

# *Bauhinia guianensis* Aubl., a Plant from Amazon Biome with Promising Biologically Active Properties: A Systematic Review

Rosemary de Carvalho Rocha Koga, Abrahão Victor Tavares de Lima Teixeira dos Santos, Rosângela do Socorro Ferreira Rodrigues Sarquis, José Carlos Tavares Carvalho\*

## ABSTRACT

**Introduction:** The literature demonstrates a scarcity of pharmacological and toxicological studies that reveal the usefulness and safety in using products that present as active raw material *Bauhinia guianensis* Aubl. This study aimed to research the botanical aspects, traditional use, and phytochemical composition of the vegetal species *Bauhinia guianensis* Aubl., described in international scientific literature. **Methods:** A search was carried out in different databases, specifically in the Biblioteca Virtual em Saúde-BVS, Embase, Lilacs, PubMed/Medline, CAPES Periodic, ResearchGate, SciELO, ScienceDirect and Scopus, with the descriptor "*Bauhinia guianensis* Aubl.," published between 1996 and 2020. **Results:** The results show few studies on this vegetal species, mainly related to the *in vivo* study of the anti-inflammatory and antinociceptive activities that extracts from both the plant how much of your endophytic fungi can present. **Conclusion:** It is also important to identify the active constituents since there are rare analyses of the composition and structure of metabolites present in this plant or its endophytic fungi. This plant species is a promising source for obtaining biologically natural compounds that validate the ethanopharmacological use of *Bauhinia guianensis* Aubl. **Key words:** *Bauhinia guianensis* Aubl., Botanical aspects, Phytochemical composition, Ethnopharmacology, Ethnobotany, Amazonia.

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## History

- Submission Date: 31-03-2021;
- Review completed: 26-04-2021;
- Accepted Date: 14-05-2021.

DOI : 10.5530/phrev.2021.15.9

## Article Available online

<http://www.phcogrev.com/v15/i29>

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## INTRODUCTION

The accumulated knowledge, empirically, about the medicinal properties of plants has been passed on since the beginning of human existence.<sup>[1,2]</sup> Thus, configuring the importance of combining the different knowledge of medicinal flora (communities and traditional specialists) with chemical studies and pharmacological.<sup>[3]</sup> Traditional use constitutes a factor of extreme relevance in scientific research.<sup>[4]</sup> Ethnocognition and its peculiarities, in pharmacodynamic terms, can lead to the identification of therapeutic or toxic properties of many vegetal species.<sup>[5,6]</sup> Therefore, ethnopharmacology permeates the formulation of valuable and promising hypotheses in developing new drugs.<sup>[7,8]</sup>

Therefore, the interrelationship between the human population and plants in systems dynamic, that is, ethnopharmacology, through traditional knowledge associated with biodiversity, push Brazil to an elite level, compared to other countries, favoring its potential in the development of new biologically active agents.<sup>[9]</sup> For example, in the Amazon Hylean, the riverside communities, quilombola, indigenous and/or interior, resort to the forest, sometimes, as the only resource accessible treatment for the cure of their illnesses, either in the treatment of inflammation, pain, or other diseases of the body and soul.<sup>[10,11]</sup>

Although empirical knowledge is essential, it is worth emphasizing the importance of phytochemical studies on the chimerdiversity of vegetal species to synthesize new drugs.<sup>[12]</sup> From the perspective of pharmaceutical innovation, the secondary metabolites of vegetal species stand out, whose active ingredients have a specific function, combined with chemical signaling, communication between species, protection from predators, and maintenance of the species in the environment, these metabolites when applied to the pharmacological environment are associated with biological activities.<sup>[13]</sup> Among the plants that produce active ingredients, the representativeness of the Family stands out of Fabaceae in the Amazon Region.

