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Review

The *Platonia insignis* Mart. as the Promising Brazilian 'Amazon Gold': The State-of-the-Art and Prospects

Simone Kelly Rodrigues Lima [1,2], Angélica Gomes Coêlho [1,3], Massimo Lucarini [4], Alessandra Durazzo [4] and Daniel Dias Rufino Arcanjo [1,*]

1 Laboratório de Estudos Funcionais e Moleculares em Fisiofarmacologia (LAFMOL), Departamento de Biofísica e Fisiologia, Universidade Federal do Piauí, Teresina 64049-550, Brazil
2 Instituto Federal de Educação, Ciência e Tecnologia do Maranhão, Bacabal 65700-000, Brazil
3 Adaya Biocosméticos, Teresina 64053-070, Brazil
4 CREA-Research Centre for Food and Nutrition, Via Ardeatina 546, 00178 Rome, Italy
* Correspondence: daniel.arcanjo@ufpi.edu.br

Abstract: Bacuri (*Platonia insignis*) is a monotype belonging to the *Clusiaceae* family. Of Amazonian origin, it is highly appreciated for fresh consumption, mainly due to its peculiar sensory characteristics. It is also widely used in the food industry, mainly in pulp (endocarp), used in the manufacture of beverages, jellies, and ice cream. Although the use of pulp is well established in the food sector, recently, research has turned attention to the use of other parts of the fruit and plant, especially in the therapeutics, cosmetics, and fuel sectors. Its bioactive components have been investigated for having important antioxidant, anti-inflammatory, immunomodulatory, hypotensive, cardioprotective, antiepileptic, antileishmanial, and antifungal activities, among others, mainly attributed to the presence of compounds such as xanthones, terpenes, phenolics, and fatty acids. Thus, this study aimed to gather data on the species *Platonia insignis* Mart. through an integrative review of the agronomic, nutritional, physical–chemical characteristics and a technological prospection about its applications. The study showed that in the last ten years there has been a significant increase in the number of patents deposited, with the prospect that with the advancement of studies on their properties, results for application in the most diverse areas will prove increasingly viable and promising.

Keywords: antioxidant; bacuri; *Clusiaceae*; Amazonian fruits; flavonoids; garcinielliptone FC; mangostine; morelloflavone; *Platonia insignis*

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1. Introduction

Brazil has the most diversified flora in the world, with approximately 33,161 plant species, corresponding to 26.5% of the total number of species currently known [1]. In this context, biodiversity is associated with a wide variety of natural compounds, with a wide possibility of developing new drugs, agrochemicals, fragrances, cosmetics, ingredients, and food supplements, providing a catalog of opportunities for biotechnological innovation and an unbeatable competitive advantage [2,3]. Nowadays, modeling the strict linkage between environmental, ecological and food resources in the biodiversity and health benefits perspectives represent great challenges [4,5].

Bacuri (*Platonia insignis*) is a tree species of the *Clusiaceae* family, which encompasses approximately 1000 species belonging to 47 genera, although bacuri is a monotype. Plantations occur in the wild, and propagation occurs through seeds or sprouts that arise spontaneously in the roots of adult plants [6,7]. The Amazon is its original area, although it also has a distribution along the Atlantic coast, going from the Guianas to the mid-northern region of Brazil. The area of greatest concentration is in the estuary of the Amazon River, and the largest production and marketing centers are in the states of Pará, Maranhão, and Piauí [8,9].

The fruits are usually collected through the extractive system, with the use of trees that already exist in the producing regions. However, besides the extractive system, at least two more types of systems are known: regrowth management and planting systems. Regrowth management is a process of improvement of simple extractivism, in which more favorable conditions are created for bacuri trees by using low-cost technologies. The system of planting saplings, seeds, and grafting, which is considered the most recent and promising, allows faster production of fruits while maintaining the preservation of the system [10].

Regarding the botanical aspects, the fruit is of berry type and presents shapes that can vary from pear-shaped to rounded [11] and may also present other intermediate types. However, in the same tree, the shape of the fruits is uniform, which demonstrates that the bacuri tree has genetically well-fixed characters [12]. The length of the fruit is 7–15 cm, and the diameter is 5–15 cm, with a weight that usually varies from 200 to 500 g [13], although some types can reach a weight of more than 1000 g [11]. The shell has a very thick structure (1–3 cm), responsible for the largest volume of the fruit, with a color that can vary from green to yellow-citrine and reddish-brown. On the other hand, the pulp has a creamy-white color and an essentially floral flavor with fruity notes [14,15].

Bacuri (Figure 1) is a fruit with very different characteristics from a physiological perspective. It presents a non-climacteric breathing pattern at all stages of maturation from the third day of harvest (ambient conditions with a relative humidity of 75.1% and 25.2 °C) [16,17]. Although there may still be a slight softening and color change when harvested before the sweet spot, no considerable improvement in their sensory and nutritional characteristics can be observed [14].

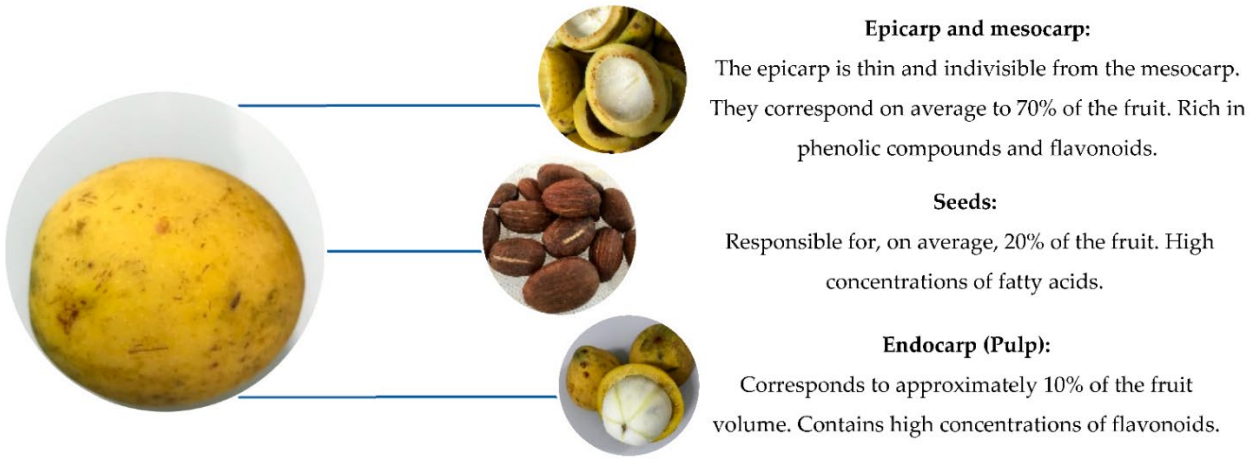


Figure 1. Contribution of bacuri (*Platonia insignis*) components to fruit volume.

The fruits are predominantly provided with seeds with an ellipsoidal shape, with an average weight of 24.4 g. The intensity of the angularities depends on the number of seeds that form in the fruit [18]. Although seeded bacuri is the most commonly found type, in 1970, seedless bacuri, a variety initially found on the island of Marajó, was reported [11]. The phenomenon of parthenocarpy occurs when none of the ovules located in one or more locules is converted into seed. It is assumed that the fraction of the pulp represented by the parthenocarpic segments is tastier, mainly due to its lower acidity. However, more studies are still needed to prove it [19].

Although seedless fruits present themselves as a viable alternative for industrial application in the food sector, recently, studies for the use of extracts obtained from seeds have gained emphasis and visibility, as well as other parts of the fruit and the palm, which diverse biological activities are being reported promising [20].

This study aimed to gather data on the species *Platonia insigns* Mart. through an integrative review of agronomic, nutritional, physical–chemical characteristics and a technological prospection about its applications.

2. Research Methodology and Selection Criteria

An integrative review concerning bacuri (*Platonia insignis* Mart.) was carried out by searching for publications in which the fruit, parts of the fruit, or the palm tree were used. The prospection was based on scientific articles and patent applications in several bacuri/bacuri tree application areas. The words "*Platonia insignis*" and "bacuri" were used as descriptors when searching scientific articles and patents. A systematic search for articles was carried out in the Capes Journal Portal, Science Direct, Web of Science, and PubMed databases. The search strategy, period, and steps followed for database analysis are shown in Supplementary Figure S1.

The documents generated in the research underwent the first screening according to the title and keywords contained in the publication. Then, they were analyzed according to the following inclusion criteria: abstracts and full texts that report the various applications of *Platonia insignis*, including its botanical and nutritional characteristics, therapeutic, nutraceutical, cosmetic, food, and industrial applications.

The research used the databases made available by the National Institute of Industrial Property (INPI), the United States Patent and Trademark Office (USPTO), the European Patent Office (EPO), and the World Property Organization. Intellectual (WIPO) to search for patents. The combinations of the words "bacuri" and "*Platonia insignis*" were used, and then, in different searches, the terms "bacuri" and later "*Platonia insignis*" in the search field for the title of the patents.

