**UNIVERSIDADE FEDERAL DE JUIZ DE FORA**
**CAMPUS GOVERNADOR VALADARES**
**INSTITUTO DE CIÊNCIAS DA VIDA**
**DEPARTAMENTO DE ODONTOLOGIA**

**Reinaldo Martins Cunha Júnior**

# **Plantas da Amazônia Brasileira:** Uma Visão Geral da Composição Química e Atividade Biológica

Governador Valadares
2022

**Reinaldo Martins Cunha Júnior**

**Plantas da Amazônia Brasileira:** Uma Visão Geral da Composição Química e Atividade Biológica

Trabalho de conclusão de curso apresentado ao Departamento de Odontologia, do Instituto de Ciências da Vida, da Universidade Federal de Juiz de Fora, Campus Governador Valadares, como requisito parcial à obtenção do grau de bacharel em Odontologia.

Orientador: Professor. D.Sc. Fabio Alessandro Pieri
Coorientadora: Professora. M.Sc. Pâmella Buenos Aires Domingues.

Governador Valadares
2022

Ficha catalográfica elaborada através do programa de geração
automática da Biblioteca Universitária da UFJF,
com os dados fornecidos pelo(a) autor(a)

Cunha-Junior, Reinaldo Martins.
Plantas da Amazônia Brasileira : Uma Visão Geral da Composição Química e Atividade Biológica / Reinaldo Martins Cunha-Junior. -- 2022.
27 f.

Orientador: Fabio Alessandro Pieri
Coorientadora: Pâmella Buenos Aires Domingues
Trabalho de Conclusão de Curso (graduação) - Universidade Federal de Juiz de Fora, Campus Avançado de Governador Valadares, Instituto de Ciências da Vida - ICV, 2022.

1. Plantas Amazônicas. 2. Extratos Vegetais. 3. Fitoquímica. 4. Bioatividade. 5. Produtos Naturais. I. Pieri, Fabio Alessandro, orient. II. Domingues, Pâmella Buenos Aires, coorient. III. Título.

**Reinaldo Martins Cunha Junior**

**Plantas da Amazônia Brasileira:** Uma Visão Geral da Composição Química e Atividade Biológica

Trabalho de conclusão de curso apresentado ao Departamento de Odontologia, do Instituto de Ciências da Vida, da Universidade Federal de Juiz de Fora, Campus Governador Valadares, como requisito parcial à obtenção do grau de bacharel em Odontologia.

Aprovada em 05 de agosto de 2022

BANCA EXAMINADORA

________________________________________

Prof. D.Sc. Fábio Alessandro Pieri – Orientador

Universidade Federal de Juiz de Fora, Campus Governador Valadares

________________________________________

Prof. D.Sc. Leandro de Morais Cardoso

Universidade Federal de Juiz de Fora, Campus Governador Valadares

________________________________________

Profa. D.Sc. Rose Mara Ortega

Universidade Federal de Juiz de Fora, Campus Governador Valadares

# RESUMO

Atualmente, o número de doenças vem aumentando e atingindo diretamente a população e o uso deliberado de medicamentos tem gerado resistência de patógenos em diversos medicamentos, fato evidenciado pelo aumento da ineficácia dos medicamentos e pela persistência de infecções no organismo. Diante disso, faz-se necessária a busca de novas alternativas medicamentosas que possam efetivamente promover uma terapia eficaz. É possível destacar, no Brasil, a diversidade da flora amazônica, que possui diversas espécies com considerável potencial como fonte de novas moléculas com atividade biológica identificada. Assim, foi realizado um estudo de revisão de literatura com o objetivo de descrever as aplicações de alguns extratos amazônicos, suas características químicas e atividade biológica. A floresta amazônica possui considerável diversidade de espécies vegetais com propriedades biológicas que podem ser úteis à saúde pública. Mais pesquisas são necessárias para identificar novos compostos com benefícios para a saúde.



**Palavras-chave:** Extratos amazônicos, atividade biológica, composição química, tratamento alternativo.

# ABSTRACT

Currently, the number of diseases has been increasing and reaching the population directly and the deliberate use of drugs have creating resistance of pathogens in several drugs, a fact evidenced by the increased ineffectiveness of drugs and the persistence of infections in the body. Given this, it is necessary the search for new alternatives drugs that can effectively promote effective therapy. It is possible to highlight, in Brazil, the diversity of the Amazonian flora, which has several species with considerable potential as a source of new molecules with identified biological activity. Thus, a literature review study was conducted in order to describe the applications of some Amazonian extracts, their chemical characteristics and biological activity. The Amazon rain forest has considerable diversity of plant species with biological properties that may be useful to public health. Further research is need to identify new compounds with health benefits.



**Keywords:** amazonian extracts, biological activity, chemical composition, alternative treatment.

SUMÁRIO

## 1 INTRODUÇÃO

A floresta amazônica é conhecida por possuir um extenso território, incluindo vários estados brasileiros e alguns outros países americanos, repleto de uma considerável diversidade de fauna e flora formando um rico ecossistema. Assim, devido à diversidade de plantas e aos efeitos colaterais dos medicamentos atualmente utilizados, como o aumento da resistência antimicrobiana, faz-se necessária a obtenção de novas alternativas que possibilitem o tratamento e/ou prevenção eficaz de doenças. (BORELLI, AZIZ AB'SÁBER, 2005)

A biodiversidade brasileira é reconhecida como uma das mais representativas da biosfera terrestre e desempenha um papel importante na manutenção do estado de si e na saúde humana, fornecendo produtos básicos e serviços ecossistêmicos. Além disso, a Amazônia brasileira fornece muitos produtos, incluindo alimentos (como gado, frutas e legumes), madeira e até medicamentos. (ALHO, 2012)

Diante disso, o objetivo do capítulo que se segue foi promover um estudo de revisão, apresentando alguns extratos amazônicos, incluídos na biodiversidade da Amazônia brasileira, bem como sua atividade biológica.

# 2 CAPÍTULO DE LIVRO

Capítulo de livro publicado no periódico 20 de março de 2020. A estruturação do artigo baseou-se nas instruções aos autores preconizadas pelo periódico (ANEXO X).

## BRAZILIAN AMAZON PLANTS: AN OVERVIEW OF CHEMICAL COMPOSITION AND BIOLOGICAL ACTIVITY

Reinaldo Martins Cunha Junior; Pâmella Buenos Aires Domingues; Rafael de Oliveira Ambrósio; Caio Augusto Freitas Martins; Jéssica Genoveva Boline Passarelli Capaz Pinto da Silva; Fabio Alessandro Pieri

Life Sciences Institute, *Campus* Governador Valadares, Federal University of Juiz de Fora. Rua São Paulo, 745, Centro, Governador Valadares-MG, Brazil. CEP: 35010-180.

Corresponding author: fabio.pieri@ufjf.edu.br.

**Abstract**

Currently, the number of diseases has been increasing and reaching the population directly and the deliberate use of drugs have creating resistance of pathogens in several drugs, a fact evidenced by the increased ineffectiveness of drugs and the persistence of infections in the body. Given this, it is necessary the search for new alternatives drugs that can effectively promote effective therapy. It is possible to highlight, in Brazil, the diversity of the Amazonian flora, which has several species with considerable potential as a source of new molecules with identified biological activity. Thus, a literature review study was conducted in order to describe the applications of some Amazonian extracts, their chemical characteristics and biological activity. The Amazon rain forest has considerable diversity of plant species with biological properties that may be useful to public health. Further research is need to identify new compounds with health benefits.

