Vol.67: e24230266, 2024
https://doi.org/10.1590/1678-4324-2024230266
ISSN 1678-4324 Online Edition

BABT
Brazilian Archives of Biology and Technology

Review - Food/Feed Science and Technology

Fruits of the Brazilian Cerrado: Possibilities of Uses for the Manufacture of Food Products

Ingrid de Souza Lopes[1]
https://orcid.org/0009-0000-2517-1939

Laiane Vieira da Silva[1]
https://orcid.org/0009-0003-3479-6342

Andressa Rodrigues Gomes[2]
https://orcid.org/0009-0007-6797-2305

Flávio Santos Lopes[3]
https://orcid.org/0000-0002-7688-184X

Cláudia Vieira Prudêncio[1*]
https://orcid.org/0000-0002-5966-785X

[1]Universidade Federal do Oeste da Bahia, Centro das Ciências Biológicas e da Saúde, Barreiras, Bahia, Brasil; [2]Universidade do Estado da Bahia, Barreiras, Bahia, Brasil [3]Frutificar Cerrado, Barreiras, Bahia, Brasil.

Editor-in-Chief: Bill Jorge Costa
Associate Editor: Bill Jorge Costa

Received: 22-Mar-2023; Accepted: 29-Nov-2023

*Correspondence: claudia.prudencio@ufob.edu.br; Tel.: +55-77-36143112 (C.V.P.).

HIGHLIGHTS

- Fruits of the Brazilian Cerrado have potential for use in food products.
- Products with Cerrado fruits present sensory acceptability.
- Beverages with Cerrado fruits may contain antioxidant compounds.

Abstract: The Cerrado is an important South American biome, with a wide diversity of fruit species, with attractive sensory characteristics and high nutritional value. In this scenario, the industrial production of food products made from Cerrado fruits is a viable alternative to favor their use and commercialization. From this perspective, this study presents an overview of food products made from Cerrado fruits, such as pequi, cagaita, baru, buriti, and caja-manga. Our data indicate that jellies, flours, beverages, and other by-products of Cerrado fruits have similar physical-chemical characteristics to those produced with conventional fruits, in addition to good sensorial acceptability and stability regarding microbiological standards. Therefore, the processing of Cerrado fruits constitutes an interesting alternative for the sustainable use of native fruits and may represent an income alternative for small rural producers, contributing to the protection of biodiversity and biome preservation. However, further research is still needed on the subject, especially with regard to processing practices and product quality.

Keywords: Native fruits; Sustainability; Production technologies.

INTRODUCTION

The United Nations (UN) promotes sustainable development through 17 sustainable development goals (SDGs) meant to be achieved by 2030 by its member states, including Brazil [1]. These goals encourage strategies directed toward the elimination of poverty and growth promotion through environmental and climate preservation [1].

However, the Cerrado biome, which occupies about 23% of the Brazilian territory and is home to important watersheds, has been extensively degraded, in a process primarily related to agricultural and cattle ranching expansion and timber extraction, which has triggered the loss of 43.4% of the natural cover of this biome [2, 3]. Thus, human intervention in the Cerrado can result in significant environmental damage, e.g., the extinction of species still unknown to science and interference with nationally important watersheds [3]. The Cerrado harbors an estimated 5% of the global biodiversity and is home to more than 13,000 plant species, justifying its classification as a global biodiversity hotspot [4, 5]. Therefore, strategies to analyze this biodiversity and provide sustainable management alternatives are essential for its conservation [5].

In this scenario, the wide variety of Cerrado fruit species stands out due to their sensory attractiveness, high nutritional value, and bioactive and antioxidant compounds, favoring their use by the food industry [6, 7, 8]. Furthermore, the processing could help reduce the fresh fruits losses, increasing their commercial value and expanding their consumer market, thus contributing to the appreciation of culture and local identity [9, 10].

In addition, processing techniques can also result in longer fruit shelf life usually limited to short periods, whereas the products has higher added value, with positive impact in the income generation for the involved population [8, 11]. From this perspective, strategies for processing Cerrado fruits can contribute to achieving the United Nations SDGs by stimulating the appreciation and sustainable use of native fruits [10].

PROCESSING OPTIONS

Different processing strategies can be used to process Cerrado fruits. However, studies should still be developed in the area as most of the research developed so far focuses on the production of jams, jellies, flours, beverages, and their use as flavor adjuvants, which will be addressed in the following topics.

Jams and jellies

Jellies are made from fruit juice or pulp, sugar, pectin, and acid, which are cooked until obtaining the characteristic gelatinous texture of the semi-solid state of this product [12]. The formulation can also include acidulants or pectin when these components are insufficient in the fruits used as raw materials [12]. However, developing strategies to minimize sensory and nutritional losses is one of the challenges for jelly production, which arises from using high temperatures during the cooking process [10]. In addition, developing manufacturing protocols to reduce the sugar content used in the formulation is also relevant to meet the growing consumer demand for healthier products with less sugar [11].

Similarly, fruit candy production is also a simple process that results in highly accepted products with significant market potential [13]. Fruit candy production involves variations that determine the classification of the product: fruit pieces or whole fruits (with or without peels, seeds, and stones) are cooked in water and sugar solution to obtain candy syrup [14]. On the other hand, paste-like sweets are made using fruit pulp and are classified according to their consistency as creamy or paste-like [15]. Thus, creamy sweets are characterized as a homogeneous paste with a soft texture. On the other hand, bulk candies, also known as cut candies, have a firm texture that allows their partition into pieces [15]. In general, sweets are free of chemical additives and have high nutritional value when appropriate processing techniques are used [16, 17].

Jams and jellies production requires few ingredients and equipment and is considered a simple technique, favoring its artisanal production, which is advantageous for production in small communities [9, 11]. On the other hand, the negative aspects of artisanal production may include products with less hygienic-sanitary rigor, no standardized recipes, and lack of necessary information in packaging and labels [16]. Therefore, more studies should be conducted to improve the production and marketing conditions of these products [16, 18].

Several studies have demonstrated the possibility of using Cerrado fruits, e.g., cagaita (*Eugenia dysenterica*), buriti (*Mauritia flexuosa*), umbu *(Spondias tuberosa)*, umbu-caja (*Spondias* sp.), seriguela (*Spondias purpurea*), murici (*Brysonima ssp*.), caja-manga (*Spondias cytherea* Sonn.), wild passion fruit (*Passiflora cincinnata*), cajui (*Anacardium occidentale*), gabiroba (*Campomanesia xanthocarpa*), Dog marmalade fruit (*Alibertia sessilis*) and others to make jellies or sweets (Table 1). These studies usually evaluate the physicochemical and microbiological parameters, sensory acceptability, and commercial stability of fruit-based products (Table 1).

Furthermore, the physicochemical characteristics of jellies and jams made from Cerrado fruits are generally similar to those produced with traditional fruits, with values within or very close to the range established by current regulations [9, 20, 22, 27-28, 31-35, 39]. Jelly stability during storage has been evidenced by several studies, demonstrating the satisfactory technological conditions of this product after storage [22-23, 37-38]. On the other hand, there are few published studies on the stability of fruit sweets during the storage period, although changes in physicochemical parameters, e.g., titratable acidity, soluble solids, total sugars, carotenoids and phenolic compounds were observed after 180 days in marolo (*Annona crassiflora*) sweets with sweet passion fruit and soursop [31].

