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Phytochemical study of the leaves of *Artocarpus heterophyllus* LAM.

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1 INTRODUCTION

Medicinal plants are widely used in many parts of the world. In Brazil, due to the influence of indigenous roots, this practice has been widespread until today, especially in northern and northeastern regions, where there is the largest concentration of indigenous tribes still alive. The precariousness of public services in remote communities has resulted in the use of plants for medicinal purposes as the main therapeutic resource of these populations and ethnic groups, given that the presence of knowledge about herbs and plant materials, which is passed on among families, is the primary source of treatment and cure of various diseases based on empirical experimentation in these communities (LEITE, 2014). Thus, it should be noted that the use of plants for curative purposes comes from the earliest reports of human societies and, currently, it can still be observed that the wealth attributed to the ancient knowledge of traditional peoples has been a potentiating factor in innovations in research and the search for new substances from what has already been described in these cultures.

The World Health Organization (WHO) provides data indicating that about 65 to 80% of the world population does not get primary health care and because of this ends up resorting to and using traditional medicine, especially medicinal plants to alleviate various diseases (PONTES et al, 2012).

Just like other living beings, plant organisms have exceptional metabolism, causing them to produce a remarkable diversity of chemical substances, and some of these substances such as nucleic acids, proteins, carbohydrates and lipids are indispensable to all living beings and are used in the process of growth, reproduction and maintenance of these plants, but the great number of chemical compounds that are produced by plants have other purposes, as can be seen below: pigments (flavonoids, anthocyanins and

betalains) and the essential oils (monoterpenes, sesquiterpenes and phenylpropanoids) attract pollinators; tannins, sesquiterpene lectones, alkaloids and iridoids besides presenting unpleasant tastes, can be toxic and irritating to other organisms (POSER AND MENTZ, 2001).

In this context, the study of botany with a pharmacological focus occurs through pharmacognosy, which is a science that addresses not only the phytotherapy of natural products, but also the pharmacology present in the active ingredients derived from plants, through phytochemical studies from extracts of plant materials, which aims at the improvement and development of research in the pharmaceutical field and enables innovations in terms of scientific knowledge (ANTÔNIO, 2014).

Artocarpus heterophyllus belongs to the Moraceae family, with probable origin in Asian regions and is popularly known as jackfruit. This plant species was introduced into Brazilian territory during the colonial period and cultivated, especially, in the capital of the empire, Rio de Janeiro. Its uses are presented in diverse areas, ranging from traditional cuisine to the vast medicinal applicability associated with this species, such as hypoglycemic activity, antifungal, anti-inflammatory and melanin production (CHÁVEZ MORALES; PÁRRAGA LOOR, 2022).

Traditionally, in the north and northeast regions, the jackfruit is used to treat tissue lesions and inflammation of the oral mucosa. These characteristics can be analyzed from the presence of several secondary metabolites that can be associated with its therapeutic activity (VITORINO FILHO et al., 2007). Furthermore, Artocarpus heterophyllus has been considered invasive in the Atlantic Forest region and several managers of conservation units have been led to control its population through girdling and other exclusion methods.

The ethnobotany associated with the jackfruit according to the research described by Fabricante et al (2007), this plant is defined as a plant species classified as a large angiosperm, because its height varies from 8 to 25 meters, has an extensive crown and is endowed with milky latex. Its fruits are large and oval, the color of its bark varies from brown to yellow, its pulp has a sweet taste, a whitish color and its consistency is vigorous, these fruits are attached to its trunk, which has a thick and robust bark, measuring about 30 to 60 diameter, its leaves are simple, dark green, oval shaped, shiny and leathery consistency. The flowers are light green, small, may be male or female, and are attached to the trunk by a small stem, which gives it support.