3. Results and Discussion

Supplementary Figure S2 reports the quantitative results of research and analysis of publications and patents. In the first step, the search accounted for a total of 443 documents initially distributed as follows: Capes Periodicals (176), Science Direct (94), Web of Science (113), and PubMed (60). In a second step, the texts were screened according to the scope of the work, leaving a total of 106 publications covering the period from 1945 to 2021 at the end of the selection. Regarding patent applications, the research found 12 deposits using bacuri. However, two were excluded because they used the term for the species *Attalea phalerata* Mart. From the 10 valid registrations, 9 are registered at the INPI and 1 at the WIPO via PCT. The WIPO platform also provides information on INPI records, considered in the phase of excluding duplicate documents. No records were found in the other patent databases. The distribution of scientific articles related to *Platonia insignis* by year of publication is reported in Supplementary Figure S3. It is possible to verify that research related to bacuri intensified from 2018 to 2021. This period corresponds to 50% of published patents. Major study focus areas for *Platonia insignis* Mart. is reported in Supplementary Figure S4. Studies related to agronomic aspects of bacuri are still predominant (31 documents). These focus mainly on care and management for cultivation, reproduction strategies, and, as a highlight recently, studies related to species maintenance and biodiversity conservation.

Another highlight has been the search to elucidate the chemical compounds responsible for the reported biological effects. In the last 10 years, research has sought to understand the biological effects of these compounds on the body or to elucidate compounds that have not yet been identified and their mechanisms of action, which opens the way for further studies. The other highlighted areas are biomedicine, science, and technology, among others.

3.1. Bacuri Composition: Pulp Characteristics and Applications

Bacuri is one of the most prominent Amazonian fruits. Its organoleptic characteristics allowed its success both in the group of fruits for in natura consumption and industrial use [21]. The pulp, in addition to the nutritional aspects, presents properties that allow its wide application in the industry, mainly for the production of juices, jellies, and ice creams. [6].

The centesimal composition, composition of minerals, vitamins, and amino acids, and physicochemical characteristics are reported of bacuri pulp (*Platonia insignis* Mart.) are reported in Tables 1–3. In quantitative terms, carbohydrates are the main macronutrients

that compose the pulp and are almost entirely responsible for energy values (Table 1). Among the total sugars, sucrose comprises 18.5%, while glucose and fructose comprise 15.5% and 15.6%, respectively [22].

Table 1. Centesimal composition of bacuri pulp (*Platonia insignis* Mart.).

Components	Quantity	Reference
Carbohydrates (g)	17.83–22.80	[23,24]
Proteins (g)	1.22–1.90	[23–25]
Lipids (g)	1.37–2.01	[23–25]
Total dietary fiber (g)	5.20–7.40	[23,24]
Moisture (g)	74.35–79.77	[23–25]
Ashes (g)	0.35–1.0	[23–25]
Energy value (Kcal)	84–105	[23,24]

Table 2. Composition of minerals, vitamins, and amino acids in bacuri pulp (*Platonia insignis* Mart.).

Components	Quantity	References
Minerals		
Calcium (mg)	17.09–20.00	
Phosphorus (mg)	10.76–36.00	[22,23]
Iron (mg)	0.45–2.20	
Potassium (mg)	149.81	
Vitamins		
Thiamine (mg)	0.04	
Riboflavin (mg)	0.04	[23]
Niacin (mg)	0.50	
Ascorbic acid (mg)	33.00	
Amino acids		
Lysine (mg)	8.13–316.00	[23,24]
Methionine (mg)	33–178.00	[23,24]
Threonine (mg)	4.7–219.00	[22,23]
Tryptophan (mg)	57.00	[23]

Table 3. Physicochemical characteristics of bacuri pulp (*Platonia insignis* Mart.).

Parameters	Values	References
Soluble solids (°Brix)	9.3–15.7	
pH	1.75–3.64	[17,19,21]
Acidity (% citric acid)	0.63–34.16	
Brix/Acidity ratio	0.39–25.02	

Previous studies have reported the wide variation in the range of values referring to physicochemical parameters of bacuri pulp, such as soluble solids, pH, and acidity, among others (Table 3), mainly related to the place of origin of the fruit, genotype, cultivation practices, maturation stage, harvest time, storage conditions and post-harvest changes [24]. In the food industry, the evaluation of these physico-chemical parameters is essential to define the possibilities and ways of pulp application. For example, fruits with higher acidity are less sweet, and therefore they are used mainly for the elaboration of products whose final formulations usually result in products with higher added sugars, such as jams and jellies [6,16].

3.2. Bacuri Shell

The shell constitutes about 70% of the total volume of the fruit. Its composition has high water content, representing more than 70% of its constitution. Even with a low lipid content, oleic, linoleic, stearic, and palmitic acids are constituents of this matrix (Table 4).

Table 4. Bacuri shell composition (*Platonia insignis* Mart.).

Parameters	Values (%)	References
Moisture	75.30–78.80	[26–28]
Ashes	0.5–1.02	
Proteins	1.16	
Lipids	1.58	
Carbohydrates	20.94	
Pectin	5.00	
Resins	1.40	
Cellulose	3.90	
Total titratable acidity (ATT)	4.10	
Reducing sugars	2.70	

Although rich in pectin (5.0%) and valuable in the food industry with gelling and stabilizing paper, the shell generated after pulping is commonly discarded (Table 4). That is mainly due to the presence of a resinous substance with a bitter taste in its constitution, called resinotrol, which elimination without the concomitant loss of aroma and flavor requires the application of specific technologies, which increases the costs of processing [6,8]. It is still a challenge for the industry to develop techniques that enable the use of the shell for this purpose.

3.3. Bacuri Seeds

Bacuri seeds are characterized by a high content of lipids and being rich in dietary fiber. Lipids constitute, on average, 31.88% of its composition, while moisture, proteins, and fixed mineral residue contribute with 31.91%, 3.15%, and 1.03%, respectively. From the 32.02% carbohydrate content, dietary fiber represents around 19.57% [29]. Previously considered just waste, the seeds began to attract attention for their constitution of lipids and biologically active compounds. The oil extracted from the seed, commonly called bacuri butter, although still used on a small scale, already appears as a promising possibility for better use of the fruit [30,31].

The bacuri seed butter has an average of 64% saturated fatty acids, 34% monounsaturated, and 2% polyunsaturated [32]. Although there are quite a few old reports on the use of oil extracted from the seeds of *Platonia insignis* in the treatment of various skin diseases and diarrhea [33], it is with the advancement in the studies on the chemical profile of its seeds that some gaps have begun to be filled (Table 5).

The seed oil has 50–55% tripalmitin in its constitution, allied to the fatty acid content [32]. This triglyceride, which originated from the acylation of the three hydroxyl groups of glycerol by palmitic acid, has humectant characteristics, providing high penetration into the skin with wound healing properties [34,35]. According to Pesce (2009) [36], the extraction of this oil presents many difficulties, mainly related to extraction methods due to the high-fat percentage. However, currently, there is an expectation of using processes in which it is possible to obtain a resin-free fat with a lighter color and more attractive sensory characteristics, which can be marketed at a higher price than the dark fat obtained by the extraction with presses.

In terms of lipid composition, the products obtained by different extraction methods of bacuri butter are similar among them. According to Sabará et al. (2018) [37], clarified butter has low levels of acidity and peroxide (Table 6), which improves its performance, making it ideal for the development of cosmetic products for mature skins.

Table 5. Lipid composition of bacuri clarified butter obtained by pressing.

Fatty Acids	Virgin	Clarified	References
Palmitic acid (C16:0)	60%	64%	[36,37]
Oleic acid (C18:1)	28%	25.32%	
Palmitoleic acid (C16:1)	7%	6.27%	
Myristic acid (C14:0)	2%	*	
Linoleic acid (C18:2)	2%	2.81%	
Lauric acid (C12:0)	1%	*	
Stearic acid (C18:0)	1%	1.44%	

Legend: (*) Unidentified values.

Table 6. Properties of virgin and clarified bacuri seed oil.

Properties	Virgin	Clarified	References
Melting point (°C)	35	55.4	[36,37]
Acidity (%)	10.71	0.97	
Saponification index (mg KOH/g)	211	198.61	
Iodine index (gI_2/100 g)	57	43.54	

Due to its characteristics and lipid composition, the oil extracted from bacuri seed is of particular interest to the food industry. Furthermore, studies have shown that bacuri seed oil possesses an important healing activity and it can be used in the treatment of burns and wounds [34,38]. Moreover, recently, in vivo studies point to an important potential antioxidant and cardioprotective action [39,40].

3.4. Volatile Flavor Compounds

The exotic flavor and aroma of bacuri reflect an immense and interesting combination of volatile compounds such as terpenes, hydrocarbons, and, to a lesser extent, aldehydes [41]. In some fruit species, a single substance can reflect the approximate flavor of a product, which is called an "impact compound" [42]; however, concerning bacuri, what is observed is a complex coexistence of substances that provide unique aromatic characteristics to this fruit [41].

Although the fruity note of bacuri is attributed to the presence of methyl hexanoate, it is currently known that linalool is the compound responsible for its more intense aroma and floral aroma [43]. Initially, linalool and 2-heptanone were identified as the responsible for the characteristic aroma of the fruit, however, abundantly, other volatile compounds were later identified in bacuri pulp [44], such as pyran and furan isomers of oxides resulting from linalool or hotrienol, 2,6-dimethyl-octa-3,7-dien-2,6-diol, α-terpineol, (E) and (Z)-2,6-dimethyl-octa- 2.7-dien-1,6-diol, methyl hexanoate and 2,6-dimethyl-octa-1,7-dien-3,6-diol (Figure 2). These compounds can be formed either from precursors or through chemical rearrangement during heat treatment [41]. An important point about aroma components involves the isomerism of these molecules. Optical isomers can, on the other hand, result in distinct aromatic notes. Although subtle chemical differences sometimes occur, these changes can strongly influence the biological effects of these compounds [45]. Many of these compounds reported for bacuri can be found both in the pulp and fruit shell, suggesting that there is a transfer of flavor between the parts and, thus, giving the shell-seed structures an important synergistic relationship for the determination of these characteristics.

