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PLATONIA INSIGNIS MART. (BACURI): SCIENTIFIC ADVANCES, PRODUCTION POTENTIAL, AND PERSPECTIVES FOR CROP VALORIZATION IN THE AMAZON

PLATONIA INSIGNIS MART. (BACURI): AVANÇOS CIENTÍFICOS, POTENCIAL PRODUTIVO E PERSPECTIVAS PARA A VALORIZAÇÃO DA CULTURA NA AMAZÔNIA

PLATONIA INSIGNIS MART. (BACURI): AVANCES CIENTÍFICOS, POTENCIAL PRODUCTIVO Y PERSPECTIVAS PARA LA VALORIZACIÓN DEL CULTIVO EN LA AMAZONIA

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Abstract

Platonia insignis Mart. is a native Amazonian fruit tree of high ecological, socioeconomic, nutritional, and agro-industrial relevance, standing out as a strategic resource for the valorization of sociobiodiversity and the Amazon bioeconomy. Despite its recognized potential, this crop remains predominantly associated with extractive or semi-extractive production systems, characterized by low technological input, irregular productivity, and structural limitations that hinder its rational cultivation and the consolidation of its production chain. In this context, this review aimed to compile, systematize, and critically discuss the scientific literature related to *P. insignis,* addressing its botanical, ecological, productive, physicochemical, nutritional, functional, genetic, socioeconomic, agro-industrial, and technological aspects. The literature analyzed indicates that *P. insignis* fruits possess highly appreciated sensory attributes, promising nutritional composition, the presence of bioactive compounds, and significant potential for whole-fruit utilization, including pulp, peel, seeds, and by-products with applications in the food, cosmetic, pharmaceutical, and biotechnological sectors. In parallel, studies also demonstrate high genetic and phenotypic variability, reinforcing both the species' domestication potential and the need for conservation strategies and the selection of superior plant materials. However, important knowledge gaps remain regarding clonal propagation, genetic improvement, ecophysiology, agronomic management, postharvest handling, processing, and industrial scale-up. Furthermore, the fragmentation of available knowledge and the lack of integrative approaches still limit the consolidation of the species as a technically structured fruit crop. It is concluded that the advancement of *P. insignis* cultivation depends on the articulation among scientific research, genetic conservation, technological innovation, production chain organization, and the strengthening of family farming, in order to expand its insertion into sustainable systems of production, value addition, and territorial development in the Amazon.

Keywords: bacuri; amazonian fruit tree; bioeconomy; agroindustrialization; sociobiodiversity.

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Resumo

Platonia insignis Mart. é uma frutífera nativa da Amazônia de elevada relevância ecológica, socioeconômica, alimentar e agroindustrial, destacando-se como recurso estratégico para a valorização da sociobiodiversidade e da bioeconomia amazônica. Apesar de seu reconhecido potencial, a cultura ainda permanece predominantemente associada a sistemas extrativistas ou semi-extrativistas, com baixa tecnificação, irregularidade produtiva e limitações estruturais ao cultivo racional e à consolidação de sua cadeia produtiva. Nesse contexto, esta revisão teve como objetivo compilar, sistematizar e discutir criticamente a literatura científica relacionada à cultura do *P. insignis*, abordando aspectos botânicos, ecológicos, produtivos, físico-químicos, nutricionais, funcionais, genéticos, socioeconômicos, agroindustriais e tecnológicos. A literatura analisada evidencia que o *P. insignis* apresenta atributos sensoriais altamente apreciados, composição nutricional promissora, presença de compostos bioativos e expressivo potencial de aproveitamento integral, incluindo polpa, casca, sementes e subprodutos com aplicações nos setores alimentício, cosmético, farmacêutico e biotecnológico. Paralelamente, os estudos também demonstram elevada variabilidade genética e fenotípica, o que reforça tanto seu potencial de domesticação quanto a necessidade de estratégias de conservação e seleção de materiais superiores. Contudo, permanecem lacunas relevantes relacionadas à propagação clonal, melhoramento genético, ecofisiologia, manejo agronômico, pós-colheita, processamento e escalonamento industrial. Além disso, a fragmentação do conhecimento disponível e a carência de abordagens integrativas ainda dificultam a consolidação da espécie como cultura frutícola tecnicamente estruturada. Conclui-se que o avanço da cultura do *P. insignis* depende da articulação entre pesquisa científica, conservação genética, inovação tecnológica, organização da cadeia produtiva e fortalecimento da agricultura familiar, de modo a ampliar sua inserção em sistemas sustentáveis de produção, agregação de valor e desenvolvimento territorial na Amazônia.

Palavras-chave: bacuri; frutífera amazônica; bioeconomia; agroindustrialização; sociobiodiversidade.

Resumen

Platonia insignis Mart. es una especie frutal nativa de la Amazonia de alta relevancia ecológica, socioeconómica, alimentaria y agroindustrial, destacándose como un recurso estratégico para la valorización de la sociobiodiversidad y de la bioeconomía amazónica. A pesar de su reconocido potencial, este cultivo aún permanece predominantemente asociado a sistemas extractivistas o semiextractivistas, con baja tecnificación, irregularidad productiva y limitaciones estructurales para su cultivo racional y la consolidación de su cadena productiva. En este contexto, la presente revisión tuvo como objetivo compilar, sistematizar y discutir críticamente la literatura científica relacionada con el cultivo de *P. insignis*, abordando aspectos botánicos, ecológicos, productivos, fisicoquímicos,

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nutricionales, funcionales, genéticos, socioeconómicos, agroindustriales y tecnológicos. La literatura analizada evidencia que *P. insignis* presenta atributos sensoriales altamente apreciados, composición nutricional prometedora, presencia de compuestos bioactivos y un notable potencial de aprovechamiento integral, incluyendo pulpa, cáscara, semillas y subproductos con aplicaciones en los sectores alimentario, cosmético, farmacéutico y biotecnológico. Paralelamente, los estudios también demuestran una elevada variabilidad genética y fenotípica, lo que refuerza tanto su potencial de domesticación como la necesidad de estrategias de conservación y selección de materiales superiores. Sin embargo, aún persisten vacíos relevantes relacionados con la propagación clonal, el mejoramiento genético, la ecofisiología, el manejo agronómico, la poscosecha, el procesamiento y el escalamiento industrial. Además, la fragmentación del conocimiento disponible y la carencia de enfoques integradores aún dificultan la consolidación de la especie como un cultivo frutícola técnicamente estructurado. Se concluye que el avance del cultivo de *P. insignis* depende de la articulación entre investigación científica, conservación genética, innovación tecnológica, organización de la cadena productiva y fortalecimiento de la agricultura familiar, con el fin de ampliar su inserción en sistemas sostenibles de producción, agregación de valor y desarrollo territorial en la Amazonia.

Palabras clave: bacuri; frutal amazónico; bioeconomía; agroindustrialización; sociobiodiversidad.

