

Review

# Systematic Mapping of the Production Chain of “Bacuri” (*Platonia insignis* Mart.) in Brazil

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**Abstract:** The Amazon contains the most significant number of known species on the planet, where fruits with peculiar characteristics can be found. The bacuri (*Platonia insignis*) is a native fruit of this region and has gained prominence over the years. A data survey was conducted to understand the bacuri production chain system and its economic potential. The results show that the popularity of the fruit has led to an increase in consumer demand and its price over the years. In addition, the mapping shows that this production chain needs a well-defined structure. Its current organization consists of the activities of associations and cooperatives that, over time, have assumed the integration between producers, industry, and the consumer market. This study also identified a gap in the official censuses and a need for studies to quantify production within the scope of small producers, aiming for more effective monitoring that allows the development and direction of policies that can support producers to strengthen this important production chain.

**Keywords:** *Platonia insignis*; data survey; Amazonian fruits; plant extractivism



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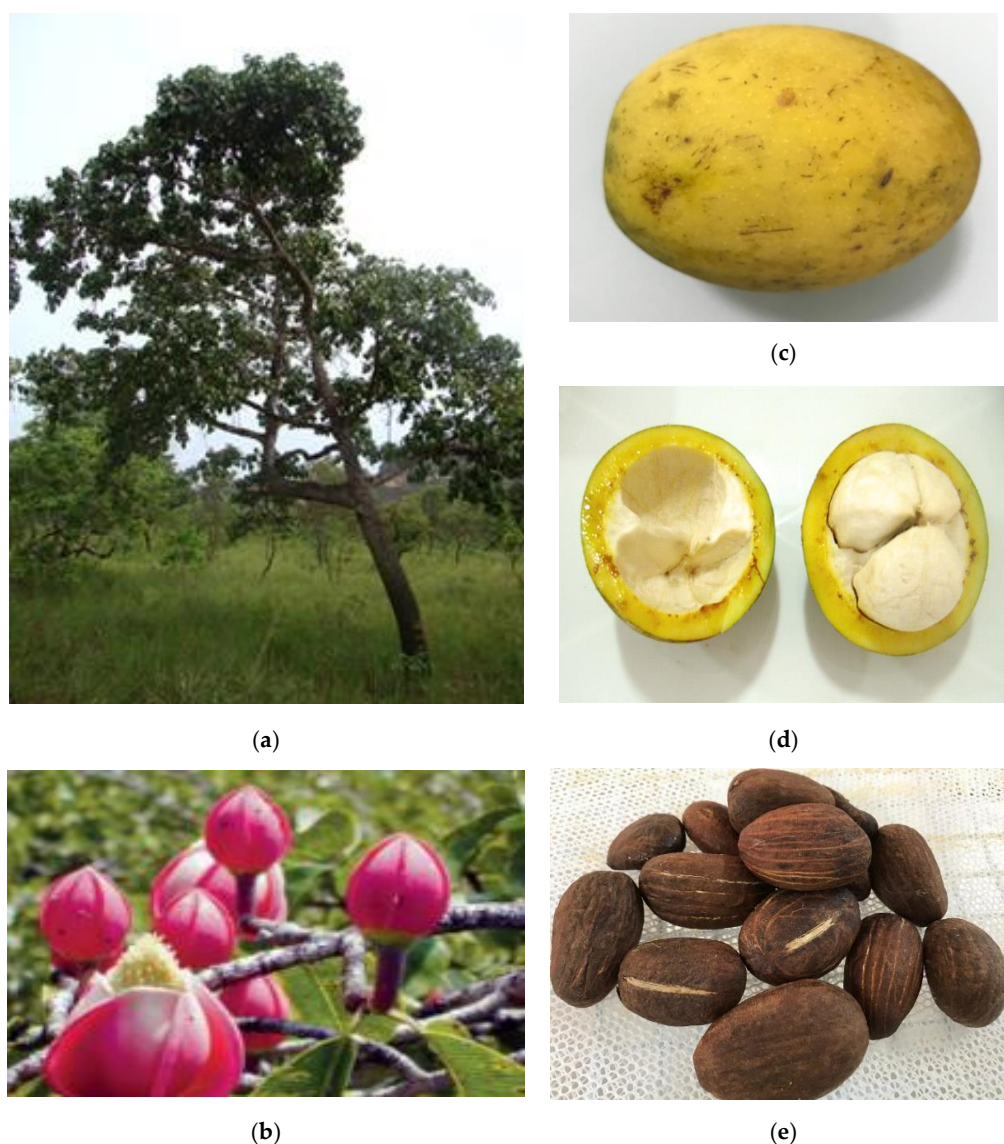
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## 1. Introduction

Brazilian biodiversity is recognized as one of the largest in the world, mainly concerning the diversity of plant species with attractive characteristics from a nutritional and pharmacological view [1–7]. The Amazon embraces the most significant number of known species on the planet [8], presenting fruits with peculiar characteristics. In this sense, plant extractivism is an essential alternative for employment and income for countless families and plays a vital role in the economy [9,10].