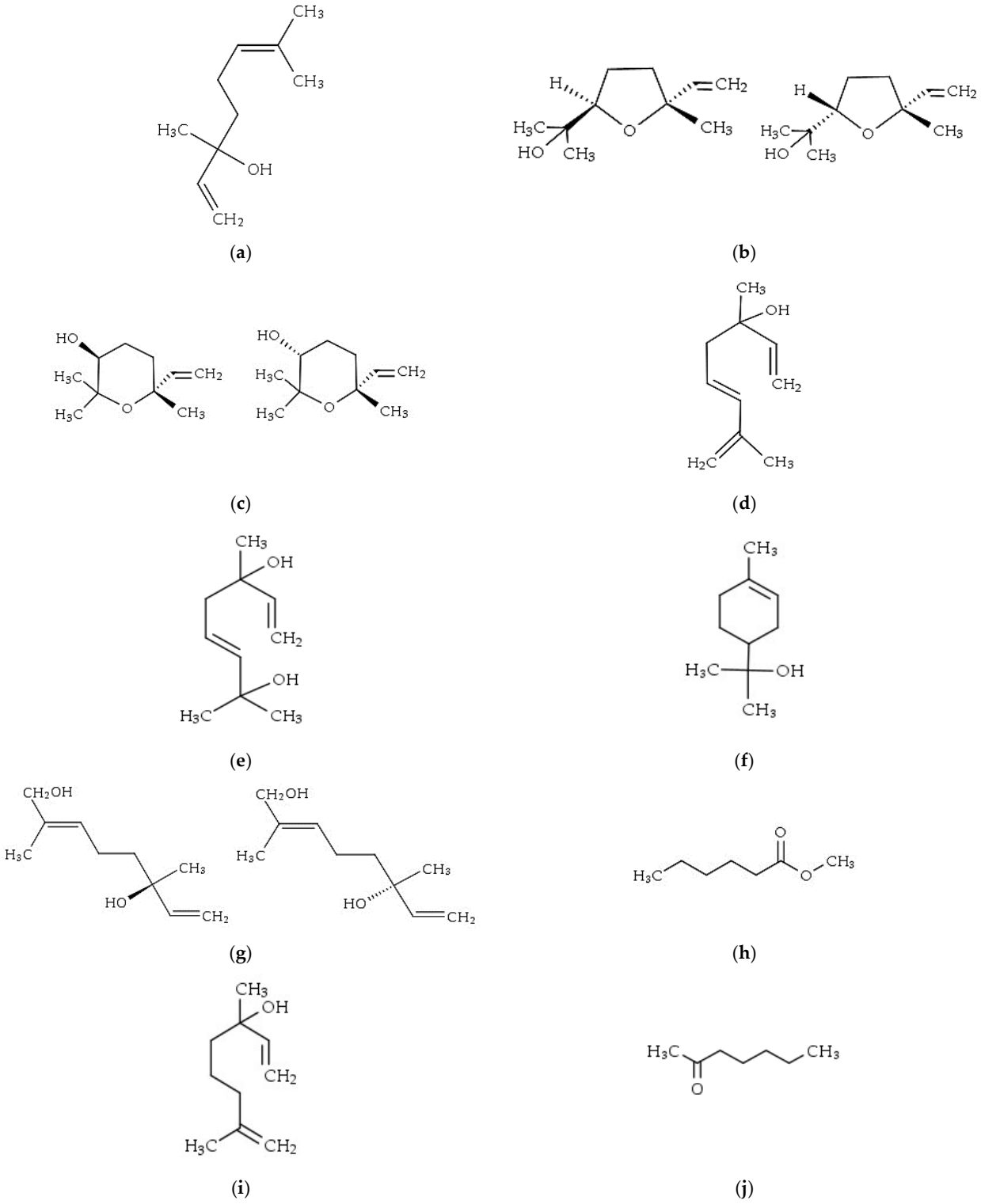


Figure 2. Volatile compounds of the aroma of bacuri. (**a**) Linalool. (**b**) (E) and (Z) Linalool furanoxides. (**c**) (E) and (Z) Linalool Pyranoxides. (**d**) Hotrienol. (**e**) 2,6-dimethyl-octa-3,7-dien-2,6-diol. (**f**) α-terpineol. (**g**) (E) and (Z)-2,6-dimethyl-octa-2,7-dien-1,6-diol. (**h**) Methyl hexanoate. (**i**) 2,6-dimethyl-octa-1,7-dien-3,6-diol. (**j**) 2-heptanone.

According to Boulanger et al. [46], the identification of the presence of fatty acid esters, ethyl hexanoate, methyl octadecanoate, ethyl octadecanoate, and dimethyl ketones with an odd number of carbons, even in small amounts, is an essential indicator of the possible

contribution of the metabolism of lipids in the biogenesis of bacuri aromatic compounds, which can be attested by the presence of important amounts of free fatty acids.

These characteristics have important value in the food industry in improving the sensory quality of food formulations. Nazaré et al. [44] carried out the extraction by heating the aroma of the compounds from the bacuri shell and its application as a replacement for the pulp to give the natural yogurt the characteristic flavor of this fruit. The study concluded that the aroma of bacuri can replace, with numerous advantages, the use of pure or diluted pulp of this fruit in the manufacture of yogurt with this flavor.

Although considered one of the most straightforward techniques for extracting aromas from bacuri, heating in different pH ranges can result in changes in the conformation of these volatile compounds, which implies, for example, greater production of oxygenated terpenes. In addition, the processing of pulp by heat can affect these components, by demonstrating the importance of cataloging them to better understand the role of these compounds in technological terms and concerning their potential biological effects for better use [41].

As an example, we have the 2,6-dimethyl oct-1-ene-3,7-diol that, when subjected to heating, results in the rearrangement that springs in linalool and R-terpineol, cited as one of the main components of bacuri aroma [41].

3.5. Phytochemical Studies and Therapeutic Use of Bacuri

The available scientific literature expressively references different biological activities. Compounds extracted from the shell, seeds, flowers, and stem bark have shown that parts of the plant can be used as an alternative in the treatment of various diseases. Its potential as cardioprotective [39,47], vasorelaxant [48], leishmanicidal [49], immunomodulatory [38], and for glycemic control [50], among others, has been reported in a variety of studies (Table 7). These effects are associated with the presence of compounds derived from terpenes, xanthones, and phenolics, in addition to saturated and unsaturated fatty acids, as can be seen in Figure 3.

Table 7. Potential therapeutic use of the bacuri tree (*Platonia insignis* Mart.).

Biological Effect	Part of the Fruit/Plant	Associated Compounds, the Action	References
Antioxidant	Epicarp and Mesocarp	GB-1a, GB-2a, Moreloflavone and Volkensiflavone	[51,52]
	Pulp	Anthocyanins and polyphenols	[53]
	Seed	Garcinieliptone FC	[49,54,55]
	Seed	γ-mangostine, α-mangostine	[56,57]
	Seed	2-oleyl-1,3-dipalmitoyl-glycerol (ODG)	[58]
Anti-glicant	Twigs	Moreloflavone	[59]
	Fruit shell	Moreloflavone	[52]
Healing	Seed	1,3-diestearyl-2-oleyl-glycerol (TG1)	[35,60,61]
Anti-inflammatory	Seed	Garcinieliptone FC	[49]
	Seed	1,3-diestearyl-2-oleyl-glycerol (TG1)	[35,62]
Hypotensive	Fruit shell	*	[63]
Glycemic control	Pulp	Flavonoids	[50]
Immunomodulator	Seed	*	[38]
Antiepileptic	Seed	Xanthones, α-mangostine, Isoalvaxanthone (IAX)	[64,65]
Neuroprotective and CNS stimulator	Seed	Garcinieliptone FC	[55,56]

Table 7. *Cont.*

Biological Effect	Part of the Fruit/Plant	Associated Compounds, the Action	References
Antileishmania effects	Seed	γ-mangostine, α-mangostine	[57]
	Seed	Garcinieliptone FC	[49]
	Seed	Fatty acids (oleic and linoleic), diterpenes, and prenylated benzophenones	[66]
	Stem bark	Triterpenoid (Lupeol)	[67]
	Flowers	Moreloflavone blend/Volkensiflavone	[68]
Antifungal	Leaves	Glycosylated flavonoids	[69]
Vasorelaxant	Seed	Prenylated Benzophenone (Garcinieliptone FC)	[48]
Cardioprotective	Flowers	*	[47]
	Seed	Unsaturated fatty acids, xanthones, prenylated benzophenone	[39]
Photoprotector	Twigs	Morelloflavone	[59]
Hypolipidemic	Seed	Unsaturated fatty acids, xanthones, prenylated benzophenone	[39]

Legend: (*) Compounds not specified.