The vast presence of the Fabaceae Family in the Northern Region, with 156 genera,<sup>[14]</sup> allied to its broad medicinal, environmental and economic importance is based on research and innovation instruments in the therapeutic field,<sup>[15]</sup> in due to widespread consumption in the form of teas and other preparations in the treatment of various illnesses, mainly infections, painful processes and diabetes.<sup>[16]</sup> Among its species is *Bauhinia guianensis* Aubl. (*B. guianensis* Aubl.), Known as the tortoise ladder, it is widespread, empirically, for treating asthma, leishmaniasis, inflammatory processes,

**Cite this article:** Koga RCR, Santos AVTLT, Sarquis RSFR, Carvalho JCT. *Bauhinia guianensis* Aubl., a Plant from Amazon Biome with Promising Biologically Active Properties: A Systematic Review. Pharmacogn Rev. 2021;15(29):76-81.

pain, antimalarial processes, diarrhea, and in the control of menstrual flow.<sup>[17,18]</sup>

This vegetal species is home to endophytic micro-organisms, fungi, and bacteria that live inside the plant in symbiotic harmony.<sup>[19]</sup> Thus, the symbiosis of plant-fungus-bacterial species arouses pharmaceutical interest regarding chemical aspects and biological activities or synergistic effects provided by that ecological association. Furthermore, the use of *B. guianensis* Aubl. in inflammatory processes can represent an alternative to minimize side effects or chemical dependence in most of the conventionally used anti-inflammatories and analgesics.<sup>[20]</sup>

So, studying the pharmacological performance of vegetal drugs, such as *B. guianensis* Aubl., Mainly because they have little information in the literature, will contribute to the scientific proof of medicinal purposes, be it the plant itself, the presence of its endophytic micro-organisms, or the synergy between species when used.<sup>[21,22]</sup>

However, *Bauhinia guianensis* Aubl. constitutes a promising source for obtaining biopharmaceuticals derived from the production of secondary metabolites of the plant species and/or its endophytic micro-organisms, with biological activities of interest, including anti-inflammatory, antinociceptive activity. It is necessary to know the research that deals with the main characteristics and its micro-organisms, such as botanical, ethanopharmacological, and phytochemical studies, aiming to guide future biological tests on the bioactive action this plant and its endophytic micro-organisms.

## METHODOLOGY

### Bibliographic survey

The bibliographic survey used different international scientific databases, such as Biblioteca Virtual em Saúde-BVS, Embase, Lilacs, PubMed/Medline, Periódicos CAPES, ResearchGate, SciELO, ScienceDirect and Scopus, using the descriptor "*Bauhinia guianensis* Aubl.," from 1996 to 2020.<sup>[16,23]</sup>

### Selection of information

The research was carried out about the studies pertinent to *B. guianensis* Aubl. Selected works that involved the investigation of this species and its endophytic fungi (Figure 1).

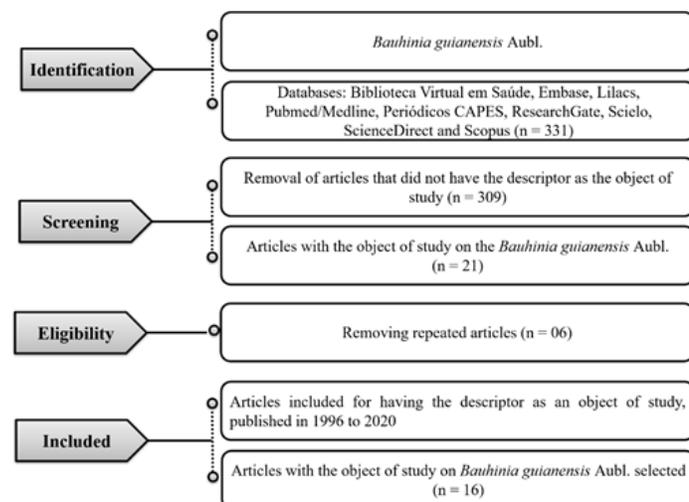


Figure 1: Flowchart of the selection criteria for the articles of interest.