**Keywords:** amazonian extracts, biological activity, chemical composition, alternative treatment.

### 1. Introduction

The Amazon rainforest is known to have an extensive territory, including several Brazilian states and some other American countries, full of a considerable diversity of fauna and flora forming a rich ecosystem. Thus, due to the diversity of plants and the side effects of the drugs currently used, such the increasing antimicrobial resistance, it is necessary to obtain new alternatives to enable the effective treatment and/or prevention of diseases [1].

Brazilian biodiversity is recognized as one of the most representative of the earth's biosphere and plays an important role in the state of itself maintence and human health by providing basic products and ecosystem services. In addition, Brazilian Amazon provides a lot of products including food (such as livestock, fruits and vegetables), wood and even drugs [2].

Given this, the aim of this chapter is to promote a review study, presenting some Amazonian extracts, included in Brazilian Amazon biodiversity, as well as their biological activity.

## *2. Astrocaryum vulgare Mart* (Tucumã)

The Amazon has innumerable native species of fruit plants that have economic, technological and nutritional potential, which has been arousing the interest of scientific studies in many fields of study, such as: food science, pharmaceutical, cosmetic, flavoring and essences. Allied to these virtues, the tucumã (*Astrocaryum vulgare* Mart.), species belonging to the family of Arecaceae, popularly known by the name of tucumanzeiro. Fruits and seeds are used in human and animal food, leaves and stems in the construction of houses by the people in the interior of Amazon. This species commonly found in the Amazon region can reach 10m to 15m in height, 15cm to 20cm in diameter of trunk. It has the characteristic present flowers and fruits almost all year round. The normally ellipsoid orange fruits, when ripe, are 3cm to 5cm long and have a characteristic odor [3].

### 2.1. Chemical Composition

The sticky and fibrous pulp is very rich in vitamin A, 90 times more than avocado and 3 times higher than carrot, also having high vitamin B (thiamine) and high vitamin C content, compared with the citric fruits. Tucumã also has high energy value (247 calories per 100 grams), and present relevant content of glycids (19.1%), lipids (16.6%) and proteins (3.5%) [3].

### 2.2. Biological activity

In addition to good nutritional values, tests were performed on hydroalcoholic, methanolic and ethanolic extracts in the epicarp of the fruit and according to Mathias [4] the tucumã presents better antioxidant activity by hydroalcoholics extracts. Thus, the antimicrobial activity of plant extracts was evaluated by determine the minimum inhibitory concentration [5]. However, despite numerous other benefits presented in tradicional acknowledgement, the tucumã extracts did not show antimicrobial activity against any of the strains (*Bacillus, Enterobacter, Enterococcus, Escherichia, Salmonella, Shigella, Streptococcus, Listeria, Staphylococcus, Geobacillus*) [4, 5].

In recent study by Bernardes *et al.* [6] tucumã presented high medicinal potential due to its composition rich in carotenoids, flavonoids, fibers and polyunsaturated fatty acids, indicating it to use on lipid metabolism and the prevention of disorders from the cardiovascular system. In this study, hyperlipidemia was inducted by intraperitoneal injection of Polaxamer 407 in rats inducing an elevated blood lipid levels (hyperlipidemia). Tucumã was not active in reduce these increasing in lipidis, however acts on modulation of purinergic enzymes, that could present the ability to keep vascular homeostasis, reducing platelet aggregation and consequent arterothrombosis, which could be converted in reducing of hyperlidemia, and cardiovascular diseases.

According to Azevedo [7] the antimicrobial activity of hexanic and methanolic extracts of tucumã pulp were tested against standard strains of the bacteria *Staphylococcus aureus* (ATCC6538), *Escherichia coli* (ATCC 35218) and *Pseudomonas aeruginosa* (ATCC 9027) and against the yeast *Candida albicans* (ATCC 12031) by microplate dilution technique [8]. No antimicrobial activity of the hexanic and methanolic extracts of the tucumã pulp against *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa* was observed confirming previous studies, without antibacterial activity [4,5]. Also, no antimicrobial activity of the hexanic and methanolic extracts of the tucumã pulp was obtained against *Candida albicans* [7].

Tucumã is a fruit rich in bioactive compounds still little explored by the scientific community. Lectins are proteins capable of selective and reversible binding to various carbohydrate types without altering the chemical structure of any glycosyl linker residue. Tucumã mesocarp extract was obtained in 1: 3 saline phosphate buffer (PBS) and was studied to verify it lectinic activity of crude extract and its fractions, by a haemagglutination assay was performed against rabbit, human and sheep boods. The results pointed to positive lectinic activity only by crude extracts, suggesting that the different fraction could act synergistically in crude extract, but fractioning technique used could have separated the synergistic active principles, making the obtained fractions inactive [9].

One study [10] measured the interference of oils extracted from tucumã in the composition of the dental biofilm and the progress of enamel demineralization, dental caries that is a multifactorial disease that is still prevalent worldwide. With relevant action of microorganisms in biofilm formation on the tooth surface, reducing of dental plaque formation bacteria could be reverted in decreasing of caries. The relationship between biofilm microorganisms and dietary elements (carbohydrates) may influence in etiology of this disease. The study performed a in situ work with volunteers, that were kept with dental enamel blocks fixed on their palates, treated with solutions. One group used a sucrose solution (20%), and others groups with sucrose solution added with natural oils including tucumã. (20%). Mineral loss of enamel blocks was assessed by Knoop surface microhardness and Optical Coherence Tomography. It was identificated reduction of counting of cariogenic bacteria *Streptococcus mutans*, Total *Streptococcus* and *Lactobacillus casei* in the group tucumã oil compared with sucrose control group, and also the mineral loss was lower ($p<0{,}05$). These findings present tucumã oil as a potential source of compounds to construction of anticaries drug in the future [10].

Neuropsychiatric diseases carry with them a complicated pathophysiology, some of which have recently been associated with excess of free radicals compared with each cell's intrinsic protective system (oxidative stress) and mitochondrial dysfunction, resulting in an exacerbated inflammatory response. Due to the complexity of the pathophysiology of neuropsychiatric diseases, research with natural products with bioactive and pharmacological characteristics is necessary, such as the use of nanotechnology to improve the bioavailability of these compounds and potentially with the potential to delay, prevent and treat such pathologies. In one study [11], tucumã oil nanoemulsions were prepared to help protect their bioactive compounds and improve their biodistribution. The stability of the formulations was tested for 90 days under different storage conditions. The SH-SY5Y and B2 neuronal strains were used to evaluate the safety profile of free tucumã oil and its nanoemulsion, in addition to its power to activate cell proliferation. Based on the results initially observed, tucumã oil nanoemulsion was tested against inflammatory activity in BV-2 cells activated by lipopolysaccharid. The best conservation condition of nanoemulsion was under refrigeration. Regarding cytotoxicity evaluations in BV-2 and SH-SY5Y cells, no significant damage was observed. Regarding the anti-neuroinflammatory effect evaluations of tucumã nanoemulsion, it was observed that although nanoformulation did not maintain cell proliferation levels equal to the negative control, there was a reduction in cell reactivity, oxidative profile normalization and cell cycle regulation. Thus, it can be suggested that tucumã oil has a potential anti-inflammatory effect and that through its nanostructuring this effect can be optimized and may perhaps overcome the blood-brain barrier and modulate possible chronic inflammatory stimuli that correlate with disease neuropsychiatric or neurodegenerative. [11].

## 3. *Caryocar sp.*

The genus *Caryocar* belongs to the Caryocaraceae family and has species that are popularly known as pequi, piqui or pequiá. The most studied species of the genus are *Caryocar brasiliense*, *Caryocar villosum* and *Caryocar coriaceum* [12].