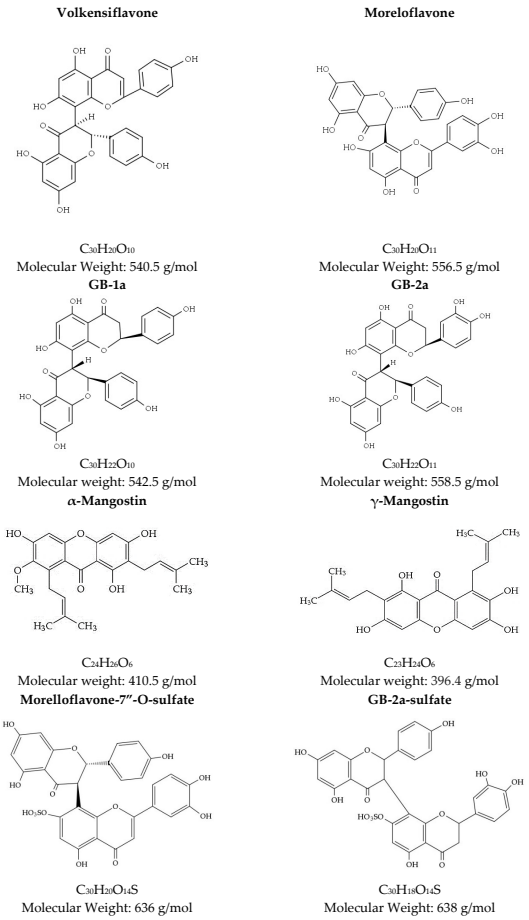
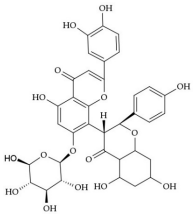


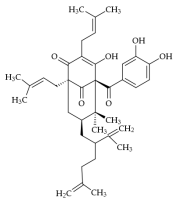
Figure 3. *Cont.*

Fukugisidium

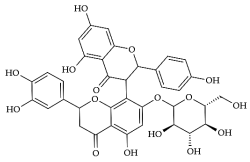


$C_{36}H_{30}O_{16}$
Molecular Weight: 718g/mol
GB-2a-Oglucopyranoside

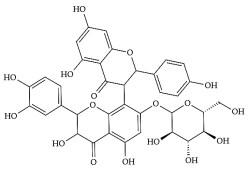
Garcinilipitona FC



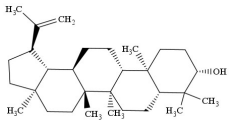
$C_{38}H_{50}O_6$
Molecular Weight: 602 g/mol
GB2-7″-Oglucopyranoside



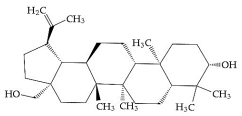
$C_{36}H_{32}O_{16}$
Molecular Weight: 720 g/mol
Lupeol



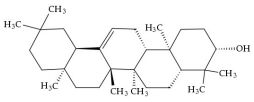
$C_{36}H_{32}O_{17}$
Molecular Weight: 736 g/mol
Betulin



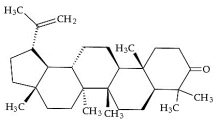
$C_{30}H_{50}O$
Molecular Weight: 426.7 g/mol
β-Amyrin



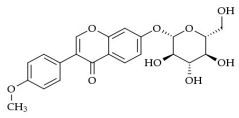
$C_{30}H_{50}O_2$
Molecular Weight: 442.72 g/mol
Lupenone



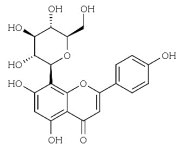
$C_{30}H_{50}O$
Molecular Weight: 426.72 g/mol
Ononin



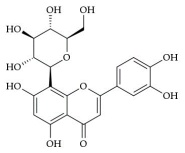
$C_{30}H_{48}O$
Molecular Weight: 424.7 g/mol
Vitexin



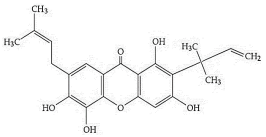
$C_{22}H_{22}O_9$
Molecular Weight: 430.4 g/mol
Orientin



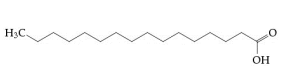
$C_{21}H_{20}O_{10}$
Molecular Weight: 432.4 g/mol
Isoalvaxanthone



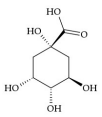
$C_{21}H_{20}O_{11}$
Molecular Weight: 448.4g/mol
Palmitic acid



$C_{23}H_{24}O_6$
Molecular Weight: 396.4 g/mol
Quinic acid



$C_{16}H_{32}O_2$
Molecular Weight: 256.42 g/mol



$C_7H_{12}O_6$
Molecular Weight: 192.17 g/mol

1,3-diestearyl-2-oleyl-glycerol (TG1)

Figure 3. *Cont*.

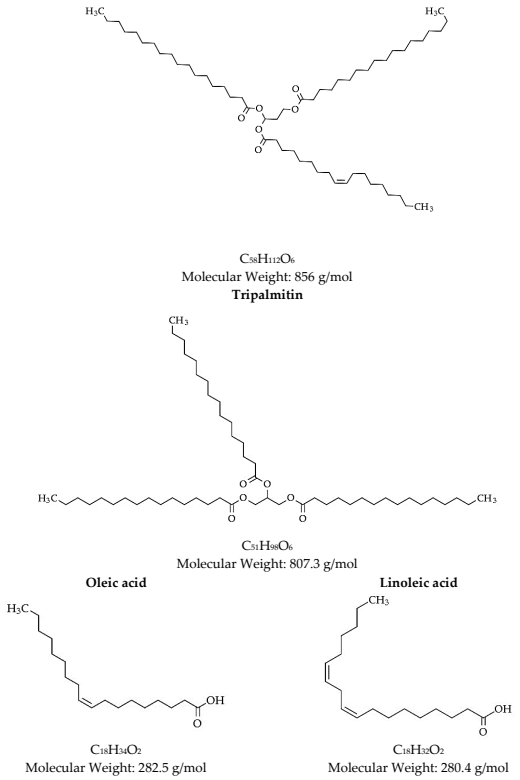


Figure 3. Chemical structures identified in the extract and fractions obtained from different parts of *Platonia insignis* Mart.

There is excellent potential for bacuri to develop drugs of natural origin, which have added economic value to the fruit, including the inedible parts of the plant [52]. The antioxidant action observed in studies with different parts of the fruit and palm has been widely cited in publications dealing with biological effects. The recognized performance of bacuri components in inhibiting the formation of free radicals or in processes of interruption of cascade reactions is related to the reduction of the presence of radicals with harmful effects in the body, an effect attributed to the action of its bioactive compounds.

3.6. Technological Prospecting

In prospective research carried out in the main patent databases, it was possible to recover 10 deposits associated with *Platonia insignis* published and, in effect, with claims for developing products or processes using different parts of the plant (Figure 4). Of the total deposits, 9 were made in Brazil through the National Institute of Industrial Property (INPI) and 1 through the Patent Cooperation Treaty (PCT) (Table 8).

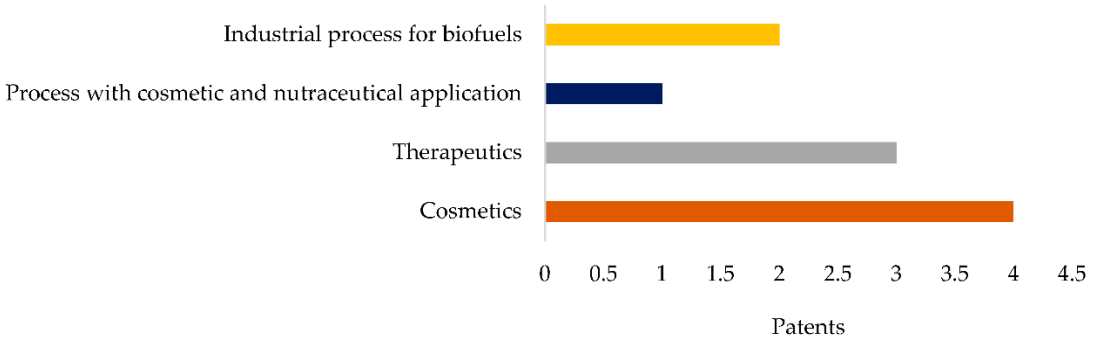


Figure 4. Distribution of patent deposits by application area.

Table 8. Records of patent applications and/or patents granted with products developed from bacuri (*Platonia insignis* Mart.).

Patent	Part of the Plant	Application	References
Cosmetic composition comprising butter from plants of the *Platonia* genus, the process of preparation of the said composition, its use, and the cosmetic method	Oil extracted from the seed of the fruit	Cosmetic	[70]
Oil-based pharmaceutical formulations of *Platonia insignis* mart seeds	Oil extracted from the seed of the fruit	Therapeutics	[71]
Antimicrobial phytotherapeutic obtained from the extract of *Platonia insignis* leaves (bacuri)	Extract of leaves	Therapeutics	[72]
Cosmetic product for the lips based on bacuri butter (*Platonia insignis*)	Oil extracted from the seed of the fruit	Cosmetic	[73]
Extracts from the Amazon rainforest for the production of cosmetics and their use in various formulations	Shells, seeds, leaves	Cosmetic	[74]
Process of application of the alcoholic extract of bacuri shell (*Platonia insignis*) as a natural antioxidant additive for biodiesel (B100)	Alcoholic extract of bacuri shell	Fuels	[75]
Process for producing refined and clarified bacuri butter and their cosmetic, pharmaceutical, and nutraceutical uses	Oil extracted from the seed of the fruit	Cosmetic Pharmaceutical Nutraceutical	[37]
Antidiabetes, phytotherapic, anti-inflammatory, analgesic, and immunomodulator obtained from the extract from the leaves of *Platonia insignis* Mart	Extract of leaves	Therapeutics	[76]
The mixture of bacuri shell alcoholic extract and rosemary leaf alcoholic extract as an antioxidant additive in biodiesel and its application	Alcoholic extract of bacuri shell	Manufacturing Fuels	[77]

The development of products in the cosmetic area ranges from extraction processes to claims about the application. For instance, there is a claim for a cosmetic composition comprising the genus *Platonia,* in which the invention uses in its composition the butter obtained from the species *Platonia insignis* associated with humectants and a cosmetically acceptable conductor [70]. This deposit was initially made in Brazil and then via IPS, covering protection simultaneously in several countries, both in preparing the said composition and on the cosmetic use and method of application.

