DETERMINATION AND IDENTIFICATION OF THE MAIN CONSTITUENTS PRESENT IN THE STEM OF THE *CACTUS* HYLOCEREUS *megalanthus*

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ABSTRACT

Cactus is a plant easily found in the Caatinga, whose stem can store a large amount of water inside. The species Hylocereus *megalanthus* grows as a vine and is highly sought after for medicinal purposes, as a source of protein and, mainly, for providing edible fruits (Pitaia or Dragon fruit). In this work, stems of the *Cactus* Hylocereus *megalanthus* were used with the aim of identifying and determining the levels of its main constituents for future applications. The fresh samples were subjected to physical pre-treatment to subsequently determine the cellulose, hemicellulose, total lignin, ash, extractives, and fat contents. As a result, the biomass presented 32,34 % cellulose, 11,51 % hemicellulose, 25,01 % lignin, 8,84 % ash, 22,20 % extractives and 9,50 % fats. From spectroscopic analysis in the Fouir transform infrared region (FTIR), it was possible to identify the presence of functional groups characteristic of lignocellulosic material, showing that this species is rich in extractable components and present significant levels of cellulose and lignin, which makes it possible its use in different segments, adding value to the process.

Keywords: *Cactus*. Hylocereus *megalanthus*. Lignocellulosic biomass. Cellulose.

1 INTRODUCTION

The Caatinga occupies an area of approximately 980 km^2, equivalent to 11,5 % of the national territory, in which the Northeast region holds much of this biome, with emphasis on the states of Alagoas, Bahia, Ceará, Paraíba, Pernambuco, Piauí, Rio Grande do Norte and Sergipe, in addition to the north of Minas Gerais (CAVALCANTE *et al*., 2013). *Cactus*, belonging to the *Cactaceae* family, are plants present in the Caatinga biome, forming part of the Angiosperms, representing the second most numerous groups in the Neotropical region, which includes both the *Cactus* typical of the locality, such as the mandacaru, and other species that have leaves (BRAVO FILHO *et al*., 2018). In addition to this biota, this plant can be found in other large Brazilian natural regions, such as the Amazon, Cerrado, Atlantic Forest, Pampas, and Pantanal. Its structure consists of a stem capable of storing a large amount of water inside, which allows for greater succulence in its vegetative organs, containing thorns on its surface that act as a defense mechanism against natural predators.

According to Bravo Filho *et al*. (2018), this plant is used on a large scale as animal feed and human food, in regions affected by long periods of water and food shortages. However, studies carried out by Otálora *et al*. (2015) and Agostini-Costa (2020) showed that cladodes are sources of antioxidants, pigments and mucilages, which allow them other applicability. Mucilage, a secretion rich in polysaccharides, has been widely explored due to its low cost and wide availability (GHERIBI & KHWALDIA, 2019). Vargas-Solano *et al*. (2022) investigated the chemical composition of the mucilage of the *Opuntia fícus-indica* species, regarding the presence of sugars available at different stages of maturation and obtained sugar levels equivalent to 45,4 g/100g for young mucilage and 47,5 g/100g for the mature stage, concluding that sucrose constitutes the main component of this viscous substance, regardless of the age of maturation. Therefore, this work aimed to identify and determine the main constituents present in the stem of Hylocereus *megalanthus* to add value to this promising biomass, still little explored, aiming for its application in the most diverse industrial areas.

2 MATERIAL & METHODS

Sample preparation: The stem of the *Cactus* Hylocereus *megalanthus* was brought from the coast of the municipality of Arraial do Cabo, Rio de Janeiro. The material was dried in an oven at 100 °C for 3 hours, crushed in a knife mill to later determine the moisture content.

Extractives content: The total extractives content was obtained using the TAPPI T204 om-88 method (TAPPI, 1996), in which 2 g of the sample was taken through the Soxhlet system together with ethanol and water separately to remove the extractables.

Chemical characterization: The methodology used was adapted from Rocha *et al*., (2014), in which 1,0 g of stem (free of extractives), previously washed, crushed, and dried, was added to a beaker for maceration with 7,5 mL of H_2SO_4 72 % (m/m), at 45 ºC, for 7 minutes. Then, the contents were transferred to a 500 mL Erlenmeyer flask and completed with 275 mL of ultrapure water, and subsequently autoclaved for 30 minutes at 121 ºC. The samples were vacuum filtered, and the liquid fraction was stored for subsequent carbohydrate analysis in HPLC. The solid fraction was washed with 2 L of distilled water, until neutral pH, and dried in an oven, at 60 ºC, until mass stabilization, for quantification of insoluble lignin and ash.

Fat determination: The adapted methodology TAPPI T204 om-88 (TAPPI, 1996) was used, in which 2 g of the fresh sample were introduced into a Soxhlet system, together with hexane, at 120 °C, for 6 hours. Then, the sample was dried in an oven at 100 °C for 3 hours.

3 RESULTS & DISCUSSION

In the chemical characterization stage, it was found that the sample, when placed in direct contact with H_2SO_4 72 % (m/m), dissolved quickly, showing that its molecular structure did not resist acid, which contributes to greater efficiency in the fiber destructuring process. Table 1 presents the results obtained regarding the mass fraction of the main constituents if the *Cactus* Hylocereus *megalanthus* stem, compared with the literature.