Moreover, microbiological safety, assessed according to the compliance with established standards, has also been evidenced for jams and jellies made from different fruits, e.g., wild passion fruit jelly [38], cagaita jelly [23], umbu jelly with mangaba [36], murici jam [10], umbu-caja jam [37], cagaita jam with mangaba [24], seriguela jam [32], marolo jam with sweet passion fruit [20], and umbu jam [34] (Table 1). From this perspective, the maintenance of microbiological safety throughout storage demonstrates the feasibility of production techniques for manufacturing safe products for consumption, as evidenced in the analysis of the mixed jam of marolo, passion fruit and soursop during 180 days of storage [31], murici jam for 12 months [10] and wild passion fruit jam for 150 days [38].

Cerrado fruits show a diversity of colors and flavors, which influence the sensory characteristics of jellies and sweets. In general, the studies conducted with these products indicate good sensory acceptability, as seen in jellies made from cagaita [23], buriti [22], umbu-caja [11], murici [10], umbu with mangaba [36], cajui [19] and gabiroba [29], and in the jams of seriguela [32], banana 'pacovan' with wild passion fruit [20], umbu [35], caja-manga [27] and araticum [17].

Moreover, adding adjuvants and aromatic herbs, e.g., pepper and mint, positively impacts the sensory acceptability of fruit-based products [26, 40]. One such example is the jelly made from caja-manga and added with mint and pepper, which achieved percentages higher than 80% for all evaluated attributes, highlighting its good sensory acceptability [26].

These data demonstrate the feasibility of using the aforementioned processing techniques for Cerrado fruits. However, the few available studies, especially those addressing the issue of characterization during storage, highlight the need to expand research in this field in order to better assess the technical feasibility of production [8].

Table 1. Possibilities of use of Cerrado fruits to make jams and jellies.

Fruit/species	Processing options	Main results	Reference
Araticum fruit (*Annona montana*)	Cutting jams with different concentrations of citric acid, pulp/sugar ratio and passion fruit albedo	FQ - Two optimized versions of the araticum jam (with a citric acid concentration of 1% and pulp/sugar ratios of 60/40 and 40/60) were found to have higher percentages of vitamin C, protein, and fiber.	[13]
	Cutting jam	SEN - The jams were well accepted in the sensory analysis.	[19]
Banana 'pacovan' (*Musa paradisiaca*) and Wild passion fruit (*Passiflora cincinnata* Mast)	Cutting jam with different proportions of pulp, sucrose, pectin and citric acid	SEN - All formulations were well accepted by consumers, with average scores higher than 6.7 in the overall acceptance. The formulation with higher addition of sucrose and lower addition of pectin received the highest score. FQ - The firmer jams had higher acidity and soluble solids values.	[20]
Bocaiuva fruit (*Acrocomia aculeata*)	Jelly with added passion fruit	FQ - The jelly retained the bioactive compounds from bocaiuva and passion fruit pulp (phenols, tannins, ascorbic acid and carotenoids) in its composition. The values of soluble solids, titratable acidity, pH and total solids were close to those of jellies with other fruits.	[21]
Buriti fruit (*Mauritia flexuosa*)	Conventional jelly with different pulp concentrations	SEN - The formulation with the highest pulp concentration (100g of pulp for 350g of water) showed the highest sensory acceptability. FQ - There was stability of the physicochemical characteristics of the formulation with higher pulp concentration after 90 days of storage.	[22]
Buriti fruit (*Mauritia flexuosa*), Cajui fruit (*Anacardium occidentale*) and Murici fruit (*Brysonima crassifolia)*	Conventional jelly	SEN – There was no significant difference between the sensory attributes of the jellies, but the cashew jelly showed higher scores. FQ - There were statistical differences among the cajui, murici and buriti jellies for the values of total acidity, moisture, non reducing sugars and vitamin C.	[17]
Cagaita fruit (*Eugenia dysenterica*)	Conventional jelly with different proportions of sucrose, pulp and pectin	SEN and MIC - All formulations showed good sensory acceptance and microbiological safety. FQ - The product showed good chemical stability, with small reductions in physicochemical parameters over 120 days.	[23]
Cagaita fruit (*Eugenia dysenterica*) and mangaba fruit (*Hancornia speciosa*)	Jelly with different proportions of cagaita and mangaba pulp combined	SEN - The formulation with the highest acceptability was the one with the lowest proportion of cagaita and the highest proportion of mangaba. MIC - All formulations showed good microbiological quality. FQ - The formulation with 40% cagaita and 60% mangaba was evaluated over 90 days of storage and remained stable in relation to the physicochemical parameters.	[24]
Caja fruit (*Spondias mombin*)	Jelly with different proportions of sugar and pectin	FQ - After 150 days of storage there was an increase in water content, total soluble solids, reducing sugars, total sugars, and ratio, and a reduction in the values of total solids, nonreducing sugars, pH, and acidity.	[25]
Caja-manga fruit (*Spondias cytherea* Sonn.)	Jelly with mint and pepper	SEN - The jelly showed high sensory acceptability, as well as high consumption frequency and purchase intention.	[26]
	Jams with different proportions of sugar	SEN - The jams were well accepted with sensory attribute averages higher than 7 (I liked it moderately), but 67% of the tasters preferred the cajá-manga candy with more sugar. FQ - The jams presented a pH lower than 3.2, which explains their firm consistency. The acidity of the candies was less than 1%. The moisture and ash contents decreased with the increase of the sugar proportion.	[27]
Dog marmalade fruit (*Alibertia sessilis*)	Cutting Jam	FQ - The physicochemical analyses attested to satisfactory technological conditions. But the jam was low in protein, ash, and lipids, and high in carbohydrates and total energy.	[28]
Gabiroba fruit (*Campomanesia xanthocarpa*)	Jelly with different concentrations of citric acid, pulp/sugar ratio and passion fruit albedo	SEN - The formulation with pulp/sugar ratio 40/60, without the addition of citric acid and pectin, showed higher scores in all attributes of the sensory tests.	[29]