In this perspective, it is worth analyzing the intimate relationship that exists between the medicinal descriptions given in the empirical use of A. heterophyllus with the presence of secondary metabolites that can justify such pharmacological properties due to their action already elucidated in the literature. According to what Ranasinghe (2019) proposed, the chemical composition of jackfruit varies according to its type. When compared to other tropical fruits, the pulp and seeds contain protein, calcium, iron, and thiamine in vast amounts. In addition, numerous antibacterial, antifungal, antidiabetic, anti-inflammatory, and antioxidant activities have been described.

Phytonutrients may prevent the formation of cancer cells, aid in the treatment of high blood pressure, and slow the degradation of collagen fibers. There are studies indicating that jackfruit contains phytochemicals such as carotenoids, flavonoids, volatile acids, sterols, and tannins. The different tests reviewed in the literature revealed that Artocarpus heterophyllus has an antioxidant activity attributable to the content of phenolic compounds; anti-inflammatory and anticancer activity by carotenoids and its antiviral activity by lectins. Additional phytochemical screening indicated that it contains alkaloids, reducing sugars, triterpenes, steroids and flavonoids and lacks anthocyanidins, resins, catechins, tannins, saponins and lactones. The chromatographic assay performed by Oliveira et al., (2009) helped to identify the amino acids found in higher proportions, such as glutamic acid and histidine.

Thus, one can infer its wide use in family medicine with the presence of metabolites according to Table 1.

Table 1 - Medicinal applications of Artocarpus heterophyllus and its association with the presence of secondary metabolites described in the literature.

PHARMACOLOGICAL ACTIVITY	ASSOCIATED METABOLITES	REFERENCE
Gastroprotective action	Phenolic compounds	(KLEIN-JUNIOR et al., 2012).
Anti-ulcer activity	Alkaloids, saponins and terpenoids	(AWAAD et al., 2013).
Action Hypotensive and hypolipemic	Cumarins	(BALIGA, 2011).
Antibacterial activity and antifungal	Tannins	(TEJPAL; AMRITA, 2016)
Antimalarial action	Flavonoids	(HOSSAIN; HAQ, 2006)

Source: Author, 2022.

2 METHODOLOGY

This is a qualitative and descriptive study, carried out at the Federal University of Amapá, where we tried to identify the possible existence of some classes of secondary metabolites present in the crude extract obtained from the hydroalcoholic extract of the leaves of Artocarpus heterophyllus.

The leaves of the plant were separated and cleaned for drying and grinding. The material was placed in an oven at 45ºC to remove water over a period of one week. After this process, it was submitted to extraction with 92.8ºGL ethanol under reflux at 45 min in a heating mantle. The process was performed twice in triplicate. In each process 500 mL of 92.8ºGL ethanol was added using a 250 mL beaker and transferred to a round bottom flask containing 60 g of the material and in the second triplicate, another 50 g of the leaves were used for the extraction of Artocarpus heterophyllus. The extract was filtered on a funnel with filter paper and stored in a glass container for the next step, concentration. The ethanolic extract of A. heterophyllus was submitted to rotary evaporator for concentration of the extract, removing the solvent and obtaining the crude ethanolic extract of Artocarpus heterophyllus.

The phytochemical analyses performed are as follows: saponins, organic acids, reducing sugars, polysaccharides, proteins and amino acids, phenols and tannins, alkaloids, purines, cardiac glycosides,

sesquiterpenolatones and lectones. These were performed according to the methodology of Barbosa (2001) using identifications from changes in coloration and precipitate formation.

3 CONCLUSION

Among the 18 phytochemical tests performed with the crude extract, positive results were obtained for 6 groups of secondary metabolites, which are: reducing sugars, azulenes, depsidones and depsidones, coumarin derivatives, phenols and tannins, and saponins as described in table 2.

Table 2 - Phytochemical tests of the crude ethanolic extract of Artocarpus heterophyllus.

