urussanga River. For this purpose, a bibliographical review was conducted for 119 tree species recorded in the study area through a previous floristic survey. We searched the Scopus, SciELO, Science Direct, and PubMed databases for ethnobotanical and phytochemical studies that addressed the medicinal potential of these species for the respiratory system. Of the 119 species, 12 (10.08%) showed medicinal potential for the respiratory system. Of these, five were recommended for coughs and unspecified diseases affecting the respiratory tract, four for asthma, three for bronchitis, two for pneumonia, and one for laryngitis and acute lung problems. This finding highlights the medicinal potential of tree species native to Brazil present in the Urussanga River Hydrographic Basin region. However, further scientific studies are necessary to evaluate the phytochemical profile and pharmacological activity of these tree species from the Atlantic Forest biome, whose floristic composition has already been notably modified.

Keywords: Medicinal plants; Phytotherapy; Respiratory problems

RESUMO

A região carbonífera do Sul de Santa Catarina concentra 10,5% das reservas de carvão mineral do Brasil, e o processo de extração do minério tem contribuído muito para a degradação ambiental da Bacia do Rio Urussanga nesta região. A nível global, as áreas contaminadas pela mineração de carvão

causam preocupações de saúde pública, devido a doenças que podem estar associadas a esta prática, por exemplo, doenças respiratórias. Neste contexto, o presente estudo teve como objetivo identificar espécies arbóreas com potencial medicinal para tratamento de doenças respiratórias, amostradas ao longo dos afluentes do Rio Urussanga. Para tanto, foi realizada uma revisão bibliográfica de 119 espécies arbóreas registradas na área de estudo através de levantamento florístico prévio. Foram pesquisadas nas bases de dados Scopus, SciELO, Science Direct e PubMed estudos etnobotânicos e fitoquímicos, que abordassem o potencial medicinal dessas espécies para o sistema respiratório. Das 119 espécies, 12 (10,08%) apresentaram potencial medicinal para o aparelho respiratório. Destes, cinco foram recomendados para tosse e doenças não especificadas que afetam o trato respiratório, quatro para asma, três para bronquite, dois para pneumonia e um para laringite e problemas pulmonares agudos. Essa constatação destaca o potencial medicinal de espécies arbóreas nativas do Brasil presentes na região da Bacia Hidrográfica do Rio Urussanga. Porém, mais estudos científicos são necessários para avaliar o perfil fitoquímico e a atividade farmacológica dessas espécies arbóreas do bioma Mata Atlântica, cuja composição florística já foi notavelmente modificada.

Palavras-chave: Plantas medicinais; Fitoterapia; Problemas respiratórios

1 INTRODUCTION

The growth of the economy throughout the 20th century was driven by the supply of energy, the main source of which consists of fossil fuels oil and coal. However, the processes involved in the production and consumption of these fuels generate serious socio-environmental damage that affects the quality of water, soil, and air (Touché, 2004).

The Southern coal region of Santa Catarina concentrates 10.5% of Brazil's mineral coal reserves which, owing to incentives for the use of mineral coal and the limitations of extraction and processing methods, have greatly contributed to the environmental degradation of the three main regional river basins: the basins of the Araranguá, Urussanga and Tubarão rivers (Menezes & Waterkemper, 2009). Therefore, these regions, even today, remain with a serious environmental liability.

The coal burning process releases a mixture of pollutants, formed by particles and toxic compounds whose main polluting agent is particulate matter, which is normally associated with other inorganic and organic pollutants emitted into the atmosphere (Rodrigues, Vormittag, Cavalcante, & Saldiva, 2015; Dias, Rinaldi, & Domingos, 2016). This is one of the reasons why areas contaminated by coal mining have raised public

health concerns, due to different pathologies that may be associated with this practice (Ranjan, 2019), e.g., respiratory diseases.

The polluting agents released by the burning of mineral coal can affect the distal regions of the airways of the exposed population, weakening their pulmonary system, causing the appearance of respiratory symptoms, as well as significant reduction of lung function, increasing the risks for the development of various respiratory diseases (Perez, Rapp, & Künzli, 2010; Pramchoo, Geater, Jamulitrat, Geater & Tangtrakulwanich 2017) which may be irreversible in some cases.