This genus is easily found in Central and South America. According to some authors, the fruit may be called by different names according to the region in which it is found, such as: the fruits of *C. brasiliense* that are more common found in the Midwest of Brazil and Minas Gerais, are called as pequi; *C. coriaceum* fruits commom in the Northeast of Brazil and it’s called as piqui; thus *C. villosum* is from the Amazon region being called as piquiá [13].

*Caryocar* spp. are a drupaceous fruit, globose, green in color, with one to four segments [13]. The ripe fruit of pequi is a shell composed of a thin brownish-green exocarp and an outer mesocarp composed of a white, inedible mass. Within the fruit is a nucleus that has an inner mesocarp or inner flesh, the generally edible fruit component, light yellow in color, abundant, oil-rich flesh, and an almond within the spinous endocarp [12, 13].

### 3.1. Chemical Composition

The fruit of pequi is rich in several important components, such as mono-unsaturated fatty acids (MUFA), bioactive compounds, fibers, minerals [13] and carotenoids [12]. The amount of each may vary according to the species analyzed, the environmental conditions in which it is inserted, the part of the fruit as well as the type of analysis that was used [13].

In the pulp of *Caryocar* spp. has a substantial amount of MUFA, dietary fiber and minerals are found, of which calcium, magnesium and potassium stand out. Fruit peel is abundant in dietary fiber, including soluble fiber and phenolic compounds, but in oil high levels of oleic acid are found [12].

Carotenoids are natural pigments of various fruits of Brazil. The presence of this pigment in *Caryocar* spp. occur with values comparable to those of papaya and guava, which are considered fruits rich in carotenoids. The carotenoids found in the pulp were β-carotene, lycopene, ζ-carotene, cryptoflavin, β-cryptoxanthin, anteraxanthin, zeaxanthin, mutatoxanthin, violaxanthin, lutein and neoxanthin [13]. However, as stated earlier, the amount present in each species varies due to several factors. In the review of Nascimento Silva and Naves [12] it was possible found this difference varying between 155μg/g and 270μg/g of carotenoids in *C. brasiliense* species, whereas from *C. villosum* it was between 17μg/g and 69μg/g.

In the study by Chisté *et al.* [14] the pulp of *C. villosum* was chemically characterized and the most representative components were total lipids (25.5% wet basis), gallic, ellagic rhamnose and ellagic acids as the main phenolic compounds, besides all-trans-antheraxanthin and all-trans-zeaxanthin as the main carotenoids.

Carotenoid profile analysis in pequi pulp has been a challenge for researchers. For best results, various procedures for carotenoid extraction with different solvents, temperatures, time periods and equipment were performed. In addition to the pulp and species extraction methodology, the ripening stage of the fruit also interferes with the composition, since carotenoid synthesis intensifies during the ripening period. Storage conditions need to be evaluated, as light-protected packaging minimizes compost loss [12].

The extraction of bioactive compounds from plant materials is strongly influenced by the solubility of each specific structure in the solvent used. Knowing this, Chisté *et al.* [14] evaluated *C. villosum* extracts using different solvents with different polarities, which was ethanol:water (1:1, v/v), ethanol:ethyl acetate (1:1, v/v) and ethyl acetate. The extracts produced solid mass ranging from 10.8% to 46.4%, depending on the solvent. The ethyl acetate and ethanol:ethyl acetate extracts showed the highest total lipid content and the highest solid mass yield. The ethanol:water extract presented the highest values of total phenolic compounds (9.2 mg garlic acid equivalent (GAE)/g of lyophilized extract), total flavonoids (3.8 mg catequin equivalent (CE)/g of freeze-dried extract) and total tannins (7.6 mg tannic acid equivalent (TAE)/g of lyophilized extract), followed by the other extracts, ethanol:ethyl acetate and ethyl acetate extracts that had the lower content of these compounds. This result can be explained considering that the main phenolic acids (gallic acid, ellagic acid and derivatives) found in *C. villosum* pulp have high affinity for high polarity solvents. In fact, water or ethanol and mixtures between them are widely used for the quantitative extraction of phenolic compounds from different plant sources.

Regarding the total carotenoid content, the ethanol extract presented the highest value (0.1mg/g), while the ethanol:water mixture presented the lowest value (0.01mg/g). Since the composition of carotenoids from *C. villosum* pulp has been reported to be primarily hydroxyl groups (xanthophylls), is more polar than carotenes generally found in large quantities in fruits of the Amazon. This fact explains why the use of high polarity solvents (such as water and ethanol:water) has low efficiency in carotenoid extraction [14].

In *C. brasiliense* pulp, larger total phenolic compounds were found than in almond. In almond oil of this same species, the values of gallic acid (GAE) were higher, up to 392 mg of GAE/100g of oil [13].

According to the literature, the total phenolic content of pulp fluctuates even in the same species. Studies with *Caryocar* spp. reported that the total phenolic content ranges from 178-334 mg / 100g gallic acid equivalents (GAE), 209 mg / 100g GAE for *C. brasiliense* and 59 mg / 100g GAE for C. villosum. Although the total phenolic content of *C. brasiliense* pulp is the lowest among other species of the genus, it is still higher than Cerrado Biome, fruits, such as jenipapo with an average of 48mg/100g and fruits such as banana with 56mg/100g or mango. with 78mg/100g [12].

### 3.2. Biological activities

In addition to the nutritional benefits, pequi has important biological activities. These include healing activity, anti-inflammatory, antimicrobial, protection against genome damage and oxidative damage. These benefits are mainly attributed to the presence of monounsaturated fatty acids (MUFA) and phytochemical compounds [13].

Gallic and ellagic acid are the phenolic compounds most present in *C. villosum* pulp. These compounds suppressed tumors, inhibiting cell proliferation-related gene expression and angiogenesis in 1,2-dimethylhydrazine (DMH)-induced tumors, transgenic prostate adenocarcinoma, and mice bearing prostate xenografts. In addition to these activities, some epidemiological studies have reported that ingestion of polyphenol-rich sources reduces the risk of developing chronic diseases such as cardiovascular disease, type 2 diabetes, cancer, and neurodegeneration [12].

Carotenoids and phenolic compounds obtained from *C. coriaceum* pulp have important antioxidant action. Active flavonoids have the ability to neutralize pathogens and eliminate reactive oxygen (ROS) either directly or indirectly, activating pathways that enable ROS degradation [15].

Doxorubicin (DOX), from the anthracycline group, is a drug given to treat cancer. However, it has side effects, such as cardiotoxicity exerted through the production of free radicals. In the study of Moura *et al.* [16] ethanolic extract of pequi bark (PSEE) was administered daily to DOX-treated rats, this led to increased activity of the enzyme glutathione reductase (GDH-Rd). This enzyme is responsible for maintaining the cellular protection system intact through a biochemical cascade. The presence of elevated GDH-Rd in the heart tissue of PSEE-treated rats showed higher antioxidant activity than those who did not undergo the treatment.

In addition to these effects, there are reports of the leishmanicidal effect of the fruit. Therefore, the search for alternative treatments, including the use of natural products with less toxicity than conventional treatments have become more frequent [17].

In leishmaniasis disease, an inflamattion must occur to control the parasitic load, being triggered by the interaction of the parasite with the host immune cells. However, an exacerbated response can cause tissue damage, similar to those seen in leishmaniasis. Thus, an antioxidant action of *C. coriaceum* controls the inflammatory response for effective disease control [15].