Another patent application refers to the elaboration and preparation with incubation of roots, shells, leaves, fruits, seeds, and oils produced from plants in the Amazon rainforest, including bacuri, which are selected, sterilized, and pasteurized to obtain a substance for use in cosmetics and formulations in general. There is still a claim in the cosmetics area about the creation of a lip cosmetic product made from bacuri butter to replace one of the main components of these products, beeswax [74].

In the therapeutic field, there are three patent applications in effect. In one of them, the hexane extract of bacuri seeds was used as a base principle, presenting a function as an antiprotozoal agent, specifically referring to the leishmanicidal potential and its use in the formulation of the product(s) for the prevention and/or treatment of diseases caused by protozoa, mainly leishmania [71].

The second application refers to obtaining antimicrobial phytotherapeutic for human use from the extract of *Platonia insignis* leaves in different administration presentations, with

microbicidal action against various bacteria and fungi of clinical interest for the isolated or associated treatment of infections caused by fungi and bacteria [72].

The most recent patent in this field relates to the invention of an antimicrobial phytotherapeutic from the concentrated, lyophilized, and/or fractionated hydroalcoholic extract of the leaves of *Platonia insignis* [73]. The product, proposed in different administration presentations, presents microbicidal action against several bacteria and fungi of clinical interest for isolated treatment or associated with fungal and bacterial infections for human use. In addition, it is also indicated for treating diabetes *mellitus* and other diseases related to glucose metabolism, inflammation, combating and decreasing pain, and acting on the immune system, providing an increase in organic responses.

Another three patents claiming the development and improvement of industrial processes through seeds and shells were also registered. One of these processes ranges from the extraction of bacuri seed oil to produce refined and clarified butter to its use as a chemical input to produce cosmetics, pharmaceuticals, and nutraceuticals, with a focus on skincare product formulations or scalp [74].

The shells were used as raw material for obtaining the alcoholic extract to increase biodiesel's oxidative stability to generate longer storage time and provide the possibility of meeting the minimum required by legislation based on additions of higher extract concentrations [75].

Another invention, also within this line of thought, claims a product that, by mixing 50% of bacuri shell alcoholic extract with 50% of rosemary alcoholic extract, increases the oxidative stability of biodiesel, decreasing the rate constant of oxidation reaction, offering, therefore, a more extended storage period [77].

During the research period, it is possible to observe that there are few patent applications related to *Platonia insignis* (Figure 5). Once advances in studies related to its properties continue, results for application in the most diverse areas will be increasingly viable and promising.

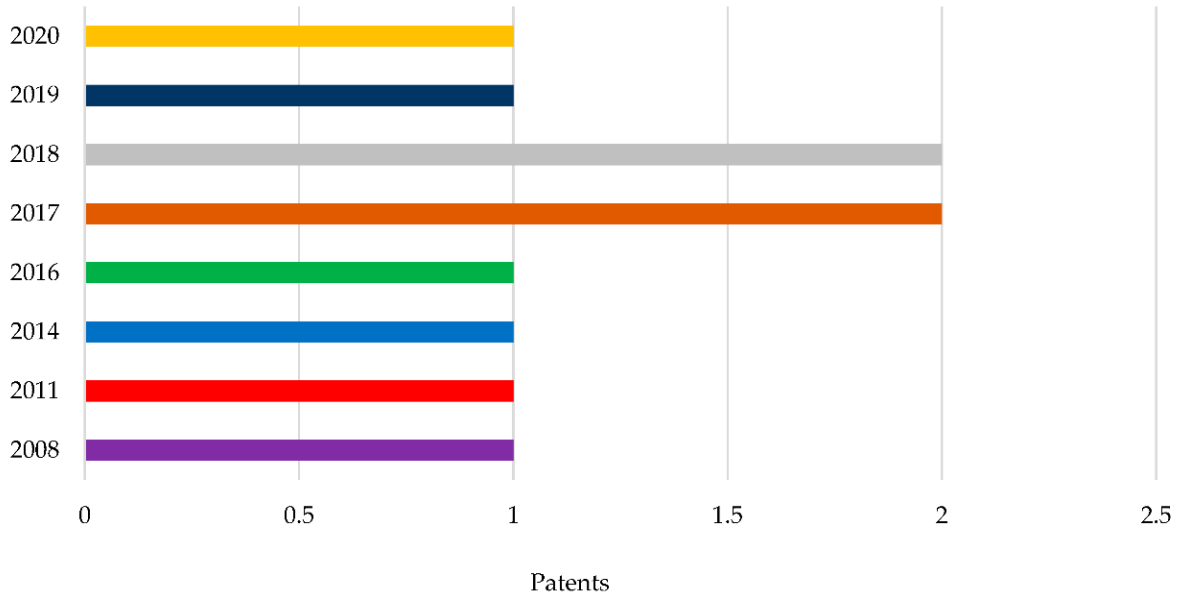


Figure 5. Distribution of patent publications related to *Platonia insignis*.

3.7. Use of Bacuri By-Products in the Production of Food Products

As a novelty in the food sector, research on using co-products from bacuri processing (shells and seeds) as ingredients in formulations has been reported with encouraging results (Table 9).

Table 9. Published studies using bacuri co-products (*Platonia insignis)* in the development of food products.

Studies for the Development of New Food Products	Results	References
They investigated the use of unconventional ingredients in the preparation of cookies without any loss of quality.	The addition of *Platonia insignis (PI)* seed increased the fiber content of the cookies produced, revealing that bacuri seed can be used as an essential functional ingredient.	[78]
They evaluated the use of bacuri shells for the manufacture of fruit structures.	They concluded the feasibility of using the shell to develop new products and generate income for small producers and agro-industries.	[79]
They used bacuri shell as the main ingredient in the formulation of sweet paste.	The results showed that removing resin and film can ensure the quality of the final product.	[80]
They made cookies with flour obtained from the bacuri shell.	The study observed that the highest percentage of biscuit consumption rejection was possibly associated with the final acidic taste; however, consumers accepted the product well.	[81]
They studied the technological use of bacuri mesocarp for making cereal bars.	They concluded that adding up to 3% of bacuri mesocarp has proved to be viable, presenting high nutritional value and good acceptance by the tasters.	[82]

Even in a very limited way, the fruit shell has been developed as a source of unconventional raw material in packaging pharmaceutical products for human consumption [30]. On the other hand, the seed has been presented as a potential functional ingredient. In addition, using unconventional parts of fruits such as bacuri in formulations can, in addition to increasing the supply of ingredients, promote the valorization of natural resources.

4. Conclusions

This integrative analysis with bacuri (*Platonia insignis*) as the study target allows us to demonstrate that, although it is considered one of the most important fruits of Amazonian origin, studies are still scarce given the multiple properties concerned with this species. The prospection about its nutritional, sensorial, functional, and pharmacological characteristics shows that, although there is a wide opportunity for applications and high demand for possible applications about the findings related to the species, there are still few patents related to *Platonia insignis*. However, in the last few years, an increase in these numbers has been observed as new studies are conducted. The studies and innovative technologies developed for bacuri so far are focused primarily on the areas of therapeutic application, optimization of industrial processes focused mainly on the biodiesel area and the cosmetics sector, the latter being the most prominent due to the involvement of foreign companies interested in product lines from the Brazilian biodiversity, demonstrating the potential of the species in the national and international market. In addition, it is essential to highlight the importance of a systematic and frequent mapping of technological prospecting for the development, improvement, and economic viability of new industrial products or processes through the use of shells, seeds, flowers, stems, and leaves from bacuri, mainly in areas of great potential and still little explored, such as the area of food ingredients, where the research for an integral use of the fruit remains a challenge.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/agriculture12111827/s1, Figure S1: Search strategy, period and steps followed for database analysis; Figure S2: Quantitative results of research and analysis of

publications and patents; Figure S3: Distribution of scientific articles related to *Platonia insignis* by year of publication.; Figure S4: Major Study Focus Areas for *Platonia insignis* Mart.