Plant extractivism can be defined as the exploration of native plant resources, including the collection of products such as wood, grains, fruits, and roots [11]. Harvesting products such as fruits and grains in extractive reserves have received considerable attention, mainly owing to their supposed potential to promote the sustainable use of natural ecosystems [12].

The bacuri (*Platonia insignis*) is a fruit of exotic characteristics native to the Brazilian Amazon. Its shell can be citrine yellow; reddish-brown; or, more rarely, green [13]. It measures 7 to 15 cm in length and has a diameter of 5 to 15 cm, with a variable weight between 200 and 500 g. The pulp has a creamy-white color and a sweet flavor with fruity notes [14–16]. The fruits are predominantly provided with seeds with an ellipsoidal shape [17] (Figure 1).



**Figure 1.** (a) *Platonia insignis* Mart. tree; (b) bacuri flowers; (c) bacuri fruit; (d) pulp (endocarp) of the fruit; (e) bacuri seed.

Despite its Amazonian origin, the fruit has spread to other regions of Brazil, playing an important economic role in the states of Pará, Maranhão, Piauí, and Tocantins, with the occurrence of this species being common in areas of secondary vegetation [18,19], where the primary vegetation was degraded. In replacement, there was the natural development of native species [20,21].

Bacuri has been called “white gold” because of its economic importance [22], which has reached a prominent level over the last century, changing from wood extraction to fruit consumption in natura or processed [18]. There are records of its use in cooking since the 19th century, when products such as sweets and jams were exported to Europe. However, reports about its industrial use began to be consolidated after 1910, when products derived from the fruit reached the retail market [23]. The segments involved in this chain cover the pulp agroindustry (for manufacturing creams, ice cream, and juices) and direct trade to the final consumer through market traders, supermarkets, and food services [24]. Although, on a smaller scale, the bacuri seed is also used to extract oil, called bacuri butter. Rich in fatty acids, it has moisturizing, healing, and emollient potential and has gained visibility in the dermo-cosmetics sector in recent years [25].

Interest in the species has grown mainly thanks to its national and international recognition from studies on the fruit and palm, which added economic value to the species over time. Studies on different parts of bacuri have recognized its photoprotective [26], anti-fungal [27], anti-inflammatory [28], antioxidant [29–31], immunomodulatory [32], hypotensive [29,33], vasorelaxant [34], hypolipidemic, cardioprotective [35], and glycemic control properties [31]. In addition, its composition, rich in fiber and bioactive compounds, may contribute to adding functional properties when added to other foods [36–39]. Although significant advances in research on its chemical composition have provided a better understanding of the relationship between nutrition and biodiversity, there is still a gap related to the dynamics of the bacuri production chain.

The lack of knowledge about this chain's organization has become a crucial constraint on public policies for developing agri-food and agro-industrial systems related to this fruit. In this scenario, this study sought to understand and describe Brazil's bacuri (*Platonia insignis*) production chain system and its economic potential.

## 2. Materials and Methods

This study was performed based on a data survey in the scientific literature and censuses from the Brazilian Institute of Geography and Statistics (IBGE, Rio de Janeiro, Brazil) [40]. The search was performed as shown in Figure 2.