### Data extraction

The selected articles were analyzed to systematize and guide future studies of this vegetal species, excluding articles that do not have the descriptor as the research object or repeated in the databases consulted.

## RESULTS AND DISCUSSION

### Publications related to plant species

Figure 2 shows the number of publications found referring to *B. guianensis* Aubl. in the different databases. In the BVS, eight articles were found. At ResearchGate, three searches were found, a repetition of the previous database. While at SciELO, an article was obtained, being a repetition of the last database. In the Science Direct database, there were nine works, three of which have already been reported in the previous databases. In the Embase, Lilacs, PubMed/Medline, CAPES Periodic, and Scopus databases, no article related to *B. guianensis* Aubl. Were found as an object study. In short, a total of sixteen studies studied *B. guianensis* Aubl. were selected.

### Botanical aspects

The genus *Bauhinia* (Fabaceae) consists of approximately 300 species. It is widely distributed in tropical regions of Africa, Asia, and South America.<sup>[24]</sup> The genus is pre-Linnean, described in 1703 by Charles Plumier. The word *Bauhinia* is a tribute to the brothers Bauhin, John, and Gaspar, doctors, and botanists of the 16th century, represented by the shape of the bilobed leaves of the species of this genus. The taxon was well accepted throughout the 18<sup>th</sup> century. Linnaeus made it valid from 1753 and described eight species.<sup>[25]</sup>

The taxonomic description of the liana "cipó," understudy, began in 1775, with the definition of *Bauhinia guianensis* exposed by the French botanist and pharmacist Fusée Aublet, in addition to other researchers dedicated to the study and identification of this taxon, such as the American botanist Richard Wunderlin and members of the Botanical Garden of Rio de Janeiro, such as the botanist Angela Vaz.<sup>[25-27]</sup>

According to Wiersema,<sup>[28]</sup> the biological classification of *B. guianensis* Aubl. Occurs in the following taxonomic classification: Reino *Plantae*, Family *Fabaceae* Lindl., Subfamily *Caesalpinioideae*, *Cercidae* Tribe, Subtribe *Bauhiniinae*, Genus *Bauhinia* L., Species *Bauhinia guianensis* Aubl.

There is an extensive synonym for species, such as: *Bauhinia chrysophylla* M. Vahl ex DC, *Bauhinia chrysophylla* Vogel, *Bauhinia excisa* (Griseb.) Hemsl., *Bauhinia guianensis* Aubl., *Bauhinia guianensis* var. *splendens* (Kunth) Amshoff, *Bauhinia manca* Standl., *Bauhinia obovata* S.F. Blake,

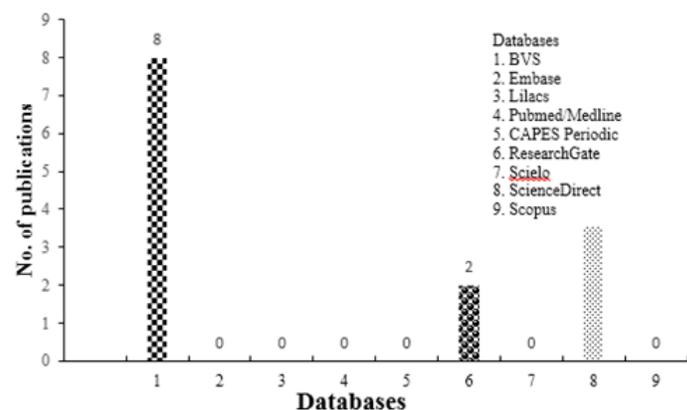


Figure 2: Number of publications with the object of study related to the species *B. guianensis* Aubl., in different databases. Published 1996 to 2020.