Cont Table 1

Guapeva fruit (*Pouteria cf. Guardneriana Radlk*)	Jelly with different concentrations of citric acid, pulp/sugar ratio and passion fruit albedo	SEN - The formulation with the highest acceptability was the one with a pulp-sugar ratio of 40/60. FQ - The formulations with a pulp-sugar ratio of 60/40 showed a higher percentage of fiber, protein and vitamin C.	[30]
Marolo fruit (*Annona crassiflora*), Sweet passion fruit (*Passiflora alata*) and Soursop (*Annona muricata*)	Dietary mixed creamy jam	MIC - The jams were microbiologically safe during the storage. FQ - An increase in titratable acidity, soluble solids, total sugars and a reduction in total carotenoids and total phenolics were observed after 180 days of storage at 25 ºC and 35 ºC.	[31]
Murici fruit (*Brysonima crassifolia*)	Conventional jelly	SEN - The products presented good sensory acceptability throughout storage, although variations were observed in the evaluated attributes, except for texture. MIC - The jellies were microbiologically safe during the 12 months of storage. FQ - The physicochemical characteristics were in accordance with the parameters established by the legislation.	[10]
Seriguela fruit (*Spondias purpurea*)	Cutting jam with different sucrose ratios	SEN - Most of the attributes obtained an average between 6.5 and 7, indicating good acceptability. The percentage of purchase intention was 82%. MIC - The jams were microbiologically safe. FQ - The physicochemical analyses attested to satisfactory technological conditions.	[32]
	Conventional and diet jelly with different proportions of sucralose and acesulfame	SEN - The formulation with the best sensory acceptability was the one with the combination of the two sweeteners, in the proportion 0.02% sucralose and 0.02% acesulfame. FQ - The jellies presented physicochemical characteristics similar to other jellies in the literature.	[33]
Umbu fruit (*Spondias tuberosa)*	Cutting jam with and without milk and different proportions of sugar	SEN - The jam without added milk was the one that presented the highest sensory acceptability. MIC - The jams were microbiologically safe. FQ - The minerals present in significant quantities in the candies were potassium, phosphorus, calcium and magnesium. The carbohydrate content, caloric value, soluble solids and total sugars increased with the higher amount of sugar.	[34]
	Cutting jam with licuri almonds	SEN – There was good acceptance of the jams formulations, with average overall acceptance scores ranging from 6.31 (I liked it slightly) to 7.30 (I liked it moderately). FQ – The formulations with less licuri added presented the highest acidity value (0.55%) and there was no difference for the values of soluble solids and pH.	[35]
Umbu fruit *(Spondias tuberosa)* and Mangaba fruit (*Hancornia speciosa*)	Jelly with and without fructooligosaccharide (FOS)	SEN - Acceptability, purchase intention, and sensory preference were similar among the different formulations. MIC - The jellies were microbiologically safe. FQ - The addition of FOS reduced the protein, ash and pH contents, and contributed to the increase in fiber.	[36]
	Conventional jelly	SEN - The jelly presented high acceptability, with acceptance ratings higher than 70% for all sensory attributes, and purchase intention of 67.5%. MIC - The jelly was microbiologically safe. FQ - The jellies showed little physicochemical changes over 180 days.	[37]
Umbu-caja fruit (*Spondias bahiensis*)	Conventional and diet jelly from different genotypes	SEN - In general, the jellies showed good sensory acceptance for all attributes, but there was a difference between the formulations for the color, aroma and flavor parameters. FQ - The jellies with sucrose presented physicochemical characteristics similar to the dietetic ones, except the contents of total sugars that were lower in the dietetic product.	[11]
Wild passion fruit (*Passiflora cincinnata*)	Conventional jelly	MIC - The jelly was microbiologically safe. FQ - The jelly showed small physicochemical variations over 150 days of storage.	[38]

Note: SEN (Sensory), MIC (Microbiological) and PQ (Physicochemical) analysis

Flours

Flours are products obtained from the processing of cereals, tubers, legumes, fruits, seeds, and rhizomes [41]. Their moisture content should be lower than 15%, achieved by adopting drying and milling methods that characterize the flour production process as simple while favoring artisanal production [42-43]. With regarding their use, flours are widely employed in cakes, breads, cookies, and other preparations [44-46].

In this context, some Cerrado fruits have the potential for producing flours, e.g., pequi, baru, and jatoba, which can be used either individually or as ingredients of other food preparations (Table 2) [45, 52, 56]. Furthermore, one of the benefits of producing flours from Cerrado fruits is better food preservation since moisture removal during production results in a less perishable product, with long shelf life and easy storage [42]. In addition, this form of processing allows using whole of some fruits instead of just certain parts [48, 56].

Nutritional quality is another interesting factor in Cerrado fruit flours since they are rich in bioactive substances, e.g., phenolic compounds, antioxidants, and dietary fiber [48, 54]. Nutrients and their contents vary according to the type of fruit and the fruit part used [48, 54]. One such example is the flour made from the buriti shell, rich in carotenoids, phenolic compounds, and vitamin C [48]. Moreover, the flour produced from marolo pulp contains fibers, vitamin C, and minerals such as phosphorus, calcium, and magnesium [54].

Improving the nutritional quality of flours by using Cerrado fruits can benefit human health [52]. An example to justify this statement is the study conducted by Silva and coauthors [52] with breads made from jatoba flour instead of wheat flour, which showing high fiber and polyphenol contents in the final product. In that study, jatoba flour bread induced a lower dose-independent glycemic response in the in vitro digestion. This result stems from the synergistic effects of fiber and phenolic compounds on glucose metabolism, significantly inhibiting the activity of α-amylase and α-glucosity. In this respect, jatoba and its by-products could be consumed by individuals with chronic diseases such as diabetes [52].

Cerrado fruit flours and their by-products show good sensory acceptability and high market potential [44, 56]. The food bars produced with different concentrations of marolo pulp flour (20, 30, 40 and 50%) are one such example, with their sensory acceptability increasing proportionally to the concentration of fruit flour [54].

However, flours made from fruits with marked sensory characteristics, e.g., pequi, should be used with caution since brownies produced with high proportions of pequi peel flour showed low sensory acceptability and purchase intention [56]. These results highlight the need to determine the ideal proportion of flour to be used in partial or complete replacement of other flours for each fruit and product.

Another important point about this processing strategy is choosing the appropriate dehydration method since nutritional and sensory losses may occur depending on the temperature and exposure time, thus decreasing the quality of the flour [42].

Table 2. Possibilities of use of Cerrado fruits to manufacture flours and its products.