Phytochemical test	**Result**
Organic acids	-
Reducing sugars	+
Alkaloids	-
Anthraquinones	-
Azulenes	+
Catechins	-
Carotenoids	-
Depsodones and depsodones	+
Coumarin Derivatives	+
Steroids and triterpenoids	-
Phenols and tannins	+
Flavonoids	-
Cardiac glycosides	-
Polysaccharides	-
Proteins and Amino Acids	-
Purines	-
Saponins	+
Sesquiterpenolactones	-

Legend:(+) present (-) absent

Reducing sugars are carbohydrates that donate electrons, because they have free or potentially free aldehydic or ketonic groups, which have the ability to decrease oxidizing agents, in an alkaline medium the reducing sugars are oxidized. These compounds are present in larger quantities in plants that are exposed to sunlight than in those that are in the shade (FAHL, 1989). In this sense, another relevant factor is that the reducing sugars identified in jackfruit may be linked to the reduction of gastric pH, which tends to improve the digestion of proteins and increases the secretion of digestive enzymes and, consequently, justify its gastroprotective activity.

Blueenes, on the other hand, are an organic compound, with molecular formula C10H8, belonging to the group of unsaturated bicyclic hydrocarbons. It is a bluish, intense, shiny, oily liquid. These compounds are pharmacologically linked to the anti-inflammatory and gastroprotective activity of A. heterophyllus (AMARAL, 2004).

Depsidones are phenolic compounds that are the precursors of depsidones and are part of the biology of lichens and higher plants due to the chemical structure of this group that contributes to the biosynthesis

and complexation of various pharmacological substances such as orsenilic acid that has antioxidant potential after the evaluation of esters obtained from lecanic acid and that are important for symbiotic associations. Depsides and depsidones are molecules of phenolic nature that have antimicrobial, antitumor, antiviral, analgesic, cytotoxic, and anti-inflammatory activity. Thus collaborating with the described pharmacological potential of A. heterophyllus that includes these same properties (REINA, 2021).

The coumarins were also detected in phytochemical tests, derive from the metabolism of phenylalanine, are widely distributed in plants, its occurrence predominates in angiosperms, can be found in all parts of the plant and has ultraviolet spectrum, has a peculiar odor and is widely used in the food industry as a flavoring, is still widely used in the cosmetics industry and cleaning products, among the pharmacological properties of coumarins are: anticoagulant, hypotensive, immunosuppressive, hypolipidemic action; these may come to be correlated with the medicinal properties traditionally described regarding Artocarpus heterophyllus (SIMÕES et al., 2007).

The phenols and tannins detected in the phytochemical tests. are part of a class that covers a wide variety of structures, the phenolic compounds which have at least one aromatic ring and at least one hydrogen is exchanged for a hydroxyl grouping, some have solubility in polar organic solvents and those that are soluble in water, by collaborating with the color, odor and flavor of vegetables are used in the food industry as dyes and flavorings, among the main pharmacological properties are: expectorant action, inhibits the synthesis of melanin, topical analgesic (SIMÕES et al, 2007).

Saponins, in turn, are molecules with amphiphilic character, which have important emulsifying action, acting as a surfactant. This compound is widely used by the pharmaceutical industry in the manufacture of contraceptives and used as adjuvants for other drugs because it increases the solubility of injectable drugs; the saponins have an action against cell membranes and can lead to cytoplasm lysis. The antibacterial action indicated in the literature concerning the A. heterophyllus can be explained by the presence of saponins, which act on the cell membranes of microorganisms (DA COSTA, 2021).

Thus, from the data analyzed and the study of chemical and biological properties performed in this research could highlight the potential already described about the species Artocarpus heterophyllus Lam., in which the ethanolic crude extract proved effective for antioxidant activity, bacterial, viral control and anti-inflammatory action from the presence of specific metabolites. The varied chemical composition of the compounds present in the crude extract of this species is the main relevant factor associated with biological activities. Several researches direct and substantiate the biological action of the major compounds in isolation or synergistically.

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