In some states of Southern Brazil, such as Santa Catarina, the incidence of respiratory disease is increasing (Ministério da Saúde, 2010). According to the Department of Health System Information (Datasus, 2024), respiratory problems in Southern Brazil were the third highest cause of hospitalization in the public health system in the year 2023.

The population of the Urussanga River Basin is approximately 120 thousand people (Adami, & Cunha, 2014). Its socio-environmental reality is strongly related to the negative impacts caused by the coal industry. However, over time, these communities surrounding the mined areas developed links with their environment, learning about the plant resources available in each location, a behavior that coevolved with the plant resources available (Blanco et al., 2020).

In this context, previous studies have sought to understand locally available plant resources that are accessible to the population, especially those that have the potential to treat respiratory diseases. Notably, few studies have been carried out with medicinal plants for the treatment of respiratory diseases in the Santa Catarina coal region; one study that is noteworthy was conducted by Borges, Amaral e Citadini-Zanette (2021b), who focused on ethnobotanical knowledge while investigating species grown in a backyard.

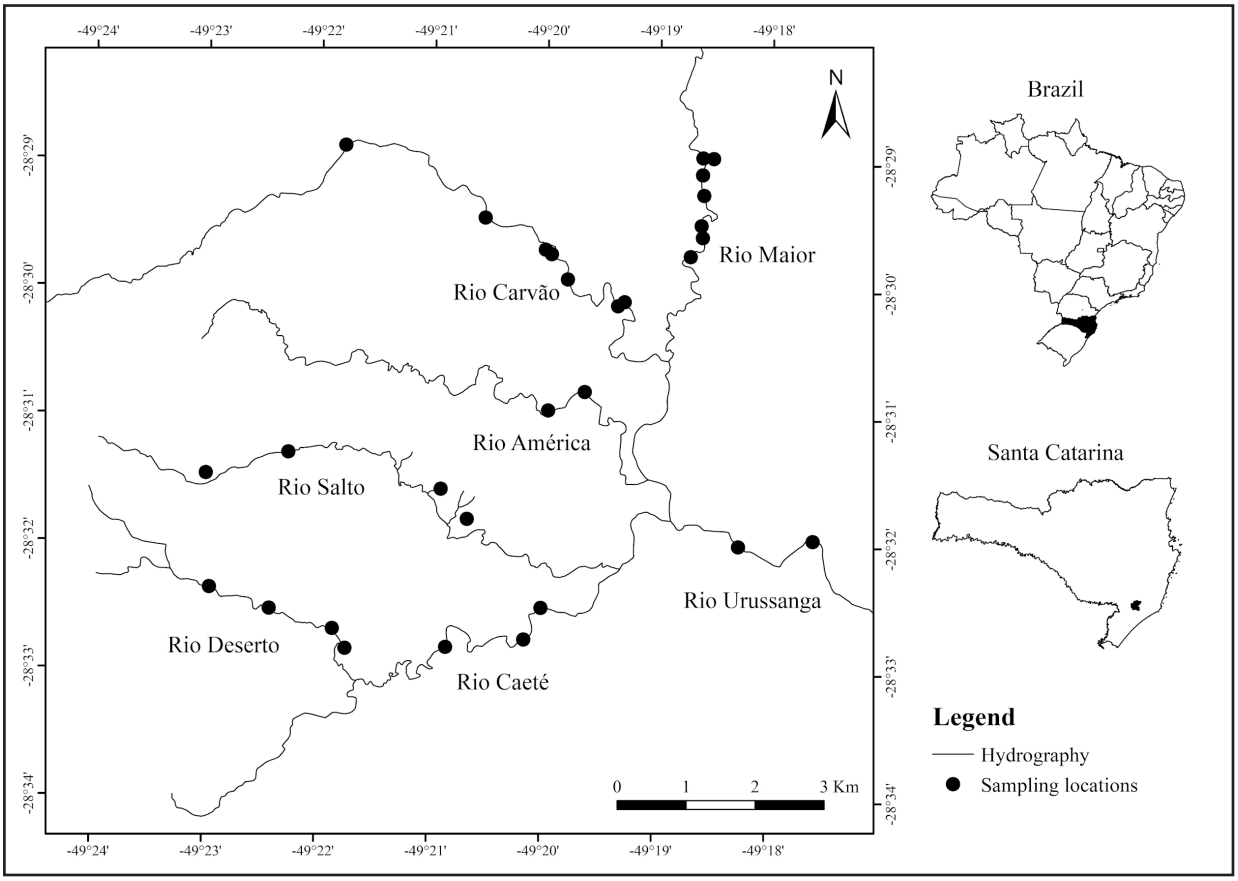
Therefore, the purpose of this study was to recognize and identify tree species native to Brazil with popular use for diseases of the respiratory system, sampled in forest remnants, belonging to the Atlantic Forest of Southern Brazil, along the rivers that make up the river basin Urussanga.