Fruit/species	Processing options	Main results	Reference
Baru fruit (*Dipteryx alata* Vog)	Cupcakes with baru flour at concentrations of 0 (F1), 6 (F2), 12 (F3) and 18% (F4)	SEN - Cupcakes with up to 12% (F3) of baru flour were well accepted similarly to the standard (F1). FQ - F3 had lower carbohydrates and higher moisture, ash, protein, lipids, and calories, and a 24% increase in fiber content.	[45]
	Cupcakes with low fat content: 70% wheat flour and 30% baru flour, plus reductions of 50 (F1), 75 (F2) and 100% (F3) margarine, compared to the control with 100% wheat flour and 100% margarine	SEN - The evaluated formulation (F2) showed good sensory acceptability and purchase intention. FQ - The baru flour had higher content of protein, fiber, minerals and lipids compared to wheat flour. The formulations F2 and F3 were considered light products and showed significant reduction of trans fatty acids.	[47]
Buriti fruit (*Mauritia flexuosa*)	Flour from the buriti peel	FQ - The flour showed higher carotenoids, phenolic compounds, vitamin C, carbohydrates, and calories content compared to the peel in natura.	[48]
	Buriti flour from 6 types of processed by-products: bleached and unbleached peels, bleached and unbleached endocarp, manually produced bran and bran from solvent extracted defatted pulp	FQ - In general, the flours showed considerable amounts of fiber, total non-extractable proanthocyanidins, and higher carotenoid content compared to the peel. In addition, they showed antioxidant activity with varying potential among the samples.	[49]
	Bread with buriti flour	MIC – The flour and bread presented good microbiological quality. FQ - The flour and bread had considerable amounts of lipids and proteins.	[50]
Jatoba fruit (*Hymenaea stilbocarpa*)	Buttery cookies with jatoba flour at concentrations of 0, 40 and 60%.	FQ - The addition of jatoba flour increased the values of moisture, lipids, calories, and acidity, and reduced the values of pH, ash, protein, and carbohydrates.	[51]
	Breads with partial replacement of wheat flour by jatoba flour at concentrations of 10 (F1), 20 (F2) and 30% (F3)	SEN - Formulations F1 and F2 were better accepted, with scores of 6 (liked slightly) to 7 (liked moderately). Formulation F3, on the other hand, was the least accepted, with an average close to 6 (liked it a little). FQ - The addition of jatoba flour to the breads increased the fiber and polyphenol content of the product.	[52]
Jenipapo fruit (*Genipa americana* L.)	Jenipapo pulp flour	FQ - The flour showed good technological and nutritional quality and significant vitamin C content.	[53]
Marolo fruit (*Annona crassiflora* Mart.)	Bars with marolo pulp flour as a replacement for whole oat flour at concentrations of 20, 30, 40 and 50%.	SEN - All the formulations presented good sensory acceptability. MIC – The bars were safe for consumption for 6 months. FQ - The flour and the food bars produced with marolo pulp showed antioxidant activity, besides fiber, minerals and vitamin C.	[54]
Seriguela fruit (*Spondias purpurea*)	Cookies with partial replacement of wheat flour by pulp and flour from seriguela residue (FRS) at concentrations of 0, 10, 20 and 30%.	SEN - In general, the cookies show good sensory acceptance for all attributes. MIC – the cookies presented good microbiological quality. FQ – The fiber, mineral, and vitamin C content was directly proportional to the concentration of FRS.	[44]
Pequi fruit (*Caryocar brasiliense*	Two flour formulations from pequi: F1 (shell and pulp) and F2 (pulp).	FQ - Both flour formulations were high in dietary fiber and antioxidants. There was no difference between the formulations.	[55]
	Cookie with partial replacement of wheat flour with pequi nut shell flour at concentrations of 12.5 (1), 25 (2), 37.5 (3) and 50% (4)	SEN - The control and samples 1 and 2 showed good sensory acceptability and the highest purchase intentions were for the control and sample 1. FQ – The formulations with pequi flour had lower carbohydrate, protein, lipid, and energy values, and higher fiber content.	[56]
	Cookie with partial replacement of wheat flour with pequi pulp flour (10% and 20%)	FQ - The cookies differed in moisture, lipid, ash and carbohydrate content. There was no difference in protein content and caloric value.	[57]
	Cookie with partial replacement of wheat flour with pequi pulp flour (10% and 20%)	SEN - The cookie with 10% pequi flour showed good sensory acceptability, good results in the intent-to-consume and purchase test, and was the preferred sample compared to sample 2 (20%).	[58]

Note: SEN (Sensory), MIC (Microbiological) and PQ (Physicochemical) analysis

Beverages

Another processing option is using of Cerrado fruits to produce alcoholic or non-alcoholic beverages.

Non-alcoholic beverages

Nine different fruits (araticum, buriti, cagaita, gabiroba, mangaba, umbu, umbu-caja, seriguela, wild passion fruit) already show potential for the production of soft drinks e.g., juices and pulps, with mangaba, umbu and cagaita ranking as the most common species for that purpose [59-73].

The physicochemical characteristics of beverages made from fruit species native to the Cerrado were similar to those observed with other fruits, although influenced by the characteristics of each fruit used [66-67]. Therefore, highly acidic fruits, such as umbu and mangaba, result in highly acidic products, as demonstrated by the low pH value of the nectars of mangaba [66] and umbu with mangaba [67], and the umbu pulp [69]. This characteristic is interesting since it assist in product preservation by inhibiting microorganisms.

Furthermore, several studies highlight the good shelf life stability of fruit products throughout storage, e.g., the pulps of araticum [60] and umbu-caja pulp [71], and gabiroba nectar [65]. Storage induced only minor variations in the physicochemical characteristics, which were insufficient to alter product quality [65].

However, preparation techniques and the addition of adjuvants can influence product stability, with variations according to the fruit used. For example, araticum pulp showed greater stability with regard to vitamin contents (all-trans-α-carotene and all-trans-β-carotene) when a combination of pasteurization and freezing was used [60]. In contrast, even with pasteurization, there was a reduction in the pH, soluble solids, and vitamin C content of umbu-caja pulp [71]. In another study, the addition of maltodextrin to seriguela and wild passion fruit pulps contributed to increasing the sugar, starch, pH, and total soluble solids, as well as negatively influenced preservation by increasing the amount of water and reducing the amount of ash [68, 72].

The microbiological quality of fruit products has been evidenced by microbiological analyses, with results within the parameters established by current regulations, as seen in the nectars of umbu and mangaba [67], mangaba and cagaita [63], buriti [62] and in umbu-caja pulp [71]. These results highlight the role of adequate production processes to obtain safe products for commercial purposes.

Moreover, products based on native Cerrado fruits also showed good sensory acceptability, both in beverages made with single fruits [62, 65-66, 72] and blends, as demonstrated for the nectars of mangaba and cagaita [63-64] and umbu and mangaba [67].

In addition, Cerrado fruits can also be used as ingredients for producing of probiotic beverages, as observed in a product made from wild passion fruit added with *Lactobacillus rhamnosus* [73]. This strategy is highlighted by potential functional claims that could be favored by the good nutritional characteristics of the fruits, which contain antioxidant compounds, vitamins, and minerals [62].

Alcoholic beverages

Fermented alcoholic beverages have a sweet and pleasant taste and alcohol contents between 4 and 15% [74]. Except for grapes, they can be obtained through fruit fermentation, thus favoring the use of various fruit sources and contributing different flavors to the beverage [75, 76].

The potential of Cerrado fruits for alcoholic beverage production is relevant due to the high consumption of this type of product, especially distilled beverages [77]. Several fruits can be used for producing fermented beverages, e.g., murici [78], umbu [74], and cagaita [79], whereas distilled spirits can be made from fruits, such as caja-manga [80], gabiroba [81], cajui [82], and buriti [83].

The physicochemical characteristics of these beverages usually meet the standards established by current regulations and are similar to those of analogous products [74, 76, 78, 83]. However, fruits with low sugar contents, e.g., caja-manga, may result in drinks with lower alcohol content [80], or require sugar addition during processing, as demonstrated with the fermented drink made from murici [78].

In addition, fruits with low acidity, e.g., umbu, can reflect on lower beverage acidity [74]. Other characteristics of production, e.g., wort management, the yeast characteristics, and time and temperature control, can also influence the parameters of the beverage, including its volatile acidity [84].