1. Introduction

Platonia insignis Mart. is a native Amazonian tree species belonging to the family Clusiaceae, subfamily Clusioideae, and is the sole representative of the genus *Platonia*. It is a fruit-bearing species of high ecological, sociocultural, and economic relevance, occurring predominantly in the Eastern Amazon, especially in the states of Pará and Maranhão, although it is also found in other regions of Brazil and in neighboring South American countries. Its wide geographic distribution, combined with its strong ecological adaptability and the nutritional and cultural value of its fruits, confers strategic importance to the species within Amazonian sociobiodiversity and traditional systems of native forest resource use (Manica, 2000; Medina; Ferreira, 2004; Lima, 2007; Lima et al., 2022).

Among the native fruit species of the Amazon region, *P. insignis* stands out for its remarkable potential for food, agro-industrial, and functional applications. Its fruits possess highly appreciated sensory attributes, characterized by intense aroma, exotic flavor, and high consumer acceptance,

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and are widely used in the production of frozen pulp, ice cream, sweets, jams, preserves, nectars, liqueurs, and dairy-based products. In parallel, scientific evidence indicates that the pulp has a promising nutritional and functional composition, including soluble sugars, dietary fiber, amino acids, minerals, and bioactive compounds, thereby expanding its relevance to the food, nutraceutical, and bioindustrial sectors (Soares, 2010; Vasconcelos et al., 2018; Rocha; Silva; Rodrigues, 2024).

From a physiological and technological perspective, *P. insignis* exhibits specific characteristics that directly affect its harvesting, handling, and postharvest utilization. It is a non-climacteric fruit whose ripening occurs predominantly on the plant, with natural abscission representing a reliable indicator of the ideal harvest stage (Shanley, 2005; Teixeira et al., 2005; Carvalho; Nascimento, 2018). Although this characteristic favors the full development of sensory and chemical attributes, it also imposes important operational constraints, especially under extractive production systems in which harvesting depends on the natural fall of fruits. In addition, the strong adhesion of the pulp to the seeds, together with the presence of resin and the lack of widely adopted mechanized pulping technologies, constitutes one of the major bottlenecks to the expansion of agro-industrial processing of the species (Carvalho; Nascimento, 2018; Rodrigues; Homma; Kato, 2019).

Despite its regional relevance and growing market recognition, *P. insignis* is still predominantly exploited under extractive or semi-extractive systems characterized by low technological input, irregular supply, and limited production standardization. This condition restricts industrial supply, compromises raw material uniformity, and keeps the species at an early stage of domestication. In this context, *P. insignis* is included among native forest species with high economic potential but still underexploited from agronomic, productive, and market-oriented perspectives, highlighting the need to expand and consolidate scientific knowledge regarding its production chain (Menezes; Homma; Schöffel, 2012; Alvarez; Potiguara, 2013; Rodrigues, 2019; Lima et al., 2022).

The growing interest in the species is also associated with the potential for

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whole-fruit utilization and its integration into strategies of bioeconomy and value addition to regional production. Although the pulp represents the main commercial fraction, other structures such as the peel, mesocarp, and seeds also exhibit technological and functional relevance and may be explored in the production of food ingredients, bioactive compounds, and inputs for the cosmetic and pharmaceutical industries. This perspective expands the role of *P. insignis* as a strategic resource for sustainable agro-industrial systems, particularly within the context of Amazonian family farming and the valorization of native biodiversity (Homma, 2014; Lima et al., 2022).

From a scientific standpoint, recent advances have significantly expanded the understanding of different dimensions of *P. insignis* cultivation, encompassing botanical, physicochemical, nutritional, sensory, phytochemical, rheological, and technological aspects. Studies have demonstrated the presence of antioxidant compounds, dietary fiber, minerals, secondary metabolites, and volatile compounds of functional relevance, in addition to highlighting the potential use of agro-industrial residues. However, despite these advances, the available knowledge remains scattered, often fragmented across different fields of study, and still lacks integrative approaches capable of providing a systemic understanding of the species (Rufino et al., 2010; Lima et al., 2022).

In addition, evidence indicates that *P. insignis* fruit quality and composition are influenced by genetic, environmental, climatic, and seasonal factors, resulting in significant variation in parameters such as soluble solids, acidity, mineral profile, sugars, amino acids, and phenolic compounds. This variability reinforces the need for integrated approaches that simultaneously consider ecological, productive, technological, and functional dimensions, particularly in a context of increasing demand for sustainable foods and the valorization of native species (Souza; Vasconcelos; Rufino et al., 2010; Rocha et al., 2025).

Nevertheless, although the number of studies on *P. insignis* has increased in recent years, there is still a lack of critical syntheses capable of organizing and integrating the scientific knowledge currently available on the species. In native crops with high economic potential and still undergoing domestication, literature

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reviews and systematic reviews play a fundamental role in compiling evidence, identifying knowledge gaps, guiding future research, and supporting strategies for management, conservation, and innovation. In this sense, understanding and studying *P. insignis* is essential to support the scientific and technological advancement of this crop (Lima et al., 2022; Rocha; Silva; Rodrigues, 2024).

1.1 General Objective

In this context, the present review aims to compile, systematize, and critically analyze the scientific literature on *P. insignis*, addressing its main botanical, agronomic, productive, postharvest, agro-industrial, nutritional, and functional aspects in order to provide an integrated and up-to-date overview of the species, while also highlighting current advances, existing limitations, and future perspectives for its valorization within tropical fruit production systems and the Amazon bioeconomy.

2. Literature Review

2.1 Botanical, Ecological, and Agronomic Aspects of *Platonia insignis* Mart.

P. insignis belonging to the family Clusiaceae and subfamily Clusioideae, is a monotypic tree species of high ecological, economic, and sociocultural relevance to the Amazon region and is widely recognized as one of the native fruit species with the greatest strategic potential for sustainable production systems and the regional bioeconomy. According to Lima et al. (2022) and Alves et al. (2025), the species is predominantly distributed within the Amazon biome, with occurrence also reported in transitional areas with the Cerrado and in portions of Northern and Northeastern Brazil, especially in the states of Pará, Maranhão, Piauí, and Tocantins, as well as in other South American countries. The state of Pará is frequently regarded as its most likely center of origin and principal area of natural diversity, a condition that reinforces its importance for genetic conservation strategies and the sustainable use of native biodiversity. This broad geographic distribution, together with its adaptation to different edaphoclimatic conditions,

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contributes to the high phenotypic and genetic variability observed among natural populations, a feature of great relevance for domestication, selection, and breeding efforts (Lima et al., 2022; Garcia et al., 2024; Alves et al., 2025).