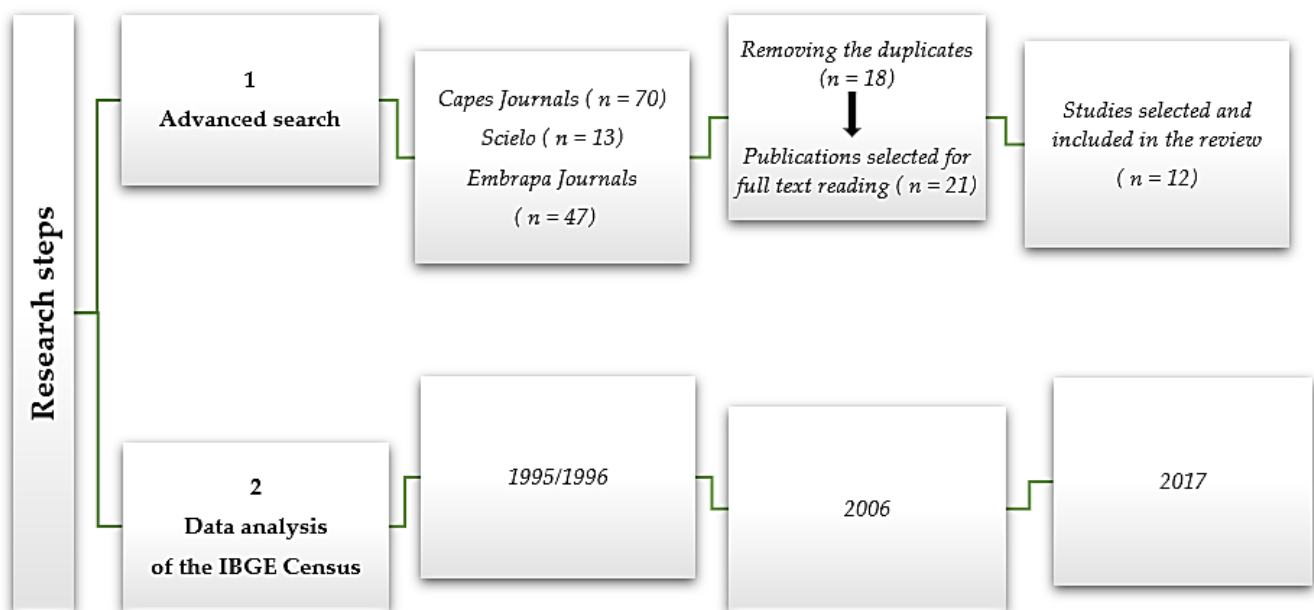


Figure 2. Bibliographic search flow chart.

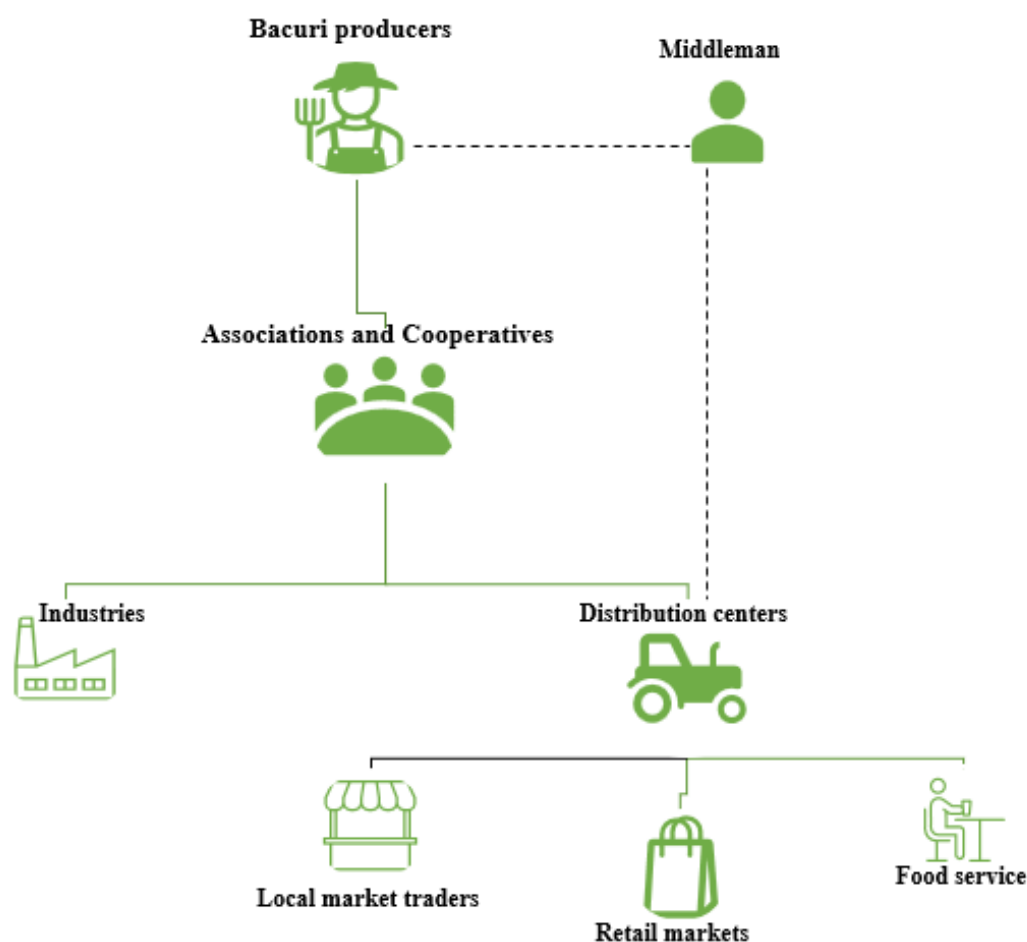
We started with a bibliographic review comprising information from 2000 to 2020 on the structural aspects of the bacuri production chain and factors that make up the productivity scenario. For the advanced search, we used the Capes Journal Portal, Brazilian Agricultural Research Corporation (Embrapa, Brasilia, Brazil) Portal, and Scientific Electronic Library Online (Scielo, Manaus, Brazil) databases. In addition, a combination of descriptors was used: “*Platonia insignis*” AND or OR “bacuri tree” AND or OR “native fruits” AND or OR “productive chain” AND or OR “economy”, as well as filters for themes related to “biodiversity”, “sustainable development”, “agronomy”, “science and technology”, “plant science”, and “analysis”. In total, the search returned 130 publications.