Beverages made from Cerrado fruits generally show good sensory acceptability and purchase intention, as demonstrated by the results obtained by Almeida and coauthors [76] when evaluating a fermented beverage made from mangaba. On the other hand, one of the advantages of using Cerrado fruits for producing alcoholic beverages is the presence of antioxidant compounds that remain in the product, as observed in gabiroba liqueur, which antioxidant compounds increased with the age of the product [81], and in cashew brandy [82].

However, further research in the area is required since technological challenges are to be overcome to reduce costs and make large-scale production feasible [83]. In this scenario, the possibility of using fruits with high perishability and low added value, e.g., gabiroba, cajui and cagaita could be an interesting alternative [79, 81-82].

Cerrado fruits as flavor adjuvants

The outstanding flavors of Cerrado fruits can contribute to the sensory characteristics of different products, e.g., chocolate bars [85], ice cream [86-87], paçoca type candies [88], cookies [89-90], cheeses [91] and yogurts [92], among others.

Products incorporated from Cerrado fruits generally show good sensory acceptability [87-93]. In addition, the good nutritional quality of such fruits can contribute to increasing the nutrient content of their by-products, as demonstrated by the increased protein and fiber contents after adding of baru nuts (*Dipteryx alata* Vogel) to ice cream [87] and paçoca type candies [88]. Similarly, the addition of pequi nuts to cookie type cookies also resulted in higher protein, lipid, and ash contents [89].

Therefore, using Cerrado fruits as flavor adjuvants in different products is an interesting strategy to favor the sensory acceptability of fruit products and improve their nutritional characteristics [87-89].

CONCLUSIONS

Cerrado fruits species have an outstanding potential to be use in different products, e.g., jam, sweets and alcoholic beverages. However, further research should be conducted to establish production technologies and analyze nutritional characteristics during storage and sensory acceptance of products, especially with use of methods based in consumer attitude and perception. These technologies can favor the valorization and sustainable use of native fruits, with positive impacts on job and income generation, and, consequently, on the preservation of natural resources of the Cerrado biome.

Funding: The authors thank to the National Council for Scientific and Technological Development (CNPq) for the ISL and LVS fellowships.
Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

1. United Nations (UN). 2020. Take action for the sustainable development goals. [Acessed at fev 24, 2021] Available from: https://www.un.org/sustainabledevelopment/sustainable-development-goals/.
2. Brasil. Ministério do Meio Ambiente. [Cerrado use and cover mapping: Terra Class Cerrado project]. Brasília: Ministério do Meio Ambiente; 2015.
3. Gastl Filho J, Mendes RG, Fialho A, Piva HT, Rezende AR, Vargas BC, et al. [Enhancement of dormancy breaking and use of bio-stimulant in the germination of mutamba diaspores]. Braz J Dev. 2019; 5(10): 17429-17445. Doi: https://doi.org/10.34117/bjdv5n10-022
4. Brasil. Ministério do Meio Ambiente. [Action plan for prevention and control of deforestation and wildfires in the Cerrado]. Brasília: Ministério do Meio Ambiente; 2010.
5. Aguiar LMS, Machado RB, Françoso RD, Neves AC, Fernandes GW, Pedroni F, et al. [The Cerrado: Land unknown of the 21st Century]. Rev Ciência Hoje. 2015; 55(330): 32-7.
6. Arruda HS, Botrel DA, Fernandes RVB, Almeida MEF. Development and sensory evaluation of products containing the Brazilian Savannah fruits araticum (*Annona crassiflora* Mart.) and cagaita (*Eugenia dysenterica* Mart.). Braz J Food Technol. 2016; 19: 1-7. Doi: https://doi.org/10.1590/1981-6723.10515.
7. Moreira-Araújo RSR, Barros NVA, Porto RGCL, Brandão ACAS, Lima A, Fett R. Bioactive compounds and antioxidante activity three fruit species from the Brazilian Cerrado. Rev Bras Frutic. 2019; 41(3): 1-8. Doi: https://doi.org/10.1590/0100-29452019011
8. Reis AF, Schmiele M. [Characteristics and potential of Cerrado fruits in the food industry]. Braz J Food Technol. 2019; 22: 1-12. Doi: https://doi.org/10.1590/1981-6723.15017
9. Garcia LGC, Guimarães WF, Rodovalho EC, Peres NRAA, Becker FS, Damiani C. [Buriti jelly (*Mauritia flexuosa*): value addition to Brazilian Cerrado fruits]. Braz J Food Technol. 2017; 20: 1-5. Doi: https://doi.org/10.1590/1981-6723.4316
10. Cunha MC. [Impact of processing, packaging, and storage time on the quality of murici jelly (*Byrsonima crassifolia* (L.) Rich)]. Lavras. Dissertation [Master in Food Science] - Universidade Federal de Lavras; 2016.
11. Viana ES, Mamede MEO, Reis RC, Carvalho LD, Fonseca MD. [Development of conventional and dietetic umbu-caja jelly]. Rev Bras Frutic. 2015; 37(3): 708-717. Doi: https://doi.org/10.1590/0100-2945-018/14