*Bauhinia outimouta* Aubl., *Bauhinia platycalyx* Benth., *Bauhinia sericella* Standl., *Bauhinia splendens* Kunth, *Bauhinia splendens* var. *latifolia* Benth., *Bauhinia sprucei* var. *acuminata* Benth., *Bauhinia thompsonii* I.M. Johnston., *Schnella bicomata* Pittier, *Schnella excisa* Griseb., *Schnella obovata* (S.F. Blake) Britton and J. N. Rose and *Schnella splendens* (Kunth) Benth.<sup>[29]</sup>

*B. guianensis* Aubl. It is distributed throughout the Amazon Biome, being found in Bolivia, Brazil, Colombia, Guyana, French Guiana, Peru, Suriname, and Venezuela. In Brazil, it is native throughout the North Region. However, in the State of Maranhão, it was also collected and identified in remnants of the Atlantic Forest Biome in the State of São Paulo.<sup>[4]</sup>

*B. guianensis* Aubl. it is a nitrogen-fixing plant and is photoautotrophic.<sup>[30,31]</sup> It is a species that varies in size, shape, and presentation of the leaves (Figures 3a and 3b). Mature specimens usually have bifoliate or at least deeply bilobed leaves (Figure 3c); inflorescences with the dense ferruginous-bright tone, developed flowers, white petals, externally villous (Figure 3d); pod-shaped fruits (Figure 3e).<sup>[32,33]</sup>

### Ethnopharmacology

There are variations in the widespread knowledge of *B. guianensis* Aubl. between villages or regions. That probably depends on external influences (indigenous or not), the number of people in the older generations, the time the community lives in the region it inhabits, and other socio-historical factors. It is also observed that the names used for the same plant can vary from one region to another.<sup>[34]</sup>

Indigenous communities of the Alto Rio Negro, in the northwest of the state of Amazonas, use the auto ladder, a term in Nheengatu, in the language of the indigenous people, to name malaria, due to the dimensions of the plant, to treat malaria. Stem in the form of tortoise and spacing between "steps".<sup>[35]</sup> Wayãpi indigenous ethnic groups, residing in French Guiana and Alto Oiapoque, use the stem, shaved into thin splinters to prepare a decoction used to treat dysentery and diarrhea. For the Wayãpis, ayâyula is the "spirit ladder," that is, a vine very close to the spirits.<sup>[36]</sup>

In Roraima, the Yanomami people use tuwakarama t<sup>h</sup> ot<sup>h</sup>o, to treat stomach pains, diarrhea, and conjunctivitis. They cut the vine, peel it, and crush it to extract its juice, mix it with water so that it can be drunk; they also tie the vine around the belly; in the treatment of conjunctivitis, the juice of the vine drips into the eyes.<sup>[37]</sup> In Yanomami cosmology, tuwakarama t<sup>h</sup> ot<sup>h</sup>o was used by ancestors as a ladder until it broke, causing the protagonists to fall and transform into different animals, according to the places of their respective falls.<sup>[34,38]</sup>

The Wajãpi women from the Midwestern state of Amapá, residing in the municipalities of Laranjal do Jari and Pedra Branca do Amapari, reported to *B. guianensis* Aubl. as kadjura, used to treat bloody diarrhea and abdominal pain.<sup>[39]</sup> In contrast, Watoriki women use white flowers of tuwakarama t<sup>h</sup> ot<sup>h</sup>o (*B. guianensis* Aubl.) as ornaments in the holes of the lobes of their ears and their cotton armbands.<sup>[34]</sup>



**Figure 3:** (a) Tendril; (b) stem; (c) Leaf; (d) Flower; (e) Fruit - *B. guianensis* Aubl. (tortoise ladder), respectively. Photos are taken in February 2020 in Macapá-AP, State of Amapá, Brazil (0°00'37"N 51°06'59"W).