From a botanical perspective, *P. insignis* is described as a medium- to large-sized tree, capable of reaching heights above 30 m and characterized by a robust trunk, dense canopy, and architecture consistent with humid tropical forest formations. Morpho-anatomical studies have shown that its leaves exhibit dorsiventral organization and a hypostomatic pattern, with predominance of paracytic stomata and the presence of secretory canals in both the mesophyll and the central vein, features consistent with anatomical adaptations to environments of high humidity and diffuse radiation (Soares et al., 2013). According to these authors, the seeds contain predominantly lipid reserves, with lower starch content, a characteristic that has important physiological implications for germination, early establishment, and propagation strategies. Although less explored in the literature than the fruits, the flowers exhibit structural complexity compatible with the allogamous reproductive system of the species, which contributes to the high levels of genetic heterogeneity found in natural populations (Garcia et al., 2024; Alves et al., 2025).

From a reproductive and agronomic standpoint, *P. insignis* presents one of the main limitations to rational cultivation among native Amazonian fruit species: a prolonged juvenile period. According to Alves et al. (2025), the species may require more than three years for satisfactory initial establishment and between 10 and 12 years to reach productive maturity under conventional conditions, which represents a major constraint to the expansion of commercial systems based on unimproved seedlings or non-clonal propagation. This behavior, combined with the predominance of semi-domesticated populations and the strong dependence on natural regeneration or root suckers, explains why a substantial portion of current production remains concentrated in extractive systems or in intermediate forms of management. Lima et al. (2022) and Rodrigues et al. (2020), emphasize that, although there are initiatives involving sprout management and the establishment of more organized orchards, the production chain still lacks a robust technological

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foundation, including consistent propagation protocols, seedling standardization, spacing definition, and the selection of superior plant material.

The fruit of *P. insignis* exhibits marked morphofunctional singularity and strong commercial appeal, being highly valued for its sensory attributes, such as intense floral aroma, exotic flavor, and high regional acceptance. As described by Rocha; Silva; and Rodrigues (2024), as well as by Rocha et al. (2025), the fruit is surrounded by a thick and resistant peel, a characteristic that favors mechanical protection and contributes to its structural integrity during transport. However, this same constitution, combined with the strong adhesion of the pulp to the seeds and the presence of resin, imposes relevant technological limitations on agro-industrial processing. *P. insignis* ripening is classified as non-climacteric, meaning that physiological maturity and the maximum expression of sensory quality occur preferentially when the fruit remains attached to the plant until natural abscission, which constitutes a practical indicator of the ideal harvest stage (Rocha; Silva; and Rodrigues, 2024; Rocha et al., 2025). This characteristic is agronomically important, but also operationally restrictive, since it limits harvest anticipation and compromises market supply standardization.

In terms of physical fruit composition, the pulp represents only a small fraction of the total fruit mass, generally ranging from 10 to 18%, whereas the peel may account for 64 to 70% and the seeds for 13 to 26%, as demonstrated by Melo et al. (2024); Rocha; Silva; and Rodrigues (2024); and Yamaguchi et al. (2021). This proportion between edible and non-edible fractions makes *P. insignis* particularly attractive from the perspective of whole-fruit utilization and biorefinery approaches, since the residual fraction, historically neglected, presents high technological and functional potential. The epicarp and mesocarp have been recognized as important sources of phenolic compounds, flavonoids, prenylated benzophenones, and natural pigments, while the seeds have also attracted interest due to their lipid composition and potential applications in cosmetics and bioactive products. Thus, *P. insignis* cultivation extends beyond strictly fruit-related interest and begins to occupy a strategic position in innovation chains based on the integral use of Amazonian biomass (Yamaguchi et al., 2021; Lima et al., 2022;

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Melo et al., 2024).

In addition to its food-related relevance, *P. insignis* has attracted increasing scientific interest due to its nutritional, functional, and phytochemical properties. The pulp contains soluble sugars, amino acids, minerals, volatile compounds, and different classes of bioactive compounds, including flavonoids, stilbenes, and other antioxidant metabolites, whose concentrations may vary significantly depending on harvest season, environment, and climatic conditions (Rocha et al., 2025). According to Rocha; Silva; and Rodrigues (2024), the fruit's aromatic profile is predominantly floral, being composed mainly of linalool, linalool oxides, and hotrienol, compounds directly associated with its sensory identity and its potential for differentiated food formulations. This composition, together with the peculiar texture of the pulp and its pseudoplastic rheological behavior, expands the possibilities for industrial use, while also highlighting the need for further studies on processing, stability, conservation, and technological standardization (Rocha; Silva; and Rodrigues, 2024; Rocha et al., 2025).

From a socioeconomic perspective, *P. insignis* cultivation is strongly linked to family farming and community-based extractivism, especially in the Northeastern region of Pará and the Marajó archipelago. Rodrigues et al. (2020), demonstrated that *P. insignis* management represents an important component of agricultural income for smallholder farmers, being particularly relevant in diversified systems that combine fruit production, food crops, fishing, and other livelihood strategies. However, Lima et al. (2022), point out that the production chain still exhibits significant structural weaknesses, including the lack of updated official statistical data, low logistical organization, poor product standardization, and limited insertion into more structured markets. This means that, despite the high cultural and economic value of the fruit, its production chain remains in a process of consolidation, reinforcing the need for integrative studies capable of articulating production, management, quality, processing, marketing, and genetic conservation.

At the same time, the conservation of *P. insignis* genetic resources plays a central role in the face of increasing anthropogenic pressure on its natural habitats.

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Agricultural expansion, wildfires, landscape fragmentation, and the replacement of native areas by anthropogenic land uses have contributed to the reduction of spontaneous populations and to the risk of genetic erosion, especially in areas historically rich in diversity. In this context, studies on population genomics and genetic conservation have gained increasing importance, as they provide valuable information for identifying population structure, maintaining genetic variability, and defining both *in situ* and *ex situ* conservation strategies (Garcia et al., 2024; Alves et al., 2025). Considering that *P. insignis* is still in an early stage of domestication, the conservation of the currently available genetic diversity is an indispensable condition for advancing breeding, clonal propagation, the selection of superior materials, and the future consolidation of more efficient and sustainable production systems.

Thus, reviewing *P. insignis* cultivation requires an integrated approach capable of articulating its botanical identity, ecological relevance, productive value, and its insertion into food, functional, and industrial value chains. More than a regional fruit species, *Platonia insignis* represents a strategic biological resource for the Amazon and for Brazil, bringing together attributes of interest to tropical fruit production, agro-industry, bioeconomy, and biodiversity conservation. However, the full utilization of its potential still depends on overcoming historical bottlenecks related to domestication, propagation, management, harvesting, postharvest handling, processing, and production chain organization, which justifies the growing scientific attention devoted to the species (Table 1) in recent decades (Lima et al., 2022; Rocha; Silva; and Rodrigues, 2024; Alves et al., 2025).

Table 1. Botanical, ecological, reproductive, and agronomic characteristics of *Platonia insignis*.