2 METHODOLOGY

This study was based on the floristic survey carried out in the Urussanga River Basin by Martins et al. (2019), located in the municipality of Urussanga, state of Santa Catarina, Southern Brazil. According to Köppen, the climate in the region is classified as Cfa, humid mesothermal, with usually well-distributed rainfall, and hot summers (Alvares, Stape, Sentelhas, Golçalves, & Sparovek, 2013). The vegetation belongs to the Dense Ombrophilous Forest Submontane formation, which is part of the Atlantic Forest biome (Instituto Brasileiro de Geografia e estatística [IBGE], 2012). This biome is under constant threat because of the anthropogenic changes, which result in the vast fragmentation of its landscape and the loss of its biological diversity. Some of the main human interventions that caused the degradation of the Atlantic Forest biome were agricultural activities, urbanization, and land subdivisions, which left only 12% of the original area of this biome in Brazil (Amorim, Sousa, & Lourenço, 2019).

Although constantly threatened, the Atlantic Forest biome is home to several plant species that have great potential for sustainable use. The present study investigated the medicinal potential of 119 tree species recorded by Martins et al. (2019) in the municipality of Urussanga, located in this biome. The survey of the riparian arboreal component was carried out in 29 forest fragments, located in seven rivers (América, Caeté, Carvão, Deserto, Maior, Salto and Urussanga) belonging to the Urussanga River Basin (Figure 1).

Figure 1 – Location of the study area and sampling sites where the survey of the arboreal component was carried out in the Urussanga River Basin, municipality of Urussanga, south of Santa Catarina, Brazil



Source: Martins et al. (2019), modified

For the 119 species sampled, a bibliographic review was carried out to record the popular use of these species for the respiratory system. For the review, ethnobotanical and phytochemical studies published until 2021 were considered. For each tree species, the scientific binomial was reviewed and updated by the Flora e Funga do Brasil (Reflora, 2023) and, after, the updated names and their synonyms were used as a search in the electronic databases Scopus, SciELO, Science Direct and PubMed, and for a refined search, the terms pneumoconiosis, bronchitis, cough, asthma, anti-inflammatory, respiratory disease, respiratory and lung were used.

The common names of the medicinal plant species used in this study are in accordance with those mentioned in the region.

3 RESULTS

The bibliographic review of the 119 tree species recorded in the floristic survey identified 12 species that showed therapeutic potential for respiratory diseases, with mention in biological and ethnobotanical studies. Of these study 12 species, five were ethnologically indicated for coughs and unspecified respiratory system diseases, four for asthma, three for bronchitis, two for pneumonia and one for laryngitis and acute lung problems (Table 1).