12. Vieira ECS, Silva EP, Amorim CCM, Sousa GM, Becker FS, Damiani C. [Acceptability and physicochemical characteristics of mixed jelly from pineapple peel and peach pulp]. Rev Científica. 2017; 45(2): 115-22. Doi: https://doi.org/10.15361/1984-5529.2017v45n2p115-122
13. Aguiar AO. [Processing and utilization of araticum fruit (*Annona crassiflora* Mart.) in the form of paste-like sweet]. Palmas, Tocantins. Dissertation [Master in Food Science and Technology] - Universidade Federal do Tocantins; 2018.
14. Silva Neto RM, Paiva FFA. [Fruit preserves in syrup]. Family Agroindustry Collection. Embrapa Technical Report. Brasília: Embrapa Informação Tecnológica; 2006.
15. Brasil. [Collegiate board Resolution n° 272, of September 22, 2005]. Approves the technical regulation for vegetable products, fruit products and edible mushrooms. Diário Oficial da União 23 set 2005.
16. Freitas MLF, Menezes CC, Carneiro JDS, Reis RP. [Diagnosis of consumption and production processes of artesanal fruit jams]. Alim. Nutr. 2012; 23(4): 589-95.
17. Oliveira MOS, Dias BB, Morais RA, Martins GAS. [Processing of araticum fruit (*Annona crassiflora* Mart.) paste-like sweet and viability for school feeding programs]. Rev Desafios. 2020a; 7(Especial): 87-93. Doi: https://doi.org/10.20873/uftsupl2020-8432
18. Abreu MCLRA, Fonseca GVM, Rodrigues ARP, Lima LB. [Socioeconomic profile and technology diffusion for the Productive Rural Women Program/Rio das Flores – RJ]. Braz J Dev. 2021; 7(1): 1879-95. Doi: https://doi.org/10.34117/bjdv7n1-128.
19. Oliveira TTB, Morais RA, Martins GAS, Marson PG, Teixeira SMF. Processing of fruits of the Cerrado in the form of integrals jellies. Rev Agrarian. 2020b; 13(47): 130-40. Doi: 10.30612/agrarian.v13i47.8958
20. Rybka ACP, Freitas ST. 2014. [Formulations of sweets with 'Pacovan' banana and wild passion fruit]. Research and Development Bulletin. Embrapa Semiarid Technical Report. Petrolina (PE): Embrapa Semiárido; 2014.
21. Souza RS, Cuellar JP, Donadon JR, Guimarães RCA. [Bioactive compounds in bocaiuva jam with passion fruit]. Multitemas. 2019; 24(57): 79-94. Doi: https://doi.org/10.20435/multi.v0i_.1803
22. Celestino SMC. [Development and shelf life evaluation of buriti jelly]. Research and Development Bulletin. Planaltina (DF): Embrapa Cerrados; 2013.
23. Santos PRG, Cardoso LM, Bedetti SF, Hamaceck FR, Moreira AVB, Martino HSD, et al. [Cagaita jelly (*Eugenia dysenterica* DC.): development, microbiological, sensory and chemical characterization and stability study]. Rev Inst Adolfo Lutz. 2012; 71(2): 281-90.
24. Silva FS. [Elaboration of jelly with a mix of cagaita pulp (*Eugenia dysenterica*) and mangaba (*Hancornia speciosa*) and evaluation of quality parameters]. Palmas. Dissertation [Master in Food Science and Technology] - Universidade Federal do Tocantins; 2017.
25. Martins JJA, Oliveira ENA, Rocha APT, Santos DC. [Stability of caja jellies during storage under ambient conditions]. Comun Sci. 2015; 6(2): 164-73.
26. Melo ACH, Borges BB, Batista Júnior ED, Souza EG, Rocha LG, Moura NM, et al. [Sensory analysis of pineapple jam with onion and caja-manga jam with mint and pepper]. Rev Biodiversidade. 2019; 3(18): 100-9.
27. Ramalhosa E, Sousa AV, Fernandes L, Delgado T, Fidalgo MC, José A, et al. [Physicochemical and sensory characterization of fruit jams from Sao Tome and Principe]. Millenium. 2017; 2(3): 77-84.
28. Silva TLL, Becker FS, Toguchi MY, Boas EVBV, Damiani C. [Technological applicability of dog marmalade fruit (*Alibertia sessilis* Schum.)]. Rev Bras Produtos Agroindustriais. 2013; 15(3): 263-71. Doi: http://dx.doi.org/10.15871/1517-8595/rbpa.v15n3p263-271
29. Pereira CMT, Silva DL, Leal GF, Martins GAS, Pires CRF. [Quantitative descriptive sensory analysis of gabiroba jelly (*Camponesia cambessedeana*)]. Rev Desafios. 2020; 7: 1-10. Doi: http://dx.doi.org/10.20873/uftsupl2020-803
30. Soares CMS. [Integral characterization of the guapeva fruit (*Pouteria cf. Guardneriana radlk*) and processing of its pulp in the form of jelly]. Palmas. Dissertation [Master in Food Science and Technology] - Universidade Federal do Tocantins, 2019.
31. Brandão TM. [Vacuum processing and storage of mixed dietary and functional candy from Cerrado fruits]. Lavras. Thesis [PhD in Food Sicence] - Universidade Federal de Lavras; 2015.
32. Lima ICGS, Meleiro CHA. [Development, physicochemical and sensory evaluation of jelly and cut candy from seriguela (*Spondias purpurea* L.) aiming at the growth of the fruit's production chain]. CEPPA. 2012; 30(2): 221-32. Doi: http://dx.doi.org/10.5380/cep.v30i2.30495
33. Nogueira JP, Jesus MACL. [Development, physicochemical, sensory, and colorimetric evaluation of diet seriguela jelly]. Rev Bras Tecnol Agroind. 2014; 8(2): 1531-44. Doi: http://dx.doi.org/10.3895/S1981-36862014000200007S1
34. Almeida RD. [Technology for industrial production of umbuzada cutting]. Campina Grande. Thesis [PhD in Process Engineering] - Universidade Federal de Campina Grande; 2016.
35. Castro CDPC, Rybka ACP. [Sensory acceptance of umbu jam with licuri almonds]. Research and Development Bulletin. Embrapa Semiarid Technical Report. Petrolina (PE): Embrapa Semiárido; 2018.
36. Souza HRS, Santos AM, Ferreira IM, Silva AMO, Nunes TP, Carvalho MG. [Elaboration and quality evaluation of umbu (*Spondias tuberosa* Arr. C.) and mangaba (*Hancornia speciosa* G.) jelly with functional claim]. Segur Aliment Nutr. 2018; 25(3): 104-113. Doi: https://doi.org/10.20396/san.v25i3.8652496
37. Oliveira ENA, Santos DC, Rocha APT, Gomes JP. [Development, characterization and stability of traditional umbu-caja jelly]. Rev Bras Frutic. 2014; 36(3): 628-39. Doi: https://doi.org/10.1590/0100-2945-366/13