Thereafter, duplicates and articles whose abstracts did not mention factors related explicitly to the bacuri production chain (i.e., data on the commercialization cycle and characteristics of production or productivity) were excluded. Further, only 12 were selected for this review, as they included quantitative and qualitative data on the evolution of the bacuri market, production, productivity, and entities involved. In the next step, data from

the Agricultural Censuses of the Brazilian Institute of Geography and Statistics (IBGE) were analyzed. We sought to identify the number and scenario of commercialization of the fruit in Brazil by evaluating the distribution, production, and location of its production units by region. For this, we used a reference to the data from 1995/1996, 2006, and 2017, years in which the volume of bacuri output appears in the official statistics.

### 3. Results

Bacuri participates in a short chain characterized by interrelationships between actors directly involved in food production, transformation, distribution, and consumption [41]. However, there are some intermediaries before reaching the final consumer. Even though cooperatives play an essential role in price negotiation, it is common to observe autonomous manufacturers, usually linked to small producers. In this context, the figure of the “middleman” between the producer and potential buyers is common in cities that include production centers, mainly because he is often responsible for the first survey of market demand, directing the production distribution, which usually leads to lower participation of agro-extractivists in the market gains [42]. Figure 3 briefly summarizes this trade circle.



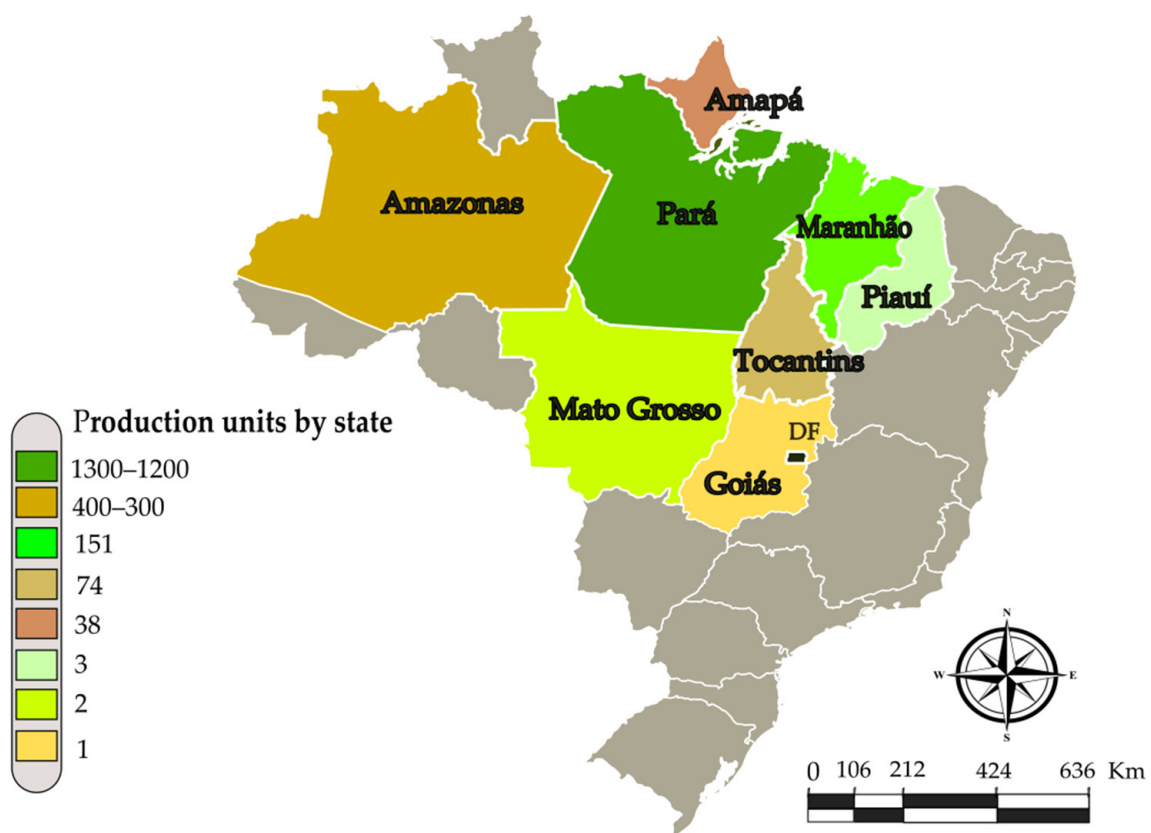
**Figure 3.** Structuring the bacuri production chain.