Table 1 – Tree species present in the Urussanga River Basin of medicinal popular use for the respiratory system, presentation of the Pharmacogen (part of the plant used), preparation method (when found), Ethnoindication, or phytochemical studies (Ethno/ Phytoc) and References where the information was found

(To be continued)

Scientific name, **(common name), botanical family**	**Pharmacogen and Preparation method**	**Ethno/Phytoc**	**References**
Annona sylvatica A.St.-Hil., (araticum), Annonaceae	Leaves infusion	Cough	Vendruscolo et al. (2005)
Campomanesia xanthocarpa **(**Mart.) O. Berg, (gabiroba), Myrtaceae	Decoction of the plant and mixture with eucalyptus, garlic, oil and bee honey	Bronchitis, pneumonia	Kujawska e Zamudio; Hilgert (2012)
Cecropia glaziovii Snethl., (embaúba), Urticaceae	Bracts	Asthma	Petroni, Huffman, & Rodrigues (2017)
	Decoction and syrup of the leaves	Bronchitis	Yazbek et al. (2019)
Cedrela fissilis Vell., (cedro-rosa), Meliaceae**.**	Bark decoction and leaves infusion	Respiratory system diseases	Bolson, Hefler, Chaves, Gasparotto, e Cardozo (2015)
Cupania vernalis Cambess., (camboatá-vermelho), Sapindaceae	Bark	Cough, Asthma	Ricardo et al. (2017)
	Bark decoction	Respiratory system diseases	Bolson et al. (2015)

Table 1 – Tree species present in the Urussanga River Basin of medicinal popular use for the respiratory system, presentation of the Pharmacogen (part of the plant used), preparation method (when found), Ethnoindication, or phytochemical studies (Ethno/Phytoc) and References where the information was found

(Conclusion)

Scientific name, **(common name), botanical family**	**Pharmacogen and Preparation method**	**Ethno/Phytoc**	**References**
Ficus luschnathiana (Miq.) Miq., (figueira-mata-pau), Moraceae	Frutos in *natura*	Asthma	Kujawska e Schmeda-Hirschmann (2022)
Eugenia involucrata DC., (cereja-do-rio-grande), Myrtaceae	Leaves infusion	Respiratory system diseases	Bolson et al. (2015)
	Bark decoction	Respiratory system diseases	Bolson et al. (2015)
	Infusion and decoction of the bark, leaves and flowers, mixed with bee honey or burnt sugar	Cough	Kujawska, e Schmeda-Hirschmann (2022)
	Decoction and syrup	Pneumonia, cough, flu	Bieski, Santos, Oliveira, Espinosa, Macedo, Albuquerque, e Martins (2012)
	Leaves infusion and bark decoction	Respiratory system diseases, laryngitis, bronchitis	Mentz, Lutzenberger, & Schenkel (1997)
Machaerium hirtum (Vell.) Stellfed, (bico-de-pato) Fabaceae	Bark decoction	Cough	Ribeiro et al. (2016) apud Ponci et al., 2020)
Nectandra leucantha Nees & Mart., (canela-branca), Lauraceae	Leaves infusion	Asthma, anti-inflammatory activity in acute lung problems	Grecco et al. (2016 apud Ponci et al., 2020)
Nectandra megapotamica (Spreng.) Mez, (canela-amarela), Lauraceae	Leaves infusion	Cough and flu	Alves, Mota, Soares, Vieira e Silva (2008)
Syagrus romanzoffiana (Cham.) Glassman, (jerivá), Arecaceae	Infusion, decoction and syrup of the roots, flowers, leaves, fruits and stem	Respiratory system diseases	Bolson et al. (2015)
	Fruit macerated in wine or syrup	Chest pains	Correa (1926 apud Silva, & Parente, 2010)

Source: Prepared by the authors (2023)

Standing out among these species is *Luehea divaricata* Mart., with antinociceptive and anti-inflammatory properties (Batista, Trindade, Lira, Muller, Silva, & Batista, 2016), which was cited in five studies, with ethnoindication for bronchitis, cough, pneumonia, laryngitis, and unspecified respiratory system diseases. Its bark and leaves are the most used parts in the form of infusions, decoctions, and syrups (Table 1).