38. Novais Júnior MM, Ferreira LG, Fonseca AAO, Cardoso RL, Hansen DS. [Development of wild passion fruit jelly (*Passiflora cincinnata*): microbiological, physical, chemical characterization and stability study]. Braz J Dev. 2020; 6(7): 43403-14. Doi: https://doi.org/10.34117/bjdv6n9-090
39. Caetano PK, Daiuto ÉR, Vieites RL. [Physicochemical and sensory characteristics of jelly made with acerola pulp and juice]. Braz J Food Technol. 2012; 15(3): 191-7. Doi: https://doi.org/10.1590/S1981-67232012005000011
40. Castro G, Lopes AH, Silva DAPT, Gorayeb TCC. [Preparation of fruit jelly with chili pepper (*Capsicum baccatum* var. Pendulum)]. Rev Agronegócio. 2016; 5: 45-57.
41. Brasil. [Collegiate board resolution nº 263, of september 22, 2005]. Technical regulation for cereal products, starches, flours and bran. Diário Oficial da União 23 set 2005.
42. Engel B, Baccar NM, Marquardt L, Oliveira MSR, Rohlfes ALB. [Atomization and dehydration technologies: alternatives for the production of flours from vegetables]. 2016; 6(1): 31-44. Doi: https://doi.org/10.17058/rjp.v6i1.7345
43. Santana GS, Oliveira Filho JG, Egea MB. [Technological characteristics of commercial vegetable flours]. Rev Agric. Neotrop. 2017; 4(2): 88-95. Doi: https://doi.org/10.32404/rean.v4i2.1549
44. Albuquerque JG, Duarte AM, Conceição ML, Aquino JS. Integral utilization of seriguela fruit (*Spondias purpurea* L.) in the production of cookies. J Food Sci Technol. 2016; 38(3): 1-7. Doi: https://doi.org/10.1590/0100-29452016229
45. Ortolan AV, Eing KKC, Santos MMR, Candido CJ, Santos EF, Novello D. [Addition of baru flour in cupcakes: physicochemical and sensory characterization among children]. O mundo da Saúde. 2016; 40(2): 213-20. Doi: 10.15343/0104-7809.20164002
46. Silva CLM, Santos TC, Oliveira MLP, Silva LMSF, Araújo CIA, Jesus CA, et al. [Centesimal composition of cookies added with *Caryocar brasiliense* Camb. (Caryocaraceae) flour]. Cad Ciências Agrárias. 2018; 10(2): 78-82.
47. Paglarini CS, Queirós MS, Tuyama SS, Moreira ACV, Chang YK, Steel CJ. Characterization of baru nut (*Dipteryx alata* Vog) flour and its application in reducet-fat cupcakes. J Food Sci Technol. 2018; 55(1): 164-72. Doi: https://doi.org/10.1007/s13197-017-2876-1
48. Morais RA, Melo KKS, Oliveira TTB, Teles JS, Peluzio JM, Martins GAS. [Chemical, physical and technological characterization of flour obtained from buriti (*Mauritia flexuosa* L. f.) peel]. Braz J Dev. 2019; 10(11): 23307-22. Doi: https://doi.org/10.34117/bjdv5n11-050
49. Resende LM, Franca AS, Oliveira LS. Buriti (*Mauritia flexuosa* L. f.) fruit by-products flours: Evaluation as source of dietary fibers and natural antioxidants. Food Chem. 2019; 270: 53-60. Doi: 10.1016/j.foodchem.2018.07.079.
50. Gomes RC, Coimbra KLF, Silva ASS, Silva Júnior ACS. [Development and characterization of bread Enriched with buriti (*Mauritia flexuosa* L.) flour]. Pubvet. 2020; 14(1): 1-5.
51. Pereira MM, Oliveira ENA, Almeida FLC, Feitosa RMF. [Processing and physicochemical characterization of shortbread cookies made with jatoba flour]. Rev Bras Tecnol. Agroind. 2016; 10(2): 2137-49. Doi:10.3895/rbta.v10n2.3905
52. Silva CP, Freitas AMS, Sampaio GR, Santos MCB, Nascimento TP, Cameron LC, et al. Identification and action of phenolic compounds of Jatoba-do-Cerrado (*Hymenaea stignocarpa* Mart.) on α-amylase and α-glucosidase activities and flour on glycemic response and nutricional quality of breads. Food Res Int. 2018; 116: 1076-83. Doi: https://doi.org/10.1016/j.foodres.2018.09.050
53. Cardoso DR, Pinto LIF, Lima MA, Soares IF, Rocha FPS, Silva RA. [Technological potential and composition of jenipapo (*Genipa americana* L.) flour obtained by convective drying]. Braz J Dev. 2020; 6(6): 33448-67. Doi: https://doi.org/10.34117/bjdv6n6-050
54. Silva JS. [Food bars with marolo (*Annona crassiflora* Mart) pulp flour: characterization and shelf life]. Goiânia. Dissertation [Master in Food Science and Technology] – Universidade Federal de Goiás, 2016.
55. Leão DP, Franca AS, Oliveira LS, Bastos R, Coimbra MA. Physicochemical characterization, antioxidant capacity, total phenolic and proanthocyanidin contente of flours prepared from pequi (*Caryocar brasiliense* Camb.) fruit by-products. Food Chem. 2017; 225: 146-53. Doi: https://doi.org/10.1016/j.foodchem.2017.01.027
56. Reis Filho J, Lustosa IBS, Sampaio RMM, Moreira MR, Morais VD, Souza VSS. [Improvement of the nutritional value of brownie using outer mesocarp flour of pequi (*Caryocar brasiliense* Camb)]. Motricidade. 2018; 14(1): 196-204.
57. Silva CLM, Santos TC, Oliveira MLP, Silva LMSF, Araújo CIA, Jesus CA, et al. [Centesimal composition of cookies added with *Caryocar brasiliense* Camb. (Caryocaraceae) flour]. Cad Ciências Agrárias. 2018; 10(2): 78-82.
58. Silva CLM, Santos TC, Oliveira MLP, Silva LMSF, Vieira CR. [Sensory acceptance of cookies added with pequi (*Caryocar Brasiliense*) flour]. Global Sci Technol. 2018; 11(3): 49-56.
59. Morais EC, Patias SGO, Ferreira NSS, Picanço N, Rodrigues EC, Nascimento E, et al. [Bioactive compounds and physicochemical characteristics of fresh and pasteurized araticum pulp]. Braz J Food Technol. 2017; 20. Doi: https://doi.org/10.1590/1981-6723.14216
60. Silva LL, Cardoso LM, Pinheiro-Sant'ana HM. [Influence of blanching, pasteurization and freezing on the physicochemical characteristics, carotenoids and vitamin A value of araticum (*Annona crassiflora* Mart.) pulp]. Rev Inst Adolfo Lutz. 2015a; 74(1): 30-8.
61. Rodrigues AMC, Bezerra CV, Silva IQS. [Rheological properties of buriti (*Mauritia flexuosa*) juice]. Rev Bras Frutic. 2016; 38(1): 176-86. Doi: https://doi.org/10.1590/0100-2945-290/14