In Guyana and Suriname, the vine is known by the Arawak people as hikuritarafon, which in their language means turtle steps. In Suriname, they are also called guayamufрати. In the same country, in another ethnicity, the Galibis call it ya-outi-mouta; the indigenous Sranans call it sekepatoe trapoe; the Tiriós call it mo-ro-go-go eh-heh; while the Wayanas know it as Ku-yu-le huh-hah-nu-kut-puh. In Guyana, the Patamona indigenous people call kha-wouii-eng-gu-mapui-yik, kha-wouii-eng-gou-ma-pouii-yik. Ethnic groups use it to treat colic, fever, intestinal worms, in addition to using it as an aphrodisiac and as a fish poison.<sup>[40]</sup>

### Traditional Use and Scientific Conception

Gupta *et al.*<sup>[32]</sup> described the use in folk medicine of *B. guianensis* Aubl. by the community of Suni Miraño, in Loreto, Peru, through interviews with healers, midwives, and residents (mainly elderly), who reported the use of this plant to treat diarrhea. Carvalho *et al.*,<sup>[41]</sup> Viana *et al.*,<sup>[42]</sup> Muñoz *et al.*<sup>[43]</sup> and Pinheiro *et al.*,<sup>[18]</sup> also described this same use. Still being more specific, it was pointed out by Carvalho *et al.*<sup>[41]</sup> and Viana *et al.*<sup>[42]</sup> as an amebicide. As described in an ethnobotanical study by Branch and Silva (1983),<sup>[44]</sup> which described the use in the folk medicine of *B. guianensis* Aubl. in a community resident in Alter do Chão-Pará-Brazil, by the settlers who treated cases of diarrhea and amoeba.

The plant is commonly reported for use in the event of an asthmatic crisis<sup>[18,41,42]</sup> as would have already been mentioned by Amorozo and Gély<sup>[45]</sup> when they raised plant species used for medicinal purposes in two villages in Barcarena-Pará-Brazil. The caboclos of the Lower Amazon mentioned *B. guianensis* Aubl. for its therapeutic use for asthma.

*B. guianensis* Aubl. it is pointed out in some studies because it is popularly used to fight infections; according to this information, Pinheiro *et al.*<sup>[18,46,47]</sup> evaluated the bioprospecting of extracts of endophytic fungi present in that plant for antibacterial activity.

Muñoz *et al.*,<sup>[43]</sup> Pinheiro *et al.*<sup>[46,47]</sup> report the use of this plant to treat painful processes. What was previously evidenced *in vivo* by Carvalho *et al.*<sup>[41]</sup> when they induced abdominal contortions with acetic acid in Swiss mice and treated them with extracts of *B. guianensis* Aubl., Obtained with dichloromethane, they administered the said extract orally, which showed significant inhibition of the algogenic process in animals.

*B. guianensis* Aubl. is indicated in the literature as beneficial for the treatment of diabetes.<sup>[17, 46,47]</sup> It is also reported by Ferreira,<sup>[48]</sup> Coe,<sup>[49]</sup> and Yazbek<sup>[50]</sup> as a medication to treat excessive menstrual bleeding; postpartum period and restore menstrual flow to normal levels. As observed by Elisabetsky and Posey,<sup>[51]</sup> contraceptives traditionally used by Kayapós Indians, from the Gorotire Kayapó Reserve, located in the south of Pará, in the study, the authors reported that the indigenous use *B. guianensis* Aubl. for the control of the menstrual cycle, cramps, and uterine bleeding. Other studies have described it as a medicinal alternative to treat stings from venomous animals, such as snakes and scorpions.<sup>[52,53]</sup>

The studies by Quintans-Júnior *et al.*<sup>[17]</sup> on 17 plants used in folk medicine suggested that the hydroalcoholic extracts of *B. guianensis* Aubl. are helpful anticonvulsants. This fact was described after using the extract in Swiss mice with convulsions induced by Pentylenetetrazole and by Electrochoque Auricular. In the test with the application of the extract, there was significant latency of the seizure threshold. *B. guianensis* Aubl. is described in the literature by Muñoz *et al.*<sup>[43]</sup> as helpful in curing relevant symptoms of malaria by Chacobos, a native community residing in the Amazonian part of Bolivia.