Component	Information	References
Taxonomic family	*Clusiaceae*	Manica (2000); Lima (2007); Lima et al. (2022)
Botanical classification	Monotypic species	Lima (2007); Lima et al. (2022)
Common name	Bacuri	Manica (2000); Shanley and Medina (2005)
Growth habit	Medium-to large-sized tree	Lima et al. (2022); Alves et al. (2025)

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Component	Information	References
Height potential	>30 m	Lima et al. (2022); Alves et al. (2025)
Main distribution	Eastern Amazon and transition zones	Lima et al. (2022); Alves et al. (2025)
Main occurrence areas	Pará, Maranhão, Piauí, Tocantins	Lima et al. (2022); Alves et al. (2025)
Probable center of origin	Pará State	Lima et al. (2022); Garcia et al. (2024)
Reproductive system	Predominantly allogamous	Garcia et al. (2024); Alves et al. (2025)
Leaf anatomical traits	Dorsiventral leaves, hypostomatic pattern, paracytic stomata	Soares et al. (2013)
Seed reserve composition	Predominantly lipids	Soares et al. (2013)
Fruit ripening behavior	Non-climacteric	Shanley and Medina (2005); Rocha, Silva, and Rodrigues (2024)
Harvest indicator	Natural fruit abscission	Shanley and Medina (2005); Rocha et al. (2025)
Juvenile period	Long	Carvalho and Nascimento (2018); Alves et al. (2025)
Productive maturity	Approximately 10–12 years under conventional conditions	Carvalho and Nascimento (2018); Alves et al. (2025)
Main propagation constraints	Seed recalcitrance, slow germination, high heterogeneity	Carvalho, Muller, and Leão (1998); Carvalho and Nascimento (2018)
Main agronomic bottlenecks	Lack of clonal standardization, prolonged juvenility, low technification	Lima et al. (2022); Carvalho and Nascimento (2018); Alves et al. (2025)

Source: Authors (2026).

Table 1 summarizes the main botanical, ecological, reproductive, and agronomic characteristics of *P. insignis*, highlighting the biological and productive attributes that define the species and condition its cultivation potential. Overall, the species is characterized as a native Amazonian tree of wide geographic distribution, high ecological adaptability, and marked reproductive and structural particularities, such as a predominantly allogamous reproductive system, non-climacteric fruit ripening, and prolonged juvenile phase. At the same time, the table

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also evidences important agronomic constraints, especially those related to seed recalcitrance, slow germination, high phenotypic heterogeneity, and the lack of standardized clonal propagation protocols, which together represent major limitations to the domestication and commercial expansion of the crop.

2.2 Physicochemical, Nutritional, and Functional Composition of *Platonia insignis* Fruits

The composition of *P. insignis* fruits constitutes one of the main factors responsible for the growing scientific, technological, and commercial interest surrounding this species, particularly in the context of valorizing native Amazonian fruits with potential for food, nutraceutical, and agro-industrial applications. From a compositional standpoint, the fruit presents a complex matrix characterized by marked heterogeneity among its structural fractions pulp, peel, and seeds each of which exhibits specific physicochemical and functional properties (Melo et al., 2024; Rocha et al., 2025).

P. insignis pulp stands out for its physicochemical composition, which is consistent with fruits of high sensory appeal and processing potential, being typically characterized by high soluble solids content, low titratable acidity, relatively high pH, and a creamy, viscous texture. These characteristics directly contribute to its organoleptic acceptance and to its wide use in the formulation of processed products such as frozen pulps, sweets, ice creams, nectars, jams, yogurts, and fermented beverages (Rocha; Silva; and Rodrigues, 2024; Mendes et al., 2021). In addition, the high consistency of the pulp, associated with its strong adhesion to the seeds, confers particular technological properties to the fruit, although it also represents an important operational challenge for pulping and industrial standardization, especially in the absence of equipment adapted to the structural specificities of the species (Rocha; Silva; and Rodrigues, 2024; Rocha et al., 2025).

From a nutritional standpoint, *P. insignis* pulp exhibits a promising composition, containing soluble carbohydrates, dietary fiber, amino acids, vitamins, and minerals, in addition to secondary metabolites of functional interest. According

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to Rocha et al. (2025), the contents of dry matter, lipids, proteins, soluble solids, sugars, and minerals may vary significantly among harvest seasons, reflecting the influence of environmental, climatic, and physiological factors on fruit development. In that study, compounds such as glutamate, arginine, and alanine were identified among the most expressive amino acids in the pulp, while minerals and antioxidant compounds also showed interannual variation, particularly as a function of rainfall, relative humidity, and temperature during the production cycle. These findings reinforce that the nutritional quality of *P. insignis* should not be interpreted as a static characteristic, but rather as an attribute highly dependent on the interaction between genotype, environment, and harvest season (Mendes et al., 2021; Rocha et al., 2025).

In phytochemical terms, the literature indicates that *P. insignis* exhibits a relevant functional profile, although part of its bioactive compounds is unevenly distributed among the different fruit fractions. The pulp contains flavonoids, stilbenes, flavonols, and other phenolic compounds in moderate concentrations, in addition to antioxidant vitamins and compounds potentially associated with redox activity and cellular protection (Rufino et al., 2010; Rocha et al., 2025). However, the peel and other non-edible fractions frequently concentrate higher levels of total phenolics, pigments, and secondary metabolites with antioxidant, anti-inflammatory, and technological potential, which has stimulated growing interest in the use of *P. insignis* agro-industrial residues in functional formulations and in the development of higher value-added ingredients (Lima et al., 2022; Melo et al., 2024). Thus, the functional value of *P. insignis* is not restricted to the pulp, but rather involves the fruit as a whole, reinforcing the importance of whole-fruit utilization approaches.

Another particularly relevant aspect of *P. insignis* quality concerns its aromatic and sensory profile, which is widely recognized as one of the main distinguishing features of the species in the regional market. According to Rocha; Silva; and Rodrigues (2024), the pulp presents a predominantly floral aroma, with fruity notes and a volatile profile strongly influenced by compounds such as linalool, *cis*-linalool oxide, *trans*-linalool oxide, and hotrienol. These compounds

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are considered determinant for the sensory identity of the fruit and for its high acceptance in processed products. In addition, volatile composition may be modulated by maturity stage, environment, and harvest season, suggesting a strong interaction between sensory quality and production conditions. From the perspective of the food industry, this characteristic is highly strategic, since intense and distinctive aromatic attributes tend to enhance the perceived value and commercial differentiation potential of the final product (Rocha; Silva; and Rodrigues, 2024; Rocha et al., 2025).