The study by Tomiotto-Pellissier [17] aimed to verify the leishmanicidal action of *C. coriaceum* leaf extracts obtained from extraction by ethyl acetate (EAC) and methanol (MET). The extracts were able to induce the parasite mitochondria membrane depolarization in the promastigote phase, such membrane is crucial for parasite survival, since *Leishmania* spp. have a single mitochondria, which is the main site for generating cellular ATP through oxidative phosphorylation, making it a promising antiparasitic target. Mitochondrial respiratory chain dysfunction can produce an enormous amount of reactive reactive oxygen species (ROS) within the organelles. Both EAC and MET promoted the increase of ROS in the promastigote phases. In addition, the cascade triggered by loss of mitochondrial integrity followed by increased ROS production can lead to parasite death through an apoptosis-like mechanism. The results showed that although both extracts showed similar results, the treatment with EAC was more efficient activity against promastigote forms than MET. The presence of catechins and steroids only in the EAC extract, and the greater amount of flavonoids compared with MET, could explain the more pronounced results found in the treatment with EAC. In addition, the effects could be given by the synergistic action of the compounds present in the extracts.

Its antimicrobial effect has been tested by Alves *et al.* [15]. The ethanolic extracts of peel and pulp of *C. coriaceum* had activity against six pathogenic strains, three of the genus *Malassezia* sp. and three from *Microsporum canis*. The minimum fungicidal concentration (MFC) and the minimum inhibitory concentration (MIC) were 39.1μg/mL (MFC) and 9.8μg/mL to 19.5μg/mL (MIC) against

*Malassezia strains* and 4.9μg/mL to 9.8μg/mL (MFC) and 4.9μg/mL (MIC) against *M. canis*. Besides that, the authors evaluated the antioxidant activity the extracts compared with a standard (rutin), obtaining higher activity of the extracts, with highlight to the pulp extract that had activity 3,6 times higher than rutin.

## 4. *Hymenaea sp.* (Jatobá)

Jatobá (*Hymenaea sp.*), belongs to the family Fabaceae, subfamily Caesalpiniodeae, and is being highlighted for a long time by folk medicine. The word jatobá has origin from Tupi language of Brazilian indians, meaning "hard fruits tree", and this species is used for various purposes, such as medicinal, food, ornamental and timber use [18]. Its distribution occurs in Central America to South America, mainly in the Amazon basin, and this genus comprises about 25 described species in America [19].

The use of this plant for medicinal purposes is not restricted to the use of its leaf or fruit extracts. The structures used are the most diverse as stem bark, leaves and roots and are prepared, for example, by infusion, cooking, maceration and syrup for phytotherapeutic extraction, and to isolation of the active compounds. Such extracts can be used for anti-inflammatory, healing, soothing, influenza, cough, pneumonia, gastritis, ulcer, burning urethra, stroke, anemia and more, showing how this plant is extremely important for culture and traditional popular medicine in Brazil [18].

### 4.1. Chemical Composition

The species *Hymenaea stigonocarpa* was studied by Cardoso et al. [20] to analyze the nutritional content of pulp of fruits. The results pointed to low pulp yield (17,1%) and moisture (8.8g/100g) and a rich presence of dietary fiber (44,3g/100g), energy (193.0kcal/100g) and protein (5.6 mg/100g). Vitamin E and folates were present in higher levels when compared with other common fruits (53.5μg and 495.5 μg/100g, respectively). Carotenoids and vitamin C were present in low concentrations (0.4mg and 8.9mg/100g, respectively). The authors concluded that the fruit of this species known as "jatobá of cerrado" is a source of vitamin C, good source of folates, and excellent source of dietary fiber.

In work of Veras *et al.* [19], leaves of *H. cangaceira* were hydrodistilled to obtaining of a yellow essential oil. Within this oil was detected fifteen compounds, which that were 85.38% of the total composition of the oil. The analysis of the composition of this oil presents a high percentage of sesquiterpenes (79.04%), besides having as main components ß-caryophilenne (23.38±0.51%), germacrene D (14.66±0.14%), α-guaiene (9.75±0.07%), β-elemene (7.05±0.02%), α-copaene (6.34±0.15%) ) and α-humulene (4.65±0.12%) [19].

Aguiar et al. [21] identified evaluating ripe and unripe peels of *H. courbaril*, corroboring Veras *et al. [*19], found as majoritary compounds sesquiterpenes (86.1% and 93.3% respectively), with different concentrations and composition in ripe and unripe peels essential oil. In ripe peels were majoritary the compounds α-copaene (11.1%), spathulenol (10.1%), β-selinene (8.2%), γ-muurolene (7.9%) and caryophyllene oxide (6.9%); unripe samples provided an oil with germacrene-D (31.9%), β-caryophyllene (27.1%), bicyclogermacrene (6.5%), α-humulene (4.2%), and α-copaene (4.2%) as the major compounds.

The crude ethanolic extract and ethyl acetate fraction obtained from stem barks of a tree of *H. martiana* was analyzed for the identification of flavonoids content. The results showed eleven peaks in the chromatograms that were identified as taxifolin, eucryphin, astilbin and 3 diastereoisomers, engeletin and 2 diastereoisomers, quercitrin and 2,6,3',4'-tetrahydroxy-2-benzylcoumaran-3-one. The ethyl acetate fraction presented 3.8 times higher concentration of astilbin than the crude extract [22].

### 4.2. Biological activities

Veras *et al.* [19], stated that the biological effects of the compounds described above (*H. cangaceira*), are:· Caryophyllene has anti-inflammatory, antibacterial, antifungal, antirheumatic, antioxidant, antitumor, analgesic and antiviral activities. Germacrene has been described with antitumor, analgesic, anti-inflammatory and antioxidant activity, as well as α-amylase and acetylcholinesterase inhibitory activity. Guaiene has reports as a cyclooxygenase inhibitor, 5-lipoxygenase and acetylcholinesterase, and has antioxidant and anti-inflammatory activity. Elemene is described as potent antimicrobial, antioxidant and anesthesic. Copaene has antimicrobial, antileishmanial, antigenotoxic and antioxidant activities Humulene is referred as anti-inflammatory, analgesic and antiallergic agent [19].

In a research conducted by the Federal Rural University of Pernambuco, it was observed the effectiveness of essential oil of jatobá leaf (*H. cangaceira*) against *Staphylococcus aureus* ATCC 43300 (MRSA), *S. aureus* ATCC 29213 (MSSA), *Pseudomonas aeruginosa* ATCC 27853, *Klebsiella pneumoniae* ATCC 700603, *Candida tropicalis* ATCC 750 and *C. krusei* ATCC 6258. The result of inhibition of both fungi and bacteria were positive for the oil of jatobá in different concentrations, and it must highlight the high activity against Gram-negative bacteria with MICs ranging between 4 µg/mL and 16µg/mL, result similar to cefepime, the control drug used [19]. The same authors also present in this work other important bioactivities, such as high antioxidant, and analgesic activities and absence of toxicity on rats and erythrocytes.

In other work from Federal University of Sergipe, *H. martiana* leaf extract was tested in inhibition of isolates of *Salmonella* spp*., Escherichia coli* and *Staphylococcus aureus, and* reduce its counts in raw milk. The Minimum Bactericidal Concentrations (MBC) against bacteria were 125.3µg/mL) against *S. aureus* (ATCC 25923), 781.2µg/mL against *E. coli* (ATCC 35218) and 1,556.5µg/mL against *S. enterica* subsp. *enterov* serovar Choleraesuis ATCC® 10708. The authors inoculated these bacteria on milk samples at different concentrations e used the extract in MBC concentrations to try to avoid bacterial growing on milk. However the results were not that expected, occurring growing of bacteria in concentrations of $10^4$ and $10^6$ UFC/mL. Only in lower concentration of bacteria on milk occur inhibition on growing of bacteria. The author suggest that the biological compounds present in milk may have reacted with the bioactive compounds of the extract, reducing their antibacterial activity [23].