### Phytochemical composition

The traditional use of the tortoise ladder in treating inflammation and pain can be attributed to the action or presence of secondary

metabolites and molecules, such as alkaloids, isocoumarins, cytochalasins, naphthoquinones, and flavonoids, already identified in *B. guianensis* Aubl.<sup>[17,18,42,47,54]</sup> Studies obtained from endophytic fungi have identified some chemical constituents, such as monocerine, ergosterol, ergosterol peroxide, mevalonolactone, cytochalasin B, cytochalasin H, isosclerone, uracil, uridine, p-hydroxybenzoic acid, cerevisterol, ducitol, monomethylsulfochrine, triphidone, triphidone A, pseurotin A; fumigaclavin C.<sup>[18,46,47,54,55]</sup> While the constituents lapachol and flavone

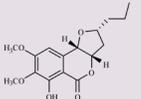
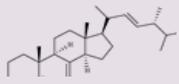
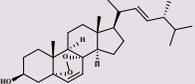
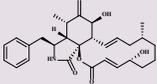
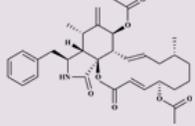
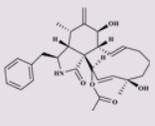
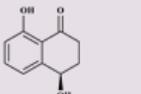
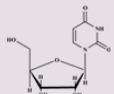
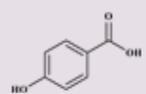
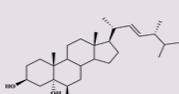
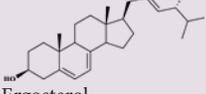
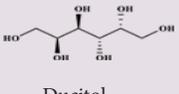
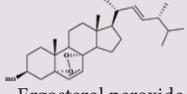
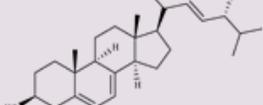
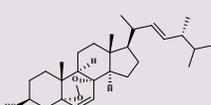
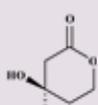
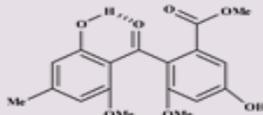
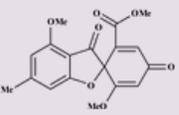
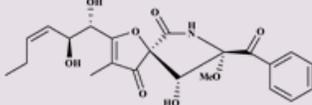
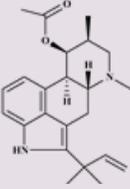
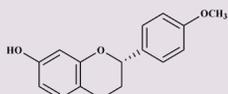
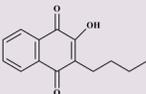
4'-hydroxy-7-methoxy flavone were extracted from *B. guianensis* Aubl., Table 1.<sup>[42]</sup>

### Biological activities

The importance of studies with biological activity, based on the citations of the use of *B. guianensis* Aubl., helps confirm its safety and efficacy and isolate bioactive constituents.<sup>[41]</sup>

The study by Pinheiro *et al.*<sup>[47]</sup> searched for new antimicrobials through bioprospecting extracts of endophytic fungi isolated from *B. guianensis*

**Table 1: Phytochemical constituents of *B. guianensis* Aubl. and/or its endophytic fungi.**

Phytochemical constituents found in endophytic fungi isolated from <i>B. guianensis</i> Aubl.		Reference
 Monocerine		[47]
 Ergosterol	 Ergosterol peroxide	[54]
	 (R)-(-)-Mevalonolactone	
 Cytochalasin B	 7,20-Diacetyl-cytochalasin B	
	 Cytochalasin H	
 4,8-dihydroxy-1-tetralone	 Uridine	[55]
	 P-hydroxybenzoic acid	
	 Cerevisterol	
 Ergosterol	 Ducitol	
	 Ergosterol peroxide	
	 Uracil	
 Ergosterol	 Ergosterol peroxide	[46]
	 Mevalonolactone	
 Monomethylsulfochrine	 Triphidone A	
 Pseurotin A	 Fumigaclavin C	[18]
Phytochemical constituents found in methanolic extract of <i>B. guianensis</i> Aubl.		Reference
 Lapachol	 4'-hydroxy-7-methoxy flavone	[41]