Luehea divaricata is a tree native to Brazil, belonging to the Malvaceae family and popularly known as açoita-cavalo. In folk medicine, it is indicated to treat different diseases (Bieski, Santos, Oliveira, Espinosa, Macedo, Albuquerque, & Martins, 2012; Bolson, Hefler, Chaves, Gasparotto, & Cardozo, 2015). Some biological activities studies report the use of the species for medicinal purposes where the leaves are used as a diuretic, the stems are used as anti-inflammatory medicines, and the bark and aerial parts are used to heal skin wounds, pimples and for vaginal washing (Zacchino et al., 1998; Tanaka et al., 2005). According to Bieski et al. (2012), the popular indication cited most prominently by those interviewed in their study was the use of *L. divaricata* to treat lung and upper airway diseases. This indication may be associated with the anti-inflammatory properties found in the species (Cruz, 2008; Batista et al., 2016).

According to Bolson et al. (2015), residents of the region surrounding forest fragments in the state of Paraná, Southern Brazil, have vast ethnomedicinal knowledge and rely on herbal remedies to treat health problems. According to data collected in their interviews, many of the participants cited the use of *L. divaricata* for the treatment of respiratory diseases, notably bronchitis. The study also demonstrated that there was a high level of agreement among informants for diseases of the respiratory system, which may be an indicator of the species' effectiveness.

Lauraceae, popularly known as the "cinnamon family", was recorded with two species in the present study (*Nectandra leucantha* Nees & Mart. and *Nectandra megapotamica* (Spreng.) Mez). Species of this family have therapeutic potential for coughs and the representatives are famous for their anti-inflammatory and antioxidant properties, such as *Cinnamomum verum* J. Presl (true cinnamon) (Ranasinghe et al.,

2013; Sharifi-Rad et al., 2021). *N. leucantha* (white cinnamon) is present with three citations in the search; the use of the leaves was cited in studies that address its medicinal potential to treat asthma, and its anti-inflammatory activity in acute lung problems (Table 1).

A phytochemical study on biological activity carried out by Bittencourt-Mernak et al. (2021) found that the treatment with eugenol and dehydrodieugenol B compounds isolated from fresh leaves of *N. leucantha*, showed positive results for the treatment of acute lung injury. According to the study, the compounds did not affect cell viability and reduced pulmonary edema and inflammatory cells, showing that eugenol and dehydrodieugenol B can be considered as a pharmacological tool to reduce acute lung inflammation.

For *Nectandra megapotamica*, only one ethnobotanical study was found regarding the use of it in the treatment of respiratory diseases. Alves, Mota, Soares, Vieira e Silva (2008), reported that tea from the plant's leaves is used to treat coughs and the flu by residents of the city of Dourados, Mato Grosso do Sul, Brazil.

Cupania vernalis Cambess., belonging to the Sapindaceae family and popularly known as camboatá-vermelho, was cited in two studies. It is recommended for coughs, asthma, and unspecified respiratory system diseases; the bark is used in the form of decoction (Table 1). A study carried out by Ricardo, Paula-Souza, Andrade, e Brandão (2017) on the species of traditional Brazilian plants, described in the books of the Polish doctor Piotr Czerniewicz (Pedro Luiz Napoleão Chernoviz, 1812–1881), showed that *C. vernalis* was cited and the use of it was subsequently published in the Medical Formulary and Guide in 1888 for the treatment of asthma and cough. This report is in line with more recent studies such as that by Bolson et al. (2015), who cited *C. vernalis* for the treatment of respiratory diseases.

Cecropia glaziovii Snethl. (embaúba), a species belonging to the Urticaceae family and typical of mountainous slopes of the Atlantic Forest Domain in Brazil (Reflora, 2023), was also addressed in two ethnobotanical studies, and they were indicated

for asthma and bronchitis. The bracts and leaves were used in the form of decoction and syrup (Table 1). The ethnoindication of *C. glaziovii* for bronchitis was based on an ethnopharmacological study focusing on medicinal plants, carried out by Yazbek et al. (2019) with a population living in quilombos located in the Southeast Region of Brazil.

Machaerium hirtum (Vell.) Stellfeld, with the common name of bico-de-pato (duckbill) and belonging to the Fabaceae family, was discussed in a study that mentions the decoction of the bark as ethnoindicated for treating coughs (Table 1). This same popular use was reported in another study, not found in the databases consulted, on Pantanal Plants carried out by Pott e Pott (1994). However, Ribeiro *et al*. (2016) also investigated its antimutagenic action.