62. Garcia L, Becker S, Damiani C. [Buriti (*Mauritia flexuosa*) nectar: the functional beverage of the Cerrado]. Rev Verde Agroecol. Desenv Sustentável. 2015; 10(1): 263-8. Doi: https://doi.org/10.18378/rvads.v10i1.2778
63. Assumpcao C, Bachiega P, Santana ATMC, Morzelle M, Boas V, Souza EC. [Mixed nectar of mangaba (*Hancoria speciosa* Gomes) and cagaita (*Eugenia dysenterica*): sensory profile and physicochemical characteristics]. Rev Bras Produtos Agroind. 2013; 15(3): 219-24. Doi: http://dx.doi.org/10.15871/1517-8595/rbpa.v15n3p219-224
64. Martins HD, Perfeito DGA, Silva AR, Peixoto N. [Characterization and study of the physical stability of sweetened mixed juice of mangaba and cagaita]. Rev Agric Neotropical. 2017; 4(2): 81-7. Doi: https://doi.org/10.32404/rean.v4i2.1542
65. Silva CL. [Development and physicochemical evaluation of nectars based on gabiroba (*Campomanesia pubescens*) at different storage periods]. Uberlândia. Dissertation [Professional Master in Food Science and Technology] - Instituto Federal de Educação, Ciência e Tecnologia do Triângulo Mineiro; 2015.
66. Lima BP, Perfeito DGA, Carvalho N, Siqueira APS, Schmidt FL. [Sensory evaluation of mangaba-based beverage]. Multi-Science J. 2017; 1(8): 1-3.
67. Lima LLA, Silva AMO, Ferreira IM, Carvalho TPNMG. [Mixed nectar of umbu (*Spondias tuberosa* Arr. Câmera) and mangaba (*Hancornia Speciosa* Gomes): preparation and quality evaluation]. Braz J Food Technol. 2018; 21: 1-8. Doi: https://doi.org/10.1590/1981-6723.03417
68. Sousa ABB, Nascimento APS, Araújo AKP, Almeida RD, Cavalcanti ASRRM, Duarte MEM. [Physicochemical characterization of mixed ceriguela pulp with *Spirulina platensis* dried by freeze-drying]. Rev Bras Produtos Agroind. 2018; 20(3): 281-8.
69. Silva MI, Martins JN, Alves JEA, Costa FFP. [Physicochemical characterization of umbu pulp in foam layer]. Rev Semiárido Visu. 2015b; 3(2): 82-91.
70. Bastos J, Martínez E, Souza S. [Physicochemical characteristics of commercial umbu (*Spondias tuberosa* Arruda Câmara) pulp: concentration effect]. J Bioenergy Food Sci. 2016; 3(1): 11-6. Doi: 10.18067/jbfs.v3i1.48
71. Santos MB, Cardoso RL, Fonseca AAO, Conceição MN, Neto ADA. [Physicochemical and microbiological evaluation of umbu-caja fruit pulp, by combined methods]. Rev Magistra. 2013; 25(1): 7-13.
72. Oliveira SND. [Freeze-drying of wild passion fruit (*Passiflora cincinnata* Mast.) pulp for the production of food products]. Campina Grande. Thesis [PhD in Agricultural Engineering] - Universidade Federal de Campina Grande; 2016.
73. Santos EKR. [Production and evaluation of stock of probiotic beverages, fermented and unfermented, based on Caatinga passion fruit (*Passiflora cincinnata* Mast.) pulp and pectin]. Recife. Dissertation [Master in Industrial Biotechnology] - Universidade Federal de Pernambuco; 2017.
74. Silva JLA, Dantas CEA. [Alcoholic fermented of umbu: production, fermentation kinetics and physicochemical characterization]. Holos. 2017; 2: 108-21. Doi: https://doi.org/10.15628/holos.2017.4506
75. Brasil. [The law n° 8.918, of july 14, 1994]. Provides for the standardization, classification, registration, inspection, production and supervision of beverages. Diário Oficial da União 14 jul 1994.
76. Almeida FLC, Oliveira ENAD, Almeida EC, Silva LND, Santos YMGD, Luna LC. [Sensory study of alcoholic beverages from mangaba (*Hancornia speciosa* Gomes)]. Braz J Food Technol. 2020; 23: 1-9. Doi: https://doi.org/10.1590/1981-6723.20819
77. World Health Organization (WHO). 2018. [Global status report on alcohol and health]. Acessed: jan 15, 2021. Available from: https://www.paho.org/annual-report-of-the-director-2019/pt/.
78. Bizinoto CS. [Development of alcoholic fermented beverage from murici (*Byrsonima crassifolia* (L.) Kunth)-malpighiaceae]. Uberaba. Dissertation [Professional Master in Food Science and Technology] - Instituto Federal do Triângulo Mineiro; 2017.
79. Valério Júnior MFR. [Study of co-culture between *Saccharomyces cerevisiae* and *Saccharomyces kudriavzevii* for the development of an alcoholic fermented beverage based on cagaita (*Eugenia dysenterica* DC.)]. Goiânia. Dissertation [Master in Chemical Engineering] - Universidade Federal do Goiás; 2018.
80. Alves HO. [Obtaining and physicochemical analysis of the alcoholic distillate from cajarana (*Spondias* sp) in the semi-arid region of Paraiba]. Patos. Dissertation [Master in Forest Sciences] - Universidade Federal de Campina Grande; 2011.
81. Melo RM. [Characterization of chemical attributes of substrates and seedling development of *Campomanesia adamantium* (Cambess) O. Berg in response to liming and nutritional characterization of the native fruit and the elaborated liqueur]. Dourados. Dissertation [Master in Agronomy] – Faculdade de Ciências Agrárias, Universidade Federal da Grande Dourados; 2017.
82. Carvalho WR, Gonçalves MA, Damiani C, Silva FA, Caliari M, Silva YPA, et al. [Cerrado cashew liquor: production and physical and chemical analyses]. Rev Processos Químicos. 2009; 3(6), 31-5. Doi: https://doi.org/10.19142/rpq.v03i06.p31-35.2009.
83. Corrêa RJL, Ferreira Júnior EDS, Ferreira KFM, dos Santos SDFF, Cantanhede WC, Nova LDSC, et al. [Production and physicochemical analysis of spirit obtained from buriti pulp]. Braz J Dev. 2020; 6(3): 9789-95. Doi: https://doi.org/10.34117/bjdv6n3-017
84. Santos CDO. [Evaluation of the use of enzymatically hydrolyzed black rice (*Oryza sativa* L.) as an adjunct in beer brewing]. Lorena. Dissertation [Master in Sciences] – Universidade de São Paulo; 2011.
85. Lubas CCS, Cândido CJ, Souza SVS, Guimarães RCA. [Nutritional quality of chocolate bars added with baru nuts]. Multitemas. 2016; 21(49): 181-92. Doi: https://doi.org/10.20435/multi.v21i49.812

86. Coelho RRP, Câmara APC, Araújo LF, Matos JDP, Coelho TJS. [Development and sensory evaluation of caja-manga ice cream]. Braz J Dev. 2020; 6(4): 20002-11. Doi: https://doi.org/10.34117/bjdv6n4-246
87. Pinho L, Mesquita DSR, Sarmento AF, Flávio EF. [Enrichment of ice cream with baru (*Dipteryx alata* Vogel) almond and consumer acceptance]. Rev Unimontes Científica. 2015; 17(1): 39-49.
88. Santos GG, Silva MR, Lacerda DBCL, Martins DMO, Almeida RA. [Acceptability and physicochemical quality of peanut candy made with baru almonds]. Pesqui Agropecu Trop. 2012; 42(2): 159-65. Doi: https://doi.org/10.1590/S1983-40632012000200003
89. Silva RR, Monteiro SS, Rosa CS. [Development of cookies formulated with pequi (*Caryocar brasiliense* Camb.) almonds compared to chocolate cookies]. Rev Bras Produtos Agroind. 2014; 16(1): 77-82. Doi: http://dx.doi.org/10.15871/1517-8595/rbpa.v16n1p77-82
90. Lemos LCS, Cavalcante ACFPS, Cândido CJ, Guimarães RCA, Siroma PAH. [Sensory evaluation, microbiological analysis and bioactive compounds of cookie developed with beer bagasse and baru nuts]. Braz J Dev. 2019; 5(12): 31030-41. Doi: https://doi.org/10.34117/bjdv5n12-207
91. Souza DG, Silva MAP, Moura LC, Dias LG, Plácido GR, Caliari M, et al. [Physicochemical and sensory parameters of fresh cheeses flavored with pequi (*Caryocar brasiliense* Camb)]. Global Sci Technol. 2017; 10(01): 105–11.
92. Gonçalves NM, Ferreira IM, Silva AMO, Carvalho MG. [Yogurt with caja jam (*Spondias mombin* L.) added with probiotics: microbiological evaluation and sensory acceptance]. Rev Bras Hig Sanidade Anim. 2018; 12(2): 169-78.
93. Braga RC, Monteiro LLL, Nascimento KKB, Silva FMR, Lima AF. [Preparation and characterization of siriguela (*Spondias purpurea*) mousse added with bee pollen]. Conexões Ci Tecnol. 2019; 13(5): 85-90. Doi: https://doi.org/10.21439/conexoes.v13i5.1817