Aguiar *et al.* [21] evaluate the activity of essential oil of ripe and unripe fruits of *H. courbaril*, as larvicide against *A. aegipty* larvae. The oil from ripe fruits was strongly larvicide against the larvae, presenting death of 50% of larvae with almost half of the concentration necessary for unripe fruits oil to obtain the same result (LC50 14.8 + 0.4 µg/mL and 28.4 + 0.3 µg/mL). The authors assign this difference to the higher concentration of oxygenated sequiterpenes in first oil, mainly spathulenol.

## *5. Mammea americana* (Apricot)

*Mammea americana*, popularly known as apricot, wild apricot or apricot from São Domingos, is a fruit originating from the West Indies and northern South America, currently found mainly in the Amazon and some few other regions [24].

According to a study by Mourão and Beltrati [25], in which they characterize the morphology and anatomy of the fruit, it was possible to typify the apricot as a berry, whose "bark" consists of the epicarp and mesocarp that together represent 13.3% of the fruit's weight. The endocarp, represents 70.7% and the remainder of the fruit is represented by the large seeds, which account for 16% of the fruit weight [26].

The first commercial orchards were established in the mid-1980s, established with seedlings that originated from seeds. Due to this fact, there was a large proportion of male plants and several phenotypic variations in the chemical and physical characteristics of the fruits. As an example, a sample of 50 fruits originating from ten different mother plants, it was possible to identify an average fruit weight of 852.8g, with minimum and maximum limits of 502.3g and 1,443.0g. Thus, it is possible to verify that the fruit weight is derivated of the genetic origin trait, although it suffers a lot of influence from the environment [26].

The apricot tree can be disseminated through a sexual or asexual route. However, being a species that presents male plants and hermaphrodite plants, the orientation is that their diffusion is effected by vegetative processes. Thus, the most widely used method is grafting. Its spread by grafting ensures early production and enables the orchard to have only hermaphrodite plants [27].

It is grown in igapós and flooded river banks in the Amazon region, mainly in the state of Pará. It's a Medium-sized tree, that can reach 20m in height, the apricot easily propagates through seeds, which germinate between 12 and 18 days. The plant can start flowering from six/eight years [28].

### 5.1. Chemical Composition

Through the study by Nascimento [29], it was possible to identify the composition of apricot, which has a vitamin content of 27.26±1.03 mg of ascorbic acid/100g in the apricot pulp. It was also possible to characterize the carotenoid content, in apricot pulp which was 161.34±0.40 bs and dehydrated product 103.53±0.65 bs (µg/100g β-carotene). By analyzing the results of quantifying antioxidant activity from the substitution calculations in the equation of the Trolox curve line, according to the ABTS method, a value of 31.96±0.76 µM Trolox/g bs was obtained from fresh apricot. The analyzes that dealt with the quantification of antioxidant activity from the consumption calculations of the DPPH radical obtained a value of 192.51±0.13 fruit/g DPPH bs in the apricot sample in natura.

### 5.2. Biological activity

Regarding its biological activity, it is possible to identify through studies found in the literature, extracts of *Mammea americana* generating results in the medical field.

According to studies by Toma *et al.* [30], that analyze the action of apricot extracts as antiulcerants in mice, the extracts showed antiulcerogenic effects with significant reduction in the damage of gastric lesions through the model of anti-inflammatory induced injury. In NSAID/cholinomimetic-induced model, ethanolic and dichloromethane extracts of apricot showed antiulcerogenic effects with significant reduction in the damage of these gastric lesions by 36% (8.3±2.0mm) and 42%. (7.5±1.4mm), respectively, as compared to the control group (13.0±0.9mm), increased the pH values and promoted reduction of acid production.

According to the studies by Braga *et al.* [31], was evaluated the antioxidant activity and the quantification of bioactive compounds (total carotenoids - CT, total polyphenols - PT and total flavonols - FT), and the physical and centesimal characterization of the compounds of apricot fruits (*Mammea americana*). Antioxidant activity was measured by two different methods, ORAC (Oxygen Radical Absorbance Capacity) and TEAC (Trolox Equivalent Antioxidant Capacity). By ORAC, the results showed antioxidant activity with results of 30,97±2,30µMol Equivalent Trolox/100g, within the results showed of acerola (*Malpighia emarginata*) according the authors. In TEAC test, the result was 11,82±1,40 µMol Equivalent Trolox/100g, inside the range of acai also. For this two method, the antioxidant activity of apricot was lower of other fruits like murici (*Byrsonima crassifolia*) and ingá (*Inga* spp.) For the bioactive compounds present in apricot in this work were found 2,61±0,73 mg Equivalent Catechin/100g of FT, 25,41±2,30 mg Equivalent Gallic acid/100g of PT and 7,55±0,78 mg Equivalent β-Carotene/100g CT. From this results must be highlighted the high content of carotenoids, which indicate that apricot is a promising source of pro-vitamin A.

According to a study found in the literature, it was possible to identify high trypanocidal activity in extracts of *Mammea americana*. In this way, compounds were obtained from *M. americana* fruit peels and their action against the parasite was tested. The compounds were tested in vitro against epimastigotes (intracellular phase, without locomotion organelles, with little cytoplasm and large nucleus) and trypomastigotes (extracellular phase, circulating in the blood) of *Trypanosoma cruzi*, the etiological agent of Chagas disease. The most potent compounds were mammea A/BA, A/BB, A/AA, A/BD and B/BA (designation based on chemical characteristics), with MC100 (minimum concentration at which all of the epimastigotes or trypomastigotes died after a 48 h-incubation) values ranging between 15 to 90 g / ml. Several active coumarins were also tested against normal human lymphocytes in vitro, which showed that mammea A/AA and A/BA did not show toxicity. Thus, through this study, it was possible to identify that these mammea-type coumarins have trypanocidal action and if they deepen the study of the compound, it may become possible to identify an important source of compounds with trypanocidal action [32].

## 6. *Platonia insignis* Mart (Bacuri)

*Platonia insignis* Mart consists of a species in the Clusiaceae family, being popularly named as bacuri. It has a fruit of appreciated flavor and is very famous in the Amazon region. The generic name, *Platonia,* is a tribute to the philosopher Plato (in Portuguese, Platão) and insignis means remarkable in reference to the size of the fruit [33]. The bacuri belongs to the subfamily Clusioideae, the genus Platonia and encompasses about 1000 species, present in tropical, subtropical and temperate regions of the world. Approximately 90 species correspond to plants, involving trees, shrubs, lianas and herbs of economic interest for the production of edible fruits, fine woods, chemical derivatives of pharmaceutical and industrial interest [34-37].

Ethnobotanical utility concerns the use of oil extracted from its seeds, such as in the production of soap and as anti- inflammatory. The seeds are used to make bacuri oil, which is popularly used in the treatment of skin diseases and as a wound healer in animals. It is noteworthy that the investigation of *P. insignis* extracts and compounds is based on popular use. However, pharmacological studies conducted with the plant point it as promising source for elaboration of phytomedicines with healing, anti-inflammatory, anticonvulsant, antimicrobial, cytotoxic and antioxidant activities and to be used in treatment of several diseases such as cancer, Alzheimer and Parkinson [38].

### 6.1. Chemical Composition

Rocha [39] evaluated the chemical composition of *Platonia insignia* leaves classified the chemical constitution as positive, moderately positive, strongly positive or negative, as can be seen in table 1.