Frozen pulp of bacuri can be used to produce different food products such as beverages, jellies, cakes, and ice cream. The frozen pulp consists of processing by extracting the endocarp of selected fruits and homogenizing them in water, which then goes through packaging and is subjected to freezing conservation methods, which allows for preserving the characteristics of the fruit and its consumption in the off-season [43]. This type of product presentation is the most commercialized form by large retail chains and is responsible for the change in the fruit trade in recent years. It is usually sold at higher prices than other exotic fruits, such as cupuaçu (*Theobroma grandiflorum*) [14] and açaí (*Euterpe oleracea*) [23].



Records from 2017 show the product being sold for R\$41.29/kg, and in 2018, with a considerable increase in its price, it started to be sold for an average of R\$55.00/kg [14,44,45]. In January 2020, the product could be found for an average price of R\$30.00/kg in the main commercialization centers [45]. In the off-season, prices for this product increase significantly, which may explain its significant periodic variation [46].

Regarding production data, the 1995 agricultural census, published by the Brazilian Institute of Geography and Statistics (IBGE), indicated the existence of 2174 production units, totaling an estimated R\$835,418.35. The north and northeast regions contributed 53% and 42.13% of production, respectively. In the 2006 census, there was a decrease in the number of establishments registered, totaling 2118 production units. However, according to data from the last census published in 2017 by IBGE, the bacuri production map catalogued around 2700 producing establishments, mostly in the northern region (69.11%), followed by the northeast (30.62%) (Figure 4).



**Figure 4.** Distribution of production units by state. Data source: 2017 Agricultural Census (IBGE). Northern region: Amazonas (AM), Amapá (AP), Pará (PA). Northeast region: Maranhão (MA) and Piauí (PI). Midwest region: Tocantins (TO), Mato Grosso (MT), Goiás (GO), and Federal District (DF). Figure charted using Inkscape Software, New York, USA.

With this expansion, the production in the Amazon region reached an average of 2250 tons per year [47,48]. Although these numbers are considered expressive, there is still a need for research to quantify bacuri production among small producers [23].

The main bacuri commercialization places are concentrated in the supply centers of the producing states and street markets [14]. The most considerable popular commerce of the fruit is located in the north region of Brazil, popularly known as the “Ver-o-Peso” fair, located in the city of Belém, in the State of Pará [45].

#### 4. Discussion

The productive chain of Amazonian fruits needs to be better structured. Concerning bacuri, its organization consists of some associations and cooperatives that have assumed

the coordination and integration between producers, industry, and the consumer market over time. Although the “in natura” fruit is commercialized, the demand generated by the fruit pulp processing agroindustry provides the starting point for prices and quantities to be traded on the market [49].

The bacuri commercialization is based on the fruit collection or pulp removal and subsequent sale to intermediaries during the harvest period, from December to March, with a productive peak in February. The fruit processing to obtain the pulp is very artisanal as there is still no equipment available to pulp the fruit properly. In addition, bacuri has a bitter-tasting resin in the peel that can be mixed with the pulp in processes in which the pulping is performed improperly [13].