Cedrela fissilis Vell., popularly known as cedro-rosa, was present in only one study, and it was ethnoindicated for unspecified diseases of the respiratory system, using decoction of the bark and infusion of the leaves (Table 1). This species, belonging to the Meliaceae family, is predominantly distributed in the South and Southeast regions of Brazil. Limonoids are the main chemical components found in *C. fissilis*, which is common in this family in the bark of the stem, and the presence of phenolic compounds are also frequently mentioned in the literature (Dutra, 2018).

Although few references were found for *Cedrella fissilis*, the species has wide use for other health problems. Popular uses of the bark include the preparation of tea, which is known for its strengthening, astringent and antipyretic properties. Furthermore, it is commonly indicated for the treatment of diarrhea and joint inflammation, such as arthritis. The bark of *C. fissilis* is also recommended for the treatment of vaginal discharge, and its decoction is used to treat wounds, ulcers and orchitis (Carvalho, 2003; Vieira, Amaral, Watanuri, Souza, & Augustini, 2016).

Campomanesia xanthocarpa (Mart.) O. Berg, popularly known as gabiroba, is a species belonging to the Myrtaceae family, known by the Tupi-Guarani people as Guabira-roba which means “spicy fruit”. This is juicy, sweet, and acidic; it is considered

very tasty, and can be consumed fresh or used in the manufacture of jellies, sweets, juices, liqueurs, and ice creams (Coradin, Siminsk, & Reis, 2011).

In the study about medicinal mixtures carried out by Kujawska, Zamudi, e Hilgert (2012), the use of *Campomanesia xanthocarpa* was associated with eucalyptus, garlic, olive oil, and bee honey. According to those interviewed in the study carried out by the authors, the leaves of the plant are used in the form of a decoction for the medicinal mixture, which is administered orally and is indicated for the treatment of bronchitis and pneumonia (Table 1).

Ficus luschnathiana (Miq.) Miq. (figueira-mata-pau), belonging to the Moraceae family, was addressed in only one study that deals with the use of it in respiratory system problems (Table 1). A survey was carried out with information about the use of

medicinal plants in the daily lives of Paraguayan residents of the Province of Misiones, Argentina. According to the interviewed respondents, the consumption of raw *F. luschnathiana* fruits is used to treat asthma. The respondents also reported that internal use of the species' leaves is indicated as an abortifacient, and its external use as sacred in the treatment of surrender" (Kujawska & Schmeda-Hirschmann, 2022).

Another species that was present in only one study was *Annona sylvatica* A.St.-Hil., popularly known as araticum; it is part of the Annonaceae botanical family (Reflora, 2023). A phytochemical study carried out with *A. sylvatica*, aiming to evaluate the anti-inflammatory and anti-allergic properties of its methanolic extract, demonstrated that *A. sylvatica* has flavonoids and acetogenins, which could be responsible for the anti-inflammatory and anti-allergic effects tested and proven in the study (Andrade-Silva et al., 2020). This result can also shed light on the use of the species in traditional medicine for the treatment of coughs (Vendruscolo, Simões, & Mentz., 2005), which can sometimes be related to allergies or inflammations.

Additionally, research with the *Annona* genus has proven that it has several pharmacological activities, such as antiulcerogenic, antioxidant, antidiarrheal and antiparasitic ones. These activities occur because *Annona* species have a large number

of phytochemicals, which can be found in almost all parts of the plant, allowing the compounds to be isolated and used in the development of herbal medicines (Kusmardiyani, Suharli, Insanu, & Fidrianny, 2020).

Eugenia involucrata DC., which has the common name of cereja-do-rio-grande and belongs of the Myrtaceae family, is a fruit species from the Atlantic Forest Biome, which has several potential uses, including its fruits, which are traditionally used in culinary and for fresh consumption (Lisbôa, Kinupp, & Barros, 2011). The leaves of *E. involucrata* are used in medicinal infusions, as shown in the study by Bolson et al. (2015), who mentioned the use of its leaves to treat diseases of the respiratory system.