The rheology of the pulp also constitutes a central technological attribute for the industrial use of *P. insignis*. According to Rocha; Silva; and Rodrigues (2024), the pulp exhibits non-Newtonian pseudoplastic behavior, meaning that its viscosity decreases as shear rate increases. This characteristic is particularly important for the design of unit operations such as pumping, mixing, concentration, filling, and formulation of derived products. In native tropical fruits, understanding rheological behavior is decisive for the development of equipment, processing parameters, and formulation stability, especially considering the growing trend toward the use of *P. insignis* in beverages, desserts, fermented foods, and structuring ingredients. Thus, knowledge of the physical and rheological composition of the pulp not only complements its nutritional characterization, but also supports technological innovation within the species' production chain (Mendes et al., 2021; Rocha; Silva; and Rodrigues, 2024).

In parallel, the functional potential of *P. insignis* has also been explored in innovative food matrices, particularly in the development of fermented and non-dairy products. Mendes et al. (2021), demonstrated that *P. insignis* juice can act as a viable substrate for the growth of probiotic microorganisms, maintaining microbiological stability and cell viability during storage, in addition to exhibiting protective effects in experimental infection models. These findings significantly broaden the perspective of fruit utilization, indicating that *P. insignis* may be explored not only as a sensory or nutritional ingredient, but also as a basis for functional formulations with probiotic and anti-infective potential. This approach aligns with contemporary trends in food science, which have increasingly valued

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native plant matrices as promising platforms for innovation in functional and health-oriented foods (Mendes et al., 2021; Lima et al., 2022; Melo et al., 2024).

In addition to the pulp, *P. insignis* peel has emerged as one of the most promising fractions for value addition, especially due to its composition rich in fiber, pectin, resins, free fatty acids, aromatic compounds, and phenolics. Melo et al. (2024), demonstrated that the powder obtained from the peel exhibits promising chemical and functional properties, including potential for the production of natural pigments through metallic complexation, thereby expanding its prospects for use in food, cosmetic, and technological applications. Considering that the peel represents the largest proportion of the fruit mass and has historically been treated as waste, its valorization represents a particularly relevant strategy from the perspectives of sustainability, circular economy, and reduction of agro-industrial losses. In this sense, *P. insignis* is consistently positioned within the contemporary debate on the integral use of plant raw materials and the redesign of production chains toward greater efficiency in biomass utilization (Lima et al., 2022; Melo et al., 2024).

Thus, the physicochemical, nutritional, and functional composition of *P. insignis* fruits demonstrates that the species brings together attributes of high interest for multiple segments of the agro-food and bioindustrial chain. However, although recent advances are significant, important gaps still remain regarding compositional standardization, the influence of genotypes and environments, the stability of bioactive compounds, processing responses, and the technological scale-up of new products. Therefore, the consolidation of *P. insignis* as a raw material of greater economic and scientific relevance depends on the continuity of integrative studies capable of articulating fruit quality, functionality, technological innovation, and whole-fruit utilization, in order to transform a regionally underexploited fruit species into an effectively strategic resource for tropical fruit production and the Amazon bioeconomy (Lima et al., 2022; Rocha; Silva; and Rodrigues, 2024; Rocha et al., 2025).

2.3 Propagation, Domestication, and Genetic Conservation of *P. insignis*

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The domestication of *P. insignis* is still constrained by biological and technological limitations that hinder its transition from an extractive species to a rationally managed fruit crop. Although *Platonia insignis* presents high agronomic, food-related, and bioindustrial potential, production still depends predominantly on natural populations or on materials managed under semi-extractive systems, as highlighted by Lima et al. (2022); and Alves et al. (2025). This scenario results from the combination of a prolonged juvenile period, difficulties in standardized propagation, high genetic heterogeneity among natural populations, and the historical absence of consolidated selection and breeding programs. Therefore, progress in the domestication of this species depends directly on the integration of efficient propagation strategies, genetic conservation, identification of superior mother plants, and the development of more technified cultivation systems (Lima et al., 2022; Alves et al., 2025; Rocha; Silva; Rodrigues, 2024).

From a reproductive perspective, *P. insignis* combines sexual and asexual propagation, the latter being particularly relevant under natural conditions. Carvalho and Nascimento (2018); demonstrated that the species produces abundant shoots originating from superficial horizontal roots, a mechanism that favors its spontaneous regeneration in areas of secondary vegetation. This behavior helps explain its high frequency in fallow areas and anthropized landscapes of Northeastern Pará, as previously documented by Ferreira (2008), reinforcing the ecological resilience of the species in environments subjected to recurrent agricultural use. However, although this regenerative capacity represents an ecological advantage, it does not eliminate the need for technically reliable methods for large-scale seedling production and for the establishment of commercial orchards with greater genetic and productive uniformity (Carvalho and Nascimento, 2018; Lima et al., 2022).

Seed propagation remains biologically feasible, but it presents serious limitations for commercial purposes. Carvalho; Muller; and Leão (1998), demonstrated that *P. insignis* seeds exhibit recalcitrant behavior, with high sensitivity to desiccation and low storage capacity, which restricts their logistical use. In addition, germination is slow and non-uniform, a problem already

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addressed by Lima et al., 2022, who tested methods to reduce emergence time, and later revisited by Carvalho and Nascimento (2018). In response to these limitations, alternatives such as direct sowing at the final planting site and the use of primary root cuttings have been proposed as promising innovations, especially because they help overcome part of the difficulties associated with the initial establishment phase. Even so, sexual propagation retains the limitation of phenotypic segregation, which hinders the faithful preservation of superior traits in plant materials intended for the establishment of productive orchards (Carvalho; Muller; and Leão, 1998; Carvalho and Nascimento, 2018).

In this context, vegetative propagation assumes a strategic role in species domestication, particularly because it enables the clonal multiplication of previously selected genotypes. Carvalho and Nascimento (2018), highlighted advances obtained with grafting, both for seedling production in nurseries and for field grafting in plants derived from direct sowing, indicating a concrete pathway to reduce the heterogeneity of commercial plantings. Complementarily, initiatives involving micropropagation and tissue culture, such as those reported by Lemos et al. (1998), reinforce the potential of biotechnology as an auxiliary tool for species multiplication. Nevertheless, these protocols are still not fully consolidated for broad commercial use, revealing the need for deeper investigation into graft compatibility, rooting, rootstock vigor, and clonal seedling standardization (Carvalho and Nascimento, 2018; Lima et al., 2022).

Another central bottleneck to domestication is the prolonged juvenile period. Carvalho and Nascimento (2018), and Alves et al. (2025), indicate that, when propagated by seeds, *P. insignis* may require 10 to 12 years to reach fruiting, which greatly reduces its economic attractiveness under commercial systems. This long interval between planting and fruit production, combined with the heterogeneity of seed-derived individuals, compromises productive predictability and hinders the planning of fruit-growing enterprises based on the species. In native fruit species at an early stage of domestication, shortening the juvenile period and fixing superior genotypes are decisive steps; in this sense, the selection of elite mother plants, clonal propagation, and the development of management

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strategies aimed at earlier production constitute important scientific and technological priorities (Carvalho and Nascimento, 2018; Lima et al., 2022; Alves et al., 2025).