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References

1. Ulloa, C.U.; Acevedo-Rodríguez, P.; Beck, S.; Belgrano, M.J.; Bernal, R.; Berry, P.E.; Brako, L.; Celis, M.; Davidse, G.; León-Yánez, S.; et al. An integrated assessment of the vascular plant species of the Americas. *Science* **2017**, *358*, 1–5. [CrossRef] [PubMed]
2. Teixeira, N.; Melo, J.C.S.S.; Batista, L.F.; Paula-Souza, J.; Fronza, P.; Brandão, M.G.L.L. Edible fruits from Brazilian biodiversity: A review on their sensorial characteristics versus bioactivity as tool to select research. *Food Res. Int.* **2019**, *119*, 325–348. [CrossRef] [PubMed]
3. Feldmanns, P.R. África e América do Sul: O futuro passa pela biodiversidade. *Estud. Avançados* **2021**, *35*, 111–124. [CrossRef]
4. Durazzo, A. The Close Linkage between Nutrition and Environment through Biodiversity and Sustainability: Local Foods, Traditional Recipes, and Sustainable Diets. *Sustainability* **2019**, *11*, 2876. [CrossRef]
5. Durazzo, A.; Lucarini, M.; Zaccardelli, M.; Santini, A. Forest, Foods, and Nutrition. *Forests* **2020**, *11*, 1182. [CrossRef]
6. Villachia, H. Frutales y hortalizas promisorios de Ia Amazonia. *Tratado Coop. Amaz.* **1996**, *44*, 50–55.
7. Carvalho, J.E.U.d. Aspectos botânicos, origem e distribuição geográfica do bacurizeiro. In *Bacuri: Agrobiodiversidade*; Instituto Interamericano de Cooperação para a Agricultura: São Luis, Brazil, 2007; p. 210.
8. Bezerra, G.D.S.A.; Maia, G.A.; de Figueiredo, R.W.; de Souza Filho, M.d.S.M. Agroeconomic Potential of Bacuri: Review. *Bol. Cent. Pesqui. Process. Aliment.* **2005**, *23*, 45–58. [CrossRef]
9. Nascimento, W.M.O.; De Carvalho, J.E.U.; Müller, C.H. Ocorrência e distribuição geográfica do bacurizeiro. *Rev. Bras. Frutic.* **2007**, *29*, 657–660. [CrossRef]
10. de Menezes, A.; Homma, A.K.O.; de Matos, G. From extractivism to domestication: The case of the bacurizeiro in northeastern Pará and on the island of Marajó. *Soc. Bras. Econ. Adm. Sociol. Rural* **2018**.
11. Calzavara, B.B.G. Fruteiras: Abieiro, abricozeiro, bacurizeiro, cupuaçuzeiro. In *Série Culturas da Amazônia,2.*; Instituto de Pesquisas e Experimentação Agropecuárias do Norte (IPEAN): Belém, Brazil, 1970; p. 84.
12. Mourão, K.S.M.; Beltrati, C.M. Morfologia dos frutos, sementes e plântulas de *Platonia insignis* Mart. (*Clusiaceae*). II morfo-anatomia dos frutos e sementes maduros. *Acta Amaz.* **1995**, *25*, 33–46. [CrossRef]
13. Souza, V.A.B.D.; Araujo, E.C.; Vasconcelos, L.F.; Lima, P.S. Variability of physical and chemical fruit characteristics of bacuri germplasm from mid-north region of Brazil. *Rev. Bras. Frutic.* **2001**, *23*, 677–683. [CrossRef]
14. Fontenele, M.A.; de Figueiredo, R.W.; Maia, G.A.; Alves, R.E.; de Sousa, P.H.M.; de Souza, V.A.B. Conservação pós-colheita de bacuri (*Platonia insignis* Mart.) sob refrigeração e embalado em PVC. *Rev. Ceres* **2010**, *57*, 292–296. [CrossRef]
15. Uekane, T.M.; Nicolotti, L.; Griglione, A.; Bizzo, H.R.; Rubiolo, P.; Bicchi, C.; Rocha-leão, M.H.M.; Rezende, C.M. Studies on the volatile fraction composition of three native Amazonian- Brazilian fruits: Murici (*Byrsonima crassifolia* L., *Malpighiaceae*), bacuri (*Platonia insignis* M., *Clusiaceae*), and sapodilla (*Manilkara sapota* L., *Sapotaceae*). *Food Chem.* **2017**, *219*, 13–22. [CrossRef]
16. Henrique, G.; Teixeira, D.A.; Durigan, J.F.; Lima, M.A. Postharvest changes and respiratory pattern of bacuri fruit (*Platonia insignis* Mart.) at different maturity stages during ambient storage. *Acta Amaz.* **2005**, *35*, 17–21.
17. Aguiar, L.P.; Figueiredo, R.W.D.; Alves, R.E.; Maia, G.A.; Aurélio, V.; Souza, B. De Caracterização física e físico-química de frutos de diferentes genótipos de bacurizeiro (*Platonia insignis* Mart.). *Cienc. Tecnol. Aliment.* **2008**, *28*, 423–428. [CrossRef]
18. Cravalho, J.E.U.; Nascimento, W.M.O.; Müller, C.H.; Carvalho, J.E.U. Sistemas alternativos para formação de mudas de bacurizeiro (*Platonia insignis* Mart.). *Comun. Técnico no° 11 Embrapa Amaz. Orient.* **1999**, 1–5.

19. Cardoso, R.C.D.; Carvalho, J.E.U.; Barbosa, W.C. Caracterização Físico-Química das Frações Polpa Aderida às Sementes e Segmentos Partenocárpicos do Bacuri (*Platonia insignis* Mart.). In *Contribuição ao Desenvolvimento da Fruticultura na Amazônia*; SBF: Belém, Brazil, 2006; pp. 143–149.
20. Yamaguchi, K.K.L.; Victor, C.; Pereira, L.; Lima, E.S.; Florêncio, V.; Junior, D.V. Química e farmacologia do bacuri (*Platonia insignis*). *Sci. Amaz.* **2014**, 39–46.
21. Carvalho, J.E.U.; De Nazaré, F.R.; Do Nascimento, W.M.O. Características físicas e físico-químicas de um tipo de bacuri (*Platonia Insignis* Mart.) com rendimento industrial superior. *Rev. Bras. Frutic.* **2003**, *25*, 326–328. [CrossRef]
22. Rogez, H.; Buxant, R.; Mignolet, E.; Souza, J.N.S.; Silva, E.M.; Larondelle, Y. Chemical composition of the pulp of three typical Amazonian fruits: Araça-boi (*Eugenia stipitata*), bacuri (*Platonia insignis*) and cupuaçu (*Theobroma grandiflorum*). *Eur. Food Res. Technol.* **2004**, *218*, 380–384. [CrossRef]
23. Morton, J. *Fruits of Warm Climates. Banana*, 1st ed.; Echo Point Books & Media: Brattleboro, VT, USA, 1987; ISBN 0-9610184-1-0.
24. Brasil Sistema de Informação Sobre a Biodiversidade Brasileira (SiBBr). Available online: https://ferramentas.sibbr.gov.br/ficha/bin/view/FN/ShortName/4192_bacuri_polpa_crua (accessed on 28 August 2021).
25. de Santana, M.d.F.S.; de Carvalho, J.E.; Nascimento, W.M.O.d. *Determinação Química da Polpa em Genótipos de Bacuri (Platonia insignis Mart.)*; Embrapa Amazônia Oriental: Belém, Brazil, 2008; Volume 13, pp. 129–130.
26. Paula, R.D.d.G. Estudos químicos de mesocarpo de bacuri. *An. Assoc. Química Bras.* **1945**, *4*, 173–176.
27. Barbosa, W.C.; De Nazaré, R.F.R.; Nagata, I. Estudo tecnológico de frutas da Amazônia. *Embrapa-CPATU* **1978**, *3*, 1–19.
28. Silva, D.C.; Silva, I.A.; Cunha, J.S. Propriedades físico-químicas e isotermas de sorção de mesocarpo de bacuri. *XXI Congr. Bras. Eng. Química* **2016**, *1*, 1–8.
29. Soares, A.G. *Caracterização Físico-Química do Resíduo Agroindustrial dos Frutos do Bacurizeiro (Platonia Insignis Mart.) com o Objetivo de Produção de Insumos Para a Indústria de Alimentos e Química*; Universidade Federal Rural do Rio de Janeiro: Seropédica, Brazil, 2010.
30. Carvalho, J.E.U.d.; Nascimento, W.M.O.d. Technological innovations in the propagation of Açaí palm and Bacuri. *Rev. Bras. Frutic.* **2018**, *40*. [CrossRef]
31. Botelho, M.G.L.; Homma, A.K.O.; Furtado, L.G.; Lima, M.d.C.S.; Costa, M.d.S.S. View of Productive and market potential of bacuri fruit (*Platonia insignis* Mart.) in Pará, Brazil. *Res. Soc. Dev.* **2020**, *9*, e989975124. [CrossRef]
32. Fasciotti, M.; Monteiro, T.V.C.; Rocha, W.F.C.; Morais, L.R.B.; Sussulini, A.; Eberlin, M.N.; Cunha, V.S. Comprehensive Triacylglycerol Characterization of Oils and Butters of 15 Amazonian Oleaginous Species by ESI-HRMS/MS and Comparison with Common Edible Oils and Fats. *Eur. J. Lipid Sci. Technol.* **2020**, *122*, 2000019. [CrossRef]
33. Agra, M.d.F.; De Freitas, P.F.; Barbosa-Filho, J.M. Synopsis of the plants known as medicinal and poisonous in Northeast of Brazil. *Rev. Bras. Farmacogn.* **2007**, *17*, 114–140. [CrossRef]
34. Lustosa, A.K.M.F.; Bezerra, É.A.B.; Rodrigues, K.A.d.F.R.; Amorim, L.V.A.; Lima Neto, J.d.S. Antileishmanial effect of fruit seeds from *Platonia insignis* against macrophage- internalized amastigote forms of *Leishmania Amazonensis*. *Rev. Cuba. Plantas* **2018**, *2*, 1–14.
35. Lustosa, A.K.M.F.; Coêlho, A.G.; Santos, A.A.d.; Barros, Y.S.O.; Rodrigues, K.A.d.F.; Amorim, L.V.; Alves, M.M.d.M.; Carvalho, A.L.M.; Mendes, A.N.; Carvalho, F.A.d.A.; et al. Topical formulations based on seeds butter from *Platonia insignis* Mart. for the treatment of injuries related to experimental cutaneous leishmaniasis. *Res. Soc. Dev.* **2021**, *10*, e52310413665. [CrossRef]
36. Pesce, C. *Oleaginosas da Amazonia*, 2nd ed.; Museu Paraense Emílio Goeldi: Belém, Brazil; Ministério do Desenvolvimento Agrário: Brasília, Brazil, 2009; ISBN 9788561377069.
37. Sabará, D.N.; Tibério, J.; Maria, C.; Dos, M.; Manoel, D.; Moraes, C.D.E. Processo Para Produção de Manteiga de Bacuri Refinada e Clarificada, Manteiga de Bacuri Refinada e Clarificada, e Seus Usos Cosméticos, Farmacêuticos e Nutracêuticos. Patent Application No. BR102016023701, 2 May 2018.
38. Lustosa, A.K.M.F.; Arcanjo, D.D.R.; Ribeiro, R.G.; Rodrigues, K.A.F.; Passos, F.F.B.; Piauilino, C.A.; Silva-Filho, J.C.; Araújo, B.Q.; Lima-Neto, J.S.; Costa-Júnior, J.S.; et al. Immunomodulatory and toxicological evaluation of the fruit seeds from *Platonia insignis*, a native species from Brazilian Amazon Rainforest. *Rev. Bras. Farmacogn.* **2016**, *26*, 77–82. [CrossRef]
39. Lima, G.D.M.; Brito, A.K.D.S.; De Farias, L.M.; Rodrigues, L.A.R.L.; Pereira, C.F.D.C.; Lima, S.K.R.; Frota, K.D.M.E.G.; Rizzo, M.D.S.; Nunes, P.H.M.; Lucarini, M.; et al. Effects of "bacuri" Seed Butter (*Platonia insignis* Mart.) on Metabolic Parameters in Hamsters with Diet-Induced Hypercholesterolemia. *Evid.-Based Complement. Altern. Med.* **2021**, *2021*, 1–8. [CrossRef]
40. Lindoso, J.V.d.S.; Alencar, S.R.; dos Santos, A.A.; Mello Neto, R.S.; Mendes, A.V.d.S.; Furtado, M.M.; da Silva, M.G.; Brito, A.K.d.S.; Batista, E.K.F.; Baêta, S.d.A.F.; et al. Effects of "Bacuri" Seed Butter (*Platonia insignis* Mart.), a Brazilian Amazon Fruit, on Oxidative Stress and Diabetes Mellitus-Related Parameters in STZ-Diabetic Rats. *Biology* **2022**, *11*, 562. [CrossRef]
41. Boulanger, R.; Crouzet, J. Changes of Volatile Compounds during Heating of Bacuri Pulp. *J. Agric. Food Chem.* **2001**, *49*, 5911–5915. [CrossRef]
42. Bicas, J.L.; Molina, G.; Dionísio, A.P.; Barros, F.F.C.; Wagner, R.; Maróstica, M.R.; Pastore, G.M. Volatile constituents of exotic fruits from Brazil. *Food Res. Int.* **2011**, *44*, 1843–1855. [CrossRef]
43. Alvarez, S.; Zoghbi, M.D.G.B. Chemical variation in essential oil constituents of *Platonia insignis* Mart. From North of Brazil. *J. Med. Plants.* **2015**, *3*, 1–8.
44. de Nazaré, R.F.R.; de Melo, C.F.M. *Extraçao do Aroma de Bacuri e Sua Utilizaçao Como Flavorizante em Iogurte Natural*; Centro de Pesquisa Agropecuária do Trópico Úmido: Belém, Brazil, 1981; p. 13.