Table 1: Qualitative and semi-quantitative evaluation of the chemical constituents in the hydroethanol extract of *Platonia insignis* Mart leaves

| **Cumarins** | **Presence of substances** |
|---|---|
| Phenols | **Strongly Positive** |
| Condensed Tannins | **Strongly Positive** |
| Catechins | **Strongly Positive** |
| Steroids | **Strongly Positive** |
| Alkaloids | **Strongly Positive** |
| Flavanonols | **Moderately positive** |
| Saponins | **Moderately positive** |
| Coumarins | **Negative** |
| Hydrolyzable tannins | **Negative** |
| Anthocyanidins and anthocyanidins | **Negative** |
| Flavones, flavonols and xanthones | **Negative** |
| Chalcones and aurones | **Negative** |
| Leucoanthocyanidins | **Negative** |
| Flavonones | **Negative** |
| Triterpenoids | **Negative** |

Note: Results expressed as average of the qualitative and semi-quantitative evaluation tests of chemical constituents performed in triplicate in the hydroalcoholic extract, by Rocha [39]. Strongly positive; Moderately positive; Positive; Negative. Source: in the [39], adapted.

### 6.2. Biological activity

Phenolic compounds present in the extract, such as catechins, flavononols, are widely distributed in the plant kingdom and associated with various biological activities, such as the fact that flavonoids have activity on capillary, anti-inflammatory, antiviral, anti-tumor and hormonal permeabilities [40, 41]. Among the phenolic compounds, flavonoids were found in large quantities in bacuri extract, which exhibit several biological properties, such as anti-inflammatory, hormonal and antioxidant action [42].

Moreover, saponins are related to the defense system of plants, being generally found in tissues more susceptible to bacteria, fungi or insects, since they have hemolytic activity, form complexes that have antifungal action, hypocholesterolemic and have the ability to change the permeability of cell membranes [41, 43, 44].

Alkaloids, in turn, are known for their antimalarial, antimicrobial and cytotoxic activities [45]. Moreover, according to [46] review, *P. insignis* has antiepileptic and vasorelaxant activity.

Finally, there are compounds in bacuri, such as kaempferol and quercetin glycosides, that express significance in the regulation of hyperglycemia, due to the strong stimulation of glucose and oleic acid absorption [47].

## 7. Conclusion

Given the information previously constructed, it is possible to infer, therefore, that the Amazon rainforest has a considerable diversity of different plants, which have several biological activities, that may be of great concern for public health application. This is a little bit example of the power of biodiversity present in Brazilian Amazon and of the Natural Resources with biopotential for treatment of a large number of diseases, being a promising source of new drugs that could be alternatives for the traditional drugs used nowadays that present side effects, such as toxicity to the patient, emergence of bacterial resistance to antibiotics among others. Thus, many new studies are needed to identify compounds with desirable health activities, and the Amazon, by their potential biodiversity, seems to be the best place to look.

## 8. Acknowledgments

The authors thank the support of the National Council for Scientific and Technological Development (CNPq), Coordination for the Improvement of Higher Education Personnel (CAPES) and the Minas Gerais State Research Support Foundation (FAPEMIG).

## 9. References

[1] Borellli DL. Aziz Ab'Sáber: problemas da Amazônia brasileira. Estudos Avançados, 19(53), 7-35.

[2] Alho CJR. Importância da biodiversidade para a saúde humana: uma perspectiva ecológica. Estudos Avançados. 2012; 74: 151-166. DOI: 10.1590/S0103-40142012000100011.

[3] Portal da Amazônia. Tucumã [Internet]. Available from: http://www.amazoniadeaaz.com.br/sem-categoria/o-que-e-tucuma/ [Accessed: 05/11/2019].

[4] Mathias CS. Estudo químico e atividades biológicas dos frutos de tucumã (*Astrocaryum aculeatum Meyer*) [Dissertation]. Manaus: Universidade Federal do Amazonas; 2014.

[5] Pinto TJA, Kaneko TM, Ohara MT. Controle Biológico de Qualidade de Produtos Farmacêuticos, Correlatos e Cosméticos. 2nd ed. São Paulo: Atheneu Editora; 2003. 325 p.

[6] Bernardes VM. Efeito do tucumã (*Astrocaryum aculeatum*) no metabolismo de nucleotídeos e nucleosídeo de adenina em plaquetas de ratos com hiperlipidemia induzida [Thesis]. Santa Maria-RS: Universidade Federal de Santa Maria; 2018.

[7] Azevedo SCM. Estudo do potencial biotecnológico da polpa de tucumã (*Astrocaryum aculeatum*) *in* natura e da conservação das suas propriedades nutricionais em embalagens a vácuo [Dissertation]. Manaus: Universidade do Estado do Amazonas; 2016.

[8] CLSI (2014). *Performance Standards for Antimicrobial Susceptibility Testing; Twenty-Fourth Informational Supplement*. Wayne, PA: Clinical and Laboratory Standards Institute. 34:1. 226 p.

[9] Aragão AB, Thomaz SMOBB. Purificação e avaliação da atividade lectínica do extrato de tucumã *(Astrocaryum vulgare Mart*.) nativo da região Amazônica. Journal of Basic and Applied Pharmaceutical Sciencies. 2015; 36.

[10] Emmi DT. Influência dos óleos do tucumã (*Astrocaryum vulgare*) e da pupunha (*Bactris gasipae*) na composição do biofilme dental e dinâmica do processo de cárie em esmalte: um estudo *in* situ [Thesis]. São Paulo: Universidade de São Paulo; 2013.

[11] Ramos AP. Nanoemulsão do óleo do tucumã (*Astrocaryum vulgare mart*.) como agente neuroprotetor *in* vitro [Thesis]. Santa Maria-RS: Universidade Franciscana; 2019.

[12] Nascimento-Silva NRRD, Naves MMV. Potential of Whole Pequi (*Caryocar spp*.) Fruit-Pulp, Almond, Oil, and Shell-as a Medicinal Food. Journal of Medicinal Food. 2019; 2:952-962. DOI: 10.1089/jmf.2018.0149.

[13] Torres LRO*,* Santana FC, Shinagawa FB, Mancini-Filho J. Bioactive compounds and functional potential of pequi (*Caryocar spp*.), a native brazilian fruit: A review. Grasas y Aceites. 2018; 69: E257. DOI: 10.3989/gya.1222172.

[14] Chisté RC, De Toledo Benassi M, Mercadante AZ. Efficiency of different solvents on the extraction of bioactive compounds from the amazonian fruit *Caryocar villosum* and the effect on its antioxidant and colour properties. Phytochemical Analysis. 2013; 25:364-372. DOI: 10.1002/pca.2489

[15] Alves DR, Morais SM, Tomiotto-Pellissier F, Miranda-Sapla MM, Vasconcelos FR, Silva ING, Sousa HA, Assolini JP, Conchon-Costa I, Pavanelli WR, Freire, FCO. Flavonoid Composition and Biological Activities of Ethanol Extracts of *Caryocar coriaceum* Wittm., a Native Plant from Caatinga Biome. Evidence-based Complementary and Alternative Medicine. 2017; 2017: 1-7. DOI: 10.1155/2017/6834218.

[16] Moura LR, Viegas AA, Almeida LM, Neves REJ, Lima CS, Moura VMBD. Effect of pequi shell ethanolic extract on glutathione reductase activity in rats exposed to doxorubicin cardiotoxicity. Revista Brasileira de Medicina Veterinaria. 2018; 40: e89018. DOI: 10.29374/2527-2179.bjvm89019.