The genetic conservation of *P. insignis* is equally strategic, since a large portion of the species' diversity is still maintained in natural populations distributed across secondary forests, transitional areas, and agro-extractive systems. Molecular characterization studies, such as those conducted by Pontes et al. (2017), demonstrate the existence of relevant genetic variability among populations and accessions, reinforcing the importance of germplasm banks and of both *in situ* and *ex situ* conservation strategies. At the genomic scale, Garcia et al. (2024), revealed pronounced genetic structure among populations, with signs of low diversity in certain contexts and a strong influence of environmental fragmentation, agricultural expansion, and wildfires on the genetic erosion of the species. These findings indicate that the conservation of *P. insignis* should not be treated solely as an environmental measure, but also as a foundation for future breeding, selection, and directed domestication programs (Pontes et al., 2017; Garcia et al., 2024).

In summary, propagation, domestication, and genetic conservation constitute inseparable dimensions for the agronomic future of *P. insignis*. Overcoming bottlenecks related to seed recalcitrance, slow germination, prolonged juvenile phase, the lack of widely validated clonal protocols, and genetic erosion in natural populations will be decisive for consolidating the species as a technically structured fruit crop. At the same time, the rational use of its genetic variability represents the main foundation for the development of superior mother plants, promising cultivars, and more efficient and sustainable production systems (Lima et al., 2022; Garcia et al., 2024; Alves et al., 2025).

2.4 Production chain, extractivism, and socioeconomic importance of *Platonia insignis*

The socioeconomic importance of *P. insignis* is deeply associated with plant extractivism, family farming, and regional markets for native fruits from the Amazon

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and transitional areas with the Cerrado. Historically, the exploitation of *Platonia insignis* has been based on fruit collection from natural populations, especially in areas of secondary vegetation, which has consolidated a production chain still strongly dependent on extractive or semi-extractive systems, as emphasized by Rodrigues et al. (2020); and Lima et al. (2022). Although this model has ensured the persistence of the species within the rural economy of different territories, it has also contributed to the maintenance of a poorly structured chain, characterized by strong seasonality, low supply standardization, and a reduced level of technological development. Thus, *P. insignis* occupies a paradoxical position: it is economically relevant and culturally valued, yet it still lacks a degree of productive organization compatible with its market potential (Rodrigues et al., 2020; Bispo et al., 2022; Lima et al., 2022).

In the Eastern Amazon, particularly in Northeastern Pará, *P. insignis* is integrated into multifunctional agricultural landscapes in which secondary vegetation, fallow lands, agroforestry homegardens, and food crops coexist with spontaneous populations of the species. Ferreira (2008), documented the expressive presence of *P. insignis* in secondary forests of this region, while subsequent studies reinforced its integration into the productive logic of family farming systems. Rodrigues et al. (2020), showed that *P. insignis* management contributes significantly to the agricultural income of smallholder farmers, especially within more diversified systems. Therefore, the *P. insignis* production chain should not be analyzed solely from the perspective of the fruit market, but rather as a component of complex rural systems in which biodiversity, economic security, and social reproduction are deeply interconnected (Rodrigues et al., 2020; Lima et al., 2022).

Despite this importance, *P. insignis* still belongs to the group of native products that are statistically underrepresented and frequently overlooked in agricultural public policies. Lima et al. (2022), pointed out gaps in official censuses and deficiencies in the quantification of smallholder production, which hinder the monitoring of the production chain and the implementation of support measures. In parallel, Botelho et al. (2020), demonstrated that the state of Pará accounts for a

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significant share of national production, highlighting the promising nature of both the fruit and pulp markets, although production remains largely based on extractivism or rudimentary forms of management. This combination of economic relevance and statistical fragility contributes to the partial invisibility of the chain and hinders its incorporation into more robust regional development strategies (Botelho et al., 2020; Lima et al., 2022).

From a commercialization standpoint, frozen pulp has become the main form of economic utilization of the fruit due to its logistical practicality and longer shelf life. Rocha; Silva; and Rodrigues (2024), however, observed that this pattern also reveals a still limited use of *P. insignis* full potential, since commercial exploitation remains concentrated in only a few products despite the broad possibilities for food, cosmetic, and technological formulations. Bispo et al. (2022), when analyzing the *P. insignis* market in southern Maranhão, showed that a large part of the commercial flow is still organized through intermediaries and pulp-processing agro-industries, with a strong influence of informality and interpersonal trust in economic relationships. This demonstrates that the value of *P. insignis* is strongly recognized in the regional market, yet the chain still operates with low institutionalization and limited territorial governance (Bispo et al., 2022; Rocha; Silva; and Rodrigues, 2024).

The economic relevance of *P. insignis* should also be interpreted in light of its contribution to the productive diversification of family-based systems. Rodrigues et al. (2020), identified different typologies of production systems in which *P. insignis* contributes significantly to agricultural income formation, including arrangements combined with fruit growing, fishing, small-scale cropping, and other livelihood sources. These authors showed that the contribution of *P. insignis* may be substantial even when it is not the sole source of income, reinforcing its role as a strategic component of rural economic stability. In regions marked by market instability, climatic seasonality, and social vulnerability, native multipurpose species such as *P. insignis* can function as productive assets of high territorial value, articulating food provision, income generation, and conservation (Rodrigues et al., 2020; Lima et al., 2022).

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In this context, the consolidation of the *P. insignis* production chain depends on overcoming historical bottlenecks across several links, including seedling production, raw material standardization, collection and processing infrastructure, industrial scaling, commercial organization, and access to more structured markets. The main challenge does not lie in the absence of potential, but rather in the lack of integration among production, technology, logistics, statistical information, and public policies. Therefore, strengthening the *P. insignis* chain requires a systemic and territorially grounded approach capable of articulating managed extractivism, family farming, agro-industrial innovation, and the valorization of Amazonian sociobiodiversity (Bispo et al., 2022; Lima et al., 2022).

2.5 Agro-industrial potential, technological applications, and innovation perspectives

The agro-industrial potential of *P. insignis* has expanded substantially as recent studies have revealed applications beyond the traditional use of its pulp. Although fresh consumption and frozen pulp production remain the most consolidated forms of utilization, Lima et al. (2022); and Rocha; Silva; and Rodrigues (2024), demonstrated that *P. insignis* exhibits characteristics that qualify it as a multifunctional raw material for the food, cosmetic, pharmaceutical, and biotechnological sectors. This growing interest is driven not only by the fruit's sensory properties, but also by the distinct chemical composition of its different fractions, including peel, seeds, leaves, and other plant tissues, positioning *P. insignis* as a strategic resource for innovation chains based on native biodiversity (Yamaguchi et al., 2021; Lima et al., 2022; Rocha; Silva; Rodrigues, 2024).