45. Felipe, L.; Bicas, J. Terpenos, aromas e a química dos compostos naturais. *Química Nov. Esc.* **2017**, *39*, 120–130. [CrossRef]
46. Boulanger, R.; Chassagne, D.; Crouzet, J. Free and Bound Flavour Components of Amazonian Fruits. 1: Bacuri. *Flavour Fragr. J.* **1999**, *14*, 303–311. [CrossRef]
47. Osório, A.T.; Bezerra, É.A.; Pinheiro, E.E.A.; Furtado, M.M.; Silva, M.G.d.; Brito, A.K.d.S.; Bezerra, I.B.M.; Morais, I.C.P.d.S.; Lima Neto, J.d.S.; Ferreira, P.M.P.; et al. Cardiovascular and Antioxidant Effects of Bacuri Flower Extract (*Platonia Insignis* Mart.) in Rats. In *Propostas, Recursos Resultados Ciências Saúde*, 7th ed.; Atena Editora: Ponta Grossa, Brazil, 2020; pp. 110–127. ISBN 6004719292446.
48. Arcanjo, D.D.R.; Da Costa, J.S.; Moura, L.H.P.; Ferraz, A.B.F.; Rossatto, R.R.; David, J.M.; Quintans-Júnior, L.J.; De Cássia Meneses Oliveira, R.; Citó, A.M.D.G.L.; De Oliveira, A.P. Garcinielliptone FC, a polyisoprenylated benzophenone from *Platonia insignis* Mart., promotes vasorelaxant effect on rat mesenteric artery. *Nat. Prod. Res.* **2014**, *28*, 923–927. [CrossRef]
49. Costa Júnior, J.S.; de Almeida, A.A.C.; Ferraz, A.d.B.F.; Rossatto, R.R.; Silva, T.G.; Silva, P.B.N.; Militão, G.C.G.; Citó, A.M.d.G.L.; Santana, L.C.L.R.; Carvalho, F.A.d.A.; et al. Cytotoxic and leishmanicidal properties of garcinielliptone FC, a prenylated benzophenone from *Platonia insignis*. *Nat. Prod. Res.* **2013**, *27*, 470–474. [CrossRef]
50. de Freitas, F.A.; Araújo, R.C.; Soares, E.R.; Nunomura, R.C.S.; da Silva, F.M.A.; da Silva, S.R.S.; de Souza, A.Q.L.; de Souza, A.D.L.; Franco-Montalbán, F.; Acho, L.D.R.; et al. Biological evaluation and quantitative analysis of antioxidant compounds in pulps of the Amazonian fruits bacuri (*Platonia insignis* Mart.), ingá (*Inga edulis* Mart.), and uchi (*Sacoglottis uchi* Huber) by UHPLC-ESI-MS/MS. *J. Food Biochem.* **2018**, *42*, e12455. [CrossRef]
51. Yamaguchi, K.K.L.; Dias, D.S.; Lamarão, C.V.; Castelo, K.F.A.; Lima, M.S.; Antonio, A.S.; Converti, A.; Lima, E.S.; Veiga-Junior, V.F. Amazonian bacuri (*Platonia insignis* Mart.) fruit waste valorisation using response surface methodology. *Biomolecules* **2021**, *11*, 1767. [CrossRef]
52. Ribeiro, D.; Russo, H.; Fraige, K.; Zeraik, M.; Nogueira, C.; da Silva, P.; Codo, A.; Calixto, G.; de Medeiros, A.; Chorilli, M.; et al. Bioactive Bioflavonoids from *Platonia insignis* (Bacuri) Residues as Added Value Compounds. *J. Braz. Chem. Soc.* **2021**, *32*, 786–799. [CrossRef]
53. Rufino, S.M.; Alves, R.E.; Brito, E.S.D.; Pérez-jiménez, J.; Saura-calixto, F.; Mancini-filho, J. Bioactive compounds and antioxidant capacities of 18 non-traditional tropical fruits from Brazil. *Food Chem.* **2010**, *121*, 996–1002. [CrossRef]
54. Costa Júnior, J.S.; Ferraz, A.B.F.; Filho, B.A.B.; Feitosa, C.M.; Citó, A.M.G.L.; Freitas, R.M.; Saffi, J. Evaluation of antioxidant effects in vitro of garcinielliptone FC (GFC) isolated from *Platonia insignis* Mart. *J. Med. Plants Res.* **2011**, *5*, 293–299.
55. Da Costa Júnior, J.S.; De Almeida, A.A.C.; Costa, J.P.; Das Graças Lopes Citó, A.M.; Saffi, J.; De Freitas, R.M. Superoxide dismutase and catalase activities in rat hippocampus pretreated with garcinielliptone FC from *Platonia insignis*. *Pharm. Biol.* **2012**, *50*, 453–457. [CrossRef] [PubMed]
56. da Costa, J.S.; de Almeida, A.A.C.; Tomé, A.D.R.; Citó, A.M.D.G.L.; Saffi, J.; de Freitas, R.M. Evaluation of possible antioxidant and anticonvulsant effects of the ethyl acetate fraction from *Platonia insignis* Mart. (Bacuri) on epilepsy models. *Epilepsy Behav.* **2011**, *22*, 678–684. [CrossRef]
57. Costa Júnior, J.S.; Ferraz, A.B.F.; Sousa, T.O.; Silva, R.A.C.; De Lima, S.G.; Feitosa, C.M.; Citó, A.M.G.L.; Melo Cavalcante, A.A.C.; Freitas, R.M.; Moura Sperotto, A.R.; et al. Investigation of biological activities of dichloromethane and ethyl acetate fractions of *Platonia insignis* Mart. Seed. *Basic Clin. Pharmacol. Toxicol.* **2013**, *112*, 34–41. [CrossRef]
58. do Nascimento Cavalcante, A.; Lima, L.K.F.; Araújo, C.M.; da Silva Santos, F.P.; do Nascimento, M.O.; de Castro e Sousa, J.M.; Rai, M.; Feitosa, C.M. Toxicity, cytotoxicity, mutagenicity and in vitro antioxidant models of 2-oleyl-1,3-dipalmitoyl-glycerol isolated from the hexane extract of *Platonia insignis* Mart. seeds. *Toxicol. Rep.* **2020**, *7*, 209–216. [CrossRef]
59. Silva, A.; Moreira, R.; Sousa, R.; Filho, E.; Veras, M.; Chaves, M.; Freitas, S. Chemical composition and photoprotective and antiradical activities of the branches of *Platonia insignis* (*Clusiaceae*). *Quim. Nova* **2021**, *44*, 954–962. [CrossRef]
60. Costa, J., Jr. *Análise Fitoquímica, Farmacológica e Toxicológica das Sementes de Platonia Insignis Mart. (Bacuri)*; Universidade Luterana do Brasil: Canoas, Brazil, 2011.
61. Feitosa, C.M.; Santos, P.R.P.d.; Freitas, R.M.d.; Rodrigues, A.M.X.; Oliveira de, G.A.L.; Costa Junior, J.S.d.; Cavalcante, A.D.N. Ensaios pré-clínicos em ratos tratados com 1,3-diestearil-2-oleil-glicerol, constituinte isolado de *Platonia insiginis*. *Consci. Saúde* **2016**, *14*, 555–567. [CrossRef]
62. Lustosa, A.K.M.F.; Silva, F.V.; Silva, E.R.S.; Mendes, A.N.; Sousa, L.R.; Carvalho, A.L.; Citó, A.M.G.L. Lecithin-based organogel for an industrialized butter from *Platonia insignis* Mart. seeds and its anti-inflammatory potential: Formulation and preclinical studies. *J. Glob. Innov.* **2020**, *2*, 1–6.
63. Mendes, M.B.; Da Silva-Filho, J.C.; Sabino, C.K.B.; Arcanjo, D.D.R.; Sousa, C.M.M.; Costa, I.C.G.; Chaves, M.H.; Oliveira, R.D.C.M.; Oliveira, A.P. Pharmacological evidence of α2-adrenergic receptors in the hypotensive effect of *Platonia insignis* Mart. *J. Med. Food* **2014**, *17*, 1079–1085. [CrossRef]
64. da Costa, J.S.; de Ferraz, A.B.F.; Feitosa, C.M.; das Graças Lopes Citó, A.M.; Saffi, J.; de Freitas, R.M. Evaluation of effects of dichloromethane fraction from *Platonia insignis* on pilocarpineinduced seizures. *Rev. Bras. Farmacogn.* **2011**, *21*, 1104–1110. [CrossRef]
65. da Costa, J.S.; Feitosa, C.M.; das Graças Lopes Citó, A.M.; de Freitas, R.M.; Henriques, J.A.P.; Saffi, J. Evaluation of effects of ethanolic extract from *Platonia insignis* Mart, on pilocarpine-induced seizures. *J. Biol. Sci.* **2010**, *10*, 747–753.

