POTENTIAL BIOTECHNOLOGICAL APPLICATIONS OF TUCUMÃ (*Astrocaryum aculeatum* Meyer) AND GUARANA (*Paullinia cupana* H.B.K.) RESIDUES FOR VALORIZATION IN THE PRODUCTION CHAIN: A REVIEW

Leandra P. da Rocha[1*], Valcilene, M. S. Souza[1], Leiliane do Socorro S. de Souza[1] & Anderson M. Pereira[1]

[1]Graduate Program in Environmental Sciences and Sustainability in the Amazon/Federal University of Amazonas, Amazonas, Brazil.*
Email: lebiologa67@gmail.com

ABSTRACT

The Amazon region is recognized as one of the most biodiverse areas on the planet, home to a vast variety of endemic fruit species that are unique to this enormous ecosystem. Among the Amazon's valuable resources are Amazonian fruits, seeds, leaves, bark, resins, fibers, etc. A wide variety of species produce fruits that are unique in taste, nutrients and medicinal properties. Examples include guarana (*Paullinia cupana* H.B.K.) and tucumã-do-Amazonas (*Astrocaryum aculeatum* Meyer). After processing, there is a residue of bark, kernel and seed, which are materials with no commercial value and whose final destination is landfills or dumps, corroborating environmental degradation (release of methane gas and leachate). The aim of this research was to identify the biotechnological applications of tucumã and guaraná waste in the literature in order to promote the valorization of the production chain of these fruits. The method used in this research was exploratory, bibliographical and qualitative. After the research, it was observed that there are few reports on the use of the residues of these species, indicating the need for more studies on them and an efficient final destination in order to generate economic benefit, the residues of these fruits have a high antioxidant capacity and can be used in various biotechnological branches, such as pharmaceuticals, phytotherapics, natural dyes, etc.

Keywords: Agro-industrial waste 1. Guaraná 2. Tucumã 3. Antioxidant capacity 4. Biotechnology 5.

1 INTRODUCTION

Biotechnology applied to the food industry promotes new ways of using fruit to generate innovative products. Promoting sustainability in food processing avoids the waste of by-products, promotes the creation of a unique and often regional identity for processed products, which ultimately attracts greater consumer attention to the consumption of sustainable and healthy food. It also transforms waste into useful resources, generating new business opportunities and sustainable development[1].

The tucumã-do-Amazonas, endemic to the central Amazon region, is a palm belonging to the Arecaceae family. In Brazil, it is distributed in the states of Acre, Mato Grosso, Rondônia, Roraima, Pará and Amazonas[2, 3]. The fruit has a number of highly nutritious medicinal properties and is widely consumed both *fresh* and processed. The fruit is considered a source of lipids (40.49%), fiber (10.93%), vitamin C (14.35 mg/100g), minerals (2.58%) and unsaturated fatty acids (68.77%), which are ideal for the production of food for human consumption[4].

Guaraná (*Paullinia cupana*) is a plant endemic to the Amazon region and a major economic driver in the state of Amazonas and other states. Its largest production is concentrated in Bahia and in the municipality of Maués in Amazonas. The potential of this fruit includes the chemical composition known as methylxanthines, mainly caffeine, which is associated with increased cognitive function and energy expenditure, in addition, it has a flavan-3-ol content, with catechin and epicatechin representing up to 3% and 2% of its composition[5, 6, 7].

In this context, the purpose of this work was to bring together the main studies in the literature on the industrial biotechnological applications of tucuma (*Astrocaryum aculeatum* Meyer) and guarana (*Paullinia cuapana)* residues, with the aim of adding value to the production chain of these fruits. We aim to identify the potential of these residues and make more efficient use of the resources available in the production of these Amazonian foods.

2 MATERIAL & METHODS

The method used in this research was exploratory, and the means were bibliographical and qualitative[8]. The bibliographic research was carried out on the Periódicos Capes and Google Scholar databases. These platforms were used exclusively as search tools for specific terms related to the topic. The selection of works was restricted to those published between 2011 and 2023, ensuring that they addressed the topics of interest to this research.