Aubl. Observed that the methanolic extract of the fungus *Exserohilum rostratum* inhibited the growth of the tested bacteria (*Escherichia coli* (ATCC 25922)).

According to Feitosa et al.<sup>[54]</sup> when evaluating the endophytic fungi of *B. guianensis* Aubl., from a strain of *Aspergillus* sp., isolated substances with high lethality against *Artemia salina*, such as cytochalasins.

Pinheiro et al.<sup>[18]</sup> by isolating endophytic fungi from *B. guianensis* Aubl., *Aspergillus* sp., also tested antimicrobial activities. Since they obtained pure substances from polar fractions of ethyl acetate extract, the alkaloids fumigaclavin C and pseurotin. When testing the substances against *Bacillus subtilis* cultures, fumigaclavin C demonstrated more significant activity.

Another study reported the isolation and structural identification of compounds obtained from the fungus *Aspergillus* sp., isolated from endophytes of *B. guianensis* Aubl. The authors observed that when testing these compounds on the bacteria *Escherichia coli*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, and *Staphylococcus aureus*, all had a bactericidal effect.<sup>[18]</sup>

A study from the biomass produced by the endophytic fungus *Pestalotiopsis* sp. obtained from the referred *B. guianensis* Aubl., isolated eight biologically active compounds, with expressive biological activities: antifungal (4,8-dihydroxy-1-tetralone), antiviral (Uridine; p-hydroxybenzoic acid), and anticancer (ergosterol and peroxide of ergosterol).<sup>[55]</sup>

## Conclusions and Future Perspectives

*B. guianensis* Aubl. is a plant native to the Brazilian Amazon; few scientific reports of biomedical and pharmacological research on chemical properties and biological activities may present this species. The possibility of anti-inflammatory and antinociceptive bioactivity of this plant can be better explored since there is still insufficient research on such activities. There is no report in the literature of studies in humans about using extracts of *B. guianensis* Aubl. Thus, there is insufficient scientific evidence to ensure that the ethanopharmacological use of this plant is safe. The interest in this plant should be focused on evaluating the extracts of both the plant and the extracts of its endophytic fungi, specifically in studies focused on anti-inflammatory and antinociceptive activity. Thus, it is important to identify its active constituents since there are rare analyses of the composition and structure of the metabolites present in this plant or from its endophytic fungi. In short, this plant is a promising source for obtaining other biologically active natural compounds.

## ACKNOWLEDGEMENT

The authors would like to thank CAPES (1723/2018 - 00 - PROCAD - AMAZONIA) and INCT North -Northeast Network of Phytoproducts -CNPq.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

## ABBREVIATIONS

**B. guianensis** Aubl.: *Bauhinia guianensis* Aubl.; **BVS**: Virtual Health Library; **CAPES**: Coordination for the Improvement of Higher Education Personnel; **EMBASE**: Excerpta Medica Database; **LILACS**: Latin American and Caribbean Literature in Health Sciences; **MEDLINE**: Medical Literature Analysis and Retrieval System Online; **SciELO**: Scientific Electronic Library Online.

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**Cite this article:** Koga RCR, Santos AVTLT, Sarquis RSFR, Carvalho JCT. *Bauhinia guianensis* Aubl., a Plant from Amazon Biome with Promising Biologically Active Properties: A Systematic Review. *Pharmacog Rev*. 2021;15(29):76-81.