[17] Tomiotto-Pellissier F, Alves DR, Miranda-Sapla MM, de Morais SM, Assolini JP, da Silva Bortoleti BT, Gonçalves MD, Cataneo AHD, Kian D, Madeira TB, Yamauchi LM, Nixdorf SL, Costa IN, Conchon-Costa I, Pavanelli WR.*Caryocar coriaceum* extracts exert leishmanicidal effect acting in promastigote forms by apoptosis-like mechanism and intracellular amastigotes by Nrf2/HO-1/ferritin dependent response and iron depletion: Leishmanicidal effect of *Caryocar coriaceum* leaf exracts. Biomedicine and Pharmacotherapy. 2018; 98: 662-672. DOI: 10.1016/j.biopha.2017.12.083

[18] Silva MR, Lamarca EV. Registros etnobotânicos e potenciais medicinais e econômicos do jatobá (*Hymenaea courbaril*). Rev. Ibirapuera. 2018; 15: 8-12.

[19] Veras BO, Oliveira MBM, Oliveira FGS, Santos YQ, Oliveira JRS, Lima VLM, Almeida JRGS, Navarro DMAF, Aguiar JCROF, Aguiar JDS, Gorlach-Lira K, Dias de Assis CR, Silva MV, Lopes ACS. Chemical composition and evaluation of the antinociceptive, antioxidant and antimicrobial effects of essential oil from Hymenaea cangaceira (Pinto, Mansano & Azevedo) native to Brazil: A natural medicine. Journal of Ethnopharmacology. 2019; 247: 112265. DOI: 10.1016/j.jep.2019.112265.

[20] Cardoso LM, Bedetti SF, Ribeiro SMR, Esteves, EA, Pinheiro-Sant'ana, HM. 'Jatobá do cerrado' (*Hymenaea stigonocarpa*): chemical composition, carotenoids and vitamins in an exotic fruit from the Brazilian Savannah. Fruits. 2013; 68: 95–107. DOI: 10.1051/fruits/2013056.

[21] Aguiar JCD, Santiago GMP, Lavor, PL, Veras HNH, Ferreira YSF, Lima MAA, Arriaga AMC, Lemos TLG, Lima JQ, Jesus HCR, Alves PB, Braz-Filho R. Chemical Constituents and Larvicidal Activity of Hymenaea courbaril Fruit Peel. Natural Product Communications. 5(12):1977-1980. DOI: 10.1177/1934578X1000501231.

[22] Pacheco AGM, Branco A, Câmara CA, Silva TMS, Silva TMG, Oliveira AP, Santos ADC, Dutra LM, Rolim LA, Oliveira GG, Mendonça JN, Lopes NP, Almeida JRGS. Identification of flavonoids in Hymenaea martiana Hayne (Fabaceae) by HPLC-DAD-MSn analysis, Natural Product Research. 2019; 8:1-6. DOI:10.1080/14786419.2019.1672062.

[23] Santana TC. Uso do extrato de folhas do Jatobá (*Hymenaea martiana Hayne*) na redução das contagens de *Salmonella spp*., *Escherichia coli* e *Staphylococcus aureus* em leite cru [Dissertation]. São Cristóvão: Universidade Federal de Sergipe; 2015.

[24] Cavalcante PB. Frutas comestíveis da Amazônia. 5 ed. Belém: Edições CEJUP/Museu Paraense Emílio Goeldi; 1991. 279 p.

[25] Mourão KSM, Beltrati CM. Morphology and anatomy of developing fruits and seeds of *Mammea americana L*. (*Clusiaceae*). Revista Brasileira de Biologia. 2000; 60: 701-711. DOI: 10.1590/S0034-71082000000400023.

[26] Carvalho JEU, Muller CH. Biometria e rendimento percentual de polpa de frutas nativas da Amazônia. Comunicado Técnico 139. Belém-PA: Embrapa Amazônia Oriental; 2005. 4 p.

[27] VIillachica H, Carvalho JEU, Müller CH, Diaz SC, Almanza M. Frutales y hortalizas promissorios de la Amazonia. Lima: TCA-SPT; 1996. 367 p.

[28] Brasil. Alimentos regionais brasileiros. 2nd ed. Brasília –DF: Ministério da saúde; 2015. 481p.

[29] Nascimento CS. Obtenção de Abricó (*Mammea americana L.*) desidratado utilizando Secagem por Refractance Window [Dissertation]. Belém: Universidade Federal Do Pará; 2015.

[30] Toma W, Hiruma-Lima CA, Guerrero RO, Brito AR. Preliminary studies of *Mammea americana* L. (Guttiferae) bark/latex extract point to an effective antiulcer effect on gastric ulcer models in mice. Phytomedicine. 2005; 12:345-50. DOI: 10.1016/j.phymed.2003.06.009.

[31] Braga ACC , Silva AE, Pelais ACA, Bichara CMG, Pompeu DR. Atividade Atioxidante e Quantificação de Compostos Bioativos Dos Frutos De Abricó (*Mammea Americana*). Alimentação e Nutrição. 2010; 21: 31-36.

[32] Reyes-Chilpa R, Estrada-Muñiz E, Vega-Avila E, Abe F, Kinjo J, Hernández-Ortega S. Trypanocidal constituents in plants: 7. Mammea-type coumarins. Memórias do Instituto Oswaldo Cruz. 2008; *103:*431-436. DOI: 10.1590/s0074-02762008000500004

[33] Yamaguchi KKL , Lamarão CV, Lima ES, Veiga-Junior, VF. Química e Farmacologia do Bacuri (*Platonia insignis*). Scientia Amazonia. 2014; 3: 39-46. DOI:

[34] Brummit RK. Vascular plant families and genera. Kew: Royal Botanic Gardens; 1992, 804 p.

[35] Barroso GM, Peixoto AL, Ichaso SLF, Guimarães EF, Sistemática de angiospermas no Brasil. Vol 1. 2nd ed. Viçosa, MG: Editora UFV; 2002. 309 p.

[36] Joly AB. Botânica: introdução à taxonomia vegetal. 11 ed. São Paulo: Editora Nacional; 1993. 777 p.

[37] Yaacob O, Tindall HD. Mangoste encultivation. Rome: Plant Production and Protection Paper; 1995. 100 p.

[38] Santos Júnior RQ, Soares LC, Maia-Filho ALM, Araujo KS, Santos IMSP, Costa-Junior JS, Saffi J. Estudo histológico da cicatrização de feridas cutâneas utilizando a banha de bacuri (*Platonia insignis Mart.*). ConScientiae Saúde. 2010; 9: 575-581.

[39] Rocha ES. Produção de bioprodutos com atividade antimicrobiana a partir do extrato das folhas de *Platonia insignis* Mart. (Bacuri) [Thesis]. Tocantins: Universidade Federal do Tocantins; 2017.

[40] Castelo KFA. Estudo químico dos extratos ativos de bacuri (*Platonia insignis*) [Dissertation]. Manaus: Universidade Federal do Amazonas; 2018.

[41] Simões CMO, Shenkel EP, Mello, JCP, Mentz LA, Petrovick, PR. Farmacognosia: da planta ao medicamento. 5 ed. Porto Alegre-Florianópolis: Editora da UFSC; 2004. 1102 p.

[42] Dovichi SS, Lajolo FM. Flavonoids and their relationship to diseases of the Central Nervous System. Nutrire: Revista da Sociedade Brasileira de Alimentação e Nutrição. 2011; 36: 123-135.

[43] Wina E, Muetzel S, Becker C. The Impact of Saponins or Saponin-Containing Plant Materials on Ruminant Production - A Review. Journal of Agricultural and Food Chemistry. 2005; 53(21):8092-8105 DOI: 10.1021/jf048053d.