The pulping process requires much labor for manual execution. Therefore, the bacuri production chain is responsible for a large informal occupation during its collection, pulping, and commercialization, in which the participation of young people and adults in rural areas is common [23,49]. Until the end of 1980, consumption of bacuri was restricted to the places of production and the harvest period [44]. Still, the dissemination of information in the country and abroad concerning its potential led to an increase in demand for this product and the consequent rise in its price in the market. Although the average weight is an important characteristic related to the physical aspects of the fruits, and the size is a quality criterion in the price determination, the consumer tends to prioritize characteristics such as external appearance, color, firmness, and aroma in the fresh food market [46].

Sustainability in bacuri extractivism has become a topic of interest among researchers, as the intense processes of resource extraction to meet the intense growth in demand can lead to the inability of the species to regenerate. According to the classification proposed by Menezes et al. [18], there are three bacuri tree exploitation systems: extractive, regrowth management, and planting. The extractive system uses trees in primary and secondary forests and is characterized by the collection of fruits in an area where bacuri trees are older than half a century. The regrowth management system comprises the recovery of plants from spontaneous shoots, represented by the regeneration of secondary vegetation. This system is understood to improve simple extractivism by creating more favorable conditions for the bacuri trees. Furthermore, it is considered a low-cost technology that uses the existing labor in the establishment. Finally, the planting system consists of planting seedlings, seeds, and grafting considered the least common and most recent. However, some producers have started to invest in this system in Pará, the main center of bacuri production, to follow the rapid growth of the bacuri fruit and pulp market identified in the mid-2000s. All of these systems are strongly associated with the pulp and fruit market growth, which allowed an increase in sales nationally and internationally and matched other prominent fruits, such as cupuaçu and açaí, by presenting comparative and competitive advantages [18,22,50].

Sustainable extraction is a process that is directly linked to knowledge about bacuri management systems, with the use of techniques to minimize the impacts of extraction and expand the supply of the product, as the collection is carried out through inadequate practices can lead to the death of the bacuri tree and, in the medium and long term, cause a decrease in the availability of fruits in the supply and, consequently, in an increase in the price of the products of this chain in an expanding market [22,51,52].

The growth of the bacuri market can have an impact that goes beyond the economic context. Climate change is already compromising local agricultural production and, consequently, the food and nutrition security of traditional populations from developing countries, especially those strongly dependent on natural resources [53,54].

In Brazil, crop productivity is likely to decrease, leading to a 2 to 5 billion US\$ loss by 2070 [55] and worsening the socio-economic vulnerability of family farmers [56]. Given the urgency to encourage sustainable practices to mitigate these negative effects of climate change, the opportunity to transform degraded regions into productive bacuri trees can discourage tree overthrow and burning practices, bringing significant gains for the environment over the years and generating income and employment [23,44].

## 5. Conclusions

There is a gap in the data on price evolution associated with the bacuri market. In addition, the official census data related to production may be underestimated as cataloging and quantifying small producers are difficult tasks in the face of informal trade. Therefore, studies focused on different points of the production chain may offer more specific answers to identify the sector's demands, becoming an essential tool for investigating the interfaces that permeate the dynamics of production systems.

More effective interventions that allow the dissemination of knowledge for improving the production, distribution, and use of the fruit can become more effective as it is possible to systematically understand what happens in the segments in which production is inserted. In this sense, it is necessary to develop and direct public policies supporting producers and stimulating sociobiodiversity. Among these actions, it is possible to highlight the need to develop educational and training guidelines for producers on planting techniques, management, and use of the fruit. It is also vital to study proposals that make it possible to include financial aid to bacuri producers in the off-season period. In addition, measures that make it possible to strengthen cooperatives and associations to minimize the effect represented by the middleman can effectively reduce the informality of this trade.

Considering that the main bacuri production centers are located in the Legal Amazon, measures to encourage the planting of this native plant could promote the recovery of deforested areas. Furthermore, the technological potential of bacuri is shown as a possible strategy for developing and encouraging bio business, especially in a promising market, where the bioeconomy through new technologies can be sustainably and innovatively applied in various sectors, opening new market opportunities.

There are many challenges, but it is essential to emphasize the importance of creating alternatives for the dissemination of the use, access, and consumption of by-products generated in the processing of bacuri in health and human nutrition, considering that the relationship between food security and biodiversity conservation in a more sustainable environment is one of the most important contemporary themes.

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