Within the food sector, *P. insignis* pulp presents sensory and technological attributes that are particularly favorable for the development of processed products. Its intense floral aroma, exotic flavor, and creamy texture enable the formulation of sweets, jams, ice creams, beverages, yogurts, and desserts with a high potential for market differentiation, as synthesized by Rocha; Silva; and Rodrigues (2024). In addition, the pseudoplastic rheological behavior of the pulp directly influences processing operations such as pumping, mixing, and filling,

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making its characterization essential for more advanced industrial applications (Table 2). Mendes et al. (2021), expanded this perspective by demonstrating that *P. insignis* juice can support the growth and viability of probiotic microorganisms, opening new opportunities for the development of non-dairy functional foods based on this fruit (Mendes et al., 2021; Rocha; Silva; and Rodrigues, 2024).

Table 2. Technological, functional, and industrial applications of different fractions of *Platonia insignis* fruit and plant tissues.

Fraction / Tissue	Main compounds or attributes	Potential applications	Industrial sectors	References
Pulp	Sugars, aroma compounds, creamy texture, rheological properties	Frozen pulp, beverages, jams, dairy products, fermented foods	Food industry	Rocha, Silva, and Rodrigues (2024); Mendes et al. (2021); Rocha et al. (2025)
Peel	Fiber, phenolics, pigments, aromatic compounds	Powder, natural pigments, antioxidant ingredients	Food, cosmetics, natural additives	Melo et al. (2024); Yamaguchi et al. (2021); Lima et al. (2022)
Seeds	Lipids, butter, bioactive compounds	Cosmetic butter, oils, topical products, nutraceutical ingredients	Cosmetics, pharmaceuticals, nutraceuticals	Lima et al. (2022); Alves et al. (2025)
Mesocarp	Secondary metabolites, phenolics	Functional extracts, ingredient recovery	Food, biotechnology	Yamaguchi et al. (2021); Lima et al. (2022)
Leaves	Bioactive extracts	Antioxidant, antifungal, pharmacological applications	Pharmaceutical, biotechnology	Alves et al. (2025); Lima et al. (2022)
Bark / stem tissues	Specialized metabolites	Therapeutic compounds, natural extracts	Pharmaceutical, bioproducts	Souza et al. (2017); Alves et al. (2025)

Source: Authors (2026).

Table 2 summarizes the main technological and industrial applications of the different fractions of *P. insignis*, demonstrating that the species presents significant potential for whole-fruit utilization. In addition to the pulp, fractions such as peel, seeds, mesocarp, and vegetative tissues contain compounds of functional and commercial interest, reinforcing the relevance of bacuri as a promising raw material for the food, cosmetic, pharmaceutical, and biotechnological sectors.

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The fruit peel, which represents the largest fraction of total biomass, has increasingly been reinterpreted from an agro-industrial residue to a value-added input. Melo et al. (2024), demonstrated that the powder obtained from this fraction exhibits promising properties as a source of phenolic compounds, dietary fiber, and natural pigments through metal complexation. Complementarily, Yamaguchi et al. (2021), showed that peel and mesocarp residues can be exploited as sources of antioxidant compounds and prenylated benzophenones, expanding their relevance within the context of plant biorefinery. These findings reinforce that the integral utilization of *P. insignis* is not only environmentally desirable, but also represents a concrete strategy for value addition and for improving production chain efficiency (Yamaguchi et al., 2021; Lima et al., 2022; Melo et al., 2024).

Seeds constitute another fraction of high technological interest, mainly due to the oil and butter extracted from *P. insignis* seeds, which are widely valued in cosmetic, pharmaceutical, and nutraceutical applications. Several studies compiled by Lima et al. (2022), and recent systematic syntheses such as Alves et al. (2025), indicate antioxidant, anti-inflammatory, immunomodulatory, metabolic, and therapeutic properties associated with seed-derived compounds. This bioactive profile has supported the development of topical formulations, organogels, refined butters, cosmetic products, and patentable pharmaceutical applications. Thus, *P. insignis* seeds are no longer viewed merely as by-products of pulp processing, but rather as high-value raw materials for specialized industrial segments (Lima et al., 2022; Alves et al., 2025).

The innovation potential of *P. insignis* is not limited to the fruit itself. Extracts from leaves, branches, flowers, and stem bark have also demonstrated relevant biological activities, including antifungal, antileishmanial, antioxidant, photoprotective, and vasorelaxant effects, as reported in recent reviews on the species. This diversity of applications suggests that *P. insignis* comprises a broad and still underexplored phytochemical repertoire, with significant potential for the discovery of new functional ingredients, cosmetic inputs, and pharmacologically active compounds. From this perspective, *P. insignis* approaches the concept of a multipurpose species with high added value, whose importance extends beyond

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conventional fruit production and into advanced bioeconomy and natural product innovation chains (Lima et al., 2022; Alves et al., 2025).

From the standpoint of formal innovation, the existence of patent applications involving *P. insignis* further reinforces its industrial potential. Lima et al. (2022), reported patents related to cosmetic formulations based on *P. insignis* butter, pharmaceutical applications of seed oil, therapeutic uses of leaf extracts, natural antioxidants for biodiesel, and processes for producing refined butter for cosmetic, pharmaceutical, and nutraceutical purposes. Although the number of patents is still limited, their thematic diversity indicates that *P. insignis* has already begun to be incorporated into technological innovation and intellectual property agendas, representing an important step toward its future economic valorization (Yamaguchi et al., 2021; Lima et al., 2022; Melo et al., 2024).

Despite this promising scenario, the agro-industrial advancement of *P. insignis* still depends on overcoming important limitations, such as difficulties in mechanized pulping, low raw material standardization, limited technological scaling, and the gap between scientific research and industrial adoption. Rocha; Silva; and Rodrigues (2024), emphasize that the main current challenge is not to demonstrate the species' potential, but to translate this potential into concrete, economically viable, and territorially applicable technological pathways. Therefore, the consolidation of *P. insignis* as a strategic input for functional foods, natural cosmetics, nutraceuticals, and bioproducts will depend on the articulation between science, innovation, entrepreneurship, and production chain organization (Lima et al., 2022; Rocha; Silva; and Rodrigues, 2024).

2.6 Challenges, knowledge gaps, and future directions for *Platonia insignis* research

Although the volume of studies on *P. insignis* has increased considerably over recent decades, an analysis of the current state of the art reveals that knowledge remains unevenly distributed across the different dimensions of this crop. Lima et al. (2022), observed a relatively greater concentration of studies on chemical composition, bioactive compounds, and pharmacological applications,

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whereas areas that are decisive for the agronomic consolidation of the species such as domestication, breeding, ecophysiology, orchard management, applied postharvest research, and industrial scaling remain insufficiently developed. This indicates that the potential of *P. insignis* is widely recognized, but not necessarily supported by an equivalent technical and scientific foundation capable of sustaining its transformation into an economically consolidated crop (Lima et al., 2022; Alves et al., 2025).