There were two studies for *Syagrus romanzoffiana* (Cham.) Glassman, a species belonging to the palm tree group (Arecaceae) and popularly known as jerivá (Table 1). According to Silva e Parente (2010), the use of it in folk medicine for respiratory tract diseases may be associated with the anti-inflammatory activity that this species presents in its phytochemical components. *S. romanzoffiana* is also widely used in Guarani indigenous medicine, in which different parts of the plant are used to treat different diseases: a) the roots are used for oral hygiene to protect against cavities, against bleeding during pregnancy, and as a blood purifier; b) the stem (stipe) is also used for oral health, as a healing agent for wounds and boils, against fever, and as an antiparasitic and antidote for snake bites; c) the apical bud is used as a healing agent and protector of the digestive system; d) the leaves are used during pregnancy, childbirth, and the postpartum period and e) the inflorescences are used to promote a good birth experience (Araújo, Keller & Hilgert, 2020).

Different studies report on the biological activity and efficiency of plant species used to treat respiratory diseases. The use of the whole plant of the *Coronopus didymus* (L.) Sm. species showed anti-allergic, anti-inflammatory and antipyretic biological activity (Mantena et al., 2005; Busnardo et al. 2010). Furthermore, studies carried out with *Lippia alba* (Mill.) N.E.Br. ex Britton & P.Wilson leaves showed analgesic and anti-inflammatory biological activity (Haldar et al., 2012; Carmona et al., 2013). Both species are used in folk

medicine to treat diseases of the respiratory system such as flu, bronchitis, pneumonia and throat and lung infections (Borges, Amaral & Citadini-Zanette, 2021a).

Based on the above, research carried out about biological activities with the species presented in this study mostly points to polyphenolic compounds as responsible for the anti-inflammatory activity, which may be responsible for helping to combat respiratory problems, remembering that they are phytoconstituents that act as antioxidants, inhibiting in a certain way the mediators of the inflammatory process, such as flavonoids (Andrade-Silva et al., 2020). From these works, two studies carried out tests with isolated compounds such as Eugenol and Dehydrodieugenol (polyphenols) (Santana et al., 2020) galactomannoglucan (carbohydrate) (Silva & Parente, 2010) which, compared to the tests carried out by these groups, these compounds help in processes of allergies and pain, which confirms popular knowledge that cannot be disregarded and highlights the medicinal potential of the species studied here.

Therefore, the popular knowledge of medicinal plants as found in nature safeguards their condition that promotes quality of life and their use can be encouraged by those who use them. However, further scientific studies are necessary to evaluate the phytochemical profile and pharmacological activity of these tree species from the Atlantic Forest biome, whose floristic composition has already been notably modified.

4 CONCLUSIONS

Floristic surveys combined with ethnobotanical surveys enable the therapeutic actions of plants to be known and, subsequently, scientifically proven through more refined analyses. Studies that seek to understand the potential of Brazilian medicinal flora species, which evaluate phytochemical and pharmacological activities, can also contribute to the conservation of these species, since many of them are still unknown to the scientific community and are threatened by intense anthropic actions, such as species from Atlantic Forest biome.

The search for the therapeutic potential of the 119 species recorded in the floristic survey carried out in the Urussanga River Basin, Southern Brazil, which resulted in 12 species with potential for respiratory system diseases, highlighted the species *Luehea divaricata* Mart. as having antinociceptive and anti-inflammatory properties and because it is the most cited in ethnobotanical studies in the databases consulted, could be a promising species for further biological studies. The main indications found in this study were for coughs and unspecified diseases that affect the respiratory tract.

This finding highlights the contribution and richness of tree species of the Brazilian flora with attributes that are little known in science and that still need to be studied further, mainly to evaluate the phytochemical profile and the relationship of its compounds with the pharmacological activity of these tree species.

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How to quote this article

Citadini-Zanette, V., Varela, E. P., De Bona, M., Tramontin, D. P., & Amaral, P. A. (2025). Medicinal potential of tree vegetation for respiratory system treatment in southern Brazil. *Ciencia e Natura*, 47, e86145. doi: 10.5902/2179460X86145.