Table 1. Mass fraction of the *Cactus* Hylocereus *megalanthus in natura*.

	Mass fraction (%)		
Components	This work (2024)	Mannai *et al*., (2017)	Khiari *et al*., (2010)
Cellulose	32,34 ± 0,02	53,00	45,00
Hemicellulose	11,51 ± 0,01	11,00	29,80
Lignin	25,01 ± 0,24	4,80	27,20
Ash	8,84 ± 0,24	5,50	5,00
Extractives	22,20 ± 0,07	25,00	20,80

It is observed that the results obtained in this work, referring to hemicellulose, ash, and extractives, were close to those found by Mannai *et al*. (2017) and Khiari *et al*. (2010), however, differed in relation to cellulose and lignin, emphasizing that factors such as temperature, soil, region, climatic conditions, and species influence the content of each constituent. Mannai *et al*. (2017) investigated the chemical composition *in natura Cactus* fibers, with the aim of verifying whether pre-treatment using NaOH/anthraquinone would be ideal for removing lignin and highlighted that this biomass, due to its low lignin content and significant cellulose can be used as an input for paper manufacturing.

The fat content present was 9,50 %, close to that found by Vargas-Solano *et al*. (2022), who obtained 4,40 %, for the species *Opuntia fícus-indica* (*Cactus* pereira), which is considered low and consequently an excellent characteristic for this biomass, as it will not influence the levels of the highest added value constituents, like cellulose. Ventura-Aguilar *et al*. (2017) studied the interference of fats and waxes in the stem of the *Cactus Opuntia fícus-indica* Mill and concluded that the amount of this component present in this species is low, compared to other constituents, such as cellulose, hemicellulose and lignin.

Figure 1 shows the spectrum obtained from FTIR for the *Cactus* Hylocereus *megalanthus*.

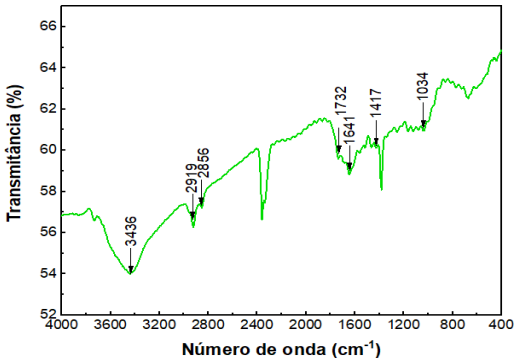

Figure 1. FTIR spectrum for the *Cactus* Hylocereus *megalanthus*.

From the spectroscopic analysis it was possible to identify the main functional groups present in the species Hylocereus *megalanthus* with emphasis on the band at 3436 cm^{-1}, equivalent to the O-H stretching, attributed to cellulose and lignin. Gheribi *et al*. (2018) identified a broad absorption band close to wavelength 3331 cm^{-1}, corresponding to the intermolecular O-H bond present in alcohols and carboxylic acids, attributed to lignin. The bands at 2919 cm^{-1} and 2856 cm^{-1}, respectively, refer to C-H stretching, attributed to hemicellulose and lignin, like that found by Vargas-Solano *et al*. (2022), in the region 2932 cm^{-1} and 2926 cm^{-1}, which are related to the asymmetric stretching (extension) of the C-H bond of the methylene group (CH_2). The bands present at 1732 cm^{-1} and 1641 cm^{-1} correspond to the stretching of the C=O bonds of the ester and amide groups, respectively, which are attributed to the presence of hemicellulose and lignin. The band at 1417 cm^{-1} refers to the C-H angular deformation of the CH_3 group attributed to lignin and, finally, the band at 1034 cm^{-1}, equivalent to the C-O stretching of the ether group, attributed to cellulose, hemicellulose, and lignin. We can highlight that the functional groups identified in this work (O-H, C-H, C=O, C-O), for the species Hylocereus *megalanthus*, were also observed by Rivera-Corona *et al*. (2014), when working with freeze-dried *Cactus* mucilage.

Table 2 presents the wavelengths referring to the absorption bands found in the *Cactus* spectrum FTIR with their respective descriptions and assignments.

Table 2. Functional groups present in the stem.

Wave-length (cm^{-1})	Description	Assignments
3436	Connections O-H	Cellulose and lignin
2919 and 2856	Connections C-H	Hemicellulose and lignin
1732	Connection C=O in ester	Hemicellulose
1641	Connection C=O in amide	Hemicellulose and lignin
1417	Angular deformation C-H of the group CH_3	Lignin
1034	Stretch C-O from the ether group	Cellulose, hemicellulose and lignin

4 CONCLUSION

From the results obtained regarding the chemical characterization of the stem of Hylocereus *megalanthus*, it was possible to verify that this biomass has a relevant composition, with emphasis on the contents of cellulose, hemicellulose, lignin, and extractives compounds with high added value and great potential to be explored. An interesting application for this biomass, used on a large scale, would be the production of second-generation ethanol, because it has a moderate lignin contend and a significant percentage of cellulose.

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ACKNOWLEDGEMENTS

Dedicated thanks to ÂNIMA, FAPESB, UFBA, IBTR and UNIFACS who made the research possible.