Among the main knowledge gaps, the absence of systematic genetic improvement programs aimed at selecting superior plant materials for productivity, fruit quality, compositional stability, and environmental adaptation is particularly noteworthy. Although the literature demonstrates expressive genetic and phenotypic variability, as evidenced by Pontes et al. (2017); and Garcia et al. (2024), this diversity is still underutilized in formal strategies of directed selection and domestication. In native species undergoing the early stages of rational cultivation, the establishment of elite mother plants, multi-environment evaluation, and clonal propagation of selected materials are essential conditions for reducing productive unpredictability and accelerating the consolidation of commercial systems. In the case of *P. insignis*, this stage remains incomplete, strongly limiting the technified expansion of the crop (Garcia et al., 2024).

Another significant limitation lies in the reduced number of studies on ecophysiology, mineral nutrition, responses to abiotic stresses, and agronomic management of the species under cultivated conditions. In a scenario marked by climate change, rainfall variability, and increasing demand for resilient production systems, the absence of a deeper ecophysiological basis represents a particularly critical gap. Information is also scarce regarding planting density, pruning, irrigation, nutrient management, responses to agroforestry systems, and the relationships between environmental conditions and productivity, which compromises the formulation of more robust agronomic recommendations. For a species with recognized expansion potential, the lack of this technical basis constitutes one of the main bottlenecks to rational cultivation (Lima et al., 2022; Garcia et al., 2024; Rocha; Silva; and Rodrigues, 2024; Rocha et al., 2025).

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In the field of postharvest and processing, despite important advances in the physicochemical, rheological, functional, and sensory characterization of the fruit, studies aimed at the development of technologies for harvesting, classification, storage, packaging, transport, and large-scale processing are still scarce. The non-climacteric behavior of the fruit, the dependence on natural abscission, the high viscosity of the pulp, and its strong adhesion to the seeds represent real challenges to the structuring of a more sophisticated industrial chain. However, these issues have not yet been sufficiently addressed at the level of applied technology, which limits the expansion of *P. insignis* into more demanding markets and into value chains with greater added value. Thus, the future of the species will depend not only on the recognition of its value, but also on the translation of that value into practical postharvest and processing solutions (Mendes et al., 2021; Rocha et al., 2025).

In parallel, the insertion of *P. insignis* into contemporary agendas of bioeconomy and sustainable territorial development requires more integrated and transdisciplinary approaches. Although the fruit presents recognized cultural, economic, and ecological value, studies capable of simultaneously articulating agronomic, ecological, market, social, and institutional dimensions of the production chain are still insufficient. In other words, relatively little is still known about how to transform *P. insignis* into an effective driver of territorial development without compromising its ecological and genetic basis. This implies expanding the dialogue among research, extension, producers, agro-industry, and public policy formulation, so that the valorization of the species does not remain restricted to the theoretical sphere, but rather produces concrete effects on production chain organization and local value generation (Rodrigues et al., 2020; Bispo et al., 2022; Lima et al., 2022).

Thus, future perspectives for *P. insignis* cultivation depend on the ability to integrate genetic conservation, domestication, food science, technological innovation, productive organization, and the territorial valorization of sociobiodiversity. *P. insignis* possesses sufficient attributes to consolidate itself as one of the most strategic native fruit species of the Amazon; however, the full

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realization of this potential will depend on the coordinated overcoming of historical bottlenecks and on the construction of a deeper, more applied, and context-oriented scientific agenda. Therefore, more than simply increasing the number of studies on *P. insignis*, the challenge of the coming decades will be to generate knowledge with greater articulation, applicability, and impact, capable of supporting its transition from an underexploited regional (Table 3), resource to a crop effectively integrated into sustainable and innovative production chains (Lima et al., 2022; Alves et al., 2025).

Table 3. Main knowledge gaps and strategic research priorities for the scientific and technological advancement of *Platonia insignis*.

Research area	**Current limitation**	**Priority research needs**	**References**
Propagation	Lack of standardized clonal protocols	Grafting optimization, rooting, nursery systems	Carvalho and Nascimento (2018); Lima et al. (2022)
Domestication	High heterogeneity, prolonged juvenility	Elite genotype selection, precocity studies	Lima et al. (2022); Alves et al. (2025)
Genetic conservation	Fragmented populations, erosion risk	In situ and ex situ conservation, population genomics	Pontes et al. (2017); Garcia et al. (2024)
Agronomic management	Scarce technical recommendations	Planting density, nutrition, pruning, irrigation	Lima et al. (2022); Rocha, Silva, and Rodrigues (2024)
Ecophysiology	Limited understanding of stress responses	Water relations, phenology, environmental adaptation	Rocha et al. (2025); Lima et al. (2022)
Postharvest	Low technological development	Harvest indices, storage, packaging, transport	Rocha, Silva, and Rodrigues (2024); Rocha et al. (2025)
Processing	Difficult pulping and	Equipment	Rocha, Silva, and

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Research area	Current limitation	Priority research needs	References
	low standardization	adaptation, scale-up studies	Rodrigues (2024); Mendes et al. (2021)
Market and chain organization	Informality and weak governance	Territorial organization, public policies, market structuring	Rodrigues et al. (2020); Bispo et al. (2022); Lima et al. (2022)
Bioeconomy and innovation	Low translation of science into products	Applied R&D, patents, industrial validation	Lima et al. (2022); Alves et al. (2025); Melo et al. (2024)

Source: Authors (2026).

Table 3 the main scientific and technological gaps that still limit the consolidation of *Platonia insignis* as a structured fruit crop. Overall, the species still requires advances in propagation, domestication, genetic conservation, agronomic management, postharvest handling, processing, and production chain organization, reinforcing the need for integrated and applied research.

3. Final Considerations

This review demonstrates that *P. insignis* possesses high agronomic, nutritional, functional, agro-industrial, and socioeconomic potential, reinforcing its relevance as a strategic species for the valorization of Amazonian sociobiodiversity. The available literature indicates that the fruit exhibits important attributes related to quality, nutritional composition, functionality, and technological utilization, in addition to promising potential for insertion into food, cosmetic, pharmaceutical, and bioeconomy-based value chains.

However, despite the scientific advances achieved to date, the crop still faces important limitations related to domestication, propagation, genetic conservation, agronomic management, postharvest handling, processing, and the structuring of its production chain. These constraints help explain why *P. insignis*

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remains predominantly associated with extractive or semi-extractive systems, characterized by low standardization and limited technological development.

Therefore, the effective valorization of bacurizeiro will depend on the integration of scientific research, genetic conservation, technological innovation, productive organization, and the strengthening of family farming. Progress across these dimensions will be essential to consolidate the species as a crop of greater relevance for tropical fruit production, the bioeconomy, and the sustainable development of the Amazon.

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