[44] Araújo LLN, Fari, MJM, Safadi GMVV. Prospecção fitoquímica da espécie *Justicia pectoralis* Jacq. var. stenophylla leonard pertencente à família Acanthaceae. Revista Eletrônica de Ciências Humanas, Saúde e Tecnologia – FaSeM Ciências. 2014; 3:(2)4-14.

[45] Oloyede KG, Oke MJ, Raji Y, Olugbade T. Antioxidant and anticonvulsant alkaloids in *Crinum ornatum* bulb extract. World Journal of Chemistry. 2012; 5: 26-31.

[46] Silva APSCL, Araújo LC, Melo BC, Silva-Filho JCCL, Oliveira MCP, Oliveira GLS, Costa-Júnior, JS. *Platonia insignis* Mart with pharmacological applications to the Central Nervous System: a review. Boletim Informativo Geum. 2016; 7:24-31.

[47] Ho GT, Kase ET, Wangensteen H, Barsett H. Effect of phenolic compounds from elderflowers on glucose-and fatty acid uptake in human myotubes and HepG2-cells. Molecules. 2017; 22:90. DOI: 10.3390/molecules22010090.

## 3 CONCLUSÃO

Diante das informações construídas anteriormente, é possível inferir, portanto, que a floresta amazônica possui uma diversidade considerável de diferentes plantas, que possuem diversas atividades biológicas, que podem ser de grande interesse para aplicação em saúde pública. Este é um pequeno exemplo do poder da biodiversidade presente na Amazônia brasileira e dos Recursos Naturais com biopotencial para o tratamento de um grande número de doenças, sendo uma promissora fonte de novos medicamentos que podem ser alternativas aos medicamentos tradicionais usados hoje em dia que apresentam efeitos colaterais, como toxicidade ao paciente, surgimento de resistência bacteriana aos antibióticos, entre outros. Assim, muitos novos estudos são necessários para identificar compostos com atividades de saúde desejáveis, e a Amazônia, por ser detentora da maior biodiversidade do planeta, parece ser o melhor lugar para se investigar.

# REFERÊNCIAS

ALHO, C. J. R. Importância da biodiversidade para a saúde humana: uma perspectiva ecológica. **Estudos Avançados**, v. 26, n. 74, p. 151–166, 2012.

BORELLLI, D. L. Aziz Ab'Sáber: problemas da Amazônia brasileira. **Estudos Avançados**, v. 19, n. 53, p. 7–35, 2005.

Portal da Amazônia. Tucumã [Internet]. Available from: http://www.amazoniadeaaz.com.br/sem-categoria/o-que-e-tucuma/ [Accessed: 05/11/2019].

Mathias CS. Estudo químico e atividades biológicas dos frutos de tucumã (*Astrocaryum aculeatum Meyer*) [Dissertation]. Manaus: Universidade Federal do Amazonas; 2014.

**ANEXO A – Normas de submissão da editora do Livro no qual o capítulo foi publicado.**

# AUTHOR GUIDELINES

Thank you for contributing to an Open Access book at IntechOpen. The following information will help you write and format your chapter for submission.

# GETTING STARTED

There are three options for writing your chapter:

- Use the IntechOpen **MS Word Template**
- Use the IntechOpen **LaTeX Template**
- Use **your own document** and set it up according to IntechOpen's formatting requirements

| FORMATTING REQUIREMENTS | |
|---|---|
| Font Size | 10pt |
| Font Type | FS Brabo or Georgia (in MS Word) URW Palladio (in LaTeX template) |
| Spacing and Indent | Single, indent 1st line 0,5cm (0,20 inch) |
| Page Size* | Custom Width: 18cm (7,086 inch) Height: 26cm (10,236 inch) |
| Margins | top 1,8cm (0,71 inch) bottom 1,4cm (0,55 inch) left & right 2,65cm (1,04 inch) |

You can download the MS Word or LaTeX Template on your Author Panel.

The MS Word template can be opened in the text processing program of any Office Suite (MS Office, LibreOffice, OpenOffice, etc). All of the required page formatting options have been preset. Note: the template will work best with MS Office.

A TeX distribution will have to be installed on your computer in order to use the LaTeX template. When sending your chapter in LaTeX, the source file(s) must be accompanied by the compiled PDF and media files.

Both templates contain all the necessary chapter preparation guidelines inside them. Simply follow the instructions and insert your text where prompted.

# SELF-CITATION

Self-citation itself is not forbidden, as long as it is not used as citation manipulation.

Citation manipulation can come in forms such as:

- The Editor pressures an author to add citations from the editor's works in order to increase citation rates,
- The Author extensively adds citations from his/her own previous published works.

Citation manipulation can be identified by the fact that the citations do not contribute to the scholarly content of the chapter and have been included solely for the purpose of increasing citations.

Generally there are no uniform criteria to identify excessive self-citation, so authors should be careful with self-citations in order to avoid possible future issues.

Authors should ensure their self citation rate is not about 25% unless there are specific reasons where this is appropriate due to the subject area and research field.

# PERMISSIONS

Authors wishing to include figures, tables, or text passages that have already been published elsewhere are required to obtain permission from the copyright owner(s) for both the print and online format.

Please note the work will be published under a CC-BY license.

Please consult the following guide for more information on different ways you can request copyright permission: http://cdn.intechopen.com/public/docs/RightsLink_Guide.pdf

We do not require Authors to submit copyright permissions along with their manuscripts, but we may ask you to provide them if there are reasons to suspect that any part of your manuscript infringes upon a third-party’s copyright.

Legitimate reuse of third-party content must include copyright holder and licensing information for the content being reused.

# MANUSCRIPT LENGTH AND CHARGES FOR ADDITIONAL PAGES

The information below is only valid for both the IntechOpen MS Word template and the LaTeX template. Note that the word and character counts are approximations only!

| CHAPTER LENGTH | |
|---|---|
| Minimum | Maximum |
| 10 pages | 20 pages |
| 33,000 characters (with spaces) | 66,000 characters (with spaces) |
| 4,500 – 4,750 words | 9,000 – 9,500 words |

The final page number can be calculated only when your unedited manuscript has gone through the technical editing process. Technical editing ensures that the manuscript is formatted according to professional academic publishing standards.
The total page count will be communicated to you by your Author Service Manager.

THE NUMBER OF PAGES INCLUDES THE ENTIRETY OF THE CONTENT: THE MAIN TEXT (WITH ABSTRACT, KEYWORDS, AFFILIATIONS, REFERENCES)

# AND ALL ADDITIONAL MATERIAL

IntechOpen can consider shorter or longer manuscripts as long as the criteria of submission are adhered to and the Academic Editor is happy that the reduced or increased length of content is required for publication.

The Open Access Publishing Fee (OAPF) for your chapter covers the production costs up to 20-page long chapters. For chapters longer than 20 pages, ADDITIONAL PAGE CHARGES may apply on a page level basis.

# POLICIES AND STANDARDS

All IntechOpen publications are published under the Open Access model, without any subscription or access fees required from the user or his/her institution. In accordance with the Budapest Open Access Initiative's (BOAI) definition of Open Access, users are allowed to read, download, copy, distribute, print, search, and link to the full text versions of all Chapters.

All published Book Chapters are licensed under a Creative Commons Attribution 3.0

Click on the links below for more information about each policy:

- OPEN ACCESS STATEMENT
- OPEN ACCESS POLICY
- COPYRIGHT AND LICENSING POLICIES
- EDITORIAL POLICY
- AUTHORSHIP POLICY
- PEER REVIEW POLICY AND PROCESS

*Document version date: December 24, 2022*