3 RESULTS & DISCUSSION

Large quantities of agro-industrial waste, such as fruit peelings, bagasse, seeds and straw, are produced daily by different economic activities. In general, little or no economic value is attributed to this waste, as it is not usually used in other processes. However, they are nutritionally rich, containing sugars, minerals and proteins. They are therefore natural sources of important compounds such as carbon, oxygen and various minerals[9, 10]. It is worth noting that improper disposal of this waste can result in serious environmental and public health impacts. Environmental pollution, the release of greenhouse gases and soil and water contamination are just some of the problems associated with the improper disposal of agro-industrial waste. It is of the utmost importance to implement policies and practices that promote the proper treatment and sustainable use of guarana and tucuma waste, ensuring that these valuable resources are used in a responsible and ecologically correct manner. This requires the involvement of governments, the private sector, non-governmental organizations and local communities in a joint effort to meet this challenge[1, 2] .

The industrial and biotechnological potential of guarana and Amazonian tucumã waste is highlighted in Table 1. For the tucumã residues, there are still no market applications, only scientific research, which shows their biotechnological potential for implementation in industry. In traditional communities, the oil from the kernel is used for hair, the residue from the shell is used to supplement food for domestic animals and the stone (woody material) is used as charcoal[11]. With regard to guarana waste, there are already biotechnological implementations aimed at creating craft beer.

Table 1 - Potential biotechnological applications of guarana (*Paullinia cuapana*) and Amazonian tucumã (*Astrocaryum aculeatum* Meyer) residues

Fruit	Waste	Applications	Ref.
Tucumã	Bark	Inhibitory action for the microorganisms *E. faecalis*, *B. cereus*, *C. albicans* and *L. monocytogenes.*	12
		Reduction of the cytotoxic effects of hydrogen peroxide on human lymphocytes.	13
		Bacterial activity against the tested strains of *E. coli, P. aeruginosa*, *S. aureus* and *K. pneumoniae*.	14
	Almond	Potential bio-oil for use as biofuel and charcoal.	15
		High fatty acid content and can be used in cooking, pharmaceuticals and cosmetics.	16
	Lump	Obtaining wood plastic composites with high-impact polystyrene.	17
Guaraná	Bark	Obtaining an extract for use as an antioxidant in food.	18
		Production of catalysts.	19
		Craft beer production.	20,21
	Bushing	Transformed into paper, eco-bags, holders made from fibers.	22
		Obtaining biofuels.	23
	Residual seed	Production of biodegradable packaging.	24

Source: Authors, 2024.

The amount of waste generated after consuming tucumã is high. In the urban area of Manaus, around 62,300 kg of waste per month is discarded and ends up in landfill or incorrectly disposed of in the environment[25], over 70% of the fruit is made up of waste[26]. As for guarana waste, after the extraction process to obtain guarana extract, the estimated annual production is between 2.9 and 4.6 tons of waste[23]. Research has shown that there are few reports on the use of the waste from these species, indicating the need for further studies and an efficient final destination in order to generate economic benefits.

Given the evidence of the above-mentioned research, which highlights the potential of guaraná and tucumã residues, it is clear that there is a significant opportunity to take advantage of these resources more widely and efficiently. Through the application of advanced biotechnological techniques, such as the bioprospecting of bioactive compounds, the biotransformation of waste into value-added products and the development of sustainable production processes, it is possible to further exploit the potential of this waste[27] .

However, it is important to note that much research to date has focused mainly on the edible or marketable part of the plant, which has greater economic value, and the waste resulting from its processing has been neglected. This results in an underutilization of these valuable resources and an increase in agro-industrial waste. Investing in new research that focuses on the valorization of waste from the biotechnological production of guaraná and tucumã can explore different methods of using this waste, from the extraction of bioactive compounds (TPC, flavonoids, tannin, alkaloids, β-carotene, gallic acid etc[12, 14, 18, 21]) to the production of biodegradable and energetic materials[2] .

As well as offering opportunities for the creation of new products and innovative technologies, this research also plays a key role in conserving Amazonian biodiversity, strengthening the local economy and promoting sustainable development in the region

4 CONCLUSION

Through this research it was possible to see that there are still few studies that address biotechnological solutions for the large demand for guaraná and tucumã waste that is produced during the processing of micro and large food companies. Given the biotechnological potential of guaraná and tucumã do-Amazonas, the opportunity to add value to these residues and boost the state's bioeconomy is clear. These Amazonian fruits not only represent valuable natural resources, but also have a rich variety of bioactive compounds that can be exploited for various industrial purposes. With the application of innovative biotechnological techniques, it is possible to transform waste from the processing of these fruits into a wide range of high value-added products, ranging from functional foods, nutritional supplements, cosmetics, herbal medicines, bioplastics, biofuels and compost.

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