66. Coêlho, E.d.S.; Lopes, G.L.N.; Pinheiro, I.M.; de Holanda, J.N.P.; Alves, M.M.d.M.; Nogueira, N.C.; Carvalho, F.A.d.A.; Carvalho, A.L.M. Emulgel based on amphotericin B and bacuri butter (*Platonia insignis* Mart.) for the treatment of cutaneous leishmaniasis: Characterization and in vitro assays. *Drug Dev. Ind. Pharm.* **2018**, *44*, 1713–1723. [CrossRef]
67. Souza, A.C.; De Alves, M.M.M.; Brito, L.M.; Oliveira, L.G.D.C.; Sobrinho-Júnior, E.P.C.; Costa, I.C.G.; Freitas, S.D.L.; Da Rodrigues, K.A.F.; Chaves, M.H.; Arcanjo, D.D.R.; et al. *Platonia insignis* Mart., a Brazilian Amazonian Plant: The Stem Barks Extract and Its Main Constituent Lupeol Exert Antileishmanial Effects Involving Macrophages Activation. *Evid.-Based Complement. Altern. Med.* **2017**, *2017*, 3126458. [CrossRef]
68. Bezerra, É.A.; Alves, M.M.d.M.; Lima, S.K.R.; Pinheiro, E.E.A.; Amorim, L.V.; Lima Neto, J.d.S.; Carvalho, F.A.d.A.; Citó, A.M.d.G.L.; Arcanjo, D.D.R. Biflavones from *Platonia insignis* Mart. Flowers Promote In Vitro Antileishmanial and Immunomodulatory Effects against Internalized Amastigote Forms of Leishmania amazonensis. *Pathogens* **2021**, *10*, 1166. [CrossRef]
69. da Silva, A.F.; da Rocha, C.Q.; da Silva, L.C.N.; Carvalho Júnior, A.R.; Mendes, I.N.F.V.; de Araruna, A.B.; Motta, E.P.; Silva, R.d.S.; Campos, C.D.L.; Farias, J.R.; et al. Antifungal and antivirulence activities of hydroalcoholic extract and fractions ofP *Platonia insignis* leaves against vaginal isolates of candida species. *Pathogens* **2020**, *9*, 84. [CrossRef]
70. Foss, S.R.; Oliveira, B.L.d.; Grandviergne, L.C.F.; Spehar, L.d.S. Composição Cosmética Compreendendo Manteiga de Planta do Gênero Platonia, Processo de Preparação da Referida Composição, Uso da Mesma e Método Cosmético. Patent Application No. BR102017010480, 4 December 2018.
71. Citó, A.M.D.G.L.; Júnior, J.S.d.C.; Santana, L.C.L.R.; Ferraz, A.d.B.F.; Freitas, R.M.d.; Carvalho, F.A.d.A.; Saffi, J. Formulações Farmacêuticas á Base de Óleo das Sementes de Platonia insignis Mart. Patent Application No. PI1101608, 3 January 2017.
72. Figueiredo, P.d.M.S.; Rocha, C.Q.d.; Rocha, E.d.S.; Carmo, L.H.A.d.; Camra, M.B.P. Fitoterápico Antimicrobiano Obtido a Partir do Extrato das Folhas de Platonia insignis (Bacuri). Patent Application No. BR102017001529, 14 August 2018.
73. Junior, J.O.C.S.; Nunes, K.M.; Gomes, M.R.F.; Costa, R.M.R. Produto Cosmético Para os Lábios a Base de Manteiga de Bacuri (Platonia insignis). Patent Application No. BR102014021702, 12 July 2016.
74. Poklen, L.d.S. Extratos da Floresta Amazônica, Para Produção de Cosméticos e Uso em Diversas Formulações. Patent Application No. PI0801629, 12 January 2010.
75. Borsato, D.; Messias, G.B.; Chendyski, L.T.; Zeraik, M.L.; Cordeiro, T. Processo de Aplicação do Extrato Alcoólico da Casca de Bacuri (Platonia insignis) Como Aditivo Antioxidante Natural Para Biodiesel (b100). Patent Application No. BR102019008456, 3 November 2020.
76. Guerra, R.N.M.; Silva, A.F.d.; Franco, D.C.G.; Monteiro, C.A. Fitoterápico Antidiabetes, Anti-Inflamatório, Analgésico e Imunomodulador Obtido a Partir do Extrato das Folhas de Platonia insignis Mart. Patent Application No. BR102020012224, 21 December 2021.
77. Borsato, D.; Chendynski, L.T.; Zeraik, M.L.; Cordeiro, T. Mistura de Extrato Alcoólico de Cascas de Bacuri e Extrato Alcoólico de Folhas de Alecrim Como Aditivo Antioxidante do Biodiesel e Sua Aplicação. Patent Application No. BR102019024432, 1 June 2021.
78. Silva, T.G.; Kasemodel, M.G.C.; Ferreira, O.M.; da Silva, R.C.L.; Souza, C.J.F.; Sanjinez-Argandona, E.J. Addition of Pachira aquatica oil and *Platonia insignis* almond in cookies: Physicochemical and sensorial aspects. *Food Sci. Nutr.* **2020**, *8*, 5267–5274. [CrossRef]
79. Carvalho, A.V.; Mattietto, R.D.A.; de Vasconcelos, M.A.M. Aproveitamento da casca do bacuri para fabricação de um novo produto. *Comun. Técnico Embrapa* **2008**, *209*, 1–4.
80. Mattietto, R.D.A.; Yorimi, C.; Yano, B. Tecnologia para obtenção de doce da casca do bacuri. *Comun. Técnico Embrapa* **2006**, *175*, 1–5.
81. Vasconcelos, K.D.M.; Santos, I.L.; Medeiros, E.D.M.; Souza, A.; Maria, K.; Vasconcelos, D.M.; Oliveira, W.V.C.D. Development and Characterization of biscuits Made from bacuri Flour (*Platonia Insignis* Mart). *Sci. Amaz.* **2018**, *S1*, 6–20.
82. Cunha, N.T.; Pires, C.R.; Pereira, A.; Carneiro, G.; Lima, J. Aproveitamento tecnológico do mesocarpo do bacuri na elaboração de barras de cereais. *Enciclopédia Biosf. Cent. Cient. Conhecer* **2015**, *11*, 3300–3310.